APPENDIX A

UPLAND BERA ENVIRONMENTAL CHEMISTRY DATA USABILITY ASSESSMENT

UPPER COLUMBIA RIVER

FINAL
Appendix A
Upland BERA Environmental Chemistry Data Usability Assessment

December 2023

CONTENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

μm	micrometer(s)
BERA	baseline ecological risk assessment
cm	centimeter(s)
COPC	chemical of potential concern
DU	decision unit
DUA	data usability assessment
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
FS	feasibility study
HHRA	human health risk assessment
ICS	incremental composite sampling
IVBA	in vitro bioaccessibility
mm	millimeter(s)
RI	remedial investigation
TAI	Teck American Incorporated
TOC	total organic carbon
UCR	Upper Columbia River

1 INTRODUCTION

This appendix presents the data usability assessment (DUA) for environmental chemistry data conducted by Teck American Incorporated (TAI) and U.S. Environmental Protection Agency (EPA) to support the baseline ecological risk assessment (BERA) for the Terrestrial Study Area[1] of the Upper Columbia River (UCR) site (hereinafter, the site[2]). The DUA is a critical predecessor to conducting analyses for ecological risk assessments (ERAs) (EPA, 1998). This appendix presents the approach and findings of the environmental chemistry DUA for the Terrestrial Study Area. It establishes the environmental chemistry data set that is suitable and of acceptable quality for use in conducting the BERA for the Terrestrial Study Area (hereinafter, the Upland BERA).

For the most part, the information in this appendix is consistent with information presented in the draft final version of Appendix A in the draft final Upland BERA prepared by TAI (2023), with the following exceptions:

- Clarifications to the definitions of "site" and Terrestrial Study Area to match terminology used in the main text of the final Upland BERA.
- Removal of references to a remote-sensing DUA and presentation of remote-sensing analyses for plants in a separate appendix. Remote-sensing evaluations are not presented in the final Upland BERA.
- Reassessment of the usability of the 2012 Washington State Department of Ecology (Ecology) soil data based on recently released study documentation (chains of custody and laboratory reports). The 2012 Ecology data, which had been identified as "conditionally acceptable" in the draft final DUA appendix, are now identified as "acceptable" in this DUA.

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[1] The term "Terrestrial Study Area" refers to the upland terrestrial habitat of the UCR Site. Though it has yet to be fully defined, the upland area is commonly described as land above the elevations of historical Columbia River flood events and within the approximate footprint of metals deposition associated with historical smelter aerial emissions. For the purposes of the Upland BERA, the upland area is operationally defined as the spatial extent of the upland soil data set used for ecological risk analysis. The geographical extent of the Terrestrial Study Area is expected to be established by analyses presented in the Draft Final Upland Remedial Investigation (RI) Report, which is currently under EPA review.

[2] As defined within the Settlement Agreement of June 2, 2006, the site consists of the areal extent of hazardous substances contamination within the United States in or adjacent to the Upper Columbia River, including the Franklin D. Roosevelt Lake, from the U.S.-Canada border to the Grand Coulee Dam, and all suitable areas in proximity to the contamination necessary for implementation of response actions.

This DUA is focused on site-specific environmental chemistry data used to calculate exposure estimates in the Upland BERA. A separate soil background evaluation DUA was conducted to establish background threshold values for metals in soil in the Upland BERA. The soil background data set is briefly summarized in Section 2.4.1.2 of the Upland BERA and described in detail in the background assessment technical memorandum (TAI, 2020a); this data set underwent a separate DUA in the soil background evaluation.

2 APPROACH

A four-step process was implemented to assess data usability for the Upland BERA, consistent with EPA's *Guidance for Data Useability in Risk Assessment* (EPA, 1992). The four steps are:

Step 1: Data inventory. Identify all studies with data potentially relevant for use in the BERA.

Step 2: Data quality assessment. Assess whether data identified in Step 1 are of acceptable quality for use in an ERA.

Step 3: Data suitability assessment. Assess relevance of sampling locations and types of measurements and the reliability of sampling and analytical methods relative to the risk questions.

Step 4: Data comparability assessment. Determine whether data collected from different studies or using different methods can be combined for specific evaluations.

The data inventory and data quality assessment (Steps 1 and 2) assess whether relevant environmental chemistry data are available and of acceptable quality to be used in specific risk assessment applications (discussed in Sections 3.1 and 3.2 of this appendix). Data found to be of acceptable quality are carried forward to the data suitability assessment (Step 3).

Step 3 (Section 3.3 of this appendix) evaluates whether data that are of sufficient quality are suitable for answering the risk questions for the Upland BERA (Section 2.6.2 of the BERA). Section 3.3 provides a decision on the overall suitability of data set within a given study based on the relevance of sampling and analytical methods. Other types of suitability considerations for specific data within a study (e.g., whether certain soil size fractions within a data set are suitable for use in specific analyses) are determined prior to each analysis (Sections 4.1 of the Upland BERA for the receptor exposure assessment, Attachment E3 in Appendix E for the in vitro bioaccessibility [IVBA] assay data, and Appendix C for bioaccumulation data).

In Step 4, the data comparability assessment (Section 3.4 of this appendix), methods for sample collection, handling, and analyses are evaluated to determine whether data sets from different studies are similar enough in study design and analytical method to be combined for a specific analysis and whether such combinations are appropriate given the particular analysis being conducted. If it is not appropriate to combine data sets, decisions about how each data set will be used separately to answer specific risk questions will be based on their relevance and reliability.

3 ENVIRONMENTAL CHEMISTRY DATA USABILITY

This section documents the Upland BERA DUA for soil chemistry data (total metals and associated conventional parameters), IVBA data, and co-located soil and biota tissue metal concentration data. The following sections document the four data usability steps conducted for each of these three data types.

3.1 STEP 1 – ENVIRONMENTAL CHEMISTRY DATA INVENTORY

All environmental chemistry data reported in the Screening-Level Ecological Risk Assessment (TAI, 2010), the BERA Work Plan (TAI, 2011), chemical of potential concern (COPC) refinement documents (TAI, 2019a, 2020b), and any relevant UCR environmental chemistry data collected since the COPC refinement were subjected to preliminary screening, as described in the following subsections. All data that passed the preliminary screening are included in the inventoried environmental chemistry data set for the Upland BERA.

3.1.1 Soil Chemistry Data

Soil chemistry data were screened for grain size, sample depth, and sample media type and/or location relative to the pre-1973 max flood extent of the river, described as follows:

- **Grain size.** Only studies with soil samples sieved to less than 2 millimeters (mm) prior to chemical analysis are included in the Upland BERA soil chemistry data inventory. Studies with data representing only the fine-grained fraction of soil samples (i.e., less than 150-micrometer [µm] samples collected specifically for use in the human health risk assessment [HHRA]) are not included.

- **Soil sample depth horizon.** Only studies with soil samples collected from depth intervals between 0 and 12 inches are included in the Upland BERA soil chemistry data inventory. The sampling depth of 0 centimeter (cm) to 25 to 30 cm (0 inch to approximately 10 to 12 inches) is defined by EPA (2015) as the "biotic zone" relevant for estimating exposure to plants and soil-dwelling ecological receptors.

- **Sample media and location.** Only studies with soil samples collected from locations above the pre-1973 maximum flood extent of the river are included in the soil chemistry data inventory. Studies in which samples were collected only below the pre-1973 maximum flood extent topographic elevations (i.e., low-elevation soil samples or beach sediment samples) or samples that were classified as sediment are not included for the Upland BERA. Soil and sediment samples collected below the pre-1973 maximum flood extent will be considered in the Aquatic BERA (Section 1 of the Upland BERA).

Eleven studies were considered for inclusion in the soil chemistry data inventory (Table A-1). Seven studies were eliminated because they did not meet the screening criteria listed as follows:

- Insufficient information was available for the Teck Cominco ERA Biomonitoring Program (Cominco, 1998) and the trail vegetation recovery study (Archibold 1974, 1978) to determine whether any of the criteria were met.
- The two residential soil studies (TAI, 2017; CH2M, 2016) and the 2018 Plant Tissue Study (TAI, 2019b) were excluded because only samples sieved to less than 150 µm were analyzed.
- The beach sediment and Northport RI studies (TAI, 2014b; Ecology, 2019) were excluded because the sample medium was sediment and/or the soil sampling locations were below the pre-1973 max flood extent of the river.

The four studies included in the soil chemistry data inventory were the Le Roi Removal Action Study (EPA, 2005), the 2014 UCR Upland Soil Study (TAI, 2015), the 2012 Ecology Upland Soil Study (Ecology, 2013), and the 2015 Bossburg Study (TAI, 2016) (Table A-1).

Table A-2 documents sample collection methods and dates, numbers of samples and field duplicates, parameters analyzed, analytical methods, and data validation procedures for the four soil studies in the soil chemistry data inventory.

3.1.2 In Vitro Bioaccessibility Data

A preliminary data screen was applied to determine which data sets were relevant for inclusion in the IVBA data inventory. IVBA studies were considered relevant if IVBA data were collected for samples included in the soil chemistry data inventory, regardless of grain size fraction (Attachment E3 to Appendix E of the Upland BERA for rationale). IVBA studies were also considered relevant if any sediment or soil samples had data for both IVBA lead and pH or both IVBA zinc and total organic carbon (TOC) (regardless of sample location or grain size) because these data were used in regression equations to estimate IVBA for samples not analyzed by IVBA assay (Attachment E3 to Appendix E for method description and rationale).

Five studies involved the collection of IVBA data. Two of these studies were excluded (the EPA and TAI residential soil studies) because they were not in the soil chemistry data inventory and TOC and/or pH data were not available for developing regressions. The remaining three studies with IVBA data passed through the IVBA screening process and were therefore included in the IVBA data inventory, as follows:

- **2009-2011 Beach Sediment Study.** Samples were analyzed for lead IVBA and pH.
- **2014 UCR Upland Soil Study.** Samples were analyzed for IVBA (all metals), pH, and TOC.
- **2015 Bossburg Study.** Samples were analyzed for lead, IVBA, and pH.

Table A-3 documents sample collection methods and dates, numbers of samples and field duplicates, parameters analyzed, analytical methods, and data validation procedures for the three studies in the IVBA data inventory.

3.1.3 Bioaccumulation Data

Studies were considered usable for bioaccumulation modeling, regardless of soil grain size, if co-located data were collected for biota tissue and soil (Table A-1). The only study with relevant data was the 2018 Plant Tissue Study (TAI, 2019b) because plants were the only terrestrial biota sampled. Table A-4 documents sample collection methods and dates, numbers of samples and field duplicates, parameters analyzed, analytical methods, and data validation procedures for the 2018 Plant Tissue Study.

3.2 STEP 2 – DATA QUALITY ASSESSMENT

The data quality assessment included a review of the 10 data quality documentation items presented in Table A-5, which align with the data usability criteria defined by EPA (1992).[3] The data validation stage was determined based on the EPA data validation checks listed in Table A-6. The outcome of the review is a data use recommendation for each study with the following categories:

- **Acceptable.** All necessary documentation is available; the review confirmed that the study data are of adequate quality for use in a risk assessment.
- **Conditionally acceptable.** There are gaps or deficiencies in the available study documentation, precluding review; however, the review of available documentation did not identify any significant data quality issues that would disqualify its use in a risk assessment.

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[3] See Exhibit 61 in EPA's Guidance for Data Useability in Risk Assessments (Part A) (EPA, 1992).

- **Not acceptable.** Significant deficiencies exist in available documentation, or available documentation indicates that data are not of sufficient quality to support use in a risk assessment.

The findings of the data quality evaluation are presented in Table A-7. The following sections describe the results for each of the three data types.

3.2.1 Soil Chemistry

Data quality documentation were present for all three soil studies and the data were deemed acceptable for use in the Upland BERA. These three studies (Ecology, 2013; TAI, 2015, 2016) are evaluated further in the data suitability assessment (Section 3.3.1 of this appendix). The Le Roi Removal Action Study (EPA, 2005) is not acceptable due to a lack of available documentation and is not carried through to the suitability assessment (Table A-7).

3.2.2 In Vitro Bioaccessibility Data

None of the IVBA data sources are missing any data documentation items, and all are acceptable for use in the Upland BERA (Table A-7). The three studies (TAI, 2014b, 2015, 2016) are evaluated further in the data suitability assessment (Section 3.3.2 of this appendix).

3.2.3 Bioaccumulation Data

All relevant data quality documentation items are available for the 2018 Plant Tissue Study (TAI, 2019b). This data source is acceptable for use in the Upland BERA and is evaluated in the data suitability assessment (Section 3.3.3 of this appendix).

3.3 STEP 3 – DATA SUITABILITY ASSESSMENT

The suitability of data for use in the BERA is dependent on the analysis objectives. Therefore, the first step in a suitability evaluation is to define the objectives of the analysis that will use the data. As described in the RI/Feasibility Study (FS) Work Plan (EPA, 2008) for the UCR, the objective of the Final Upland BERA is to assess potential risks posed by hazardous substances in soils to terrestrial ecological assessment endpoints within the Terrestrial Study Area of the site under baseline conditions (EPA, 1998, 2016) and provide a basis for informed discussions with risk managers about the causes, nature, and extent of any such risks. A data suitability evaluation based on these objectives, as well as the risk questions presented in Section 2.6.2 of the Upland BERA, is presented in this section.

3.3.1 Soil Chemistry

Soil chemistry data are used to estimate the exposure of terrestrial receptors to COPCs. Data from the 2014 UCR Upland Soil Study (TAI, 2015) were collected from the aerial deposition area, relict floodplain deposition areas, and windblown sediment deposition areas using the incremental composite sampling (ICS) method, which consisted of 30 increments collected and composited within approximately 25-acre (approximately 10 hectares) decision units (DUs) (TAI, 2014a). All sampled DUs are considered potential habitat for terrestrial receptors. However, any exposure of terrestrial receptors in relict floodplain and sediment deposition areas will be addressed in the Aquatic BERA (Section 1 of the Upland BERA); therefore, samples from these locations are not suitable for inclusion in the Upland BERA. The aerial deposition area is located above the pre-1973 max flood extent of the river, so samples from this area are suitable for use in the Upland BERA. Chemical analyses were performed on the less than 2-mm size fraction of incremental composite samples specifically to evaluate ecological risk; thus, data for the less than 2-mm size fraction are suitable for use in the Upland BERA.

As in the 2014 UCR Upland Soil Study, soil samples from the 2015 Bossburg Study were collected from DUs using the ICS method (TAI, 2016). The six sampled upland soil DUs are potential habitat for terrestrial receptors and are located at or above the pre-1973 max flood extent of the river; therefore, samples from these DUs are suitable for use in the Upland BERA. Exposure of terrestrial receptors to Bossburg Flat Beach sediment will be addressed in the Aquatic BERA (Section 1 of the Upland BERA). Analytical data from the less than 2-mm soil fraction were collected specifically to evaluate risk to ecological receptors, so data from this size fraction are suitable for use in the Upland BERA. The vertical profile core samples co-located with the ICS method samples in the 2015 Bossburg Study are not suitable for use in the BERA because they are considered geographically redundant and not as representative of ecological receptor's exposures as the samples collected using ICS methods in this study.

Data from the 2012 Ecology Upland Soil Study (Ecology, 2013) were collected from areas near the U.S.-Canada border. Samples were collected using a four-point composite approach for areas within an approximately 20-foot radius from a fixed point; samples were sieved to less than 2 mm prior to analysis and analyzed using standard, EPA-approved analytical methods (Ecology, 2013). Ecology did not identify ERA as a primary or secondary use of its data (e.g., data quality objective). Therefore, method detection limits and method reporting limits were not compared to soil screening levels to evaluate whether analytical methods were adequately sensitive for ERA. This could impact the data's suitability for certain receptor-metal combinations, but in general, the study is considered suitable for use in the Upland BERA. Similar to the 2015 Bossburg Study, the vertical profile core samples co-located with the composite samples in the 2012 Ecology Upland Soil Study are considered geographically redundant and less representative of ecological receptor exposures, and are thus not considered suitable for use in the Upland BERA.

3.3.2 In Vitro Bioaccessibility Data

IVBA data are used to estimate the bioavailability of metals in soil to wildlife receptors. A subset of soil samples from the 2014 UCR Upland Soil Study and all soil samples from the 2015 Bossburg Study were analyzed for IVBA using the Ruby Bioavailability method (EPA, 2017). The less than 149-µm and less than 150-µm size fractions were analyzed for IVBA, whereas the total metals fraction (used to estimate exposure in the BERA) was analyzed in the less than 2-mm size fraction. The IVBA data for the smaller size fraction are suitable for estimating the bioavailability of metals in the larger size fraction (see Attachment E3 of Appendix E for reasoning).

IVBA data are not available for all samples in the soil chemistry data set. However, regression relationships were established for pH/lead and TOC/zinc, as described in Appendix E (Attachment E3). Using these relationships, lead and zinc IVBA data can be estimated for the samples without IVBA data. All soil and sediment samples analyzed for IVBA data in the 2014 UCR Upland Soil Study and the 2009-2011 Beach Sediment Study area suitable for developing these regressions, as described in Appendix E (Attachment E3). All ICS samples from the 2015 Bossburg Study are suitable for developing these regressions; the core samples are geographically redundant and less relevant to wildlife exposures due to their greater depth, and thus are not considered suitable for use.

3.3.3 Bioaccumulation Data

Plant tissue and co-located soil data from the 2018 Plant Tissue Study (TAI, 2019b) were collected from Tribal allotments at the site for use in the RI/FS and HHRA. These data were collected from 12 sampling areas, which are not spatially representative of all the areas sampled as part of the 2014 UCR Upland Soil Study, the 2012 Ecology Upland Soil Study, or the 2015 Bossburg Study (see Map 2-1 of the BERA). Thus, these data are not suitable for direct use as wildlife dietary exposure estimates across the Terrestrial Study Area. However, because the data represent co-located soil and plant tissue data, these are suitable for use in modeling plant tissue concentrations for the Upland BERA. These data may lack relevance to ERA due to the soil sieve sizes and the sampled plant species and plant parts; a further discussion of the suitability of these data for bioaccumulation modeling is provided in Appendix C.

3.4 STEP 4 – DATA COMPARABILITY ASSESSMENT

This section discusses whether data collected from different studies or using different methods should be combined for specific evaluations, such as calculating exposure point concentrations.

3.4.1 Soil Chemistry

Soil data from the 2012 Ecology Upland Soil Study, the 2014 UCR Upland Soil Study, and the 2015 Bossburg Study can be used in the Upland BERA. However, the 2014 UCR Upland Soil Study and the 2015 Bossburg Study used the ICS method, compositing 30 soil sample increments from either approximately 25-acre or 1- to 3-acre areas (TAI, 2015, 2016), and the 2012 Ecology Upland Soil Study used a four-point composite sampling method in areas approximately 0.025 acre in size (Ecology, 2012). Because the three studies used different sample compositing methods to sample areas of substantially different sizes, the studies are not comparable. In addition, the samples were collected from different soil depths (0 to 7.5 cm for 2014 UCR Upland Soil Study samples and 2012 Ecology Upland Soil Study samples, and 0 to 15 cm for the 2015 Bossburg Study samples). Finally, the 2015 Bossburg Study soil samples were collected in a distinctly different area south of both the 2014 UCR Upland Soil Study samples and 2012 Ecology Upland Soil Study samples. Therefore, data from these three studies will not be combined for the purpose of calculating values such as exposure point concentrations for use in the Upland BERA.

The relative suitability of each of the three data sets for ERA, including the measurement of bioavailability parameters and the representativeness of the sample spatial areas, is discussed in further detail in Section 4.1.1 of the Upland BERA.

3.4.2 In Vitro Bioaccessibility Data

Sample-specific soil IVBA data collected for the 2014 UCR Upland Soil Study and 2015 Bossburg Study are comparable in terms of the ICS compositing and analytical chemistry methods, but different soil depths were collected (0 to 7.5 cm and 0 to 15 cm, respectively). Therefore, these data should not be combined for calculating area-wide bioavailability estimates.

The three studies with data considered suitable for IVBA regression analyses (2014 UCR Upland Soil Study, 2009-2011 Beach Sediment Study, and 2015 Bossburg Study) used the same analytical methods. Sampling methods differed slightly among studies, as follows:

- **2014 UCR Upland Soil Study.** Soil samples were collected using ICS from depths of 0 to 7.5 cm; samples were sieved to less than 149 μm.
- **2015 Bossburg Study.** Soil and sediment samples were collected using ICS from depths of 0 cm to 15 cm; soil samples were sieved to less than 150 μm, and sediment samples were sieved to less than 250 μm.
- **2009-2011 Beach Sediment Study.** Sediment samples were collected from depths of 0 cm to 15 cm; 60 randomly distributed locations on each beach were used to create five composite samples, and one composite sample from each beach was analyzed for IVBA; four grain size fractions were analyzed for IVBA: less than 63 μm, 63 to 125 μm, 125 to 250 μm, and 250 μm to 2 mm.

The rationale for combining these data to develop regression relationships is described in Appendix E (Attachment E3).

3.4.3 Bioaccumulation Data

The data comparability evaluation is not applicable to the 2018 Plant Tissue Study because only one study is included in the data inventory and analytical methods were applied consistently throughout the study.

3.5 CHEMISTRY DUA SUMMARY

This DUA evaluated the quality and suitability of available data for use in the Upland BERA, with the following summarized conclusions (Table A-8):

- **Soil chemistry data.** The 2012 Ecology Upland Soil Study, the 2014 UCR Upland Soil Study, and the 2015 Bossburg Study are relevant sources of soil chemistry data for use in the Upland BERA. These studies contain acceptable data. Only soil chemistry results from the less than 2-mm fraction of soil samples are suitable for evaluating ecological risk. In addition, all samples are suitable for use in the Upland BERA except those collected from relict floodplains, windblown sediment deposition areas, and other areas below the pre-1973 maximum flood extent of the river. The 2012 Ecology Upland Soil Study data set is not comparable to the 2014 UCR Upland Soil Study or the 2015 Bossburg Study data sets because of sample collection methods; therefore, data from these studies will not be combined in the Upland BERA.

- **IVBA data.** The 2014 UCR Upland Soil Study, the 2009-2011 Beach Sediment Study, and the 2015 Bossburg Study are included in the IVBA data inventory, either because co-located IVBA data were collected for samples included in the soil chemistry data set or because IVBA data could be used in regressions analyses to estimate bioavailability for soil samples for which IVBA data were not collected (i.e., co-located IVBA lead/pH and IVBA zinc/TOC data). All three studies have data of acceptable quality. The two studies with soil IVBA data for samples in the soil chemistry data set (the 2014 UCR Upland Soil Study and the 2015 Bossburg Study) are suitable for estimating bioavailability in soil samples but not comparable because of the different soil depths analyzed. Data from all three studies are suitable and comparable for use in developing regression relationships to estimate IVBA data where such data were not collected, with the exception of core samples, which are geographically redundant and less relevant to wildlife exposures than the ICS samples.
- **Bioaccumulation data.** Only one study—the 2018 Plant Tissue Study—collected co-located data that could be used in bioaccumulation modeling. This study has acceptable data quality and is suitable for use in modeling plant tissue concentrations for the Upland BERA.

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TABLES

Table A-1. Results of Data Inventory Screening

			Soil Chemistry Data				IVBA Data			Bioaccumulation Data		
Study Title	Study Name Used in Upland BERA	Study ID in UCR Project Data Base	Grain Size (< 2 mm)	Depth Horizon (0-12 in.)	Sample Media Type and Location Relative to Pre-1973 Max Flood Extent	Include in Inventory[a]?	Sample-Specific Data for Upland BERA Locations	Data Usable for Regressions	Include in Inventory[b]?	Co-located Soil and Tissue Data	Include in Inventory?	Relevant Citation
Vegetation recovery following pollution control at Trail, British Columbia	NA	Not in data base	na	na	na	No	NM	NM	No	NM	No	Archibold (1974, 1978)
Biomonitoring System Development for Cominco	NA	Not in data base	na	na	na	No	NM	NM	No	NM	No	Cominco (1998)
Le Roi Smelter Removal Action Report	Le Roi Removal Action Study	LeRoi2005	✓	✓	✓	Yes	NM	NM	No	NM	No	EPA (2005)
2009-2011 Beach Sediment Study	2009-2011 Beach Sediment Study	Teck_2009_BeachSD Teck_2010_BeachSD Teck_2011_BeachSD	✓	✓	NM	No	NM	✓	Yes	NM	No	TAI (2014b)
Upper Columbia River Upland Soil Sampling Study	2012 Ecology Upland Soil Study	HARTC13A	✓	✓	✓	Yes	NM	NM	No	NM	No	Ecology (2013)
Soil Study	2014 UCR Upland Soil Study	Teck_2014_UplandSoil	✓	✓	✓	Yes	✓	✓	Yes	NM	No	TAI (2015)
UCR Residential Soil Study	NA	USEPA_2014_ResSoil	NM	NM	✓	No	NM	NM	No	NM	No	CH2M (2016)
Bossburg Flat Beach Refined Sediment and Soil Study	2015 Bossburg Study	Teck_2015_Bossburg	✓	✓	✓	Yes	✓	✓	Yes	NM	No	TAI (2016)
2016 Residential Soil Study	NA	Teck_2016_ResSoil	NM	NM	✓	No	NM	NM	No	NM	No	TAI (2017)
Plant Tissue Study	2018 Plant Tissue Study	Teck_2017_PlantTissue	NM	✓	NM	No	NM	NM	No	✓	Yes	TAI (2019b)
2019 Northport Waterfront RI	NA	WADOE_2019A	na	✓	NM	No	NM	NM	No	NM	No	Ecology (2019)

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Teck American Incorporated (TAI). 2015. *Upper Columbia River Final Soil study Data Summary and Data Gap Report.* Prepared by Windward Environmental LLC, Seattle, WA.

Teck American Incorporated (TAI). 2016. *Upper Columbia River Final Bossburg Flat Beach Refined Sediment and Soil Study Data Summary Report.* Prepared by Windward Environmental LLC, Seattle, WA.

Teck American Incorporated (TAI). 2017. *Upper Columbia River Final Residential Soil Study Data Summary Report* . Prepared by Ramboll Environ, Exponent, Parametrix, and Windward Environmental LLC, Seattle, WA.

Teck American Incorporated (TAI). 2019b. *Upper Columbia River Final Plant Tissue Study Data Summary Report* . Prepared by Ramboll Environ, AECOM, and Parametrix, Seattle, WA.

U.S. Environmental Protection Agency (EPA). 2005. *Le Roi Smelter Removal Action Report, Northport, Stevens County, WA* . Prepared by Weston, Seattle, WA.

Washington State Department of Ecology (Ecology). 2013. *Upper Columbia River Upland Soil Sampling Study.* Prepared by Hart Crowser, Seattle, WA.

Washington State Department of Ecology (Ecology). 2019. R*emedial Investigation, Northport Waterfront* . Prepared by GeoEngineers, Spokane, WA. Draft-final.

[a] All criteria needed to be met for inclusion in the soil chemistry data inventory.

[b] Either of the two criteria needed to be met for inclusion in the IVBA data inventory.

Notes:

✓ indicates study criteria were met
< = less than
BERA = baseline ecological risk assessment
ID = identification
in. = inch(es)
IVBA = in vitro bioaccessibility
mm = millimeter(s)
na = not available
NA = not applicable
NM = criteria not met
RI = remedial investigation
UCR = Upper Columbia River

Table A-2. Inventory of Soil Chemistry Data

Study	Sampling Date(s) [1]	Media Type [1,3]	Number of Samples Excluding Field Replicates[1,5]	Number of Field Replicates[1,5]	Sample Collection Method(s) and Fractions [1,3]	Analyte Group(s) and Analytical Method(s) [1,6,9]	Analytical Laboratory(s) [1,6]	Data Validator [1,10]	Data Validation Stage [1,10; a]	Significant Analytical Issues [1,10]	Missing Documentation [1,2,3,4,5,6,7,8,9,10]	Relevant Citations
LeRoi Removal Action Study	5/2004-9/2004	Soil	Not clear; 192 properties sampled in and near Northport	Unknown	Not sieved 4 phases of sampling primarily using 5-point composites for residential and commercial properties and public lands; 0-1 in., 1-6 in., 6-12 in., 12-18 in., 18-24 in. depending on part of property sampled and property use (e.g., play area, garden area)	Select metals (arsenic, cadmium, copper, lead) (subset): EPA 6010B SPLP extract metals (subset): EPA 6010B TAL metals (subset): EPA CLP-SOW	Laucks Testing, Severn Trent, Bonner Analytical, Sentinel	EPA and Weston	Not specified; 2B inferred	None documented	coordinates for some locations, COCs, sample handling and field QA/QC sample information, DLs and RLs, lab reports and Form 1s	EPA (2005)
2012 Ecology Upland Soil Study	10/30/2012-11/10/2012	Soil	106 surface soil composite samples and 51 vertical profile samples	13 (surface soil replicates)	All samples sieved to ≤ 2 mm 8 to 10 surface soil samples collected in each of 13 subareas; 4-point composite approach (top 0-3 in. excluding groundcover); collected with stainless-steel tools Soil profiles up to 2 feet deep from each of 13 subareas: 0-3 in., 3-6 in., 6-12 in., 12-24 in.; collected from borehole excavated with auger, shovel, or trowel	TAL metals: EPA 6010C and 6020 Mercury: EPA 7471A TOC: Plumb (1981) Solids: SM 2540B pH: EPA 9045	ARI	Hart Crowser, Inc.	Not specified; 2B inferred	None	NA	Ecology (2012, 2013)
2014 UCR Upland Soil Study	9/8/2014-10/29/2014	Soil	142 from ADAs, 16 from RFAs, and 13 from WSDAs	66 (includes field splits, triplicates, and EPA splits)	Incremental composite sampling from 0-7.5 cm at 171 DUs, sieved to < 2 mm	TAL metals and molybdenum: EPA 6010 and 6020 Mercury: EPA 7471B Grain size (bulk soil only): PSEP pH (bulk soil only): EPA 9045D CEC: EPA 9080 TOC: ASTM D4129-05 Percent moisture: EPA 160.3	ALS	Environmental Standards, Inc.	2B (85%), 4 (15%)	None	NA	TAI (2015)
2015 Bossburg Study	4/14/2015-5/7/2015	Soil	6 incremental composite samples and 54 discrete core samples (3 separate depths at 18 locations)	4 (incremental composite samples; includes field splits, triplicates, and EPA splits), and 14 (core samples; includes field splits and EPA splits)	Incremental composite sampling from 0-15 cm at 6 DUs, sieved to < 2 mm discrete core samples up to 18 in. deep: 0-6.9 in., 6.9-12 in., and 12-18 in.; collected using a coring tool	TAL metals: EPA 6010C and 6020A Mercury: EPA 7471B Grain size (bulk soil only): PSEP pH (bulk soil only): EPA 9045D CEC: EPA 9080 TOC: ASTM D4129-05 Percent moisture: EPA 160.3	ALS	Environmental Standards, Inc.	2B (82%), 4 (18%)	None	NA	TAI (2016)

Sources:

Teck American Incorporated (TAI). 2015. *Upper Columbia River Final Soil study Data Summary and Data Gap Report.* Prepared by Windward Environmental LLC, Seattle, WA.
Teck American Incorporated (TAI). 2016. *Upper Columbia River Final Bossburg Flat Beach Refined Sediment and Soil Study Data Summary Report.* Prepared by Windward Environmental LLC, Seattle, WA.
U.S. Environmental Protection Agency (EPA). 2005. *Le Roi Smelter Removal Action Report, Northport, Stevens County, WA*. Prepared by Weston, Seattle, WA.
Washington State Department of Ecology (Ecology). 2012. *2012 Sampling and Analysis Plan Quality Assurance Project Plan Upper Columbia River Upland Soil Sampling Study.* Prepared by Hart Crowser, Seattle, WA. Final.
Washington State Department of Ecology (Ecology). 2013. *Upper Columbia River Upland Soil Sampling Study.* Prepared by Hart Crowser, Seattle, WA.

[a] See Table A-6 for data validation stages.
[1-10] - Superscript numbers (1-10) correspond to Item # in Table A-5 Chemistry Data Quality Documentation Items.
< = less than
≤ = less than or equal to
ADA = aerial deposition area
ALS = ALS Environmental Laboratory, Kelso, Washington
ARI = Analytical Resources, Inc.
ASTM = ASTM International (formerly American Society for Testing and Materials)
CEC = cation exchange capacity
cm = centimeter(s)
COC = chain of custody
DL = detection limit
DU = decision unit
EPA = U.S. Environmental Protection Agency
in. = inch(es)
mm = millimeter(s)
NA = not applicable
PSEP = Puget Sound Estuary Program
QA/QC = quality assurance/quality control
RFA = relict floodplain area
RL = reporting limit
SPLP = synthetic precipitation leach procedure
TAL = target analyte list
TOC = total organic carbon
WSDA = windblown sediment deposition area

Table A-3. Inventory of IVBA Data

Study	Sampling Date(s) ^{1}	Media Type ^{1,3}	Number of Samples Excluding Field Replicates^{1,5}	Number of Field Replicates^{1,5}	Sample Collection Method(s) and Fractions ^{1,3}	Analyte Group(s) and Analytical Method(s) ^{1,6,9}	Analytical Laboratory(s) ^{1,6}	Data Validator ^{1,10}	Data Validation Stage $^{1,10; a}$	Significant Analytical Issues ^{1,10}	Missing Documentation ^{1,2,3,4,5,6,7,8,9,10}	Relevant Citations
2009-2011 Beach Sediment Study	9/2009, 4/2010, 4/2011-5/2011	Sediment	33	6 (includes field and EPA splits)	Composites collected from 0-15 cm at 33 beaches, sieved to <63 µm, 63-125 µm, 125-250 µm, 250 µm-2 mm	Arsenic and lead: EPA 6010B, EPA 6020 IVBA (arsenic and lead): Ruby extraction: EPA 6020 pH (<2 mm fraction only): EPA 9045D TOC (<2 mm fraction only): D412982M	CAS Kelso, Pace Analytical	Environmental Standards Inc.	not specified; 2B (~70%) and 4 (~30%) inferred from QAPP	None	NA	TAI (2014b)
2014 UCR Upland Soil Study	9/8/2014-10/29/2014	Soil	25	14 (includes field splits, triplicates, and EPA splits)	Incremental composite sampling from 0-7.5 cm at 25 DUs, sieved to < 149 µm	TAL metals and molybdenum: EPA 6010C, 6020A mercury: EPA 7471B IVBA (TAL metals and molybdenum): Ruby extraction: EPA 6010C, 6020A, 7470A pH (bulk soil only): EPA 9045D TOC (<2 mm fraction only): ASTM D4129-05 Percent moisture: EPA 160.3	ALS	Environmental Standards Inc.	2B (85%), 4 (15%)	None	NA	TAI (2015)
2015 Bossburg Study	4/14/2015- 5/7/2015	Sediment	10	13 (includes field splits, triplicates, and EPA splits)	Incremental composite sampling from 0-15 cm at 10 DUs, sieved to < 250 µm	Arsenic and lead: EPA 6020A IVBA (arsenic and lead): Ruby extraction: EPA 6020A pH (bulk soil only): EPA 9045D TOC (<2 mm fraction only): ASTM D4129-05	ALS	Environmental Standards Inc.	2B (82%), 4 (18%)	None	NA	TAI (2016)
		Soil	6 incremental composite samples and 54 discrete core samples (3 separate depths at 18 locations)	4 (incremental composite samples; includes field splits, triplicates, and EPA splits), and 14 (core samples; includes field splits and EPA splits)	Incremental composite sampling from 0-15 cm at 6 DUs, sieved to < 2 mm Discrete core samples up to 18 in. deep: 0-6.9 in., 6.9-12 in., and 12-18 in.; collected using a coring tool							

Sources:
Teck American Incorporated (TAI). 2014b. *Upper Columbia River Final Beach Sediment Study Field Sampling and Data Summary Report.* Prepared by Integral, Portland, OR.
Teck American Incorporated (TAI). 2015. *Upper Columbia River Final Soil study Data Summary and Data Gap Report.* Prepared by Windward Environmental LLC, Seattle, WA.
Teck American Incorporated (TAI). 2016. *Upper Columbia River Final Bossburg Flat Beach Refined Sediment and Soil Study Data Summary Report.* Prepared by Windward Environmental LLC, Seattle, WA.

[a] See Table A-6 for data validation stages.
[1-10] - Superscript numbers (1-10) correspond to Item # in Table A-5 Chemistry Data Quality Documentation Items.
< = less than
µm = micrometer(s)
ALS = ALS Environmental Laboratory, Kelso, Washington
ASTM = ASTM International (formerly American Society for Testing and Materials)
CAS = Columbia Analytical Servies, Kelso, Washington
cm = centimeter(s)
DU = decision unit
EPA = U.S. Environmental Protection Agency
in. = inch(es)
IVBA = in vitro bioaccessibility
mm = millimeter(s)
NA = not applicable
QAPP = quality assurance project plan
TAL = target analyte list
TOC = total organic carbon

Table A-4. Inventory of Bioaccumulation Data

Study	Sampling Date(s) [1]	Media Type [1,3]	Number of Samples Excluding Field Replicates [1,5]	Number of Field Replicates [1,5]	Sample Collection Method(s) and Fractions [1,3]	Analyte Group(s) and Analytical Method(s) [1,6,9]	Analytical Laboratory(s) [1,6]	Data Validator [1,10]	Data Validation Stage [1,10; a]	Significant Analytical Issues [1,10]	Missing Documentation [1,2,3,4,5,6,7,8,9,10]	Relevant Citations
2018 Plant Tissue Study	4/25/2018-8/28/2018	Co-located soil and plant tissue	156	34 (includes field and EPA splits)	Individual samples and composites of six individual plants with co-located soil; soil collected from top 0-3 in., sieved to <150 µm	TAL metals (except calcium, potassium, and sodium): EPA 6020A mercury (subset): EPA 1631E total solids: EPA 160.3	ALS	Environmental Standards Inc.	2B (86%), 4 (14%)	None	NA	TAI (2019b)

Source: Teck American Incorporated (TAI). 2019b. *Upper Columbia River Final Plant Tissue Study Data Summary Report*. Prepared by Ramboll Environ, AECOM, and Parametrix, Seattle, WA.

[a] See Table A-6 for data validation stages.

[1-10] - Superscript numbers (1-10) correspond to Item # in Table A-5 Chemistry Data Quality Documentation Items.

< = less than

µm = micrometer(s)

ALS = ALS Environmental Laboratory, Kelso, Washington

EPA = U.S. Environmental Protection Agency

NA = not applicable

TAL = target analyte list

Table A-5. Chemistry Data Quality Documentation Items

Item #	Type of Documentation	Data Usability Criteria[a] in Exhibit 61 of EPA (1992)
Sampling Event		
1	hard copy or original electronic copy of data report	5.1, 5.2, 5.3
2	field coordinates (or a description of compositing methodology, if applicable)	5.1, 5.2
3	information on sampling methods (e.g., sediment sample depth, soil sample depth and sieve size, tissue whole body or portion)	5.2
4	supporting documentation (e.g., field data and reports, chain-of-custody forms, and sample handling descriptions)	5.1, 5.2, 5.3
Sample		
5	sample type (i.e., field-collected samples vs. laboratory replicate and other QC sample)	5.6
Result		
6	laboratory-generated analytical form/raw data (e.g., Form 1)	5.1, 5.3, 5.4
7	detection/reporting limits, especially for nondetected results	5.1
8	data for individual components for recalculating analytical sums (e.g., total PCBs or total PAHs)	5.1
9	information on analytical methods (e.g., use of routine/EPA-approved methods), qualifier definitions, and data quality indicators (e.g., PARCC)	5.1, 5.4, 5.6
10	data validation conducted and validation qualifiers applied in a manner consistent with EPA functional guidelines	5.5

Source: U.S. Environmental Protection Agency (EPA). 1992. *Guidance for Data Useability in Risk Assessment (Part A)* . Office of Emergency and Remedial Response. https://www.epa.gov/risk/guidance-data-useability-risk-assessment-part-3-final-april-1992.

Notes:

See also EPA (1992).

Items are numbered to identify them in Table A-7.

[a] **Data Usability Criteria (EPA, 1992):**

5.1 Reports to Risk Assessors: site description; sampling design with sample locations; analytical methods; results on per-sample basis; quantitation and detection limits for nondetected results; field conditions; preliminary reports; meteorological data; field reports

5.2 Documentation: sample results related to geographic location (chain-of-custody, standard operating procedures, field and analytical records)

5.3 Data Sources: analytical data results for one sample per medium per exposure pathway; broad spectrum analysis for one sample per medium per exposure pathway; field measurements data for media and environment

5.4 Analytical Methods and Detection Limit: routine (federally documented) methods used to analyze chemicals of potential concern (COPCs) in critical samples

5.5 Data Review: defined level of data review for all data

5.6 Data Quality Indicators: sampling variability quantified for each analyte; quality control (QC) samples to identify and quantify precision and accuracy; sampling and analytical precision and accuracy quantified

EPA = U.S. Environmental Protection Agency

PAH = polycyclic aromatic hydrocarbon

PARCC = precision, accuracy, representativeness, comparability, and completeness

PCB = polychlorinated biphenyl

Table A-6. EPA Data Validation Guidance/Levels of Validation

	Validation Stage				
Validation Check	1	2A	2B	3	4
Sample collection and laboratory receipt documentation reported	X	X	X	X	X
Correct analytical methods performed and dates reported	X	X	X	X	X
Correct analytes and laboratory qualifiers reported	X	X	X	X	X
Reporting limits reported and below requested reporting limits	X	X	X	X	X
Basic evaluation of results reported (e.g., to analytical method or contract requirements)	X	X	X	X	X
Requested sample handling and preparation methods performed and dates reported		X	X	X	X
Analytical and field QC data and acceptance criteria reported		X	X	X	X
Requested spikes added and frequency of QC samples appropriate		X	X	X	X
Holding times evaluated		X	X	X	X
Calibration data (e.g., initial and continuing calibration verifications and blanks) reported and frequency appropriate			X	X	X
Instrument performance checks and instrument QC samples reported and appropriate			X	X	X
Instrument response data for all instrument, laboratory, and field QC samples reported				X	X
Recalculation and compliance check of initial calibration curve, opening and/or closing continuing calibration verification and blank, percent ratios for each tune, instrument performance checks, and retention time windows, as applicable				X	X
Instrument response checked against minimum response requirements				X	X
Recalculation of reported results, laboratory QC, and spike recoveries from instrument response				X	X
Instrument outputs (e.g., chromatograms and background/interference corrections) reported					X
Sample results, including nondetected results and tentatively identified analytes, checked against instrument output for correct identification and quantification					X

Source: U.S. Environmental Protection Agency (EPA). 2009. *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* . Report No. EPA 540-R-08-005. OSWER No. 9200.1-85.

Notes:

Each subsequent validation stage builds upon the previous stage (e.g., Stage 3 includes the checks for Stages 1 and 2), with Stage 4 providing the most comprehensive level of data review.

Validation checks are intended for use in conjunction with the EPA national functional guidelines for data review.

QC = quality control

Table A-7. Chemistry Data Quality Information

Study/Data Source [1]	Sampling Date(s) [1]	Media Type [1,3]	Missing Documentation [1,2,3,4,5,6,7,8,9,10]	Data Use Recommendation	Data Quality Documentation Item [a]										Notes
					#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	
LeRoi Removal Action Study (EPA, 2005)	5/2004-9/2004	Soil	Coordinates for some locations, chain-of-custody, sample handling and field QA/QC sample information, lab reports, Form 1s, DLs and RLs	Not acceptable	A	C	A	N	N	N	N	NA	A	A	#2: No coordinates for some locations #4: No chain-of-custody or sample handling information #5: No field QA/QC information #6: No lab reports or Form 1s #7: No DLs or RLs
2009-2011 Beach Sediment Study (TAI, 2014b)	9/2009, 4/2010, 4/2011-5/2011	Sediment	NA	Acceptable	A	A	A	A	A	A	A	NA	A	A	
2012 Ecology Upland Soil Study (Ecology, 2013)	10/30/2012-11/10/2012	Soil	NA	Acceptable	A	A	A	A	A	A	A	NA	A	A	#7: Available in EIM
2014 UCR Upland Soil Study (TAI, 2015)	9/8/2014-10/29/2014	Soil	NA	Acceptable	A	A	A	A	A	A	A	NA	A	A	
2015 Bossburg Study (TAI, 2016)	4/14/2015- 5/7/2015	Soil	NA	Acceptable	A	A	A	A	A	A	A	NA	A	A	
2018 Plant Tissue Study (TAI, 2019b)	4/25/2018-8/28/2018	Co-located soil and plant tissue	NA	Acceptable	A	A	A	A	A	A	A	NA	A	A	

Sources:

Teck American Incorporated (TAI). 2014b. *Upper Columbia River Final Beach Sediment Study Field Sampling and Data Summary Report.* Prepared by Integral, Portland, OR.

Teck American Incorporated (TAI). 2015. *Upper Columbia River Final Soil study Data Summary and Data Gap Report.* Prepared by Windward Environmental LLC, Seattle, WA.

Teck American Incorporated (TAI). 2016. *Upper Columbia River Final Bossburg Flat Beach Refined Sediment and Soil Study Data Summary Report.* Prepared by Windward Environmental LLC, Seattle, WA.

Teck American Incorporated (TAI). 2019b. *Upper Columbia River Final Plant Tissue Study Data Summary Report* . Prepared by Ramboll Environ, AECOM, and Parametrix, Seattle, WA.

U.S. Environmental Protection Agency (EPA). 2005. *Le Roi Smelter Removal Action Report, Northport, Stevens County, WA* . Prepared by Weston, Seattle, WA.

Washington State Department of Ecology (Ecology). 2013. *Upper Columbia River Upland Soil Sampling Study.* Prepared by Hart Crowser, Seattle, WA.

[1-10] - Superscript numbers (1-10) correspond to Item # in Table A-5 Chemistry Data Quality Documentation Items.

[a] A - acceptable, C - conditionally acceptable, N - not acceptable.

DL = detection limit

EIM = Environmental Information Management System

NA = not applicable

QA/QC = quality assurance/quality control

RL = reporting limit

Table A-8. Chemistry DUA Summary

Study/Data source	Sampling Date(s)	Media Type	Data Quality	Data Suitability[a]	Data Comparability
Soil Chemistry					
LeRoi Removal Action Study (EPA, 2005)	5/2004-9/2004	Soil	Not acceptable	NA	NA
2012 Ecology Upland Soil Study (Ecology, 2013)	10/30/2012-11/10/2012	Soil	Acceptable	Suitable, with the exception of core samples	Not comparable
2014 UCR Upland Soil Study (TAI, 2015)	9/8/2014-10/29/2014	Soil	Acceptable	Suitable, with the exception of data collected from WSDAs and RFAs	Not comparable
2015 Bossburg Study (TAI, 2016)	4/14/2015- 5/7/2015	Soil	Acceptable	Suitable, with the exception of core samples	Not comparable
IVBA					
Studies with Data for Soil Samples in the Soil Chemistry Inventory					
2014 UCR Upland Soil Study (TAI, 2015)	9/8/2014-10/29/2014	Soil	Acceptable	Suitable	Not comparable
2015 Bossburg Study (TAI, 2016)	4/14/2015- 5/7/2015	Soil	Acceptable	Suitable	Not comparable
Studies with Data for Regressions					
2009-2011 Beach Sediment Study (TAI, 2014b)	9/2009, 4/2010, 4/2011-5/2011	Sediment	Acceptable	Suitable	Comparable
2014 UCR Upland Soil Study (TAI, 2015)	9/8/2014-10/29/2014	Soil	Acceptable	Suitable	
2015 Bossburg Study (TAI, 2016)	4/14/2015- 5/7/2015	Soil and sediment	Acceptable	Suitable, with the exception of core samples	
Bioaccumulation					
2018 Plant Tissue Study (TAI, 2019b)	4/25/2018-8/28/2018	Co-located soil and plant tissue	Acceptable	Suitable	NA

Sources:

Teck American Incorporated (TAI). 2014b. *Upper Columbia River Final Beach Sediment Study Field Sampling and Data Summary Report.* Prepared by Integral, Portland, OR.

Teck American Incorporated (TAI). 2015. *Upper Columbia River Final Soil study Data Summary and Data Gap Report.* Prepared by Windward Environmental LLC, Seattle, WA.

Teck American Incorporated (TAI). 2016. *Upper Columbia River Final Bossburg Flat Beach Refined Sediment and Soil Study Data Summary Report.* Prepared by Windward Environmental LLC, Seattle, WA.

Teck American Incorporated (TAI). 2019b. *Upper Columbia River Final Plant Tissue Study Data Summary Report* . Prepared by Ramboll Environ, AECOM, and Parametrix, Seattle, WA.

U.S. Environmental Protection Agency (EPA). 2005. *Le Roi Smelter Removal Action Report, Northport, Stevens County, WA* . Prepared by Weston, Seattle, WA.

Washington State Department of Ecology (Ecology). 2013. *Upper Columbia River Upland Soil Sampling Study.* Prepared by Hart Crowser, Seattle, WA.

[a] The data suitability evaluation was conducted for data of acceptable or conditionally acceptable quality.

DUA = data usability assessment
IVBA = in vitro bioaccessibility
NA = not applicable
RFA = relict floodplain area
UCR = Upper Columbia River
WSDA = windblown sediment deposition area

APPENDIX B

SOIL CHEMISTRY DATA SET USED IN THE UPLAND BERA

UPPER COLUMBIA RIVER

FINAL
Appendix B
Soil Chemistry Data Set Used in the Upland BERA

December 2023

This appendix presents the soil chemistry data sets used in the Upland Baseline Ecological Risk Assessment (BERA). Table B-1 lists the sample results organized by study name and sample and Table B-2 provides summary statistics for each study data set. For the most part, the information in this appendix is consistent with information presented in the draft final version of Appendix B in the draft final Upland BERA prepared by Teck American Incorporated (2023),[1] with the following exceptions:

- Chemistry data for decision unit ADA-140, located in the northern part of the site, adjacent to the western shoreline of the Columbia River are no longer presented in Table B-1 and results for the decision unit are not included in the summary statistics for the 2014 Upland Soil Study in Table B-2. Data for this decision unit will be evaluated in the Aquatic BERA.
- Chemistry data for the 2012 Ecology Upland Soil Study samples are no longer organized and compiled by subarea in Tables B-1 and B-2.

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[1] Teck American Incorporated (TAI). 2023. Upland Baseline Ecological Risk Assessment. Prepared for TAI by ERM. Carpinteria, California. Draft Final. February.

TABLES

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

									Aluminum			Antimony			Arsenic		
Location ID	Sample ID	Sample Date	Depth Range (in.)	TOC (%)	Total Solids (%)	Clay (%)	eCEC	pH (H_2O)	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study																	
ADA-001	ADA-001	2014-09-13	0-3	5.32	95.3	3.43	17.7	5.95	14,200		Yes	2.82	J	Yes	16.1		Yes
ADA-002	ADA-002	2014-10-09	0-3	1.98	96.3	8.61	12.5	6.75	16,100		Yes	2.01	J	Yes	14.0		Yes
ADA-004	ADA-004	2014-10-09	0-3	3.55	93.5	3.83	17.8	5.98	13,900		Yes	2.94	J	Yes	15.7		Yes
ADA-005	ADA-005	2014-10-08	0-3	1.75	96.8	13.3	11.0	6.68	15,600		Yes	2.66	J	Yes	19.4		Yes
ADA-006	ADA-006	2014-10-11	0-3	3.37	97.8	2.07	12.4	5.89	9,360		Yes	2.82	J	Yes	12.3		Yes
ADA-008	ADA-008	2014-10-11	0-3	5.73	93.9	3.17	23.4	6.01	12,600		Yes	5.68	J	Yes	20.0		Yes
ADA-010	ADA-010	2014-10-02	0-3	7.22	94.8	4.94	13.7	6.43	17,500		Yes	4.62	J	Yes	24.6		Yes
ADA-015	ADA-015	2014-09-13	0-3	5.37	94.9	1.46	15.3	5.55	8,920		Yes	1.54	J	Yes	8.31		Yes
ADA-016	ADA-016-A	2014-09-24	0-3	4.77	99.0	0.804	11.0	5.69	8,060		Yes	1.62	J	Yes	8.32		Yes
ADA-016	ADA-016-B	2014-09-24	0-3	3.11	98.8	0.356	9.21	5.68	7,260		Yes	1.67	J	Yes	8.00		Yes
ADA-016	ADA-016-C	2014-09-24	0-3	3.55	99.0	0.0516	12.1	5.63	7,030		Yes	1.55	J	Yes	7.21		Yes
ADA-017	ADA-017	2014-10-01	0-3	3.47	97.5	4.15	15.5	5.96	11,300		Yes	3.85	J	Yes	18.4		Yes
ADA-018	ADA-018	2014-10-01	0-3	5.78	93.7	14.7	25.7	5.91	12,300		Yes	7.04	J	Yes	15.8		Yes
ADA-019	ADA-019	2014-10-11	0-3	5.44	96.1	2.67	21.3	6.46	12,400		Yes	1.17	J	Yes	13.8		Yes
ADA-020	ADA-020-A	2014-09-13	0-3	2.38	97.7	2.04	13.6	6.02	15,600		Yes	0.840	J	Yes	8.43		Yes
ADA-020	ADA-020-B	2014-09-13	0-3	2.53	97.8	2.10	15.6	6.06	17,300		Yes	1.02	J	Yes	9.39		Yes
ADA-020	ADA-020-C	2014-09-13	0-3	2.45	97.7	1.83	13.5	6.11	16,800		Yes	0.941	J	Yes	10.2		Yes
ADA-021	ADA-021	2014-09-30	0-3	6.54	96.8	1.44	25.6	6.72	11,200		Yes	1.61	J	Yes	23.0		Yes
ADA-023	ADA-023-A	2014-09-13	0-3	2.96	96.4	4.92	10.8	6.37	12,400		Yes	1.91	J	Yes	13.8		Yes
ADA-023	ADA-023-B	2014-09-13	0-3	3.17	95.9	4.89	12.1	6.49	12,000		Yes	2.11	J	Yes	16.6		Yes
ADA-023	ADA-023-C	2014-09-13	0-3	3.77	95.5	5.64	12.3	6.41	13,100		Yes	2.36	J	Yes	18.4		Yes
ADA-024	ADA-024	2014-09-30	0-3	5.83	97.4	3.37	24.2	6.40	13,700		Yes	6.44	J	Yes	27.7		Yes
ADA-025	ADA-025	2014-09-17	0-3	5.67	88.7	1.45	24.0	6.22	15,900		Yes	2.84	J	Yes	20.7		Yes
ADA-026	ADA-026	2014-09-17	0-3	8.30	87.3	2.87	25.6	6.13	13,300		Yes	2.50	J	Yes	11.3		Yes
ADA-028	ADA-028	2014-10-03	0-3	4.00	95.0	4.05	13.3	6.50	13,900		Yes	2.96	J	Yes	20.0		Yes
ADA-033	ADA-033	2014-09-24	0-3	2.63	97.6	4.47	16.8	7.06	19,500		Yes	1.10	J	Yes	13.6		Yes
ADA-034	ADA-034	2014-10-10	0-3	2.50	95.8	6.08	15.8	6.91	19,700		Yes	1.00	J	Yes	9.62		Yes
ADA-035	ADA-035	2014-10-03	0-3	5.26	97.2	4.24	22.1	6.50	17,700		Yes	2.24	J	Yes	15.5		Yes
ADA-039	ADA-039	2014-10-01	0-3	2.43	93.1	4.12	20.2	6.10	19,400		Yes	0.782	J	Yes	8.31		Yes
ADA-042	ADA-042	2014-10-09	0-3	3.19	94.7	5.18	14.2	5.64	13,800		Yes	1.94	J	Yes	11.7		Yes
ADA-043	ADA-043	2014-10-03	0-3	7.42	96.9	8.54	26.0	6.35	15,900		Yes	2.36	J	Yes	12.7		Yes
ADA-044	ADA-044	2014-09-18	0-3	8.17	92.4	1.68	27.6	5.93	19,200		Yes	1.76	J	Yes	14.5		Yes
ADA-045	ADA-045	2014-10-09	0-3	7.92	84.5	3.17	26.6	6.13	15,800		Yes	5.97	J	Yes	27.4		Yes
ADA-046	ADA-046	2014-10-01	0-3	4.27	94.4	3.70	10.8	5.89	11,400		Yes	3.24	J	Yes	14.0		Yes
ADA-047	ADA-047	2014-09-30	0-3	5.14	97.2	2.05	27.3	6.42	16,400		Yes	4.05	J	Yes	19.2		Yes
ADA-048	ADA-048	2014-10-22	0-3	11.2	82.6	4.31	33.6	6.31	15,600		Yes	2.16	J	Yes	10.8		Yes
ADA-049	ADA-049	2014-09-17	0-3	3.82	92.8	2.48	22.0	6.07	22,500		Yes	0.978	J	Yes	12.1		Yes
ADA-050	ADA-050	2014-10-04	0-3	8.38	97.2	1.83	20.8	6.11	21,400		Yes	4.20	J	Yes	21.8		Yes
ADA-051	ADA-051	2014-10-22	0-3	5.22	95.4	3.00	19.0	6.12	13,200		Yes	1.52	J	Yes	9.98		Yes
ADA-052	ADA-052	2014-10-02	0-3	7.47	91.9	2.93	22.6	6.40	15,800		Yes	4.75	J	Yes	19.1		Yes
ADA-053	ADA-053	2014-10-07	0-3	9.10	86.5	5.25	27.0	5.83	21,400		Yes	1.36	J	Yes	11.1		Yes
ADA-054	ADA-054	2014-09-30	0-3	10.1	96.3	1.56	38.1	5.92	17,300		Yes	5.86	J	Yes	24.1		Yes
ADA-055	ADA-055-A	2014-10-08	0-3	6.00	94.2	3.40	18.1	6.34	16,500		Yes	2.90	J	Yes	23.6		Yes
ADA-055	ADA-055-B	2014-10-08	0-3	4.97	93.7	3.31	20.6	6.51	17,400		Yes	3.41	J	Yes	24.9		Yes
ADA-055	ADA-055-C	2014-10-08	0-3	5.63	93.3	2.95	38.4	6.47	16,300		Yes	2.80	J	Yes	22.2		Yes
ADA-056	ADA-056	2014-09-15	0-3	5.26	95.5	5.63	21.5	5.80	19,800		Yes	0.961	J	Yes	11.5		Yes
ADA-057	ADA-057	2014-10-07	0-3	4.28	95.5	4.58	18.2	6.45	16,700		Yes	1.56	J	Yes	14.6		Yes
ADA-058	ADA-058	2014-09-19	0-3	5.87	93.9	5.80	19.9	6.01	18,000		Yes	0.796	J	Yes	7.91		Yes
ADA-059	ADA-059	2014-10-07	0-3	6.16	92.8	3.37	24.2	5.85	17,300		Yes	2.01	J	Yes	11.8		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

									Aluminum			Antimony			Arsenic		
Location ID	Sample ID	Sample Date	Depth Range (in.)	TOC (%)	Total Solids (%)	Clay (%)	eCEC	pH (H_2O)	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study (continued)																	
ADA-060	ADA-060-A	2014-10-06	0-3	7.87	94.5	1.48	22.2	5.92	15,000		Yes	3.33	J	Yes	19.1		Yes
ADA-060	ADA-060-B	2014-10-06	0-3	5.94	95.2	1.19	16.0	6.40	15,200		Yes	3.77	J	Yes	21.1		Yes
ADA-060	ADA-060-C	2014-10-06	0-3	6.88	95.2	1.58	33.0	6.24	14,500		Yes	3.02	J	Yes	21.0		Yes
ADA-061	ADA-061	2014-09-16	0-3	9.90	93.5	1.27	78.8	5.57	20,200	J	Yes	0.991	J	Yes	15.0		Yes
ADA-062	ADA-062	2014-10-06	0-3	7.94	94.6	2.20	13.2	6.08	14,600		Yes	2.58	J	Yes	15.7		Yes
ADA-063	ADA-063	2014-09-17	0-3	7.18	91.9	1.42	20.7	5.62	17,300		Yes	2.40	J	Yes	14.4		Yes
ADA-064	ADA-064	2014-09-16	0-3	6.95	95.3	2.06	25.2	5.49	16,000	J	Yes	1.05	J	Yes	16.5		Yes
ADA-065	ADA-065	2014-10-07	0-3	2.84	97.6	1.98	8.83	6.11	9,140		Yes	2.18	J	Yes	10.7		Yes
ADA-066	ADA-066	2014-10-06	0-3	4.83	95.8	1.91	16.6	5.98	11,300		Yes	2.15	J	Yes	11.9		Yes
ADA-067	ADA-067	2014-09-17	0-3	4.43	93.1	2.60	17.3	6.08	18,400		Yes	1.26	J	Yes	11.1		Yes
ADA-070	ADA-070	2014-10-01	0-3	7.24	90.3	3.60	28.4	6.03	19,800		Yes	5.41	J	Yes	20.0		Yes
ADA-071	ADA-071	2014-10-07	0-3	5.23	95.1	2.14	17.2	5.82	13,100		Yes	3.96	J	Yes	15.8		Yes
ADA-073	ADA-073	2014-10-03	0-3	6.71	97.4	2.55	25.7	5.18	13,700		Yes	5.61	J	Yes	19.7		Yes
ADA-076	ADA-076	2014-10-14	0-3	9.86	90.0	2.85	37.3	5.09	19,400		Yes	7.52	J	Yes	24.3		Yes
ADA-078	ADA-078	2014-09-29	0-3	4.24	96.8	3.22	23.7	5.81	16,400		Yes	4.98	J	Yes	21.6		Yes
ADA-079	ADA-079	2014-10-14	0-3	13.5	83.7	2.36	36.5	5.47	16,500		Yes	3.47	J	Yes	14.8		Yes
ADA-081	ADA-081	2014-10-08	0-3	4.84	92.4	2.65	15.8	5.55	12,200		Yes	3.14	J	Yes	14.7		Yes
ADA-082	ADA-082	2014-10-04	0-3	7.59	94.7	4.08	26.5	5.98	15,100		Yes	2.01	J	Yes	12.9		Yes
ADA-084	ADA-084	2014-10-09	0-3	10.1	86.4	2.10	34.1	6.31	15,600		Yes	2.68	J	Yes	12.5		Yes
ADA-085	ADA-085	2014-09-17	0-3	11.5	78.2	4.41	31.7	6.56	15,300		Yes	1.86	J	Yes	10.7		Yes
ADA-088	ADA-088	2014-10-02	0-3	7.68	92.4	1.76	24.4	6.18	15,000		Yes	3.22	J	Yes	19.2		Yes
ADA-089	ADA-089	2014-10-07	0-3	6.17	92.4	2.50	16.6	6.15	17,900		Yes	3.04	J	Yes	24.2		Yes
ADA-090	ADA-090	2014-10-07	0-3	8.28	91.6	3.95	31.7	5.81	16,800		Yes	3.26	J	Yes	12.9		Yes
ADA-091	ADA-091	2014-10-02	0-3	5.96	93.7	2.81	22.6	6.08	16,700		Yes	3.11	J	Yes	19.8		Yes
ADA-092	ADA-092	2014-10-06	0-3	10.1	87.9	2.69	30.9	5.98	17,900		Yes	2.93	J	Yes	23.4		Yes
ADA-093	ADA-093	2014-09-16	0-3	5.83	93.1	7.36	22.3	5.80	21,800	J	Yes	2.22	J	Yes	19.0		Yes
ADA-094	ADA-094	2014-10-16	0-3	4.92	88.8	3.43	19.8	5.78	16,500		Yes	1.32	J	Yes	12.6		Yes
ADA-095	ADA-095	2014-10-08	0-3	10.3	87.7	3.39	26.6	6.30	18,700		Yes	2.66	J	Yes	17.0		Yes
ADA-096	ADA-096	2014-09-26	0-3	8.01	96.4	2.95	12.7	6.23	13,400		Yes	3.39	J	Yes	14.7		Yes
ADA-097	ADA-097	2014-09-24	0-3	11.8	96.4	1.23	33.4	6.32	13,900		Yes	5.47	J	Yes	19.6		Yes
ADA-099	ADA-099	2014-10-10	0-3	8.32	91.4	2.24	25.3	6.00	20,700		Yes	3.21	J	Yes	21.1		Yes
ADA-101	ADA-101	2014-10-11	0-3	7.00	96.0	3.27	16.9	8.00	15,000		Yes	4.04	J	Yes	17.3		Yes
ADA-102	ADA-102	2014-10-08	0-3	4.71	93.6	4.25	19.9	6.07	19,500		Yes	1.99	J	Yes	13.5		Yes
ADA-103	ADA-103	2014-09-26	0-3	5.57	97.1	5.18	21.7	6.60	16,800		Yes	1.95	J	Yes	15.9		Yes
ADA-104	ADA-104	2014-09-19	0-3	6.86	87.5	4.53	20.1	5.82	19,000		Yes	1.45	J	Yes	11.0		Yes
ADA-105	ADA-105	2014-10-10	0-3	6.18	91.8	1.92	21.1	6.29	16,500		Yes	3.83	J	Yes	16.0		Yes
ADA-106	ADA-106-A	2014-10-15	0-3	7.40	92.1	4.60	29.4	5.88	21,200		Yes	1.80	J	Yes	11.7		Yes
ADA-106	ADA-106-B	2014-10-15	0-3	5.87	92.5	4.57	22.4	5.37	20,600		Yes	1.52	J	Yes	11.5		Yes
ADA-106	ADA-106-C	2014-10-16	0-3	7.07	85.0	2.35	22.5	5.62	19,500		Yes	1.87	J	Yes	11.5		Yes
ADA-107	ADA-107-A	2014-10-02	0-3	7.35	92.3	2.76	26.9	6.16	23,500		Yes	1.66	J	Yes	12.4		Yes
ADA-107	ADA-107-B	2014-10-01	0-3	5.33	96.4	3.09	29.2	6.34	25,900		Yes	1.51	J	Yes	16.2		Yes
ADA-107	ADA-107-C	2014-10-01	0-3	5.25	96.0	3.32	29.8	6.01	26,200		Yes	1.51	J	Yes	12.7		Yes
ADA-108	ADA-108-A	2014-10-10	0-3	7.09	92.6	2.71	19.9	6.20	14,000		Yes	2.05	J	Yes	12.9		Yes
ADA-108	ADA-108-B	2014-10-10	0-3	6.50	91.2	1.64	18.4	6.23	12,900		Yes	2.09	J	Yes	13.2		Yes
ADA-108	ADA-108-C	2014-10-09	0-3	8.16	92.8	1.51	21.5	6.31	13,600		Yes	1.70	J	Yes	10.7		Yes
ADA-109	ADA-109	2014-09-30	0-3	9.78	97.0	0.982	33.2	6.11	11,400		Yes	4.85	J	Yes	15.1		Yes
ADA-110	ADA-110	2014-09-26	0-3	4.77	98.0	2.04	34.5	6.02	12,300		Yes	3.25	J	Yes	12.6		Yes
ADA-111	ADA-111	2014-10-07	0-3	4.84	93.3	2.84	23.4	6.24	19,500		Yes	1.18	J	Yes	11.3		Yes
ADA-112	ADA-112	2014-10-16	0-3	9.12	81.0	5.54	32.1	5.77	22,800		Yes	1.35	J	Yes	11.6		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

									Aluminum			Antimony			Arsenic		
Location ID	Sample ID	Sample Date	Depth Range (in.)	TOC (%)	Total Solids (%)	Clay (%)	eCEC	pH (H_2O)	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study (continued)																	
ADA-113	ADA-113	2014-09-20	0-3	7.68	91.7	2.48	27.2	5.90	20,200		Yes	1.23	J	Yes	13.0		Yes
ADA-114	ADA-114	2014-10-06	0-3	8.89	86.5	4.53	24.3	4.95	18,900		Yes	1.36	J	Yes	16.7		Yes
ADA-115	ADA-115	2014-10-17	0-3	6.50	95.8	3.63	15.9	6.11	15,700		Yes	1.81	J	Yes	14.0		Yes
ADA-116	ADA-116	2014-10-08	0-3	4.22	92.1	3.38	29.4	5.70	14,900		Yes	2.04	J	Yes	15.2		Yes
ADA-117	ADA-117	2014-09-29	0-3	3.86	97.7	1.59	21.6	5.66	14,100		Yes	2.22	J	Yes	15.4		Yes
ADA-118	ADA-118	2014-09-30	0-3	5.70	96.5	1.11	31.6	6.31	18,300		Yes	1.72	J	Yes	13.1		Yes
ADA-119	ADA-119	2014-10-02	0-3	6.49	90.9	3.14	15.2	6.31	13,800		Yes	1.99	J	Yes	13.3		Yes
ADA-121	ADA-121	2014-10-14	0-3	6.36	93.7	3.74	29.3	6.28	21,200		Yes	2.99	J	Yes	17.5		Yes
ADA-122	ADA-122	2014-10-10	0-3	6.71	83.7	3.73	15.7	6.06	20,700		Yes	1.57	J	Yes	10.4		Yes
ADA-124	ADA-124-A	2014-10-04	0-3	4.45	97.7	0.788	17.9	4.86	8,560		Yes	3.73	J	Yes	12.2		Yes
ADA-124	ADA-124-B	2014-10-04	0-3	5.01	98.6	1.20	18.6	5.17	8,240		Yes	2.81	J	Yes	12.3		Yes
ADA-124	ADA-124-C	2014-10-04	0-3	3.31	98.6	1.33	11.8	5.22	8,900		Yes	2.00	J	Yes	10.9		Yes
ADA-125	ADA-125	2014-10-23	0-3	2.98	97.2	1.57	13.3	5.55	9,970		Yes	2.24	J	Yes	13.2		Yes
ADA-126	ADA-126	2014-09-11	0-3	4.03	94.7	3.14	16.6	6.15	11,300		Yes	3.95	J	Yes	22.1		Yes
ADA-127	ADA-127	2014-10-14	0-3	4.87	96.7	1.80	21.8	6.44	17,300		Yes	2.54	J	Yes	19.0		Yes
ADA-128	ADA-128	2014-10-03	0-3	2.8	99.2	1.38	10.2	6.32	6,250		Yes	3.48	J	Yes	10.6		Yes
ADA-131	ADA-131-A	2014-09-18	0-3	7.29	90.3	3.12	21.5	5.60	14,400		Yes	7.10	J	Yes	28.8		Yes
ADA-131	ADA-131-B	2014-09-18	0-3	5.85	90.6	1.71	21.7	5.17	13,800		Yes	5.29	J	Yes	24.0		Yes
ADA-131	ADA-131-C	2014-09-18	0-3	7.25	90.2	1.16	22.5	5.69	13,700		Yes	7.88	J	Yes	23.4		Yes
ADA-132	ADA-132	2014-09-16	0-3	4.14	97.7	6.88	19.9	4.86	7,940	J	Yes	2.49	J	Yes	11.9		Yes
ADA-133	ADA-133	2014-09-23	0-3	4.61	98.0	1.77	18.9	5.76	12,100	J	Yes	3.30	J	Yes	15.4		Yes
ADA-135	ADA-135-A	2014-09-17	0-3	2.57	97.8	1.15	6.60	6.06	8,480		Yes	1.26	J	Yes	8.78		Yes
ADA-135	ADA-135-B	2014-09-17	0-3	2.28	97.7	0.673	6.26	5.89	8,220		Yes	1.14	J	Yes	7.84		Yes
ADA-135	ADA-135-C	2014-09-18	0-3	2.40	97.2	1.32	8.70	5.99	7,950		Yes	1.18	J	Yes	8.16		Yes
ADA-136	ADA-136	2014-09-10	0-3	3.58	97.7	2.54	17.1	6.09	7,600		Yes	3.09	J	Yes	10.5		Yes
ADA-139	ADA-139	2014-10-14	0-3	4.72	94.5	3.45	21.8	6.00	16,300		Yes	3.62	J	Yes	18.7		Yes
ADA-141	ADA-141	2014-09-23	0-3	3.94	98.2	3.73	17.8	5.81	10,200	J	Yes	1.95	J	Yes	12.0	J	Yes
ADA-142	ADA-142	2014-09-25	0-3	3.56	98.3	1.99	17.9	6.14	6,820		Yes	3.77	J	Yes	10.9		Yes
ADA-143	ADA-143	2014-09-15	0-3	2.58	98.3	2.17	9.09	5.78	10,300		Yes	2.46	J	Yes	9.86		Yes
ADA-144	ADA-144	2014-09-29	0-3	4.97	98.6	1.35	17.0	5.54	9,060		Yes	5.62	J	Yes	19.1		Yes
ADA-145	ADA-145	2014-09-24	0-3	5.35	97.3	3.51	26.9	6.31	14,000		Yes	3.71	J	Yes	16.5		Yes
ADA-146	ADA-146	2014-10-02	0-3	3.83	96.6	2.69	9.48	5.99	9,280		Yes	3.84	J	Yes	16.8		Yes
ADA-147	ADA-147	2014-09-29	0-3	5.03	98.9	0.896	21.3	5.50	6,610		Yes	7.06	J	Yes	17.0		Yes
ADA-148	ADA-148	2014-10-06	0-3	2.88	97.6	2.00	7.60	5.15	6,310		Yes	3.84	J	Yes	16.5		Yes
ADA-150	ADA-150	2014-10-06	0-3	2.78	97.7	1.31	10.4	5.5	8,310		Yes	4.55	J	Yes	17.7		Yes
ADA-151	ADA-151	2014-10-04	0-3	3.44	98.8	0.907	91.0	5.05	5,510		Yes	5.50	J	Yes	13.6		Yes
ADA-152	ADA-152	2014-10-09	0-3	5.50	90.6	2.48	21.0	5.98	17,000		Yes	3.78	J	Yes	26.4		Yes
ADA-153	ADA-153	2014-09-20	0-3	7.85	92.1	2.40	27.3	5.87	13,100		Yes	3.57	J	Yes	20.8		Yes
ADA-154	ADA-154-A	2014-09-20	0-3	5.52	94.7	1.50	24.0	5.56	12,900		Yes	3.58	J	Yes	18.2		Yes
ADA-154	ADA-154-B	2014-09-20	0-3	8.92	94.3	1.33	20.9	5.77	14,400		Yes	3.91	J	Yes	20.3		Yes
ADA-154	ADA-154-C	2014-09-20	0-3	6.10	94.8	2.59	24.2	5.57	14,700		Yes	4.09	J	Yes	20.0		Yes
ADA-155	ADA-155	2014-09-15	0-3	4.71	96.8	2.54	16.4	5.23	8,420		Yes	5.01	J	Yes	17.1		Yes
ADA-156	ADA-156	2014-10-07	0-3	6.89	87.2	4.33	17.4	5.79	12,000		Yes	6.91	J	Yes	19.1		Yes
ADA-158	ADA-158-A	2014-10-07	0-3	2.56	94.7	2.65	9.9	5.87	7,560		Yes	3.8	J	Yes	14.0		Yes
ADA-158	ADA-158-B	2014-10-07	0-3	3.10	93.2	2.70	11.9	6.00	7,940		Yes	5.54	J	Yes	18.4		Yes
ADA-158	ADA-158-C	2014-10-07	0-3	4.12	89.5	2.34	13.2	5.98	8,040		Yes	7.82	J	Yes	23.7		Yes
ADA-159	ADA-159-A	2014-10-04	0-3	6.44	98.1	1.41	26.1	6.09	12,000		Yes	4.74	J	Yes	18.8		Yes
ADA-159	ADA-159-B	2014-10-04	0-3	7.48	97.6	1.85	19.5	6.15	10,500		Yes	5.97	J	Yes	17.5		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

									Aluminum			Antimony			Arsenic		
Location ID	Sample ID	Sample Date	Depth Range (in.)	TOC (%)	Total Solids (%)	Clay (%)	eCEC	pH (H_2O)	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study (continued)																	
ADA-159	ADA-159-C	2014-10-04	0-3	4.36	98.4	2.35	14.8	5.72	9,010		Yes	6.09	J	Yes	16.2		Yes
ADA-160	ADA-160	2014-10-03	0-3	3.47	98.8	2.10	10.8	5.61	8,550		Yes	3.38	J	Yes	13.9		Yes
ADA-161	ADA-161	2014-10-03	0-3	5.42	92.1	4.02	14.5	4.82	10,900		Yes	4.51	J	Yes	16.5		Yes
ADA-162	ADA-162	2014-10-09	0-3	5.40	93.4	0.999	20.1	5.91	7,040		Yes	10.1	J	Yes	19.6		Yes
ADA-164	ADA-164	2014-09-30	0-3	6.44	97.8	0.882	19.8	6.24	9,380		Yes	6.96	J	Yes	19.7		Yes
ADA-165	ADA-165	2014-09-16	0-3	4.59	97.3	1.92	19.2	5.82	11,300	J	Yes	5.60	J	Yes	22.4		Yes
ADA-168	ADA-168	2014-10-14	0-3	3.41	96.9	1.17	16.0	6.13	12,300		Yes	4.94	J	Yes	25.8		Yes
ADA-169	ADA-169-A	2014-09-19	0-3	7.39	89.8	7.54	27.4	5.96	20,000		Yes	0.681	J	Yes	11.9		Yes
ADA-169	ADA-169-B	2014-09-19	0-3	8.90	90.3	7.50	29.5	5.78	18,900		Yes	0.681	J	Yes	10.2		Yes
ADA-169	ADA-169-C	2014-09-19	0-3	9.14	86.1	7.76	28.2	6.44	21,800		Yes	0.604	J	Yes	10.6		Yes
ADA-170	ADA-170	2014-09-23	0-3	9.20	95.9	5.55	38.5	5.46	17,700	J	Yes	1.68	J	Yes	12.8		Yes
ADA-171	ADA-171	2014-09-23	0-3	6.15	97.1	5.92	23.1	5.80	13,500	J	Yes	1.07	J	Yes	11.0		Yes
ADA-172	ADA-172	2014-09-29	0-3	16.3	95.2	7.03	49.5	5.16	13,600		Yes	1.20	J	Yes	6.23		Yes
ADA-173	ADA-173-A	2014-09-12	0-3	6.08	95.6	5.23	28.6	5.43	21,600		Yes	1.43	J	Yes	12.5		Yes
ADA-173	ADA-173-B	2014-09-12	0-3	5.69	95.5	5.06	19.1	5.86	18,800		Yes	1.57	J	Yes	11.5		Yes
ADA-173	ADA-173-C	2014-09-12	0-3	7.87	93.3	4.69	39.3	5.58	21,400		Yes	1.84	J	Yes	11.9		Yes
ADA-174	ADA-174	2014-09-12	0-3	9.32	93.5	5.26	55.4	5.25	20,900		Yes	1.97	J	Yes	11.1		Yes
ADA-175	ADA-175	2014-09-15	0-3	6.04	94.9	3.94	30.3	5.13	14,600		Yes	0.718	J	Yes	5.98		Yes
ADA-176	ADA-176	2014-09-12	0-3	5.91	96.5	4.16	23.5	5.56	19,300		Yes	0.636	J	Yes	5.59		Yes
ADA-177	ADA-177	2014-09-16	0-3	13.3	90.7	1.87	30.9	4.84	14,100	J	Yes	0.744	J	Yes	9.09		Yes
ADA-178	ADA-178	2014-09-11	0-3	7.60	86.5	6.47	24.3	5.52	18,500		Yes	0.733	J	Yes	9.37		Yes
ADA-179	ADA-179	2014-09-18	0-3	6.50	85.1	3.50	22.2	5.70	17,400		Yes	1.48	J	Yes	8.78		Yes
ADA-180	ADA-180	2014-09-19	0-3	7.07	90.8	7.20	24.6	6.16	15,200		Yes	1.93	J	Yes	8.67		Yes
ADA-181	ADA-181	2014-09-12	0-3	9.92	89.8	6.81	27.2	5.76	16,700		Yes	1.99	J	Yes	10.1		Yes
ADA-182	ADA-182	2014-10-13	0-3	6.28	87.5	4.52	24.5	5.66	15,700		Yes	1.38	J	Yes	8.12		Yes
ADA-183	ADA-183	2014-09-11	0-3	12.2	89.0	5.93	37.5	5.58	10,900		Yes	3.94	J	Yes	16.4		Yes
ADA-184	ADA-184	2014-09-11	0-3	8.61	89.1	4.20	30.3	6.02	15,300		Yes	1.30	J	Yes	9.61		Yes
2012 Ecology Upland Soil Study																	
SA1-1C	SA1-1C	2012-10-30	0-3	9.54	87.6	nm	nm	5.83	21,700		Yes	0.200	UJ	No	10.7		Yes
SA1-2C	SA1-2C	2012-10-30	0-3	5.51	94.5	nm	nm	5.91	23,600		Yes	0.200	UJ	No	13.8		Yes
SA1-3C	SA1-3C	2012-10-30	0-3	5.85	95.7	nm	nm	5.90	23,000		Yes	0.200	UJ	No	9.80		Yes
SA1-3C	SA1-3C2	2012-10-30	0-3	3.93	96.6	nm	nm	5.69	26,600		Yes	0.200	UJ	No	12.2		Yes
SA1-4C	SA1-4C	2012-10-30	0-3	2.97	94.5	nm	nm	5.84	26,800		Yes	0.200	UJ	No	9.40		Yes
SA1-5C	SA1-5C	2012-10-30	0-3	8.47	93.2	nm	nm	5.87	17,900		Yes	0.200	UJ	No	16.9		Yes
SA1-6C	SA1-6C	2012-10-30	0-3	4.75	93.0	nm	nm	5.56	20,600		Yes	0.200	UJ	No	21.2		Yes
SA1-7C	SA1-7C	2012-10-30	0-3	4.96	94.9	nm	nm	5.90	20,800		Yes	0.200	UJ	No	12.6		Yes
SA1-8C	SA1-8C	2012-10-30	0-3	7.92	94.9	nm	nm	5.68	16,500		Yes	0.200	UJ	No	10.4		Yes
SA10-1C	SA10-1C	2012-11-08	0-3	8.80	94.3	nm	nm	6.14	17,400		Yes	0.200	UJ	No	11.9		Yes
SA10-2C	SA10-2C	2012-11-08	0-3	12.8	91.7	nm	nm	5.96	20,800		Yes	1.70	J	Yes	55.5		Yes
SA10-3C	SA10-3C	2012-11-05	0-3	6.66	95.8	nm	nm	6.02	18,100		Yes	0.800	J	Yes	28.7		Yes
SA10-3C	SA10-3C2	2012-11-05	0-3	4.13	96.4	nm	nm	6.08	19,000		Yes	0.500	J	Yes	30.9		Yes
SA10-4C	SA10-4C	2012-11-05	0-3	21.3	89.6	nm	nm	5.97	18,700		Yes	1.50	J	Yes	5.60		Yes
SA10-5C	SA10-5C	2012-11-05	0-3	9.37	95.3	nm	nm	6.41	17,900		Yes	0.200	J	Yes	11.5		Yes
SA10-6C	SA10-6C	2012-11-05	0-3	11.1	94.7	nm	nm	5.74	23,700		Yes	0.200	UJ	No	16.4		Yes
SA10-7C	SA10-7C	2012-11-05	0-3	8.72	95.4	nm	nm	6.12	19,500		Yes	0.400	J	Yes	39.3		Yes
SA10-8C	SA10-8C	2012-11-08	0-3	5.02	94.9	nm	nm	6.08	20,600		Yes	0.400	J	Yes	21.2		Yes
SA11-1C	SA11-1C	2012-11-08	0-3	1.98	97.8	nm	nm	6.09	23,500		Yes	0.200	UJ	No	12.3		Yes
SA11-2C	SA11-2C	2012-11-06	0-3	3.01	97.3	nm	nm	6.19	16,600		Yes	0.200	UJ	No	10.6		Yes
SA11-3C	SA11-3C	2012-11-10	0-3	5.68	94.7	nm	nm	6.52	16,100		Yes	0.200	UJ	No	9.00		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

									Aluminum			Antimony			Arsenic		
Location ID	Sample ID	Sample Date	Depth Range (in.)	TOC (%)	Total Solids (%)	Clay (%)	eCEC	pH (H_2O)	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2012 Ecology Upland Soil Study (continued)																	
SA11-4C	SA11-4C	2012-11-08	0-3	8.71	95.7	nm	nm	6.37	14,900		Yes	0.600	J	Yes	20.7		Yes
SA11-5C	SA11-5C	2012-11-06	0-3	5.13	95.3	nm	nm	5.41	15,000		Yes	0.800	J	Yes	21.0		Yes
SA11-6C	SA11-6C	2012-11-06	0-3	6.23	97.6	nm	nm	5.54	21,400		Yes	0.300	J	Yes	22.4		Yes
SA11-7C	SA11-7C	2012-11-06	0-3	23.4	89.3	nm	nm	5.16	6,940		Yes	17.2	J	Yes	28.6		Yes
SA11-8C	SA11-8C	2012-11-07	0-3	1.99	97.2	nm	nm	5.27	18,900		Yes	0.200	J	Yes	20.2		Yes
SA11-8C	SA11-8C2	2012-11-07	0-3	3.20	96.0	nm	nm	5.41	19,000		Yes	0.900	J	Yes	37.3		Yes
SA11-9C	SA11-9C	2012-11-08	0-3	8.29	97.2	nm	nm	5.90	22,500		Yes	0.900	J	Yes	35.0		Yes
SA12-1C	SA12-1C	2012-11-07	0-3	3.21	97.2	nm	nm	6.06	34,600		Yes	0.200	J	Yes	25.3		Yes
SA12-2C	SA12-2C	2012-11-10	0-3	4.47	94.8	nm	nm	5.08	20,800		Yes	0.200	UJ	No	16.3		Yes
SA12-3C	SA12-3C	2012-11-10	0-3	10.6	97.0	nm	nm	5.89	17,000		Yes	0.400	J	Yes	11.0		Yes
SA12-4C	SA12-4C	2012-11-10	0-3	5.55	97.0	nm	nm	6.75	16,600		Yes	0.200	UJ	No	10.0		Yes
SA12-6C	SA12-6C	2012-11-10	0-3	3.90	94.7	nm	nm	6.42	25,100		Yes	0.200	UJ	No	13.4		Yes
SA12-7C	SA12-7C	2012-11-10	0-3	1.38	96.6	nm	nm	6.13	25,600		Yes	0.200	UJ	No	15.6		Yes
SA12-7C	SA12-7C2	2012-11-10	0-3	3.29	96.3	nm	nm	6.25	23,600		Yes	0.200	UJ	No	17.4		Yes
SA12-8C	SA12-8C	2012-11-10	0-3	2.40	97.1	nm	nm	5.61	19,200		Yes	0.200	UJ	No	15.8		Yes
SA12-9C	SA12-9C	2012-11-10	0-3	2.97	95.9	nm	nm	6.24	26,200		Yes	0.200	UJ	No	13.8		Yes
SA13-1C	SA13-1C	2012-11-10	0-3	11.5	96.0	nm	nm	6.18	21,000		Yes	0.200	UJ	No	7.70		Yes
SA13-2C	SA13-2C	2012-11-10	0-3	12.6	92.5	nm	nm	6.68	13,900		Yes	0.300	UJ	No	5.90		Yes
SA13-3C	SA13-3C	2012-11-10	0-3	3.20	95.8	nm	nm	5.77	17,500		Yes	0.300	J	Yes	12.8		Yes
SA13-4C	SA13-4C	2012-11-10	0-3	5.64	95.7	nm	nm	5.95	12,700		Yes	0.200	UJ	No	5.30		Yes
SA13-5C	SA13-5C	2012-11-10	0-3	4.31	95.4	nm	nm	6.34	22,400		Yes	0.500	J	Yes	17.3		Yes
SA13-5C	SA13-5C2	2012-11-10	0-3	6.33	95.5	nm	nm	6.19	22,200		Yes	0.500	J	Yes	18.4		Yes
SA13-6C	SA13-6C	2012-11-10	0-3	2.77	95.3	nm	nm	5.73	28,200		Yes	0.400	J	Yes	22.4		Yes
SA13-7C	SA13-7C	2012-11-07	0-3	2.57	97.0	nm	nm	5.96	19,400		Yes	0.500	J	Yes	21.7		Yes
SA13-8C	SA13-8C	2012-11-10	0-3	3.69	96.7	nm	nm	5.29	17,300		Yes	0.300	J	Yes	16.4		Yes
SA2-1C	SA2-1C	2012-10-31	0-3	6.60	95.7	nm	nm	5.65	21,600		Yes	0.300	J	Yes	16.2		Yes
SA2-2C	SA2-2C	2012-10-31	0-3	2.37	97.1	nm	nm	5.73	18,800		Yes	0.200	UJ	No	12.2		Yes
SA2-3C	SA2-3C	2012-10-31	0-3	2.56	97.3	nm	nm	6.11	15,900		Yes	0.200	UJ	No	8.20		Yes
SA2-4C	SA2-4C	2012-10-31	0-3	3.13	95.7	nm	nm	5.22	16,600		Yes	0.200	UJ	No	13.9		Yes
SA2-4C	SA2-4C2	2012-10-31	0-3	3.28	97.9	nm	nm	5.27	14,700		Yes	0.400	J	Yes	16.8		Yes
SA2-5C	SA2-5C	2012-10-31	0-3	3.87	98.4	nm	nm	5.65	11,200		Yes	0.200	UJ	No	7.40		Yes
SA2-6C	SA2-6C	2012-10-31	0-3	3.63	98.0	nm	nm	5.85	14,800		Yes	0.200	J	Yes	22.7		Yes
SA2-7C	SA2-7C	2012-10-31	0-3	6.59	97.4	nm	nm	5.80	21,100		Yes	0.200	UJ	No	17.7		Yes
SA2-8C	SA2-8C	2012-10-31	0-3	2.14	97.5	nm	nm	6.26	23,600		Yes	0.200	UJ	No	16.2		Yes
SA3-1C	SA3-1C	2012-11-01	0-3	1.76	97.3	nm	nm	5.97	21,900		Yes	0.200	UJ	No	6.50		Yes
SA3-2C	SA3-2C	2012-11-01	0-3	1.98	97.5	nm	nm	5.58	17,200		Yes	0.200	UJ	No	5.90		Yes
SA3-3C	SA3-3C	2012-11-01	0-3	2.42	97.5	nm	nm	6.26	20,300		Yes	0.200	UJ	No	15.2		Yes
SA3-4C	SA3-4C	2012-11-01	0-3	2.42	97.8	nm	nm	5.87	14,800		Yes	0.200	UJ	No	12.8		Yes
SA3-5C	SA3-5C	2012-11-01	0-3	2.17	98.4	nm	nm	6.58	11,000		Yes	0.200	UJ	No	8.70		Yes
SA3-6C	SA3-6C	2012-11-01	0-3	6.97	94.5	nm	nm	5.63	19,700		Yes	0.200	UJ	No	17.7		Yes
SA3-6C	SA3-6C2	2012-11-01	0-3	15.7	94.9	nm	nm	6.41	22,100		Yes	0.200	UJ	No	17.3		Yes
SA3-7C	SA3-7C	2012-11-01	0-3	9.03	95.7	nm	nm	5.76	14,700		Yes	0.600	J	Yes	14.2		Yes
SA3-8C	SA3-8C	2012-11-01	0-3	4.02	97.7	nm	nm	5.94	14,600		Yes	0.200	UJ	No	7.90		Yes
SA4-1C	SA4-1C	2012-11-01	0-3	6.59	98.1	nm	nm	6.00	16,600		Yes	0.200	J	Yes	14.3		Yes
SA4-2C	SA4-2C	2012-11-01	0-3	8.72	96.9	nm	nm	6.59	14,700		Yes	0.200	UJ	No	9.10		Yes
SA4-3C	SA4-3C	2012-11-01	0-3	9.55	98.1	nm	nm	4.69	15,000		Yes	0.300	J	Yes	20.2		Yes
SA4-4C	SA4-4C	2012-11-01	0-3	11.4	96.7	nm	nm	5.40	14,300		Yes	0.200	J	Yes	11.8		Yes
SA4-5C	SA4-5C	2012-11-01	0-3	5.70	98.2	nm	nm	6.00	17,300		Yes	0.200	UJ	No	11.9		Yes
SA4-6C	SA4-6C	2012-11-02	0-3	12.2	96.6	nm	nm	5.77	12,900		Yes	0.300	J	Yes	16.1		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

									Aluminum			Antimony			Arsenic		
Location ID	Sample ID	Sample Date	Depth Range (in.)	TOC (%)	Total Solids (%)	Clay (%)	eCEC	pH (H_2O)	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2012 Ecology Upland Soil Study (continued)																	
SA4-6C	SA4-6C2	2012-11-02	0-3	10.2	97.7	nm	nm	5.80	14,700		Yes	0.200	J	Yes	17.8		Yes
SA4-7C	SA4-7C	2012-11-01	0-3	4.90	96.8	nm	nm	5.90	18,700		Yes	0.200	UJ	No	15.0		Yes
SA4-8C	SA4-8C	2012-11-01	0-3	5.14	97.2	nm	nm	5.63	13,800		Yes	0.200	UJ	No	12.5		Yes
SA5-1C	SA5-1C	2012-11-09	0-3	6.81	84.1	nm	nm	6.47	14,300		Yes	0.500	J	Yes	11.0		Yes
SA5-2C	SA5-2C	2012-11-09	0-3	5.96	94.5	nm	nm	6.15	31,600		Yes	0.200	UJ	No	12.1		Yes
SA5-3C	SA5-3C	2012-11-03	0-3	3.59	96.4	nm	nm	6.79	15,500		Yes	0.300	J	Yes	17.0		Yes
SA5-4C	SA5-4C	2012-11-02	0-3	4.69	96.4	nm	nm	6.12	12,000		Yes	0.500	J	Yes	8.70		Yes
SA5-4C	SA5-4C2	2012-11-02	0-3	5.46	97.2	nm	nm	6.16	11,800		Yes	0.300	J	Yes	10.4		Yes
SA5-5C	SA5-5C	2012-11-09	0-3	6.01	94.9	nm	nm	6.17	14,500		Yes	0.200	UJ	No	8.40		Yes
SA5-7C	SA5-7C	2012-11-02	0-3	5.54	97.6	nm	nm	6.19	10,700		Yes	0.300	J	Yes	10.1		Yes
SA5-8C	SA5-8C	2012-09-11	0-3	3.52	98.7	nm	nm	6.10	17,700		Yes	0.300	J	Yes	26.2		Yes
SA6-1C	SA6-1C	2012-11-02	0-3	6.74	97.5	nm	nm	5.91	9,020		Yes	0.300	J	Yes	15.5		Yes
SA6-2C	SA6-2C	2012-11-02	0-3	3.92	97.6	nm	nm	6.09	16,400		Yes	0.300	J	Yes	14.8		Yes
SA6-2C	SA6-2C2	2012-11-02	0-3	4.24	97.5	nm	nm	5.78	15,600		Yes	0.400	J	Yes	15.6		Yes
SA6-3C	SA6-3C	2012-11-02	0-3	8.08	97.4	nm	nm	5.46	16,200		Yes	0.200	J	Yes	25.6		Yes
SA6-4C	SA6-4C	2012-11-03	0-3	4.84	99.6	nm	nm	5.53	6,060		Yes	0.200	UJ	No	5.70		Yes
SA6-5C	SA6-5C	2012-11-03	0-3	2.56	99.7	nm	nm	6.02	4,590		Yes	0.300	J	Yes	6.90		Yes
SA6-6C	SA6-6C	2012-11-03	0-3	11.2	98.8	nm	nm	5.18	5,190		Yes	1.500	J	Yes	9.50		Yes
SA6-7C	SA6-7C	2012-11-02	0-3	7.92	97.7	nm	nm	5.30	17,100		Yes	0.500	J	Yes	36.3		Yes
SA6-8C	SA6-8C	2012-11-03	0-3	9.66	99.0	nm	nm	6.17	8,500		Yes	0.500	J	Yes	12.9		Yes
SA7-1C	SA7-1C	2012-11-03	0-3	6.63	97.9	nm	nm	5.65	12,400		Yes	0.800	J	Yes	16.6		Yes
SA7-2C	SA7-2C	2012-11-03	0-3	2.87	98.7	nm	nm	6.15	8,140		Yes	0.400	J	Yes	8.80		Yes
SA7-3C	SA7-3C	2012-11-03	0-3	8.81	98.6	nm	nm	5.48	10,500		Yes	1.70	J	Yes	29.5		Yes
SA7-4C	SA7-4C	2012-11-03	0-3	9.91	99.4	nm	nm	5.23	4,600		Yes	1.50	J	Yes	10.0		Yes
SA7-5C	SA7-5C	2012-11-03	0-3	8.07	96.7	nm	nm	5.12	17,500		Yes	3.30	J	Yes	35.5		Yes
SA7-5C	SA7-5C2	2012-11-03	0-3	6.12	97.1	nm	nm	5.43	20,200		Yes	0.700	J	Yes	24.9		Yes
SA7-6C	SA7-6C	2012-11-03	0-3	4.26	98.3	nm	nm	5.89	11,000		Yes	0.600	J	Yes	15.6		Yes
SA7-7C	SA7-7C	2012-11-09	0-3	5.19	96	nm	nm	5.46	13,000		Yes	1.10	J	Yes	24.1		Yes
SA7-8C	SA7-8C	2012-11-09	0-3	1.21	97.4	nm	nm	5.97	28,400		Yes	0.300	J	Yes	38.7		Yes
SA8-1C	SA8-1C	2012-11-04	0-3	3.85	98.0	nm	nm	5.66	10,400		Yes	0.600	J	Yes	20.2		Yes
SA8-2C	SA8-2C	2012-11-04	0-3	10.7	98.0	nm	nm	5.32	9,990		Yes	0.900	J	Yes	28.6		Yes
SA8-3C	SA8-3C	2012-11-03	0-3	1.85	99.5	nm	nm	5.7	8,730		Yes	0.200	UJ	No	7.60		Yes
SA8-3C	SA8-3C2	2012-11-03	0-3	1.27	99.4	nm	nm	5.59	9,120		Yes	0.200	UJ	No	11.9		Yes
SA8-4C	SA8-4C	2012-11-04	0-3	7.52	97.7	nm	nm	5.62	8,590		Yes	0.400	J	Yes	11.7		Yes
SA8-5C	SA8-5C	2012-11-04	0-3	18.3	96.7	nm	nm	5.43	7,360		Yes	1.20	J	Yes	17.0		Yes
SA8-6C	SA8-6C	2012-11-04	0-3	1.82	98.7	nm	nm	5.66	13,000		Yes	0.200	J	Yes	17.3		Yes
SA8-7C	SA8-7C	2012-11-04	0-3	8.30	96.3	nm	nm	5.56	16,000		Yes	0.700	J	Yes	37.6		Yes
SA8-8C	SA8-8C	2012-11-04	0-3	3.79	93.3	nm	nm	5.76	15,000		Yes	2.60	J	Yes	45.1		Yes
SA9-10C	SA9-10C	2012-11-09	0-3	9.18	95.9	nm	nm	6.03	18,700		Yes	0.200	UJ	No	22.0		Yes
SA9-10C	SA9-10C2	2012-11-09	0-3	6.56	96.0	nm	nm	6.11	16,200		Yes	0.300	J	Yes	30.6		Yes
SA9-1C	SA9-1C	2012-11-08	0-3	4.06	95.0	nm	nm	6.19	20,800		Yes	0.400	J	Yes	28.6		Yes
SA9-2C	SA9-2C	2012-11-09	0-3	3.80	98.0	nm	nm	6.10	28,700		Yes	0.200	UJ	No	10.3		Yes
SA9-3C	SA9-3C	2012-11-08	0-3	4.78	97.4	nm	nm	5.96	29,400		Yes	0.200	UJ	No	13.7		Yes
SA9-4C	SA9-4C	2012-11-08	0-3	3.32	93.0	nm	nm	6.13	15,600		Yes	0.500	J	Yes	17.9		Yes
SA9-5C	SA9-5C	2012-11-07	0-3	5.34	93.8	nm	nm	6.10	18,400		Yes	1.10	J	Yes	28.1		Yes
SA9-6C	SA9-6C	2012-11-07	0-3	8.40	95.6	nm	nm	6.44	15,300		Yes	0.500	J	Yes	14.1		Yes
SA9-7C	SA9-7C	2012-11-07	0-3	2.79	96.4	nm	nm	5.78	18,200		Yes	0.500	J	Yes	36.0		Yes
SA9-8C	SA9-8C	2012-11-08	0-3	12.4	93.7	nm	nm	5.97	21,200		Yes	0.700	J	Yes	26.3		Yes
SA9-9C	SA9-9C	2012-11-07	0-3	3.29	97.4	nm	nm	5.60	21,000		Yes	0.200	UJ	No	33.3		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

									Aluminum			Antimony			Arsenic		
Location ID	Sample ID	Sample Date	Depth Range (in.)	TOC (%)	Total Solids (%)	Clay (%)	eCEC	pH (H_2O)	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2015 Bossburg Flat Beach Study																	
UDU-01-ICS	UDU-01-ICS	2015-04-14	0-6	1.51	99.1	1.53	8.42	6.11	10,800		Yes	0.837	J	Yes	6.25		Yes
UDU-02-ICS	UDU-02-ICS	2015-04-16	0-6	1.55	98.8	1.58	7.44	6.14	11,800		Yes	0.886	J	Yes	5.86		Yes
UDU-03-ICS	UDU-03-ICS	2015-04-16	0-6	1.08	99.2	1.61	5.47	6.31	9,230		Yes	46.2	J	Yes	6.43		Yes
UDU-04-ICS	UDU-04-ICS-A	2015-04-17	0-6	1.47	98.9	1.49	6.15	5.57	9,470		Yes	2.24	J	Yes	6.80		Yes
UDU-04-ICS	UDU-04-ICS-B	2015-04-18	0-6	1.75	99.2	1.79	7.25	5.49	9,870		Yes	2.57	J	Yes	8.08		Yes
UDU-04-ICS	UDU-04-ICS-C	2015-04-18	0-6	1.50	99.3	1.77	6.81	5.76	8,760		Yes	1.46	J	Yes	5.97		Yes
UDU-05-ICS	UDU-05-ICS	2015-04-29	0-6	1.51	98.0	9.58	10.1	7.32	12,100		Yes	0.652	J	Yes	6.24		Yes
UDU-06-ICS	UDU-06-ICS	2015-05-07	0-6	4.05	93.2	3.43	22.1	8.02	8,820		Yes	0.978	J	Yes	10.7		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Barium			Beryllium			Cadmium			Calcium			Chromium		
Location ID	Sample ID	Sample Date	Value^a (mg/kg)	Qualifier	Detected Result?	Value^a (mg/kg)	Qualifier	Detected Result?	Value^a (mg/kg)	Qualifier	Detected Result?	Value^a (mg/kg)	Qualifier	Detected Result?	Value^a (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study																	
ADA-001	ADA-001	2014-09-13	192		Yes	0.449		Yes	7.13		Yes	5,010		Yes	18.8		Yes
ADA-002	ADA-002	2014-10-09	262		Yes	0.638		Yes	2.85		Yes	4,660		Yes	22.0		Yes
ADA-004	ADA-004	2014-10-09	428		Yes	0.529		Yes	6.20		Yes	5,030		Yes	13.8		Yes
ADA-005	ADA-005	2014-10-08	259		Yes	0.665	J	Yes	3.06		Yes	3,600		Yes	21.4		Yes
ADA-006	ADA-006	2014-10-11	126		Yes	0.33		Yes	4.12		Yes	3,120		Yes	15.1		Yes
ADA-008	ADA-008	2014-10-11	289		Yes	0.503		Yes	7.06		Yes	5,400		Yes	25.2		Yes
ADA-010	ADA-010	2014-10-02	196		Yes	0.607	J	Yes	9.64		Yes	12,200		Yes	18.3		Yes
ADA-015	ADA-015	2014-09-13	163		Yes	0.304		Yes	2.72		Yes	2,780		Yes	11.5		Yes
ADA-016	ADA-016-A	2014-09-24	95.8		Yes	0.299		Yes	2.73		Yes	2,020		Yes	12.8		Yes
ADA-016	ADA-016-B	2014-09-24	89.9		Yes	0.249		Yes	2.54		Yes	2,080		Yes	8.75		Yes
ADA-016	ADA-016-C	2014-09-24	83.6		Yes	0.260		Yes	2.62		Yes	2,020		Yes	9.05		Yes
ADA-017	ADA-017	2014-10-01	178	J	Yes	0.373	J	Yes	6.04		Yes	3,010		Yes	14.2		Yes
ADA-018	ADA-018	2014-10-01	263	J	Yes	0.435	J	Yes	10.1		Yes	4,200		Yes	20.4		Yes
ADA-019	ADA-019	2014-10-11	159		Yes	0.529		Yes	2.00		Yes	10,000		Yes	29.6		Yes
ADA-020	ADA-020-A	2014-09-13	163		Yes	0.604		Yes	1.47		Yes	2,820		Yes	19.1		Yes
ADA-020	ADA-020-B	2014-09-13	180		Yes	0.656		Yes	1.85		Yes	2,940		Yes	19.7		Yes
ADA-020	ADA-020-C	2014-09-13	179		Yes	0.655		Yes	1.62		Yes	2,940		Yes	19.9		Yes
ADA-021	ADA-021	2014-09-30	194		Yes	0.523		Yes	2.13		Yes	9,480		Yes	23.4		Yes
ADA-023	ADA-023-A	2014-09-13	203		Yes	0.432		Yes	4.80		Yes	5,300		Yes	24.1		Yes
ADA-023	ADA-023-B	2014-09-13	188		Yes	0.396		Yes	5.19		Yes	5,850		Yes	25.2		Yes
ADA-023	ADA-023-C	2014-09-13	204		Yes	0.435		Yes	6.31		Yes	5,770		Yes	26.1		Yes
ADA-024	ADA-024	2014-09-30	248		Yes	0.477		Yes	10.7		Yes	7,650		Yes	14.4		Yes
ADA-025	ADA-025	2014-09-17	820		Yes	0.522		Yes	11.0	J	Yes	5,270		Yes	8.01		Yes
ADA-026	ADA-026	2014-09-17	630		Yes	0.449		Yes	7.34	J	Yes	6,300		Yes	9.66		Yes
ADA-028	ADA-028	2014-10-03	221		Yes	0.401	J	Yes	5.80		Yes	4,800		Yes	13.9		Yes
ADA-033	ADA-033	2014-09-24	517		Yes	0.622		Yes	5.00		Yes	15,600		Yes	10.7		Yes
ADA-034	ADA-034	2014-10-10	316		Yes	0.722		Yes	1.66		Yes	9,730		Yes	14.0	J	Yes
ADA-035	ADA-035	2014-10-03	307		Yes	0.572	J	Yes	5.85		Yes	13,200		Yes	12.4		Yes
ADA-039	ADA-039	2014-10-01	643	J	Yes	0.635	J	Yes	5.57		Yes	3,360		Yes	14.1		Yes
ADA-042	ADA-042	2014-10-09	449		Yes	0.429		Yes	2.27		Yes	2,920		Yes	16.9		Yes
ADA-043	ADA-043	2014-10-03	1170		Yes	0.390	J	Yes	4.90		Yes	7,550		Yes	23.3		Yes
ADA-044	ADA-044	2014-09-18	435		Yes	0.676		Yes	12.4	J	Yes	6,100		Yes	37.7		Yes
ADA-045	ADA-045	2014-10-09	257		Yes	0.475		Yes	10.6		Yes	8,130		Yes	15.1		Yes
ADA-046	ADA-046	2014-10-01	230	J	Yes	0.342	J	Yes	5.19		Yes	4,020		Yes	13.2		Yes
ADA-047	ADA-047	2014-09-30	233		Yes	0.563		Yes	7.70		Yes	10,200		Yes	27.4		Yes
ADA-048	ADA-048	2014-10-22	1420		Yes	0.464		Yes	5.16		Yes	9,290		Yes	15.4		Yes
ADA-049	ADA-049	2014-09-17	618		Yes	0.665		Yes	7.11	J	Yes	3,090		Yes	13.1		Yes
ADA-050	ADA-050	2014-10-04	213		Yes	0.779		Yes	10.3		Yes	9,670		Yes	32.6		Yes
ADA-051	ADA-051	2014-10-22	802		Yes	0.457		Yes	8.16		Yes	8,350		Yes	12.1		Yes
ADA-052	ADA-052	2014-10-02	343		Yes	0.461	J	Yes	9.85		Yes	6,910		Yes	28.7		Yes
ADA-053	ADA-053	2014-10-07	565		Yes	0.548	J	Yes	2.40		Yes	6,090		Yes	35.0		Yes
ADA-054	ADA-054	2014-09-30	232		Yes	0.551		Yes	9.98		Yes	5,520		Yes	16.6		Yes
ADA-055	ADA-055-A	2014-10-08	1360		Yes	0.513	J	Yes	10.4		Yes	6,400		Yes	13.9		Yes
ADA-055	ADA-055-B	2014-10-08	1470		Yes	0.563	J	Yes	10.7		Yes	6,300		Yes	14.9		Yes
ADA-055	ADA-055-C	2014-10-08	1310		Yes	0.505	J	Yes	8.62		Yes	5,690		Yes	14.7		Yes
ADA-056	ADA-056	2014-09-15	551		Yes	0.618	J	Yes	2.27		Yes	4,540		Yes	32.5		Yes
ADA-057	ADA-057	2014-10-07	285		Yes	0.518		Yes	2.90		Yes	4,960		Yes	35.4		Yes
ADA-058	ADA-058	2014-09-19	424		Yes	0.470	J	Yes	2.33		Yes	5,560		Yes	20.2		Yes
ADA-059	ADA-059	2014-10-07	588		Yes	0.480	J	Yes	3.46		Yes	5,990		Yes	29.9		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Barium			Beryllium			Cadmium			Calcium			Chromium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study (continued)																	
ADA-060	ADA-060-A	2014-10-06	201		Yes	0.525		Yes	7.36		Yes	6,490		Yes	24.4		Yes
ADA-060	ADA-060-B	2014-10-06	224		Yes	0.541		Yes	7.50		Yes	7,030		Yes	29.9		Yes
ADA-060	ADA-060-C	2014-10-06	194		Yes	0.531		Yes	6.42		Yes	6,100		Yes	24.0		Yes
ADA-061	ADA-061	2014-09-16	620		Yes	0.614		Yes	2.83		Yes	5,540		Yes	78.7		Yes
ADA-062	ADA-062	2014-10-06	235		Yes	0.538		Yes	6.45		Yes	4,690		Yes	19.9		Yes
ADA-063	ADA-063	2014-09-17	1370		Yes	0.533		Yes	7.19	J	Yes	5,080		Yes	16.8		Yes
ADA-064	ADA-064	2014-09-16	517		Yes	0.572		Yes	2.68		Yes	5,180		Yes	37.0		Yes
ADA-065	ADA-065	2014-10-07	102		Yes	0.328	J	Yes	3.17		Yes	2,440		Yes	10.9		Yes
ADA-066	ADA-066	2014-10-06	211		Yes	0.472		Yes	4.53		Yes	4,170		Yes	19.9		Yes
ADA-067	ADA-067	2014-09-17	811		Yes	0.552		Yes	8.18	J	Yes	5,550		Yes	24.9		Yes
ADA-070	ADA-070	2014-10-01	347	J	Yes	0.513	J	Yes	6.28		Yes	4,920		Yes	26.1		Yes
ADA-071	ADA-071	2014-10-07	287		Yes	0.499	J	Yes	5.85		Yes	3,840		Yes	20.9		Yes
ADA-073	ADA-073	2014-10-03	286		Yes	0.463	J	Yes	5.00		Yes	4,150		Yes	20.1		Yes
ADA-076	ADA-076	2014-10-14	397		Yes	0.524	J	Yes	12.9		Yes	4,290		Yes	20.3		Yes
ADA-078	ADA-078	2014-09-29	420		Yes	0.521		Yes	6.13	J	Yes	4,690	J	Yes	24.5		Yes
ADA-079	ADA-079	2014-10-14	937		Yes	0.513	J	Yes	12.2		Yes	5,860		Yes	21.0		Yes
ADA-081	ADA-081	2014-10-08	216		Yes	0.444	J	Yes	2.91		Yes	4,190		Yes	29.5		Yes
ADA-082	ADA-082	2014-10-04	288		Yes	0.475		Yes	3.16		Yes	7,800		Yes	24.7		Yes
ADA-084	ADA-084	2014-10-09	326		Yes	0.451		Yes	4.00		Yes	8,760		Yes	21.9		Yes
ADA-085	ADA-085	2014-09-17	296		Yes	0.482		Yes	4.18	J	Yes	23,700		Yes	18.2		Yes
ADA-088	ADA-088	2014-10-02	379		Yes	0.605	J	Yes	5.98		Yes	6,920		Yes	33.0		Yes
ADA-089	ADA-089	2014-10-07	402		Yes	0.734	J	Yes	5.59		Yes	5,650		Yes	25.2		Yes
ADA-090	ADA-090	2014-10-07	482		Yes	0.576	J	Yes	5.56		Yes	8,050		Yes	26.6		Yes
ADA-091	ADA-091	2014-10-02	309		Yes	0.589	J	Yes	7.52		Yes	6,600		Yes	35.7		Yes
ADA-092	ADA-092	2014-10-06	423		Yes	0.573		Yes	8.69		Yes	7,370		Yes	24.3		Yes
ADA-093	ADA-093	2014-09-16	416		Yes	0.616		Yes	4.46		Yes	3,780		Yes	18.5		Yes
ADA-094	ADA-094	2014-10-16	359		Yes	0.615		Yes	1.96		Yes	4,860		Yes	22.6		Yes
ADA-095	ADA-095	2014-10-08	347		Yes	0.705	J	Yes	2.86		Yes	6,090		Yes	30.0		Yes
ADA-096	ADA-096	2014-09-26	470		Yes	0.643		Yes	6.16		Yes	8,390		Yes	14.5		Yes
ADA-097	ADA-097	2014-09-24	346		Yes	0.536		Yes	9.89		Yes	8,950		Yes	28.9		Yes
ADA-099	ADA-099	2014-10-10	386		Yes	0.985		Yes	5.81		Yes	6,940		Yes	25.7	J	Yes
ADA-101	ADA-101	2014-10-11	237		Yes	0.400	J	Yes	3.93		Yes	4,240		Yes	21.5		Yes
ADA-102	ADA-102	2014-10-08	400		Yes	0.523	J	Yes	2.87		Yes	5,140		Yes	21.8		Yes
ADA-103	ADA-103	2014-09-26	518		Yes	0.655		Yes	3.68		Yes	6,660		Yes	31.5		Yes
ADA-104	ADA-104	2014-09-19	423		Yes	0.541	J	Yes	2.54		Yes	4,120		Yes	12.8		Yes
ADA-105	ADA-105	2014-10-10	427		Yes	0.473		Yes	6.95		Yes	7,230		Yes	23.2	J	Yes
ADA-106	ADA-106-A	2014-10-15	636		Yes	0.541		Yes	3.00		Yes	5,160		Yes	19.5		Yes
ADA-106	ADA-106-B	2014-10-15	594		Yes	0.548		Yes	2.47		Yes	4,750		Yes	19.3		Yes
ADA-106	ADA-106-C	2014-10-16	885		Yes	0.510		Yes	3.07		Yes	5,200		Yes	19.7		Yes
ADA-107	ADA-107-A	2014-10-02	568		Yes	0.533	J	Yes	5.47		Yes	7,730		Yes	35.5		Yes
ADA-107	ADA-107-B	2014-10-01	540	J	Yes	0.549	J	Yes	4.42		Yes	7,010		Yes	50.0		Yes
ADA-107	ADA-107-C	2014-10-01	577	J	Yes	0.611	J	Yes	5.03		Yes	7,440		Yes	38.3		Yes
ADA-108	ADA-108-A	2014-10-10	274		Yes	0.588		Yes	3.67		Yes	6,400		Yes	50.5	J	Yes
ADA-108	ADA-108-B	2014-10-10	247		Yes	0.501		Yes	3.84		Yes	6,850		Yes	30.1	J	Yes
ADA-108	ADA-108-C	2014-10-09	248		Yes	0.498		Yes	3.73		Yes	6,190		Yes	36.8		Yes
ADA-109	ADA-109	2014-09-30	217		Yes	0.412		Yes	7.46		Yes	7,430		Yes	21.3		Yes
ADA-110	ADA-110	2014-09-26	183		Yes	0.436		Yes	5.22		Yes	4,720		Yes	20.0		Yes
ADA-111	ADA-111	2014-10-07	373		Yes	0.483	J	Yes	2.71		Yes	6,840		Yes	33.1		Yes
ADA-112	ADA-112	2014-10-16	451		Yes	0.655		Yes	3.29		Yes	7,690		Yes	20.7		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Barium			Beryllium			Cadmium			Calcium			Chromium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study (continued)																	
ADA-113	ADA-113	2014-09-20	545	J	Yes	0.729		Yes	2.73		Yes	6,530		Yes	25.8	J	Yes
ADA-114	ADA-114	2014-10-06	401		Yes	0.747		Yes	2.85		Yes	6,690		Yes	20.1		Yes
ADA-115	ADA-115	2014-10-17	320		Yes	0.574		Yes	2.66		Yes	3,930		Yes	17.4		Yes
ADA-116	ADA-116	2014-10-08	266		Yes	0.510	J	Yes	2.57		Yes	3,900		Yes	19.1		Yes
ADA-117	ADA-117	2014-09-29	292		Yes	0.488		Yes	3.71	J	Yes	3,520	J	Yes	18.5		Yes
ADA-118	ADA-118	2014-09-30	411		Yes	0.696		Yes	4.95		Yes	7,080		Yes	43.9		Yes
ADA-119	ADA-119	2014-10-02	268		Yes	0.519	J	Yes	3.87		Yes	6,310		Yes	24.6		Yes
ADA-121	ADA-121	2014-10-14	393		Yes	0.501	J	Yes	5.84		Yes	7,740		Yes	25.4		Yes
ADA-122	ADA-122	2014-10-10	431		Yes	0.609		Yes	2.90		Yes	4,620		Yes	19.4	J	Yes
ADA-124	ADA-124-A	2014-10-04	164		Yes	0.310		Yes	3.17		Yes	2,440		Yes	10.5		Yes
ADA-124	ADA-124-B	2014-10-04	147		Yes	0.295		Yes	2.94		Yes	2,310		Yes	10.6		Yes
ADA-124	ADA-124-C	2014-10-04	157		Yes	0.327		Yes	2.30		Yes	1,980		Yes	11.2		Yes
ADA-125	ADA-125	2014-10-23	144		Yes	0.333		Yes	2.35		Yes	1,630		Yes	9.73		Yes
ADA-126	ADA-126	2014-09-11	282		Yes	0.357	J	Yes	7.90		Yes	4,990		Yes	12.1		Yes
ADA-127	ADA-127	2014-10-14	492		Yes	0.478	J	Yes	6.32		Yes	5,440		Yes	17.5		Yes
ADA-128	ADA-128	2014-10-03	85.1		Yes	0.239	J	Yes	5.13		Yes	2,780		Yes	8.51		Yes
ADA-131	ADA-131-A	2014-09-18	413		Yes	0.434		Yes	10.0	J	Yes	4,140		Yes	17.0		Yes
ADA-131	ADA-131-B	2014-09-18	359		Yes	0.448		Yes	6.28	J	Yes	3,440		Yes	17.4		Yes
ADA-131	ADA-131-C	2014-09-18	362		Yes	0.423		Yes	9.17	J	Yes	4,050		Yes	16.8		Yes
ADA-132	ADA-132	2014-09-16	163		Yes	0.292		Yes	3.25		Yes	2,400		Yes	16.1		Yes
ADA-133	ADA-133	2014-09-23	210		Yes	0.375	J	Yes	4.98		Yes	3,850		Yes	15.5		Yes
ADA-135	ADA-135-A	2014-09-17	95.4		Yes	0.372		Yes	2.61	J	Yes	3,570		Yes	20.2		Yes
ADA-135	ADA-135-B	2014-09-17	103		Yes	0.359		Yes	2.40	J	Yes	3,040		Yes	18.7		Yes
ADA-135	ADA-135-C	2014-09-18	100		Yes	0.349		Yes	2.44	J	Yes	3,060		Yes	18.9		Yes
ADA-136	ADA-136	2014-09-10	136		Yes	0.298	J	Yes	5.59		Yes	3,670		Yes	13.8		Yes
ADA-139	ADA-139	2014-10-14	314		Yes	0.407	J	Yes	5.10		Yes	6,860		Yes	22.2		Yes
ADA-141	ADA-141	2014-09-23	203		Yes	0.386	J	Yes	3.04		Yes	2,770	J	Yes	16.7	J	Yes
ADA-142	ADA-142	2014-09-25	125		Yes	0.278		Yes	5.16		Yes	2,540		Yes	12.2		Yes
ADA-143	ADA-143	2014-09-15	109		Yes	0.314	J	Yes	2.98		Yes	2,330		Yes	12.3		Yes
ADA-144	ADA-144	2014-09-29	88.6		Yes	0.330		Yes	5.78	J	Yes	1,670	J	Yes	7.44		Yes
ADA-145	ADA-145	2014-09-24	235		Yes	0.490		Yes	6.83		Yes	6,950		Yes	16.6		Yes
ADA-146	ADA-146	2014-10-02	182		Yes	0.324	J	Yes	6.35		Yes	3,100		Yes	13.1		Yes
ADA-147	ADA-147	2014-09-29	88.0		Yes	0.263		Yes	5.52	J	Yes	1,620	J	Yes	7.32		Yes
ADA-148	ADA-148	2014-10-06	88.7		Yes	0.268		Yes	5.99		Yes	1,860		Yes	12.7		Yes
ADA-150	ADA-150	2014-10-06	83.0		Yes	0.298		Yes	5.03		Yes	1,860		Yes	10.3		Yes
ADA-151	ADA-151	2014-10-04	56.2		Yes	0.218		Yes	3.42		Yes	2,120		Yes	12.7		Yes
ADA-152	ADA-152	2014-10-09	375		Yes	0.488		Yes	7.58		Yes	5,290		Yes	27.8		Yes
ADA-153	ADA-153	2014-09-20	224	J	Yes	0.372		Yes	7.52		Yes	5,330		Yes	16.1	J	Yes
ADA-154	ADA-154-A	2014-09-20	304	J	Yes	0.364		Yes	6.15		Yes	4,890		Yes	41.0	J	Yes
ADA-154	ADA-154-B	2014-09-20	289	J	Yes	0.454		Yes	6.78		Yes	5,610		Yes	43.6	J	Yes
ADA-154	ADA-154-C	2014-09-20	305	J	Yes	0.426		Yes	7.08		Yes	5,350		Yes	36.8	J	Yes
ADA-155	ADA-155	2014-09-15	184		Yes	0.283	J	Yes	4.98		Yes	2,760		Yes	9.67		Yes
ADA-156	ADA-156	2014-10-07	328		Yes	0.427		Yes	8.44		Yes	3,970		Yes	20.2		Yes
ADA-158	ADA-158-A	2014-10-07	101		Yes	0.305	J	Yes	5.18		Yes	3,510		Yes	16.3		Yes
ADA-158	ADA-158-B	2014-10-07	125		Yes	0.298	J	Yes	6.57		Yes	3,300		Yes	16.9		Yes
ADA-158	ADA-158-C	2014-10-07	118		Yes	0.300		Yes	8.53		Yes	4,300		Yes	19.2		Yes
ADA-159	ADA-159-A	2014-10-04	198		Yes	0.429		Yes	7.74		Yes	4,830		Yes	24.7		Yes
ADA-159	ADA-159-B	2014-10-04	203		Yes	0.368		Yes	8.05		Yes	5,410		Yes	23.4		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Barium			Beryllium			Cadmium			Calcium			Chromium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study (continued)																	
ADA-159	ADA-159-C	2014-10-04	182		Yes	0.339		Yes	7.11		Yes	4,210		Yes	15.5		Yes
ADA-160	ADA-160	2014-10-03	105		Yes	0.274	J	Yes	4.31		Yes	1,710		Yes	9.82		Yes
ADA-161	ADA-161	2014-10-03	245		Yes	0.352	J	Yes	7.24		Yes	3,720		Yes	18.6		Yes
ADA-162	ADA-162	2014-10-09	118		Yes	0.265		Yes	11.5		Yes	3,160		Yes	10.5		Yes
ADA-164	ADA-164	2014-09-30	203		Yes	0.307		Yes	9.23		Yes	9,410		Yes	14.4		Yes
ADA-165	ADA-165	2014-09-16	208		Yes	0.384		Yes	10.8		Yes	3,750		Yes	17.4		Yes
ADA-168	ADA-168	2014-10-14	187		Yes	0.359	J	Yes	7.55		Yes	3,240		Yes	16.4		Yes
ADA-169	ADA-169-A	2014-09-19	225		Yes	0.587	J	Yes	0.850		Yes	4,900		Yes	14.3		Yes
ADA-169	ADA-169-B	2014-09-19	187		Yes	0.545	J	Yes	0.924		Yes	6,890		Yes	14.8		Yes
ADA-169	ADA-169-C	2014-09-19	201		Yes	0.646	J	Yes	0.901		Yes	9,950		Yes	14.7		Yes
ADA-170	ADA-170	2014-09-23	218		Yes	0.489	J	Yes	2.37		Yes	6,460		Yes	14.7		Yes
ADA-171	ADA-171	2014-09-23	221		Yes	0.408	J	Yes	2.76		Yes	6,440		Yes	13.4		Yes
ADA-172	ADA-172	2014-09-29	220		Yes	0.424		Yes	0.890	J	Yes	3,770	J	Yes	10.7		Yes
ADA-173	ADA-173-A	2014-09-12	313	J	Yes	0.550		Yes	1.86		Yes	4,110		Yes	15.0		Yes
ADA-173	ADA-173-B	2014-09-12	326	J	Yes	0.515		Yes	1.92		Yes	5,390		Yes	15.7		Yes
ADA-173	ADA-173-C	2014-09-12	335	J	Yes	0.518		Yes	2.20		Yes	4,700		Yes	15.3		Yes
ADA-174	ADA-174	2014-09-12	417	J	Yes	0.529		Yes	3.41		Yes	4,480		Yes	13.7		Yes
ADA-175	ADA-175	2014-09-15	286		Yes	0.432	J	Yes	0.936		Yes	4,990		Yes	16.3		Yes
ADA-176	ADA-176	2014-09-12	371	J	Yes	0.523		Yes	0.851		Yes	6,620		Yes	24.4		Yes
ADA-177	ADA-177	2014-09-16	188		Yes	0.390		Yes	0.701		Yes	3,690		Yes	19.0		Yes
ADA-178	ADA-178	2014-09-11	178		Yes	0.476	J	Yes	0.734		Yes	9,570		Yes	17.6		Yes
ADA-179	ADA-179	2014-09-18	302		Yes	0.586		Yes	1.99	J	Yes	5,190		Yes	12.4		Yes
ADA-180	ADA-180	2014-09-19	585		Yes	0.497	J	Yes	4.12		Yes	7,620		Yes	13.1		Yes
ADA-181	ADA-181	2014-09-12	420	J	Yes	0.469		Yes	4.27		Yes	6,820		Yes	13.9		Yes
ADA-182	ADA-182	2014-10-13	362		Yes	0.504		Yes	5.20		Yes	4,910		Yes	15.0		Yes
ADA-183	ADA-183	2014-09-11	433		Yes	0.443	J	Yes	14.3		Yes	7,940		Yes	14.6		Yes
ADA-184	ADA-184	2014-09-11	757		Yes	0.439	J	Yes	9.86		Yes	5,950		Yes	10.8		Yes
2012 Ecology Upland Soil Study																	
SA1-1C	SA1-1C	2012-10-30	665		Yes	0.800		Yes	3.30		Yes	10,800		Yes	47.1		Yes
SA1-2C	SA1-2C	2012-10-30	1120		Yes	1.20		Yes	2.10		Yes	7,500		Yes	29.8		Yes
SA1-3C	SA1-3C	2012-10-30	425		Yes	1.00		Yes	1.00		Yes	5,140		Yes	27.3		Yes
SA1-3C	SA1-3C2	2012-10-30	426		Yes	1.00		Yes	0.900		Yes	4,980		Yes	26.7		Yes
SA1-4C	SA1-4C	2012-10-30	487		Yes	0.800		Yes	1.00		Yes	3,690		Yes	21.8		Yes
SA1-5C	SA1-5C	2012-10-30	267		Yes	0.800		Yes	1.70		Yes	5,000		Yes	23.5		Yes
SA1-6C	SA1-6C	2012-10-30	261		Yes	0.700		Yes	1.60		Yes	3,110		Yes	22.9		Yes
SA1-7C	SA1-7C	2012-10-30	226		Yes	0.700		Yes	1.50		Yes	5,720		Yes	19.5		Yes
SA1-8C	SA1-8C	2012-10-30	399		Yes	0.700		Yes	2.00		Yes	5,280		Yes	14.7		Yes
SA10-1C	SA10-1C	2012-11-08	507		Yes	0.600		Yes	7.40		Yes	8,760		Yes	34.0		Yes
SA10-2C	SA10-2C	2012-11-08	498		Yes	1.20		Yes	37.3		Yes	14,000		Yes	20.6		Yes
SA10-3C	SA10-3C	2012-11-05	512		Yes	0.700		Yes	22.2		Yes	9,030		Yes	15.0		Yes
SA10-3C	SA10-3C2	2012-11-05	441		Yes	0.700		Yes	19.8		Yes	7,390		Yes	14.9		Yes
SA10-4C	SA10-4C	2012-11-05	132		Yes	0.500		Yes	6.40		Yes	21,100		Yes	11.2		Yes
SA10-5C	SA10-5C	2012-11-05	229		Yes	0.500		Yes	4.50		Yes	10,700		Yes	26.2		Yes
SA10-6C	SA10-6C	2012-11-05	427		Yes	0.800		Yes	4.10		Yes	7,650		Yes	20.4		Yes
SA10-7C	SA10-7C	2012-11-05	502		Yes	0.700		Yes	9.00		Yes	9,480		Yes	20.6		Yes
SA10-8C	SA10-8C	2012-11-08	374		Yes	0.600		Yes	7.40		Yes	6,330		Yes	21.2		Yes
SA11-1C	SA11-1C	2012-11-08	230		Yes	0.700		Yes	2.20		Yes	4,010		Yes	31.9		Yes
SA11-2C	SA11-2C	2012-11-06	443		Yes	0.400		Yes	2.50		Yes	5,590		Yes	19.5		Yes
SA11-3C	SA11-3C	2012-11-10	255		Yes	0.500		Yes	2.40		Yes	10,900		Yes	23.2		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Barium			Beryllium			Cadmium			Calcium			Chromium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2012 Ecology Upland Soil Study (continued)																	
SA11-4C	SA11-4C	2012-11-08	484		Yes	0.600		Yes	13.3		Yes	7,340		Yes	21.5		Yes
SA11-5C	SA11-5C	2012-11-06	413		Yes	0.500		Yes	6.90		Yes	4,640		Yes	14.9		Yes
SA11-6C	SA11-6C	2012-11-06	192		Yes	0.700		Yes	6.30		Yes	3,780		Yes	31.4		Yes
SA11-7C	SA11-7C	2012-11-06	876		Yes	0.600		Yes	15.8		Yes	12,100		Yes	8.60		Yes
SA11-8C	SA11-8C	2012-11-07	276		Yes	0.500		Yes	5.00		Yes	4,130		Yes	25.9		Yes
SA11-8C	SA11-8C2	2012-11-07	523		Yes	0.500		Yes	14.7		Yes	5,680		Yes	19.8		Yes
SA11-9C	SA11-9C	2012-11-08	420		Yes	1.00		Yes	16.9		Yes	8,990		Yes	31.2		Yes
SA12-1C	SA12-1C	2012-11-07	266		Yes	1.30		Yes	6.23		Yes	6,040		Yes	35.0		Yes
SA12-2C	SA12-2C	2012-11-10	252		Yes	0.500		Yes	2.80		Yes	3,250		Yes	21.4		Yes
SA12-3C	SA12-3C	2012-11-10	154		Yes	0.400		Yes	4.10		Yes	10,400		Yes	16.1		Yes
SA12-4C	SA12-4C	2012-11-10	425		Yes	0.400		Yes	4.00		Yes	6,910		Yes	16.0		Yes
SA12-6C	SA12-6C	2012-11-10	370		Yes	1.60		Yes	3.30		Yes	5,720		Yes	15.1		Yes
SA12-7C	SA12-7C	2012-11-10	590		Yes	0.600		Yes	4.90		Yes	6,770		Yes	20.9		Yes
SA12-7C	SA12-7C2	2012-11-10	414		Yes	0.600		Yes	4.20		Yes	5,500		Yes	22.6		Yes
SA12-8C	SA12-8C	2012-11-10	362		Yes	0.500		Yes	2.60		Yes	4,530		Yes	17.7		Yes
SA12-9C	SA12-9C	2012-11-10	406		Yes	0.700		Yes	2.00		Yes	4,690		Yes	22.6		Yes
SA13-1C	SA13-1C	2012-11-10	274		Yes	0.800		Yes	2.40		Yes	6,490		Yes	21.5		Yes
SA13-2C	SA13-2C	2012-11-10	311		Yes	0.500		Yes	4.40		Yes	24,500		Yes	21.2		Yes
SA13-3C	SA13-3C	2012-11-10	385		Yes	0.500		Yes	3.90		Yes	4,510		Yes	18.7		Yes
SA13-4C	SA13-4C	2012-11-10	157		Yes	0.400		Yes	1.30		Yes	10,200		Yes	22.0		Yes
SA13-5C	SA13-5C	2012-11-10	452		Yes	0.500		Yes	12.9		Yes	9,820		Yes	28.0		Yes
SA13-5C	SA13-5C2	2012-11-10	454		Yes	0.500		Yes	11.7		Yes	9,680		Yes	28.0		Yes
SA13-6C	SA13-6C	2012-11-10	294		Yes	0.600		Yes	3.60		Yes	3,050		Yes	18.0		Yes
SA13-7C	SA13-7C	2012-11-07	295		Yes	0.500		Yes	2.60		Yes	2,700		Yes	22.0		Yes
SA13-8C	SA13-8C	2012-11-10	272		Yes	0.500		Yes	2.80		Yes	4,280		Yes	21.4		Yes
SA2-1C	SA2-1C	2012-10-31	744		Yes	0.700		Yes	5.20		Yes	5,730		Yes	16.4		Yes
SA2-2C	SA2-2C	2012-10-31	344		Yes	0.600		Yes	2.00		Yes	4,150		Yes	31.7		Yes
SA2-3C	SA2-3C	2012-10-31	321		Yes	0.500		Yes	1.90		Yes	5,010		Yes	15.3		Yes
SA2-4C	SA2-4C	2012-10-31	264		Yes	0.500		Yes	2.40		Yes	3,370		Yes	17.3		Yes
SA2-4C	SA2-4C2	2012-10-31	308		Yes	0.500		Yes	4.90		Yes	3,390		Yes	15.9		Yes
SA2-5C	SA2-5C	2012-10-31	90.4		Yes	0.400		Yes	1.40		Yes	7,760		Yes	20.6		Yes
SA2-6C	SA2-6C	2012-10-31	203		Yes	0.500		Yes	13.1		Yes	5,940		Yes	48.6		Yes
SA2-7C	SA2-7C	2012-10-31	209		Yes	0.900		Yes	3.20		Yes	5,230		Yes	28.7		Yes
SA2-8C	SA2-8C	2012-10-31	392		Yes	0.800		Yes	2.10		Yes	4,590		Yes	30.3		Yes
SA3-1C	SA3-1C	2012-11-01	316		Yes	0.600		Yes	0.600		Yes	4,090		Yes	20.6		Yes
SA3-2C	SA3-2C	2012-11-01	442		Yes	0.500		Yes	1.40		Yes	2,800		Yes	11.8		Yes
SA3-3C	SA3-3C	2012-11-01	422		Yes	0.900		Yes	4.00		Yes	6,260		Yes	62.0		Yes
SA3-4C	SA3-4C	2012-11-01	275		Yes	0.500		Yes	1.60		Yes	2,930		Yes	12.3		Yes
SA3-5C	SA3-5C	2012-11-01	269		Yes	0.400		Yes	2.30		Yes	2,990		Yes	20.6		Yes
SA3-6C	SA3-6C	2012-11-01	934		Yes	0.800		Yes	11.1		Yes	14,900		Yes	94.0		Yes
SA3-6C	SA3-6C2	2012-11-01	827		Yes	0.900		Yes	6.80		Yes	15,200		Yes	110		Yes
SA3-7C	SA3-7C	2012-11-01	301		Yes	0.500		Yes	7.70		Yes	7,960		Yes	20.3		Yes
SA3-8C	SA3-8C	2012-11-01	313		Yes	0.400		Yes	3.60		Yes	4,970		Yes	14.6		Yes
SA4-1C	SA4-1C	2012-11-01	290		Yes	0.500		Yes	5.44		Yes	5,650		Yes	27.5		Yes
SA4-2C	SA4-2C	2012-11-01	168		Yes	0.500		Yes	3.40		Yes	7,470		Yes	21.9		Yes
SA4-3C	SA4-3C	2012-11-01	135		Yes	0.500		Yes	9.00		Yes	4,420		Yes	28.9		Yes
SA4-4C	SA4-4C	2012-11-01	215		Yes	0.500		Yes	5.60		Yes	7,740		Yes	28.0		Yes
SA4-5C	SA4-5C	2012-11-01	175		Yes	0.700		Yes	2.70		Yes	4,980		Yes	20.7		Yes
SA4-6C	SA4-6C	2012-11-02	207		Yes	0.500		Yes	9.20		Yes	6,410		Yes	24.5		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Barium			Beryllium			Cadmium			Calcium			Chromium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2012 Ecology Upland Soil Study (continued)																	
SA4-6C	SA4-6C2	2012-11-02	202		Yes	0.600		Yes	7.60		Yes	5,690		Yes	30.5		Yes
SA4-7C	SA4-7C	2012-11-01	383		Yes	0.600		Yes	5.50		Yes	7,070		Yes	53.8		Yes
SA4-8C	SA4-8C	2012-11-01	182		Yes	0.500		Yes	3.60		Yes	4,840		Yes	13.5		Yes
SA5-1C	SA5-1C	2012-11-09	197		Yes	0.600		Yes	5.60		Yes	10,300		Yes	16.5		Yes
SA5-2C	SA5-2C	2012-11-09	773		Yes	0.800		Yes	3.70		Yes	7,540		Yes	182		Yes
SA5-3C	SA5-3C	2012-11-03	293		Yes	0.600		Yes	8.60		Yes	15,300		Yes	22.2		Yes
SA5-4C	SA5-4C	2012-11-02	227		Yes	0.400		Yes	7.50		Yes	6,910		Yes	14.0		Yes
SA5-4C	SA5-4C2	2012-11-02	199		Yes	0.400		Yes	6.60		Yes	5,960		Yes	19.3		Yes
SA5-5C	SA5-5C	2012-11-09	160		Yes	0.400		Yes	2.90		Yes	7,000		Yes	21.1		Yes
SA5-7C	SA5-7C	2012-11-02	130		Yes	0.300		Yes	9.50		Yes	7,260		Yes	15.5		Yes
SA5-8C	SA5-8C	2012-09-11	176		Yes	0.600		Yes	5.90		Yes	4,120		Yes	33.8		Yes
SA6-1C	SA6-1C	2012-11-02	352		Yes	0.400		Yes	8.60		Yes	5,920		Yes	20.0		Yes
SA6-2C	SA6-2C	2012-11-02	319		Yes	0.600		Yes	8.90		Yes	4,790		Yes	20.6		Yes
SA6-2C	SA6-2C2	2012-11-02	315		Yes	0.500		Yes	7.17		Yes	4,070		Yes	17.3		Yes
SA6-3C	SA6-3C	2012-11-02	340		Yes	0.600		Yes	10.6		Yes	4,800		Yes	40.3		Yes
SA6-4C	SA6-4C	2012-11-03	44.1		Yes	0.200		Yes	1.50		Yes	1,590		Yes	8.90		Yes
SA6-5C	SA6-5C	2012-11-03	34.8		Yes	0.200		Yes	1.10		Yes	1,310		Yes	8.30		Yes
SA6-6C	SA6-6C	2012-11-03	138		Yes	0.200		Yes	8.40		Yes	3,010		Yes	7.60		Yes
SA6-7C	SA6-7C	2012-11-02	295		Yes	0.600		Yes	9.80		Yes	4,950		Yes	27.8		Yes
SA6-8C	SA6-8C	2012-11-03	119		Yes	0.300		Yes	2.50		Yes	1,730		Yes	9.20		Yes
SA7-1C	SA7-1C	2012-11-03	292		Yes	0.400		Yes	5.60		Yes	3,310		Yes	16.1		Yes
SA7-2C	SA7-2C	2012-11-03	99.4		Yes	0.300		Yes	5.80		Yes	5,160		Yes	18.1		Yes
SA7-3C	SA7-3C	2012-11-03	120		Yes	0.400		Yes	6.80		Yes	1,960		Yes	10.3		Yes
SA7-4C	SA7-4C	2012-11-03	55.0		Yes	0.200		Yes	4.77		Yes	1,630		Yes	7.00		Yes
SA7-5C	SA7-5C	2012-11-03	159		Yes	0.500		Yes	9.00		Yes	3,330		Yes	11.3		Yes
SA7-5C	SA7-5C2	2012-11-03	167		Yes	0.600		Yes	8.10		Yes	3,360		Yes	15.1		Yes
SA7-6C	SA7-6C	2012-11-03	167		Yes	0.400		Yes	11.1		Yes	4,060		Yes	12.5		Yes
SA7-7C	SA7-7C	2012-11-09	274		Yes	0.400		Yes	17.2		Yes	7,110		Yes	18.5		Yes
SA7-8C	SA7-8C	2012-11-09	514		Yes	0.700		Yes	13.9		Yes	6,730		Yes	159		Yes
SA8-1C	SA8-1C	2012-11-04	192		Yes	0.400		Yes	10.8		Yes	4,010		Yes	12.2		Yes
SA8-2C	SA8-2C	2012-11-04	159		Yes	0.300		Yes	8.60		Yes	2,280		Yes	9.10		Yes
SA8-3C	SA8-3C	2012-11-03	75.7		Yes	0.200		Yes	1.50		Yes	3,250		Yes	17.1		Yes
SA8-3C	SA8-3C2	2012-11-03	82.9		Yes	0.300		Yes	3.00		Yes	2,820		Yes	16.9		Yes
SA8-4C	SA8-4C	2012-11-04	161		Yes	0.300		Yes	6.50		Yes	3,540		Yes	10.6		Yes
SA8-5C	SA8-5C	2012-11-04	119		Yes	0.300		Yes	9.30		Yes	3,810		Yes	11.7		Yes
SA8-6C	SA8-6C	2012-11-04	191		Yes	0.400		Yes	6.80		Yes	3,070		Yes	14.5		Yes
SA8-7C	SA8-7C	2012-11-04	268		Yes	0.500		Yes	18.4		Yes	4,830		Yes	15.8		Yes
SA8-8C	SA8-8C	2012-11-04	427		Yes	0.400		Yes	18.5		Yes	7,020		Yes	11.9		Yes
SA9-10C	SA9-10C	2012-11-09	189		Yes	0.600		Yes	6.70		Yes	8,250		Yes	25.6		Yes
SA9-10C	SA9-10C2	2012-11-09	186		Yes	0.600		Yes	10.5		Yes	7,230		Yes	26.4		Yes
SA9-1C	SA9-1C	2012-11-08	721		Yes	0.600		Yes	24.2		Yes	7,380		Yes	43.9		Yes
SA9-2C	SA9-2C	2012-11-09	2590		Yes	1.500		Yes	4.90		Yes	13,200		Yes	470		Yes
SA9-3C	SA9-3C	2012-11-08	597		Yes	0.800		Yes	4.26		Yes	5,180		Yes	89.0		Yes
SA9-4C	SA9-4C	2012-11-08	120		Yes	0.500		Yes	6.50		Yes	10,300		Yes	19.4		Yes
SA9-5C	SA9-5C	2012-11-07	445		Yes	0.600		Yes	12.8		Yes	8,760		Yes	18.1		Yes
SA9-6C	SA9-6C	2012-11-07	368		Yes	0.600		Yes	13.9		Yes	11,900		Yes	24.9		Yes
SA9-7C	SA9-7C	2012-11-07	354		Yes	0.600		Yes	13.6		Yes	4,810		Yes	24.2		Yes
SA9-8C	SA9-8C	2012-11-08	535		Yes	0.600		Yes	16.0		Yes	13,200		Yes	33.5		Yes
SA9-9C	SA9-9C	2012-11-07	375		Yes	0.600		Yes	9.80		Yes	3,590		Yes	29.7		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Barium			Beryllium			Cadmium			Calcium			Chromium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2015 Bossburg Flat Beach Study																	
UDU-01-ICS	UDU-01-ICS	2015-04-14	107		Yes	0.359		Yes	1.19		Yes	2,200		Yes	11.8		Yes
UDU-02-ICS	UDU-02-ICS	2015-04-16	168		Yes	0.383		Yes	0.990		Yes	2,570		Yes	13.4		Yes
UDU-03-ICS	UDU-03-ICS	2015-04-16	106		Yes	0.310		Yes	0.909		Yes	2,460		Yes	12.9		Yes
UDU-04-ICS	UDU-04-ICS-A	2015-04-17	131		Yes	0.319		Yes	1.41		Yes	2,180		Yes	12.4		Yes
UDU-04-ICS	UDU-04-ICS-B	2015-04-18	157		Yes	0.313		Yes	1.93		Yes	2,380		Yes	11.8		Yes
UDU-04-ICS	UDU-04-ICS-C	2015-04-18	109		Yes	0.298		Yes	1.38		Yes	1,870		Yes	11.8		Yes
UDU-05-ICS	UDU-05-ICS	2015-04-29	131		Yes	0.466		Yes	1.01		Yes	6,250		Yes	24.1		Yes
UDU-06-ICS	UDU-06-ICS	2015-05-07	196		Yes	0.352		Yes	1.25		Yes	77,600		Yes	23.5		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Cobalt			Copper			Iron			Lead			Magnesium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study																	
ADA-001	ADA-001	2014-09-13	8.63		Yes	22.3		Yes	17,500		Yes	316		Yes	4,240		Yes
ADA-002	ADA-002	2014-10-09	9.28		Yes	31.4		Yes	21,800		Yes	49.6		Yes	5,220		Yes
ADA-004	ADA-004	2014-10-09	6.19		Yes	22.2		Yes	16,000		Yes	152		Yes	3,110		Yes
ADA-005	ADA-005	2014-10-08	9.98		Yes	35.3		Yes	20,400		Yes	74.2	J	Yes	4,800		Yes
ADA-006	ADA-006	2014-10-11	4.83		Yes	15.1		Yes	12,600		Yes	186		Yes	3,310		Yes
ADA-008	ADA-008	2014-10-11	6.47		Yes	20.5		Yes	19,000		Yes	407		Yes	3,720		Yes
ADA-010	ADA-010	2014-10-02	9.27		Yes	31.8		Yes	19,100		Yes	429		Yes	5,880		Yes
ADA-015	ADA-015	2014-09-13	3.75		Yes	11.1		Yes	10,000		Yes	141		Yes	2,310		Yes
ADA-016	ADA-016-A	2014-09-24	3.45		Yes	9.90		Yes	9,590		Yes	110		Yes	2,460		Yes
ADA-016	ADA-016-B	2014-09-24	2.74		Yes	8.70		Yes	8,370		Yes	105		Yes	1,940		Yes
ADA-016	ADA-016-C	2014-09-24	2.90		Yes	8.50		Yes	8,710		Yes	108		Yes	2,060		Yes
ADA-017	ADA-017	2014-10-01	4.97		Yes	19.6		Yes	12,700		Yes	267		Yes	3,130	J	Yes
ADA-018	ADA-018	2014-10-01	6.91		Yes	29.5		Yes	15,800		Yes	592		Yes	4,280	J	Yes
ADA-019	ADA-019	2014-10-11	8.95		Yes	22.5		Yes	23,200		Yes	76.6		Yes	8,130		Yes
ADA-020	ADA-020-A	2014-09-13	6.82		Yes	15.3		Yes	16,600		Yes	59.0		Yes	3,990		Yes
ADA-020	ADA-020-B	2014-09-13	7.08		Yes	16.6		Yes	17,700		Yes	70.3		Yes	4,020		Yes
ADA-020	ADA-020-C	2014-09-13	7.43		Yes	16.0		Yes	17,800		Yes	63.6		Yes	4,120		Yes
ADA-021	ADA-021	2014-09-30	14.5		Yes	49.5		Yes	27,000		Yes	66.7		Yes	4,520		Yes
ADA-023	ADA-023-A	2014-09-13	8.14		Yes	28.5		Yes	17,200		Yes	121		Yes	5,410		Yes
ADA-023	ADA-023-B	2014-09-13	8.30		Yes	31.0		Yes	17,500		Yes	125		Yes	5,650		Yes
ADA-023	ADA-023-C	2014-09-13	8.44		Yes	32.9		Yes	17,800		Yes	140		Yes	5,700		Yes
ADA-024	ADA-024	2014-09-30	5.17		Yes	42.8		Yes	14,100		Yes	506		Yes	5,350		Yes
ADA-025	ADA-025	2014-09-17	7.02		Yes	24.3		Yes	15,600		Yes	283		Yes	1,820		Yes
ADA-026	ADA-026	2014-09-17	5.84		Yes	25.2		Yes	15,600		Yes	104		Yes	2,730		Yes
ADA-028	ADA-028	2014-10-03	5.29		Yes	21.5		Yes	13,100		Yes	280		Yes	3,580		Yes
ADA-033	ADA-033	2014-09-24	6.13		Yes	16.2		Yes	15,700		Yes	89.7		Yes	2,610		Yes
ADA-034	ADA-034	2014-10-10	6.76		Yes	15.8		Yes	19,400		Yes	62.0		Yes	7,150		Yes
ADA-035	ADA-035	2014-10-03	5.01		Yes	11.0		Yes	15,300		Yes	236		Yes	8,540		Yes
ADA-039	ADA-039	2014-10-01	6.56		Yes	13.2		Yes	16,200		Yes	47.7		Yes	2,660	J	Yes
ADA-042	ADA-042	2014-10-09	7.48		Yes	14.8		Yes	18,000		Yes	116		Yes	3,370		Yes
ADA-043	ADA-043	2014-10-03	13.5		Yes	40.8		Yes	28,100		Yes	121		Yes	5,200		Yes
ADA-044	ADA-044	2014-09-18	11.3		Yes	27.9		Yes	23,800		Yes	152		Yes	7,010		Yes
ADA-045	ADA-045	2014-10-09	7.02		Yes	27.5		Yes	17,600		Yes	497		Yes	4,210		Yes
ADA-046	ADA-046	2014-10-01	4.95		Yes	18.1		Yes	13,400		Yes	269		Yes	3,060	J	Yes
ADA-047	ADA-047	2014-09-30	8.71		Yes	25.8		Yes	19,800		Yes	316		Yes	9,510		Yes
ADA-048	ADA-048	2014-10-22	9.45		Yes	27.5		Yes	21,800		Yes	127		Yes	3,580		Yes
ADA-049	ADA-049	2014-09-17	8.20		Yes	21.4		Yes	19,800		Yes	57.2		Yes	2,550		Yes
ADA-050	ADA-050	2014-10-04	11.9		Yes	46.2		Yes	22,200		Yes	387		Yes	8,600		Yes
ADA-051	ADA-051	2014-10-22	7.57		Yes	48.9		Yes	19,000		Yes	114		Yes	2,740		Yes
ADA-052	ADA-052	2014-10-02	8.67		Yes	26.0		Yes	19,000		Yes	398		Yes	5,580		Yes
ADA-053	ADA-053	2014-10-07	10.0		Yes	18.4		Yes	22,400		Yes	123		Yes	5,560		Yes
ADA-054	ADA-054	2014-09-30	6.46		Yes	31.9		Yes	15,600		Yes	398		Yes	4,190		Yes
ADA-055	ADA-055-A	2014-10-08	8.88		Yes	42.6		Yes	26,900		Yes	188	J	Yes	2,730		Yes
ADA-055	ADA-055-B	2014-10-08	9.36		Yes	40.0		Yes	28,300		Yes	216	J	Yes	3,020		Yes
ADA-055	ADA-055-C	2014-10-08	8.11		Yes	33.4		Yes	24,900		Yes	182	J	Yes	2,700		Yes
ADA-056	ADA-056	2014-09-15	10.1		Yes	17.5		Yes	23,800		Yes	92.0		Yes	5,710		Yes
ADA-057	ADA-057	2014-10-07	11.4		Yes	26.3		Yes	24,800		Yes	127		Yes	7,220		Yes
ADA-058	ADA-058	2014-09-19	10.6		Yes	14.7		Yes	25,600		Yes	94.1		Yes	5,330	J	Yes
ADA-059	ADA-059	2014-10-07	11.2		Yes	23.2		Yes	25,100		Yes	137		Yes	6,420		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Cobalt			Copper			Iron			Lead			Magnesium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study (continued)																	
ADA-060	ADA-060-A	2014-10-06	8.92		Yes	31.0		Yes	20,000		Yes	271		Yes	5,900		Yes
ADA-060	ADA-060-B	2014-10-06	9.62		Yes	31.4		Yes	20,700		Yes	313		Yes	6,650		Yes
ADA-060	ADA-060-C	2014-10-06	9.71		Yes	31.7		Yes	19,300		Yes	264		Yes	6,240		Yes
ADA-061	ADA-061	2014-09-16	13.3		Yes	19.4		Yes	26,200		Yes	141		Yes	9,150		Yes
ADA-062	ADA-062	2014-10-06	6.98		Yes	19.7		Yes	16,700		Yes	277		Yes	4,580		Yes
ADA-063	ADA-063	2014-09-17	9.27		Yes	17.3		Yes	21,000		Yes	163		Yes	3,510		Yes
ADA-064	ADA-064	2014-09-16	10.9		Yes	20.2		Yes	25,700		Yes	126		Yes	6,450		Yes
ADA-065	ADA-065	2014-10-07	4.21		Yes	13.1		Yes	11,300		Yes	145		Yes	2,850		Yes
ADA-066	ADA-066	2014-10-06	6.46		Yes	18.5		Yes	15,600		Yes	181		Yes	3,910		Yes
ADA-067	ADA-067	2014-09-17	11.2		Yes	45.9		Yes	25,800		Yes	105		Yes	4,920		Yes
ADA-070	ADA-070	2014-10-01	8.54		Yes	22.6		Yes	19,400		Yes	300		Yes	5,560	J	Yes
ADA-071	ADA-071	2014-10-07	6.62		Yes	18.0		Yes	17,800		Yes	294		Yes	4,300		Yes
ADA-073	ADA-073	2014-10-03	6.26		Yes	18.1		Yes	15,400		Yes	274		Yes	4,030		Yes
ADA-076	ADA-076	2014-10-14	7.82		Yes	21.0		Yes	18,000		Yes	392		Yes	3,820		Yes
ADA-078	ADA-078	2014-09-29	7.82		Yes	16.2		Yes	19,800		Yes	272		Yes	4,580		Yes
ADA-079	ADA-079	2014-10-14	6.52		Yes	19.0		Yes	14,800		Yes	176		Yes	2,710		Yes
ADA-081	ADA-081	2014-10-08	7.50		Yes	17.2		Yes	19,900		Yes	157	J	Yes	4,800		Yes
ADA-082	ADA-082	2014-10-04	7.65		Yes	24.1		Yes	18,000		Yes	153		Yes	5,130		Yes
ADA-084	ADA-084	2014-10-09	9.06		Yes	20.1		Yes	21,600		Yes	184		Yes	4,920		Yes
ADA-085	ADA-085	2014-09-17	7.70		Yes	17.1		Yes	20,000		Yes	143		Yes	5,860		Yes
ADA-088	ADA-088	2014-10-02	11.0		Yes	25.5		Yes	25,000		Yes	242		Yes	6,290		Yes
ADA-089	ADA-089	2014-10-07	10.9		Yes	24.6		Yes	25,300		Yes	274		Yes	4,490		Yes
ADA-090	ADA-090	2014-10-07	8.59		Yes	19.4		Yes	20,600		Yes	222		Yes	4,870		Yes
ADA-091	ADA-091	2014-10-02	9.82		Yes	22.4		Yes	19,900		Yes	267		Yes	6,440		Yes
ADA-092	ADA-092	2014-10-06	8.52		Yes	23.7		Yes	19,900		Yes	273		Yes	4,850		Yes
ADA-093	ADA-093	2014-09-16	8.13		Yes	15.5		Yes	19,800		Yes	197		Yes	3,520		Yes
ADA-094	ADA-094	2014-10-16	7.97		Yes	16.4		Yes	20,700		Yes	98.4		Yes	4,210		Yes
ADA-095	ADA-095	2014-10-08	10.1		Yes	18.4		Yes	22,700		Yes	161	J	Yes	5,230		Yes
ADA-096	ADA-096	2014-09-26	6.85		Yes	18.2		Yes	17,600		Yes	282		Yes	3,280		Yes
ADA-097	ADA-097	2014-09-24	8.37		Yes	28.6		Yes	18,200		Yes	419		Yes	5,010		Yes
ADA-099	ADA-099	2014-10-10	9.34		Yes	22.4		Yes	19,900		Yes	264		Yes	4,940		Yes
ADA-101	ADA-101	2014-10-11	8.15		Yes	20.8		Yes	20,200		Yes	227		Yes	4,640	J	Yes
ADA-102	ADA-102	2014-10-08	8.94		Yes	19.2		Yes	21,100		Yes	148	J	Yes	4,790		Yes
ADA-103	ADA-103	2014-09-26	15.5		Yes	25.9		Yes	30,900		Yes	130		Yes	5,000		Yes
ADA-104	ADA-104	2014-09-19	6.86		Yes	14.2		Yes	19,100		Yes	94.2		Yes	2,990		Yes
ADA-105	ADA-105	2014-10-10	9.04		Yes	25.5		Yes	19,800		Yes	274		Yes	5,430		Yes
ADA-106	ADA-106-A	2014-10-15	10.9		Yes	19.5		Yes	25,200		Yes	94.2		Yes	4,660	J	Yes
ADA-106	ADA-106-B	2014-10-15	10.8		Yes	22.3		Yes	25,100		Yes	71.6		Yes	4,870	J	Yes
ADA-106	ADA-106-C	2014-10-16	9.45		Yes	18.4		Yes	22,700		Yes	88.2		Yes	3,980	J	Yes
ADA-107	ADA-107-A	2014-10-02	12.7		Yes	33.9		Yes	25,900		Yes	171		Yes	6,650		Yes
ADA-107	ADA-107-B	2014-10-01	13.6		Yes	33.5		Yes	25,400		Yes	143		Yes	8,520	J	Yes
ADA-107	ADA-107-C	2014-10-01	13.7		Yes	29.8		Yes	24,600		Yes	128		Yes	7,570	J	Yes
ADA-108	ADA-108-A	2014-10-10	9.61		Yes	23.2		Yes	19,700		Yes	163		Yes	6,220		Yes
ADA-108	ADA-108-B	2014-10-10	7.79		Yes	20.9		Yes	16,800		Yes	150		Yes	4,730		Yes
ADA-108	ADA-108-C	2014-10-09	9.01		Yes	21.7		Yes	19,700		Yes	155		Yes	6,460		Yes
ADA-109	ADA-109	2014-09-30	5.89		Yes	20.4		Yes	13,700		Yes	327		Yes	4,010		Yes
ADA-110	ADA-110	2014-09-26	6.03		Yes	18.8		Yes	14,300		Yes	216		Yes	4,230		Yes
ADA-111	ADA-111	2014-10-07	10.1		Yes	22.0		Yes	22,300		Yes	108		Yes	7,130		Yes
ADA-112	ADA-112	2014-10-16	8.35		Yes	19.8		Yes	20,900		Yes	103		Yes	4,720		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Cobalt			Copper			Iron			Lead			Magnesium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study (continued)																	
ADA-113	ADA-113	2014-09-20	8.64		Yes	17.9		Yes	20,400		Yes	145		Yes	4,790		Yes
ADA-114	ADA-114	2014-10-06	7.21		Yes	16.6		Yes	18,400		Yes	133		Yes	3,750		Yes
ADA-115	ADA-115	2014-10-17	5.99		Yes	12.6		Yes	15,300		Yes	148		Yes	3,160		Yes
ADA-116	ADA-116	2014-10-08	7.20		Yes	14.6		Yes	17,900		Yes	131	J	Yes	3,780		Yes
ADA-117	ADA-117	2014-09-29	7.15		Yes	15.7		Yes	17,600		Yes	165		Yes	4,100		Yes
ADA-118	ADA-118	2014-09-30	8.89		Yes	17.9		Yes	20,600		Yes	154		Yes	5,880		Yes
ADA-119	ADA-119	2014-10-02	8.01		Yes	19.7		Yes	17,300		Yes	175		Yes	4,580		Yes
ADA-121	ADA-121	2014-10-14	9.91		Yes	25.6		Yes	22,500		Yes	242		Yes	5,990	J	Yes
ADA-122	ADA-122	2014-10-10	8.09		Yes	13.0		Yes	19,900		Yes	102		Yes	3,600		Yes
ADA-124	ADA-124-A	2014-10-04	3.60		Yes	12.1		Yes	10,400		Yes	218		Yes	2,100		Yes
ADA-124	ADA-124-B	2014-10-04	3.74		Yes	11.5		Yes	10,300		Yes	181		Yes	2,120		Yes
ADA-124	ADA-124-C	2014-10-04	3.98		Yes	10.9		Yes	10,700		Yes	134		Yes	2,170		Yes
ADA-125	ADA-125	2014-10-23	3.45		Yes	11.7		Yes	10,100		Yes	158		Yes	1,990		Yes
ADA-126	ADA-126	2014-09-11	4.86		Yes	51.8		Yes	12,500		Yes	379		Yes	2,700		Yes
ADA-127	ADA-127	2014-10-14	10.4		Yes	29.4		Yes	20,000		Yes	189		Yes	4,000	J	Yes
ADA-128	ADA-128	2014-10-03	2.85		Yes	17.1		Yes	7,570		Yes	230		Yes	2,000		Yes
ADA-131	ADA-131-A	2014-09-18	7.24		Yes	22.8		Yes	16,500		Yes	561		Yes	3,350		Yes
ADA-131	ADA-131-B	2014-09-18	6.99		Yes	21.0		Yes	16,400		Yes	297		Yes	3,230		Yes
ADA-131	ADA-131-C	2014-09-18	6.95		Yes	22.2		Yes	16,800		Yes	532		Yes	3,580		Yes
ADA-132	ADA-132	2014-09-16	4.99		Yes	13.9		Yes	12,400		Yes	224		Yes	3,590		Yes
ADA-133	ADA-133	2014-09-23	5.66		Yes	17.2		Yes	13,900	J	Yes	255		Yes	3,530	J	Yes
ADA-135	ADA-135-A	2014-09-17	6.02		Yes	18.6		Yes	14,900		Yes	116		Yes	4,110		Yes
ADA-135	ADA-135-B	2014-09-17	5.69		Yes	17.3		Yes	14,500		Yes	100		Yes	3,880		Yes
ADA-135	ADA-135-C	2014-09-18	5.64		Yes	16.4		Yes	13,900		Yes	108		Yes	3,760		Yes
ADA-136	ADA-136	2014-09-10	4.74		Yes	15.6		Yes	11,200		Yes	215		Yes	2,870		Yes
ADA-139	ADA-139	2014-10-14	7.99		Yes	18.9		Yes	18,700		Yes	236		Yes	4,680		Yes
ADA-141	ADA-141	2014-09-23	5.38	J	Yes	12.3		Yes	13,400	J	Yes	140	J	Yes	2,930	J	Yes
ADA-142	ADA-142	2014-09-25	3.33		Yes	12.3		Yes	9,570		Yes	232		Yes	2,200		Yes
ADA-143	ADA-143	2014-09-15	4.02		Yes	15.0		Yes	10,700		Yes	141		Yes	2,650		Yes
ADA-144	ADA-144	2014-09-29	2.81		Yes	18.2		Yes	8,440		Yes	260		Yes	1,820		Yes
ADA-145	ADA-145	2014-09-24	6.97		Yes	20.0		Yes	17,500		Yes	309		Yes	3,850		Yes
ADA-146	ADA-146	2014-10-02	4.65		Yes	18.3		Yes	11,700		Yes	290		Yes	2,890		Yes
ADA-147	ADA-147	2014-09-29	2.26		Yes	16.9		Yes	7,440		Yes	352		Yes	1,470		Yes
ADA-148	ADA-148	2014-10-06	4.21		Yes	18.8		Yes	11,400		Yes	342		Yes	2,810		Yes
ADA-150	ADA-150	2014-10-06	4.22		Yes	19.8		Yes	10,100		Yes	326		Yes	2,450		Yes
ADA-151	ADA-151	2014-10-04	3.82		Yes	17.1		Yes	10,800		Yes	328		Yes	2,770		Yes
ADA-152	ADA-152	2014-10-09	9.42		Yes	23.5		Yes	22,100		Yes	300		Yes	5,790		Yes
ADA-153	ADA-153	2014-09-20	7.21		Yes	23.6		Yes	16,800		Yes	321		Yes	4,090		Yes
ADA-154	ADA-154-A	2014-09-20	6.92		Yes	20.9		Yes	14,100		Yes	263		Yes	5,690		Yes
ADA-154	ADA-154-B	2014-09-20	9.46		Yes	28.8		Yes	18,400		Yes	346		Yes	7,120		Yes
ADA-154	ADA-154-C	2014-09-20	7.52		Yes	25.0		Yes	15,600		Yes	354		Yes	5,520		Yes
ADA-155	ADA-155	2014-09-15	3.36		Yes	13.0		Yes	9,090		Yes	249		Yes	2,050		Yes
ADA-156	ADA-156	2014-10-07	6.70		Yes	21.6		Yes	15,200		Yes	551		Yes	3,590		Yes
ADA-158	ADA-158-A	2014-10-07	5.26		Yes	19.1		Yes	13,200		Yes	278		Yes	3,510		Yes
ADA-158	ADA-158-B	2014-10-07	5.45		Yes	24.1		Yes	14,000		Yes	433		Yes	3,530		Yes
ADA-158	ADA-158-C	2014-10-07	5.59		Yes	28.4		Yes	14,300		Yes	578		Yes	3,650		Yes
ADA-159	ADA-159-A	2014-10-04	8.60		Yes	23.1		Yes	18,000		Yes	310		Yes	4,880		Yes
ADA-159	ADA-159-B	2014-10-04	7.45		Yes	21.6		Yes	16,100		Yes	406		Yes	4,310		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Cobalt			Copper			Iron			Lead			Magnesium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study (continued)																	
ADA-159	ADA-159-C	2014-10-04	5.61		Yes	20.3		Yes	13,600		Yes	394		Yes	3,390		Yes
ADA-160	ADA-160	2014-10-03	3.06		Yes	12.4		Yes	8,610		Yes	224		Yes	2,020		Yes
ADA-161	ADA-161	2014-10-03	6.02		Yes	19.8		Yes	14,100		Yes	355		Yes	3,860		Yes
ADA-162	ADA-162	2014-10-09	2.99		Yes	29.6		Yes	9,490		Yes	681		Yes	2,240		Yes
ADA-164	ADA-164	2014-09-30	5.14		Yes	22.2		Yes	12,700		Yes	452		Yes	3,260		Yes
ADA-165	ADA-165	2014-09-16	5.71		Yes	26.8		Yes	12,900		Yes	504		Yes	3,630		Yes
ADA-168	ADA-168	2014-10-14	5.66		Yes	20.5		Yes	14,500		Yes	307		Yes	3,420		Yes
ADA-169	ADA-169-A	2014-09-19	8.82		Yes	11.2		Yes	25,300		Yes	79.6		Yes	2,710	J	Yes
ADA-169	ADA-169-B	2014-09-19	9.16		Yes	12.1		Yes	25,100		Yes	81.9		Yes	3,160	J	Yes
ADA-169	ADA-169-C	2014-09-19	9.22		Yes	12.4		Yes	24,700		Yes	66.3		Yes	3,140	J	Yes
ADA-170	ADA-170	2014-09-23	7.36		Yes	14.6		Yes	19,300	J	Yes	122		Yes	4,840	J	Yes
ADA-171	ADA-171	2014-09-23	6.30		Yes	17.4		Yes	16,200	J	Yes	100		Yes	4,550	J	Yes
ADA-172	ADA-172	2014-09-29	5.29		Yes	8.22		Yes	15,100		Yes	82.0		Yes	1,700		Yes
ADA-173	ADA-173-A	2014-09-12	6.36		Yes	12.2		Yes	18,400		Yes	90.6		Yes	3,350		Yes
ADA-173	ADA-173-B	2014-09-12	6.97		Yes	15.0		Yes	18,900		Yes	115		Yes	4,320		Yes
ADA-173	ADA-173-C	2014-09-12	6.18		Yes	11.5		Yes	17,500		Yes	111		Yes	3,200		Yes
ADA-174	ADA-174	2014-09-12	5.55		Yes	10.3		Yes	14,800		Yes	94.5		Yes	2,100		Yes
ADA-175	ADA-175	2014-09-15	7.47		Yes	13.2		Yes	16,200		Yes	76.6		Yes	4,510		Yes
ADA-176	ADA-176	2014-09-12	11.9		Yes	17.5		Yes	21,100		Yes	63.4		Yes	8,310		Yes
ADA-177	ADA-177	2014-09-16	9.89		Yes	13.0		Yes	20,800		Yes	70.4		Yes	3,770		Yes
ADA-178	ADA-178	2014-09-11	10.4		Yes	13.3		Yes	23,500		Yes	58.7		Yes	4,010		Yes
ADA-179	ADA-179	2014-09-18	5.92		Yes	11.7		Yes	17,300		Yes	86.2		Yes	2,910		Yes
ADA-180	ADA-180	2014-09-19	6.11		Yes	16.4		Yes	17,400		Yes	122		Yes	3,820		Yes
ADA-181	ADA-181	2014-09-12	6.08		Yes	17.8		Yes	16,000		Yes	102		Yes	3,050		Yes
ADA-182	ADA-182	2014-10-13	6.74		Yes	19.7		Yes	18,000		Yes	44.5		Yes	2,930		Yes
ADA-183	ADA-183	2014-09-11	6.13		Yes	32.3		Yes	15,600		Yes	49.0		Yes	1,900		Yes
ADA-184	ADA-184	2014-09-11	7.50		Yes	22.0		Yes	15,700		Yes	74.7		Yes	2,280		Yes
2012 Ecology Upland Soil Study																	
SA1-1C	SA1-1C	2012-10-30	10.9		Yes	25.0		Yes	22,700		Yes	158		Yes	8,750		Yes
SA1-2C	SA1-2C	2012-10-30	12.3		Yes	18.2		Yes	40,800		Yes	84.9		Yes	6,550		Yes
SA1-3C	SA1-3C	2012-10-30	9.20		Yes	20.5		Yes	23,700		Yes	62.9		Yes	5,780		Yes
SA1-3C	SA1-3C2	2012-10-30	10.0		Yes	21.6		Yes	24,900		Yes	51.2		Yes	6,080		Yes
SA1-4C	SA1-4C	2012-10-30	8.10		Yes	15.0		Yes	22,100		Yes	37.6		Yes	4,340		Yes
SA1-5C	SA1-5C	2012-10-30	8.30		Yes	19.6		Yes	21,900		Yes	72.5		Yes	5,230		Yes
SA1-6C	SA1-6C	2012-10-30	9.00		Yes	16.7		Yes	22,500		Yes	89.4		Yes	5,030		Yes
SA1-7C	SA1-7C	2012-10-30	7.10		Yes	16.0		Yes	20,700		Yes	66.3		Yes	4,360		Yes
SA1-8C	SA1-8C	2012-10-30	6.00		Yes	14.3		Yes	17,200		Yes	81.7		Yes	3,670		Yes
SA10-1C	SA10-1C	2012-11-08	9.00		Yes	39.1		Yes	20,300		Yes	330		Yes	6,280		Yes
SA10-2C	SA10-2C	2012-11-08	21.5		Yes	62.9		Yes	33,900		Yes	1240		Yes	6,200		Yes
SA10-3C	SA10-3C	2012-11-05	12.1		Yes	41.8		Yes	24,400		Yes	400		Yes	4,040		Yes
SA10-3C	SA10-3C2	2012-11-05	10.6		Yes	39.2		Yes	25,200		Yes	328		Yes	3,890		Yes
SA10-4C	SA10-4C	2012-11-05	2.90		Yes	30.8		Yes	9,150		Yes	222		Yes	2,510		Yes
SA10-5C	SA10-5C	2012-11-05	8.60		Yes	20.7		Yes	21,100		Yes	200		Yes	6,080		Yes
SA10-6C	SA10-6C	2012-11-05	10.6		Yes	26.5		Yes	23,000		Yes	162		Yes	5,170		Yes
SA10-7C	SA10-7C	2012-11-05	12.4		Yes	38.8		Yes	29,000		Yes	246		Yes	4,360		Yes
SA10-8C	SA10-8C	2012-11-08	9.00		Yes	27.0		Yes	22,500		Yes	313		Yes	5,070		Yes
SA11-1C	SA11-1C	2012-11-08	10.8		Yes	32.0		Yes	27,100		Yes	83.0		Yes	7,150		Yes
SA11-2C	SA11-2C	2012-11-06	7.90		Yes	18.7		Yes	21,900		Yes	94.7		Yes	5,460		Yes
SA11-3C	SA11-3C	2012-11-10	6.00		Yes	22.6		Yes	17,600		Yes	113		Yes	4,420		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Cobalt			Copper			Iron			Lead			Magnesium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2012 Ecology Upland Soil Study (continued)																	
SA11-4C	SA11-4C	2012-11-08	6.70		Yes	24.9		Yes	18,000		Yes	500		Yes	4,570		Yes
SA11-5C	SA11-5C	2012-11-06	6.40		Yes	24.1		Yes	15,700		Yes	374		Yes	3,290		Yes
SA11-6C	SA11-6C	2012-11-06	8.70		Yes	32.5		Yes	24,000		Yes	572		Yes	6,410		Yes
SA11-7C	SA11-7C	2012-11-06	4.10		Yes	52.0		Yes	9,140		Yes	1920		Yes	1,960		Yes
SA11-8C	SA11-8C	2012-11-07	8.10		Yes	25.1		Yes	22,300		Yes	209		Yes	5,420		Yes
SA11-8C	SA11-8C2	2012-11-07	7.80		Yes	41.9		Yes	21,500		Yes	810		Yes	4,870		Yes
SA11-9C	SA11-9C	2012-11-08	12.2		Yes	43.5		Yes	31,000		Yes	715		Yes	7,580		Yes
SA12-1C	SA12-1C	2012-11-07	18.6		Yes	52.9		Yes	40,800		Yes	207		Yes	9,370		Yes
SA12-2C	SA12-2C	2012-11-10	8.80		Yes	18.4		Yes	22,700		Yes	224		Yes	4,980		Yes
SA12-3C	SA12-3C	2012-11-10	6.50		Yes	21.0		Yes	17,900		Yes	217		Yes	4,600		Yes
SA12-4C	SA12-4C	2012-11-10	6.70		Yes	14.7		Yes	18,200		Yes	183		Yes	3,910		Yes
SA12-6C	SA12-6C	2012-11-10	6.50		Yes	42.9		Yes	19,700		Yes	120		Yes	3,280		Yes
SA12-7C	SA12-7C	2012-11-10	8.60		Yes	25.9		Yes	25,400		Yes	210		Yes	6,250		Yes
SA12-7C	SA12-7C2	2012-11-10	8.40		Yes	21.6		Yes	23,800		Yes	204		Yes	5,540		Yes
SA12-8C	SA12-8C	2012-11-10	7.20		Yes	15.2		Yes	21,200		Yes	249		Yes	4,370		Yes
SA12-9C	SA12-9C	2012-11-10	10.3		Yes	19.8		Yes	26,500		Yes	66.4		Yes	4,640		Yes
SA13-1C	SA13-1C	2012-11-10	8.50		Yes	25.6		Yes	23,000		Yes	104		Yes	5,530		Yes
SA13-2C	SA13-2C	2012-11-10	7.10		Yes	39.0		Yes	17,200		Yes	202		Yes	4,800		Yes
SA13-3C	SA13-3C	2012-11-10	6.90		Yes	17.9		Yes	19,000		Yes	163		Yes	3,510		Yes
SA13-4C	SA13-4C	2012-11-10	9.00		Yes	21.5		Yes	20,900		Yes	31.9		Yes	4,770		Yes
SA13-5C	SA13-5C	2012-11-10	11.0		Yes	43.7		Yes	24,600		Yes	649		Yes	6,070		Yes
SA13-5C	SA13-5C2	2012-11-10	11.0		Yes	34.6		Yes	25,800		Yes	551		Yes	6,610		Yes
SA13-6C	SA13-6C	2012-11-10	7.00		Yes	16.9		Yes	22,400		Yes	289		Yes	3,940		Yes
SA13-7C	SA13-7C	2012-11-07	9.00		Yes	18.6		Yes	22,000		Yes	281		Yes	4,330		Yes
SA13-8C	SA13-8C	2012-11-10	7.80		Yes	16.4		Yes	23,100		Yes	168		Yes	4,200		Yes
SA2-1C	SA2-1C	2012-10-31	6.40		Yes	20.4		Yes	20,800		Yes	248		Yes	4,470		Yes
SA2-2C	SA2-2C	2012-10-31	8.50		Yes	17.5		Yes	20,900		Yes	86.5		Yes	5,000		Yes
SA2-3C	SA2-3C	2012-10-31	5.30		Yes	12.0		Yes	18,300		Yes	107		Yes	3,220		Yes
SA2-4C	SA2-4C	2012-10-31	6.90		Yes	11.9		Yes	19,900		Yes	122		Yes	4,270		Yes
SA2-4C	SA2-4C2	2012-10-31	6.40		Yes	15.8		Yes	18,700		Yes	229		Yes	4,100		Yes
SA2-5C	SA2-5C	2012-10-31	6.80		Yes	19.5		Yes	21,100		Yes	69.5		Yes	5,620		Yes
SA2-6C	SA2-6C	2012-10-31	9.40		Yes	30.4		Yes	23,100		Yes	405		Yes	6,570		Yes
SA2-7C	SA2-7C	2012-10-31	17.6		Yes	34.3		Yes	28,700		Yes	105		Yes	5,720		Yes
SA2-8C	SA2-8C	2012-10-31	8.50		Yes	17.6		Yes	23,700		Yes	59.5		Yes	5,490		Yes
SA3-1C	SA3-1C	2012-11-01	6.40		Yes	17.5		Yes	20,400		Yes	31.0		Yes	4,260		Yes
SA3-2C	SA3-2C	2012-11-01	4.60		Yes	9.8		Yes	14,200		Yes	64.1		Yes	2,350		Yes
SA3-3C	SA3-3C	2012-11-01	11.0		Yes	21.7		Yes	23,300		Yes	174		Yes	8,830		Yes
SA3-4C	SA3-4C	2012-11-01	4.90		Yes	10.3		Yes	14,700		Yes	73.8		Yes	2,670		Yes
SA3-5C	SA3-5C	2012-11-01	5.60		Yes	14.7		Yes	15,100		Yes	105		Yes	3,420		Yes
SA3-6C	SA3-6C	2012-11-01	22.0		Yes	47.0		Yes	36,300		Yes	509		Yes	11,800		Yes
SA3-6C	SA3-6C2	2012-11-01	23.0		Yes	43.6		Yes	39,100		Yes	348		Yes	13,800		Yes
SA3-7C	SA3-7C	2012-11-01	6.70		Yes	28.7		Yes	18,000		Yes	430		Yes	4,570		Yes
SA3-8C	SA3-8C	2012-11-01	5.00		Yes	13.8		Yes	16,600		Yes	199		Yes	3,820		Yes
SA4-1C	SA4-1C	2012-11-01	9.60		Yes	25.3		Yes	22,700		Yes	213		Yes	5,120		Yes
SA4-2C	SA4-2C	2012-11-01	7.60		Yes	22.1		Yes	21,800		Yes	135		Yes	5,440		Yes
SA4-3C	SA4-3C	2012-11-01	9.70		Yes	36.0		Yes	23,900		Yes	398		Yes	7,580		Yes
SA4-4C	SA4-4C	2012-11-01	8.30		Yes	27.1		Yes	19,800		Yes	224		Yes	4,830		Yes
SA4-5C	SA4-5C	2012-11-01	9.30		Yes	23.5		Yes	21,500		Yes	109		Yes	4,370		Yes
SA4-6C	SA4-6C	2012-11-02	8.40		Yes	25.2		Yes	19,600		Yes	512		Yes	4,830		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Cobalt			Copper			Iron			Lead			Magnesium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2012 Ecology Upland Soil Study (continued)																	
SA4-6C	SA4-6C2	2012-11-02	8.90		Yes	23.7		Yes	22,000		Yes	386		Yes	5,660		Yes
SA4-7C	SA4-7C	2012-11-01	9.30		Yes	25.9		Yes	22,900		Yes	299		Yes	7,900		Yes
SA4-8C	SA4-8C	2012-11-01	6.00		Yes	17.6		Yes	15,400		Yes	133		Yes	3,280		Yes
SA5-1C	SA5-1C	2012-11-09	5.00		Yes	35.2		Yes	15,100		Yes	337		Yes	3,330		Yes
SA5-2C	SA5-2C	2012-11-09	20.0		Yes	22.8		Yes	41,500		Yes	139		Yes	24,500		Yes
SA5-3C	SA5-3C	2012-11-03	7.60		Yes	30.9		Yes	18,400		Yes	301		Yes	4,680		Yes
SA5-4C	SA5-4C	2012-11-02	5.20		Yes	20.4		Yes	13,900		Yes	344		Yes	3,670		Yes
SA5-4C	SA5-4C2	2012-11-02	5.60		Yes	19.7		Yes	14,100		Yes	250		Yes	3,640		Yes
SA5-5C	SA5-5C	2012-11-09	6.60		Yes	22.4		Yes	16,400		Yes	118		Yes	4,840		Yes
SA5-7C	SA5-7C	2012-11-02	4.80		Yes	21.7		Yes	13,900		Yes	389		Yes	3,690		Yes
SA5-8C	SA5-8C	2012-09-11	9.50		Yes	35.0		Yes	22,500		Yes	340		Yes	7,860		Yes
SA6-1C	SA6-1C	2012-11-02	8.30		Yes	18.1		Yes	16,600		Yes	402		Yes	3,570		Yes
SA6-2C	SA6-2C	2012-11-02	8.90		Yes	28.3		Yes	21,000		Yes	401		Yes	4,010		Yes
SA6-2C	SA6-2C2	2012-11-02	8.00		Yes	26.0		Yes	19,800		Yes	359		Yes	3,950		Yes
SA6-3C	SA6-3C	2012-11-02	11.7		Yes	33.9		Yes	25,300		Yes	523		Yes	6,200		Yes
SA6-4C	SA6-4C	2012-11-03	2.50		Yes	7.50		Yes	8,830		Yes	84.5		Yes	1,980		Yes
SA6-5C	SA6-5C	2012-11-03	2.20		Yes	6.40		Yes	8,170		Yes	60.3		Yes	1,800		Yes
SA6-6C	SA6-6C	2012-11-03	2.60		Yes	20.1		Yes	7,980		Yes	619		Yes	2,050		Yes
SA6-7C	SA6-7C	2012-11-02	9.30		Yes	33.1		Yes	27,200		Yes	616		Yes	6,070		Yes
SA6-8C	SA6-8C	2012-11-03	2.90		Yes	11.5		Yes	9,680		Yes	122		Yes	2,090		Yes
SA7-1C	SA7-1C	2012-11-03	5.50		Yes	18.8		Yes	15,600		Yes	309		Yes	3,700		Yes
SA7-2C	SA7-2C	2012-11-03	5.60		Yes	18.7		Yes	15,700		Yes	314		Yes	4,440		Yes
SA7-3C	SA7-3C	2012-11-03	3.40		Yes	30.1		Yes	11,200		Yes	637		Yes	2,550		Yes
SA7-4C	SA7-4C	2012-11-03	2.10		Yes	12.7		Yes	7,620		Yes	268		Yes	1,760		Yes
SA7-5C	SA7-5C	2012-11-03	4.30		Yes	43.5		Yes	15,800		Yes	906		Yes	3,300		Yes
SA7-5C	SA7-5C2	2012-11-03	5.80		Yes	31.7		Yes	16,300		Yes	356		Yes	3,200		Yes
SA7-6C	SA7-6C	2012-11-03	4.60		Yes	22.0		Yes	14,100		Yes	496		Yes	3,340		Yes
SA7-7C	SA7-7C	2012-11-09	6.40		Yes	37.4		Yes	18,000		Yes	1280		Yes	4,480		Yes
SA7-8C	SA7-8C	2012-11-09	22.0		Yes	62.0		Yes	41,200		Yes	934		Yes	23,400		Yes
SA8-1C	SA8-1C	2012-11-04	4.30		Yes	20.8		Yes	13,100		Yes	381		Yes	2,800		Yes
SA8-2C	SA8-2C	2012-11-04	3.60		Yes	24.7		Yes	10,600		Yes	363		Yes	2,180		Yes
SA8-3C	SA8-3C	2012-11-03	6.30		Yes	16.6		Yes	16,700		Yes	62.5		Yes	4,250		Yes
SA8-3C	SA8-3C2	2012-11-03	6.40		Yes	17.8		Yes	17,000		Yes	129		Yes	4,170		Yes
SA8-4C	SA8-4C	2012-11-04	3.50		Yes	15.0		Yes	11,200		Yes	449		Yes	2,470		Yes
SA8-5C	SA8-5C	2012-11-04	3.90		Yes	29.1		Yes	10,700		Yes	737		Yes	2,900		Yes
SA8-6C	SA8-6C	2012-11-04	5.10		Yes	18.6		Yes	15,400		Yes	308		Yes	3,210		Yes
SA8-7C	SA8-7C	2012-11-04	8.30		Yes	41.0		Yes	17,600		Yes	1070		Yes	4,150		Yes
SA8-8C	SA8-8C	2012-11-04	4.90		Yes	49.4		Yes	11,400		Yes	1440		Yes	2,600		Yes
SA9-10C	SA9-10C	2012-11-09	8.10		Yes	24.7		Yes	22,000		Yes	260		Yes	6,040		Yes
SA9-10C	SA9-10C2	2012-11-09	8.20		Yes	23.4		Yes	20,400		Yes	436		Yes	5,780		Yes
SA9-1C	SA9-1C	2012-11-08	10.0		Yes	32.4		Yes	25,300		Yes	1040		Yes	8,560		Yes
SA9-2C	SA9-2C	2012-11-09	24.2		Yes	50.1		Yes	40,400		Yes	230		Yes	34,900		Yes
SA9-3C	SA9-3C	2012-11-08	14.4		Yes	38.0		Yes	33,700		Yes	165		Yes	15,200		Yes
SA9-4C	SA9-4C	2012-11-08	6.20		Yes	25.8		Yes	14,200		Yes	503		Yes	2,850		Yes
SA9-5C	SA9-5C	2012-11-07	7.80		Yes	30.5		Yes	17,200		Yes	534		Yes	3,960		Yes
SA9-6C	SA9-6C	2012-11-07	8.60		Yes	28.3		Yes	19,700		Yes	651		Yes	5,670		Yes
SA9-7C	SA9-7C	2012-11-07	8.60		Yes	30.9		Yes	22,900		Yes	539		Yes	5,400		Yes
SA9-8C	SA9-8C	2012-11-08	11.4		Yes	38.4		Yes	28,300		Yes	691		Yes	8,250		Yes
SA9-9C	SA9-9C	2012-11-07	10.2		Yes	33.1		Yes	28,100		Yes	362		Yes	6,630		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Cobalt			Copper			Iron			Lead			Magnesium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2015 Bossburg Flat Beach Study																	
UDU-01-ICS	UDU-01-ICS	2015-04-14	4.20		Yes	13.4		Yes	11,600		Yes	182		Yes	3,040		Yes
UDU-02-ICS	UDU-02-ICS	2015-04-16	4.22		Yes	17.6		Yes	13,000		Yes	258		Yes	2,790		Yes
UDU-03-ICS	UDU-03-ICS	2015-04-16	3.99		Yes	55.4		Yes	11,900		Yes	410		Yes	2,690		Yes
UDU-04-ICS	UDU-04-ICS-A	2015-04-17	4.09		Yes	16.9		Yes	12,900		Yes	2550	J	Yes	2,630		Yes
UDU-04-ICS	UDU-04-ICS-B	2015-04-18	4.22		Yes	15.6		Yes	13,500		Yes	2140	J	Yes	2,570		Yes
UDU-04-ICS	UDU-04-ICS-C	2015-04-18	3.80		Yes	12.4		Yes	10,700		Yes	695	J	Yes	2,450		Yes
UDU-05-ICS	UDU-05-ICS	2015-04-29	7.42		Yes	23.4		Yes	18,600		Yes	48.3		Yes	6,130		Yes
UDU-06-ICS	UDU-06-ICS	2015-05-07	6.83		Yes	20.9		Yes	14,800		Yes	38.4		Yes	9,030	J	Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Manganese			Mercury			Molybdenum			Nickel			Potassium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study																	
ADA-001	ADA-001	2014-09-13	647		Yes	0.069		Yes	0.610		Yes	18.7		Yes	2,760		Yes
ADA-002	ADA-002	2014-10-09	501		Yes	0.024		Yes	4.54		Yes	36.0		Yes	3,280		Yes
ADA-004	ADA-004	2014-10-09	826		Yes	0.066		Yes	4.48		Yes	26.5		Yes	1,930		Yes
ADA-005	ADA-005	2014-10-08	573		Yes	0.029		Yes	6.03		Yes	38.9		Yes	3,460		Yes
ADA-006	ADA-006	2014-10-11	446		Yes	0.042		Yes	0.520		Yes	12.0		Yes	1,540		Yes
ADA-008	ADA-008	2014-10-11	757		Yes	0.108		Yes	0.710		Yes	22.0		Yes	1,760		Yes
ADA-010	ADA-010	2014-10-02	1,390		Yes	0.105		Yes	0.740	J	Yes	18.8		Yes	2,000		Yes
ADA-015	ADA-015	2014-09-13	552		Yes	0.048		Yes	0.700		Yes	9.85		Yes	1,130		Yes
ADA-016	ADA-016-A	2014-09-24	395		Yes	0.032		Yes	0.560		Yes	10.5		Yes	1,060		Yes
ADA-016	ADA-016-B	2014-09-24	361		Yes	0.031		Yes	0.460		Yes	7.14		Yes	804		Yes
ADA-016	ADA-016-C	2014-09-24	363		Yes	0.033		Yes	0.440		Yes	7.51		Yes	894		Yes
ADA-017	ADA-017	2014-10-01	649		Yes	0.059		Yes	0.730		Yes	11.4		Yes	1,930		Yes
ADA-018	ADA-018	2014-10-01	1,010		Yes	0.106		Yes	1.17		Yes	16.3		Yes	3,060		Yes
ADA-019	ADA-019	2014-10-11	537		Yes	0.036		Yes	0.660		Yes	26.4		Yes	1,810		Yes
ADA-020	ADA-020-A	2014-09-13	431		Yes	0.019	J	Yes	0.720		Yes	14.3		Yes	1,800		Yes
ADA-020	ADA-020-B	2014-09-13	458		Yes	0.023		Yes	0.720		Yes	14.5		Yes	1,920		Yes
ADA-020	ADA-020-C	2014-09-13	457		Yes	0.022		Yes	0.750		Yes	14.0		Yes	1,910		Yes
ADA-021	ADA-021	2014-09-30	664		Yes	0.043		Yes	1.51		Yes	38.4		Yes	1,880		Yes
ADA-023	ADA-023-A	2014-09-13	405		Yes	0.039		Yes	2.76		Yes	23.9		Yes	3,450		Yes
ADA-023	ADA-023-B	2014-09-13	388		Yes	0.038		Yes	3.66		Yes	25.4		Yes	3,330		Yes
ADA-023	ADA-023-C	2014-09-13	407		Yes	0.040		Yes	3.45		Yes	25.6		Yes	3,470		Yes
ADA-024	ADA-024	2014-09-30	824		Yes	0.136		Yes	0.770		Yes	13.3		Yes	1,650		Yes
ADA-025	ADA-025	2014-09-17	1,490		Yes	0.079		Yes	5.89		Yes	31.7		Yes	1,430		Yes
ADA-026	ADA-026	2014-09-17	705		Yes	0.069		Yes	5.52		Yes	42.6		Yes	1,390		Yes
ADA-028	ADA-028	2014-10-03	905	J	Yes	0.060		Yes	0.670		Yes	11.1		Yes	1,690		Yes
ADA-033	ADA-033	2014-09-24	1,160		Yes	0.029		Yes	3.85		Yes	45.0		Yes	1,320		Yes
ADA-034	ADA-034	2014-10-10	931		Yes	0.026		Yes	2.55		Yes	24.4		Yes	1,530		Yes
ADA-035	ADA-035	2014-10-03	1,250	J	Yes	0.063		Yes	0.720		Yes	11.3		Yes	1,260		Yes
ADA-039	ADA-039	2014-10-01	1,080		Yes	0.028		Yes	3.06		Yes	33.2		Yes	1,160		Yes
ADA-042	ADA-042	2014-10-09	908		Yes	0.048		Yes	2.55		Yes	18.3		Yes	1,630		Yes
ADA-043	ADA-043	2014-10-03	958	J	Yes	0.067		Yes	2.86		Yes	40.2		Yes	2,890		Yes
ADA-044	ADA-044	2014-09-18	943		Yes	0.076		Yes	3.12		Yes	64.7		Yes	2,400		Yes
ADA-045	ADA-045	2014-10-09	1,110		Yes	0.115		Yes	0.580		Yes	16.1		Yes	1,460		Yes
ADA-046	ADA-046	2014-10-01	638		Yes	0.075		Yes	0.580		Yes	10.8		Yes	1,490		Yes
ADA-047	ADA-047	2014-09-30	851		Yes	0.084		Yes	0.790		Yes	20.7		Yes	3,090		Yes
ADA-048	ADA-048	2014-10-22	1,030		Yes	0.083		Yes	2.60		Yes	30.8		Yes	1,840		Yes
ADA-049	ADA-049	2014-09-17	1,470		Yes	0.046		Yes	4.01		Yes	27.1		Yes	1,190		Yes
ADA-050	ADA-050	2014-10-04	577		Yes	0.109		Yes	1.27		Yes	34.6		Yes	4,320		Yes
ADA-051	ADA-051	2014-10-22	783		Yes	0.039		Yes	2.88		Yes	35.3		Yes	2,050		Yes
ADA-052	ADA-052	2014-10-02	872		Yes	0.123		Yes	0.830	J	Yes	22.4		Yes	2,950		Yes
ADA-053	ADA-053	2014-10-07	1,940		Yes	0.076		Yes	0.860		Yes	29.8		Yes	1,910		Yes
ADA-054	ADA-054	2014-09-30	661		Yes	0.122		Yes	0.990		Yes	15.0		Yes	1,620		Yes
ADA-055	ADA-055-A	2014-10-08	1,380		Yes	0.040		Yes	6.03		Yes	46.5		Yes	1,590		Yes
ADA-055	ADA-055-B	2014-10-08	1,680		Yes	0.039		Yes	4.89		Yes	44.1		Yes	1,750		Yes
ADA-055	ADA-055-C	2014-10-08	1,510		Yes	0.034		Yes	3.77		Yes	38.4		Yes	1,530		Yes
ADA-056	ADA-056	2014-09-15	2,060		Yes	0.041		Yes	0.910		Yes	28.9		Yes	2,220		Yes
ADA-057	ADA-057	2014-10-07	913		Yes	0.052		Yes	0.830		Yes	30.9		Yes	3,410		Yes
ADA-058	ADA-058	2014-09-19	1,950		Yes	0.060		Yes	1.52		Yes	26.8		Yes	2,060		Yes
ADA-059	ADA-059	2014-10-07	1,880		Yes	0.079		Yes	1.55		Yes	31.9		Yes	2,700		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Manganese			Mercury			Molybdenum			Nickel			Potassium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study (continued)																	
ADA-060	ADA-060-A	2014-10-06	759		Yes	0.085		Yes	0.830		Yes	23.4		Yes	2,830		Yes
ADA-060	ADA-060-B	2014-10-06	762		Yes	0.098		Yes	0.590		Yes	25.4		Yes	3,440		Yes
ADA-060	ADA-060-C	2014-10-06	664		Yes	0.085		Yes	0.730		Yes	25.5		Yes	2,900		Yes
ADA-061	ADA-061	2014-09-16	2,350		Yes	0.045		Yes	0.780		Yes	37.3		Yes	2,770		Yes
ADA-062	ADA-062	2014-10-06	736		Yes	0.083		Yes	0.690		Yes	18.7		Yes	1,510		Yes
ADA-063	ADA-063	2014-09-17	1,570		Yes	0.094		Yes	1.72		Yes	27.1		Yes	1,440		Yes
ADA-064	ADA-064	2014-09-16	2,270		Yes	0.043		Yes	1.30		Yes	33.2		Yes	2,380		Yes
ADA-065	ADA-065	2014-10-07	472		Yes	0.043		Yes	0.530		Yes	10.4		Yes	911		Yes
ADA-066	ADA-066	2014-10-06	711		Yes	0.055		Yes	0.910		Yes	16.1		Yes	2,220		Yes
ADA-067	ADA-067	2014-09-17	1,360		Yes	0.059		Yes	2.73		Yes	33.8		Yes	1,970		Yes
ADA-070	ADA-070	2014-10-01	972		Yes	0.115		Yes	0.760		Yes	20.6		Yes	2,100		Yes
ADA-071	ADA-071	2014-10-07	959		Yes	0.072		Yes	0.980		Yes	18.9		Yes	1,600		Yes
ADA-073	ADA-073	2014-10-03	847	J	Yes	0.099		Yes	0.980		Yes	18.3		Yes	1,360		Yes
ADA-076	ADA-076	2014-10-14	1,050		Yes	0.164		Yes	1.58		Yes	26.4		Yes	1,250		Yes
ADA-078	ADA-078	2014-09-29	1,230	J	Yes	0.084		Yes	0.760		Yes	19.5		Yes	1,630	J	Yes
ADA-079	ADA-079	2014-10-14	1,030		Yes	0.109		Yes	3.21		Yes	27.6		Yes	1,210		Yes
ADA-081	ADA-081	2014-10-08	803		Yes	0.060		Yes	0.790		Yes	20.8		Yes	1,200		Yes
ADA-082	ADA-082	2014-10-04	674		Yes	0.077		Yes	0.760		Yes	19.6		Yes	1,640		Yes
ADA-084	ADA-084	2014-10-09	1,590		Yes	0.102		Yes	0.700		Yes	23.3		Yes	1,610		Yes
ADA-085	ADA-085	2014-09-17	1,100		Yes	0.107		Yes	1.39		Yes	23.1		Yes	1,140		Yes
ADA-088	ADA-088	2014-10-02	1,300		Yes	0.097		Yes	0.930	J	Yes	29.9		Yes	2,160		Yes
ADA-089	ADA-089	2014-10-07	1,540		Yes	0.081		Yes	0.750		Yes	29.5		Yes	1,830		Yes
ADA-090	ADA-090	2014-10-07	1,300		Yes	0.122		Yes	0.650		Yes	20.5		Yes	2,090		Yes
ADA-091	ADA-091	2014-10-02	1,020		Yes	0.088		Yes	0.680	J	Yes	34.5		Yes	1,980		Yes
ADA-092	ADA-092	2014-10-06	1,530		Yes	0.093		Yes	2.03		Yes	30.6		Yes	1,510		Yes
ADA-093	ADA-093	2014-09-16	1,920		Yes	0.086		Yes	0.780		Yes	19.6		Yes	1,070		Yes
ADA-094	ADA-094	2014-10-16	918		Yes	0.057		Yes	0.680	J	Yes	20.9		Yes	1,510		Yes
ADA-095	ADA-095	2014-10-08	1,240		Yes	0.082		Yes	0.680		Yes	28.1		Yes	1,490		Yes
ADA-096	ADA-096	2014-09-26	1,250		Yes	0.096		Yes	0.700		Yes	16.0		Yes	1,590		Yes
ADA-097	ADA-097	2014-09-24	1,190		Yes	0.132		Yes	1.14		Yes	21.9		Yes	1,700		Yes
ADA-099	ADA-099	2014-10-10	1,580		Yes	0.122		Yes	0.740		Yes	28.6		Yes	1,500		Yes
ADA-101	ADA-101	2014-10-11	1,110		Yes	0.093		Yes	0.970		Yes	18.6		Yes	1,310		Yes
ADA-102	ADA-102	2014-10-08	1,000		Yes	0.052		Yes	0.650		Yes	18.8		Yes	1,550		Yes
ADA-103	ADA-103	2014-09-26	2,140		Yes	0.070		Yes	1.15		Yes	42.0		Yes	2,320		Yes
ADA-104	ADA-104	2014-09-19	1,180		Yes	0.077		Yes	2.70		Yes	18.9		Yes	961		Yes
ADA-105	ADA-105	2014-10-10	1,060		Yes	0.106		Yes	0.510		Yes	18.2		Yes	2,190		Yes
ADA-106	ADA-106-A	2014-10-15	1,580		Yes	0.079		Yes	2.11	J	Yes	33.5		Yes	1,480		Yes
ADA-106	ADA-106-B	2014-10-15	1,360		Yes	0.072		Yes	2.30	J	Yes	33.8		Yes	1,400		Yes
ADA-106	ADA-106-C	2014-10-16	1,130		Yes	0.070		Yes	2.45	J	Yes	31.8		Yes	1,270		Yes
ADA-107	ADA-107-A	2014-10-02	2,220		Yes	0.091		Yes	2.24	J	Yes	27.7		Yes	2,260		Yes
ADA-107	ADA-107-B	2014-10-01	2,040		Yes	0.076		Yes	1.19	J	Yes	39.0		Yes	2,560		Yes
ADA-107	ADA-107-C	2014-10-01	1,930		Yes	0.082		Yes	1.33	J	Yes	37.4		Yes	2,160		Yes
ADA-108	ADA-108-A	2014-10-10	810		Yes	0.065		Yes	0.510		Yes	28.0		Yes	2,180		Yes
ADA-108	ADA-108-B	2014-10-10	759		Yes	0.073		Yes	0.480		Yes	18.9		Yes	1,960		Yes
ADA-108	ADA-108-C	2014-10-09	815		Yes	0.058		Yes	0.470		Yes	19.5		Yes	2,240		Yes
ADA-109	ADA-109	2014-09-30	696		Yes	0.129		Yes	0.740		Yes	15.1		Yes	1,650		Yes
ADA-110	ADA-110	2014-09-26	482		Yes	0.067		Yes	0.390		Yes	12.3		Yes	2,220		Yes
ADA-111	ADA-111	2014-10-07	1,070		Yes	0.072		Yes	0.480		Yes	22.1		Yes	2,260		Yes
ADA-112	ADA-112	2014-10-16	1,520		Yes	0.088		Yes	0.580	J	Yes	14.8		Yes	1,310		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Manganese			Mercury			Molybdenum			Nickel			Potassium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study (continued)																	
ADA-113	ADA-113	2014-09-20	1,490		Yes	0.107		Yes	0.60		Yes	20.9		Yes	1,460		Yes
ADA-114	ADA-114	2014-10-06	1,500		Yes	0.100		Yes	0.850		Yes	20.9		Yes	1,320		Yes
ADA-115	ADA-115	2014-10-17	1,190		Yes	0.074		Yes	0.510		Yes	12.7		Yes	1,070		Yes
ADA-116	ADA-116	2014-10-08	1,110		Yes	0.065		Yes	0.580		Yes	14.7		Yes	1,190		Yes
ADA-117	ADA-117	2014-09-29	1,270	J	Yes	0.056		Yes	0.660		Yes	13.5		Yes	1,430	J	Yes
ADA-118	ADA-118	2014-09-30	1,430		Yes	0.079		Yes	0.660		Yes	26.2		Yes	2,050		Yes
ADA-119	ADA-119	2014-10-02	948		Yes	0.078		Yes	0.520	J	Yes	21.4		Yes	1,800		Yes
ADA-121	ADA-121	2014-10-14	1,190		Yes	0.091		Yes	0.880		Yes	22.6		Yes	2,040		Yes
ADA-122	ADA-122	2014-10-10	1,620		Yes	0.082		Yes	1.05		Yes	25.7		Yes	1,010		Yes
ADA-124	ADA-124-A	2014-10-04	637		Yes	0.070		Yes	0.890		Yes	9.57		Yes	938		Yes
ADA-124	ADA-124-B	2014-10-04	597		Yes	0.057		Yes	0.810		Yes	9.40		Yes	948		Yes
ADA-124	ADA-124-C	2014-10-04	651		Yes	0.042		Yes	0.790		Yes	9.64		Yes	933		Yes
ADA-125	ADA-125	2014-10-23	475		Yes	0.053		Yes	0.810		Yes	9.81		Yes	857		Yes
ADA-126	ADA-126	2014-09-11	778		Yes	0.103		Yes	0.780		Yes	10.8		Yes	1,550		Yes
ADA-127	ADA-127	2014-10-14	762		Yes	0.039		Yes	1.00		Yes	31.5		Yes	1,780		Yes
ADA-128	ADA-128	2014-10-03	301	J	Yes	0.039		Yes	0.380		Yes	7.32		Yes	883		Yes
ADA-131	ADA-131-A	2014-09-18	979		Yes	0.140		Yes	0.980		Yes	19.0		Yes	1,580		Yes
ADA-131	ADA-131-B	2014-09-18	730		Yes	0.106		Yes	0.910		Yes	18.1		Yes	1,720		Yes
ADA-131	ADA-131-C	2014-09-18	878		Yes	0.139		Yes	0.970		Yes	17.5		Yes	1,590		Yes
ADA-132	ADA-132	2014-09-16	338		Yes	0.069		Yes	0.720		Yes	10.8		Yes	1,390		Yes
ADA-133	ADA-133	2014-09-23	714		Yes	0.061		Yes	0.980		Yes	15.9		Yes	1,350	J	Yes
ADA-135	ADA-135-A	2014-09-17	348		Yes	0.034		Yes	0.470		Yes	13.4		Yes	1,530		Yes
ADA-135	ADA-135-B	2014-09-17	349		Yes	0.029		Yes	0.450		Yes	13.2		Yes	1,610		Yes
ADA-135	ADA-135-C	2014-09-18	352		Yes	0.028		Yes	0.510		Yes	12.7		Yes	1,540		Yes
ADA-136	ADA-136	2014-09-10	478		Yes	0.062		Yes	0.540	J	Yes	10.8		Yes	1,520		Yes
ADA-139	ADA-139	2014-10-14	804		Yes	0.077		Yes	0.940		Yes	21.2		Yes	1,680		Yes
ADA-141	ADA-141	2014-09-23	651		Yes	0.085		Yes	0.680		Yes	15.2		Yes	1,100	J	Yes
ADA-142	ADA-142	2014-09-25	477		Yes	0.056		Yes	0.500		Yes	8.08		Yes	944		Yes
ADA-143	ADA-143	2014-09-15	329		Yes	0.044		Yes	0.500		Yes	8.90		Yes	1,010		Yes
ADA-144	ADA-144	2014-09-29	327	J	Yes	0.062		Yes	0.440		Yes	6.21		Yes	624	J	Yes
ADA-145	ADA-145	2014-09-24	792		Yes	0.099		Yes	0.660		Yes	15.4		Yes	1,590		Yes
ADA-146	ADA-146	2014-10-02	591		Yes	0.063		Yes	0.600	J	Yes	11.0		Yes	1,370		Yes
ADA-147	ADA-147	2014-09-29	298	J	Yes	0.086		Yes	0.400		Yes	5.59		Yes	550	J	Yes
ADA-148	ADA-148	2014-10-06	437		Yes	0.079		Yes	0.440		Yes	10.2		Yes	1,170		Yes
ADA-150	ADA-150	2014-10-06	320		Yes	0.073		Yes	0.400		Yes	8.50		Yes	888		Yes
ADA-151	ADA-151	2014-10-04	220		Yes	0.098		Yes	0.320		Yes	9.59		Yes	1,050		Yes
ADA-152	ADA-152	2014-10-09	1,040		Yes	0.100		Yes	0.590		Yes	22.2		Yes	2,170		Yes
ADA-153	ADA-153	2014-09-20	695		Yes	0.082		Yes	0.590		Yes	13.8		Yes	1,490		Yes
ADA-154	ADA-154-A	2014-09-20	861		Yes	0.069		Yes	0.600		Yes	26.2		Yes	2,050		Yes
ADA-154	ADA-154-B	2014-09-20	828		Yes	0.084		Yes	0.700		Yes	27.9		Yes	2,880		Yes
ADA-154	ADA-154-C	2014-09-20	769		Yes	0.101		Yes	0.650		Yes	25.8		Yes	2,090		Yes
ADA-155	ADA-155	2014-09-15	669		Yes	0.080		Yes	0.620		Yes	8.13		Yes	875		Yes
ADA-156	ADA-156	2014-10-07	999		Yes	0.141		Yes	1.07		Yes	15.5		Yes	1,650		Yes
ADA-158	ADA-158-A	2014-10-07	434		Yes	0.071	J	Yes	0.480		Yes	11.4		Yes	1,510		Yes
ADA-158	ADA-158-B	2014-10-07	521		Yes	0.091	J	Yes	0.630		Yes	12.1		Yes	1,570		Yes
ADA-158	ADA-158-C	2014-10-07	422		Yes	0.122	J	Yes	0.610		Yes	12.5		Yes	1,620		Yes
ADA-159	ADA-159-A	2014-10-04	840		Yes	0.091		Yes	0.600		Yes	18.1		Yes	2,250		Yes
ADA-159	ADA-159-B	2014-10-04	885		Yes	0.116		Yes	0.660		Yes	17.1		Yes	1,590		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Manganese			Mercury			Molybdenum			Nickel			Potassium		
Location ID	Sample ID	Sample Date	Value^a (mg/kg)	Qualifier	Detected Result?	Value^a (mg/kg)	Qualifier	Detected Result?	Value^a (mg/kg)	Qualifier	Detected Result?	Value^a (mg/kg)	Qualifier	Detected Result?	Value^a (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study (continued)																	
ADA-159	ADA-159-C	2014-10-04	724		Yes	0.093		Yes	0.590		Yes	12.7		Yes	1,550		Yes
ADA-160	ADA-160	2014-10-03	335	J	Yes	0.060		Yes	0.440		Yes	8.37		Yes	761		Yes
ADA-161	ADA-161	2014-10-03	778	J	Yes	0.096		Yes	0.660		Yes	14.2		Yes	1,850		Yes
ADA-162	ADA-162	2014-10-09	431		Yes	0.156		Yes	0.430		Yes	7.76		Yes	950		Yes
ADA-164	ADA-164	2014-09-30	764		Yes	0.124		Yes	0.670		Yes	11.8		Yes	1,160		Yes
ADA-165	ADA-165	2014-09-16	631		Yes	0.148		Yes	0.630		Yes	11.9		Yes	1,950		Yes
ADA-168	ADA-168	2014-10-14	640		Yes	0.079		Yes	0.620		Yes	13.7		Yes	1,370		Yes
ADA-169	ADA-169-A	2014-09-19	964		Yes	0.053		Yes	0.560		Yes	24.3		Yes	1,010		Yes
ADA-169	ADA-169-B	2014-09-19	793		Yes	0.058		Yes	0.550		Yes	22.7		Yes	935		Yes
ADA-169	ADA-169-C	2014-09-19	911		Yes	0.065		Yes	0.520		Yes	24.5		Yes	999		Yes
ADA-170	ADA-170	2014-09-23	931		Yes	0.095		Yes	1.48		Yes	16.4		Yes	1,340	J	Yes
ADA-171	ADA-171	2014-09-23	805		Yes	0.087		Yes	2.00		Yes	17.6		Yes	874	J	Yes
ADA-172	ADA-172	2014-09-29	1,100	J	Yes	0.098		Yes	0.510		Yes	13.3		Yes	976	J	Yes
ADA-173	ADA-173-A	2014-09-12	1,160		Yes	0.073		Yes	1.80	J	Yes	15.9		Yes	1,070		Yes
ADA-173	ADA-173-B	2014-09-12	1,290		Yes	0.076		Yes	2.06	J	Yes	16.8		Yes	1,130		Yes
ADA-173	ADA-173-C	2014-09-12	1,310		Yes	0.085		Yes	1.77	J	Yes	15.6		Yes	1,030		Yes
ADA-174	ADA-174	2014-09-12	1,410		Yes	0.116		Yes	2.13	J	Yes	14.5		Yes	971		Yes
ADA-175	ADA-175	2014-09-15	1,070		Yes	0.050		Yes	0.550		Yes	23.7		Yes	1,490		Yes
ADA-176	ADA-176	2014-09-12	858		Yes	0.055		Yes	0.420	J	Yes	44.8		Yes	3,250		Yes
ADA-177	ADA-177	2014-09-16	1,140		Yes	0.071		Yes	0.550		Yes	21.3		Yes	956		Yes
ADA-178	ADA-178	2014-09-11	871		Yes	0.059		Yes	0.920		Yes	23.3		Yes	897		Yes
ADA-179	ADA-179	2014-09-18	1,190		Yes	0.076		Yes	1.91		Yes	15.1		Yes	1,030		Yes
ADA-180	ADA-180	2014-09-19	894		Yes	0.082		Yes	3.14		Yes	19.6		Yes	1,530		Yes
ADA-181	ADA-181	2014-09-12	1,180		Yes	0.106		Yes	3.25	J	Yes	20.4		Yes	1,250		Yes
ADA-182	ADA-182	2014-10-13	590		Yes	0.065		Yes	2.83	J	Yes	27.2		Yes	955		Yes
ADA-183	ADA-183	2014-09-11	491		Yes	0.162		Yes	7.81		Yes	57.6		Yes	1,070		Yes
ADA-184	ADA-184	2014-09-11	1,160		Yes	0.062		Yes	3.97		Yes	30.5		Yes	1,010		Yes
2012 Ecology Upland Soil Study																	
SA1-1C	SA1-1C	2012-10-30	2,320		Yes	0.073		Yes	nm	nm	nm	33.6		Yes	1,570		Yes
SA1-2C	SA1-2C	2012-10-30	2,340		Yes	0.042		Yes	nm	nm	nm	20.9		Yes	1,820		Yes
SA1-3C	SA1-3C	2012-10-30	1,030		Yes	0.048		Yes	nm	nm	nm	25.4		Yes	1,370		Yes
SA1-3C	SA1-3C2	2012-10-30	957		Yes	0.050		Yes	nm	nm	nm	26.5		Yes	1,490		Yes
SA1-4C	SA1-4C	2012-10-30	914		Yes	0.044		Yes	nm	nm	nm	23.4		Yes	1,500		Yes
SA1-5C	SA1-5C	2012-10-30	1,150		Yes	0.046		Yes	nm	nm	nm	19.9		Yes	1,170		Yes
SA1-6C	SA1-6C	2012-10-30	1,670		Yes	0.040		Yes	nm	nm	nm	24.7		Yes	1,090		Yes
SA1-7C	SA1-7C	2012-10-30	1,120		Yes	0.049		Yes	nm	nm	nm	19.8		Yes	1,220		Yes
SA1-8C	SA1-8C	2012-10-30	1,330		Yes	0.059		Yes	nm	nm	nm	13.1		Yes	1,170		Yes
SA10-1C	SA10-1C	2012-11-08	1,070		Yes	0.104		Yes	nm	nm	nm	24.8		Yes	2,120		Yes
SA10-2C	SA10-2C	2012-11-08	5,490		Yes	0.232		Yes	nm	nm	nm	52.9		Yes	1,380		Yes
SA10-3C	SA10-3C	2012-11-05	2,870		Yes	0.094		Yes	nm	nm	nm	57.2		Yes	1,600		Yes
SA10-3C	SA10-3C2	2012-11-05	2,340		Yes	0.060		Yes	nm	nm	nm	54.8		Yes	1,430		Yes
SA10-4C	SA10-4C	2012-11-05	44		Yes	0.114		Yes	nm	nm	nm	13.1		Yes	460		Yes
SA10-5C	SA10-5C	2012-11-05	830		Yes	0.083		Yes	nm	nm	nm	24.9		Yes	1,860		Yes
SA10-6C	SA10-6C	2012-11-05	2,190		Yes	0.077		Yes	nm	nm	nm	25.5		Yes	1,660		Yes
SA10-7C	SA10-7C	2012-11-05	3,810		Yes	0.088		Yes	nm	nm	nm	40.9		Yes	1,840		Yes
SA10-8C	SA10-8C	2012-11-08	2,840		Yes	0.124		Yes	nm	nm	nm	29.8		Yes	1,390		Yes
SA11-1C	SA11-1C	2012-11-08	880		Yes	0.035		Yes	nm	nm	nm	31.1		Yes	1,760		Yes
SA11-2C	SA11-2C	2012-11-06	1,200		Yes	0.050		Yes	nm	nm	nm	19.2		Yes	1,930		Yes
SA11-3C	SA11-3C	2012-11-10	497		Yes	0.074		Yes	nm	nm	nm	18.6		Yes	1,440		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Manganese			Mercury			Molybdenum			Nickel			Potassium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2012 Ecology Upland Soil Study (continued)																	
SA11-4C	SA11-4C	2012-11-08	1,330		Yes	0.126		Yes	nm	nm	nm	17.9		Yes	2,230		Yes
SA11-5C	SA11-5C	2012-11-06	1,630		Yes	0.150		Yes	nm	nm	nm	14.4		Yes	1,260		Yes
SA11-6C	SA11-6C	2012-11-06	676		Yes	0.104		Yes	nm	nm	nm	22.8		Yes	1,300		Yes
SA11-7C	SA11-7C	2012-11-06	1,460		Yes	0.527		Yes	nm	nm	nm	7.80		Yes	1,200		Yes
SA11-8C	SA11-8C	2012-11-07	726		Yes	0.071		Yes	nm	nm	nm	20.4		Yes	2,000		Yes
SA11-8C	SA11-8C2	2012-11-07	1,570		Yes	0.185		Yes	nm	nm	nm	20.7		Yes	1,870		Yes
SA11-9C	SA11-9C	2012-11-08	2,850		Yes	0.150		Yes	nm	nm	nm	38.8		Yes	2,010		Yes
SA12-1C	SA12-1C	2012-11-07	1,610		Yes	0.080		Yes	nm	nm	nm	76.4		Yes	1,920		Yes
SA12-2C	SA12-2C	2012-11-10	1,470		Yes	0.063		Yes	nm	nm	nm	20.4		Yes	1,400		Yes
SA12-3C	SA12-3C	2012-11-10	655		Yes	0.135		Yes	nm	nm	nm	14.3		Yes	1,100		Yes
SA12-4C	SA12-4C	2012-11-10	966		Yes	0.045		Yes	nm	nm	nm	17.9		Yes	1,580		Yes
SA12-6C	SA12-6C	2012-11-10	1,250		Yes	0.073		Yes	nm	nm	nm	16.5		Yes	1,330		Yes
SA12-7C	SA12-7C	2012-11-10	2,380		Yes	0.065		Yes	nm	nm	nm	24.4		Yes	2,010		Yes
SA12-7C	SA12-7C2	2012-11-10	1,860		Yes	0.061		Yes	nm	nm	nm	23.8		Yes	1,470		Yes
SA12-8C	SA12-8C	2012-11-10	1,370		Yes	0.067		Yes	nm	nm	nm	18.0		Yes	1,530		Yes
SA12-9C	SA12-9C	2012-11-10	2,750		Yes	0.046		Yes	nm	nm	nm	35.5		Yes	1,620		Yes
SA13-1C	SA13-1C	2012-11-10	851		Yes	0.044		Yes	nm	nm	nm	17.7		Yes	1,230		Yes
SA13-2C	SA13-2C	2012-11-10	1,260		Yes	0.100		Yes	nm	nm	nm	17.3		Yes	1,470		Yes
SA13-3C	SA13-3C	2012-11-10	1,480		Yes	0.085		Yes	nm	nm	nm	18.5		Yes	1,300		Yes
SA13-4C	SA13-4C	2012-11-10	317		Yes	0.058		Yes	nm	nm	nm	26.5		Yes	1,200		Yes
SA13-5C	SA13-5C	2012-11-10	1,480		Yes	0.113		Yes	nm	nm	nm	22.1		Yes	2,380		Yes
SA13-5C	SA13-5C2	2012-11-10	1,370		Yes	0.101		Yes	nm	nm	nm	21.9		Yes	2,280		Yes
SA13-6C	SA13-6C	2012-11-10	2,270		Yes	0.100		Yes	nm	nm	nm	15.5		Yes	1,250		Yes
SA13-7C	SA13-7C	2012-11-07	833		Yes	0.068		Yes	nm	nm	nm	18.9		Yes	1,340		Yes
SA13-8C	SA13-8C	2012-11-10	1,180		Yes	0.069		Yes	nm	nm	nm	19.7		Yes	1,350		Yes
SA2-1C	SA2-1C	2012-10-31	2,510		Yes	0.062		Yes	nm	nm	nm	14.2		Yes	2,050		Yes
SA2-2C	SA2-2C	2012-10-31	1,090		Yes	0.040		Yes	nm	nm	nm	20.7		Yes	1,630		Yes
SA2-3C	SA2-3C	2012-10-31	818		Yes	0.030		Yes	nm	nm	nm	14.3		Yes	1,570		Yes
SA2-4C	SA2-4C	2012-10-31	1,240		Yes	0.033		Yes	nm	nm	nm	13.5		Yes	1,900		Yes
SA2-4C	SA2-4C2	2012-10-31	1,270		Yes	0.060		Yes	nm	nm	nm	12.9		Yes	1,620		Yes
SA2-5C	SA2-5C	2012-10-31	399		Yes	0.043		Yes	nm	nm	nm	15.3		Yes	1,320		Yes
SA2-6C	SA2-6C	2012-10-31	702		Yes	0.066		Yes	nm	nm	nm	26.3		Yes	3,380		Yes
SA2-7C	SA2-7C	2012-10-31	1,120		Yes	0.041		Yes	nm	nm	nm	41.2		Yes	2,730		Yes
SA2-8C	SA2-8C	2012-10-31	1,160		Yes	0.033		Yes	nm	nm	nm	31.7		Yes	2,090		Yes
SA3-1C	SA3-1C	2012-11-01	862		Yes	0.022		Yes	nm	nm	nm	19.4		Yes	1,640		Yes
SA3-2C	SA3-2C	2012-11-01	1,290		Yes	0.031		Yes	nm	nm	nm	13.0		Yes	990		Yes
SA3-3C	SA3-3C	2012-11-01	1,420		Yes	0.036		Yes	nm	nm	nm	55.8		Yes	2,800		Yes
SA3-4C	SA3-4C	2012-11-01	983		Yes	0.027		Yes	nm	nm	nm	11.4		Yes	1,090		Yes
SA3-5C	SA3-5C	2012-11-01	622		Yes	0.025		Yes	nm	nm	nm	14.0		Yes	1,120		Yes
SA3-6C	SA3-6C	2012-11-01	2,420		Yes	0.148		Yes	nm	nm	nm	73.9		Yes	4,310		Yes
SA3-6C	SA3-6C2	2012-11-01	1,850		Yes	0.126		Yes	nm	nm	nm	95.3		Yes	4,730		Yes
SA3-7C	SA3-7C	2012-11-01	1,090		Yes	0.106	J	Yes	nm	nm	nm	21.7		Yes	1,810		Yes
SA3-8C	SA3-8C	2012-11-01	902		Yes	0.051		Yes	nm	nm	nm	11.9		Yes	1,450		Yes
SA4-1C	SA4-1C	2012-11-01	870		Yes	0.057		Yes	nm	nm	nm	21.2		Yes	2,790		Yes
SA4-2C	SA4-2C	2012-11-01	574		Yes	0.049		Yes	nm	nm	nm	15.3		Yes	3,520		Yes
SA4-3C	SA4-3C	2012-11-01	654		Yes	0.080		Yes	nm	nm	nm	17.0		Yes	2,830		Yes
SA4-4C	SA4-4C	2012-11-01	831		Yes	0.073		Yes	nm	nm	nm	19.3		Yes	2,870		Yes
SA4-5C	SA4-5C	2012-11-01	842		Yes	0.039		Yes	nm	nm	nm	21.7		Yes	2,760		Yes
SA4-6C	SA4-6C	2012-11-02	1,040		Yes	0.139		Yes	nm	nm	nm	21.3		Yes	2,010		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Manganese			Mercury			Molybdenum			Nickel			Potassium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2012 Ecology Upland Soil Study (continued)																	
SA4-6C	SA4-6C2	2012-11-02	801		Yes	0.102		Yes	nm	nm	nm	24.3		Yes	2,450		Yes
SA4-7C	SA4-7C	2012-11-01	1,190		Yes	0.075		Yes	nm	nm	nm	35.5		Yes	1,930		Yes
SA4-8C	SA4-8C	2012-11-01	612		Yes	0.051		Yes	nm	nm	nm	14.5		Yes	1,350		Yes
SA5-1C	SA5-1C	2012-11-09	851		Yes	0.090		Yes	nm	nm	nm	10.8		Yes	1,120		Yes
SA5-2C	SA5-2C	2012-11-09	963		Yes	0.050		Yes	nm	nm	nm	44.9		Yes	10,400		Yes
SA5-3C	SA5-3C	2012-11-03	1,090		Yes	0.088		Yes	nm	nm	nm	23.5		Yes	1,690		Yes
SA5-4C	SA5-4C	2012-11-02	539		Yes	0.079		Yes	nm	nm	nm	10.8		Yes	2,360		Yes
SA5-4C	SA5-4C2	2012-11-02	492		Yes	0.054		Yes	nm	nm	nm	12.4		Yes	2,560		Yes
SA5-5C	SA5-5C	2012-11-09	435		Yes	0.043		Yes	nm	nm	nm	16.6		Yes	2,600		Yes
SA5-7C	SA5-7C	2012-11-02	427		Yes	0.114		Yes	nm	nm	nm	10.9		Yes	2,060		Yes
SA5-8C	SA5-8C	2012-09-11	540		Yes	0.068		Yes	nm	nm	nm	20.9		Yes	3,320		Yes
SA6-1C	SA6-1C	2012-11-02	2,020		Yes	0.096		Yes	nm	nm	nm	16.6		Yes	1,490		Yes
SA6-2C	SA6-2C	2012-11-02	942		Yes	0.080		Yes	nm	nm	nm	22.2		Yes	1,830		Yes
SA6-2C	SA6-2C2	2012-11-02	1,140		Yes	0.082		Yes	nm	nm	nm	20.3		Yes	1,800		Yes
SA6-3C	SA6-3C	2012-11-02	1,280		Yes	0.093		Yes	nm	nm	nm	27.3		Yes	2,280		Yes
SA6-4C	SA6-4C	2012-11-03	162		Yes	0.026		Yes	nm	nm	nm	7.10		Yes	600		Yes
SA6-5C	SA6-5C	2012-11-03	182		Yes	0.015		Yes	nm	nm	nm	6.90		Yes	790		Yes
SA6-6C	SA6-6C	2012-11-03	692		Yes	0.108		Yes	nm	nm	nm	6.60		Yes	740		Yes
SA6-7C	SA6-7C	2012-11-02	1,380		Yes	0.103		Yes	nm	nm	nm	30.3		Yes	2,480		Yes
SA6-8C	SA6-8C	2012-11-03	461		Yes	0.029		Yes	nm	nm	nm	9.00		Yes	730		Yes
SA7-1C	SA7-1C	2012-11-03	1,050		Yes	0.064		Yes	nm	nm	nm	15.6		Yes	1,370		Yes
SA7-2C	SA7-2C	2012-11-03	362		Yes	0.075		Yes	nm	nm	nm	14.3		Yes	2,370		Yes
SA7-3C	SA7-3C	2012-11-03	364		Yes	0.091		Yes	nm	nm	nm	9.80		Yes	860		Yes
SA7-4C	SA7-4C	2012-11-03	254		Yes	0.055		Yes	nm	nm	nm	5.90		Yes	490		Yes
SA7-5C	SA7-5C	2012-11-03	395		Yes	0.192		Yes	nm	nm	nm	11.2		Yes	1,040		Yes
SA7-5C	SA7-5C2	2012-11-03	559		Yes	0.099		Yes	nm	nm	nm	14.5		Yes	1,160		Yes
SA7-6C	SA7-6C	2012-11-03	542		Yes	0.113		Yes	nm	nm	nm	11.5		Yes	1,400		Yes
SA7-7C	SA7-7C	2012-11-09	933		Yes	0.278		Yes	nm	nm	nm	16.4		Yes	2,430		Yes
SA7-8C	SA7-8C	2012-11-09	1,040		Yes	0.17		Yes	nm	nm	nm	83.8		Yes	13,900		Yes
SA8-1C	SA8-1C	2012-11-04	713		Yes	0.085		Yes	nm	nm	nm	11.5		Yes	1,110		Yes
SA8-2C	SA8-2C	2012-11-04	557		Yes	0.072		Yes	nm	nm	nm	8.90		Yes	610		Yes
SA8-3C	SA8-3C	2012-11-03	304		Yes	0.019		Yes	nm	nm	nm	14.4		Yes	1,330		Yes
SA8-3C	SA8-3C2	2012-11-03	376		Yes	0.033		Yes	nm	nm	nm	14.7		Yes	1,390		Yes
SA8-4C	SA8-4C	2012-11-04	601		Yes	0.098		Yes	nm	nm	nm	9.60		Yes	740		Yes
SA8-5C	SA8-5C	2012-11-04	619		Yes	0.157		Yes	nm	nm	nm	10.1		Yes	790		Yes
SA8-6C	SA8-6C	2012-11-04	856		Yes	0.055		Yes	nm	nm	nm	14.1		Yes	1,670		Yes
SA8-7C	SA8-7C	2012-11-04	796		Yes	0.169		Yes	nm	nm	nm	17.6		Yes	1,480		Yes
SA8-8C	SA8-8C	2012-11-04	918		Yes	0.287		Yes	nm	nm	nm	11.3		Yes	1,410		Yes
SA9-10C	SA9-10C	2012-11-09	654		Yes	0.094		Yes	nm	nm	nm	26.9		Yes	1,890		Yes
SA9-10C	SA9-10C2	2012-11-09	671		Yes	0.113		Yes	nm	nm	nm	26.7		Yes	1,530		Yes
SA9-1C	SA9-1C	2012-11-08	1,730		Yes	0.136		Yes	nm	nm	nm	20.9		Yes	2,390		Yes
SA9-2C	SA9-2C	2012-11-09	840		Yes	0.054		Yes	nm	nm	nm	178		Yes	17,200		Yes
SA9-3C	SA9-3C	2012-11-08	1,260		Yes	0.054		Yes	nm	nm	nm	37.4		Yes	5,570		Yes
SA9-4C	SA9-4C	2012-11-08	334		Yes	0.157		Yes	nm	nm	nm	20.7		Yes	1,150		Yes
SA9-5C	SA9-5C	2012-11-07	1,730		Yes	0.191		Yes	nm	nm	nm	25.9		Yes	1,510		Yes
SA9-6C	SA9-6C	2012-11-07	1,150		Yes	0.184		Yes	nm	nm	nm	27.4		Yes	2,020		Yes
SA9-7C	SA9-7C	2012-11-07	1,260		Yes	0.115		Yes	nm	nm	nm	25.9		Yes	1,800		Yes
SA9-8C	SA9-8C	2012-11-08	2,030		Yes	0.262		Yes	nm	nm	nm	33.5		Yes	1,860		Yes
SA9-9C	SA9-9C	2012-11-07	1,340		Yes	0.068		Yes	nm	nm	nm	35.5		Yes	2,900		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Manganese			Mercury			Molybdenum			Nickel			Potassium		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2015 Bossburg Flat Beach Study																	
UDU-01-ICS	UDU-01-ICS	2015-04-14	323		Yes	0.044		Yes	nm	nm	nm	10.9		Yes	1,060		Yes
UDU-02-ICS	UDU-02-ICS	2015-04-16	322		Yes	0.116		Yes	nm	nm	nm	11.2		Yes	1,130		Yes
UDU-03-ICS	UDU-03-ICS	2015-04-16	277		Yes	0.119		Yes	nm	nm	nm	10.1		Yes	1,130		Yes
UDU-04-ICS	UDU-04-ICS-A	2015-04-17	332		Yes	0.287		Yes	nm	nm	nm	9.77		Yes	975		Yes
UDU-04-ICS	UDU-04-ICS-B	2015-04-18	328		Yes	0.179		Yes	nm	nm	nm	9.76		Yes	1,050		Yes
UDU-04-ICS	UDU-04-ICS-C	2015-04-18	285		Yes	0.205		Yes	nm	nm	nm	9.41		Yes	973		Yes
UDU-05-ICS	UDU-05-ICS	2015-04-29	396		Yes	0.031		Yes	nm	nm	nm	20.9		Yes	2,360		Yes
UDU-06-ICS	UDU-06-ICS	2015-05-07	345		Yes	0.035		Yes	nm	nm	nm	21.0		Yes	2,270		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Selenium			Silver			Sodium			Thallium			Vanadium			Zinc		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study																				
ADA-001	ADA-001	2014-09-13	0.270		Yes	0.249		Yes	85.0		Yes	0.369		Yes	26.5		Yes	301		Yes
ADA-002	ADA-002	2014-10-09	0.750		Yes	0.334		Yes	258		Yes	0.256		Yes	53.7		Yes	292		Yes
ADA-004	ADA-004	2014-10-09	0.510		Yes	0.326		Yes	129		Yes	0.264		Yes	32.3		Yes	353		Yes
ADA-005	ADA-005	2014-10-08	0.900		Yes	0.400		Yes	138		Yes	0.330		Yes	57.6		Yes	283		Yes
ADA-006	ADA-006	2014-10-11	0.200		Yes	0.153		Yes	117		Yes	0.231		Yes	23.1		Yes	197		Yes
ADA-008	ADA-008	2014-10-11	0.400		Yes	0.318		Yes	184		Yes	0.346		Yes	32.9		Yes	330		Yes
ADA-010	ADA-010	2014-10-02	0.390		Yes	0.433	J	Yes	111		Yes	0.421		Yes	22.9		Yes	401		Yes
ADA-015	ADA-015	2014-09-13	0.140	J	Yes	0.094		Yes	63.4		Yes	0.192		Yes	15.8		Yes	150		Yes
ADA-016	ADA-016-A	2014-09-24	0.140	J	Yes	0.092		Yes	58.0	U*	No	0.165		Yes	15.0		Yes	126		Yes
ADA-016	ADA-016-B	2014-09-24	0.130	J	Yes	0.081		Yes	51.4	U*	No	0.141		Yes	13.1		Yes	111		Yes
ADA-016	ADA-016-C	2014-09-24	0.130	J	Yes	0.081		Yes	59.6	U*	No	0.146		Yes	13.0		Yes	117		Yes
ADA-017	ADA-017	2014-10-01	0.230		Yes	0.213		Yes	77.3		Yes	0.306		Yes	22.0		Yes	268		Yes
ADA-018	ADA-018	2014-10-01	0.350		Yes	0.351		Yes	114		Yes	0.501		Yes	26.3		Yes	455		Yes
ADA-019	ADA-019	2014-10-11	0.220		Yes	0.163		Yes	156		Yes	0.154		Yes	42.1		Yes	152		Yes
ADA-020	ADA-020-A	2014-09-13	0.140	J	Yes	0.091		Yes	76.5		Yes	0.159		Yes	31.7		Yes	117		Yes
ADA-020	ADA-020-B	2014-09-13	0.170	J	Yes	0.115		Yes	85.6		Yes	0.177		Yes	33.9		Yes	134		Yes
ADA-020	ADA-020-C	2014-09-13	0.170	J	Yes	0.097		Yes	82.1		Yes	0.173		Yes	34.0		Yes	126		Yes
ADA-021	ADA-021	2014-09-30	0.380		Yes	0.216		Yes	77.6	J	Yes	0.124		Yes	24.6		Yes	156		Yes
ADA-023	ADA-023-A	2014-09-13	0.590		Yes	0.428		Yes	126		Yes	0.280		Yes	43.1		Yes	257		Yes
ADA-023	ADA-023-B	2014-09-13	0.830		Yes	0.527		Yes	122		Yes	0.279		Yes	49.5		Yes	266		Yes
ADA-023	ADA-023-C	2014-09-13	0.770		Yes	0.523		Yes	142		Yes	0.303		Yes	49.9		Yes	313		Yes
ADA-024	ADA-024	2014-09-30	0.370		Yes	0.541		Yes	137		Yes	0.413		Yes	22.1		Yes	466		Yes
ADA-025	ADA-025	2014-09-17	0.580		Yes	0.467		Yes	132		Yes	0.307		Yes	19.2		Yes	514		Yes
ADA-026	ADA-026	2014-09-17	0.570		Yes	0.438		Yes	87.5		Yes	0.225		Yes	28.7		Yes	420		Yes
ADA-028	ADA-028	2014-10-03	0.200		Yes	0.233		Yes	144		Yes	0.268		Yes	21.0		Yes	246		Yes
ADA-033	ADA-033	2014-09-24	0.380		Yes	0.281		Yes	144		Yes	0.334		Yes	30.8		Yes	485		Yes
ADA-034	ADA-034	2014-10-10	0.310		Yes	0.111	J	Yes	133		Yes	0.244		Yes	32.9		Yes	229		Yes
ADA-035	ADA-035	2014-10-03	0.200		Yes	0.156		Yes	145		Yes	0.281		Yes	20.5		Yes	415		Yes
ADA-039	ADA-039	2014-10-01	0.330		Yes	0.328		Yes	103		Yes	0.211		Yes	33.0		Yes	277		Yes
ADA-042	ADA-042	2014-10-09	0.290		Yes	0.175		Yes	112		Yes	0.189		Yes	26.4		Yes	180		Yes
ADA-043	ADA-043	2014-10-03	0.630		Yes	0.294		Yes	63.6	J	Yes	0.219		Yes	32.9		Yes	292		Yes
ADA-044	ADA-044	2014-09-18	0.680		Yes	0.557		Yes	182	J	Yes	0.349		Yes	50.8		Yes	486		Yes
ADA-045	ADA-045	2014-10-09	0.390		Yes	0.339		Yes	168		Yes	0.539		Yes	23.3		Yes	432		Yes
ADA-046	ADA-046	2014-10-01	0.250		Yes	0.200		Yes	116		Yes	0.259		Yes	21.6		Yes	221		Yes
ADA-047	ADA-047	2014-09-30	0.370		Yes	0.420		Yes	183	J	Yes	0.414		Yes	38.4		Yes	478		Yes
ADA-048	ADA-048	2014-10-22	0.780		Yes	0.299		Yes	80.6		Yes	0.199		Yes	23.3		Yes	297		Yes
ADA-049	ADA-049	2014-09-17	0.480		Yes	0.804		Yes	116		Yes	0.215		Yes	38.6		Yes	290		Yes
ADA-050	ADA-050	2014-10-04	0.660		Yes	0.774		Yes	204	J	Yes	0.549		Yes	63.2		Yes	546		Yes
ADA-051	ADA-051	2014-10-22	0.880		Yes	0.404		Yes	90.4		Yes	0.211		Yes	26.8		Yes	418		Yes
ADA-052	ADA-052	2014-10-02	0.390		Yes	0.403	J	Yes	131		Yes	0.438		Yes	36.1		Yes	456		Yes
ADA-053	ADA-053	2014-10-07	0.340		Yes	0.163		Yes	138		Yes	0.237	J	Yes	37.6		Yes	190		Yes
ADA-054	ADA-054	2014-09-30	0.410		Yes	0.390		Yes	110		Yes	0.403		Yes	29.8		Yes	468		Yes
ADA-055	ADA-055-A	2014-10-08	0.840		Yes	0.548		Yes	100		Yes	0.329		Yes	38.8		Yes	552		Yes
ADA-055	ADA-055-B	2014-10-08	0.690		Yes	0.555		Yes	104		Yes	0.382		Yes	37.4		Yes	544		Yes
ADA-055	ADA-055-C	2014-10-08	0.740		Yes	0.461		Yes	113		Yes	0.320		Yes	32.5		Yes	460		Yes
ADA-056	ADA-056	2014-09-15	0.210		Yes	0.164		Yes	117		Yes	0.218		Yes	33.6		Yes	193		Yes
ADA-057	ADA-057	2014-10-07	0.240		Yes	0.173		Yes	190		Yes	0.254		Yes	48.4		Yes	180		Yes
ADA-058	ADA-058	2014-09-19	0.180	J	Yes	0.156		Yes	78	U*	No	0.154	J	Yes	20.5		Yes	210		Yes
ADA-059	ADA-059	2014-10-07	0.290		Yes	0.183		Yes	104		Yes	0.256	J	Yes	35.0		Yes	236		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Selenium			Silver			Sodium			Thallium			Vanadium			Zinc		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study (continued)																				
ADA-060	ADA-060-A	2014-10-06	0.310		Yes	0.336		Yes	134		Yes	0.360		Yes	32.3		Yes	361		Yes
ADA-060	ADA-060-B	2014-10-06	0.320		Yes	0.371		Yes	138	J	Yes	0.419		Yes	35.5		Yes	365		Yes
ADA-060	ADA-060-C	2014-10-06	0.320		Yes	0.388		Yes	119		Yes	0.370		Yes	32.2		Yes	323		Yes
ADA-061	ADA-061	2014-09-16	0.210		Yes	0.122		Yes	103	J	Yes	0.285	J	Yes	40.8		Yes	211	J	Yes
ADA-062	ADA-062	2014-10-06	0.240		Yes	0.230		Yes	90.1		Yes	0.314		Yes	30.4		Yes	303		Yes
ADA-063	ADA-063	2014-09-17	0.380		Yes	0.349		Yes	90.1		Yes	0.241		Yes	27.1		Yes	291		Yes
ADA-064	ADA-064	2014-09-16	0.380		Yes	0.151		Yes	99.5	J	Yes	0.244	J	Yes	29.4		Yes	233	J	Yes
ADA-065	ADA-065	2014-10-07	0.170	J	Yes	0.147		Yes	55.0		Yes	0.197	J	Yes	20.3		Yes	160		Yes
ADA-066	ADA-066	2014-10-06	0.210		Yes	0.192		Yes	77.4		Yes	0.242		Yes	26.3		Yes	243		Yes
ADA-067	ADA-067	2014-09-17	0.380		Yes	0.348		Yes	73.2		Yes	0.228		Yes	33.8		Yes	279		Yes
ADA-070	ADA-070	2014-10-01	0.410		Yes	0.335		Yes	151		Yes	0.365		Yes	38.0		Yes	338		Yes
ADA-071	ADA-071	2014-10-07	0.270		Yes	0.231		Yes	108		Yes	0.329	J	Yes	33.5		Yes	266		Yes
ADA-073	ADA-073	2014-10-03	0.310		Yes	0.254		Yes	107		Yes	0.288		Yes	31.5		Yes	240		Yes
ADA-076	ADA-076	2014-10-14	0.690		Yes	0.590		Yes	147	J	Yes	0.378		Yes	30.1		Yes	514		Yes
ADA-078	ADA-078	2014-09-29	0.320		Yes	0.247		Yes	107	J	Yes	0.309		Yes	39.9		Yes	281		Yes
ADA-079	ADA-079	2014-10-14	0.450		Yes	0.965		Yes	111	U*	No	0.226		Yes	29.4		Yes	448		Yes
ADA-081	ADA-081	2014-10-08	0.230		Yes	0.166		Yes	114		Yes	0.213		Yes	46.0		Yes	155		Yes
ADA-082	ADA-082	2014-10-04	0.360		Yes	0.194		Yes	188		Yes	0.218		Yes	34.6		Yes	190		Yes
ADA-084	ADA-084	2014-10-09	0.310		Yes	0.313		Yes	160		Yes	0.267		Yes	27.3		Yes	276		Yes
ADA-085	ADA-085	2014-09-17	0.480		Yes	0.290		Yes	117		Yes	0.285		Yes	31.4		Yes	1,070		Yes
ADA-088	ADA-088	2014-10-02	0.410		Yes	0.271	J	Yes	96.5	J	Yes	0.272		Yes	35.4		Yes	290		Yes
ADA-089	ADA-089	2014-10-07	0.330		Yes	0.241		Yes	106		Yes	0.296	J	Yes	29.3		Yes	312		Yes
ADA-090	ADA-090	2014-10-07	0.300		Yes	0.246		Yes	124		Yes	0.294	J	Yes	33.4		Yes	305		Yes
ADA-091	ADA-091	2014-10-02	0.330		Yes	0.288	J	Yes	120		Yes	0.359		Yes	33.3		Yes	358		Yes
ADA-092	ADA-092	2014-10-06	0.560		Yes	0.365		Yes	97.3		Yes	0.346		Yes	27.6		Yes	413		Yes
ADA-093	ADA-093	2014-09-16	0.330		Yes	0.237		Yes	133	J	Yes	0.285	J	Yes	29.8		Yes	265	J	Yes
ADA-094	ADA-094	2014-10-16	0.180	J	Yes	0.155		Yes	132		Yes	0.178		Yes	30.5		Yes	152		Yes
ADA-095	ADA-095	2014-10-08	0.290		Yes	0.225		Yes	109		Yes	0.231		Yes	29.4		Yes	187		Yes
ADA-096	ADA-096	2014-09-26	0.380		Yes	0.260		Yes	90.9		Yes	0.267		Yes	21.0		Yes	307		Yes
ADA-097	ADA-097	2014-09-24	0.470		Yes	0.485		Yes	85.5	U*	No	0.375		Yes	25.6		Yes	446		Yes
ADA-099	ADA-099	2014-10-10	0.290		Yes	0.236	J	Yes	104		Yes	0.328		Yes	29.5		Yes	324		Yes
ADA-101	ADA-101	2014-10-11	0.400		Yes	0.286		Yes	124	U*	No	0.281		Yes	36.8		Yes	254		Yes
ADA-102	ADA-102	2014-10-08	0.270		Yes	0.194		Yes	152		Yes	0.234		Yes	38.0		Yes	211		Yes
ADA-103	ADA-103	2014-09-26	0.340		Yes	0.170		Yes	91.0	J	Yes	0.201		Yes	32.3		Yes	257		Yes
ADA-104	ADA-104	2014-09-19	0.470		Yes	0.490		Yes	79.5	U*	No	0.189	J	Yes	32.7		Yes	231		Yes
ADA-105	ADA-105	2014-10-10	0.280		Yes	0.419	J	Yes	183		Yes	0.33		Yes	40.8		Yes	389		Yes
ADA-106	ADA-106-A	2014-10-15	0.520		Yes	0.273		Yes	114		Yes	0.189		Yes	32.2		Yes	243		Yes
ADA-106	ADA-106-B	2014-10-15	0.600		Yes	0.341		Yes	99.0		Yes	0.178		Yes	34.0		Yes	220		Yes
ADA-106	ADA-106-C	2014-10-16	0.780		Yes	0.363		Yes	101		Yes	0.178		Yes	32.9		Yes	215		Yes
ADA-107	ADA-107-A	2014-10-02	0.300		Yes	0.251	J	Yes	162	J	Yes	0.312		Yes	45.8		Yes	332		Yes
ADA-107	ADA-107-B	2014-10-01	0.330		Yes	0.257		Yes	190	J	Yes	0.329		Yes	51.2		Yes	266		Yes
ADA-107	ADA-107-C	2014-10-01	0.300		Yes	0.190		Yes	168	J	Yes	0.302		Yes	50.7		Yes	285		Yes
ADA-108	ADA-108-A	2014-10-10	0.210		Yes	0.203	J	Yes	90.4		Yes	0.206		Yes	32.2		Yes	221		Yes
ADA-108	ADA-108-B	2014-10-10	0.210		Yes	0.210	J	Yes	80.8		Yes	0.214		Yes	28.2		Yes	226		Yes
ADA-108	ADA-108-C	2014-10-09	0.180	J	Yes	0.179		Yes	139		Yes	0.206		Yes	35.7		Yes	210		Yes
ADA-109	ADA-109	2014-09-30	0.460		Yes	0.421		Yes	93.4		Yes	0.305		Yes	21.0		Yes	393		Yes
ADA-110	ADA-110	2014-09-26	0.220		Yes	0.287		Yes	98.3		Yes	0.271		Yes	28.6		Yes	257		Yes
ADA-111	ADA-111	2014-10-07	0.200	J	Yes	0.166		Yes	183		Yes	0.229	J	Yes	47.5		Yes	188		Yes
ADA-112	ADA-112	2014-10-16	0.300		Yes	0.268		Yes	163		Yes	0.202		Yes	37.1		Yes	193		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Selenium			Silver			Sodium			Thallium			Vanadium			Zinc		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study (continued)																				
ADA-113	ADA-113	2014-09-20	0.260		Yes	0.184		Yes	97.5	J	Yes	0.204		Yes	34.3		Yes	175		Yes
ADA-114	ADA-114	2014-10-06	0.210	J	Yes	0.219		Yes	101		Yes	0.204		Yes	26.8		Yes	200		Yes
ADA-115	ADA-115	2014-10-17	0.180	J	Yes	0.168		Yes	86.7		Yes	0.188		Yes	24.6		Yes	192		Yes
ADA-116	ADA-116	2014-10-08	0.200	J	Yes	0.155		Yes	105		Yes	0.206		Yes	32.2		Yes	177		Yes
ADA-117	ADA-117	2014-09-29	0.160	J	Yes	0.155		Yes	84.3		Yes	0.248		Yes	31.7		Yes	214		Yes
ADA-118	ADA-118	2014-09-30	0.220		Yes	0.204		Yes	125	J	Yes	0.209		Yes	31.1		Yes	304		Yes
ADA-119	ADA-119	2014-10-02	0.190	J	Yes	0.182	J	Yes	95.4		Yes	0.220		Yes	24.8		Yes	237		Yes
ADA-121	ADA-121	2014-10-14	0.310		Yes	0.288		Yes	200	J	Yes	0.317		Yes	44.2		Yes	360		Yes
ADA-122	ADA-122	2014-10-10	0.360		Yes	0.235	J	Yes	126		Yes	0.176		Yes	26.8		Yes	220		Yes
ADA-124	ADA-124-A	2014-10-04	0.250		Yes	0.141		Yes	46.7		Yes	0.205		Yes	15.3		Yes	148		Yes
ADA-124	ADA-124-B	2014-10-04	0.180	J	Yes	0.149		Yes	44.5		Yes	0.193		Yes	15.2		Yes	139		Yes
ADA-124	ADA-124-C	2014-10-04	0.160	J	Yes	0.105		Yes	50.5		Yes	0.167		Yes	15.6		Yes	118		Yes
ADA-125	ADA-125	2014-10-23	0.190	J	Yes	0.122		Yes	50.4		Yes	0.180		Yes	14.7		Yes	120		Yes
ADA-126	ADA-126	2014-09-11	0.330		Yes	0.489		Yes	89.0		Yes	0.317		Yes	19.6		Yes	322		Yes
ADA-127	ADA-127	2014-10-14	0.380		Yes	0.304		Yes	125	U*	No	0.237		Yes	29.8		Yes	365		Yes
ADA-128	ADA-128	2014-10-03	0.180	J	Yes	0.214		Yes	46.4		Yes	0.220		Yes	13.8		Yes	231		Yes
ADA-131	ADA-131-A	2014-09-18	0.550		Yes	0.415		Yes	204		Yes	0.486		Yes	24.9		Yes	419		Yes
ADA-131	ADA-131-B	2014-09-18	0.470		Yes	0.369		Yes	200		Yes	0.322		Yes	25.8		Yes	314		Yes
ADA-131	ADA-131-C	2014-09-18	0.530		Yes	0.418		Yes	191		Yes	0.434		Yes	26.9		Yes	386		Yes
ADA-132	ADA-132	2014-09-16	0.220		Yes	0.256		Yes	64.0		Yes	0.256	J	Yes	21.4		Yes	193	J	Yes
ADA-133	ADA-133	2014-09-23	0.260		Yes	0.225		Yes	98.6		Yes	0.277		Yes	24.4		Yes	269		Yes
ADA-135	ADA-135-A	2014-09-17	0.250		Yes	0.210		Yes	98.3		Yes	0.176		Yes	28.3		Yes	180		Yes
ADA-135	ADA-135-B	2014-09-17	0.190	J	Yes	0.187		Yes	84.3		Yes	0.178		Yes	26.1		Yes	211		Yes
ADA-135	ADA-135-C	2014-09-18	0.200		Yes	0.180		Yes	142		Yes	0.173		Yes	25.6		Yes	161		Yes
ADA-136	ADA-136	2014-09-10	0.220		Yes	0.241		Yes	59.6		Yes	0.229	J	Yes	19.0		Yes	274		Yes
ADA-139	ADA-139	2014-10-14	0.370		Yes	0.260		Yes	230	J	Yes	0.281		Yes	32.3		Yes	304		Yes
ADA-141	ADA-141	2014-09-23	0.190	J	Yes	0.161		Yes	65.3		Yes	0.191		Yes	22.0	J	Yes	193		Yes
ADA-142	ADA-142	2014-09-25	0.200		Yes	0.215		Yes	35.7	J	Yes	0.250		Yes	20.9		Yes	241		Yes
ADA-143	ADA-143	2014-09-15	0.210		Yes	0.206		Yes	68.1		Yes	0.189		Yes	20.8		Yes	167		Yes
ADA-144	ADA-144	2014-09-29	0.260		Yes	0.299		Yes	44.7		Yes	0.258		Yes	15.8		Yes	233		Yes
ADA-145	ADA-145	2014-09-24	0.290		Yes	0.362		Yes	91.5	U*	No	0.276		Yes	24.5		Yes	332		Yes
ADA-146	ADA-146	2014-10-02	0.250		Yes	0.241	J	Yes	72.0		Yes	0.317		Yes	18.5		Yes	331		Yes
ADA-147	ADA-147	2014-09-29	0.290		Yes	0.336		Yes	37.1		Yes	0.276		Yes	13.5		Yes	224		Yes
ADA-148	ADA-148	2014-10-06	0.240		Yes	0.266		Yes	37.1	J	Yes	0.342		Yes	18.3		Yes	225		Yes
ADA-150	ADA-150	2014-10-06	0.250		Yes	0.352		Yes	50.5		Yes	0.304		Yes	16.6		Yes	229		Yes
ADA-151	ADA-151	2014-10-04	0.270		Yes	0.380		Yes	47.8		Yes	0.318		Yes	20.9		Yes	244		Yes
ADA-152	ADA-152	2014-10-09	0.320		Yes	0.304		Yes	212		Yes	0.379		Yes	36.9		Yes	438		Yes
ADA-153	ADA-153	2014-09-20	0.310		Yes	0.328		Yes	85.8		Yes	0.327		Yes	25.1		Yes	378		Yes
ADA-154	ADA-154-A	2014-09-20	0.280		Yes	0.306		Yes	78.1		Yes	0.302		Yes	22.7		Yes	328		Yes
ADA-154	ADA-154-B	2014-09-20	0.320		Yes	0.333		Yes	118		Yes	0.326		Yes	30.2		Yes	318		Yes
ADA-154	ADA-154-C	2014-09-20	0.320		Yes	0.323		Yes	83.6		Yes	0.335		Yes	26.3		Yes	347		Yes
ADA-155	ADA-155	2014-09-15	0.250		Yes	0.250		Yes	47.2		Yes	0.262		Yes	14.3		Yes	253		Yes
ADA-156	ADA-156	2014-10-07	0.370		Yes	0.546		Yes	119		Yes	0.400		Yes	23.7		Yes	444		Yes
ADA-158	ADA-158-A	2014-10-07	0.300		Yes	0.333		Yes	77.4		Yes	0.295	J	Yes	24.9		Yes	306		Yes
ADA-158	ADA-158-B	2014-10-07	0.340		Yes	0.415		Yes	76.6		Yes	0.400	J	Yes	25.0		Yes	361		Yes
ADA-158	ADA-158-C	2014-10-07	0.450		Yes	0.565		Yes	105		Yes	0.473		Yes	27.7		Yes	487		Yes
ADA-159	ADA-159-A	2014-10-04	0.290		Yes	0.355		Yes	76.7		Yes	0.315		Yes	25.5		Yes	343		Yes
ADA-159	ADA-159-B	2014-10-04	0.330		Yes	0.416		Yes	54.4		Yes	0.344		Yes	23.6		Yes	390		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Selenium			Silver			Sodium			Thallium			Vanadium			Zinc		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2014 UCR Upland Soil Study (continued)																				
ADA-159	ADA-159-C	2014-10-04	0.290		Yes	0.437		Yes	54.7		Yes	0.314		Yes	21.1		Yes	314		Yes
ADA-160	ADA-160	2014-10-03	0.180	J	Yes	0.234		Yes	52.5		Yes	0.242		Yes	14.3		Yes	195		Yes
ADA-161	ADA-161	2014-10-03	0.260		Yes	0.353		Yes	104		Yes	0.367		Yes	24.5		Yes	363		Yes
ADA-162	ADA-162	2014-10-09	0.420		Yes	0.791		Yes	72.6		Yes	0.523		Yes	15.7		Yes	543		Yes
ADA-164	ADA-164	2014-09-30	0.790		Yes	0.472		Yes	64.9		Yes	0.400		Yes	24.0		Yes	420		Yes
ADA-165	ADA-165	2014-09-16	0.380		Yes	0.540		Yes	90.5		Yes	0.472	J	Yes	21.0		Yes	562	J	Yes
ADA-168	ADA-168	2014-10-14	0.290		Yes	0.368		Yes	114	U*	No	0.369		Yes	24.5		Yes	419		Yes
ADA-169	ADA-169-A	2014-09-19	0.130	J	Yes	0.052		Yes	115	U*	No	0.126	J	Yes	20.1		Yes	103		Yes
ADA-169	ADA-169-B	2014-09-19	0.160	J	Yes	0.056		Yes	109	U*	No	0.129	J	Yes	19.6		Yes	98		Yes
ADA-169	ADA-169-C	2014-09-19	0.150	J	Yes	0.069		Yes	125	U*	No	0.134	J	Yes	19.8		Yes	108		Yes
ADA-170	ADA-170	2014-09-23	0.310		Yes	0.302		Yes	107		Yes	0.220		Yes	37.7		Yes	355		Yes
ADA-171	ADA-171	2014-09-23	0.300		Yes	0.581		Yes	80.4		Yes	0.208		Yes	33.0		Yes	433		Yes
ADA-172	ADA-172	2014-09-29	0.260		Yes	0.130		Yes	61.6		Yes	0.124		Yes	17.8		Yes	72		Yes
ADA-173	ADA-173-A	2014-09-12	0.260		Yes	0.275		Yes	121		Yes	0.214		Yes	33.6		Yes	180		Yes
ADA-173	ADA-173-B	2014-09-12	0.270		Yes	0.267		Yes	138		Yes	0.226		Yes	34.9		Yes	195		Yes
ADA-173	ADA-173-C	2014-09-12	0.310		Yes	0.273		Yes	130		Yes	0.211		Yes	32.3		Yes	197		Yes
ADA-174	ADA-174	2014-09-12	0.340		Yes	0.497		Yes	102		Yes	0.176		Yes	27.0		Yes	219		Yes
ADA-175	ADA-175	2014-09-15	0.170	J	Yes	0.095		Yes	91.5		Yes	0.181		Yes	22.3		Yes	117		Yes
ADA-176	ADA-176	2014-09-12	0.160	J	Yes	0.083		Yes	158		Yes	0.249		Yes	32.9		Yes	109		Yes
ADA-177	ADA-177	2014-09-16	0.180	J	Yes	0.094		Yes	75.3		Yes	0.141	J	Yes	25.2		Yes	104	J	Yes
ADA-178	ADA-178	2014-09-11	0.170	J	Yes	0.098		Yes	95.6		Yes	0.127		Yes	28.5		Yes	158		Yes
ADA-179	ADA-179	2014-09-18	0.300		Yes	0.279		Yes	136		Yes	0.181		Yes	31.0		Yes	227		Yes
ADA-180	ADA-180	2014-09-19	0.540		Yes	0.417		Yes	82.5	U*	No	0.201	J	Yes	32.0		Yes	367		Yes
ADA-181	ADA-181	2014-09-12	0.600		Yes	0.709		Yes	101		Yes	0.340		Yes	40.9		Yes	298		Yes
ADA-182	ADA-182	2014-10-13	0.620		Yes	0.480		Yes	107		Yes	0.151		Yes	34.9		Yes	244		Yes
ADA-183	ADA-183	2014-09-11	3.32		Yes	1.13		Yes	61.1		Yes	0.175		Yes	47.9		Yes	585		Yes
ADA-184	ADA-184	2014-09-11	0.600		Yes	1.18		Yes	82.3		Yes	0.148		Yes	26.1		Yes	352		Yes
2012 Ecology Upland Soil Study																				
SA1-1C	SA1-1C	2012-10-30	0.600	U	No	0.200	U	No	150		Yes	0.300		Yes	35.7		Yes	171		Yes
SA1-2C	SA1-2C	2012-10-30	0.500	U	No	0.200	U	No	130	U	No	0.200		Yes	42.5		Yes	227		Yes
SA1-3C	SA1-3C	2012-10-30	0.500	U	No	0.200	U	No	160		Yes	0.200	U	No	34.6		Yes	131		Yes
SA1-3C	SA1-3C2	2012-10-30	0.500	U	No	0.200	U	No	170		Yes	0.200	U	No	33.8		Yes	133		Yes
SA1-4C	SA1-4C	2012-10-30	0.500	U	No	0.200	U	No	200		Yes	0.200	U	No	32.3		Yes	147		Yes
SA1-5C	SA1-5C	2012-10-30	0.500	U	No	0.200	U	No	100		Yes	0.200	U	No	32.7		Yes	127		Yes
SA1-6C	SA1-6C	2012-10-30	0.500	U	No	0.200	U	No	160		Yes	0.200	U	No	28.3		Yes	134		Yes
SA1-7C	SA1-7C	2012-10-30	0.500	U	No	0.200	U	No	200		Yes	0.200	U	No	27.8		Yes	150		Yes
SA1-8C	SA1-8C	2012-10-30	0.500	U	No	0.200	U	No	100		Yes	0.200	U	No	23.0		Yes	150		Yes
SA10-1C	SA10-1C	2012-11-08	0.500	U	No	0.200	U	No	130	U	No	0.400		Yes	42.4		Yes	370		Yes
SA10-2C	SA10-2C	2012-11-08	1.30		Yes	0.600		Yes	150		Yes	1.20		Yes	24.6		Yes	1,330		Yes
SA10-3C	SA10-3C	2012-11-05	0.500		Yes	0.400		Yes	200		Yes	0.400		Yes	21.4		Yes	830		Yes
SA10-3C	SA10-3C2	2012-11-05	0.500	U	No	0.400		Yes	190		Yes	0.400		Yes	20.8		Yes	810		Yes
SA10-4C	SA10-4C	2012-11-05	5.20		Yes	0.300		Yes	230		Yes	0.200	U	No	21.5		Yes	165		Yes
SA10-5C	SA10-5C	2012-11-05	0.500	U	No	0.200		Yes	250		Yes	0.300		Yes	25.6		Yes	250		Yes
SA10-6C	SA10-6C	2012-11-05	0.500	U	No	0.200		Yes	160		Yes	0.300		Yes	26.7		Yes	267		Yes
SA10-7C	SA10-7C	2012-11-05	0.500	U	No	0.300		Yes	200		Yes	0.400		Yes	22.3		Yes	520		Yes
SA10-8C	SA10-8C	2012-11-08	0.500	U	No	0.300		Yes	200		Yes	0.500		Yes	25.7		Yes	400		Yes
SA11-1C	SA11-1C	2012-11-08	0.500	U	No	0.200		Yes	140		Yes	0.200		Yes	41.2		Yes	169		Yes
SA11-2C	SA11-2C	2012-11-06	0.500	U	No	0.200	U	No	240		Yes	0.200		Yes	31.3		Yes	196		Yes
SA11-3C	SA11-3C	2012-11-10	0.700		Yes	0.200	U	No	280		Yes	0.200		Yes	30.7		Yes	187		Yes

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			Selenium			Silver			Sodium			Thallium			Vanadium			Zinc		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2012 Ecology Upland Soil Study (continued)																				
SA11-4C	SA11-4C	2012-11-08	0.500	U	No	0.300		Yes	160		Yes	0.600		Yes	26.2		Yes	700		Yes
SA11-5C	SA11-5C	2012-11-06	0.500	U	No	0.400		Yes	270		Yes	0.500		Yes	24.8		Yes	410		Yes
SA11-6C	SA11-6C	2012-11-06	0.500	U	No	0.300		Yes	120	U	No	0.500		Yes	47.3		Yes	310		Yes
SA11-7C	SA11-7C	2012-11-06	2.00	U	No	2.00		Yes	140	U	No	1.00		Yes	11.4		Yes	1,150		Yes
SA11-8C	SA11-8C	2012-11-07	0.500	U	No	0.300		Yes	280		Yes	0.300		Yes	33.7		Yes	268		Yes
SA11-8C	SA11-8C2	2012-11-07	0.500	U	No	0.600		Yes	320		Yes	0.600		Yes	28.8		Yes	660		Yes
SA11-9C	SA11-9C	2012-11-08	0.600		Yes	0.500		Yes	130		Yes	0.700		Yes	31.1		Yes	750		Yes
SA12-1C	SA12-1C	2012-11-07	0.500	U	No	1.20		Yes	170		Yes	0.400		Yes	44.3		Yes	428		Yes
SA12-2C	SA12-2C	2012-11-10	0.500	U	No	0.200	U	No	270		Yes	0.300		Yes	33.6		Yes	218		Yes
SA12-3C	SA12-3C	2012-11-10	0.600		Yes	0.300		Yes	310		Yes	0.200		Yes	25.0		Yes	196		Yes
SA12-4C	SA12-4C	2012-11-10	0.500	U	No	0.200	U	No	160		Yes	0.200		Yes	23.4		Yes	249		Yes
SA12-6C	SA12-6C	2012-11-10	0.500	U	No	0.200	U	No	220		Yes	0.200		Yes	23.7		Yes	251		Yes
SA12-7C	SA12-7C	2012-11-10	0.500	U	No	0.300		Yes	270		Yes	0.300		Yes	31.4		Yes	440		Yes
SA12-7C	SA12-7C2	2012-11-10	0.500	U	No	0.200		Yes	190		Yes	0.300		Yes	31.4		Yes	350		Yes
SA12-8C	SA12-8C	2012-11-10	0.500	U	No	0.200	U	No	230		Yes	0.200		Yes	26.1		Yes	239		Yes
SA12-9C	SA12-9C	2012-11-10	0.500	U	No	0.200		Yes	190		Yes	0.200	U	No	28.5		Yes	163		Yes
SA13-1C	SA13-1C	2012-11-10	0.500	U	No	0.200	U	No	200		Yes	0.200		Yes	37.7		Yes	172		Yes
SA13-2C	SA13-2C	2012-11-10	1.70		Yes	0.300		Yes	290		Yes	0.200		Yes	27.2		Yes	305		Yes
SA13-3C	SA13-3C	2012-11-10	0.500	U	No	0.300		Yes	170		Yes	0.300		Yes	23.3		Yes	280		Yes
SA13-4C	SA13-4C	2012-11-10	2.00	U	No	0.300		Yes	130	U	No	0.200	U	No	30.0		Yes	160		Yes
SA13-5C	SA13-5C	2012-11-10	0.500	U	No	0.400		Yes	290		Yes	0.500		Yes	39.0		Yes	660		Yes
SA13-5C	SA13-5C2	2012-11-10	0.500	U	No	0.300		Yes	230		Yes	0.500		Yes	38.0		Yes	600		Yes
SA13-6C	SA13-6C	2012-11-10	0.500	U	No	0.300		Yes	220		Yes	0.400		Yes	32.0		Yes	271		Yes
SA13-7C	SA13-7C	2012-11-07	0.500	U	No	0.300		Yes	210		Yes	0.300		Yes	35.0		Yes	217		Yes
SA13-8C	SA13-8C	2012-11-10	0.500	U	No	0.200	U	No	170		Yes	0.200		Yes	34.6		Yes	186		Yes
SA2-1C	SA2-1C	2012-10-31	0.500	U	No	0.200	U	No	190		Yes	0.300		Yes	22.6		Yes	490		Yes
SA2-2C	SA2-2C	2012-10-31	0.500	U	No	0.200	U	No	220		Yes	0.200	U	No	33.8		Yes	254		Yes
SA2-3C	SA2-3C	2012-10-31	0.500	U	No	0.200	U	No	180		Yes	0.200	U	No	17.5		Yes	130		Yes
SA2-4C	SA2-4C	2012-10-31	0.500	U	No	0.200	U	No	180		Yes	0.200		Yes	30.1		Yes	180		Yes
SA2-4C	SA2-4C2	2012-10-31	0.500	U	No	0.200	U	No	180		Yes	0.300		Yes	25.3		Yes	252		Yes
SA2-5C	SA2-5C	2012-10-31	0.500	U	No	0.200	U	No	260		Yes	0.200	U	No	34.6		Yes	105		Yes
SA2-6C	SA2-6C	2012-10-31	0.500	U	No	0.200		Yes	170		Yes	0.500		Yes	27.7		Yes	520		Yes
SA2-7C	SA2-7C	2012-10-31	0.500	U	No	0.200	U	No	120	U	No	0.200		Yes	28.6		Yes	188		Yes
SA2-8C	SA2-8C	2012-10-31	0.500	U	No	0.200		Yes	220		Yes	0.200	U	No	25.7		Yes	210		Yes
SA3-1C	SA3-1C	2012-11-01	0.500	U	No	0.200	U	No	210		Yes	0.200	U	No	23.7		Yes	83		Yes
SA3-2C	SA3-2C	2012-11-01	0.500	U	No	0.200	U	No	220		Yes	0.200	U	No	17.5		Yes	143		Yes
SA3-3C	SA3-3C	2012-11-01	0.500	U	No	0.200	U	No	150		Yes	0.200		Yes	35.0		Yes	272		Yes
SA3-4C	SA3-4C	2012-11-01	0.500	U	No	0.200	U	No	170		Yes	0.200	U	No	18.7		Yes	128		Yes
SA3-5C	SA3-5C	2012-11-01	0.500	U	No	0.200	U	No	110		Yes	0.200	U	No	19.5		Yes	144		Yes
SA3-6C	SA3-6C	2012-11-01	0.500	U	No	0.300		Yes	130	U	No	0.600		Yes	36.0		Yes	660		Yes
SA3-6C	SA3-6C2	2012-11-01	0.500	U	No	0.300		Yes	130	U	No	0.500		Yes	39.0		Yes	470		Yes
SA3-7C	SA3-7C	2012-11-01	0.500	U	No	0.200		Yes	170		Yes	0.300		Yes	18.3		Yes	390		Yes
SA3-8C	SA3-8C	2012-11-01	0.500	U	No	0.200	U	No	180		Yes	0.200		Yes	17.5		Yes	233		Yes
SA4-1C	SA4-1C	2012-11-01	0.500	U	No	0.200		Yes	130		Yes	0.300		Yes	28.6		Yes	281		Yes
SA4-2C	SA4-2C	2012-11-01	0.500	U	No	0.200	U	No	160		Yes	0.200		Yes	32.9		Yes	186		Yes
SA4-3C	SA4-3C	2012-11-01	0.500	U	No	0.200		Yes	150		Yes	0.400		Yes	43.1		Yes	370		Yes
SA4-4C	SA4-4C	2012-11-01	0.500	U	No	0.200	U	No	130	U	No	0.300		Yes	28.6		Yes	320		Yes
SA4-5C	SA4-5C	2012-11-01	0.500	U	No	0.200	U	No	130	U	No	0.200		Yes	26.4		Yes	192		Yes
SA4-6C	SA4-6C	2012-11-02	0.500	U	No	0.400		Yes	140		Yes	0.400		Yes	23.0		Yes	430		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Selenium			Silver			Sodium			Thallium			Vanadium			Zinc		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2012 Ecology Upland Soil Study (continued)																				
SA4-6C	SA4-6C2	2012-11-02	0.500	U	No	0.300		Yes	160		Yes	0.400		Yes	25.4		Yes	380		Yes
SA4-7C	SA4-7C	2012-11-01	0.500	U	No	0.300		Yes	150		Yes	0.300		Yes	29.4		Yes	270		Yes
SA4-8C	SA4-8C	2012-11-01	0.500	U	No	0.200	U	No	160		Yes	0.200	U	No	18.4		Yes	186		Yes
SA5-1C	SA5-1C	2012-11-09	0.600	U	No	0.300		Yes	230		Yes	0.200		Yes	20.5		Yes	320		Yes
SA5-2C	SA5-2C	2012-11-09	0.500	U	No	0.200	U	No	210		Yes	0.500		Yes	73.0		Yes	233		Yes
SA5-3C	SA5-3C	2012-11-03	0.500	U	No	0.300		Yes	190		Yes	0.400		Yes	22.9		Yes	510		Yes
SA5-4C	SA5-4C	2012-11-02	0.500	U	No	0.300		Yes	180		Yes	0.300		Yes	20.5		Yes	360		Yes
SA5-4C	SA5-4C2	2012-11-02	0.500	U	No	0.200		Yes	140		Yes	0.300		Yes	22.1		Yes	300		Yes
SA5-5C	SA5-5C	2012-11-09	0.500	U	No	0.200		Yes	230		Yes	0.200		Yes	26.5		Yes	161		Yes
SA5-7C	SA5-7C	2012-11-02	0.500	U	No	0.400		Yes	270		Yes	0.400		Yes	21.3		Yes	460		Yes
SA5-8C	SA5-8C	2012-09-11	0.500	U	No	0.400		Yes	260		Yes	0.400		Yes	40.6		Yes	227		Yes
SA6-1C	SA6-1C	2012-11-02	0.500	U	No	0.300		Yes	160		Yes	0.300		Yes	22.2		Yes	460		Yes
SA6-2C	SA6-2C	2012-11-02	0.500	U	No	0.300		Yes	180		Yes	0.400		Yes	23.3		Yes	420		Yes
SA6-2C	SA6-2C2	2012-11-02	0.500	U	No	0.300		Yes	190		Yes	0.300		Yes	20.3		Yes	440		Yes
SA6-3C	SA6-3C	2012-11-02	0.500	U	No	0.400		Yes	140		Yes	0.400		Yes	28.5		Yes	470		Yes
SA6-4C	SA6-4C	2012-11-03	0.500	U	No	0.200	U	No	120	U	No	0.200	U	No	12.4		Yes	87		Yes
SA6-5C	SA6-5C	2012-11-03	0.500	U	No	0.200	U	No	120	U	No	0.200	U	No	11.6		Yes	70		Yes
SA6-6C	SA6-6C	2012-11-03	0.500	U	No	0.300		Yes	120	U	No	0.400		Yes	10.6		Yes	370		Yes
SA6-7C	SA6-7C	2012-11-02	0.500	U	No	0.300		Yes	160		Yes	0.400		Yes	22.7		Yes	540		Yes
SA6-8C	SA6-8C	2012-11-03	0.500	U	No	0.200	U	No	120	U	No	0.200	U	No	12.7		Yes	128		Yes
SA7-1C	SA7-1C	2012-11-03	0.500	U	No	0.200		Yes	130		Yes	0.300		Yes	18.7		Yes	340		Yes
SA7-2C	SA7-2C	2012-11-03	0.500	U	No	0.300		Yes	160		Yes	0.400		Yes	23		Yes	400		Yes
SA7-3C	SA7-3C	2012-11-03	0.500	U	No	0.500		Yes	140		Yes	0.500		Yes	17.5		Yes	285		Yes
SA7-4C	SA7-4C	2012-11-03	0.500	U	No	0.200		Yes	120	U	No	0.200		Yes	9.00		Yes	188	J	Yes
SA7-5C	SA7-5C	2012-11-03	0.500	U	No	0.900		Yes	180		Yes	0.600		Yes	19.1		Yes	490		Yes
SA7-5C	SA7-5C2	2012-11-03	0.500	U	No	0.500		Yes	200		Yes	0.400		Yes	23.6		Yes	480		Yes
SA7-6C	SA7-6C	2012-11-03	0.500	U	No	0.400		Yes	120	U	No	0.500		Yes	16.7		Yes	650		Yes
SA7-7C	SA7-7C	2012-11-09	0.600		Yes	1.00		Yes	160		Yes	0.800		Yes	22.4		Yes	1,130		Yes
SA7-8C	SA7-8C	2012-11-09	0.500	U	No	0.900		Yes	320		Yes	0.900		Yes	75.0		Yes	770		Yes
SA8-1C	SA8-1C	2012-11-04	0.500	U	No	0.300		Yes	130	U	No	0.400		Yes	15.6		Yes	560		Yes
SA8-2C	SA8-2C	2012-11-04	0.500	U	No	0.400		Yes	130	U	No	0.300		Yes	15.6		Yes	330		Yes
SA8-3C	SA8-3C	2012-11-03	0.500	U	No	0.200	U	No	140		Yes	0.200	U	No	30.8		Yes	112		Yes
SA8-3C	SA8-3C2	2012-11-03	0.500	U	No	0.200	U	No	120		Yes	0.200		Yes	29.7		Yes	149		Yes
SA8-4C	SA8-4C	2012-11-04	0.500	U	No	0.200	U	No	130	U	No	0.300		Yes	15.7		Yes	297		Yes
SA8-5C	SA8-5C	2012-11-04	0.500	U	No	0.600		Yes	120	U	No	0.500		Yes	18.7		Yes	410		Yes
SA8-6C	SA8-6C	2012-11-04	0.500	U	No	0.300		Yes	130		Yes	0.300		Yes	19.2		Yes	370		Yes
SA8-7C	SA8-7C	2012-11-04	0.500	U	No	0.600		Yes	170		Yes	0.900		Yes	25.0		Yes	860		Yes
SA8-8C	SA8-8C	2012-11-04	0.700		Yes	1.20		Yes	270		Yes	1.00		Yes	12.9		Yes	1,210		Yes
SA9-10C	SA9-10C	2012-11-09	0.500	U	No	0.300		Yes	310		Yes	0.300		Yes	26.7		Yes	310		Yes
SA9-10C	SA9-10C2	2012-11-09	0.500	U	No	0.300		Yes	210		Yes	0.400		Yes	29.1		Yes	440		Yes
SA9-1C	SA9-1C	2012-11-08	0.500	U	No	0.500		Yes	160		Yes	0.800		Yes	36.5		Yes	780		Yes
SA9-2C	SA9-2C	2012-11-09	0.500	U	No	0.500		Yes	310		Yes	0.800		Yes	73.5		Yes	360		Yes
SA9-3C	SA9-3C	2012-11-08	0.500	U	No	0.300		Yes	150		Yes	0.500		Yes	61.9		Yes	280		Yes
SA9-4C	SA9-4C	2012-11-08	1.00		Yes	0.600		Yes	340		Yes	0.400		Yes	18.9		Yes	490		Yes
SA9-5C	SA9-5C	2012-11-07	0.500	U	No	0.600		Yes	200		Yes	0.500		Yes	17.3		Yes	720		Yes
SA9-6C	SA9-6C	2012-11-07	0.500	U	No	0.500		Yes	290		Yes	0.600		Yes	25.3		Yes	550		Yes
SA9-7C	SA9-7C	2012-11-07	0.500	U	No	0.400		Yes	210		Yes	0.600		Yes	28.7		Yes	580		Yes
SA9-8C	SA9-8C	2012-11-08	0.500	U	No	0.500		Yes	150		Yes	0.900		Yes	20.9		Yes	850		Yes
SA9-9C	SA9-9C	2012-11-07	0.500	U	No	0.300		Yes	230		Yes	0.300		Yes	26.1		Yes	430		Yes

Table B-1. Soil Chemistry Data Sets Used in the Upland BERA

			Selenium			Silver			Sodium			Thallium			Vanadium			Zinc		
Location ID	Sample ID	Sample Date	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?	Value[a] (mg/kg)	Qualifier	Detected Result?
2015 Bossburg Flat Beach Study																				
UDU-01-ICS	UDU-01-ICS	2015-04-14	0.130	J	Yes	0.199		Yes	72.7		Yes	0.136		Yes	22.0		Yes	104		Yes
UDU-02-ICS	UDU-02-ICS	2015-04-16	0.120	J	Yes	0.326		Yes	110		Yes	0.130		Yes	23.1		Yes	122		Yes
UDU-03-ICS	UDU-03-ICS	2015-04-16	0.110	J	Yes	0.212		Yes	88.0		Yes	0.115		Yes	22.0		Yes	114		Yes
UDU-04-ICS	UDU-04-ICS-A	2015-04-17	0.190	J	Yes	1.79	J	Yes	72.7		Yes	0.140		Yes	22.0		Yes	170		Yes
UDU-04-ICS	UDU-04-ICS-B	2015-04-18	0.190	J	Yes	1.38	J	Yes	88.9		Yes	0.183		Yes	21.5		Yes	176		Yes
UDU-04-ICS	UDU-04-ICS-C	2015-04-18	0.150	J	Yes	0.553	J	Yes	65.7		Yes	0.126		Yes	20.1		Yes	141		Yes
UDU-05-ICS	UDU-05-ICS	2015-04-29	0.160	J	Yes	0.129		Yes	166		Yes	0.189		Yes	37.5		Yes	116		Yes
UDU-06-ICS	UDU-06-ICS	2015-05-07	0.660		Yes	0.131		Yes	151		Yes	0.135		Yes	26.6		Yes	102		Yes

[a] Value column is populated with the detected result, or if Not detected, either the method reporting limit or the method detection limit as reported by the study.

BERA = baseline ecological risk assessment

eCEC = effective cation exchange capacity

ID = identification

in. = inch(es)

J = The associated value is an estimated quantity

mg/kg = milligram(s) per kilogram

nm = not measured

pH (H_2O) = pH analyzed using water method

TOC = total organic carbon

U = The material was analyzed for, but was Not detected at or above the associated sample quantitation limit or sample detection limit. The associated value is either the sample quantitation limit or the sample detection limit

UJ = The material was analyzed for, but was Not detected. The associated value is an estimate and may be inaccurate or imprecise.

U* = This analyte should be considered "Not-detected" because it was detected in an associated blank at a similar level

UCR = Upper Columbia River

Table B-2. BERA Soil Data Set Summary Statistics

			Analyte Concentration (mg/kg unless otherwise noted)								
Analyte	Number of Samples	Number of Detected Results	Minimum	Mean	Standard Deviation	Median	95th Percentile	Maximum Detected Value	Maximum MDL or MRL for Nondetects	Maximum of Detected Values, MDLs, or MRLs	Sample ID(s) of Maximum Detected Value
2012 Ecology Upland Soil Study											
Entire Study Area Included in the Upland BERA											
Aluminum	106	106	4590	17313	5869	17150	27850	34600	NA	34600	SA12-1C
Antimony	106	61	0.200	0.621	1.70	0.300	1.50	17.2	0.300	17.2	SA11-7C
Arsenic	106	106	5.30	17.7	9.67	15.6	37.1	55.5	NA	55.5	SA10-2C
Barium	106	106	34.8	349	290	295	738	2590	NA	2590	SA9-2C
Cadmium	106	106	0.6	6.94	5.80	5.47	17.1	37.3	NA	37.3	SA10-2C
Chromium	106	106	7.00	30.4	49.7	20.7	60.0	470	NA	470	SA9-2C
Cobalt	106	106	2.10	8.36	4.22	8.00	18.4	24.2	NA	24.2	SA9-2C
Copper	106	106	6.40	26.5	11.4	24.4	48.8	62.9	NA	62.9	SA10-2C
Iron	106	106	7620	20779	7319	20900	37800	41500	NA	41500	SA5-2C
Lead	106	106	31.0	351	324	249	1014	1920	NA	1920	SA11-7C
Manganese	106	106	43.6	1184	800	1040	2690	5490	NA	5490	SA10-2C
Mercury	106	106	0.0150	0.0918	0.0690	0.0735	0.192	0.527	NA	0.527	SA11-7C
Nickel	106	106	5.90	24.3	21.1	19.6	55.1	178	NA	178	SA9-2C
Selenium[a]	106	10	0.500	0.605	0.515	0.500	0.925	5.2	2.00	5.2	SA10-4C
Silver	106	67	0.200	0.341	0.257	0.300	0.825	2.00	0.200	2.00	SA11-7C
Thallium	106	84	0.200	0.373	0.214	0.300	0.875	1.2	0.200	1.2	SA10-2C
Vanadium	106	106	9.00	27.8	11.7	25.9	44.0	75.0	NA	75.0	SA7-8C
Zinc	106	106	70.0	373	253	291	845	1330	NA	1330	SA10-2C
% OC	106	106	1.21	6.21	3.91	5.26	12.2	23.4	NA	23.4	SA11-7C
pH (H20)	106	106	4.69	5.88	0.381	5.91	6.51	6.79	NA	6.79	SA5-3C
pH (0.01 M $CaCl_2$)	106	106	4.15	5.34	0.381	5.37	5.97	6.25	NA	6.25	SA5-3C
2014 UCR Upland Soil Study											
Entire Study Area Included in the Upland BERA											
Aluminum	141	141	5510	14857	4190	15200	21400	26200	NA	26200	ADA-107-C
Antimony	141	141	0.636	3.02	1.81	2.58	6.91	10.1	NA	10.1	ADA-162
Arsenic	141	141	5.59	15.4	4.95	14.7	24.3	28.8	NA	28.8	ADA-131-A
Barium	141	141	56.2	353	245	289	811	1470	NA	1470	ADA-055-B
Cadmium	141	141	0.701	5.40	2.92	5.13	10.7	14.3	NA	14.3	ADA-183
Chromium	141	141	7.32	20.4	9.63	18.6	35.7	78.7	NA	78.7	ADA-061
Cobalt	141	141	2.26	7.53	2.54	7.36	11.4	15.5	NA	15.5	ADA-103
Copper	141	141	8.22	21.4	8.27	19.7	40.8	51.8	NA	51.8	ADA-126
Iron	141	141	7440	17808	4771	18000	25700	30900	NA	30900	ADA-103
Lead	141	141	44.5	216	131	176	497	681	NA	681	ADA-162

Table B-2. BERA Soil Data Set Summary Statistics

Analyte	Number of Samples	Number of Detected Results	Analyte Concentration (mg/kg unless otherwise noted)								Sample ID(s) of Maximum Detected Value
			Minimum	Mean	Standard Deviation	Median	95th Percentile	Maximum Detected Value	Maximum MDL or MRL for Nondetects	Maximum of Detected Values, MDLs, or MRLs	
Manganese	141	141	220	976	450	913	1920	2350	NA	2350	ADA-061
Mercury	141	141	0.0230	0.0793	0.0300	0.0780	0.132	0.164	NA	0.164	ADA-076
Molybdenum	141	141	0.32	1.36	1.34	0.77	4.01	7.81	NA	7.81	ADA-183
Nickel	141	141	5.59	21.7	10.4	19.6	40.2	64.7	NA	64.7	ADA-044
Selenium	141	141	0.14	0.370	0.301	0.31	0.78	3.32	NA	3.32	ADA-183
Silver	141	141	0.0690	0.315	0.187	0.271	0.590	1.18	NA	1.18	ADA-184
Thallium	141	141	0.124	0.274	0.090	0.256	0.438	0.549	NA	0.549	ADA-050
Vanadium	141	141	13.5	29.6	9.27	29.4	47.9	63.2	NA	63.2	ADA-050
Zinc	141	141	72.4	298	131	276	514	1070	NA	1070	ADA-085
% Clay	141	141	0.404	3.39	2.12	2.95	7.03	14.7	NA	14.7	ADA-018
% OC	141	141	1.75	6.15	2.55	5.83	10.3	16.3	NA	16.3	ADA-172
eCEC (cmolc/kg)	141	141	5.85	15.1	5.56	14.7	24.9	32.3	NA	32.3	ADA-172
pH (H20)	141	141	4.82	5.95	0.453	5.98	6.56	8.00	NA	8.00	ADA-101
pH (0.01 M $CaCl_2$)	141	141	4.28	5.41	0.453	5.44	6.02	7.46	NA	7.46	ADA-101
2015 Bossburg Flat Beach Study											
Entire Study Area Included in the Upland BERA											
Aluminum	6	6	8820	10437	1353	10335	12025	12100	NA	12100	UDU-05-ICS
Antimony	6	6	0.652	8.69	18.4	0.932	35.3	46.2	NA	46.2	UDU-03-ICS
Arsenic	6	6	5.86	7.26	1.86	6.34	10.0	10.7	NA	10.7	UDU-06-ICS
Barium	6	6	106	144	35.9	144	189	196	NA	196	UDU-06-ICS
Cadmium	6	6	0.909	1.21	0.374	1.10	1.76	1.93	NA	1.93	UDU-04-ICS-B
Chromium	6	6	11.8	16.4	5.80	13.2	24.0	24.1	NA	24.1	UDU-05-ICS
Cobalt	6	6	3.99	5.15	1.55	4.22	7.27	7.42	NA	7.42	UDU-05-ICS
Copper	6	6	13.4	24.6	15.5	19.3	47.4	55.4	NA	55.4	UDU-03-ICS
Iron	6	6	11600	13900	2575	13250	17650	18600	NA	18600	UDU-05-ICS
Lead	6	6	38.4	581	974	220	2015	2550	NA	2550	UDU-04-ICS-A
Manganese	6	6	277	333	38.7	328	383	396	NA	396	UDU-05-ICS
Mercury	6	6	0.0310	0.105	0.0975	0.0800	0.245	0.287	NA	0.287	UDU-04-ICS-A
Nickel	6	6	9.77	14.0	5.43	11.1	21.0	21.0	NA	21.0	UDU-06-ICS
Selenium	6	6	0.11	0.228	0.213	0.145	0.543	0.660	NA	0.66	UDU-06-ICS
Silver	6	6	0.129	0.465	0.653	0.206	1.42	1.79	NA	1.79	UDU-04-ICS-A
Thallium	6	6	0.115	0.148	0.030	0.136	0.188	0.189	NA	0.189	UDU-05-ICS
Vanadium	6	6	22.0	25.5	6.13	22.6	34.8	37.5	NA	37.5	UDU-05-ICS
Zinc	6	6	102	122	27.3	115	163	176	NA	176	UDU-04-ICS-B
% Clay	6	6	1.53	3.24	3.19	1.65	8.04	9.58	NA	9.58	UDU-05-ICS

Table B-2. BERA Soil Data Set Summary Statistics

Analyte	Number of Samples	Number of Detected Results	Analyte Concentration (mg/kg unless otherwise noted)								Sample ID(s) of Maximum Detected Value
			Minimum	Mean	Standard Deviation	Median	95th Percentile	Maximum Detected Value	Maximum MDL or MRL for Nondetects	Maximum of Detected Values, MDLs, or MRLs	
% OC	6	6	1.08	1.88	1.08	1.53	3.43	4.05	NA	4.05	UDU-06-ICS
eCEC (cmolc/kg)	6	6	3.43	6.89	4.75	4.31	13.9	15.2	NA	15.2	UDU-06-ICS
pH (H_20)	6	6	5.61	6.58	0.901	6.23	7.85	8.02	NA	8.02	UDU-06-ICS
pH (0.01 M $CaCl_2$)	6	6	5.07	6.04	0.901	5.69	7.31	7.48	NA	7.48	UDU-06-ICS

[a] The majority of selenium results from 2012 Ecology Upland Soil Study samples are nondetected with elevated MRLs.

BERA = baseline ecological risk assessment

$CaCl_2$ = calcium chloride

cmolc/kg = centimol positive charge per kg of soil

eCEC - effective cation exchange capacity (centimol positive charge per kg of soil)

ID = identification

MDL = method detection limit

mg/kg = milligram(s) per kilogram

MRL = method reporting limit

NA = not applicable

OC = organic carbon

UCR = Upper Columbia River

APPENDIX C

TERRESTRIAL BIOACCUMULATION MODELS

No changes were made to draft final version of Appendix C (Terrestrial Bioaccumulation Models) presented in the draft final Upland BERA prepared by Teck American Incorporated. The appendix that follows is a reproduction of that previously-submitted document.

UPPER COLUMBIA RIVER

DRAFT FINAL
Appendix C
Terrestrial Bioaccumulation Models

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ACRONYMS AND ABBREVIATIONS

ADA	aerial deposition area
ANCOVA	analysis of covariance
BAF	bioaccumulation factor
BERA	baseline ecological risk assessment
CCT	Confederated Tribes of the Colville Reservation
CI	confidence interval
COPC	chemical of potential concern
DU	decision unit
Eco-SSL	ecological soil screening level
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
RFDA	relict floodplain deposition area
Site	Upper Columbia River site
TAI	Teck American Incorporated
TAL	target analyte list
UCR	Upper Columbia River
USACHPPM	U.S. Army Center for Health Promotion and Preventative Medicine

UNITS OF MEASURE

mg/kg	milligram(s) per kilogram
mm	millimeter(s)
μm	micrometer(s)

1 INTRODUCTION

Teck American Incorporated (TAI) conducted an evaluation to identify existing bioaccumulation models and derive additional bioaccumulation models for use in the baseline ecological risk assessment (BERA) for the Terrestrial Study Area[1] of the Upper Columbia River (UCR) site (hereinafter, the Site).[2] Bioaccumulation models are used to estimate uptake from soil into biota (e.g., terrestrial plants, terrestrial arthropods, and small mammals) for avian and mammalian wildlife receptors that are evaluated for the dietary exposure pathway. Past screening-level ecological risk assessments (ERAs) for the Site (TAI 2010, 2020) did not identify or use bioaccumulation models for terrestrial biota;[3] thus, models are needed for use in the Upland BERA.

Literature containing bioaccumulation models commonly used in Superfund site risk assessments is the primary source for the bioaccumulation models used in the Upland BERA. A literature search was conducted for additional metal-specific soil-to-biota pairings; this search found that, in particular, data were lacking for molybdenum. Sources were ranked by considering the following: Site-specificity, well-respected sources commonly used in ERAs, availability of models, and availability of raw data that could be used to develop additional models. Bioaccumulation model source rankings for the Upland BERA are as follows (with Source 1 as the most preferred and Source 4 the least):

1. Site-specific models developed from co-located soil and plant tissue data from the 2018 Plant Tissue Study (TAI 2019)
2. Models from commonly used and well-respected Oak Ridge National Laboratory sources (Bechtel Jacobs 1998; Sample et al. 1998a,b)

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[1] The term "Terrestrial Study Area" refers to the upland terrestrial portions of the UCR Site. The geographical extent of the Terrestrial Study Area will be clarified in the Upland Remedial Investigation report. However, for the Upland BERA, the Terrestrial Study Area is operationally defined by the spatial extent of the data set, as described in Section 3 of the Upland BERA.

[2] As per the June 2, 2006 Settlement Agreement for Implementation of Remedial Investigation and Feasibility Study (RI/FS) at the Upper Columbia River Site (referred to herein as the UCR Site or Site), the Site consists of the areal extent of hazardous substances contamination within the United States in or adjacent to the Upper Columbia River, including the Franklin D. Roosevelt Lake, from the U.S.-Canada border to the Grand Coulee Dam, and all suitable areas in proximity to such contamination necessary for implementation of the response actions (RI/FS) described therein.

[3] In TAI (2010), soil data were not available for modeling purposes. In TAI (2020), the evaluation relied on soil screening benchmarks; thus, bioaccumulation modeling was not required.

3. Database from the U.S. Department of Defense, U.S. Army Center for Health Promotion and Preventative Medicine (USACHPPM 2004)
4. Models reported in peer-reviewed literature (e.g., Hargreaves et al. 2011).

The availability of models and data from the ranked sources varies by chemical of potential concern (COPC) for birds or mammals and by biota type, as presented in Table C-1. Models and/or data were selected in order from the ranked sources until a model was available for each of the required COPC-biota type pairings for the Upland BERA. Source 1 above has available plant models for all COPCs except molybdenum, but lacks models for terrestrial arthropods, flying insects, earthworms, and small mammals. Thus, models for earthworms and small mammals were selected from Source 2 above. Models for terrestrial arthropods and flying insects were selected from Source 3 above when data were available. Models for molybdenum uptake into terrestrial plants were selected from Source 3 as well. Source 4 was used for models of molybdenum uptake into terrestrial arthropods and flying insects.

Additionally, model types were ranked according to the criteria outlined in the U.S. Environmental Protection Agency's (EPA's) ecological soil screening levels (Eco-SSL) guidance (USEPA 2007); regression models were prioritized over median bioaccumulation factors (BAFs) when the regression model was significant (slope $p < 0.05$) and met minimum correlation requirements ($R^2 \geq 0.2$). In addition to these criteria from USEPA (2007), two more criteria were applied to ensure sufficient model performance, a positive slope, and more than 10 data points. The regression models better account for variable uptake over differing concentrations in soil than BAFs, which are a static ratio. Model selection for each metal was done first by ranking the sources (1 to 4) as above, then by ranking the model type (i.e., regression or BAF). For example, a BAF from model Source 1 above would be selected over a regression from model Source 2.

Sources 1 and 3 present raw data of paired soil and biota metal concentrations. Appropriate bioaccumulation models had to be derived from the raw data in these reports. This appendix presents the methods used to derive the most reliable and relevant models possible using the information in Source 1 (2018 Plant Tissue Study [TAI 2019]) or Source 3 (USACHPPM 2004 database). Specific invertebrate classes and plant parts that aligned best with Upper Columbia River terrestrial wildlife receptor diets were selected. Regression modeling was conducted and evaluated for reliability using a three-part validation process. The validated models developed from Source 1 and Source 3 and reported in this appendix are used in the Upland BERA.

Sources 2 and 4 present their models and any validation work in their respective documentation. Bioaccumulation models selected from Sources 2 and 4 are taken directly from their documentation without alteration. These models are presented in Section 4.1.7 of the Upland BERA and are not discussed further in this appendix.

2 DATA AND APPROACH

This section documents the data set acquisition, data handling, and modeling approach used to derive bioaccumulation models from the 2018 Plant Tissue Study data set and the USACHPPM (2004) database.

2.1 SELECTED DATA SETS

This subsection presents an overview of the two data sets selected for modeling, the 2018 Plant Tissue Study (TAI 2019) and USACHPPM (2004).

2.1.1 2018 Plant Tissue Study

The 2018 Plant Tissue Study data collection was designed to evaluate the concentrations of metals in the tissue of wild upland plants sampled from tribal allotments in the study area. TAI collected plant tissue and co-located soil samples during three sampling events in 2018: April, June, and August.

Sampling design was focused on characterizing metal concentrations in upland plants that are ingested, mouthed, or otherwise used by Confederated Tribes of the Colville Reservation (CCT) members with the intent to evaluate the potential human exposure to metals and mercury[4]. Plants and co-located soil samples were collected from 12 sampling areas, all located on CCT tribal allotments, designated as either "high lead" or "low lead," based on soil lead data collected in the 2014 Soil Study (TAI 2015), 2014 Residential Soil Study (CH2M Hill 2016), and 2016 Residential Soil Study (TAI 2017). The 2018 Plant Tissue Study data selected for use in the Upland BERA are from sampling areas located on tribal allotments within the Terrestrial Study Area. A total of six high lead and six lower lead plant tissue and co-located soil samples were targeted for each plant species and tissue type.

Co-located soil samples were collected next to small plants or below the crown of larger bushes and trees. For individual plant samples, one co-located soil sample was collected. For composite plant samples, a co-located soil sample was collected for each individual plant sampled and soil was composited in the field proportionally to the weight of the plant tissue from each plant in the composite.

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[4] Mercury was analyzed in only selected leaves and stems of the following plants: kinnikinnick leaves, wild rose leaves and stems, wild mint, willows, and tules.

Data collected for this study included the following:

- A total of 174 plant tissue and 174 co-located soil samples were collected and analyzed for target analyte list (TAL) metals, including 63 select plant tissue and co-located soil samples that were also analyzed for mercury.
- Plant tissue types (plant parts) collected are black tree lichen; camas bulbs; kinnikinnick leaves; lomatium roots; Indian potato corms; willow branches; huckleberry berries; wild rose stems, leaves, and rose hips; chokecherry berries; hazelnuts; ponderosa pine nuts; sarvisberry berries; tule culms; and wild mint leaves.
- Soil samples were collected from 0 to 3 in. below the ground surface. Soil samples were air dried and passed through a No. 100 sieve to isolate the target particle size of < 150 µm. This particle size fraction is intended to represent the fraction expected to adhere to skin via dermal contact (Ruby and Lowney 2012).

All the plant tissue and soil samples were analyzed for TAL metals (except calcium, magnesium, potassium, and sodium), and leaf and stem tissues collected from kinnikinnick, wild rose, willows, tule, and wild mint (59 plant tissue samples), and the associated soil samples for these were also analyzed for mercury. Additionally, three sarvisberry samples and one wild rosehip sample were also analyzed for mercury. Mercury was only analyzed in stem and leaf tissue due to research demonstrating that mercury was highest in these tissues (Li et al. 2017) and the associated co-located soil samples. Detailed results of the 2018 field sampling effort for the plant tissue study conducted for the UCR Site are presented in TAI (2019).

2.1.2 USACHPPM (2004)

USACHPPM (2004) reports the results of a literature search for bioaccumulation data for metals and other contaminants. This literature search was conducted by USACHPPM to fill a gap in the existing literature specific to non-earthworm terrestrial arthropods and different terrestrial plant parts (i.e., seed, fruit, and root). A database was populated with the results of this literature search and is presented in Appendix B of USACHPPM (2004).

Data in the USACHPPM database were restricted to the following:

- Co-located biota and soil samples
- Relevant species for the biota types for which models needed to be developed from this source, including terrestrial flying insects and arthropods (such as spiders, millipedes, centipedes, mollusks, and isopods, and excluding all data on earthworms) or terrestrial plants (such as trees, shrubs, grasses, vegetables, and fruits)

- Whole-body concentrations (terrestrial arthropods) or seed, fruit, stem, leaf, root, and/or whole-plant concentrations (terrestrial plants)
- Data likely to have biota concentrations that were at equilibrium with soil concentrations (i.e., field-collected studies of resident biota or laboratory studies of sufficient duration)
- Total (e.g., concentrated acid extraction) chemical analyses of both soil and biota
- Mean or composite concentration reported for each sampling location, for each species reported.

Data are available for metals, including essential nutrients such as sodium and magnesium, with all concentrations reported as mg/kg dry weight. Concentrations reported as wet weight in the original study were converted to dry weight using either a water content reported in the study or an estimated water content percentage from EPA (1993). In addition, class, order, and family taxonomic data were included where possible in the database. A quality assurance and quality control procedure was followed by USACHPPM (2004) to minimize errors in the database.

The USACHPPM (2004) report calculates summary statistics for BAFs (the ratio of the concentration in biota to the concentration in soil) by class and order for terrestrial arthropods and by plant part for terrestrial plants. No regression modeling was done in the report. Since regression models that meet acceptance criteria are preferred over BAFs (see Section 1 of this appendix), data were extracted from the report to derive regression models for use in the Upland BERA.

2.2 DATA HANDLING

This subsection describes how data were handled in deriving bioaccumulation models from the 2018 Plant Tissue Study (TAI 2019) and USACHPPM (2004) database for use in the Upland BERA.

2.2.1 2018 Plant Tissue Study

Fines-bulk correction factors, exclusions, transformations, and data groupings are described for the data from the 2018 Plant Tissue Study.

2.2.1.1 Fines-Bulk Correction

Soil data collected as part of the 2018 Plant Tissue Study are limited to the fines soil fraction (< 150 μm) because the data were intended for evaluation of human exposure. Since soil data used in the Upland BERA are based on the < 2 mm soil fraction, the soil data from the 2018 Plant Tissue Study had to be corrected to represent the < 2 mm fraction that is relevant to ecological organisms.

Fines-bulk correction factors were developed using co-located fines and bulk soil data from the 2014 UCR Upland Soil Study data set (TAI 2015).

The steps used to develop the fines-bulk correction factors consisted of the following:

1. Paired fines-bulk soil data from the 2014 UCR Upland Soil Study (TAI 2015) were compiled. Samples for the 2014 UCR Upland Soil Study were collected using the incremental composite sampling method. Samples were collected from decision units (DUs) in the aerial deposition areas (ADAs) and relict floodplain deposition areas (RFDAs). Duplicates from split samples and field duplicate samples were averaged. Paired data without detect-detect pairs were excluded.
2. An analysis of covariance (ANCOVA) determined the ADAs and RFDA-B/RFDA-C could be pooled as they were not significantly different ($p > 0.05$). However, RFDA-A and RFDA-D were consistently different ($p < 0.05$) from other areas and were removed from the data set (Figure C-1 and Table C-2).
3. Fines-bulk data were plotted for each COPC and tested for the following.
   a. A statistically significant linear relationship
   b. Whether the relationships are statistically significantly different than a 1:1 relationship.
4. Correction factors were then determined in the following way.
   a. If the relationship between fines and bulk data for a COPC is statistically significant and significantly different than a 1:1 relationship, then a linear correction was used as a correction on the fines.
   b. If the relationship between fines and bulk data for a COPC is statistically significant and not significantly different than a 1:1 relationship, no correction factor was applied to the fines data.
   c. If the relationship between fines and bulk data for a COPC is not statistically significant, no correction factor was applied to the fines data.

The fines-bulk data for each COPC are shown in Figure C-2. Table C-3 summarizes the model parameters and the decision to apply a correction factor to fines data. The following COPCs had fines-bulk correction factors applied to the soil data from the 2018 Plant Tissue Study: barium, cadmium, chromium, copper, iron, lead, mercury, molybdenum, selenium, thallium, and vanadium.

2.2.1.2 Exclusions

Data from the 2018 Plant Tissue Study were excluded if concentrations were below detection limits or plant tissue types were not relevant. Two plant tissue types were excluded (black tree lichen and willow inner bark) because the lichen is not exposed to soil and the willow inner bark samples are only located in the RFDAs.

2.2.1.3 Data Transformations

Normality testing was performed, which confirmed that the data were log-normally distributed for most of the analytes. Therefore, all soil and biota concentrations were natural log transformed prior to regression modeling. This is consistent with the approaches used in other commonly used bioaccumulation model sources, such as those used for EPA's Eco-SSLs (Bechtel Jacobs 1998; Sample et al. 1998a,b).

2.2.1.4 Selected Plant Groups and Metals for Modeling

Plant part types were grouped into two categories: aboveground plant parts and belowground plant parts. Aboveground plant parts include berries, cherries, hips, nuts, culms, leaves, and stems. Belowground plant parts include bulbs, corms, and roots. Initial data exploration showed no improvements by evaluating more data groupings (e.g., separating fruits from nuts).

Data are available for modeling all COPCs except for:

- Molybdenum in aboveground and belowground plant parts
- Mercury in belowground plant parts.

2.2.2 USACHPPM (2004)

Details of data handing for the USACHPPM (2004) report are provided below.

2.2.2.1 Database Extraction

The database was extracted electronically from the PDF file of the USACHPPM (2004) report. Extraction was performed using the R package pdf tools, version 2.3.1 (Ooms 2020). Table B-1 (terrestrial arthropods) and Table B-2 (terrestrial plants) were extracted from the PDF of the USACHPPM database.

Page 36 of Table B-1 (page 550 of the PDF file) is blank. While the report does not list the total number of data points, it appears that this potential error in the PDF file results in a loss of approximately 50 data points in the database specific to terrestrial arthropods. The total available data points for terrestrial arthropods for all reported metals is 1,901. No blank pages were identified for terrestrial plants; the total number of data points for all reported metals is 2,082. Uncertainty associated with the loss of data points is discussed later in Section 4.2 of this appendix.

2.2.2.2 Exclusions

Data points without concentration values for both soil and biota were excluded from the modeling data set. In addition, data points with nondetected concentrations for either soil or biota were excluded. Nondetected concentrations were identified as those values reported as 0 or those values qualified with a “U”[5] in the database.

Terrestrial Arthropods

Mollusks were considered from the USACHPPM (2004) database for invertebrate prey but were excluded from the modeling data set because mollusks (i.e., snails and slugs) are not anticipated to be a major food source for Upper Columbia River upland invertivorous receptors (i.e., tree swallow, American robin, little brown bat, and masked shrew; see Table 4-3 of the Upland BERA for information on receptor dietary composition), and therefore only terrestrial arthropods were considered from the remaining data. This exclusion resulted in a negligible decrease in data points because limited data (one sample for six analytes) were available for mollusks in the USACHPPM (2004) database. Data on spiders, insects, millipedes, centipedes, and isopods were all retained for the terrestrial arthropod modeling data set.

Aerial Insects

A subset of the terrestrial arthropod modeling data set was used to generate models specific to aerial insects, the preferred prey for aerial insectivore receptors such as the tree swallow and the little brown bat. Given the differences in life history characteristics and degree of exposure to soil, it is reasonable to assume that uptake may be different for flying aerial insects than for ground-dwelling arthropods. To generate this subset of data, available taxonomic information for each data point was scrutinized to assess whether the species was an aerial insect or not, as reported in Table C-4. Spiders, millipedes, centipedes, isopods, and some insects (such as specific beetle, weevil, ant, grasshopper, and cockroach species that cannot or generally do not fly) were excluded from the aerial insect modeling data set. Insects, such as most beetles, weevils, flies, aphids, moths, grasshoppers, and crickets, were included in the aerial insect modeling data set. Where specified in the database, aerial insect species that were labeled as a ground-dwelling larval form (such as caterpillars) were excluded from the aerial insect modeling data set. For data

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[5] The “U” qualifier means that the analyte was not detected at a concentration higher than the quantitation limit.

points with limited taxonomic information that precluded categorization (e.g., "chewing insect" or "non-spider"), it was assumed that the species was not an aerial insect.

Terrestrial Plants

Data were reported in the USACHPPM (2004) database for both aboveground and belowground plant parts.

A review of the terrestrial plant data for molybdenum was performed as it was the only COPC that did not have an available model or data in ranked Sources 1 and 2 (see Table C-1). This review indicated that all data points were based on terrestrial species with co-located soil samples. Therefore, no exclusions were made.

2.2.2.3 Outlier Evaluation and Corrections

Data from the USACHPPM database were assumed to be correct and were not independently verified. However, a visual assessment of the database was conducted to identify outliers or data clusters indicating potential errors in concentration reporting. Any outliers were then verified to ensure that the data had been appropriately included and calculated. The following sets of outliers were identified and handled as described:

- **Watson et al. (1976) soil concentrations.** Visual assessment of the terrestrial arthropod data set identified a study with soil concentrations, particularly for lead, substantially different than all others. This study (Watson et al. 1976) was reviewed and an error in unit conversions for the database was identified. Soil concentrations from this study were corrected to mg/kg, according to the information in the study's table headings. Database gaps for soil concentration for a limited subset of litter grazer rows were also identified. These gaps were populated according to the soil concentrations reported for each of the Watson et al. (1976) sample locations in the database.
- **Ramirez and Rogers (2000) soil concentrations**. A single grasshopper sample from Ramirez and Rogers (2000) was identified as an outlier for copper. After reviewing the original study, the geometric mean soil concentration of this sample appears to have been calculated in error. The geometric mean was calculated as per the study results and corrected the soil concentration in the terrestrial arthropod data set.

This detailed level of scrutiny was reserved only for visual outliers; no other studies or data points were scrutinized as part of this modeling effort.

2.2.2.4 Data Transformations

Normality testing was performed, which confirmed that the data were log-normally distributed for the majority of analytes. Therefore, all soil and biota concentrations were natural log transformed prior to regression modeling. This is consistent with the approaches used in other commonly used bioaccumulation model sources, such as those used for EPA's Eco-SSLs (Bechtel Jacobs 1998; Sample et al. 1998a, b).

2.2.2.5 Selected Metals for Modeling

Bioaccumulation models are only necessary for COPCs evaluated through the dietary exposure pathway for wildlife. Models from the USACHPPM (2004) database were only needed for COPC-biota type pairings for which no model from a higher-ranked source was available. Table C-1 delineates which COPC-biota type pairings needed bioaccumulation model calculations from the USACHPPM (2004) data set.

For terrestrial plants, Bechtel Jacobs (1998) (the second-ranked source for plants) does not present models or data for molybdenum. Thus, the USACHPPM (2004) data set was used to develop terrestrial plant models for molybdenum, as noted in Table C-1.

2.3 MODEL DEVELOPMENT

Bioaccumulation models were developed and validated consistent with approaches used in other commonly used bioaccumulation model sources (Bechtel Jacobs 1998; Sample et al. 1998a, b).

2.3.1 Model Types

Bioaccumulation models for ERAs are typically calculated as either a linear regression model on log-transformed data or as BAFs. Regression models better account for variable (nonlinear) uptake over differing concentrations in soil than BAFs, which are static ratios that assume linear accumulation (Sample et al. 1998a). Thus, regression models are preferred over BAFs as long as the regression models meet minimum acceptability requirements as described below.

Regression models are calculated using Equation 1:

Equation 1: Bioaccumulation regression model

$$\ln(C_{biota}) = a * \ln(C_{soil}) + b$$

Where: a = Slope of the model

b = y-intercept of the model

C_{biota} = Concentration of the analyte in biota tissue (mg/kg dry weight)

C_{soil} = Concentration of the analyte in soil (mg/kg dry weight)

BAFs are calculated using Equation 2:

Equation 2: Bioaccumulation BAF model

$$\mathrm{BAF} = \frac{C_{biota}}{C_{soil}}$$

Where: C_{biota} = Concentration of the analyte in biota tissue (mg/kg dry weight)

C_{soil} = Concentration of the analyte in soil (mg/kg dry weight)

EPA's Eco-SSL guidance (USEPA 2007) outlines acceptance criteria for regression models of a statistically significant slope ($p < 0.05$) and a minimum correlation ($R^2 \geq 0.2$). In addition, two further acceptance criteria were identified: 1) a positive slope, indicating that plant tissue concentrations increase with soil concentrations, and 2) a data size requirement of > 10 to ensure that regression models were not well correlated simply due to a small number of data points. Thus, the regression models derived from the 2018 Plant Tissue Study (TAI 2019) and USACHPPM (2004) database must meet all four of the above acceptance criteria to be selected for use over BAFs.

For COPC-biota type combinations where the regression model fails the acceptance criteria, a BAF calculated from the same data is used instead. Consistent with EPA's Eco-SSL methodology (USEPA 2007), the summary statistic used for the BAF is the median value.

Regression models and median BAFs were computed using R statistical software (R Core Team 2020).

2.3.2 Model Validation

A series of model validation procedures were used to confirm the reliability of the model-estimated linear relationships between biota and soil concentrations. The goal was to assess the sensitivity and variability of the model estimates. Three model validation methods were conducted, including the following:

1. Data splitting based on studies (similar to methods in Sample et al. [1998a])
2. Data truncation of extremes
3. Bootstrap resampling.

Regression models were validated using all three of the methods, where data permitted. BAFs were validated using only the third method, bootstrap resampling.

2.3.2.1 Data Splitting

Similar to validation methods used in Sample et al. (1998a), data were separated into training and validation data sets based on the required sample sizes to achieve approximately an 80/20 split.

Studies were assigned as either training or validation so that samples in the same studies were kept together since sampling and analytical variability are likely to be correlated among data from the same study. The assignment of studies and corresponding sample sizes are shown in Table C-5. Aluminum, iron, mercury, and thallium were not included in this validation process for terrestrial arthropods because all samples came from a single study. For all COPCs except for molybdenum, no data from plants were included in the data splitting set since all samples came from the 2018 Plant Tissue Study. Also, the number of studies used for molybdenum plant samples from the USACHPPM (2004) database was not sufficient to conduct a study split; thus, no plant samples were evaluated for molybdenum using this validation method. Wilcoxon signed-rank test and proportional deviation were used to assess how well the biota response in the validation data set was predicted by the training model.

2.3.2.2 Data Truncation

Soil concentrations in the top 20 percent were treated as the validation data set, and linear models were fit to the remaining data. Prediction intervals were produced from the linear models and the number of validation data points falling outside of the prediction intervals were tallied. The fitted lines and prediction intervals for both the full data set and truncated data set were compared to assess the sensitivity of the linear relationships to removal of high data extremes. The same procedure was applied to soil concentrations in the bottom 20 percent.

2.3.2.3 Bootstrap Resampling

Bootstrap samples (repeatedly sampling the original data set with replacement) of the same size as the original data set were produced, and linear regression models were fit to each bootstrap sample. The variability in the bootstrap model parameters was assessed using histograms and scatterplots. Similarly, median BAFs were computed for each bootstrap sample, and the variability of the bootstrap sample median BAFs was assessed using histograms. For this analysis, 100 bootstrap samples were used.

3 RESULTS

This section presents the validation results and selected bioaccumulation models used in the Upland BERA.

3.1 MODEL DEVELOPMENT

Regression models and median BAFs were calculated using the data set described above in Section 2 of this appendix for each of the COPC-biota type pairings specified in Table C-1. Calculated model parameters and summary statistics are reported in Table C-6 (terrestrial arthropods), Table C-7 (aerial insects), Table C-8 (aboveground terrestrial plant parts) and Table C-9 (belowground terrestrial plant parts).

3.2 MODEL VALIDATION

Results for the validation techniques are presented in Figures C-3 through C-4 (data splitting), Figures C-5 through C-12 (data truncation low and data truncation high), and Figures C-13 through C-24 (bootstrap resampling). Where appropriate, fitted regressions and 95-percent prediction intervals using the training data set, as well as the entire data set, are shown.

Overall, COPC-biota type pairings with large sample sizes ($n \geq 60$) yielded more robust regression models, and pairings with small sample sizes ($n \leq 30$) yielded more variable and sensitive regression models. If more data were available for the COPC-biota type pairings with small sample sizes ($n \leq 30$), especially data for soil concentrations not represented in the current data set, it is likely that the resulting model relationship would change with the addition of new data. Confidence in regression models with larger sample sizes is thus higher than models with smaller sample sizes. For all biota types, the median of bootstrap sample median BAFs were similar in value to the median BAFs computed from all the data, which suggests that median BAF calculations are not highly sensitive to varying the underlying data set. Confidence in median BAFs from the data is thus increased due to the bootstrap resampling validation results.

Specific uncertainties with models for particular COPC-biota type pairings are discussed in Section 4 of this appendix.

3.3 FINAL SELECTED MODELS

The models selected for use in the Upland BERA are highlighted in bold in Tables C-6 through C-9. The final regression models (based on the full data sets), along with a statement as to whether the models meet acceptance criteria or not, are presented visually in Figures C-25 though C-28.

3.3.1 Terrestrial Arthropods

COPCs with regression models that met the acceptance criteria are aluminum, cadmium, and lead (Figure C-25). These regression models were selected for use in the Upland BERA. For all other COPCs (barium, chromium, copper, iron, mercury, selenium, thallium, vanadium, and zinc), the median BAF was selected for use. Modeling could not be conducted for molybdenum due to a lack of data in the USACHPPM (2004) database.

3.3.2 Aerial Insects

COPCs with regression models that met the acceptance criteria are cadmium, copper, lead, and zinc (Figure C-26). These regression models were selected for use in the Upland BERA. For all other COPCs (aluminum, barium, chromium, iron, mercury, selenium, thallium, and vanadium), the median BAF was selected for use. Modeling could not be conducted for molybdenum due to a lack of data in the USACHPPM (2004) database.

3.3.3 Terrestrial Plants

None of the regression models for aboveground plant parts met the acceptance criteria (Figure C-27). The median BAF for aboveground plant parts was selected for all COPCs (aluminum, barium, cadmium, chromium, copper, iron, lead, mercury, molybdenum, selenium, thallium, vanadium, and zinc).

Chromium and vanadium are the COPCs with regression models for belowground plant parts that met the acceptance criteria (Figure C-28). The median BAF for belowground plant parts was selected for all other COPCs (aluminum, barium, cadmium, copper, iron, lead, molybdenum, selenium, thallium, and zinc).

4 UNCERTAINTIES

Uncertainties associated with development of bioaccumulation models are discussed below. Uncertainties associated with dietary exposure pathways and the use of bioaccumulation models for hazard quotient calculations are discussed in the bird and mammal risk characterization sections of the Upland BERA.

4.1 UNCERTAINTIES FOR THE PLANT BIOACCUMULATION MODELS

A general uncertainty associated with the plant bioaccumulation models is:

- **Regression models versus BAFs**. There is higher uncertainty in BAFs than in regression models that meet the acceptance criteria. As a static ratio, BAFs do not account for nonlinear bioaccumulation and assume that there is no threshold to concentrations in biota (Sample et al. 1998a). If metals are regulated by the biota, such as essential nutrients (e.g., copper or zinc) that are actively metabolized, sequestered, or excreted as compared to non-essential metals that may not be regulated (e.g., cadmium, mercury, or lead), these assumptions may not hold. Regression models better account for variable bioaccumulation across different soil concentrations (e.g., in situations where bioaccumulation rates are higher at lower soil concentrations and bioaccumulation rates are lower at higher soil concentrations), and thus have less uncertainty than BAFs.

Uncertainties specific to the plant bioaccumulation models derived from 2018 Plant Tissue Study data are listed below.

- **Spatial relevance.** The 12 sampling areas where plant tissue samples were collected have limited spatial coverage and poor overlap with locations where soil samples suitable for use in ERA were collected and are not likely to be representative of the range of environmental conditions across the spatial extent of the Terrestrial Study Area. The co-located soil samples represent a single point near each collected plant tissue sample, unlike the 2014 UCR Upland Soil Study DUs, which represent a composite across approximately 25 acres. Bioavailability parameters were not measured in these co-located soil samples. However, the range of metal concentrations in the co-located soil samples is similar to the range of metal concentrations seen in the 2014 UCR Upland Soil Study samples. Thus, bioaccumulation models developed from these data have relevance to ADA DU soil metal concentrations.

- **Relevance to herbivorous wildlife diets.** The specific plants and plant parts sampled were selected for their cultural significance (e.g., inner bark of willow for medicinal tea, kinnikinnick leaves for smoking), during the window of their seasonal availability (April, May, June, and August). While some wildlife species may include some of the sampled plant parts in their diet (e.g., robins eating rose hips in the early fall), the specific plant samples are unlikely to represent the entire range or the dominant portion of herbivore diets in the UCR Site, which includes many more plant species and plant parts across all four seasons. TAI assessed which sampled plant parts are consumed by the different wildlife receptor species and concluded that each sampled plant part was likely to be consumed by at least one terrestrial receptor, with the exceptions of lichen and willow bark. There is substantial uncertainty in assuming that the sampled plant species and parts are representative of the entirety of the plant material that any one receptor might eat over all four seasons. However, this uncertainty is the same or greater with the Bechtel Jacobs (1998) plant models commonly used for ERAs.
- **Sieve size correction factors**. Co-located soil samples from the plant tissue sampling were sieved to < 150 µm for evaluation in the human health risk assessment, whereas data sets used in the Upland BERA were from soil samples sieved to < 2 mm. Developing relevant bioaccumulation models from these data requires the development of correction factors between < 150 µm and 2 mm soil chemistry data. While TAI was able to develop statistically significant correction factors (with R^2 values above 0.6) between the < 150 µm and < 2 mm soil samples for most COPCs (aluminum, barium, cadmium, chromium, copper, iron, lead, mercury, selenium, thallium, vanadium, and zinc) using the 2014 UCR Upland Soil Study data set (TAI 2015), this correction does add uncertainty.
- **Poor regression model performance**. For most COPCs and tissue type groupings (e.g., aboveground or belowground plant parts), scatterplots of the plant tissue and co-located soil data do not show identifiable direct relationships (see Figures C-27 and C-28); this is supported by the low R^2 values (< 0.1) and non-significant p-values ($p > 0.05$) observed for nearly all regression models (exceptions being chromium and vanadium in belowground plant parts). Models were evaluated by three plant part groups (roots, foliage, and fruits and nuts) as well as individual plant parts (e.g., cherries, berries, nuts, leaves, bulbs) and had similarly poor model performance; a few models had good relationships ($R^2 > 0.1$ and significant p-values [$p < 0.05$]), but these were not consistent across COPCs or plant parts. Terrestrial plant tissue COPCs concentrations at the Site are not well predicted by the COPCs' concentrations in co-located soil. This is likely due to the highly variable uptake, transport, and sequestration mechanisms across different plant species and different plant parts (e.g., roots, leaves, and reproductive parts) and also plant regulation of essential

metals (Kabata-Pendias and Pendias 2011). The poor model performance adds uncertainty to the use of bioaccumulation models derived from these data.

Uncertainties specific to the plant bioaccumulation models derived from data in the USACHPPM (2004) database are listed below.

- **Relevance of database species, life stages, and plant parts to receptor dietary items.** Species in the terrestrial plant modeling data set include terrestrial grasses, berries, and forbs. This represents a limited range of species and may not encompass many species-specific differences in soil exposure and metal regulation mechanisms that may modify bioaccumulation.
- **Environmental relevance of the underlying data set**. The USACHPPM (2004) database contains bioaccumulation data from soils across North America, South America, Europe, and Asia. None of the studies were conducted with soils from Washington State. The bioaccumulation models thus have broad relevance to a variety of different soil types but are not specifically relevant to upland soils at the Site. Depending on the physical soil characteristics and bioavailability of metals in Site soils, the bioaccumulation models may over- or under-estimate bioaccumulation into terrestrial arthropods and plants.

4.2 UNCERTAINTIES FOR THE TERRESTRIAL ARTHROPOD AND AERIAL INSECT MODELS

A general uncertainty associated with the terrestrial arthropod and aerial insect bioaccumulation models is in regression models versus BAFs (see bullet listed above in Section 4.1 of this appendix for terrestrial plant models).

Uncertainties specific to the bioaccumulation modeling conducted by TAI using the USACHPPM (2004) database are discussed below.

- **Loss of data points**. Approximately 50 data points for terrestrial arthropods may have been lost due to a blank page in the publicly available PDF file of the USACHPPM (2004) database. Through comparison of the summary statistics in the USACHPPM (2004) report and the extracted data set, the loss of the following 48 data points was identified: aluminum (6), antimony (2), arsenic (5), lead (1), sodium (1), thallium (9), vanadium (12), and zinc (12). It is unclear in the report if this was done intentionally or inadvertently. The loss of these data points is irrelevant for antimony, arsenic, and sodium because these metals are not COPCs for which bioaccumulation modeling was conducted for the Upland BERA. The loss of these data points is negligible for lead and zinc, for which a large data set of over 250 samples remains. However, the missing samples for aluminum, thallium, and vanadium represent a substantial portion of the data sets for these three COPCs, which have remaining sample sizes of 24, 14, and 19, respectively, for terrestrial arthropods. It is unknown how the missing samples for aluminum, thallium, and vanadium might have changed the results of the bioaccumulation modeling.

- **Relevance of database species, life stages, and plant parts to receptor dietary items**. The biota included in the USACHPPM (2004) database represent a variety of global species, many of which are not likely to be the exact species consumed by UCR Site upland receptors. However, the database includes classes, orders, and families related to dietary species for UCR Site upland receptors. The bioaccumulation models are broadly relevant to terrestrial arthropods and aerial insects.
  - **Terrestrial arthropods.** Species in the terrestrial arthropod modeling data set include spiders, centipedes, millipedes, beetles, termites, weevils, flies, true bugs, sawflies, ants, hornets, moths, butterflies, lacewings, grasshoppers, cockroaches, crickets, woodlice, and isopods. This represents a broad range of species that is expected to encompass many species-specific differences in life history characteristics and metal regulation mechanisms that may modify bioaccumulation.
  - **Aerial insects.** Species in the aerial insect modeling data set include beetles, weevils, flies, true bugs, sawflies, hornets, moths, butterflies, lacewings, grasshoppers, and crickets. Data points specific to larval stages of these species were not included. The restriction of the aerial insect data set to just flying adults increases the relevance of the aerial insect models to the UCR Site upland aerial insectivorous receptors (tree swallow and little brown bat). These insect species have undergone metamorphosis to reach the flying adult stage, and metal concentrations may decrease after metamorphosis (Kraus et al. 2014). Additionally, aerial insects may have less exposure to soil, which can further decrease metal bioaccumulation.
- **Different trophic levels of biota species.** The USACHPPM (2004) database contains data representing different trophic levels of terrestrial arthropods. For some COPCs, such as mercury, that may bio-magnify in higher trophic levels, predaceous arthropods (e.g., spiders) may have higher bioaccumulation than herbivorous or detritivorous arthropods (e.g., millipedes). The bioaccumulation models developed by TAI aggregate the different trophic levels. Therefore, the models may underestimate bioaccumulation into predaceous biota and overestimate bioaccumulation into herbivorous or detritivorous biota. However, the models are representative of bioaccumulation across different trophic levels. These models are thus relevant to the UCR Site upland receptor diets because the

invertivores (i.e., tree swallow, American robin, little brown bat, and shrew) eat a wide range of invertebrate prey.

- **Environmental relevance of the underlying data set**. See bullet listed above, in Section 4.1, for terrestrial plant models developed using data from the USACHPPM (2004) database.

4.3 CONTEXT PROVIDED BY THE VALIDATION ACTIVITIES ON THE FINAL SELECTED MODELS.

Interpretation and discussion of the validation activities is provided below, for the bioaccumulation models developed for terrestrial arthropods, aerial insects, and plants.

- Terrestrial arthropods
    - Cadmium and lead regression models, which meet the acceptance criteria and have sample sizes between 250 to 300 observations, have the lowest uncertainty of the terrestrial arthropod models developed for the Upland BERA. For most of the validation methods, the models for the training data and all data are similar, which indicates that the models are robust. For cadmium, training models for terrestrial arthropods are more sensitive to the removal of the lowest 20 percent of soil concentrations as compared to the highest 20 percent (Figures C-5 and C-9). This indicates that there is greater uncertainty in predicted biota concentrations from lower soil concentrations relative to higher soil concentrations for cadmium.
    - The aluminum regression model meets the acceptance criteria but has a sample size of 24. In the model validation, the aluminum model shows high sensitivity and variability, particularly in the bootstrap resampling validation (Figure C-17). The aluminum regression model has high uncertainty due to the low sample size and sensitivity of the model to the input data.
    - All other selected models for terrestrial arthropods out of the USACHPPM (2004) database are median BAFs. For copper, lead, mercury, selenium, and vanadium, the median of bootstrap samples median BAFs is nearly identical to the median BAF calculated for all data (Figure C-21). But for chromium and zinc, the median of bootstrap samples median BAFs is not identical to the median BAF calculated for all data. Thus, there is high uncertainty in the median BAF values for chromium and zinc.
- Aerial insects
    - Cadmium, copper, lead, and zinc regression models meet the acceptance criteria and have a sample size ≥ 60. Each of these show sensitivity and variability for all of the

model validation techniques. These models have moderate uncertainty due to the moderate sample size.

  - All other selected models for aerial insects out of the USACHPPM (2004) database are median BAFs. For each of these (aluminum, chromium, mercury, selenium, and vanadium), the median of the bootstrap samples' median BAFs is nearly identical to the median BAF calculated for all data (Figure C-22). Uncertainty in the median BAF values for these metals is low.

- Terrestrial plants
  - The only regression models that met the acceptance criteria for terrestrial plants are cadmium and vanadium for belowground plant parts. These models show sensitivity and variability in the truncated and bootstrap resampling validation techniques (Figures C-8, C-12, and C-20) but have moderate sample sizes, thus indicating moderate uncertainty. No regression models met the acceptance criteria for aboveground plant parts. All other selected models are median BAFs. For each of these, the median of the bootstrap samples' median BAFs is very similar to the median BAF calculated for all data (Figure C-23 and Figure C-24), which indicates low uncertainty.

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FIGURES

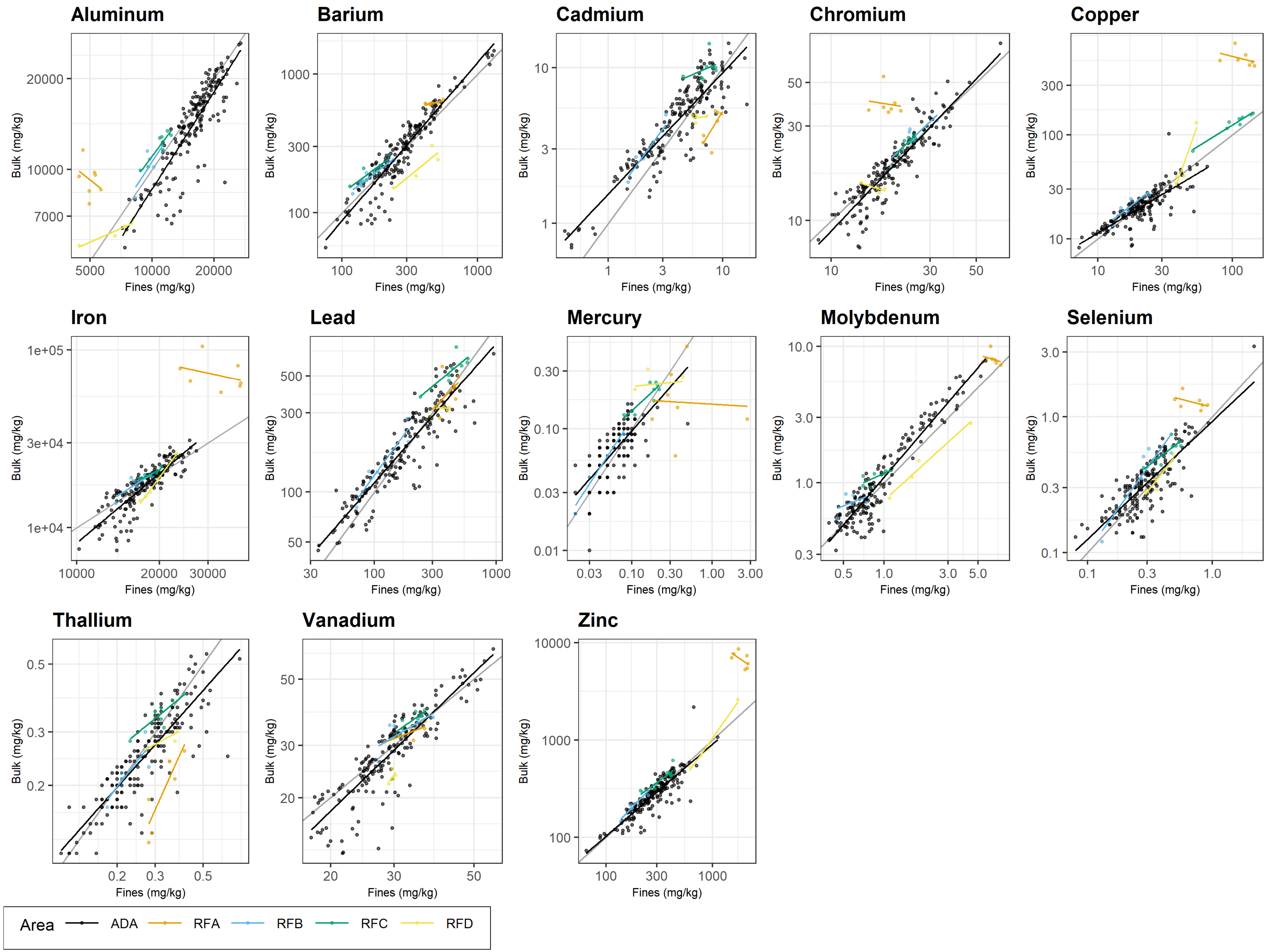

Figure C-1. ANCOVA Results

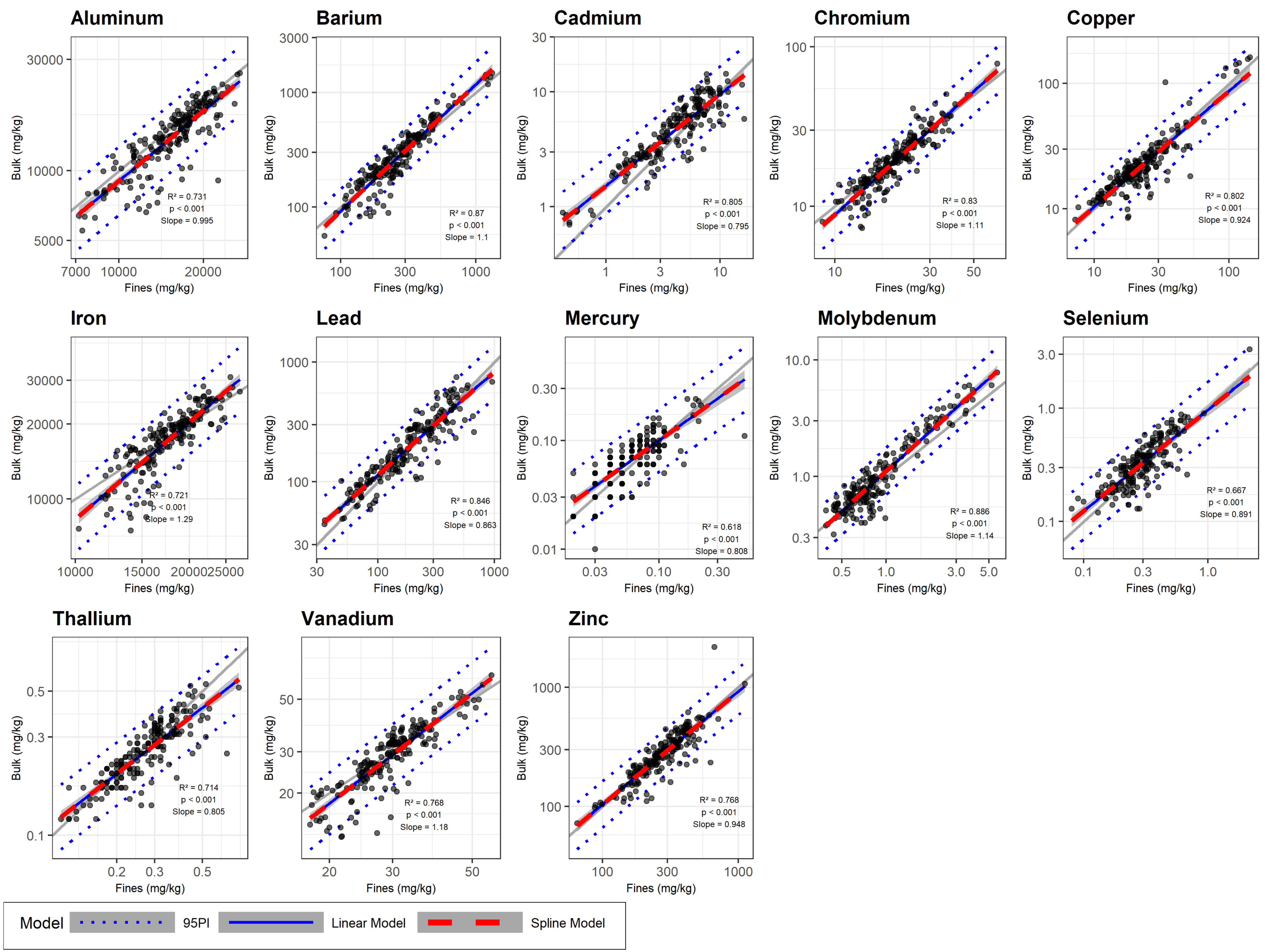

Figure C-2. Fines-Bulk Model Derived from 2018 Plant Tissue Study Soil Data

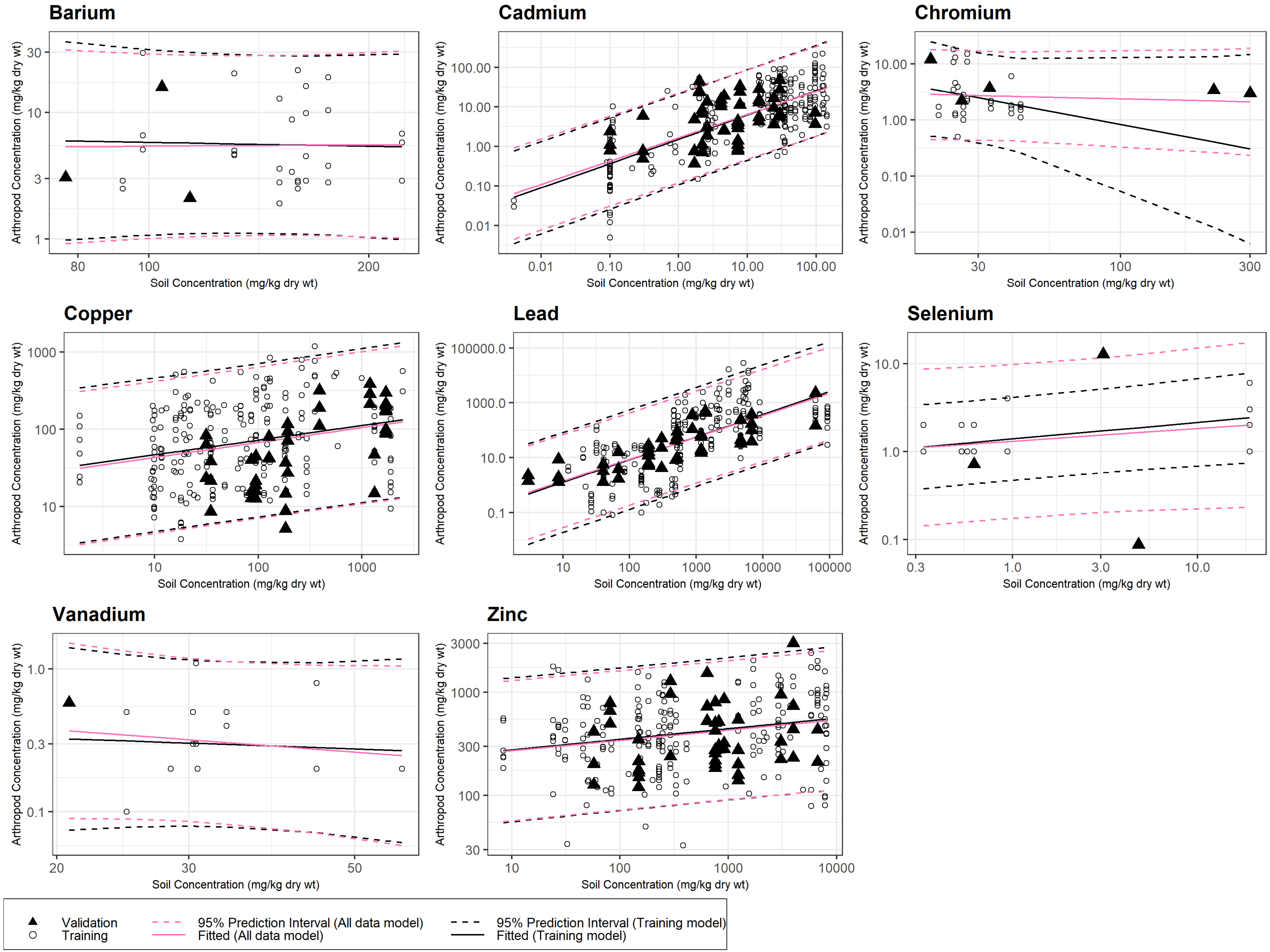

Figure C-3. Study Split Validation for Terrestrial Arthropods

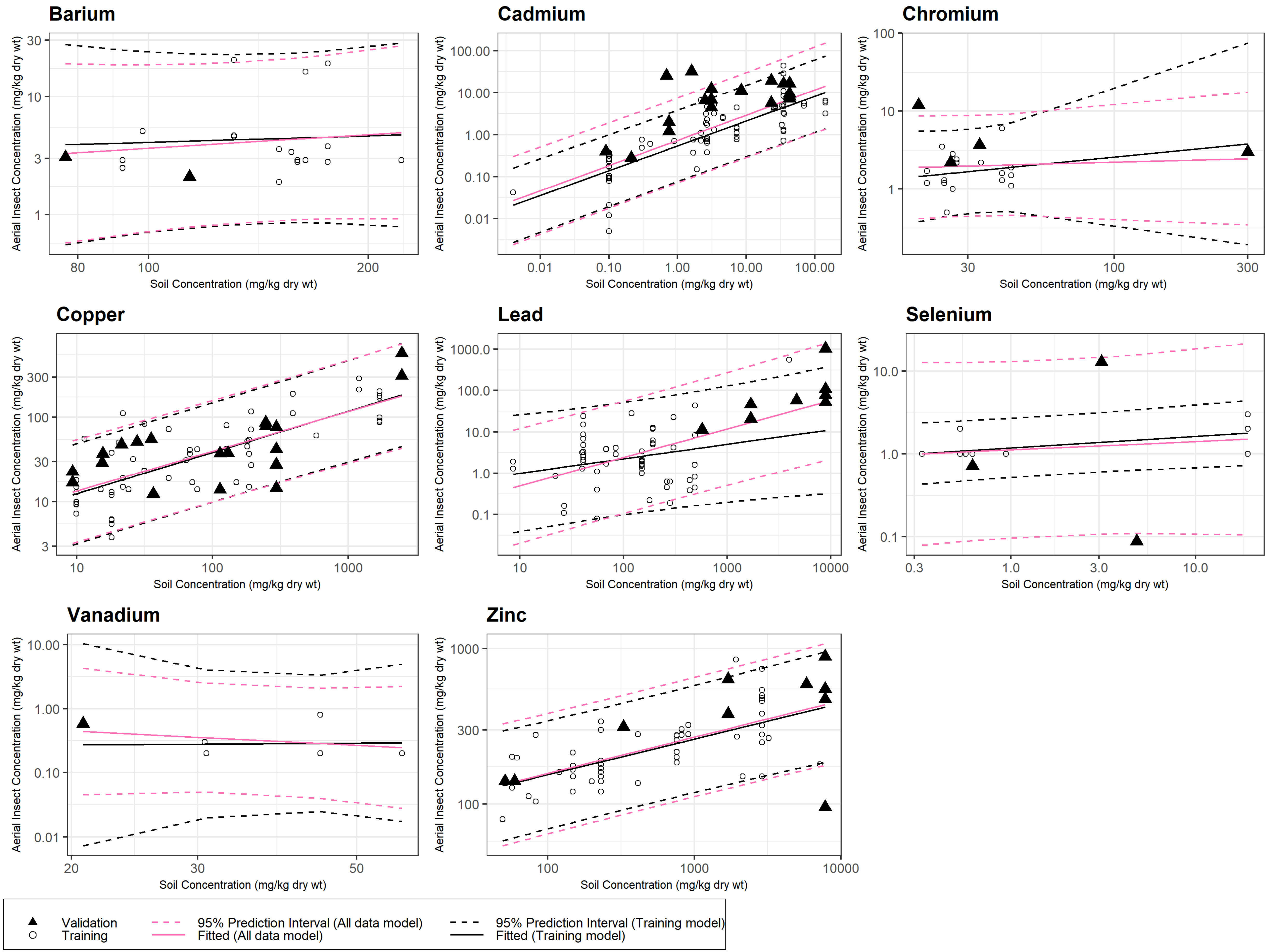

Figure C-4. Study Split Validation for Aerial Insects

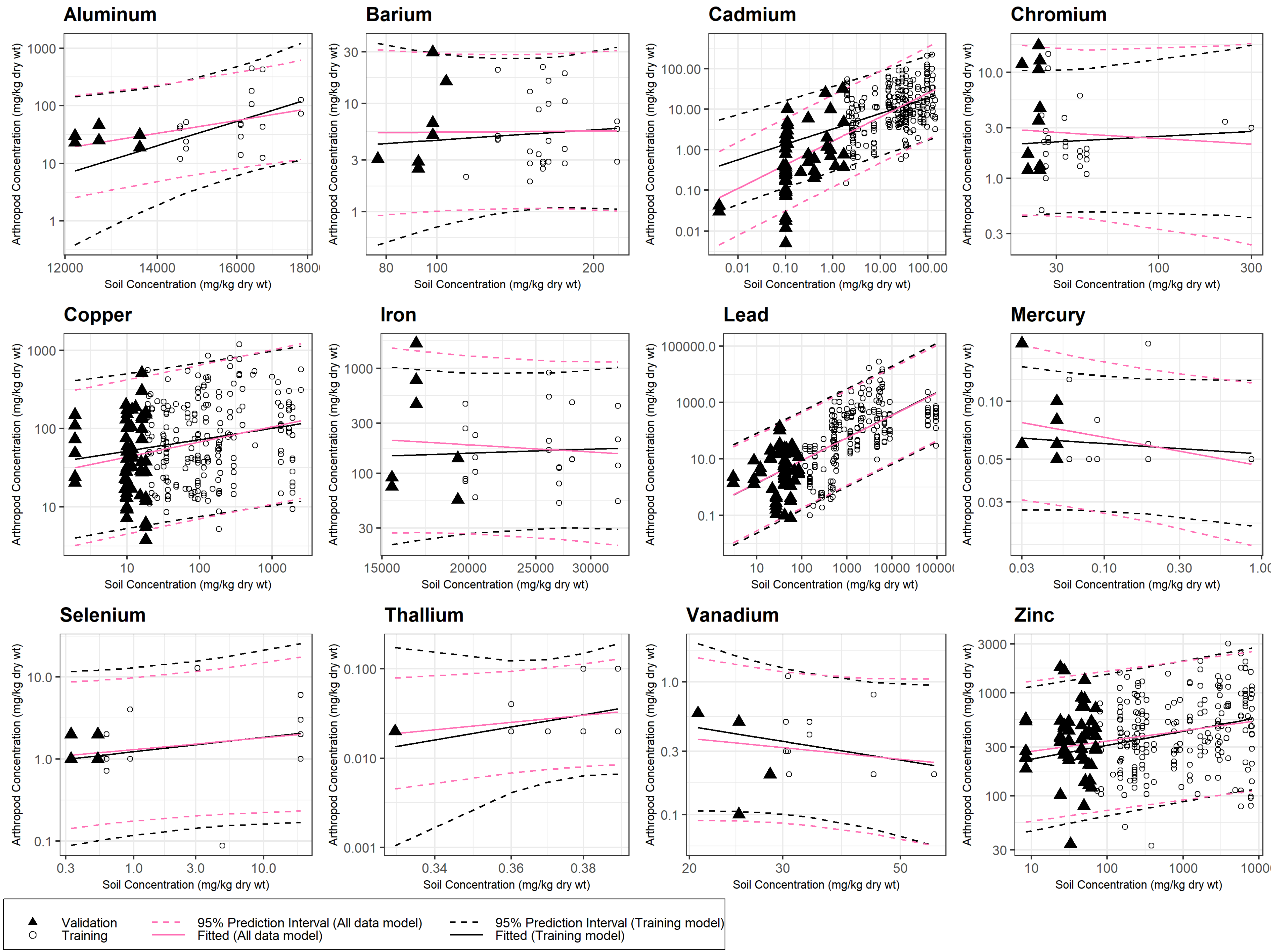

Figure C-5. Truncated (Low) Validation for Terrestrial Arthropods

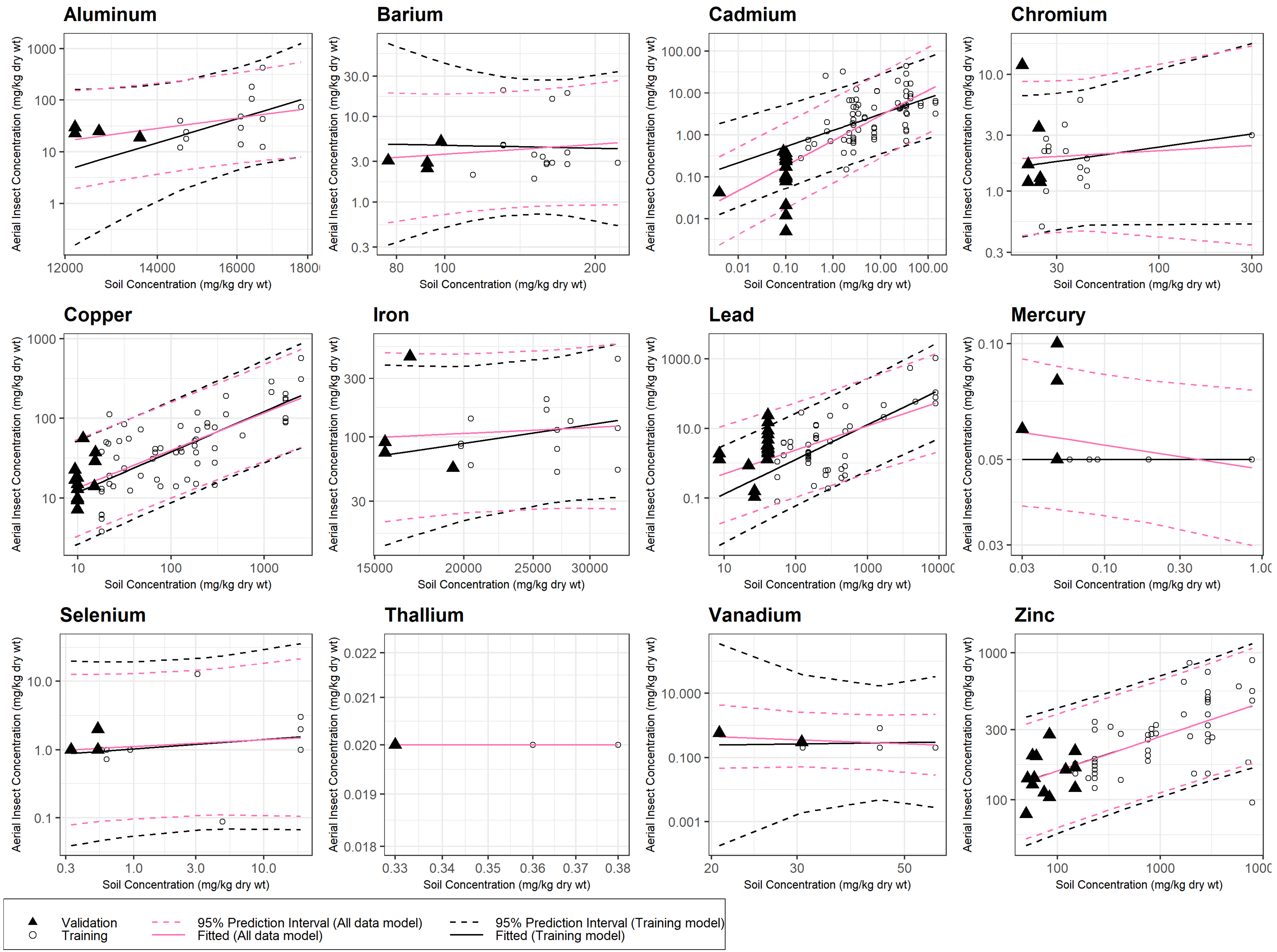

Figure C-6. Truncated (Low) Validation for Aerial Insects

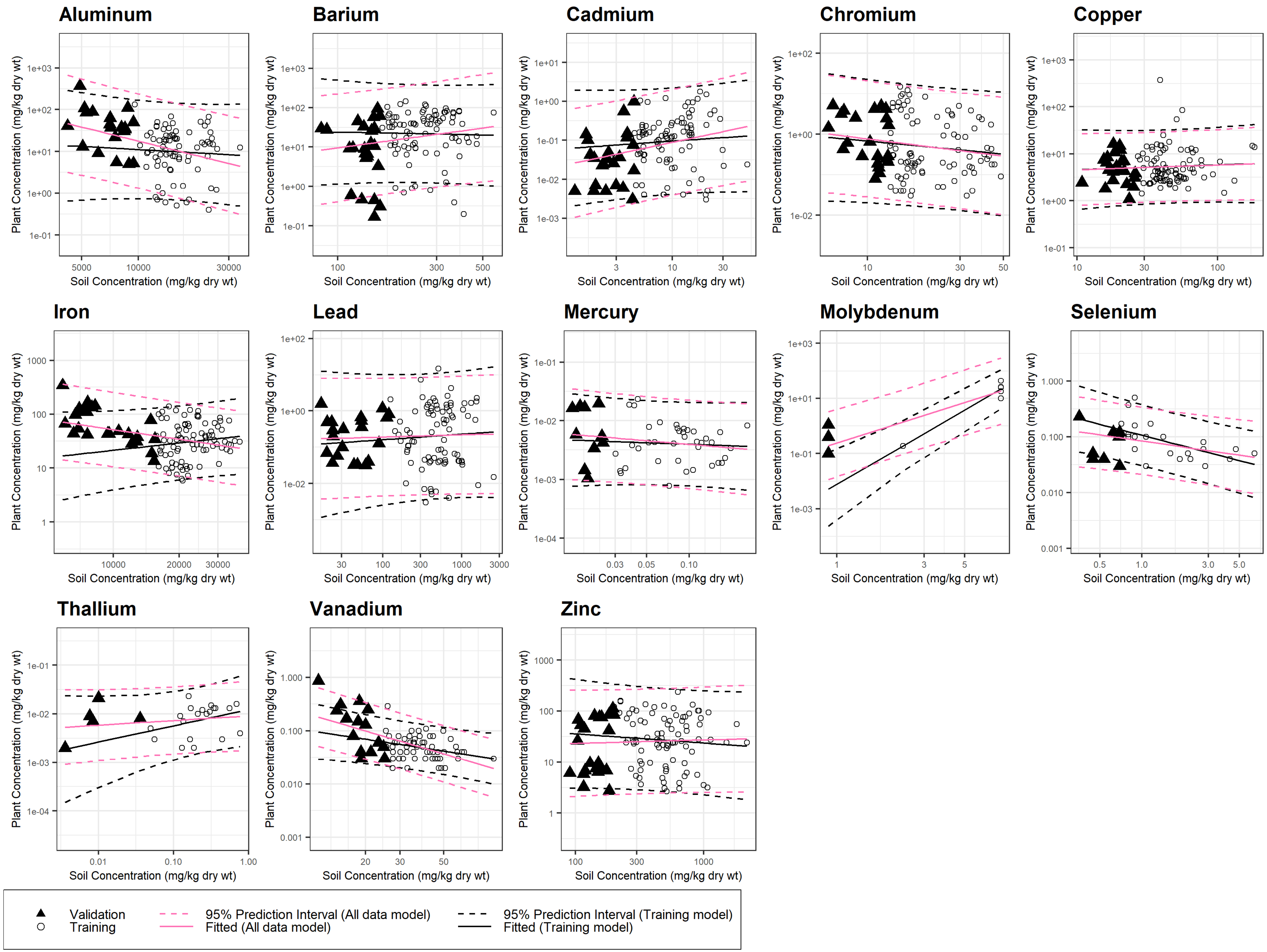

Figure C-7. Truncated (Low) Validation for Aboveground Terrestrial Plant Parts

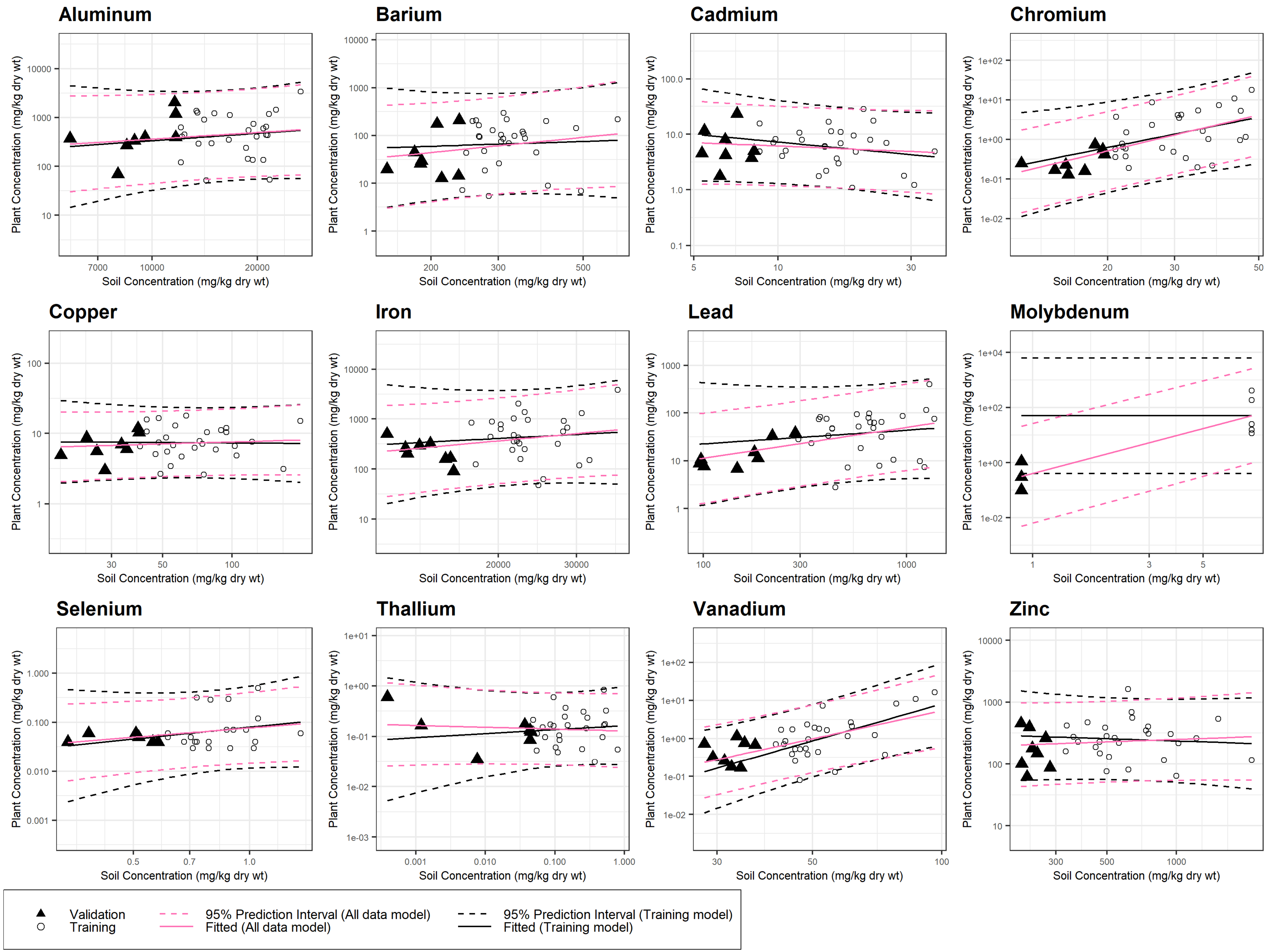

Figure C-8. Truncated (Low) Validation for Belowground Terrestrial Plant Parts

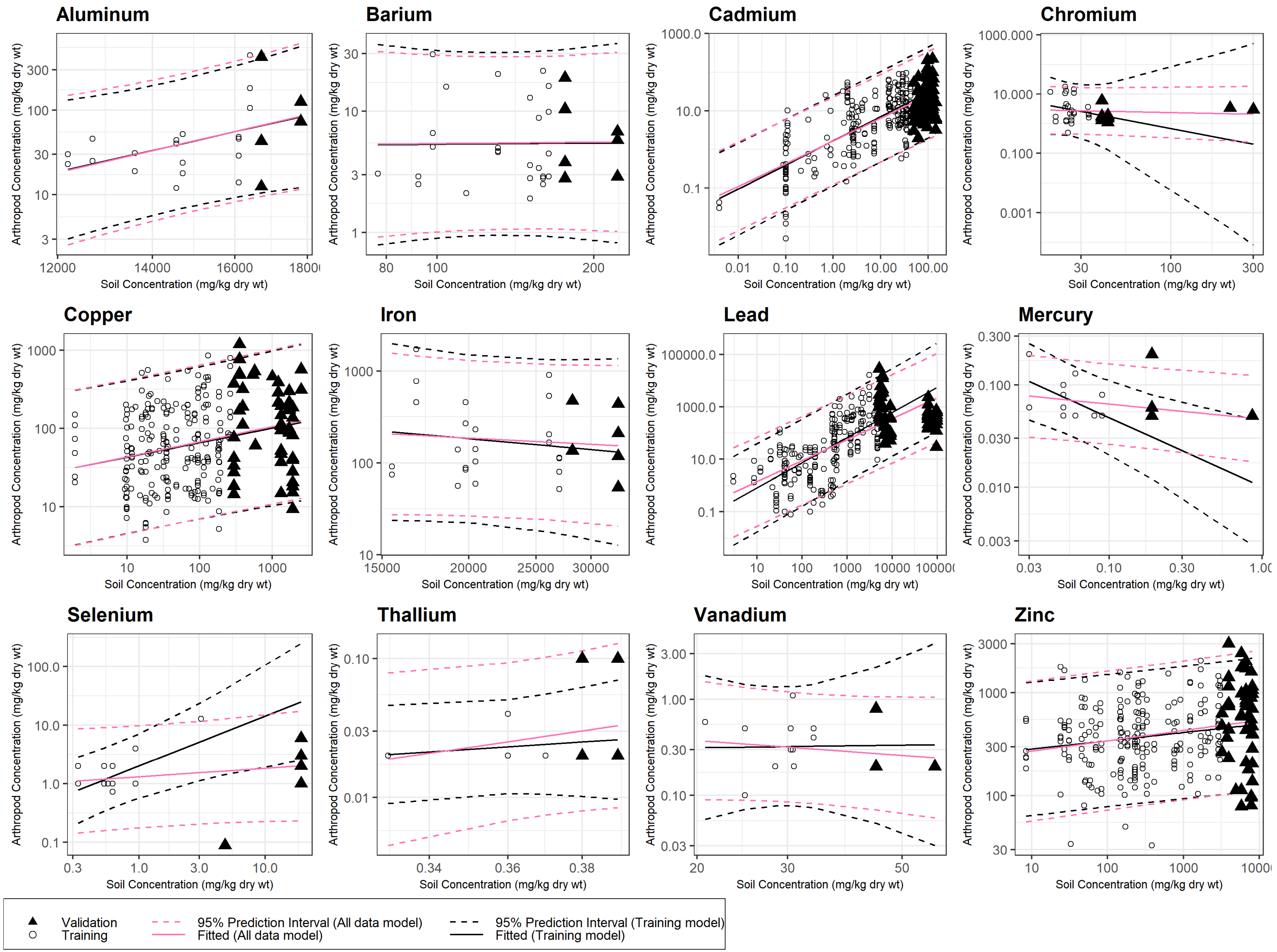

Figure C-9. Truncated (High) Validation for Terrestrial Arthropods

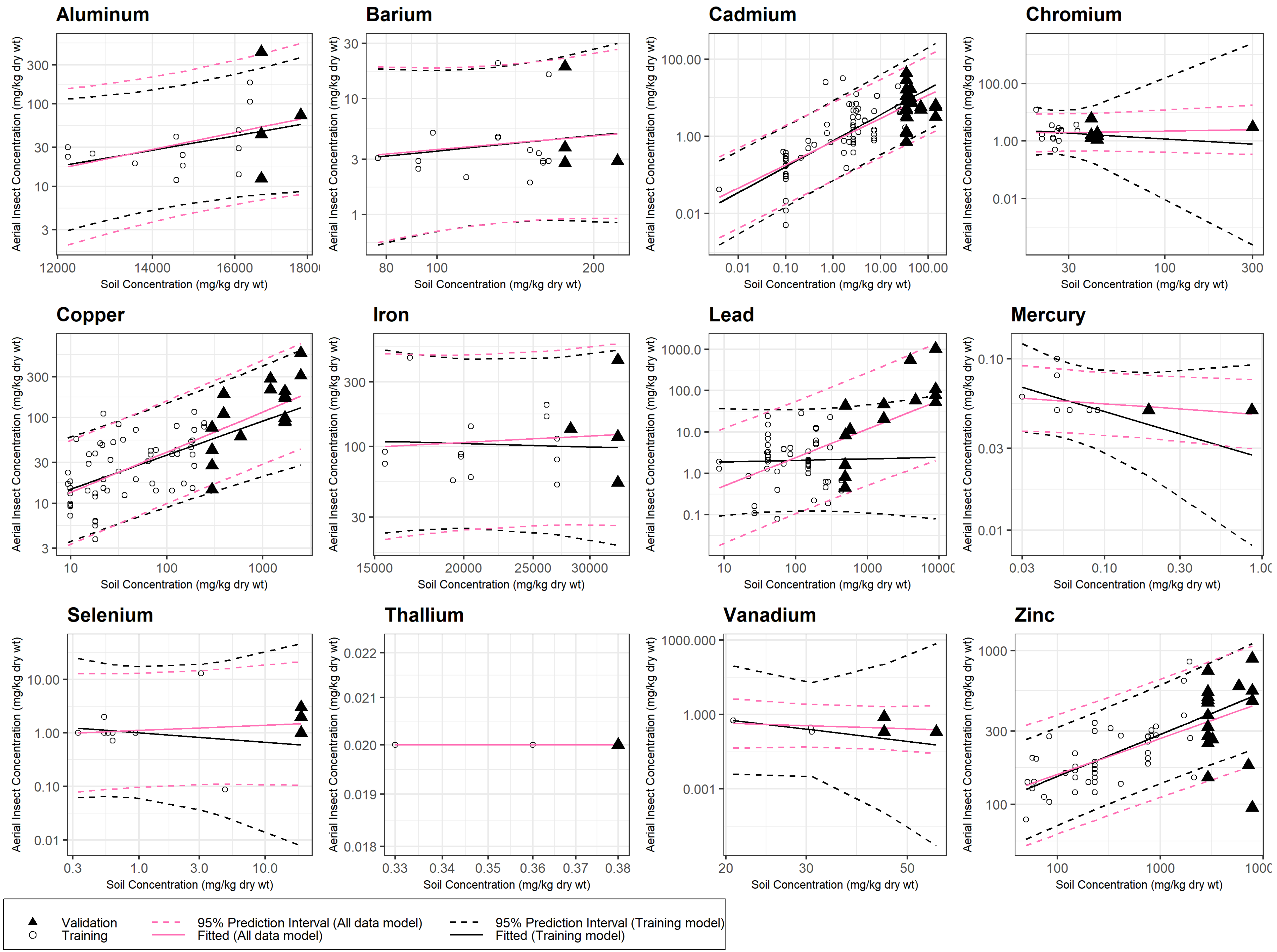

Figure C-10. Truncated (High) Validation for Aerial Insects

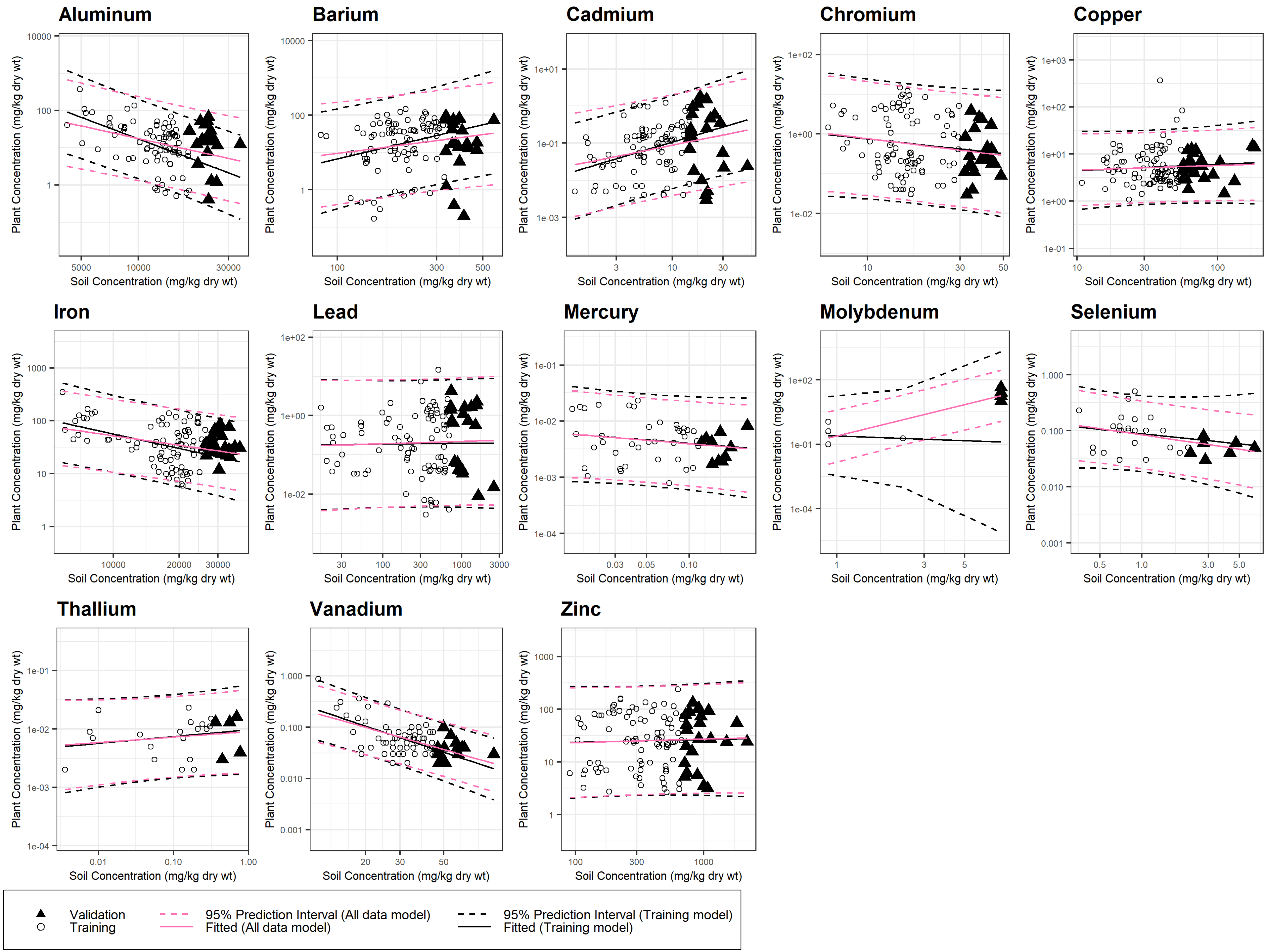

Figure C-11. Truncated (High) Validation for Aboveground Terrestrial Plant Parts

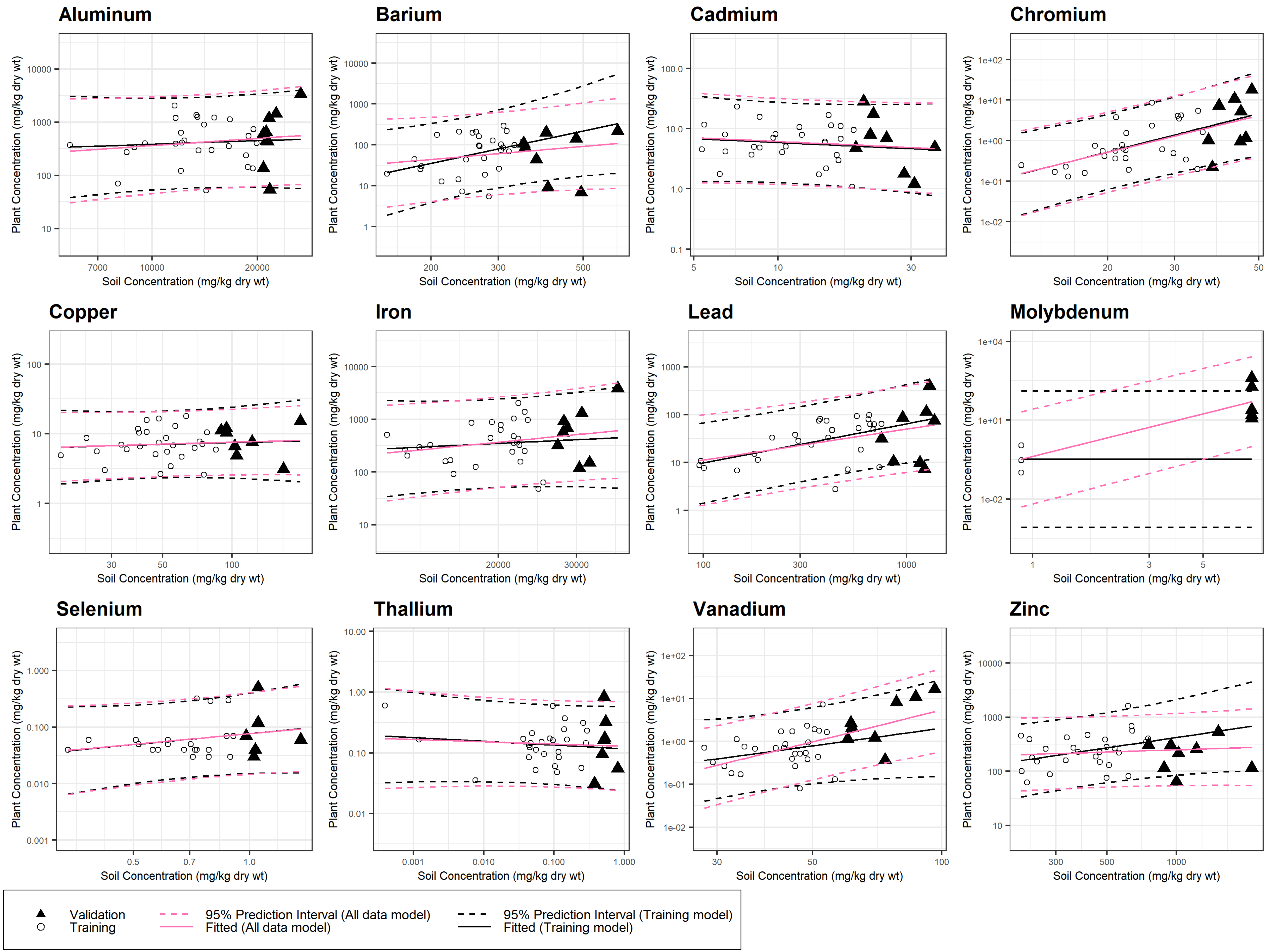

Figure C-12. Truncated (High) Validation for Belowground Terrestrial Plant Parts

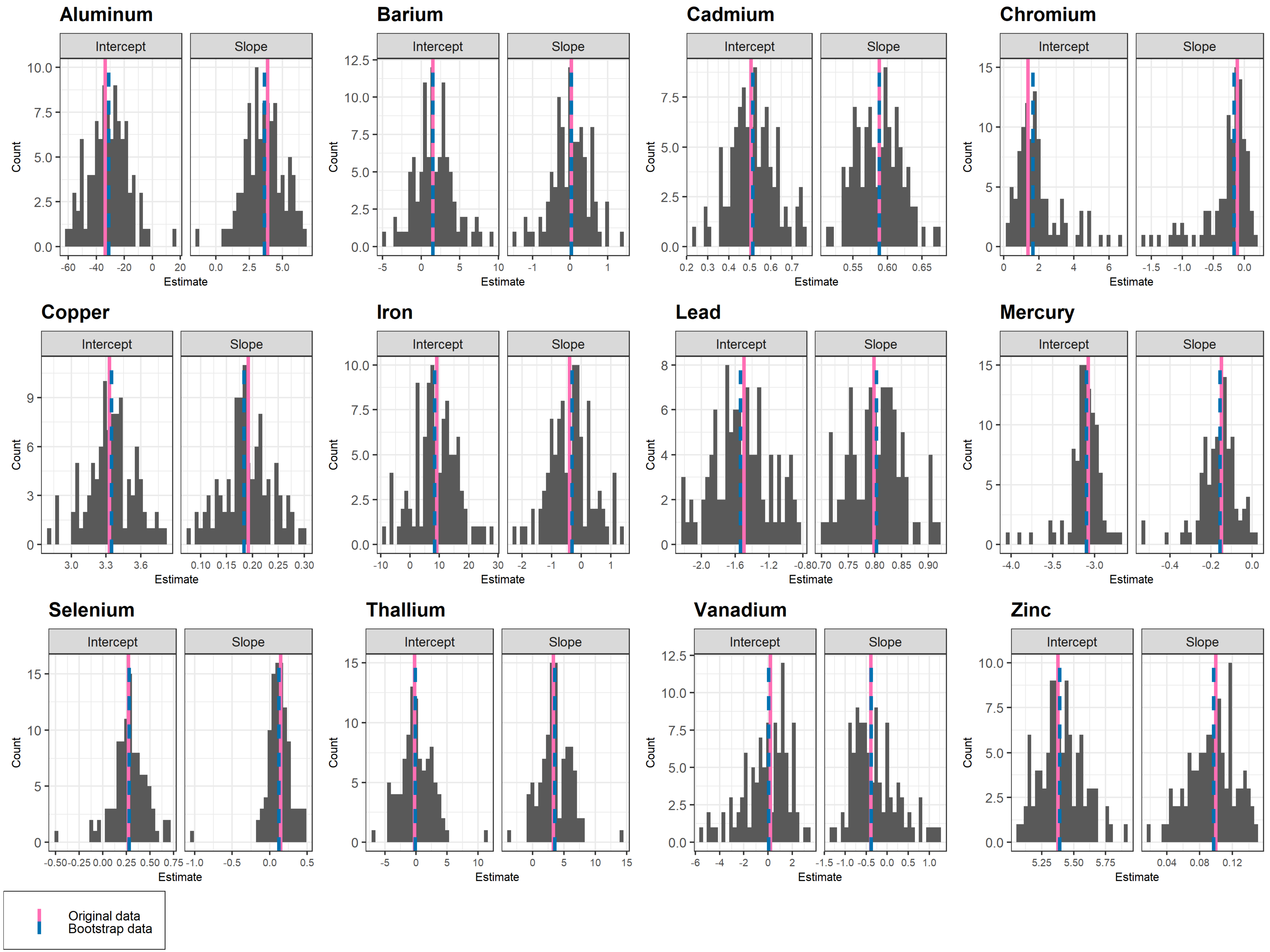

Figure C-13. Bootstrap Regression Model Parameter Estimates for Terrestrial Arthropods

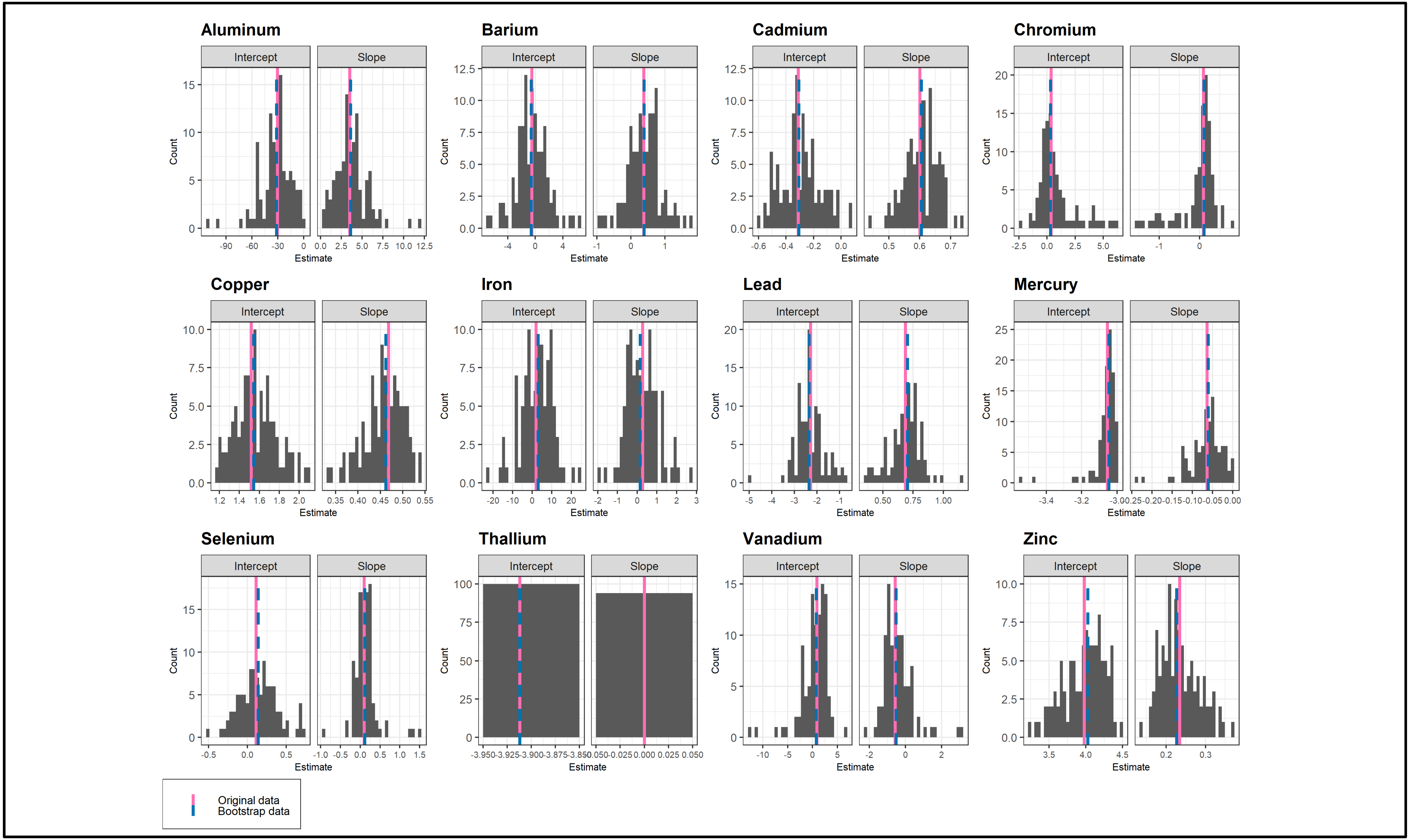

Figure C-15. Bootstrap Regression Model Parameter Estimates for Aerial Insects

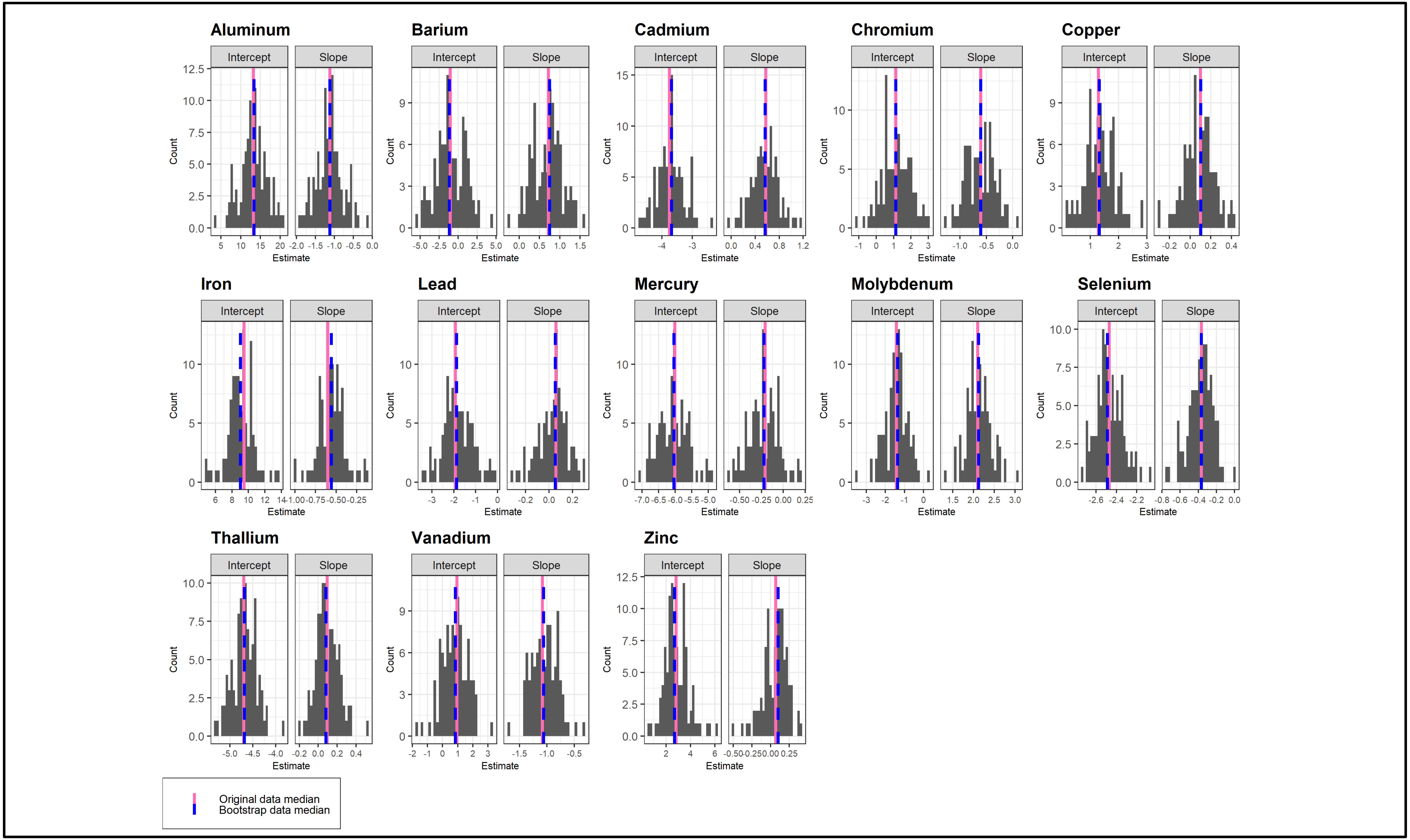

Figure C-15. Bootstrap Regression Model Parameter Estimates for Aboveground Terrestrial Plant Parts

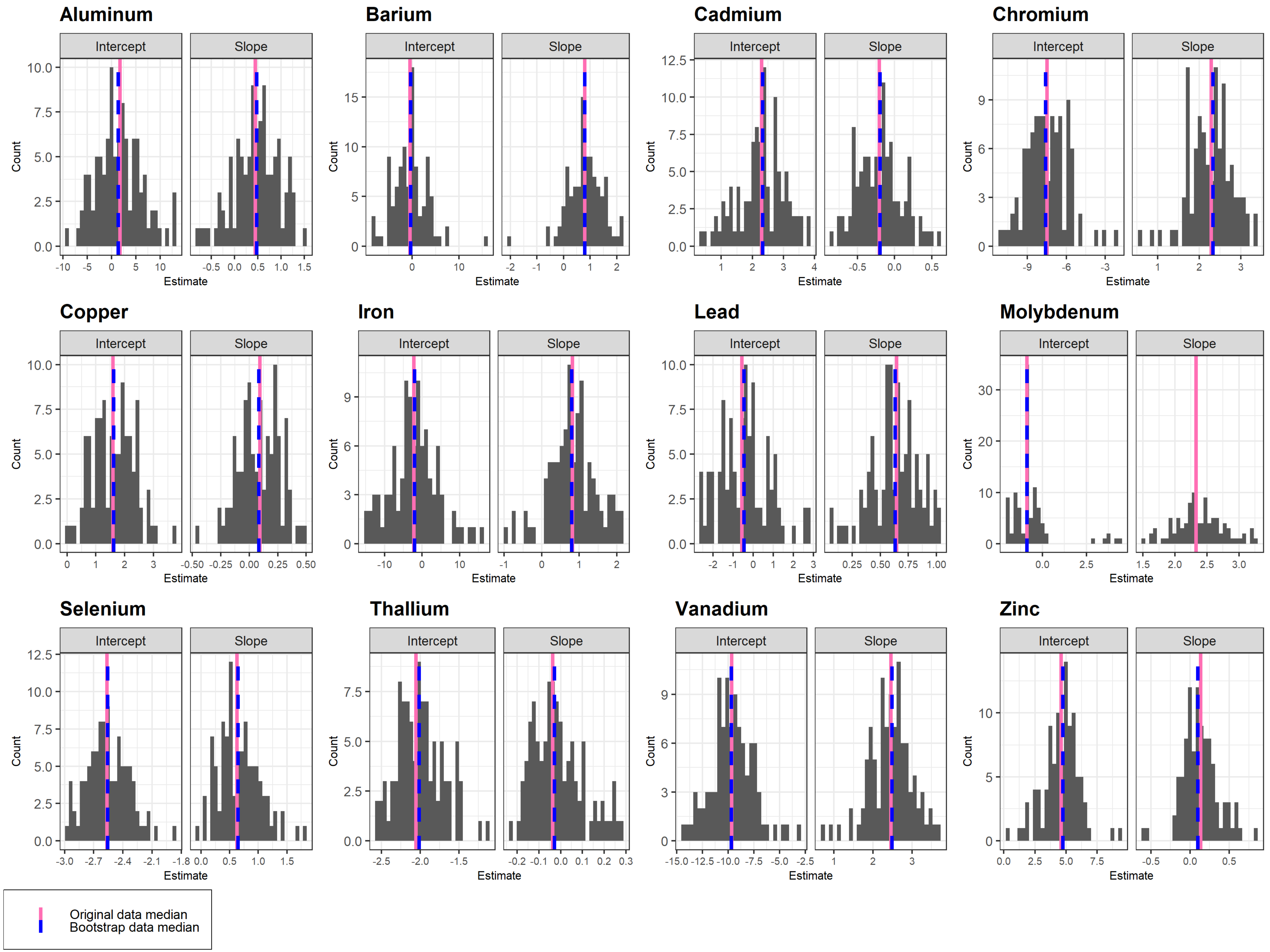

Figure C-16. Bootstrap Regression Model Parameter Estimates for Belowground Terrestrial Plant Parts

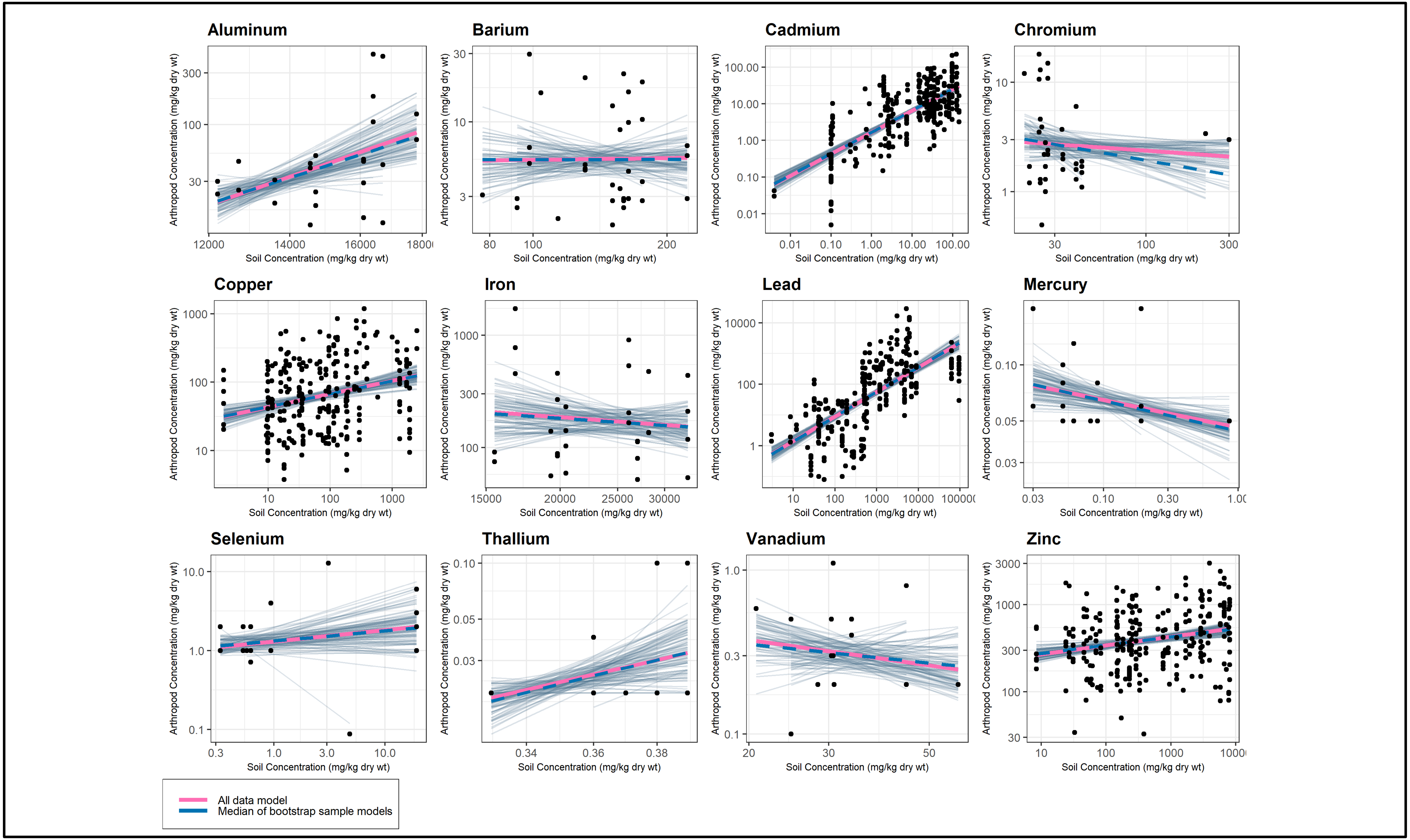

Figure C-17. Bootstrap Regression Model Fits for Terrestrial Arthropods

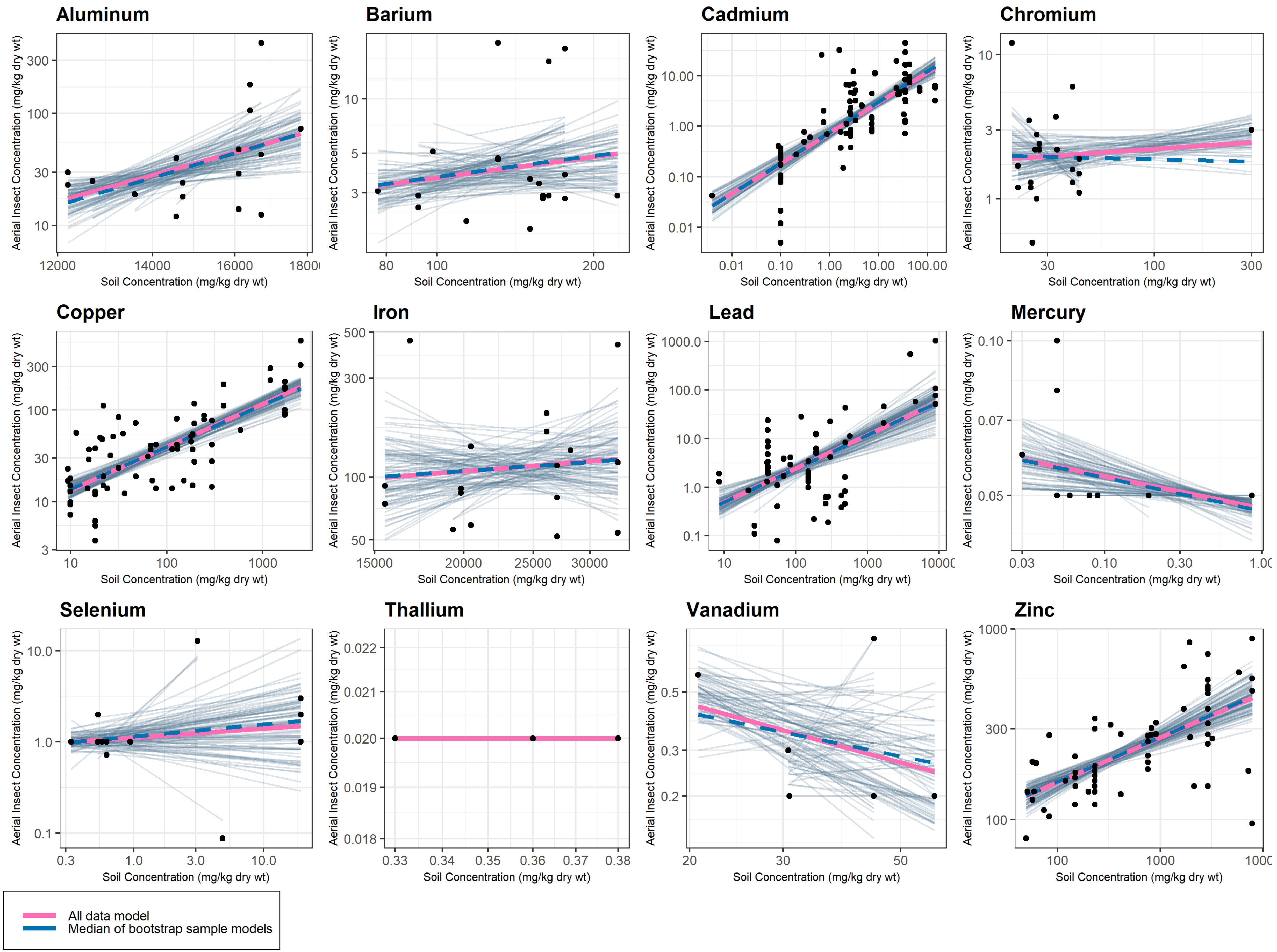

Figure C-18. Bootstrap Regression Model Fits for Aerial Insects

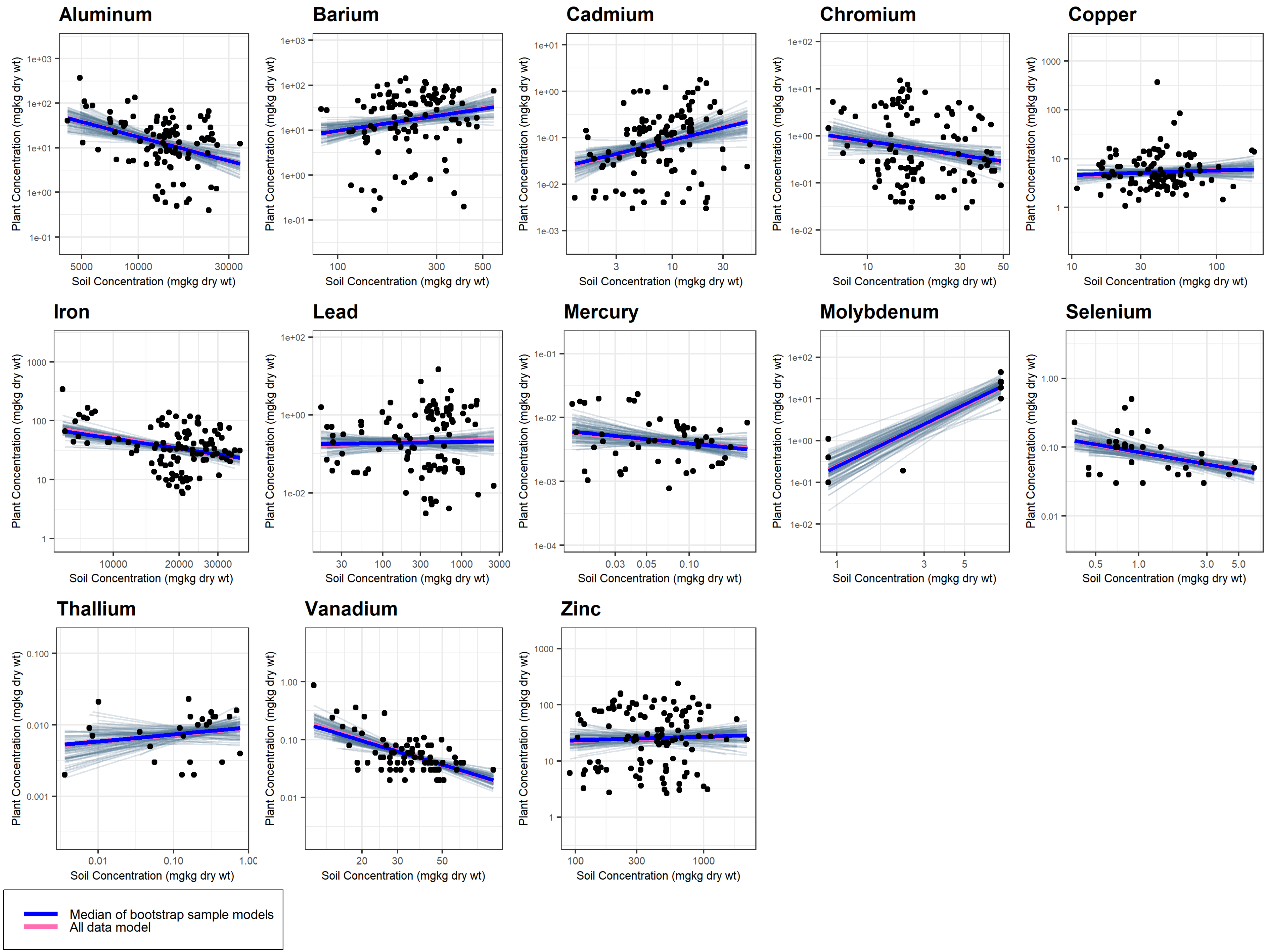

Figure C-19. Bootstrap Regression Model Fits for Aboveground Terrestrial Plant Parts

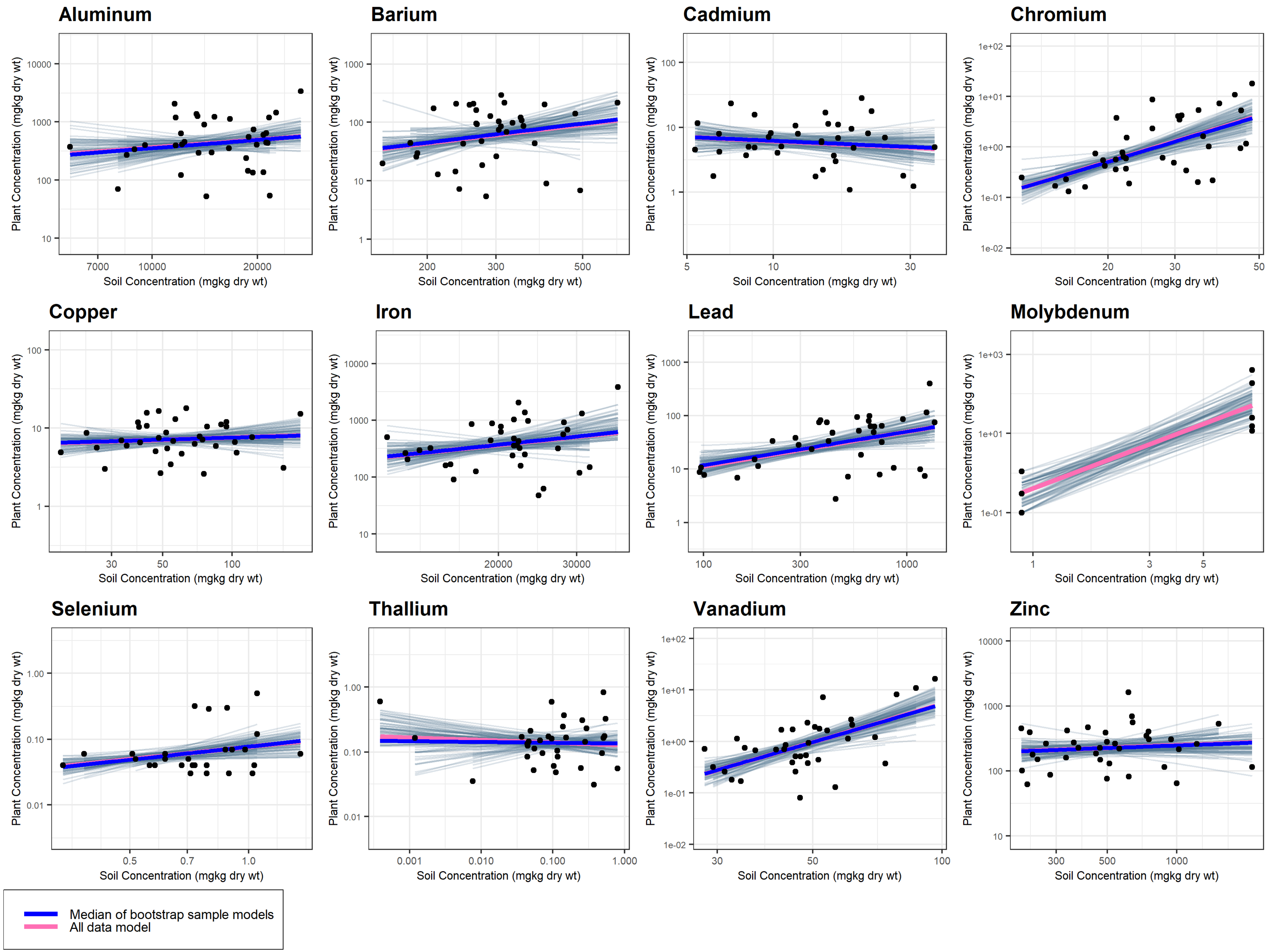

Figure C-20. Bootstrap Regression Model Fits for Belowground Terrestrial Plant Parts

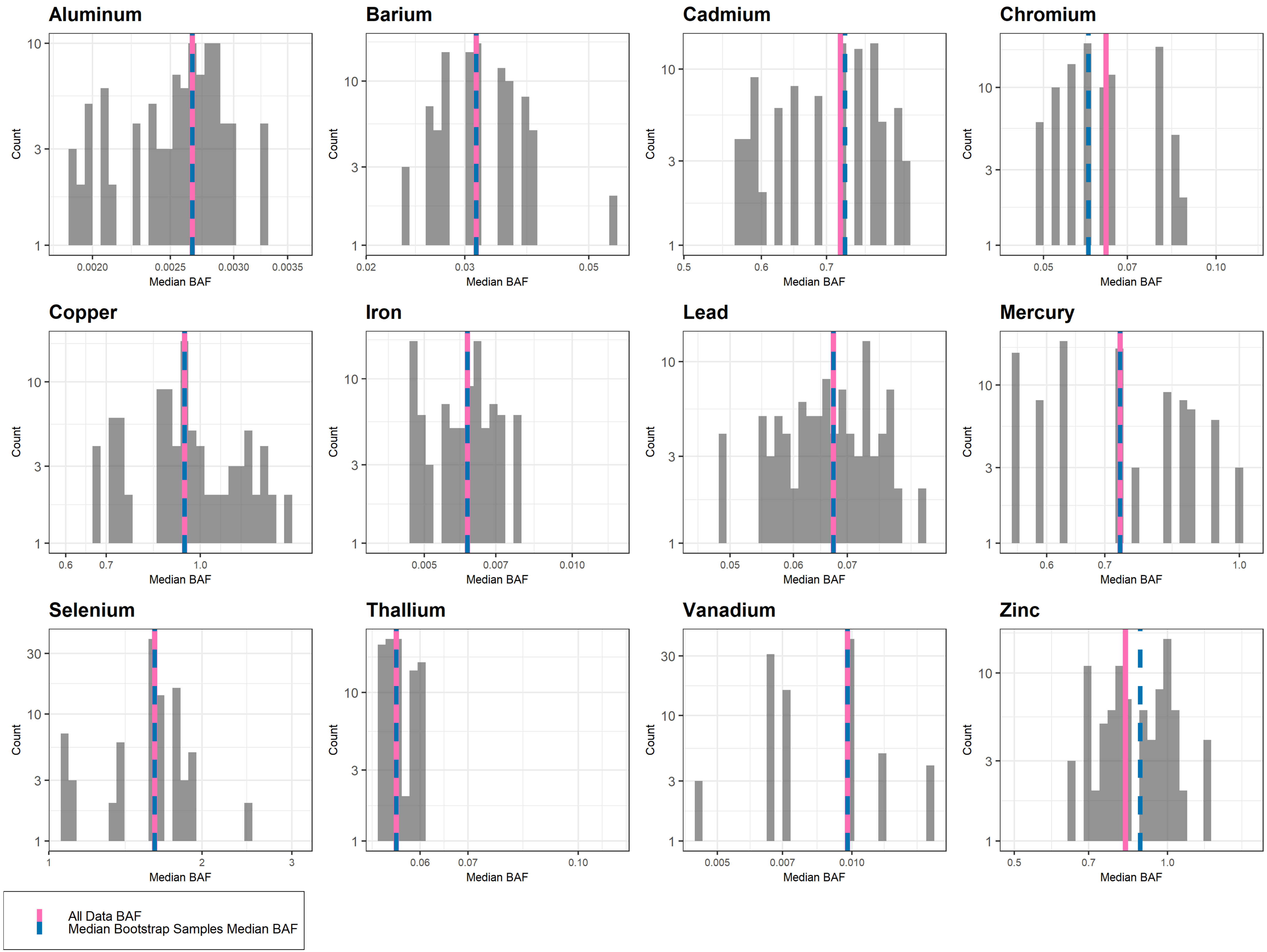

Figure C-21. Bootstrap Median BAF Estimates for Terrestrial Arthropods

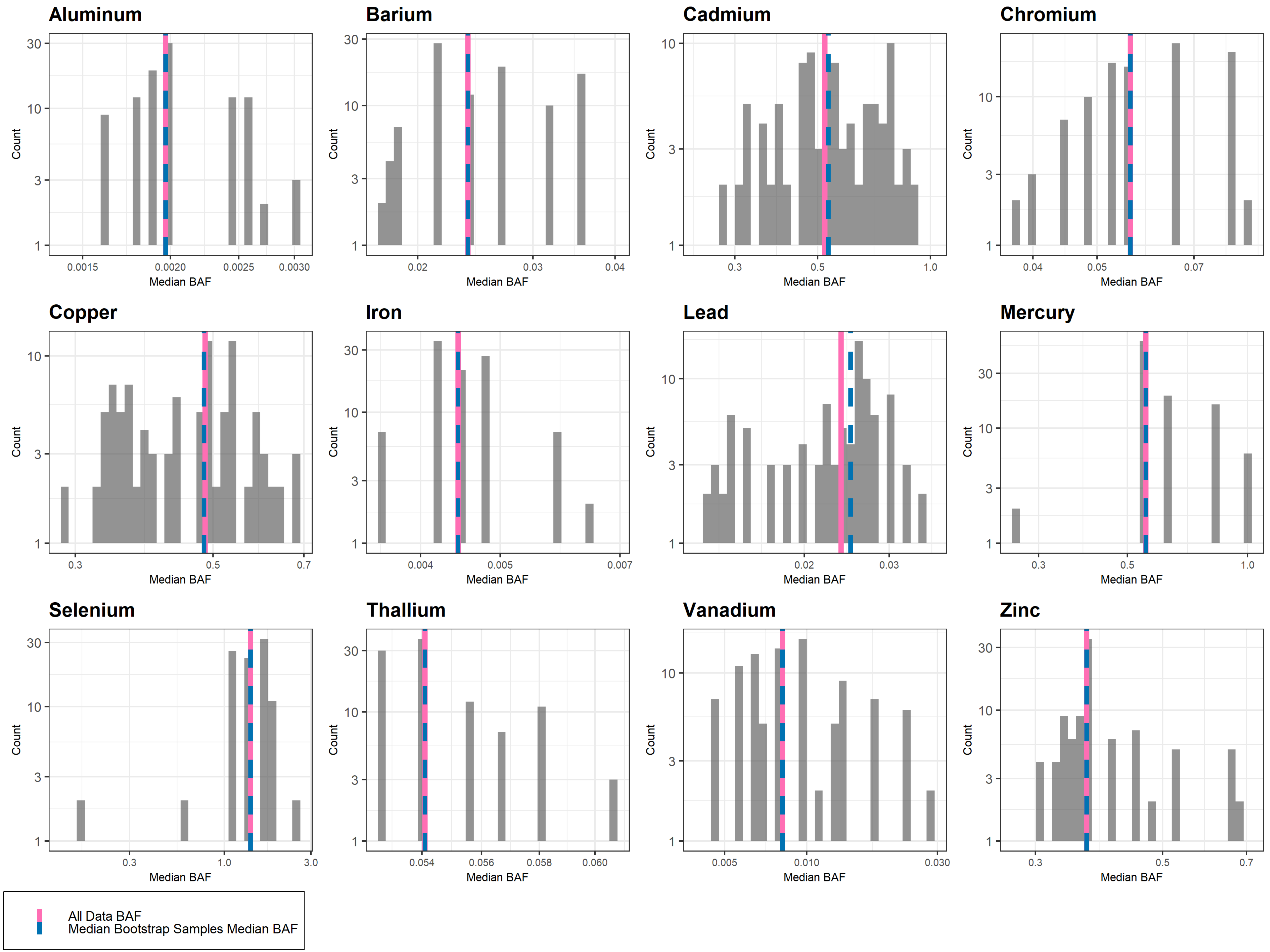

Figure C-22. Bootstrap Median BAF Estimates for Aerial Insects

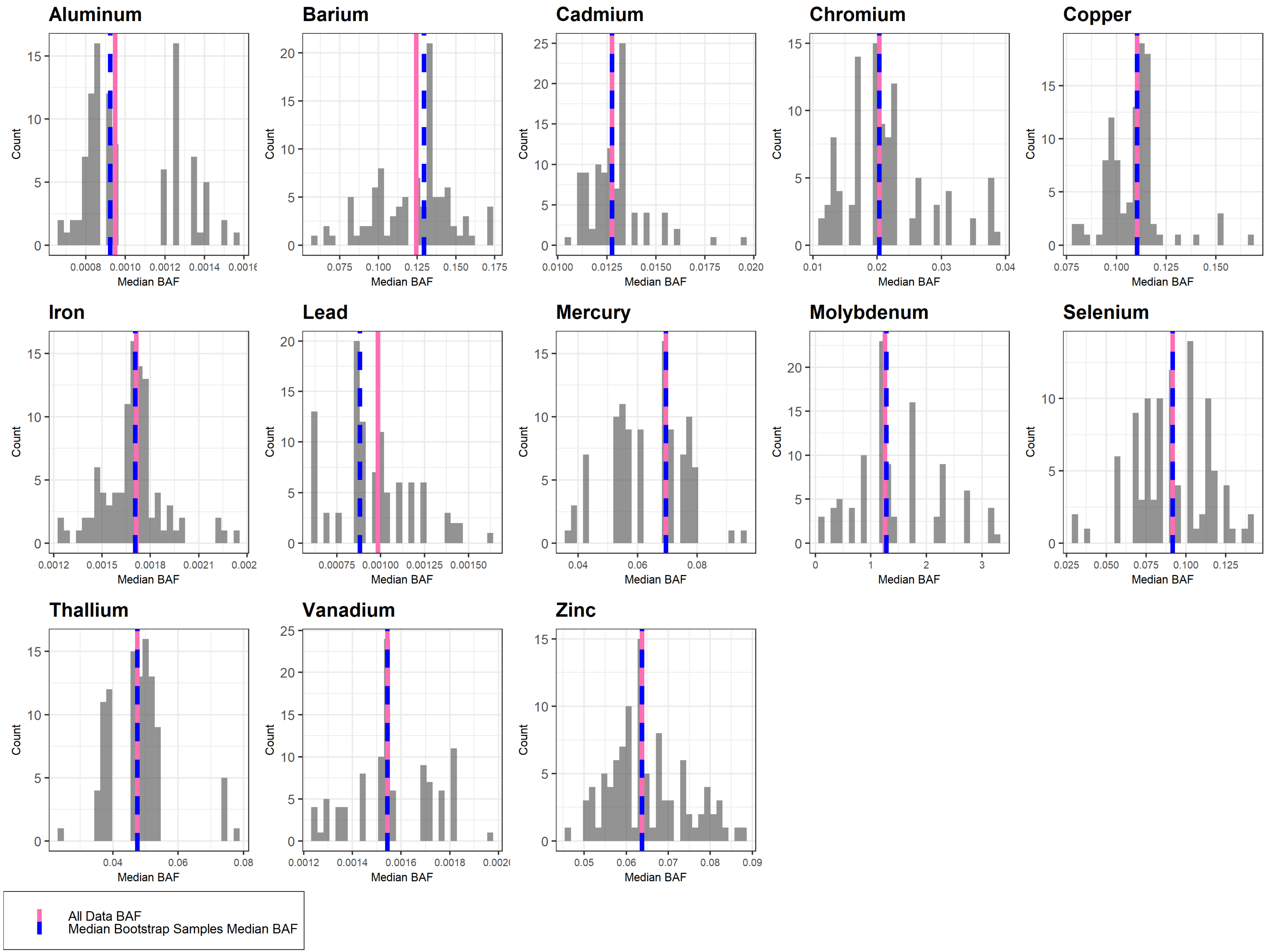

Figure C-23. Bootstrap Median BAF Estimates for Aboveground Terrestrial Plant Parts

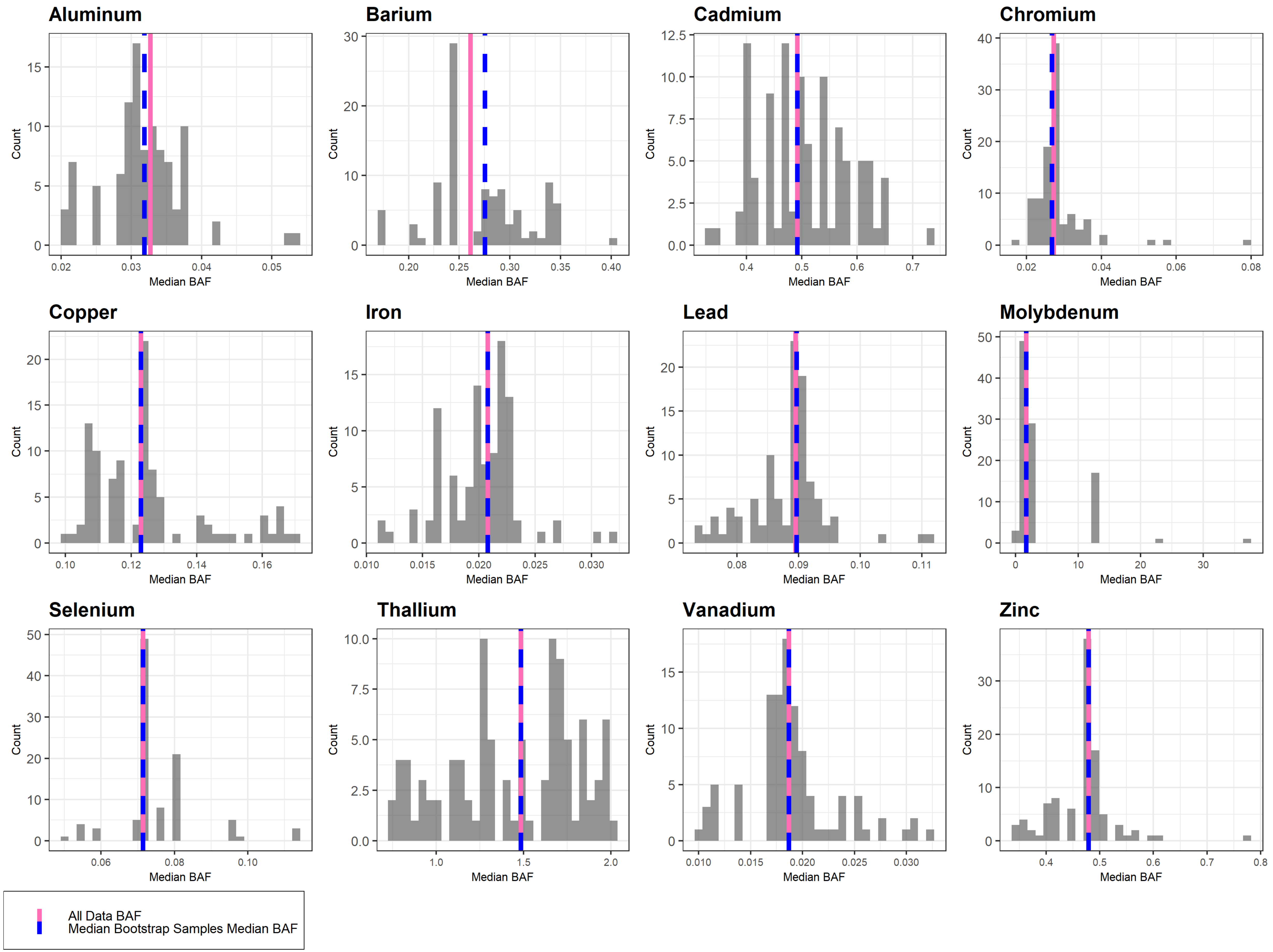

Figure C-24. Bootstrap Median BAF Estimates for Belowground Terrestrial Plant Parts

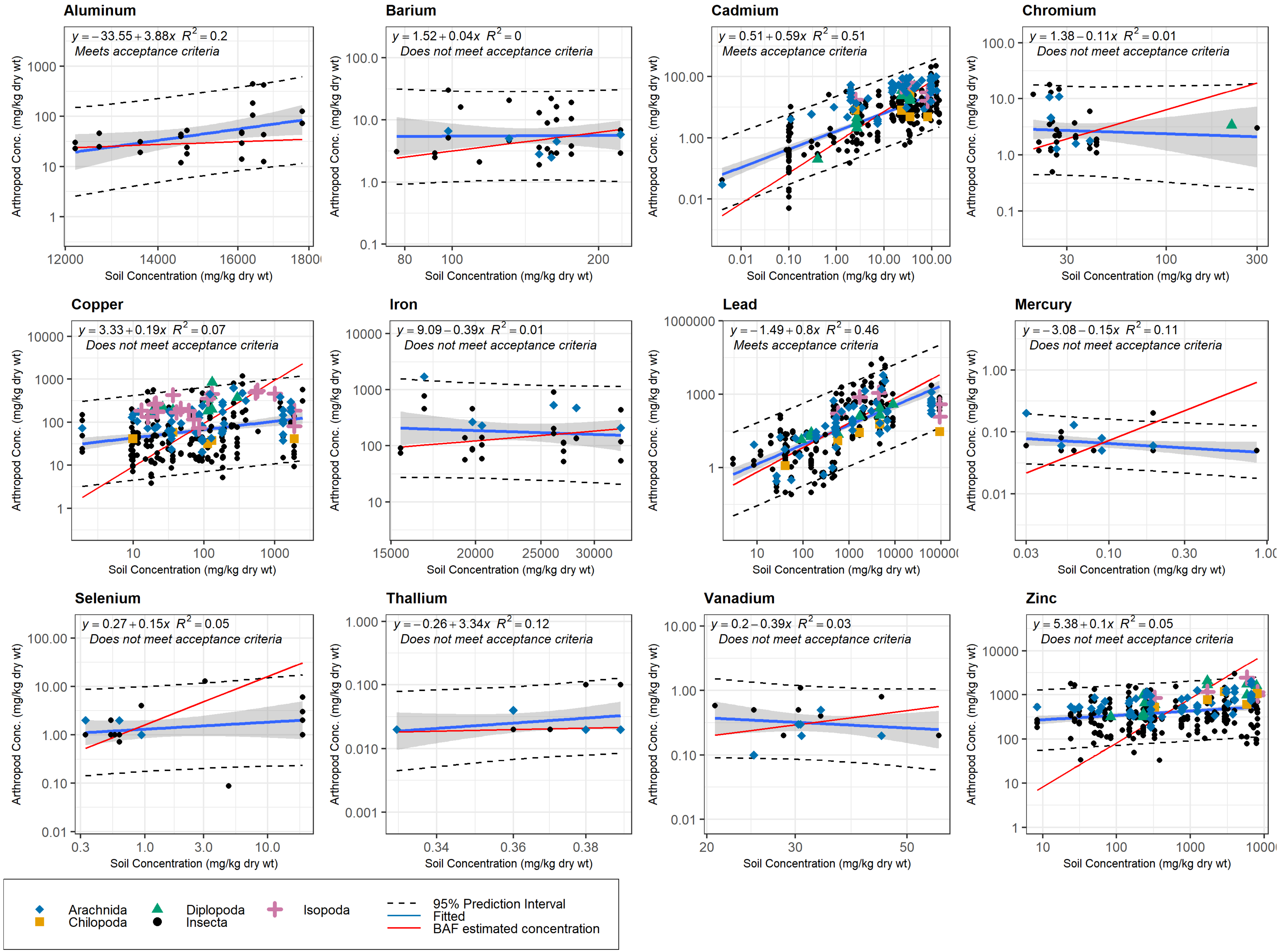

Figure C-25. Regression Models using All Data for Terrestrial Arthropods

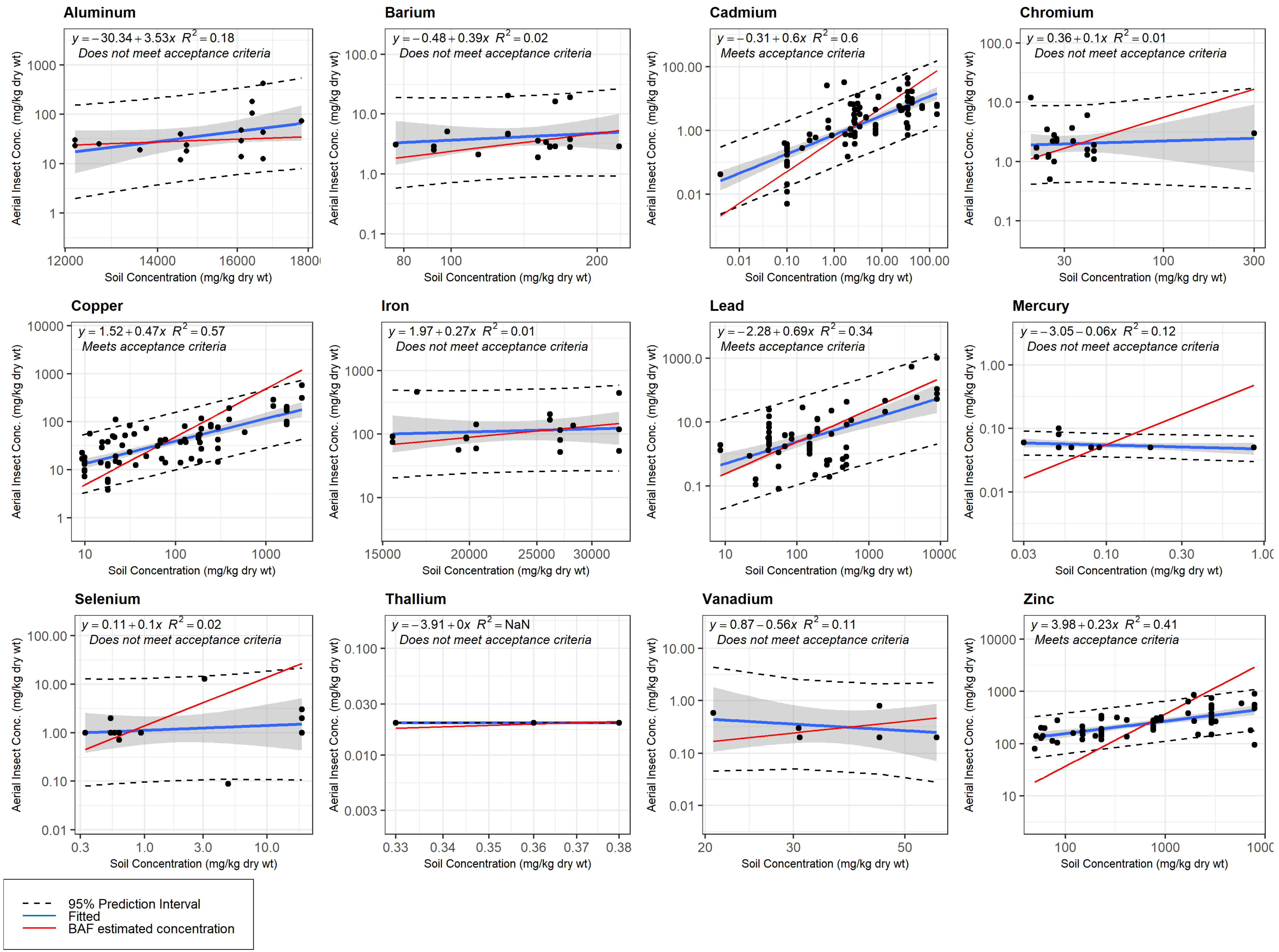

Figure C-26. Regression Models Using All Data for Aerial Insects

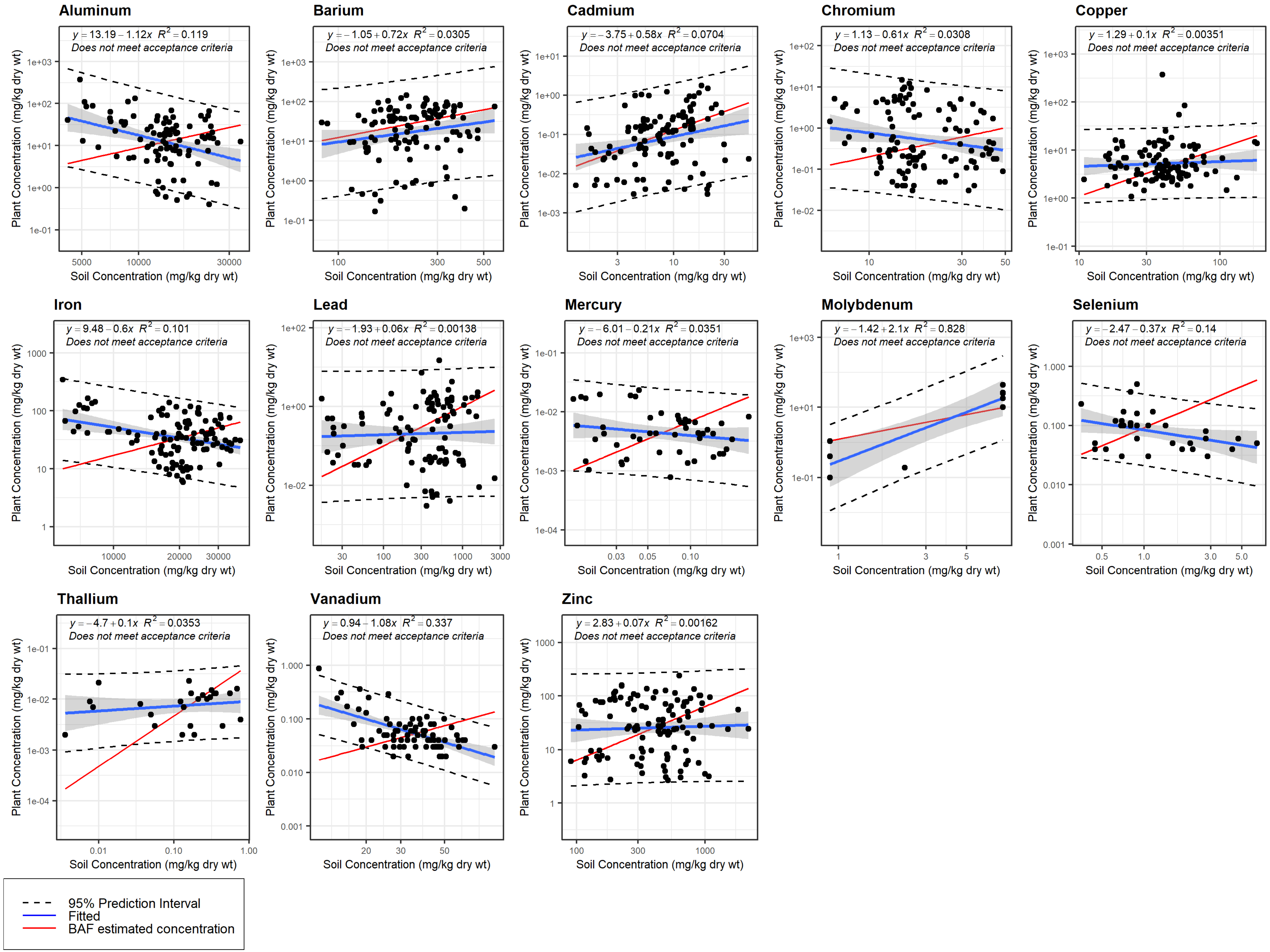

Figure C-27. Regression Models Using All Data for Aboveground Terrestrial Plant Parts-

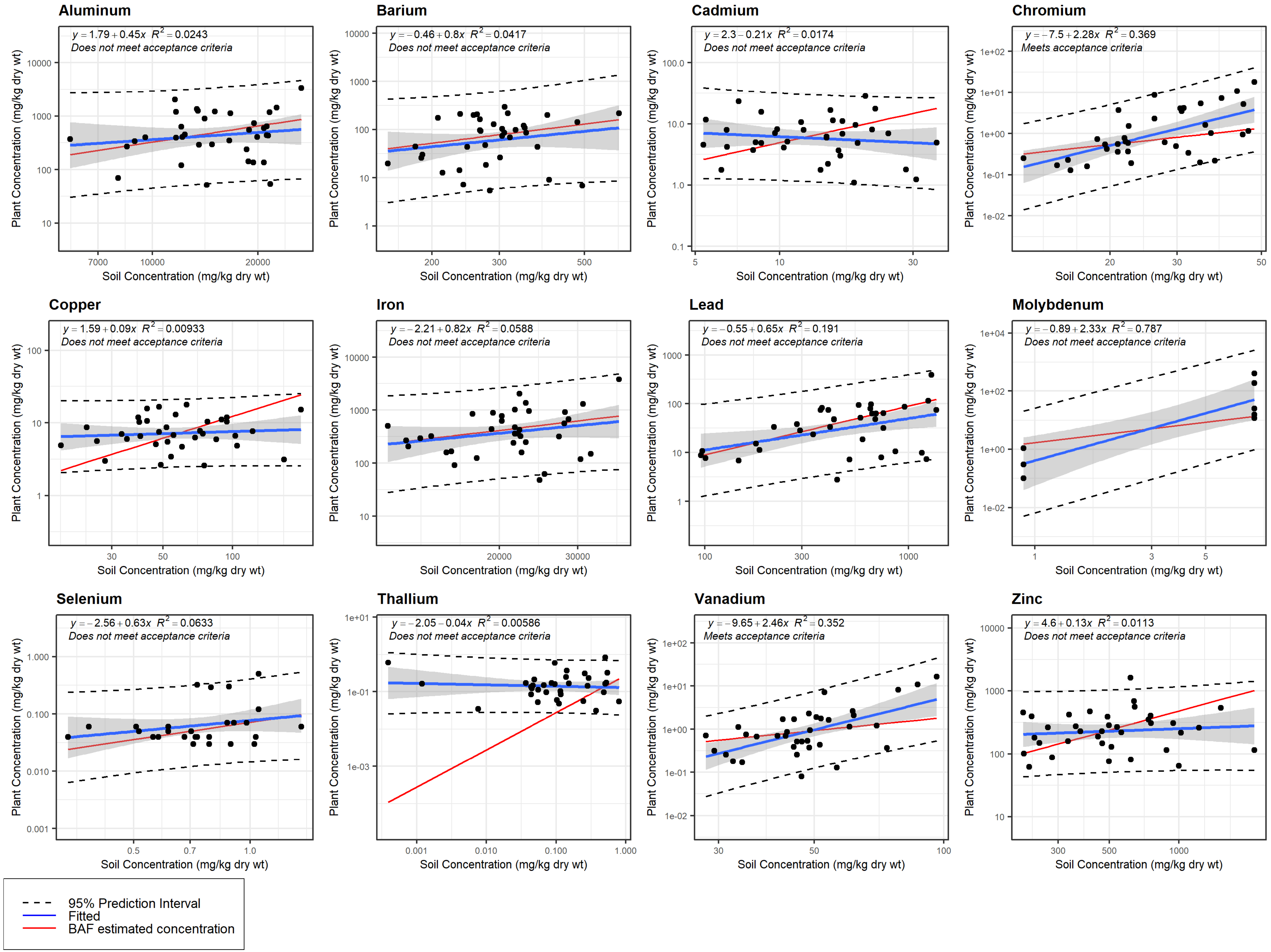

Figure C-28. Regression Models Using All Data for Belowground Terrestrial Plant Parts

TABLES

Table C-1. Available Bioaccumulation Models and/or Data from Ranked Sources

Dietary COPC for Birds and/or Mammals	Ranked Sources for Models and/or Data			
	1. Site-Specific (2018 Plant Tissue Study) [a]	2. Oak Ridge National Laboratory Reports (Bechtel 1998; Sample et al. 1998a,b)	3. USACHPPM (2004) Raw Database (see Appendix C)	4. Other Peer-Reviewed Literature
Terrestrial Plant Prey - Aboveground Plant Parts				
Aluminum	data available (N = 99)	NA	NA	NA
Barium	data available (N = 112)	NA	NA	NA
Cadmium	data available (N = 111)	NA	NA	NA
Chromium	data available (N = 109)	NA	NA	NA
Copper	data available (N = 112)	NA	NA	NA
Iron	data available (N = 112)	NA	NA	NA
Lead	data available (N = 105)	NA	NA	NA
Mercury	data available (N = 49)	NA	NA	NA
Molybdenum	no model or data available	no model or data available	data available (N = 10)	NA
Selenium	data available (N = 32)	NA	NA	NA
Thallium	data available (N = 45)	NA	NA	NA
Vanadium	data available (N = 73)	NA	NA	NA
Zinc	data available (N = 112)	NA	NA	NA
Terrestrial Plant Prey- Belowground Plant Parts				
Aluminum	data available (N = 36)	NA	NA	NA
Barium	data available (N = 36)	NA	NA	NA
Cadmium	data available (N = 36)	NA	NA	NA
Chromium	data available (N = 36)	NA	NA	NA
Copper	data available (N = 36)	NA	NA	NA
Iron	data available (N = 36)	NA	NA	NA
Lead	data available (N = 36)	NA	NA	NA
Mercury	surrogate data available (N = 49) b	NA	NA	NA
Molybdenum	no model or data available	no model or data available	data available (N = 8)	NA
Selenium	data available (N = 27)	NA	NA	NA
Thallium	data available (N = 36)	NA	NA	NA
Vanadium	data available (N = 36)	NA	NA	NA
Zinc	data available (N = 36)	NA	NA	NA

Table C-1. Available Bioaccumulation Models and/or Data from Ranked Sources

Dietary COPC for Birds and/or Mammals	Ranked Sources for Models and/or Data			
	1. Site-Specific (2018 Plant Tissue Study) [a]	2. Oak Ridge National Laboratory Reports (Bechtel 1998; Sample et al. 1998a,b)	3. USACHPPM (2004) Raw Database (see Appendix C)	4. Other Peer-Reviewed Literature
Terrestrial Arthropod Prey				
Aluminum	no model or data available	no model or data available	data available (N = 24)	NA
Barium	no model or data available	no model or data available	data available (N = 33)	NA
Cadmium	no model or data available	no model or data available	data available (N = 299)	NA
Chromium	no model or data available	no model or data available	data available (N = 35)	NA
Copper	no model or data available	no model or data available	data available (N = 274)	NA
Iron	no model or data available	no model or data available	data available (N = 30)	NA
Lead	no model or data available	no model or data available	data available (N = 268)	NA
Mercury	no model or data available	no model or data available	data available (N = 30)	NA
Molybdenum	no model or data available	no model or data available	no model or data available	model available
Selenium	no model or data available	no model or data available	data available (N = 22)	NA
Thallium	no model or data available	no model or data available	data available (N = 14)	NA
Vanadium	no model or data available	no model or data available	data available (N = 19)	NA
Zinc	no model or data available	no model or data available	data available (N = 258)	NA
Flying Insect Prey				
Aluminum	no model or data available	no model or data available	data available (N = 17)	NA
Barium	no model or data available	no model or data available	data available (N = 19)	NA
Cadmium	no model or data available	no model or data available	data available (N = 94)	NA
Chromium	no model or data available	no model or data available	data available (N = 21)	NA
Copper	no model or data available	no model or data available	data available (N = 78)	NA
Iron	no model or data available	no model or data available	data available (N = 17)	NA
Lead	no model or data available	no model or data available	data available (N = 64)	NA
Mercury	no model or data available	no model or data available	data available (N = 17)	NA
Molybdenum	no model or data available	no model or data available	no model or data available	model available
Selenium	no model or data available	no model or data available	data available (N = 14)	NA
Thallium	no model or data available	no model or data available	data available (N = 4)	NA
Vanadium	no model or data available	no model or data available	data available (N = 6)	NA
Zinc	no model or data available	no model or data available	data available (N = 60)	NA

Table C-1. Available Bioaccumulation Models and/or Data from Ranked Sources

Dietary COPC for Birds and/or Mammals	Ranked Sources for Models and/or Data			
	1. Site-Specific (2018 Plant Tissue Study) [a]	2. Oak Ridge National Laboratory Reports (Bechtel 1998; Sample et al. 1998a,b)	3. USACHPPM (2004) Raw Database (see Appendix C)	4. Other Peer-Reviewed Literature
Earthworm Prey				
Aluminum	no model or data available	model available	NA	NA
Barium	no model or data available	model available	NA	NA
Cadmium	no model or data available	model available	NA	NA
Chromium	no model or data available	model available	NA	NA
Copper	no model or data available	model available	NA	NA
Iron	no model or data available	model available	NA	NA
Lead	no model or data available	model available	NA	NA
Mercury	no model or data available	model available	NA	NA
Molybdenum	no model or data available	model available	NA	NA
Selenium	no model or data available	model available	NA	NA
Thallium	no model or data available	no model or data available	no model or data available	no model or data available
Vanadium	no model or data available	model available	NA	NA
Zinc	no model or data available	model available	NA	NA
Small Mammal and Ungulate Prey				
Aluminum	no model or data available	model available	NA	NA
Barium	no model or data available	model available	NA	NA
Cadmium	no model or data available	model available	NA	NA
Chromium	no model or data available	model available	NA	NA
Copper	no model or data available	model available	NA	NA
Iron	no model or data available	model available	NA	NA
Lead	no model or data available	model available	NA	NA
Mercury	no model or data available	model available	NA	NA
Molybdenum	no model or data available	no model or data available	no model or data available	no model or data available
Selenium	no model or data available	model available	NA	NA
Thallium	no model or data available	model available	NA	NA

Table C-1. Available Bioaccumulation Models and/or Data from Ranked Sources

Dietary COPC for Birds and/or Mammals	Ranked Sources for Models and/or Data			
	1. Site-Specific (2018 Plant Tissue Study) [a]	2. Oak Ridge National Laboratory Reports (Bechtel 1998; Sample et al. 1998a,b)	3. USACHPPM (2004) Raw Database (see Appendix C)	4. Other Peer-Reviewed Literature
Small Mammal and Ungulate Prey (continued)				
Vanadium	no model or data available	model available	NA	NA
Zinc	no model or data available	model available	NA	NA

Sources: Betchtel Jacobs (1998), Sample et al. (1998a), Sample et. al. (1998b), USACHPPM (U.S. Army Center for Health Promotion and Preventative Medicine) (2004)

Notes

[a] Counts of available data points for the 2018 Plant Tissue Study report the number of detected pairs of data between soil and plant parts. Nondetected results were excluded from the analysis.

[b] Belowground plant samples were not analyzed for mercury, because the highest concentrations were expected in aboveground plant parts (TAI 2019). Aboveground plant parts are thus used as conservative surrogate data for belowground plant parts.

COPC - chemical of potential concern

N - number of data points

NA - not applicable; model was chosen in previous source

Orange highlight indicates that no model or data are available for the given diet type, COPC, and source.

Light green highlight indicates that co-located soil and biota data are available for the given prey type, COPC, and source.

Dark green highlight indicates that a calculated model is available for the given prey type, COPC, and source.

Table C-2. ANCOVA Coefficients for Fines-Bulk Analysis

Term	Estimate	Standard Error	Statistic	p-Value	Statistically Significant
Aluminum					
(intercept)	-0.804	0.440	-1.83	0.0693	no
log(fines)	1.07	0.0455	23.5	6.71e-58	yes
area_idRFA	14.6	6.70	2.17	0.0312	yes
area_idRFB	0.387	6.69	0.0579	0.954	no
area_idRFC	1.69	5.02	0.338	0.736	no
area_idRFD	6.89	3.10	2.22	0.0276	yes
log(Fines):area_idRFA	-1.61	0.786	-2.05	0.0416	yes
log(Fines):area_idRFB	-0.0195	0.728	-0.0268	0.979	no
log(Fines):area_idRFC	-0.157	0.540	-0.290	0.772	no
log(Fines):area_idRFD	-0.769	0.353	-2.18	0.0306	yes
Barium					
(intercept)	-0.773	0.177	-4.37	2.02e-05	yes
log(fines)	1.14	0.0313	36.4	3.72e-87	yes
area_idRFA	5.94	4.78	1.24	0.215	no
area_idRFB	2.19	2.02	1.08	0.280	no
area_idRFC	2.44	1.96	1.24	0.216	no
area_idRFD	1.40	2.15	0.651	0.516	no
log(Fines):area_idRFA	-0.935	0.779	-1.20	0.231	no
log(Fines):area_idRFB	-0.395	0.400	-0.986	0.325	no
log(Fines):area_idRFC	-0.429	0.385	-1.11	0.267	no
log(Fines):area_idRFD	-0.341	0.362	-0.942	0.348	no
Cadmium					
(intercept)	0.429	0.0438	9.80	1.40E-18	yes
log(fines)	0.780	0.0285	27.3	2.07e-67	yes
area_idRFA	-1.57	1.62	-0.967	0.335	no
area_idRFB	-0.152	0.337	-0.449	0.654	no
area_idRFC	1.23	0.954	1.29	0.200	no
area_idRFD	1.01	2.28	0.441	0.660	no
log(Fines):area_idRFA	0.433	0.767	0.564	0.573	no
log(Fines):area_idRFB	0.236	0.391	0.604	0.546	no
log(Fines):area_idRFC	-0.460	0.483	-0.953	0.342	no
log(Fines):area_idRFD	-0.710	1.27	-0.561	0.576	no
Chromium					
(intercept)	-0.347	0.112	-3.11	0.00214	yes
log(fines)	1.10	0.0372	29.6	1.29e-72	yes
area_idRFA	4.49	1.75	2.57	0.0110	yes
area_idRFB	0.464	1.48	0.313	0.754	no
area_idRFC	0.453	2.88	0.157	0.875	no
area_idRFD	4.02	2.40	1.67	0.0957	no

Table C-2. ANCOVA Coefficients for Fines-Bulk Analysis

Term	Estimate	Standard Error	Statistic	p-Value	Statistically Significant
Chromium (continued)					
log(Fines):area_idRFA	-1.26	0.597	-2.12	0.0354	yes
log(Fines):area_idRFB	-0.118	0.462	-0.255	0.799	no
log(Fines):area_idRFC	-0.114	0.913	-0.124	0.901	no
log(Fines):area_idRFD	-1.45	0.857	-1.69	0.0918	no
Copper					
(intercept)	0.647	0.125	5.19	5.52e-07	yes
log(fines)	0.774	0.0406	19.0	9.8e-46	yes
area_idRFA	7.19	2.02	3.55	0.000486	yes
area_idRFB	-0.467	1.32	-0.355	0.723	no
area_idRFC	0.491	1.16	0.424	0.672	no
area_idRFD	-10.4	2.89	-3.62	0.000384	yes
log(Fines):area_idRFA	-1.10	0.425	-2.58	0.0105	yes
log(Fines):area_idRFB	0.220	0.464	0.474	0.636	no
log(Fines):area_idRFC	0.0251	0.251	0.100	0.920	no
log(Fines):area_idRFD	2.87	0.766	3.75	0.000236	yes
Iron					
(intercept)	-2.99	0.583	-5.12	7.42e-07	yes
log(fines)	1.30	0.0596	21.9	1.70E-53	yes
area_idRFA	17.7	3.09	5.72	4.24e-08	yes
area_idRFB	3.25	6.55	0.497	0.620	no
area_idRFC	5.37	7.69	0.698	0.486	no
area_idRFD	-7.88	6.42	-1.23	0.222	no
log(Fines):area_idRFA	-1.64	0.298	-5.49	1.29e-07	yes
log(Fines):area_idRFB	-0.323	0.676	-0.478	0.633	no
log(Fines):area_idRFC	-0.538	0.783	-0.686	0.493	no
log(Fines):area_idRFD	0.790	0.652	1.21	0.227	no
Lead					
(intercept)	0.871	0.143	6.08	6.45e-09	yes
log(fines)	0.839	0.0277	30.3	2.71e-74	yes
area_idRFA	0.552	3.14	0.176	0.861	no
area_idRFB	-0.655	1.35	-0.484	0.629	no
area_idRFC	1.73	1.98	0.873	0.384	no
area_idRFD	5.05	8.72	0.579	0.563	no
log(Fines):area_idRFA	-0.0805	0.524	-0.154	0.878	no
log(Fines):area_idRFB	0.165	0.282	0.584	0.56	no
log(Fines):area_idRFC	-0.230	0.325	-0.709	0.479	no
log(Fines):area_idRFD	-0.865	1.47	-0.589	0.557	no

Table C-2. ANCOVA Coefficients for Fines-Bulk Analysis

Term	Estimate	Standard Error	Statistic	p-Value	Statistically Significant
Mercury					
(intercept)	-0.601	0.158	-3.81	0.000190	yes
log(fines)	0.756	0.0549	13.8	2.94e-30	yes
area_idRFA	-1.24	0.247	-5.00	1.33e-06	yes
area_idRFB	0.829	1.09	0.761	0.448	no
area_idRFC	0.0473	0.693	0.0683	0.946	no
area_idRFD	-0.747	0.598	-1.25	0.213	no
log(Fines):area_idRFA	-0.796	0.172	-4.63	6.82e-06	yes
log(Fines):area_idRFB	0.260	0.329	0.791	0.430	no
log(Fines):area_idRFC	-0.145	0.370	-0.391	0.696	no
log(Fines):area_idRFD	-0.690	0.351	-1.97	0.0506	no
Molybdenum					
(intercept)	0.0942	0.0173	5.44	1.68e-07	yes
log(fines)	1.15	0.0293	39.2	2.10E-92	yes
area_idRFA	2.54	1.62	1.56	0.120	no
area_idRFB	-0.202	0.363	-0.556	0.579	no
area_idRFC	0.0650	0.0929	0.699	0.485	no
area_idRFD	-0.387	0.186	-2.08	0.0391	yes
log(Fines):area_idRFA	-1.44	0.877	-1.65	0.101	no
log(Fines):area_idRFB	-0.746	0.617	-1.21	0.228	no
log(Fines):area_idRFC	-0.703	0.432	-1.63	0.105	no
log(Fines):area_idRFD	-0.258	0.224	-1.15	0.250	no
Selenium					
(intercept)	-0.0767	0.0614	-1.25	0.213	no
log(fines)	0.868	0.0465	18.7	1.02e-44	yes
area_idRFA	0.236	0.211	1.12	0.264	no
area_idRFB	0.757	0.415	1.83	0.0695	no
area_idRFC	0.0726	0.386	0.188	0.851	no
area_idRFD	0.216	0.753	0.286	0.775	no
log(Fines):area_idRFA	-1.11	0.479	-2.31	0.0220	yes
log(Fines):area_idRFB	0.416	0.302	1.38	0.170	no
log(Fines):area_idRFC	-0.170	0.450	-0.378	0.706	no
log(Fines):area_idRFD	0.309	0.730	0.424	0.672	no
Thallium					
(intercept)	-0.339	0.0504	-6.74	1.92e-10	yes
log(fines)	0.796	0.0371	21.5	1.79e-52	yes
area_idRFA	0.454	0.529	0.857	0.392	no
area_idRFB	0.176	0.699	0.252	0.801	no
area_idRFC	-0.0682	0.463	-0.147	0.883	no
area_idRFD	-0.500	0.704	-0.710	0.478	no

Table C-2. ANCOVA Coefficients for Fines-Bulk Analysis

Term	Estimate	Standard Error	Statistic	p-Value	Statistically Significant
Thallium (continued)					
log(Fines):area_idRFA	0.785	0.473	1.66	0.0984	no
log(Fines):area_idRFB	0.108	0.469	0.229	0.819	no
log(Fines):area_idRFC	-0.219	0.400	-0.549	0.584	no
log(Fines):area_idRFD	-0.418	0.646	-0.646	0.519	no
Vanadium					
(intercept)	-0.608	0.159	-3.81	0.000185	yes
log(fines)	1.17	0.0471	24.8	3.81e-61	yes
area_idRFA	2.46	2.28	1.08	0.282	no
area_idRFB	1.64	1.95	0.84	0.402	no
area_idRFC	1.18	2.89	0.407	0.684	no
area_idRFD	-1.61	16.1	-0.100	0.920	no
log(Fines):area_idRFA	-0.698	0.649	-1.07	0.284	no
log(Fines):area_idRFB	-0.451	0.568	-0.795	0.427	no
log(Fines):area_idRFC	-0.308	0.820	-0.375	0.708	no
log(Fines):area_idRFD	0.417	4.74	0.088	0.930	no
Zinc					
(intercept)	0.273	0.216	1.26	0.208	no
log(fines)	0.947	0.0383	24.7	6.67e-61	yes
area_idRFA	14.2	4.53	3.12	0.00207	yes
area_idRFB	-0.730	2.44	-0.299	0.765	no
area_idRFC	1.08	1.91	0.566	0.572	no
area_idRFD	-4.00	1.93	-2.07	0.0402	yes
log(Fines):area_idRFA	-1.69	0.601	-2.81	0.00542	yes
log(Fines):area_idRFB	0.170	0.467	0.364	0.716	no
log(Fines):area_idRFC	-0.150	0.326	-0.459	0.647	no
log(Fines):area_idRFD	0.599	0.283	2.12	0.0357	yes

Notes:

ANCOVA - analysis of covariance

Statistical significance based on p-value < 0.05

Table C-3. Correction Factors for Fines-Bulk Analysis

Analyte	Intercept	Slope	Slope Standard Error	Slope 95% CI Lower Bound	Slope 95% CI Upper Bound	Intercept 95% CI Lower Bound	Intercept 95% CI Upper Bound	p-Value	R^2	Slope = 1	Intercept = 0	Correction Factor Applied
Aluminum	-0.0534	0.995	0.0442	0.907	1.08	-0.894	0.787	< 0.001	0.73	yes	yes	no
Barium	-0.554	1.10	0.0312	1.04	1.16	-0.900	-0.208	< 0.001	0.87	no	no	yes
Cadmium	0.424	0.795	0.0287	0.739	0.852	0.337	0.511	< 0.001	0.80	no	no	yes
Chromium	-0.369	1.11	0.0368	1.04	1.18	-0.588	-0.151	< 0.001	0.83	no	no	yes
Copper	0.212	0.924	0.0337	0.857	0.990	0.00344	0.421	< 0.001	0.80	no	no	yes
Iron	-2.90	1.29	0.0589	1.18	1.41	-4.03	-1.76	< 0.001	0.72	no	no	yes
Lead	0.762	0.863	0.0270	0.810	0.917	0.485	1.04	< 0.001	0.85	no	no	yes
Mercury	-0.442	0.808	0.0466	0.716	0.900	-0.704	-0.180	< 0.001	0.62	no	no	yes
Molybdenum	0.105	1.14	0.0299	1.08	1.20	0.0703	0.139	< 0.001	0.89	no	no	yes
Selenium	-0.0333	0.891	0.0461	0.800	0.982	-0.152	0.0855	< 0.001	0.67	no	yes	yes
Thallium	-0.320	0.805	0.0373	0.731	0.878	-0.420	-0.220	< 0.001	0.71	no	no	yes
Vanadium	-0.630	1.18	0.0474	1.08	1.27	-0.947	-0.313	< 0.001	0.77	no	no	yes
Zinc	0.278	0.948	0.0382	0.873	1.02	-0.146	0.703	< 0.001	0.77	yes	yes	no

Notes:

CI - confidence interval

Table C-4. Identification of Non-Larval Aerial Insect Data Points from Terrestrial Arthropod Data in USACHPPM (2004) Database

Taxa Information as Provided in USACHPPM (2004) Database						
Order	Family	Species	Common Name	Number of Data Points in Database	Included in Aerial Insect Data Set?	Notes
Arachnida						
Araneae	nd	*Alopecosa cuneata*	wolf spider	4	no	NA
Araneae	nd	*Alopecosa trabalis*	wolf spider	16	no	NA
Araneae	nd	*Amaurobius obustus*	wolf spider	4	no	NA
Araneae	nd	*Gonatium rubidium*	lace-webbed spider	4	no	NA
Araneae	nd	*Hahnia ononidum*	dwarf spider	8	no	NA
Araneae	nd	*Harpactea lepida*	dwarf sheet spider	4	no	NA
Araneae	nd	*Histopona torpida*	woodhouse hunting spiders	4	no	NA
Araneae	nd	*Lycosa* sp.	funnel weaver spider	1	no	NA
Araneae	nd	*Macrargus rufus*	wolf spider	8	no	NA
Araneae	nd	*Micaria fulgens*	dwarf spider	8	no	NA
Araneae	nd	*Pardosa alacris*	ground spider	4	no	NA
Araneae	nd	*Pardosa luubris s. Str.*	wolf spider	4	no	NA
Araneae	nd	*Phrurolithus festivis*	wolf spider	4	no	NA
Araneae	nd	spider	araneomorph spider	169	no	NA
Araneae	nd	spider	spider	4	no	NA
Araneae	nd	*Xerolycosa nemoralis*	spider	4	no	NA
Araneae	nd	*Zelotes apricorum*	burnt wolf spider	4	no	NA
Araneae	nd	*Zelotes electus*	ground spider	4	no	NA
Araneae	nd	*Zodarion rubidum*	ground spider	4	no	NA
Opiliones	Opilionidae	*Lacinius ephippiatus*	ant-eating spider	4	no	NA
Opiliones	Opilionidae	*Lophopilio palpinalis*	harvestmen spider	8	no	NA
Opiliones	Opilionidae	*Nelima semproni*	harvestmen spider	4	no	NA
Opiliones	Opilionidae	*Oliolophus tridens*	harvestmen spider	8	no	NA
Opiliones	Opilionidae	*Paranemastoma 4-punctatum*	harvestmen spider	8	no	NA
Opiliones	Opilionidae	*Phalangium opilio*	harvestmen spider	4	no	NA
Araneae	nd	spider	harvestmen spider	40	no	NA
Chilopoda						
nd	nd	centipede	centipede	4	no	NA
nd	nd	*chilopoda - E. grossipes*	centipede	4	no	NA
nd	nd	*chilopoda - L. forficatus*	centipede	8	no	NA
nd	nd	*chilopoda - L. tricuspis*	centipede	4	no	NA
Diplopoda						
nd	Polydesmida	nd	centipede	8	no	NA
nd	nd	*diplopoda-M. mutabilis*	millipede	8	no	NA
nd	nd	*diplopoda-O. pusilla*	millipede	12	no	NA
nd	nd	*diplopoda-P. complanatus*	millipede	4	no	NA

Table C-4. Identification of Non-Larval Aerial Insect Data Points from Terrestrial Arthropod Data in USACHPPM (2004) Database

Taxa Information as Provided in USACHPPM (2004) Database						
Order	Family	Species	Common Name	Number of Data Points in Database	Included in Aerial Insect Data Set?	Notes
Diplopoda (continued)						
nd	nd	*millepede-1*	millipede	4	no	NA
nd	nd	*millepede-2*	millipede	4	no	NA
nd	nd	*millepede-3*	millipede	4	no	NA
nd	nd	*millipedes*	millipede	3	no	NA
Insecta						
nd	nd	nd	millipede	144	no	Unidentified insect class, excluded from flying category
nd	nd	beetles and termite larva	insect	1	no	NA
nd	nd	chewing insects	beetle and termite larva	4	no	Unidentified insect class, excluded from flying category
nd	nd	herbivore arthropods	chewing insect	8	no	Unidentified insect class, excluded from flying category
nd	nd	litter-grazer	herbivore arthropod	48	no	Unidentified insect class, excluded from flying category
nd	nd	non-spider	litter grazer	48	no	Unidentified insect class, excluded from flying category
nd	nd	omnivore arthropods	non-spider	8	no	Unidentified insect class, excluded from flying category
nd	nd	predatory arthropds	omnivore arthropod	8	no	Unidentified insect class, excluded from flying category
nd	nd	predatory inscets	predatory arthropod	4	no	Unidentified insect class, excluded from flying category
nd	nd	sucking insects	predatory insect	4	no	Unidentified insect class, excluded from flying category
Coleoptera	nd	*Amphimallon solstitiale*	sucking insect	1	yes	NA
Coleoptera	nd	beetle	european june beetle	115	yes	NA
Coleoptera	nd	beetle	beetle	45	yes	NA
Coleoptera	nd	carnivore arthropods	beetle	6	yes	NA
Coleoptera	nd	*Geotrupes stercorarious*	carnivore arthropod	1	yes	NA
Coleoptera	nd	herbivore arthropods	earth-boring dung beetle	6	yes	NA
Coleoptera	nd	*Lagrea hirta*	herbivore arthropod	1	yes	NA
Coleoptera	nd	*Phyllobius arborator*	beetle	1	yes	NA
Coleoptera	nd	*Phyllobius sinuatus*	broad-nosed weevil	1	yes	NA
Coleoptera	nd	*Psylliodes chrysocephala*	weevil	1	yes	NA
Coleoptera	nd	*Pterostichus oblongopuntatus*	leaf beetle	1	yes	NA
Coleoptera	nd	*Rhagium sycophanta (larvae)*	ground beetle	1	no	NA
Coleoptera	nd	*Rhagium sycophanta (pupae)*	longhorn beetle larvae	1	no	NA
Coleoptera	nd	*Strangalia maculata*	longhorn beetle pupae	1	yes	NA
Coleoptera	carabidae	*Molops piceus*	longhorn beetle	1	no	This family is generally unable or reluctant to fly
Coleoptera	Carabidae	*Abax parallelepipedus*	ground beetle	1	no	This family is generally unable or reluctant to fly
Coleoptera	Carabidae	*carabidae*	ground beetle	4	no	This family is generally unable or reluctant to fly
Coleoptera	Carabidae	*carabidae-A. lunicollis*	ground beetle	4	no	This family is generally unable or reluctant to fly
Coleoptera	Carabidae	*carabidae-C. erratus*	ground beetle	4	no	This family is generally unable or reluctant to fly
Coleoptera	Carabidae	*carabidae-C. hortensis*	ground beetle	8	no	This family is generally unable or reluctant to fly
Coleoptera	Carabidae	*carabidae-H. rufipes*	ground beetle	4	no	This family is generally unable or reluctant to fly
Coleoptera	Carabidae	*carabidae-P. metallicus*	ground beetle	4	no	This family is generally unable or reluctant to fly

Table C-4. Identification of Non-Larval Aerial Insect Data Points from Terrestrial Arthropod Data in USACHPPM (2004) Database

Taxa Information as Provided in USACHPPM (2004) Database						
Order	Family	Species	Common Name	Number of Data Points in Database	Included in Aerial Insect Data Set?	Notes
Insecta (continued)						
Coleoptera	Carabidae	*carabidae-P. oblongopunctatus*	ground beetle	8	no	This family is generally unable or reluctant to fly
Coleoptera	Carabidae	*carabidae-P. versicolor*	ground beetle	8	no	This family is generally unable or reluctant to fly
Coleoptera	Carabidae	*carabidae ad*	ground beetle	3	no	This family is generally unable or reluctant to fly
Coleoptera	Carabidae	*Carabus coriaceus*	ground beetle	1	no	This family is generally unable or reluctant to fly
Coleoptera	Cerambycidae	*A villosoviridescens*	ground beetle	6	yes	NA
Coleoptera	Coccinelidae	*C septempunctata*	longhorn beetle	32	yes	NA
Coleoptera	Coccinellidae	*Calvia decemguttata*	ladybug	1	yes	NA
Coleoptera	Curculionidae	*curculionidae-H. abietus*	beetle	4	no	Adults can fly, but is a rarity for this order. Assumed not flying.
Coleoptera	Curculionidae	*curculionidae-O. crategi*	true weevil	4	no	Adults cannot fly
Coleoptera	Curculionidae	*curculionidae-O. ovatus*	true weevil	8	no	Adults cannot fly
Coleoptera	Curculionidae	*curculionidae-O. raucus*	true weevil	4	no	Adults cannot fly
Coleoptera	Curculionidae	*Neochetina eichhornae*	true weevil	18	no	Adults cannot fly
Coleoptera	Curculionidae	*Neochetina eichhorniae*	true weevil	9	no	Adults cannot fly
Coleoptera	Scolytidae	bark beetle larvae	true weevil	8	no	NA
Coleoptera	silphidae	*Necrophorus vespilloides*	bark beetle larvae	1	yes	NA
Coleoptera	Staphylinidae	*staphylinid ad*	burying beetle	3	yes	NA
Coleoptera	Staphylinidae	*staphylinidae-G. circellaris*	rove beetle	4	yes	NA
Coleoptera	Staphylinidae	*staphylinidae-P. fossor*	rove beetle	12	yes	NA
Coleoptera	Staphylinidae	*staphylinidae-Q. fuliginosus*	rove beetle	8	yes	NA
Coleoptera	Staphylinidae	*staphylinidae-X. linearis*	rove beetle	4	yes	NA
Coleoptera	Staphylinidae	*staphylinidae-Z. humeralis*	rove beetle	4	yes	NA
Coleoptera	Sylphidae	*carrion beetles*	rove beetle	8	yes	NA
Collembola	nd	*Orchesella cincta*	carrion beetle	22	no	NA
Diptera	nd	*diptera*	springtail	6	yes	NA
Diptera	Calliphoridae	*dip. Calliphoridae*	true flies	4	yes	NA
Diptera	Sarcophagidae	*dip. Sarcophagidae*	bow flies	4	yes	NA
Diptera	Syrphidae	*Syrphidae*	fresh fly	1	yes	NA
Hemiptera	nd	*Acanthosoma haemorrhoidale*	hoverfly	1	yes	NA
Hemiptera	Pentatomidae	*Pentatoma rufipes*	hawthorn shield bug	1	yes	NA
Homoptera	Aphididae	*Aphididae*	forest bug	1	yes	NA
Homoptera	Aphididae	*Aphis fabae*	aphid	6	yes	NA
Hymenoptera	Diprionidae	*D. pini (adult)*	black bean aphid	3	yes	NA
Hymenoptera	Diprionidae	*Diprion pini (larvae)*	sawflies	3	no	NA
Hymenoptera	Diprionidae	*Dolerus nigratus (larvae)*	sawflies larvae	3	no	NA
Hymenoptera	formicidae	*Araschnia levana (larvae)*	sawflies larvae	1	no	NA
Hymenoptera	formicidae	*Myrmicinae*	map butterfly larvae	1	no	Some adults do fly, but expected to be insignificant portion of diets for aerial insectivores
Hymenoptera	Formicidae	*Camponitus ligniperda*	ants	12	no	Some adults do fly, but expected to be insignificant portion of diets for aerial insectivores

Table C-4. Identification of Non-Larval Aerial Insect Data Points from Terrestrial Arthropod Data in USACHPPM (2004) Database

Taxa Information as Provided in USACHPPM (2004) Database						
Order	Family	Species	Common Name	Number of Data Points in Database	Included in Aerial Insect Data Set?	Notes
Insecta (continued)						
Hymenoptera	Formicidae	*Camponitus vagus*	biting ant	4	no	Some adults do fly, but expected to be insignificant portion of diets for aerial insectivores
Hymenoptera	Formicidae	*Formica fusca*	carpenter ant	5	no	Some adults do fly, but expected to be insignificant portion of diets for aerial insectivores
Hymenoptera	Formicidae	*Formica rufa*	wood ant	1	no	Some adults do fly, but expected to be insignificant portion of diets for aerial insectivores
Hymenoptera	Formicidae	*Formica sanguinea*	wood ant	1	no	Some adults do fly, but expected to be insignificant portion of diets for aerial insectivores
Hymenoptera	Formicidae	*Lasius platythorax*	wood ant	12	no	Some adults do fly, but expected to be insignificant portion of diets for aerial insectivores
Hymenoptera	Formicidae	*Leptohorax acervorum*	formicine ant	4	no	Some adults do fly, but expected to be insignificant portion of diets for aerial insectivores
Hymenoptera	Formicidae	*Myrmica sabuleti*	ant	24	no	Some adults do fly, but expected to be insignificant portion of diets for aerial insectivores
Hymenoptera	Formicidae	*Tapinoma ambigumm*	ant	4	no	Some adults do fly, but expected to be insignificant portion of diets for aerial insectivores
Hymenoptera	Formicidae	*Tetramorium caespitum*	ant	4	no	Some adults do fly, but expected to be insignificant portion of diets for aerial insectivores
Hymenoptera	Tenthedinidae	*D. nigratus (adult)*	ant	3	yes	NA
Hymenoptera	Tenthedinidae	*E. baltica (adult)*	sawflies	3	yes	NA
Hymenoptera	Tenthedinidae	*Empria baltica (larvae)*	sawflies	3	no	NA
Hymenoptera	Vespidae	hornets	sawflies larvae	4	yes	NA
Lepidoptera	nd	catapillar	hornet	161	no	NA
Lepidoptera	nd	*Eilema deplana*	caterpillar	1	yes	NA
Lepidoptera	nd	*Eilema lurideiola*	scarce footman moth	1	yes	NA
Lepidoptera	nd	*Scotia exlamationis*	common footman moth	1	yes	NA
Lepidoptera	Arctiidae	*Halisidota and spilosoma*	heart and dart moth	4	yes	NA
Lepidoptera	Arctiidae	*lep. H. tessellaris*	moth	4	yes	NA
Lepidoptera	Lasiocampidae	*lep. M. americanum*	moth	4	yes	NA
Lepidoptera	Limacodidae	*Apoda limacodes*	lappet moth	1	yes	NA
Lepidoptera	Lymantriidae	*lep. P. dispar*	cup moth	7	yes	NA
Lepidoptera	Lymantriidae	*lep.P. dispar*	tussock moth	1	yes	NA
Lepidoptera	Noctuidae	*lep. A. pyramidoides*	tussock moth	8	yes	NA
Lepidoptera	Noctuidae	*lep. C. paleogama*	owlet moth	8	yes	NA
Lepidoptera	Noctuidae	*lep. L. unipuncta*	owlet moth	8	yes	NA
Lepidoptera	Noctuidae	*lep. N. c-nigrum*	owlet moth	8	yes	NA
Lepidoptera	Noctuidae	*lep. P. excaecatus*	owlet moth	4	yes	NA
Lepidoptera	Nymphalidae	*A. urticae (adult)*	owlet moth	3	yes	NA
Lepidoptera	Nymphalidae	*Tortrix viridana (larvae)*	true butterfly	3	no	NA
Lepidoptera	Tortricidae	*Aglais urticae (larvae)*	true butterfly larvae	3	no	NA
Lepidoptera	Tortricidae	*T. viridana (adult)*	tortix moth larvae	3	yes	NA
Neuroptera	Chrysopidae	*Chrysopidae*	tortix moth	1	yes	NA
Orthoptera	Acrididae	*Aiolopus thalassinus*	green lacewings	26	yes	NA
Orthoptera	Acrididae	*Chorthippus brunneus*	grasshopper	12	yes	NA
Orthoptera	Acrididae	*Eyprepocnemis plorans*	grasshopper	28	yes	NA
Orthoptera	Acrididae	*grasshopper*	grasshopper	239	yes	NA

Table C-4. Identification of Non-Larval Aerial Insect Data Points from Terrestrial Arthropod Data in USACHPPM (2004) Database

Taxa Information as Provided in USACHPPM (2004) Database			Common Name	Number of Data Points in Database	Included in Aerial Insect Data Set?	Notes
Order	Family	Species				
Insecta (continued)						
Orthoptera	Acrididae	grasshopper	grasshopper	40	yes	NA
Orthoptera	Acrididae	grasshopper	grasshopper	8	yes	NA
Orthoptera	Acrididae	grasshopper	grasshopper	17	yes	NA
Orthoptera	Acrididae	*Orthoptera-C. montanus*	grasshopper	4	no	NA
Orthoptera	Blattodidae	*Blattodea-E. sylvestris*	grasshopper	4	no	NA
Orthoptera	Gryllidae	*Acheta domesticus*	cockroach	6	yes	NA
Orthoptera	Gryllidae	*P.fasciatus*	true cricket	1	yes	NA
Isopoda						
nd	nd	*isopoda-P. scaber*	true cricket	4	no	NA
nd	nd	*isopoda-T. rathkei*	rough woodlouse	4	no	NA
nd	nd	*isopoda-T. ratzeburgi*	woodlouse	12	no	NA
nd	nd	isopods	woodlouse	7	no	NA
nd	nd	*O. asellus, P. scaber*	isopods	1	no	NA
nd	nd	*P. pictus, P. scaber, T. rathkei*	woodlouse	2	no	NA
nd	nd	*P. scaber*	woodlouse	8	no	NA
nd	nd	*P. scaber, P.picuts*	woodlouse	1	no	NA
nd	nd	*Porcellio larvis*	woodlouse	5	no	NA
nd	nd	*Porcellio scaber*	woodlouse	10	no	NA
nd	nd	*Tracheoniscus rathkei*	woodlouse	1	no	NA
nd	nd	*Tracheoniscus rathkei, P.pictus*	woodlouse	2	no	NA

Notes:
NA - not applicable
nd - no data populated in database cell

Table C-5. Study Assignment for Single-Split Validation

Analyte	Studies Assigned to the Training Data Set [a]	Studies Assigned to the Validation Data Set [a]	Data Points in Training Data Set	Data Points in Validation Data Set
Terrestrial Arthropods				
Aluminum	PTI (1995)		24	na
Barium	PTI (1995)	Hope et al. (1996), Ramirez and Rogers (2000)	30	3
Cadmium	Beyer et al. (1985), Carter (1983), Hemminga et al. (1989), Hunter and Johnson (1982), Knutti et al. (1988), Pascoe et al. (1996), Posthuma (1990), PTI (1995), Rabitsch (1995a), Rabitsch (1995c), Ramirez and Rogers (2000), Van Hook and Yates (1975), Watson et al. (1976)	Dmowski and Karolewski (1979), Rabitsch (1995b), PTI (1994)	248	51
Chromium	PTI (1995)	Beyer et al. (1990)	30	5
Copper	Beyer et al. (1985), Beyer et al. (1990), Carter (1983), Hemminga et al. (1989), Hunter and Johnson (1982), Pascoe et al. (1996), PTI (1995), Rabitsch (1995a), Rabitsch (1995c), Ramirez and Rogers (2000), Watson et al. (1976), Wieser et al. (1976), Wieser et al. (1977)	Rabitsch (1995b), PTI (1994)	232	42
Iron	PTI (1995)		30	
Lead	Andrews et al. (1989a), Beyer et al. (1985), Beyer et al. (1990), Price et al. (1974), PTI (1995), Rabitsch (1995a), Rabitsch (1995c), Watson et al. (1976)	Dmowski and Karolewski (1979), Rabitsch (1995b), PTI (1994)	218	50
Mercury	PTI (1995)		30	
Selenium	PTI (1995)	Beyer et al. (1990), Ramirez and Rogers (2000)	19	3
Thallium	PTI (1995)		14	
Vanadium	PTI (1995)	Ramirez and Rogers (2000)	18	1
Zinc	Andrews et al. (1989b), Beyer et al. (1985), Beyer et al. (1990), Carter (1983), Pascoe et al. (1996), Posthuma (1990), PTI (1995), Rabitsch (1995a), Rabitsch (1995c), Ramirez and Rogers (2000), Watson et al. (1976)	Dmowski and Karolewski (1979), Rabitsch (1995b), PTI (1994)	210	48
Flying Insects				
Aluminum	PTI (1995)		17	
Barium	PTI (1995)	Ramirez and Rogers (2000)	17	2
Cadmium	Beyer et al. (1985), Carter (1983), Knutti et al. (1988), Pascoe et al. (1996), PTI (1995), Van Hook and Yates (1975), PTI (1994)	Hemminga et al. (1989), Hunter and Johnson (1982), Rabitsch (1995a), Ramirez and Rogers (2000)	75	19
Chromium	PTI (1995)	Beyer et al. (1990)	17	4
Copper	Beyer et al. (1985), Beyer et al. (1990), Carter (1983), Pascoe et al. (1996), PTI (1995), PTI (1994)	Hemminga et al. (1989), Hunter and Johnson (1982), Rabitsch (1995a), Ramirez and Rogers (2000)	59	19
Iron	PTI (1995)	.	17	
Lead	Andrews et al. (1989a), Beyer et al. (1985), Beyer et al. (1990), PTI (1995), PTI (1994)	Rabitsch (1995a)	56	8
Mercury	PTI (1995)		17	
Selenium	PTI (1995)	Beyer et al. (1990), Ramirez and Rogers (2000)	11	3
Thallium	PTI (1995)	.	4	
Vanadium	PTI (1995)	Ramirez and Rogers (2000)	5	1
Zinc	Andrews et al. (1989b), Beyer et al. (1985), Beyer et al. (1990), Carter (1983), Pascoe et al. (1996), PTI (1995), PTI (1994)	Rabitsch (1995a), Ramirez and Rogers (2000)	50	10

Notes

[a] Studies as cited in USACHPPM (2004)

Table C-6. Results for Terrestrial Arthropod Bioaccumulation Modeling

			Regression Models [a]					BAF							
Analyte	Number of Studies	Number of Data Points	Intercept	Slope	R^2	p-Value	Acceptable Regression Model? [B]	Distribution [c]	Mean	Standard Deviation	Minimum	Median	90th Percentile	Maximum	Final Model Selection
Aluminum	1	24	**-33.5**	**3.88**	0.203	0.0272	yes	lognormal	0.00499	0.00696	0.000749	0.00266	0.00988	0.0271	regression
Barium	3	33	1.52	0.0375	0.000166	0.943	no	neither	0.0558	0.0599	0.0126	**0.0315**	0.130	0.302	median BAF
Cadmium	16	299	**0.506**	**0.588**	0.512	3.10E-48	yes	neither	3.03	7.95	0.0206	0.723	7.60	92.7	regression
Chromium	2	35	1.38	-0.112	0.00513	0.683	no	lognormal	0.149	0.191	0.0100	**0.0643**	0.492	0.741	median BAF
Copper	15	274	3.33	0.192	0.0722	6.44E-06	no	lognormal	3.220	7.50	0.00495	**0.942**	8.23	78.6	median BAF
Iron	1	30	9.09	-0.390	0.0100	0.599	no	lognormal	0.0134	0.0198	0.00165	**0.00612**	0.0278	0.102	median BAF
Lead	11	268	**-1.49**	**0.799**	0.460	1.78E-37	yes	neither	0.294	0.676	0.000314	0.0672	0.627	5.54	regression
Mercury	1	30	-3.08	-0.149	0.106	0.0787	no	neither	1.18	1.59	0.0581	**0.729**	2.02	6.67	median BAF
Selenium	3	22	0.270	0.145	0.0488	0.323	no	normal	1.94	1.61	0.0183	**1.61**	4.11	6.06	median BAF
Thallium	1	14	-0.265	3.34	0.118	0.230	no	neither	0.0885	0.0741	0.0513	**0.0556**	0.213	0.263	median BAF
Vanadium	2	19	0.195	-0.392	0.0319	0.465	no	lognormal	0.0116	0.00883	0.00345	**0.00977**	0.0217	0.0358	median BAF
Zinc	14	258	5.38	0.0997	0.0534	0.000181	no	lognormal	4.04	9.49	0.0103	**0.827**	10.5	74.1	median BAF

Notes:

Bolded values represent the selected model parameters.

[a] Regression model equation is ln (C_{biota}) = slope * ln (C_{soil}) + intercept

[b] Regression model acceptabililty criteria: $p < 0.05$, $R^2 > 0.2$, positive slope, and number of data points > 10

[c] Normality testing was conducted on calculated BAFs for both normal and lognormal distributions

BAF - bioaccumulation factor

Table C-7. Results for Aerial Insect Bioaccumulation Modeling

			Regression Models [a]					BAF							
Analyte	Number of Studies	Number of Data Points	Intercept	Slope	R^2	p-Value	Acceptable Regression Model? [b]	Distribution [c]	Mean	Standard Deviation	Minium	Median	90th Percentile	Maximum	Final Model Selection
Aluminum	1	17	-30.3	3.53	0.180	0.0899	no	lognormal	0.00413	0.00607	0.000749	**0.00197**	0.00832	0.0255	median BAF
Barium	3	19	-0.480	0.386	0.0224	0.541	no	neither	0.0402	0.0386	0.0126	**0.0238**	0.101	0.156	median BAF
Cadmium	16	94	**-0.311**	**0.601**	0.600	5.35E-20	yes	lognormal	1.60	4.43	0.0206	0.522	2.68	37.1	regression
Chromium	2	21	0.360	0.0951	0.00622	0.734	no	lognormal	0.0912	0.123	0.0100	**0.0561**	0.144	0.600	median BAF
Copper	15	78	**1.52**	**0.469**	0.573	1.11E-15	yes	lognormal	0.841	0.972	0.0492	0.485	1.95	5.07	regression
Iron	1	17	1.97	0.273	0.0113	0.685	no	lognormal	0.00621	0.00602	0.00165	**0.00444**	0.00998	0.0270	median BAF
Lead	11	64	**-2.28**	**0.687**	0.345	0.000000338	yes	lognormal	0.0581	0.0957	0.000675	0.0238	0.147	0.585	regression
Mercury	1	17	-3.05	-0.0629	0.118	0.177	no	neither	0.764	0.618	0.0581	**0.556**	1.76	2.00	median BAF
Selenium	3	14	0.112	0.0996	0.0204	0.627	no	normal	1.53	1.34	0.0183	**1.39**	3.55	4.15	median BAF
Thallium	1	4	-3.91	0	NA	NA	no	lognormal	0.0554	0.00376	0.0526	**0.0541**	0.0591	0.0606	median BAF
Vanadium	2	6	0.874	-0.559	0.112	0.516	no	lognormal	0.0117	0.00953	0.00345	**0.00813**	0.0230	0.0279	median BAF
Zinc	14	60	**3.98**	**0.234**	0.412	3.28E-08	yes	lognormal	0.756	0.857	0.0123	0.368	1.68	3.52	regression

Notes

[a] Regression model equation is ln (Cbiota) = slope * ln (Csoil) + intercept

[b] Regression model acceptabililty criteria: $p < 0.05$, $R2 > 0.2$, positive slope, and number of data points > 10

[c] Normality testing was conducted on calculated BAFs for both normal and lognormal distributions

Bolded values represent the selected model parameters

BAF - bioaccumulation factor

NA - not applicable; all flying insect concentrations were the same, so no values could be calculated for R^2 and p-value

Table C-8. Results for Aboveground Terrestrial Plant Parts Bioaccumulation Modeling

		Regression Models [a]					BAF							
Analyte	Number of Data Points	Intercept	Slope	R^2	p-Value	Acceptable Regression Model? [b]	Distribution [c]	Mean	Standard Deviation	Minimum	Median	90th Percentile	Maximum	Final Model Selection
Aluminum	99	13.2	-1.12	0.119	0.000461	no	lognormal	0.00304	0.00825	0.0000170	**0.000948**	0.00527	0.0760	median BAF
Barium	112	-1.05	0.718	0.0305	0.0654	no	neither	0.153	0.145	0.000492	**0.124**	0.352	0.677	median BAF
Cadmium	111	-3.75	0.577	0.0704	0.00490	no	neither	0.0254	0.0388	0.000144	**0.0128**	0.0597	0.222	median BAF
Chromium	109	1.13	-0.606	0.0308	0.0678	no	neither	0.119	0.198	0.000927	**0.0203**	0.417	1.02	median BAF
Copper	112	1.29	0.101	0.00351	0.535	no	neither	0.279	0.910	0.0131	**0.110**	0.427	9.53	median BAF
Iron	112	9.48	-0.601	0.101	0.000658	no	neither	0.00364	0.00663	0.000282	**0.00171**	0.00665	0.0585	median BAF
Lead	105	-1.93	0.0589	0.00138	0.707	no	neither	0.00388	0.0105	0.00000557	**0.000984**	0.00939	0.0949	median BAF
Mercury	49	-6.01	-0.206	0.0351	0.197	no	neither	0.171	0.273	0.0108	**0.0694**	0.506	1.09	median BAF
Molybdenum	10	-1.42	2.10	0.828	0.000260	no	lognormal	1.75	1.81	0.0826	**1.25**	3.51	5.56	median BAF
Selenium	32	-2.47	-0.366	0.140	0.0346	no	lognormal	0.130	0.154	0.00779	**0.0917**	0.234	0.645	median BAF
Thallium	25	-4.70	0.0952	0.0353	0.369	no	lognormal	0.231	0.480	0.00522	**0.0475**	0.719	2.09	median BAF
Vanadium	73	0.937	-1.08	0.337	7.26E-08	no	neither	0.00380	0.00944	0.000334	**0.00154**	0.00783	0.0755	median BAF
Zinc	112	2.83	0.0695	0.00162	0.674	no	lognormal	0.141	0.175	0.00293	**0.0637**	0.422	0.710	median BAF

Notes

[a] Regression model equation is $\ln(C_{biota}) = slope * \ln(C_{soil}) + intercept$

[b] Regression model acceptabililty criteria: $p < 0.05$, $R^2 > 0.2$, positive slope, and number of data points > 10

[c] Normality testing was conducted on calculated BAFs for both normal and lognormal distributions

Bolded values represent the selected model parameters

BAF - bioaccumulation factor

Table C-9. Results for Belowground Terrestrial Plant Parts Bioaccumulation Modeling

		Regression models [a]					BAF							
Analyte	Number of Data Points	Intercept	Slope	R^2	p-Value	Acceptable Regression Model? [b]	Distribution [c]	Mean	Standard Deviation	Minimum	Median	90th Percentile	Maximum	Final Model Selection
Aluminum	36	1.79	0.446	0.0243	0.364	no	lognormal	0.0435	0.0384	0.00248	**0.0327**	0.0970	0.176	median BAF
Barium	36	-0.457	0.801	0.0417	0.232	no	neither	0.321	0.267	0.0138	**0.261**	0.780	0.949	median BAF
Cadmium	36	2.30	-0.208	0.0174	0.444	no	lognormal	0.670	0.648	0.0399	**0.491**	1.31	3.27	median BAF
Chromium	36	**-7.50**	**2.28**	0.369	0.0000862	yes	lognormal	0.0730	0.0927	0.00580	0.0272	0.181	0.378	regression
Copper	36	1.59	0.0942	0.00933	0.575	no	lognormal	0.154	0.0975	0.0186	**0.123**	0.291	0.371	median BAF
Iron	36	-2.21	0.819	0.0588	0.154	no	lognormal	0.0264	0.0231	0.00194	**0.0208**	0.0479	0.103	median BAF
Lead	36	-0.551	0.646	0.191	0.00767	no	neither	0.0934	0.0656	0.00600	**0.0895**	0.174	0.307	median BAF
Molybdenum	8	-0.892	2.33	0.787	0.00331	no	lognormal	10.4	18.3	0.111	**1.70**	31.7	51.4	median BAF
Selenium	27	-2.56	0.629	0.0633	0.206	no	neither	0.122	0.126	0.0293	**0.0714**	0.350	0.476	median BAF
Thallium	34	-2.05	-0.0372	0.00586	0.667	no	lognormal	0.327	0.307	0.0359	**0.278**	0.586	1.51	median BAF
Vanadium	36	**-9.65**	**2.46**	0.352	0.000138	yes	lognormal	0.0320	0.0393	0.00171	0.0187	0.0757	0.169	regression
Zinc	36	4.60	0.134	0.0113	0.537	no	lognormal	0.635	0.564	0.0542	**0.479**	1.20	2.61	median BAF

Notes

[a] Regression model equation is ln (C_{biota}) = slope * ln (C_{soil}) + intercept

[b] Regression model acceptabililty criteria: $p < 0.05$, $R^2 > 0.2$, positive slope, and number of data points > 10

[c] Normality testing was conducted on calculated BAFs for both normal and lognormal distributions

Bolded values represent the selected model parameters

BAF - bioaccumulation factor

APPENDIX D

SOIL INVERTEBRATE AND PLANT TOXICITY BENCHMARKS

FINAL
Appendix D
Soil Invertebrate and Plant Toxicity Benchmarks

December 2023

CONTENTS

LIST OF ATTACHMENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

BAB	bioavailability-adjusted benchmark
BERA	baseline ecological risk assessment
CEC	cation exchange capacity
COI	chemical of interest
COPC	chemical of potential concern
eCEC	effective cation exchange capacity
Eco-SSL	ecological soil screening level
EPA	U.S. Environmental Protection Agency
SSL	soil screening level
TAI	Teck American Incorporated
UCR	Upper Columbia River

1 INTRODUCTION

This appendix presents the evaluations conducted primarily by Teck American Incorporated (TAI) to derive terrestrial invertebrate and plant toxicity benchmarks for use in the baseline ecological risk assessment (BERA) for the Terrestrial Study Area[1] of the Upper Columbia River (UCR) site (hereinafter the site[2]). Soil toxicity benchmarks are used to evaluate the potential for adverse effects to invertebrates and plants from direct contact exposure to chemicals of potential concern (COPCs) in soil using hazard quotient calculations. For the most part, the information in this appendix is consistent with information presented in the draft final version of Appendix D in the draft final Upland BERA prepared by TAI (2023), with the following exceptions:

  - ○ Clarifications to the definitions of "site" and Terrestrial Study Area to match terminology used in the main text of the final Upland BERA.
  - ○ Removal of references to weight of evidence evaluations in the main text of the final Upland BERA.

- Removal of references to regionally relevant toxicity data from soil bioassays conducted for the Hanford site in south-central Washington State (changes to tables and Attachment D2).
- Replacement of Attachment D2 to describe use of minimum percent clay and effective cation exchange capacity (eCEC) values measured at decision units from the 2014 UCR Upland Soil Study located within each of the 13 Washington State Department of Ecology (Ecology) subareas as surrogate values to calculate plant and soil invertebrate bioavailability-adjusted benchmarks (BABs) for the 2012 Ecology Upland Soil Study samples.

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[1] The term "Terrestrial Study Area" refers to the upland terrestrial habitat of the UCR Site. Though it has yet to be fully defined, the upland area is commonly described as land above the elevations of historical Columbia River flood events and within the approximate footprint of metals deposition associated with historical smelter aerial emissions. For the purposes of the Upland BERA, the upland area is operationally defined as the spatial extent of the upland soil data set used for ecological risk analysis. The geographical extent of the Terrestrial Study Area is expected to be established by analyses presented in the Draft Final Upland Remedial Investigation Report, which is currently under U.S. Environmental Protection Agency review.

[2] As defined within the Settlement Agreement of June 2, 2006, the site consists of the areal extent of hazardous substances contamination within the United States in or adjacent to the Upper Columbia River, including the Franklin D. Roosevelt Lake, from the U.S.-Canada border to the Grand Coulee Dam, and all suitable areas in proximity to the contamination necessary for implementation of response actions.

Two different methods were used to develop soil toxicity benchmarks. Both methods are intended to provide conservative estimates of adverse effect thresholds, where conservative means that the benchmark is less than the expected value of the corresponding adverse effect threshold. In other words, the estimation assumptions used to develop the terrestrial invertebrate and plant toxicity benchmarks are defined such that the probability of incorrectly concluding that an adverse effect threshold was not exceeded is low.

Each of the two different methods used to develop soil toxicity benchmarks is based on different information, so the benchmarks developed by the two different methods are addressed as separate pieces of evidence for the soil chemistry line of evidence used to evaluate potential risk to terrestrial invertebrates and plants.

The objective of this appendix is to present the approach used for deriving the soil toxicity benchmarks that are used in the Upland BERA. The terrestrial invertebrate and plant soil toxicity benchmarks described in this appendix build off work previously presented to the U.S. Environmental Protection Agency (EPA) in the Draft *Upper Columbia River Soil Evaluation for Plants and Invertebrates: Results from Steps 1 through 6 of the Proposed Approach* (TAI, 2020a). Two types of soil toxicity benchmarks were presented in TAI (2020a): screening-level benchmarks (e.g., EPA ecological soil screening levels [Eco-SSLs]) and BABs calculated from a soil threshold calculator (similar to a predicted no-effect concentration). Additional screening-level benchmarks and BABs have been developed for use in the BERA that were not included in TAI (2020a) because new COPCs[3] and chemicals of interest (COIs)[4] were added or because some COPCs were not evaluated using BABs in TAI (2020a). While some COPCs and COIs are not "true" metals but rather metalloids, [5] COPCs and COIs are collectively referred to as "metals" in the remainder of this appendix.

Section 2 of this appendix provides an overview of the approach used to develop the soil screening-level benchmarks and BABs. Section 3 of this appendix provides a summary of

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[3] If the maximum detected concentration within an exposure area exceeded the Eco-SSL and more than one concentration exceeded the Eco-SSL, then the COI was considered a COPC for the receptor.

[4] As described in the COPC Refinement (TAI, 2020c), certain COIs were retained for evaluation in the BERA based on uncertainty, including the following: COIs were not analyzed; COIs had no benchmark or screening-level toxicity reference value; COI's detection limits exceeded the benchmark in more than one sample; or there was a single exceedance of the benchmark for a COI in a sample that had at least one other COI exceedance.

[5] Barium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, silver, thallium, and vanadium are metals. Aluminum, antimony, arsenic, and selenium are metalloids.

the benchmark values used in the Upland BERA. An uncertainty discussion for the benchmarks is provided in Section 4 of this appendix.

Details on the derivation of both benchmark types are presented in attachments to this appendix. Attachment D1 presents the EPA-approved Soil Screening Levels for Plants and Invertebrates technical memorandum (TAI, 2020b), which describes the development of soil screening levels (SSLs) for the eight metals lacking Eco-SSLs. Attachment D2 describes the derivation of BABs, which are not presented in TAI (2020b).

2 OVERVIEW OF PLANT AND INVERTEBRATE BENCHMARKS

This section provides an overview of how SSLs and BABs were developed for the Upland BERA. Details on their derivation are presented in Attachments D1 and D2. Table D-1 contains a list of the metals for plants and invertebrates identified in the COPC refinement that are evaluated in the Upland BERA (TAI, 2019, 2020c), as well as the reports that include the benchmark derivations.

2.1 SOIL SCREENING-LEVEL BENCHMARKS

When available, EPA's Eco-SSLs (EPA, 2016) were used as SSL benchmarks to evaluate the toxicity of metals to plant and invertebrates. SSLs were developed for metals when a plant and/or invertebrate Eco-SSL had not been developed. SSLs were developed for the site by following the methods used by EPA to derive Eco-SSLs (EPA, 2003). The approach used for developing SSLs is documented in TAI (2020b), which was reviewed and approved by EPA and is included as Attachment D1. SSLs documented in Attachment D1 include the following:

- Antimony, chromium, molybdenum, and thallium for plants
- Arsenic, cobalt, molybdenum, silver, thallium, and vanadium for invertebrates

In response to EPA comments on TAI (2020a), TAI developed additional SSLs for two metal/receptor combinations not included in TAI (2020b): barium/plants and chromium/invertebrates. The derivation of these SSLs followed the same procedures described in TAI (2020b) and is presented in Attachment D2.

2.2 BIOAVAILABILITY-ADJUSTED BENCHMARKS

BABs refine SSLs by accounting for bioavailability of metals in soils. Bioavailability-adjusted toxicity effect levels for terrestrial plants and invertebrates were calculated for six metals incorporating sample-specific soil properties that included organic matter content, percent clay, pH, and cation exchange capacity (CEC). These data were collected as part of the Upland Soil Study (TAI, 2015). VNM was used to generate the sample-specific BABs, based on measured, sample-specific soil characteristics such as eCEC and pH. BABs were developed for the following metal/receptor combinations for which relevant toxicity data are available:

- Cobalt, copper, lead, molybdenum, nickel, and zinc for plants
- Cobalt, copper, molybdenum, and zinc for invertebrates

A detailed description of the derivation of the BABs is presented in Attachment D2.

3 RESULTS

Two benchmark types were developed for evaluating potential risk to terrestrial plants and invertebrates in the Terrestrial Study Area: soil screening benchmarks (Eco-SSLs/SSLs) and BABs. Dependent upon the availability of data, one or both benchmark types were developed for aluminum, antimony, arsenic, barium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, thallium, vanadium, and zinc, as appropriate for evaluating plants and/or invertebrates. These benchmarks are presented in Table D-2.

4 UNCERTAINTY

This section summarizes uncertainties associated with the selected soil benchmarks for plants and invertebrates.

4.1 ECO-SSLs/SSLs

The Eco-SSLs derived by EPA and the additional SSLs that were developed following EPA's guidance for developing Eco-SSLs are intended to be conservative and applied during the screening stage of ecological risk assessments (EPA, 2003). Key uncertainties in the terrestrial plant and invertebrate Eco-SSLs and SSLs are as follows.

4.1.1 Toxicity Tests Conducted in Soils with Physical and Chemical Properties that Favor Higher Bioavailability Conditions

EPA's Eco-SSL guidance notes that soil pH, CEC, clay content, and organic matter all influence metal bioavailability in soils but only soil pH and organic matter are routinely reported (EPA, 2005a). Accordingly, soil toxicity test results compiled to support Eco-SSL development included bioavailability scores based on soil pH and organic matter. Eco-SSLs were weighted toward conditions that favored higher bioavailability. For example, for cationic metals (such as aluminum, antimony, barium, cobalt, copper, iron, lead, manganese, nickel, silver, thallium, and zinc), tests conducted in combinations of low pH and low organic matter conditions were given the highest bioavailability score of 2 (high/very high) and tests conducted in combinations of high pH and high organic matter conditions were given the lowest bioavailability score of 0 (very low/low) (low pH and low organic matter favor increased bioavailability for cationic metals; the opposite is true for pH and anionic metals, such as chromium and vanadium). Eco-SSLs are calculated based on the tests with the highest bioavailability scores, which will be those tests with a score of 2, if available for three or more tests. For cationic metals, tests with a bioavailability score of 2 either have a soil pH of 4.0 to 5.5 and an organic matter content less than or equal to 6 percent or a pH of 5.5 to 7.0 and an organic matter content less than 2 percent. Eco-SSLs will be increasingly conservative for metal cations (metals in aqueous solution) as the pH and organic matter content increase in site soils relative to these ranges.

The use of toxicity tests with the highest bioavailability scores is conservative and likely to overestimate toxicity compared to Terrestrial Study Area soils. A summary of qualitative bioavailability scores using the criteria outlined in EPA (2005a) is provided for Terrestrial Study Area soil samples in Table D-3. For the 2014 UCR Upland Soil Study and

2012 Ecology Upland Soil Study, greater than 96 percent of samples have a qualitative bioavailability score of 0 or 1 (very low, low, or medium). Thus, for nearly all samples within these two studies, bioavailability within the soil is likely to be less than the bioavailability of the toxicity test conditions used to develop the Eco-SSLs and SSLs. Eco-SSLs/SSLs generally exclude toxicity data for low bioavailability soils, including studies with higher and lower effects thresholds than included. This difference in bioavailability is likely to overestimate the potential for adverse effects in hazard quotients using Eco-SSL and SSL benchmarks.

4.1.2 Toxicity Tests Conducted in Unaged and/or Unleached Soils

Soil toxicity tests with metals are typically conducted in soils freshly spiked with metal salts. The soil solution in freshly spiked soils, however, is rarely reflective of field-contaminated soils (Smolders et al., 2009). A freshly spiked metal salt increases the ionic strength of the soil and reduces the pH. In its Eco-SSL guidance, EPA recognized the importance of aging, but noted that few studies had incorporated a step to age or weather the tested soils (EPA, 2003). As such, most of the toxicity tests used to develop metal Eco-SSLs were based on unaged and unleached soils. As summarized in the ARCHE Consulting (ARCHE) calculator (ARCHE, 2020) and in Section 4.2 of this appendix, leaching and aging of soils in toxicity tests with metals can reduce toxicity by a factor of 2 to more than an order of magnitude; thus, Eco-SSLs and SSLs are conservative for field soils.

4.1.3 Relevance of Tested Plant and Invertebrate Species to Site Species

The Eco-SSLs for plants are frequently based on species of agricultural significance, with common test species being ryegrass, alfalfa, and barley. For invertebrates, commonly tested species are earthworms and springtails. The relative sensitivity of commonly tested terrestrial plant and invertebrate species compared to site species is unknown. However, for highly tested metals, such as cadmium, copper, lead, and zinc, there is evidence that "wild" or non-crop plants are not more sensitive than crop plants:

- For cadmium, trees such as white pine (*Pinus strobus*), yellow birch (*Betula alleghaniensis*), and loblolly pine (*Pinus taeda*) are similar in sensitivity to several crop species, and data for these species, along with crop species, are incorporated into calculation of the Eco-SSL (EPA, 2005b).

- For copper, the plant Eco-SSL is based on the geometric mean of soil toxicity thresholds for a variety of species, including more commonly tested alfalfa (*Medicago sativa*) and ryegrass (*Lolium perenne* L.), but also black bindweed (*Polygonum convolvulus*), a vine species, and the Cleopatra mandarin orange (*Citrus reshni*) (EPA, 2007). Less sensitive plants species not included in the calculation of the Eco-SSL were additional crop and grass species. Therefore, non-crop species are contributing to the copper Eco-SSL, and there is no evidence that crop and non-crop species have unique sensitivities to copper.
- For lead, the loblolly pine (*P. taeda*) and red maple (*Acer rubrum*) have a sensitivity similar to clover (*Trifolium alexandrinum*) and ryegrass (*L. rigidum*), and toxicity threshold data for all four species were used to drive the lead Eco-SSL.
- For zinc, the Eco-SSL is based on toxicity threshold data for crop species and all acceptable data for Eco-SSL development were for crop species. As such, at least based on the Eco-SSL data set, the relative sensitivities of crop and non-crop species to zinc could not be summarized.

Thus, there is no evidence that non-crop species are more sensitive to metals than crop species, while for invertebrates, most soil toxicity data are available for earthworms and springtails, and the sensitivities of these organisms to metals relative to other soil invertebrates is unknown. Overall, consistent with Eco-SSL guidance, the relative sensitivity of commonly tested terrestrial plant and invertebrate species is assumed to be adequately representative for conducting ecological risk assessments.

4.1.4 Toxicity Data Available for a Limited Number of Plant or Invertebrate Species

Some SSLs were developed for metals where the available toxicity data meet EPA’s Eco-SSL guidance for test acceptability but did not meet EPA’s guidance for the minimum number of toxicity tests required to derive an Eco-SSL (i.e., data were only available for one or two tests, while a minimum of three tests are required for Eco-SSL development). For example, plant SSLs for antimony and thallium and the invertebrate SSL for arsenic were each based on data from two tests, while the plant SSL for chromium and invertebrate SSL for cobalt were each based on data from one test. It is unknown whether these uncertainties due to limited toxicity data may lead to the over- or underestimation of SSLs, but the species tested were the same as, or similar to, test species used to derive Eco-SSLs that are assumed to be protective of terrestrial plant and invertebrate communities.

4.2 BIOAVAILABILITY-ADJUSTED BENCHMARKS

The BABs differ from Eco-SSLs/SSLs in the following ways: (1) benchmarks are adjusted to account for soil conditions that influence bioavailability to plants and invertebrates; (2) benchmarks are adjusted to account for soil aging, which also influences bioavailability; and (3) benchmarks are derived from the 5th percentile of a species sensitivity distribution of EC20s (20 percent effect concentrations). Key uncertainties in the BABs are as follows.

4.2.1 Bioavailability Equations Based on Physical and Chemical Soil Properties

The soil threshold calculator uses regression-based equations to predict the toxicity of metals as a function of one or more soil properties that strongly influence metal bioavailability to plants and invertebrates (for each metal, separate regression models are used for plants and invertebrates). ARCHE (2020) reviewed regression-based bioavailability models developed for European, Australian, and Chinese soils that were reported in peer-reviewed publications or in industry-sponsored studies conducted at university laboratories. ARCHE (2020) concluded that differences in the models were mainly due to differences in methods for soil analyses (e.g., measurement of CEC versus eCEC) and endpoints measured and that the applicability of models would not be restricted to a specific region or soil types. It is assumed that the regression-based bioavailability equations are reasonably generalized over a range of plant or invertebrate species, including tested species compared to those at the site.

4.2.2 Bioavailability-adjustments for Soil Leaching and Aging

As noted in Section 4.1.2 of this appendix, spiking of metal salts into soil for toxicity testing without a leaching or aging step can impact the ionic strength and pH of the soil and also overstate the bioavailability of metals relative to field-contaminated soils (such as site soils, because metal releases to Terrestrial Study Area soils are historical). Since EPA’s Eco-SSL guidance was developed (EPA, 2003), more studies have evaluated the influence of leaching and aging of metals in soil on toxicity to plants and invertebrates. The soil threshold calculator includes default leaching and aging factors that range between 2 and 4 for most metals. These factors typically range over an order of magnitude, with the default factors being conservative relative to the range of factors available. Accordingly, uncertainty in the default leaching and aging factors leans toward conservatism, but use of these factors decreases the overestimation bias generally present in Eco-SSLs and SSLs.

4.2.3 Applicability of Bioavailability-based Benchmarks to Regional Conditions

As noted in the first bullet in this section, the soil threshold calculator is based on models developed for European soils. ARCHE (2020), however, did conduct an evaluation of bioavailability corrections for North American soils and concluded that the soils used to develop the models covered the relevant range (10th to 90th percentile) of abiotic soil conditions in the U.S. and Canada. As such, soil conditions used to develop the European bioavailability models are not unique and can generally be applied to North America.

Note that percent clay and eCEC data were not measured as part of the 2012 Ecology Upland Soil Study. Minimum percent clay and eCEC values measured at decision units from the 2014 UCR Upland Soil Study that were located within each of the 13 Ecology subareas were therefore used as surrogate values to calculate plant and soil invertebrate BABs. Additional discussion of the selection of these values is presented in Attachment D2.

4.2.4 Relevance of Tested Plant and Invertebrate Species to Site Species

As for the soil toxicity tests used to develop the Eco-SSLs, the toxicity tests used to develop the BABs are frequently based on plant species of agricultural significance and, for invertebrates, commonly tested species are earthworms and springtails. As noted earlier, however, the plant species used to develop the Eco-SSLs for metals are often a mixture of crop and non-crop species, indicating that crops and non-crop plants are not uniquely sensitive. As such, the evidence indicates that the toxicity data for plant species used to derive the BABs are likely to be protective of site species. Further, the toxicity data sets used to develop the BABs were developed more recently and include studies that were not available when the Eco-SSLs were developed. This increases the likelihood of more sensitive species being tested and incorporated into the benchmarks.

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ATTACHMENT D1

SOIL SCREENING LEVELS FOR PLANTS AND INVERTEBRATES FOR THE BASELINE ECOLOGICAL RISK ASSESSMENT

Windward environmental LLC

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MEMORANDUM

To: Teck American Incorporated

From: Windward Environmental LLC

Subject: Soil Screening Levels for Plants and Invertebrates for the Baseline Ecological Risk Assessment

Date: January 29, 2020

INTRODUCTION

As outlined in the *Proposed Approach for Evaluating the Potential for Metals Toxicity to Plants and Invertebrates in the Baseline Ecological Risk Assessment (BERA) for the Upper Columbia River Remedial Investigation and Feasibility Study* (Windward 2019a), the first step in the risk assessment for plants and invertebrates is a comparison of metals concentrations in Upper Columbia River (UCR) soils to the U.S. Environmental Protection Agency's (EPA's) ecological soil screening levels (Eco-SSLs) for plants and invertebrates (USEPA 2016). Among the metals analyzed in UCR soils, eight lack an Eco-SSL or soil screening level benchmark for plants, invertebrates, or both (Table 1)[1] and therefore could not be screened in the draft final Chemicals of Potential Concern (COPC) Refinement (Windward 2019b). For six of these metals (antimony, arsenic, chromium, cobalt, silver, and vanadium), Eco-SSL documents were prepared, but Eco-SSL values could not be derived for either plants, invertebrates, or both because of

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[1] In addition to the eight metals discussed in herein, EPA (2016) states that Eco-SSLs are not available for aluminum "[b]ecause the measurement of total aluminum in soils is not considered suitable or reliable for the prediction of potential toxicity and bioaccumulation, an alternative procedure is recommended for screening aluminum in soils. The procedure is intended as a practical approach for determining if aluminum in site soils could pose a potential risk to ecological receptors. This alternative procedure replaces the derivation of numeric Eco-SSL values for aluminum. Potential ecological risks associated with aluminum are identified based on the measured soil pH. Aluminum is identified as a COPC only at sites where the soil pH is less than 5.5."

insufficient toxicity data. For two additional metals, molybdenum and thallium, Eco-SSL documents were never developed. The purpose of this document is to describe the development of soil screening levels for the eight metals lacking Eco-SSLs following EPA's Eco-SSL guidance.

Table 1. Metals needing soil screening levels

Metal	Soil Screening Level Needed?	
	Plants	Invertebrates
Antimony	yes	no[a]
Arsenic	no[b]	yes
Chromium	yes	no[a]
Cobalt	no[b]	yes
Molybdenum	yes	yes
Silver	no[a]	yes
Thallium	yes	yes
Vanadium	no[a]	yes

[a] A soil screening level is not needed because the metal is not a COPC for the receptor indicated.

[b] A soil screening level is not needed because there is an Eco-SSL value for the receptor indicated.

Eco-SSL – ecological soil screening level

METHODS

Compilation of toxicity data

The first step in developing the soil screening levels was to compile available and relevant toxicity data. For cobalt and molybdenum, the recently updated threshold calculator for metals in soil (V2.0) (ARCHE 2018) was relied on as the source of toxicity data. For antimony, arsenic, chromium, silver, and vanadium, which are not included in ARCHE's threshold calculator, toxicity data were first obtained from the Eco-SSL documents. These documents include all toxicity data with a score of at least 10 (see Data Extraction and Scoring section below) found from the literature search conducted as part of the Eco-SSL development process, even if there were not enough data points to derive an Eco-SSL. A literature search was then conducted for data published after the Eco-SSL publication dates for these five chemicals (2005 to 2007).

The literature search was conducted using the U.S. Department of Agriculture AGRICOLA database, the ECOTOXicology knowledgebase (ECOTOX) database, the U.S. National Library of Medicine's Toxicology Data Network (TOXNET), and Google Scholar. Only papers that met the Eco-SSL literature acceptance criteria were considered in deriving the soil screening levels (USEPA 2003a). In addition, only studies using the trivalent form of chromium were considered acceptable. Studies using the hexavalent form are not relevant because UCR soils are predominantly acidic (median and 95th percentile pH levels of 6.0 and 6.8, respectively) (Windward 2015) and acidic soils favor the transformation of hexavalent chromium to trivalent chromium (USEPA 2008).

Data extraction and scoring

Papers identified for antimony, arsenic, chromium, silver, and vanadium were reviewed to determine if any acceptable toxicity values were presented. Acceptable toxicity values included no-observed-adverse-effect concentrations (NOAECs), lowest-observed-adverse-effect concentration (LOAECs), or effect concentrations for 10 to 20% of the population (EC10 to EC20) (USEPA 2003b). If no acceptable toxicity values were presented in a paper, it was eliminated from further evaluation. In addition, only toxicity values presented as a concentration in soil were considered acceptable for deriving soil screening levels.

Each acceptable toxicity study was scored using nine study evaluation criteria from EPA (USEPA 2003b), as follows:

1) Testing was done under conditions of high bioavailability; bioavailability scores of 0, 1, or 2 were assigned based on the scoring matrix from EPA (2003b, Attachment A). Per USEPA (2003b), bioavailability was evaluated differently for cationic metals than for anionic metals (as described in the next section of this memo on derivation of soil screening levels; see footnote 5 on page 5).
2) Experimental designs for laboratory and field studies were documented and appropriate.
3) Concentration of test substance in soil was reported.
4) Control responses were acceptable.
5) Test was a chronic or life cycle test.
6) Chemical dosing procedure was reported and appropriate for chemical and test.
7) Dose-response relationship was reported or can be established from reported data.
8) The statistical tests used to calculate the benchmark and the level of significance were described.
9) The origin of the test organisms was described.

The methods for scoring are described in detail in Attachment A to the Eco-SSL standard operating procedure (SOP) No. 2 (USEPA 2003b). Studies that did not receive an overall score of at least 10 or a bioavailability score greater than zero were not considered further in the screening-level derivation process. Each criterion was allotted a maximum of 2 points.

If a paper reported toxicity data for more than one test species, chemical form, or soil type (including pH and organic matter [OM]), these data were considered to come from different studies for the purpose of deriving a soil screening level. Ecologically relevant endpoints for deriving Eco-SSLs are reproduction, population,[2] growth, biomass (plants only), and physiology (plants only), as specified by EPA and described in more detail in Table 1 of the SOP (USEPA 2003b).

For cobalt and molybdenum, chronic EC20s were compiled from the threshold calculator for metals in soil (ARCHE 2018). The soil toxicity data in the threshold calculator met relevance and reliability criteria put forth by Klimisch et al. (1997) and scoring systems for reporting and evaluating ecotoxicity data described in Moermond et al. (2016). Relevance and reliability requirements included:

1) Endpoints related to population-level effects (survival, growth, reproduction)
2) Testing of sensitive life stages
3) Complete description of test methods
4) Description of test soil characteristics
5) Analytical verification of test chemical concentrations or demonstration of nominal concentrations close to actual concentrations
6) Adequate control response and a clear concentration-response relationship.

Tests included in the threshold calculator, therefore, were considered to meet the minimum acceptability requirements for Eco-SSL calculations and were not scored (ARCHE 2018).[3]

Derivation of soil screening levels

The first step in deriving soil screening levels from the extracted data was to select a preferred toxicity value from a study if more than one value was presented for a particular species, soil type (including pH and OM), and chemical form. Using the methods outlined in the Eco-SSL guidance (USEPA 2003b), the following hierarchy was applied in selecting the preferred toxicity value:

EC20 > Maximum Acceptable Threshold Concentration (MATC)[4] > EC10

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[2] Population measures provided in Table 1 (USEPA 2003b) apply to a group of soil invertebrates of the same species occupying the same area at a given time, and include measures such as population density (number/area) and intrinsic population growth rate.

[3] The soil toxicity data included in the threshold calculator were evaluated relative to the Klimisch and Criteria for Reporting and Evaluating ecotoxicity Data (CRED) scoring systems (Klimisch et al. 1997; Moermond et al. 2016) and only those data in Category 1 ("Reliable without restrictions") and Category 2 ("Reliable with restrictions") were included (ARCHE 2018). Because the database went through extensive quality assurance/quality control review, additional review of the studies was not conducted as part of this evaluation.

[4] If only NOAEC and LOAEC values were presented for the study, the MATC was calculated as the geomean of the two values.

If a study reported toxicity values for more than one endpoint for a particular species, soil type, or chemical form, the following hierarchy from EPA (2003b) was applied for invertebrates:

Reproduction > Population > Growth

For plants, the most sensitive measurement of biomass production was selected. If biomass was measured in more than one way (i.e., shoot growth and root length), the most sensitive endpoint was selected (i.e., the endpoint with the lowest threshold).

The studies were then ranked by bioavailability score. Because the bioavailability of metals is influenced by pH and soil OM, a score of 0, 1 or 2 was assigned using a scoring matrix based on ranges of pH and OM (USEPA 2003b, Attachment A);[5] the higher score was associated with greater bioavailability. Bioavailability scoring differs for cationic metals and anionic metals, with the primary difference between the two being that cationic metals have a higher bioavailability score in acidic soils and anionic metals have a higher bioavailability score in less acidic soils. In this evaluation, arsenic, molybdenum, and vanadium were evaluated as anionic metals in soil, while the remaining were considered cationic metals in soil. Bioavailability scores were assigned to both the data from the reviewed literature and the data from the threshold calculator (ARCHE 2018); scores were already available for data from Eco-SSL documents.

At least three data points were needed to calculate a geomean for use as the soil screening level. If there were at least three data points with a bioavailability score of 2, all of the toxicity values with scores of 2 were used to calculate a geomean; none of the toxicity values with scores of 1 would be included.[6] If there were fewer than three data points with a bioavailability score of 2, all data points with bioavailability scores of 1 were added to the pool of data. For example, if there were two data points with scores of 2 and two data points with scores of 1, all four values would be used to calculate the geomean. For antimony, arsenic, chromium, silver, and vanadium, any acceptable data points from the literature reviews conducted in association with the Eco-SSL documents were also included in this step.

EPA's SOP for deriving plant and invertebrate Eco-SSL values (USEPA 2003b) requires at least three data points in order for the geomean calculated to be used as an Eco-SSL. In this document, the EPA method was modified so that soil screening levels could be

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[5] Per USEPA (2003b), cationic metals in natural soils were assigned a low bioavailability score of 0 if soil pH was >7 and OM was between 2 and 6 percent or if soil pH was ≥5.5 and OM was >6 percent. Anionic metals in natural soils were assigned a low bioavailability score of 0 if soil pH was ≤5.5 and OM was between 2 and 6 percent or if soil pH was <7 and OM was >10 percent.

[6] Studies excluded from the calculation of the geomean because of low bioavailability scores will be retained for potential use in the BERA. If hazard quotients indicate the potential for unacceptable risk for a particular metal using the Eco-SSLs or SSLs, then a bioavailability-based evaluation will be conducted using toxicity tests data from the excluded studies, or using ARCHE's threshold calculator (2018) for those metals included in the calculator. Bioavailability-based assessments are included as one of the steps in the proposed soil BERA approach (Windward 2019a).

derived if there were fewer than three data points. If only two data points were available, the lower value was selected as the soil screening level. Uncertainties associated with screening levels derived using only two data points are discussed in the Uncertainties section of this memorandum.

Lastly, the Eco-SSL guidance document (USEPA 2005c) indicates that preference in deriving the Eco-SSLs is given to studies with high bioavailability, and in general, metals in wetland soils are expected be less bioavailable because of the high organic content of the soil. As stated by EPA (2005c), Eco-SSLs are expected to be conservative for most soils including wetlands, and therefore may be useful for screening contaminants in wetland soils as long as they are not continuously inundated (i.e., sediments).

Results

Table 2 presents a list of papers reviewed, and whether data were considered acceptable for deriving a soil screening level and, if not acceptable, the rationale. The acceptable data points for deriving the soil screening levels based on the process described in the Methods section are presented in Table 3 and the calculated screening levels are presented in Table 4. The following subsections summarize the data used to calculate the screening level for each metal and receptor group.

Table 2. Non-Eco-SSL papers reviewed

Citation	Used to Derive Screening Level?	Reason Not Used to Derive Screening Level	Full Reference
Antimony and Plants			
Oorts et al. (2008)	yes	na	Oorts K, Smolders E, Degryse F, Buekers J, Gasco G, Cornelis G, Mertens J. 2008. Solubility and toxicity of antimony trioxide (Sb_2O_3) in soil. Environ Sci Tech 42:4378-4383.
Pan et al. (2011)	no	pH and organic matter not reported	Pan X, Zhang D, Chen X, Bao A, Li L. 2011. Antimony accumulation, growth performance, antioxidant defense system and photosynthesis of Zea mays in response to antimony pollution in soil. Wat Air Soil Pollut 215(1-4):517-523.
Tschan et al. (2009)	no	no data reported	Tschan M, Robinson BH, Nodari M, Schulin R. 2009. Antimony uptake by different plant species from nutrient solution, agar and soil. Environ Chem 6:144-152.
Tschan et al. (2010)	no	effect levels not relevant	Tschan M, Robinson B, Johnson CA, Burgi A, Schulin R. 2010. Antimony uptake and toxicity in sunflower and maize growing in SBIII and SBV contaminated soil. Plant Soil 334:235-245.
Zhao et al. (2015)	no	organic matter out of range	Zhao X, Zheng L, Xia X, Yin W, Lei J, Shi S, Shi X, Li H, Li Q, Wei Y, Chang E, Jiang Z, Liu J. 2015. Responses and acclimation of Chinese cork oak (*Quercus variabilis* Bl.) to metal stress: the inducible antimony tolerance in oak trees. Environ Sci Pollut Res 22(15):11456-11466.
Arsenic and Invertebrates			
Alves et al. (2018)	yes	na	Alves PRL, da Silva EB, Cardoso EJBN, Alleoni LRF. 2018. Ecotoxicological impact of arsenic on earthworms and collembolans as affected by attributes of a highly weathered tropical soil. Environ Sci Pollut Res 25:13217-13225.
Crouau and Moia (2006)	no	unacceptable low bioavailability score of 0	Crouau Y, Moia C. 2006. The relative sensitivity of growth and reproduction in the springtail, *Folsomia candida,* exposed to xenobiotics in the laboratory: an indicator of soil toxicity. Ecotoxicol Environ Saf 64:115-121.
Lin et al. (2019)	no	effect level not relevant	Lin X, Sun Z, Zhao L, Ma J, Li X, He F, Hou H. 2019. The toxicity of exogenous arsenic to soil-dwelling springtail *Folsomia candida* in relation to soil properties and aging time. Ecotoxicol Environ Saf 171:530-538.
Lock and Janssen (2002)	no	unacceptable low bioavailability score of 0	Lock K, Janssen CR. 2002. Toxicity of arsenate to the compostworm *Eisenia fetida*, the potworm *Enchytraeus albidus* and the springtail *Folsomia candida*. Bull Environ Contam Toxicol 68:760-765.

Table 2. Non-Eco-SSL papers reviewed

Citation	Used to Derive Screening Level?	Reason Not Used to Derive Screening Level	Full Reference
Chromium and Plants			
Baderna et al. (2015)	no	low bioavailability score (standard artificial soil receives score of 1 per USEPA [2003b] and sufficient data with higher bioavailability score are available)	Baderna D, Lomazzi E, Pogliaghi A, Ciaccia G, Lodi M, Benfenati E. 2015. Acute phytotoxicity of seven metals alone and in mixture: Are Italian soil threshold concentrations suitable for plant protection? Environ Res 140:102-111.
Bahrami et al. (2016)	no	OM not reported, no effects	Bahrami M, Heidari M, Ghorbani H. 2016. Variation in antioxidant enzyme activities, growth and some physiological parameters of bitter melon (*Momordica charantia*) under salinity and chromium stress. J Environ Biol 37:529-535.
Ding et al. (2014)	yes	na	Ding C, Li X, Zhang T, Ma Y, Wang X. 2014. Phytotoxicity and accumulation of chromium in carrot plants and the derivation of soil thresholds for Chinese soils. Ecotox Environ Saf 108:179-186.
do Nascimento et al. (2018)	no	OM not reported, no effect levels	do Nascimento JL, de Almeida A-AF, Barroso JP, Mangabeira PAO, Ahnert D, Sousa AGR, Silva JVS, Baligar VC. 2018. Physiological, ultrastructural, biochemical and molecular responses of young cocoa plants to the toxicity of Cr (III) in soil. Ecotox Environ Saf 159:272-283.
Fozia et al. (2008)	no	OM not reported, no effect levels	Fozia A, Muhammad AZ, Muhammad A, Zafar MK. 2008. Effect of chromium on growth attributes in sunflower (*Helianthus annuus* L.). J Environ Sci 20:1475-1480.
Lukina et al. (2016)	no	low bioavailability score (standard artificial soil receives score of 1 per USEPA [2003b] and sufficient data with higher bioavailability score are available)	Lukina AO, Boutin C, Rowland O, Carpenter DJ. 2016. Evaluating trivalent chromium toxicity on wild terrestrial and wetland plants. Chemosphere 162:355-364.
Su et al. (2005)	no	OM not reported, no effect levels	Su Y, Han FX, Sridhar BBM, Monts DL. 2005. Phytotoxicity and phytoaccumulation of trivalent and hexavalent chromium in brake fern. Environ Toxicol Chem 24(8):2019-2026.

Table 2. Non-Eco-SSL papers reviewed

Citation	Used to Derive Screening Level?	Reason Not Used to Derive Screening Level	Full Reference
UdDin et al. (2015)	no	OM not reported, no effect levels	UdDin I, Bano A, Masood S. 2015. Chromium toxicity tolerance of *Solanum nigrum* L. and *Parthenium hysterophorus* L. plants with reference to ion pattern, antioxidation activity and root exudation. Ecotox Environ Saf 113:271-278.
Wyszkowski and Radziemska (2010)	no	no effect levels	Wyszkowski M, Radziemska M. 2010. Effects of chromium (III and VI) on spring barley and maize biomass yield and content of nitrogenous compounds. J Toxicol Env Health Part A 73:1274-1282.
Silver and Invertebrates			
Bicho et al. (2016)	yes	na	Bicho RC, Ribeiro T, Rodrigues NP, Scott-Fordsmand JJ, Amorim MJB. 2016. Effects of Ag nanomaterials (NM300K) and Ag salt ($AgNO_3$) can be discriminated in a full life cycle long term test with *Enchytraeus crypticus*. J Haz Mat 318:608-614.
Diez-Ortiz et al. (2015)	no	effect level not relevant	Diez-Ortiz M, Lahive E, George S, Ter Schure A, Van Gestel CAM, Jurkschat K, Svendsen C, Spurgeon DJ. 2015. Short-term soil bioassays may not reveal the full toxicity potential for nanomaterials; bioavailability and toxicity of silver ions ($AgNO_3$) and silver nanoparticles to earthworm Eisenia fetida in long-term aged soils. Environ Pollut 203:191-198.
Mendes et al. (2015)	yes	na	Mendes LA, Maria VL, Scott-Fordsmand JJ, Amorim MJB. 2015. Ag nanoparticles (Ag NM300K) in the terrestrial environment: effects at population and cellular level in *Folsomia candida* (Collembola). Int J Environ Res Public Health 12:12530-12542.
Mendes et al. (2018)	no	effect level not relevant	Mendes LA, Maria VL, Scott-Fordsmand JJ, Amorim MJB. 2018. Multigenerational exposure of *Folsomia candida* to silver: effect of different contamination scenarios (continuous versus pulsed and recovery). Sci Tot Environ 631-632:326-333.
Schlich et al. (2013)	no	effect level not relevant	Schlich K, Klawonn T, Terytze K, Hund-Rinke K. 2013. Effects of silver nanoparticles and silver nitrate in the earthworm reproduction test. Environ Toxicol Chem 32(1):181-188.
Waalewijn-Kool et al. (2014)	yes	na	Waalewijn-Kool PL, Klein K, Fornies RM, van Gestel CAM. 2014. Bioaccumulation and toxicity of silver nanoparticles and silver nitrate to the soil arthropod *Folsomia candida*. Ecotoxicol 23:1629-1637.

Eco-SSL – ecological soil screening level

na – not applicable

OM – organic matter

Table 3. Toxicity data used to derive soil screening levels

Reference	Bioavailability Score	Chemical Form	Scientific Name	Common Name	Soil pH	% OM	Endpoint	Type of Effect (Toxicity Parameter)	Effect Level/ Toxicity Value (mg/kg dw)[a]
Antimony and Plants									
Oorts et al. (2008)	1	antimony trioxide	*Lactuca sativa* cv. Pontiac	lettuce	7.0	1.6	shoot yield	EC10	4,505
Oorts et al. (2008)	1	antimony trioxide	*Hordeum vulgare* cv. Mauritia	summer barley	7.0	1.6	root elongation	EC10	1,948
								lowest value	*1,948*
Arsenic and Invertebrates									
Alves et al. (2018)	1	sodium arsenate	*Eisenia andrei*	oligochaete	6.1	5.24	number of juveniles	EC20	7.3
Alves et al. (2018)	1	sodium arsenate	*Folsomia candida*	springtail	6.1	5.24	number of juveniles	EC20	8.4
								lowest value	*7.3*
Chromium and Plants									
Ding et al. (2014)	2	chromium chloride	*Daucus carota*	carrot	4.84	0.9	yield (edible portion of plant)	MATC	199.3
Ding et al. (2014)	2	chromium chloride	*Daucus carota*	carrot	4.99	1.7	yield (edible portion of plant)	MATC	182.0
Ding et al. (2014)	2	chromium chloride	*Daucus carota*	carrot	5.35	1.5	yield (edible portion of plant)	MATC	182.8
Ding et al. (2014)	2	chromium chloride	*Daucus carota*	carrot	5.68	1.7	yield (edible portion of plant)	MATC	153.2

Table 3. Toxicity data used to derive soil screening levels

Reference	Bioavailability Score	Chemical Form	Scientific Name	Common Name	Soil pH	% OM	Endpoint	Type of Effect (Toxicity Parameter)	Effect Level/ Toxicity Value (mg/kg dw)[a]
Ding et al. (2014)	2	chromium chloride	*Daucus carota*	carrot	6.83	1.0	yield (edible portion of plant)	MATC	211.0
Ding et al. (2014)	2	chromium chloride	*Daucus carota*	carrot	6.93	1.7	yield (edible portion of plant)	MATC	230.3
								geomean	*192*
Cobalt and Invertebrates[b]									
De Schamphelaere et al. (2008) as cited in ARCHE (2018)	2	cobalt chloride	*Folsomia candida*	springtail	4.4	2.1	number of juveniles per jar	EC20	28.2
De Schamphelaere et al. (2008) as cited in ARCHE (2018)	2	cobalt chloride	*Folsomia candida*	springtail	4.5	2.7	number of juveniles per jar	EC20	124.1
De Schamphelaere et al. (2008) as cited in ARCHE (2018)	2	cobalt chloride	*Folsomia candida*	springtail	4.7	3.7	number of juveniles per jar	EC20	219.3
De Schamphelaere et al. (2008) as cited in ARCHE (2018)	2	cobalt chloride	*Folsomia candida*	springtail	5.7	1.4	number of juveniles per jar	EC20	339.2
								geomean	*127*
Molybdenum and Plants[b]									
as cited in ARCHE (2018)	2	sodium molybdate	*Brassica napus*	rapeseed	6.7	1.5	yield (shoot)	EC20	11.8

Table 3. Toxicity data used to derive soil screening levels

Reference	Bioavailability Score	Chemical Form	Scientific Name	Common Name	Soil pH	% OM	Endpoint	Type of Effect (Toxicity Parameter)	Effect Level/ Toxicity Value (mg/kg dw)[a]
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Brassica napus*	rapeseed	6.8	1.0	yield (shoot)	EC20	21.5
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Brassica napus*	rapeseed	7.3	2.2	yield (shoot)	EC20	30.5
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Brassica napus*	rapeseed	7.6	3.6	yield (shoot)	EC20	7.1
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Brassica napus*	rapeseed	7.8	1.4	yield (shoot)	EC20	5.2
Mico et al. (2007) as cited in ARCHE (2018)	2	sodium molybdate	*Hordeum vulgare*	barley	6.7	1.5	yield (root length)	EC20	63.2
Mico et al. (2007) as cited in ARCHE (2018)	2	sodium molybdate	*Hordeum vulgare*	barley	6.8	1.0	yield (root length)	EC20	1,325.3
Mico et al. (2007) as cited in ARCHE (2018)	2	sodium molybdate	*Hordeum vulgare*	barley	7.3	2.2	yield (root length)	EC20	37.7
Mico et al. (2007) as cited in ARCHE (2018)	2	sodium molybdate	*Hordeum vulgare*	barley	7.6	3.6	yield (root length)	EC20	53.7
Mico et al. (2007) as cited in ARCHE (2018)	2	sodium molybdate	*Hordeum vulgare*	barley	7.8	1.4	yield (root length)	EC20	8.5
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Lolium perenne*	ryegrass	6.7	1.5	yield (shoot)	EC20	46.7

Table 3. Toxicity data used to derive soil screening levels

Reference	Bioavailability Score	Chemical Form	Scientific Name	Common Name	Soil pH	% OM	Endpoint	Type of Effect (Toxicity Parameter)	Effect Level/ Toxicity Value (mg/kg dw)[a]
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Lolium perenne*	ryegrass	6.8	1.0	yield (shoot)	EC20	167.2
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Lolium perenne*	ryegrass	7.3	2.2	yield (shoot)	EC20	55.3
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Lolium perenne*	ryegrass	7.6	3.6	yield (shoot)	EC20	28.2
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Lolium perenne*	ryegrass	7.8	1.4	yield (shoot)	EC20	40.5
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Lycopersicon esculentum*	tomato	6.7	1.5	yield (shoot)	EC20	46.7
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Lycopersicon esculentum*	tomato	6.8	1.0	yield (shoot)	EC20	111.9
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Lycopersicon esculentum*	tomato	7.3	2.2	yield (shoot)	EC20	18.0
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Lycopersicon esculentum*	tomato	7.6	3.6	yield (shoot)	EC20	18.4
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Lycopersicon esculentum*	tomato	7.8	1.4	yield (shoot)	EC20	6.1
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Trifolium pratense*	red clover	6.7	1.5	yield (shoot)	EC20	45.4

Table 3. Toxicity data used to derive soil screening levels

Reference	Bioavailability Score	Chemical Form	Scientific Name	Common Name	Soil pH	% OM	Endpoint	Type of Effect (Toxicity Parameter)	Effect Level/ Toxicity Value (mg/kg dw)[a]
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Trifolium pratense*	red clover	6.8	1.0	yield (shoot)	EC20	1.6
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Trifolium pratense*	red clover	7.3	2.2	yield (shoot)	EC20	22.5
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Trifolium pratense*	red clover	7.6	3.6	yield (shoot)	EC20	5.8
Mico et al. (2009) as cited in ARCHE (2018)	2	sodium molybdate	*Trifolium pratense*	red clover	7.8	1.4	yield (shoot)	EC20	9.3
								geomean	26.0
Molybdenum and Invertebrates[b,c]									
van Gestel et al. (2010) as cited in ARCHE (2018)	2	sodium molybdate	*Eisenia andrei*	oligochaete	6.7	1.5	number of juveniles per jar	EC20	37.1
van Gestel et al. (2010) as cited in ARCHE (2018)	2	sodium molybdate	*Eisenia andrei*	oligochaete	7.3	2.2	number of juveniles per jar	EC20	31.7
van Gestel et al. (2010) as cited in ARCHE (2018)	2	sodium molybdate	*Eisenia andrei*	oligochaete	7.6	3.6	number of juveniles per jar	EC20	64.4
van Gestel et al. (2010) as cited in ARCHE (2018)	2	sodium molybdate	*Eisenia andrei*	oligochaete	7.8	1.4	number of juveniles per jar	EC20	37.9
van Gestel et al. (2010) as cited in ARCHE (2018)	2	sodium molybdate	*Enchytraeus crypticus*	oligochaete	6.7	1.5	number of juveniles per jar	EC20	784.7
van Gestel et al. (2010) as cited in ARCHE (2018)	2	sodium molybdate	*Enchytraeus crypticus*	oligochaete	6.8	1.0	number of juveniles per jar	EC20	2,048.4

Table 3. Toxicity data used to derive soil screening levels

Reference	Bioavailability Score	Chemical Form	Scientific Name	Common Name	Soil pH	% OM	Endpoint	Type of Effect (Toxicity Parameter)	Effect Level/ Toxicity Value (mg/kg dw)[a]
van Gestel et al. (2010) as cited in ARCHE (2018)	2	sodium molybdate	*Enchytraeus crypticus*	oligochaete	7.3	2.2	number of juveniles per jar	EC20	1,130.9
van Gestel et al. (2010) as cited in ARCHE (2018)	2	sodium molybdate	*Enchytraeus crypticus*	oligochaete	7.8	1.4	number of juveniles per jar	EC20	1,694.8
								geomean	233
Silver and Invertebrates									
Mendes et al. (2015)	2	silver nitrate	*Folsomia candida*	springtail	5.5	3.0	number of juveniles	EC20	76
Bicho et al. (2016)	2	silver nitrate	*Enchytraeus crypticus*	oligochaete	5.5	1.77	FLC reproduction @ 46 days	EC20	68
Bicho et al. (2016)	2	silver nitrate	*Enchytraeus crypticus*	oligochaete	5.5	1.77	ERT reproduction @ 21 days	EC20	47
Waalewijn-Kool et al. (2014)	2	silver nitrate	*Folsomia candida*	springtail	5.5	3.6	juveniles per jar	EC10	47.6
								geomean	58.3
Thallium and Plants									
Heim et al. (2002)	1	thallium carbonate	*Lepidium sativum*	garden cress	6.0	10	growth (roots)	MATC	31.6
Heim et al. (2002)	1	thallium carbonate	*Lepidium sativum*	garden cress	6.0	10	growth (shoots)	MATC	3.2
								lowest value	3.2
Thallium and Invertebrates									
Heim et al. (2002)	1	thallium carbonate	*Eisenia fetida*	earthworm	6.0	10	mortality	MATC	223.6

Table 3. Toxicity data used to derive soil screening levels

Reference	Bioavailability Score	Chemical Form	Scientific Name	Common Name	Soil pH	% OM	Endpoint	Type of Effect (Toxicity Parameter)	Effect Level/ Toxicity Value (mg/kg dw)[a]
Heim et al. (2002)	1	thallium carbonate	*Eisenia fetida*	earthworm	6.0	10	growth	MATC	70.7
Heim et al. (2002)	1	thallium carbonate	*Eisenia fetida*	earthworm	6.0	10	number of cocoons	MATC	22.4
Heim et al. (2002)	1	thallium carbonate	*Eisenia fetida*	earthworm	6.0	10	number of juveniles	MATC	2.2
Heim et al. (2002)	1	thallium carbonate	*Arianta arbustorum*	land snail	6.0	10	growth	MATC	31.6
								geomean	30.2
Vanadium and Invertebrates									
Environment Canada (1995) as cited in Environment Canada (1999)	1	vanadium pentoxide	*Eisenia fetida*	earthworm	4.2-4.3	5.6	mortality	MATC	294

[a] If wet weight or dry weight was not specified in the data source, dry weight was assumed.

[b] Because the ARCHE database went through extensive quality assurance/quality control review (ARCHE 2018), additional review of the studies for cobalt and molybdenum was not conducted as part of this evaluation.

[c] One test result for *Eisenia andrei* (bioavailability score of 2 and EC20 of 1,299 mg/kg) was excluded because of control performance issues (ARCHE 2018). The mean control reproduction in this test was 5.8 juveniles per jar, while controls in the other tests had mean control reproduction ranging from 37.3 to 97.3 juveniles per jar.

EC10 – effect concentrations for 10% of the population

EC20 – effect concentrations for 20% of the population

ERT – enchytraeid reproduction test

FLC – full life cycle test

MATC – maximum acceptable toxicant concentration

nr – not reported

OM – organic matter

Table 4. Calculated soil screening levels

Metal	Soil Screening Level (mg/kg dw)			
	Plants	Data Points Used to Derive Screening Level	Invertebrates	Data Points Used to Derive Screening Level
Antimony	1,900[a]	2 EC10s	not needed[b]	not applicable
Arsenic	not needed[c]	not applicable	7.3[a]	2 EC20s
Chromium	190	6 MATCs	not needed[b]	not applicable
Cobalt	not needed[c]	not applicable	130	4 EC20s
Molybdenum	26	25 EC20s	233	8 EC20s
Silver	not needed[b]	not applicable	58	3 EC20s; 1 EC10
Thallium	3.2[a]	2 MATCs	30	5 MATCs
Vanadium	not needed[b]	not applicable	294	1 MATC[d]

Note: Two significant figures are used for the soil screening levels.

[a] These soil screening levels were not derived using EPA's SOP for deriving plant and invertebrate Eco-SSLs, because there were not at least three data points available to calculate a geomean; instead the lower of the two data points was selected

[b] A soil screening level is not needed because the metal is not a COPC for the receptor indicated.

[c] A soil screening level is not needed because there is an Eco-SSL value.

[d] The vanadium soil screening level for invertebrates was not derived using EPA's SOP for deriving an Eco-SSL because the unpublished study was not available to review the study evaluation criteria, and because at least three data points were not available to calculate a geomean.

EC10 – effect concentrations for 10% of the population
EC20 – effect concentrations for 20% of the population
Eco-SSL – ecological soil screening level
EPA – US Environmental Protection Agency
MATC – maximum acceptable threshold concentration
mg/kg dw – milligrams per kilogram dry weight
SOP – standard operating procedure

Antimony

Only two datasets were acceptable to derive a soil screening level for antimony and plants. The screening level of 1,900 mg/kg for barley growth shown in Table 4 is based on the lower of two EC10s from Oorts et al. (2008). There were no acceptable data points in the Eco-SSL document (USEPA 2005a).

Arsenic

Only two datasets were acceptable to derive a soil screening level for arsenic and invertebrates. The screening level of 7.3 mg/kg shown in Table 4 is based on the lower of two EC20s from Alves et al. (2018). The effect is for oligochaete reproduction in soil with a bioavailability score of 1. There were no acceptable data points in the Eco-SSL document (USEPA 2005b).

Chromium

For plants, the screening level of 190 mg/kg shown in Table 4 is based on the geomean of six MATCs from Ding et al. (2014). The effects are for carrot growth (i.e., yield) in six soil types with bioavailability scores of 2. There were no acceptable data points for plants in the Eco-SSL document (USEPA 2008).

Cobalt

For invertebrates, the screening level of 130 mg/kg shown in Table 4 is based on the geomean of four EC20s from the threshold calculator (ARCHE 2018). The effects are for springtail reproduction in four soil types with bioavailability scores of 2. The threshold calculator included additional acceptable data points, but they were not used in deriving a screening level because they had bioavailability scores of less than 2 and there were at least three data points with scores of 2.

Molybdenum

For plants, the screening level of 26 mg/kg shown in Table 4 is based on the geomean of 25 EC20s from the threshold calculator (ARCHE 2018). The effects are for rapeseed, barley, ryegrass, tomato, and red clover growth (i.e., yield) in five soil types with bioavailability scores of 2.

For invertebrates, the screening level of 233 mg/kg shown in Table 4 is based on the geomean of 8 EC20s from the threshold calculator (ARCHE 2018). The effects are for oligochaete reproduction (i.e., number of juveniles) in different soils with bioavailability scores of 2. There was a ninth oligochaete test with a bioavailability score of 2 and an EC20 of 1,299 mg/kg, but it was excluded due to low control performance.

Additional acceptable data for plants and invertebrates were included in the threshold calculator (ARCHE 2018), but these had bioavailability scores of less than 2 and were not used in deriving a screening level because there were at least three data points with scores of 2.

Silver

For invertebrates, the screening level of 58 mg/kg shown in Table 4 is based on the geomean of one EC20 from Mendes et al. (2015), two EC20s from Bicho et al. (2016), and one EC10 from Waalewijn-Kool et al. (2014). The effects are for springtail and oligochaete reproduction in soils with bioavailability scores of 2. There were no acceptable data points in the Eco-SSL document (USEPA 2006).

Thallium

For plants, only two datasets were available to derive a soil screening level. The screening level of 3.2 mg/kg for garden cress growth shown in Table 4 is based on the lower of the two MATCs from Heim et al. (2002).

For invertebrates, the screening level of 30 mg/kg shown in Table 4 is based on the geomean of 5 MATCs from Heim et al. (2002). The effects are for earthworm mortality, growth, and reproduction and land snail growth in artificial soil with a bioavailability score of 1.

Vanadium

For invertebrates, toxicity data were available from only one study, although the original paper was unpublished and not available for review (Environment Canada

(1995), as cited in Environment Canada (1999)). Because this study could not be reviewed, information on some of the nine study evaluation criteria was not available. However, these data were used to derive the soil screening level because of the lack of any other data for vanadium, and because the study was considered acceptable by Environment Canada in deriving their soil quality guideline for vanadium. The soil screening level of 294 mg/kg is based on earthworm mortality in soil with a bioavailability score of 2.

UNCERTAINTIES

Key uncertainties in calculating the soil screening levels are associated with sample size limitations, the range of available toxicity values, representativeness of tested species, the range of soil types tested, the representativeness of the endpoints tested, and uncertainty about bioavailability in tested soils. In general, soil screening levels derived using a greater number of data points that encompass a variety of species, soil types, and endpoints are more likely to represent the average toxicity over a range of conditions than those calculated using limited data. However, there is some uncertainty associated with soil screening levels that are based on a large range of toxicity values (i.e., molybdenum for plants and invertebrates).

Soil screening levels for antimony/plants, arsenic/invertebrates, and thallium/plants are more uncertain than those for the other metals in this document. For antimony/plants and thallium/plants, only two acceptable data points were available, the bioavailability score was 1, and only one species was represented. Similarly, for arsenic/invertebrates, two acceptable data points were available and the bioavailability score was 1, but data for two species were available. Soil screening levels for other metal/receptor combinations were derived from at least four data points with bioavailability scores of 2. There is also some uncertainty associated with soil screening levels for chromium/plants and cobalt/invertebrates because only one species was represented. It is unknown whether these uncertainties due to limited toxicity data may lead to the over- or underestimation of soil screening levels, as it depends on whether the species tested for each metal are representative of sensitive species.

The vanadium/invertebrate soil screening level is uncertain because only one data point was available. In addition, the unpublished study was not available for review, although it is presumably of acceptable quality because it was used by Environment Canada to derive the soil quality guideline for vanadium.

In addition, there is uncertainty created by using different effect levels (e.g., EC10, EC20, and MATC). The preferred effect level is 20%, following EPA guidance (USEPA 2005c). Thus, the use of EC10s is conservative relative to the use of EC20s, whereas the use of MATCs may under- or over-predict the 20% effect level depending on the effect levels associated with the NOAEC and LOAEC used to derive the MATC.

SUMMARY

EPA's Eco-SSL guidance was used to derive soil screening levels for metals without Eco-SSL values. Toxicity data used to derive the soil screening levels were obtained from a literature search, from the threshold calculator (ARCHE 2018), and from the Eco-SSL documents. Soil screening levels were derived for antimony (plants), arsenic (invertebrates), chromium (plants), cobalt (invertebrates), molybdenum (plants and invertebrates), silver (invertebrates), and thallium (plants and invertebrates).

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ATTACHMENT D2

PLANT AND INVERTEBRATE SOIL BENCHMARKS FOR USE IN THE UPPER COLUMBIA RIVER BASELINE ECOLOGICAL RISK ASSESSMENT

Plant and Invertebrate Soil Benchmarks for Use in the Upper Columbia River Baseline Ecological Risk Assessment

Prepared by: CH2M, EPA, and Ecological Risk Incorporated, December 2023

1 INTRODUCTION

This technical memorandum describes the benchmarks that will be used in the Upper Columbia River (UCR) baseline ecological risk assessment (BERA) for the evaluation of risk to plants and invertebrates from the soil exposure pathway. Two types of benchmarks will be used:

- U.S. Environmental Protection Agency (EPA) ecological soil screening levels (Eco-SSLs) for plants and invertebrates , or soil screening levels (SSLs) developed for use in the BERA for metals without Eco-SSLs (Windward 2020)
- Bioavailability-adjusted benchmarks derived from the Threshold Calculator for metals in soil developed by Oorts (2020)

Section 2 of this memorandum presents the metals identified for evaluation in the BERA based on the *Chemicals of Potential Concern Refinement for Aquatic and Terrestrial Receptors* (TAI 2019, 2020) (hereinafter referred to as the COPC refinement). Sections 3 and 4 of this memorandum present the Eco-SSLs and SSLs and the bioavailability-adjusted benchmarks from the Threshold Calculator, respectively. Section 5 describes estimation of percent clay (%Clay) and effective cation exchange capacity (cCEC) for the 2012 Ecology Upland Soil Study samples that were not analyzed for these parameters.

2 METALS FOR EVALUATION IN THE BERA

The COPC refinement (TAI 2019, 2020) identified a metal as a COPC for plants or invertebrates if that metal had more than one exceedance of its Eco-SSL (Table 1). Metal/receptor combinations that had only one exceedance or that had no benchmarks were identified as chemicals of interest (COIs) that would be evaluated in more depth in the BERA. The remaining metal/receptor combinations that did not screen in as COPCs were eliminated from further evaluation. Metal/receptor combinations identified as COPCs or COIs in Table 1 will be further evaluated in the BERA using benchmarks presented in this memorandum.

Table 1. COPC refinement results for metals

Metal	Terrestrial Plants	Terrestrial Invertebrates
Aluminum	COPC	COPC
Antimony	retained as COI[a]	not a COPC
Arsenic	COPC	retained as COI[a]
Barium	COPC[b,c]	COPC
Beryllium	not a COPC	not a COPC
Cadmium	not a COPC	not a COPC
Chromium	retained as COI[a]	retained as COI[c,d]
Cobalt	COPC	retained as COI[a]
Copper	COPC	COPC
Iron	COPC	COPC
Lead	COPC	not a COPC
Manganese	COPC	COPC
Mercury	not a COPC	not a COPC
Molybdenum	retained as COI[a]	retained as COI[a]
Nickel	COPC	not a COPC
Selenium	COPC	not a COPC
Silver	not a COPC	retained as COI[a]
Thallium	retained as COI[a]	retained as COI[a]
Vanadium	not a COPC	retained as COI[a]
Zinc	COPC	COPC

[a] Retained as a COI because no benchmark (i.e., Eco-SSL) was available.

[b] Barium was originally identified as a COI in the COPC refinement but is now identified as a COPC based on rationale described in the text directly below this table (TAI 2019, 2020).

[c] Eco-SSLs value could not be developed for barium (USEPA 2005) or chromium (USEPA 2008), because toxicity data were insufficient (i.e., the minimum of three toxicity studies were not available). Therefore, the benchmarks used in the COPC refinement were derived from the lowest available acceptable toxicity values presented in the Eco-SSL documents.

[d] Retained as a COI because there was only one exceedance of the benchmark.

COI – chemical of interest
COPC – chemical of potential concern
Eco-SSL – ecological soil screening level

It should be noted that barium was identified as a COI for plants in the COPC refinement (TAI 2019, 2020) because there was only one exceedance of the benchmark using the mean value at locations where three triplicate soil variability samples were collected during the UCR upland soil study (TAI 2015). If the individual triplicate values are used instead, there are two exceedances of the benchmark. Based on this observation, EPA requested that barium be retained for the BERA as a COPC for plants (USEPA 2020).

3 SOIL SCREENING LEVEL BENCHMARKS

Eco-SSLs will be used as soil benchmarks in the BERA if they are available. For metals and receptors that were not evaluated in the COPC refinement (TAI 2019, 2020) because they lacked Eco-SSLs, as shown in Table 1, TAI developed SSLs for use in the BERA following the same methods used by EPA to derive the Eco-SSLs (USEPA 2003d). The methods used to compile toxicity data, extract data from papers, score studies based on acceptability criteria, and derive screening levels from the acceptable data are described in detail in a technical memorandum from Teck American Incorporated (TAI) to EPA (Windward 2020).[1] Briefly, studies received scores of 0, 1, or 2 for bioavailability, as determined by pH and organic matter (OM) content, a score of 2 representing the greatest bioavailability. Only studies with bioavailability scores of 1 or 2 were used to derive SSLs. Acceptable toxicity effect levels for use in deriving SSLs were the maximum acceptable threshold concentration (MATC)[2] and effect concentrations for 10 or 20% of the test population (EC10s or EC20s) (USEPA 2003a). Additional details on the derivation of the EPA-approved SSLs for use in the UCR BERA are described in the SSL development technical memorandum by Windward (2020) that is included as Attachment D1 of the upland BERA.

Two metal/receptor combinations (barium/plants and chromium/invertebrates) were not included in the SSL development technical memorandum (Windward 2020). Therefore, the methods described by Windward (2020) were used to derive SSLs for these two metal/receptor combinations. Although Eco-SSL documents were prepared for barium and chromium, Eco-SSL values could not be derived for barium/plants or chromium/invertebrates because of an insufficient number of studies. The literature search for studies conducted after publication of the Eco-SSL documents resulted in the identification of one potentially acceptable paper for barium/plants (Melo et al. 2011), which was reviewed and scored based on the nine acceptability criteria described by Windward (2020). Melo et al. (2011) received an overall score of less than 10, so it could not be used in SSL derivation. As a result, the lowest toxicity values presented in the Eco-SSL documents were selected as SSLs, as follows:

- Barium/plants: 1,414 mg/kg, based on the toxicity value from Chaudhry et al. (1977), as cited in Table 3.1 of the barium Eco-SSL document (USEPA 2005)
- Chromium/invertebrates: 57 mg/kg, based on identical toxicity values from van Gestel et al. (1993) and van Gestel et al. (1992), as cited in Table 4.1 of the chromium Eco-SSL document (USEPA 2008)

For arsenic/invertebrates, a recent study (Lin et al. 2019) was found that was not available in the spring of 2019, when the literature search had been conducted for the development of SSLs (Windward 2020). The SSL of 7.3 mg/kg dry weight (dw) (Windward 2020) was derived as the lesser of only two toxicity values available at the time, both of which were from a study by Alves et al. (2018). The Alves et al. (2018) study conducted 28-day reproduction toxicity tests with both springtail (*Folsomia candida*) and earthworm (*Eisenia andrei*) using a soil type with a bioavailability score of 1 (moderate level) based on EPA's bioavailability scoring matrix (USEPA 2003d). The more recent Lin et al. (2019) study investigated not only the effects of soil pH and OM content on arsenic bioavailability and toxicity, but also the effects of soil aging, which is an important variable affecting metal bioavailability. Ten different soils with pHs ranging from 4.9 to 8.4 and OM ranging from 1.1 to 4.6% were evaluated for toxicity to springtail (Lin et al. 2019). Using EPA's bioavailability scoring matrix (USEPA 2003d), six soils had a score of 1 (moderate level) and four soils had a score of 2 (high level). Soils were spiked with sodium arsenate and then aged for 150 days prior to conducting 28-day reproduction toxicity tests. Toxicity results from Lin et al. (2019) were presented as NOECs and LOECs, allowing for the calculation of an MATC for each soil type. If the Lin et al. (2019) study had been available at the time of SSL development, the SSL would have been calculated as 153 mg/kg dw according to EPA's Eco-SSL methods (i.e., the geomean of the preferred toxicity values for soils with the highest bioavailability

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[1] EPA approved this approach memorandum via email on February 11, 2020.

[2] The MATC is the geomean of the no-observed-adverse-effect concentration (NOEC) and the lowest-observed-adverse-effect concentration (LOEC).

score).[3] Therefore, the value of 153 mg/kg dw is used as the SSL for arsenic/invertebrates in this evaluation.

The Eco-SSLs and SSLs for metal/receptor combinations evaluated in the BERA are listed in Table 2. EPA did not develop Eco-SSLs for aluminum or iron because measurements of total concentrations of those metals in soils are not suitable or reliable for the prediction of potential toxicity. The aluminum and iron Eco-SSL documents recommend identifying these metals as COPCs if the soil pH is less than 5.5 or 5.0, respectively (USEPA 2003b, c).

Table 2. Soil screening levels for metals and receptors evaluated in the BERA

	Plants		Invertebrates	
Metal	**Screening Level (mg/kg dw)**	**Type of Screening Level**	**Screening Level (mg/kg dw)**	**Type of Screening Level**
Aluminum	pH < 5.5	Eco-SSL	pH < 5.5	Eco-SSL
Antimony	1,900	SSL	not a COPC	na
Arsenic	18	Eco-SSL	153	SSL
Barium	1,414	SSL	330	Eco-SSL
Chromium	190	SSL	57	SSL
Cobalt	13	Eco-SSL	130	SSL
Copper	70	Eco-SSL	80	Eco-SSL
Iron	pH < 5.0	Eco-SSL	pH < 5.0	Eco-SSL
Lead	120	Eco-SSL	not a COPC	na
Manganese	220	Eco-SSL	450	Eco-SSL
Molybdenum	26	SSL	233	SSL
Nickel	38	Eco-SSL	not a COPC	na
Selenium	0.52	Eco-SSL	not a COPC	na
Silver	not a COPC	na	58	SSL
Thallium	3.2	SSL	30	SSL
Vanadium	not a COPC	na	294	SSL
Zinc	160	Eco-SSL	120	Eco-SSL

BERA – baseline ecological risk assessment
COPC – chemical of potential concern
Eco-SSL – ecological soil screening level
mg/kg dw – milligram per kilogram dry weight
na – not applicable
SSL – soil screening level

4 BIOAVAILABILITY-ADJUSTED BENCHMARKS

Bioavailability-adjusted benchmarks were calculated using the Threshold Calculator for metals in soil (Oorts 2020). This tool includes data on the chronic toxicity of seven metals (cadmium, cobalt, copper, lead, molybdenum, nickel, and zinc) to plants and invertebrates. In developing the Threshold Calculator,

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[3] The soils with the highest bioavailability scores were the four soils from Lin et al. (2019) with scores of 2; the MATCs for these soils were 480, 480, 12, and 20 mg/kg.

soil properties that may have an important influence on metals bioavailability and toxicity—namely, organic carbon (OC) content, pH, clay content, and cation exchange capacity (CEC)—were also compiled for each toxicity test. For those plant and invertebrate species tested over a wide range of soil bioavailability conditions, empirical regression relationships between metal toxicity and one or more soil parameters were developed (Oorts 2020). For divalent cationic metals, increased OC content, pH, clay content, and CEC reduce metal bioavailability in soil. For oxyanions such as molybdenum, bioavailability is greater at higher pH.

For this evaluation, the Threshold Calculator was used to adjust all toxicity values in its database to the relevant soil conditions at each UCR sampling location (i.e., benchmarks were calculated on a sample-by-sample basis based on measured soil conditions in each sample). The Threshold Calculator requires that pH be reported using the 0.01 molar (M) calcium chloride ($CaCl_2$) method and that CEC be reported as effective CEC (eCEC)[4] (Oorts 2020). In the UCR uplands soil study, however, pH was measured using the water method and CEC was measured rather than eCEC (TAI 2015). Following (Oorts 2020), pH based on the 0.01 M $CaCl_2$ method was estimated from the water method as follows:

$$\textbf{pH (0.01 M CaCl}_2\textbf{ method)} = -0.54 + 1.00 \times \textbf{pH (water method)} \qquad \textbf{Equation 1}$$

The eCEC was calculated from pH, %clay, and OC using the following equation (Oorts 2020):

$$\textbf{eCEC (cmolc/kg)} = (30 + 4.4 \times \text{pH}) \times \%\text{Clay}/100 + (-59 + 51 \times \text{pH}) \times \%\text{OC}/100 \qquad \textbf{Equation 2}$$

The toxicity values were defined as the effect concentrations causing a 20% effect (EC20s), which is consistent with the chronic effect level used to develop ambient water quality criteria (AWQC) (USEPA 2013, 2016). This process resulted in a species sensitivity distribution (SSD) of EC20s adjusted to the relevant bioavailability condition at each location. The bioavailability-adjusted benchmark was then calculated as the 5th percentile of the SSD on a location-specific basis. This approach is analogous to EPA's approach to calculating hardness-based AWQC, which entails the application of a hardness-based bioavailability model to adjust toxicity data in the SSD to a water hardness of interest; the 5th percentile of the SSD is then calculated to derive the criterion.

The following bullets summarize the user-defined selections in the Input+Output tab of the Threshold Calculator. Note that each Threshold Calculator "run" is composed of a single metal and trophic level of interest (e.g., plants):

- Select metal: A dropdown menu allows for selection of the metal of interest.
- Select trophic levels to be protected: A dropdown menu provides various options, but plants and invertebrates were of interest for the present evaluation; each was run separately to derive a bioavailability-adjusted plant benchmark and a bioavailability-adjusted invertebrate benchmark.
- Enter effect level (x in ECx): "20" was entered because the effect level of interest was the EC20.
- Enter the probability level (p in HCp): "5" was entered because the 5th percentile of the SSD was of interest.
- Use NOEC, MATC, and LOEC values in case no reliable ECx value can be derived: "Yes" was selected in the dropdown menu to maximize the amount of toxicity information and species included in the SSD. The default upper effect boundaries of 10% for the NOEC, 25% for the MATC, and 40% for the LOEC were retained. These boundaries ensured that the values did not deviate substantially from the target effect level of 20%.

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[4] The eCEC is measured at the existing pH of the soil, while the CEC is measured at a buffered pH (e.g., pH 7).

- Total or added metal approach: The total metal approach was selected, meaning that total metals concentrations were used to characterize metals concentrations in the soil toxicity tests used to identify the EC20s (and NOECs, LOECs, and MATCs in the absence of an EC20 for a given test). The use of total metals concentrations accounts for the background concentrations of the metals in the tested soils. In comparing site soil concentrations to the benchmarks, total metals concentrations are applied (the same approach for comparing site soil concentrations to Eco-SSLs).[5]
- Jurisdiction: The "open/global" option was selected so as not to be constrained by European chemical registration requirements (i.e., the other option in the Threshold Calculator).

The Threshold Calculator also includes a Lab-field and Assessment Factor tab. A lab-field factor provides a correction for aging and leaching processes, or for aging processes only if it was not necessary to account for leaching processes. Leaching processes are corrected for in toxicity tests conducted with soils freshly spiked with metal, as the change in ionic strength and pH of the freshly spiked soils increases metal bioavailability relative to the bioavailability that would be observed in a natural soil. The default lab-field factors in the Threshold Calculator were retained. These factors were based on a weight of evidence that considered both the changes in metal toxicity with long-term equilibration (aging) or leaching of excess ions and changes in metal behavior in soil (e.g., pore water concentrations, E-values[6]) (Oorts 2020). Assessment factors in the Threshold Calculator were not applied, as these are policy-based factors applicable to the European Union REACH program for chemical registration and thus not relevant to the UCR.

Based on the Threshold Calculator selections described above, the Multiple Soil-specific Input tab was used to develop bioavailability-adjusted benchmarks for the metals to be evaluated in the BERA that are included in the Threshold Calculator, and for all upland soil samples with sufficient data for bioavailability parameters. In addition to the bioavailability-adjusted benchmark, the Threshold Calculator provides the potentially affected fraction (PAF) for each sample. The PAF is derived based on the measured metal concentration in the sample relative to the bioavailability-adjusted SSD for that sample (i.e., the same bioavailability-adjusted SSD from which the 5th percentile is used to derive the benchmark). For example, if the measured concentration of a metal falls at the 20th percentile of its respective SSD, the PAF is 20% (i.e., 20% of the species are estimated to have an EC20 less than the measured metal concentration). Thus, while a hazard quotient (HQ) provides information on how the measured metal concentration compares to its benchmark, the PAF accounts for the slope (or steepness) of the SSD by providing additional information on the estimated percentage of species with EC20s exceeded by the measured metal concentration (e.g., an HQ of 3 based on an SSD with a steep slope will have a higher PAF than an HQ of 3 based on an SSD with a shallower slope).

The BERA metals (and receptors) in the Threshold Calculator are cobalt (plants, invertebrates), copper (plants, invertebrates), lead (plants), molybdenum (plants, invertebrates), nickel (plants), and zinc (plants, invertebrates). For cobalt, copper, lead, nickel, and zinc, the bioavailability models are based on eCEC (and both eCEC and pH for zinc/plants); for molybdenum, the bioavailability models are based on clay and pH for plants and just clay for invertebrates. The types of endpoints and species included in the Threshold Calculator for BERA metal/receptor combinations are presented in Table 3, including the most

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[5] The added metal approach entails subtracting background metals concentrations from both the soil toxicity tests used to derive the bioavailability-adjusted benchmarks and site soils. If the background concentration of a given metal at a site is greater than the background concentration of that metal in the toxicity tests that are the "drivers" of the bioavailability-adjusted benchmark, then the total metal approach would err toward conservatism. The opposite would be true if a site had a lower background concentration of that metal relative to the toxicity tests that were drivers of the bioavailability-adjusted benchmark.

[6] The E-value is a measure of the isotopically exchangeable metals fraction, which provides a measure of the metals pool that is potentially bioavailable in an aged soil (Ma et al. 2006; OECD 2016).

sensitive species with the lowest EC20s that drove the SSD used to derive the bioavailability-adjusted benchmark.

Table 3. Data used in the Threshold Calculator to calculate bioavailability-adjusted benchmarks for metals and receptors evaluated in the BERA

Metal	Endpoints	Number and Type of Species	Most Sensitive Species and Endpoints
Plants			
Cobalt	yield (roots, shoots)	7 species of grasses, flowering plants, and root vegetables	clover (root yield); alfalfa (shoot yield)
Copper	mortality, reproduction, seedling emergence, yield (seeds, roots, and shoots)	10 species of grasses and flowering plants	tomato (shoot yield); barley grass (root length yield)
Lead	net photosynthesis, yield (roots, shoots, total plant)	16 species of grasses, flowering plants, and evergreen trees	barley grass (shoot yield); tomato (shoot yield)
Molybdenum	yield (shoots, roots)	5 species of grasses and flowering plants	rapeseed (shoot yield); tomato (shoot yield); clover (shoot yield)
Nickel	yield (seeds, roots, shoots)	11 species of grasses and flowering plants	tomato (shoot yield); spinach (shoot yield)
Zinc	first bloom, yield (seeds, roots, shoots)	18 species grasses, flowering plants, and root vegetables	red clover (root and shoot yield); barley grass (shoot yield)
Invertebrates			
Cobalt	reproduction	4 species of oligochaete worms and springtails	oligochaete worms (reproduction)
Copper	growth, reproduction, mortality, litter breakdown	14 species of oligochaete worms, springtails, mites, and nematodes	oligochaete worm (reproduction); springtail (reproduction)
Molybdenum	reproduction	3 species of oligochaete worms and springtails	oligochaete worms (reproduction)
Zinc	growth and reproduction	9 species of oligochaete worms and springtails	springtail (reproduction); oligochaete worm (reproduction)

BERA – baseline ecological risk assessment

5 ESTIMATION OF %CLAY AND ECEC FOR THE 2012 ECOLOGY SOIL SAMPLES

The parameters, %Clay and eCEC, necessary for calculation of BABs, were not analyzed in the 2012 Ecology dataset. Multiple analyses were performed using the 2014 UCR Upland Soil Study data to develop an approach to estimate these missing parameter values for the 2012 Ecology sample locations. Estimation approaches evaluated included the use of:

a) the minimum %clay and eCEC measured by the 2014 UCR Upland Soil Study over all DUs from within the total 2012 Ecology study area;

b) the maximum %clay and eCEC measured by the 2014 UCR Upland Soil Study over all DUs from within the total 2012 Ecology study area;

c) the minimum %clay and eCEC measured by the 2014 UCR Upland Soil Study for DUs from within each Ecology subarea; and

d) the maximum %clay and eCEC measured by the 2014 UCR Upland Soil Study for DUs from within each Ecology subarea.

These analyses are described in more detail below.

5.1 Sample Locations and Data

Data for DUs from the 2014 UCR Upland Soil Study that were located within or immediately adjacent to each of the 13 Ecology subareas used to identify surrogate % Clay and eCEC values are summarized in Table 4. Data consisted of the % Clay, CEC, TOC, and pH measured within each DU.

5.2 Estimation of %Clay and eCEC for BAB calculation

The minimum and maximim %clay and eCEC over all subareas combined and for each subarea separately were calculated and are presented in Table 4.

5.3 Selection of Model for Application in the BERA

HC5s (i.e., BABs) and PAFs for all 106 2012 Ecology Study samples were calculated using each of the four %Clay and eCEC estimation approaches. Boxplots displaying the distributions of the BABs calculated by the 4 different approaches for each of the 5 COPCs (Co, Cu, Pb, Ni, and Zn) are presented in Figures 1 through 5.

Whereas BABs based on the maximum %clay with eCEC over all Ecology subareas was consistently the least conservative, the overall minimum %clay with eCEC were most conservative for all five metals ((Figures 1 through 5). Using the minimum and maximum measured %Clay and eCEC within each Ecology subarea resulted in intermediate BAB and PAF values, although estimates based on minimum measured %Clay and eCEC were always more conservative (i.e., lower BAB and higher PAF) than those based on maximum measured %Clay and eCEC. The approach based on the minimum measured %Clay and eCEC within each of the 13 Ecology subareas was selected to calculate BABs and PAFs for risk estimation for terrestrial plants. This approach was selected because it was based on spatially-associated measured data (i.e., ADA DUs within each Ecology subarea), allows BABs to vary spatially as parameters that dictate bioavailability vary, and maximizes consideration of bioavailability while not resulting in the most conservative BAB estimate.

5.4 Uncertainty in BAB Derivation

The absence of %Clay and eCEC measurements associated with each location in the 2012 Ecology Soil study and use of the minimum measured %Clay and eCEC from the 2014 UCR Upland Study for ADA DUs located within each of the 13 Ecology subareas, imparts some uncertainty to the final calculated BAB and PAF values. Because %Clay and eCEC values were selected based upon ADA DUs located within each Ecology subarea, a degree of the spatial variability in these values is retained within BAB and PAF calculation. Use of minimum %Clay and eCEC values increases COPC bioavailability and is thus conservative. BAB and PAFs may therefore be underestimated. The magnitude of this conservatism is intermediate among the estimation approaches considered (see Figures 1 through 5). Overall uncertainty is limited because %Clay and eCEC values was based on measured data that were spatially-associated (i.e., ADA DUs within each Ecology subarea), allowing BABs and PAFs to vary spatially (albeit to a lesser degree than if sample specific data were available) as other parameters that dictate bioavailability (i.e., pH and TOC) vary, and maximizes consideration of bioavailability while not resulting in the most conservative BAB estimate.

Table 4. Soil bioavailability parameters for DUs from the 2014 UCR Soil Study located within or adjacent to Subareas from the 2012 Ecology Upland Soil Study.

Location ID	Sample ID	Ecology Subarea	Depth (inches)	Sieve Size	pH (0.01 M CaCl2)	pH (H20)	% OC	% Clay	eCEC (cmolc/kg)	Minimum		Maximum		Difference between Min and Max	
										%clay	CEC	%clay	CEC	%clay	CEC
ADA-113	ADA-113	1	0-3	< 2 mm	5.36	5.9	7.68	2.48	17.8	2.48	17	4.53	17.8	2.05	0.8
ADA-114	ADA-114	1	0-3	< 2 mm	4.41	4.95	8.89	4.53	17						
ADA-097	ADA-097	2	0-3	< 2 mm	5.78	6.32	11.8	1.23	28.5	1.11	8.64	1.59	28.5	0.48	19.86
ADA-117	ADA-117	2	0-3	< 2 mm	5.12	5.66	3.86	1.59	8.64						
ADA-118	ADA-118	2	0-3	< 2 mm	5.77	6.31	5.7	1.11	14						
ADA-108	ADA-108-A	3	0-3	< 2 mm	5.66	6.2	7.09	2.71	17.8	1.51	15.9	3.14	20	1.63	4.1
ADA-108	ADA-108-B	3	0-3	< 2 mm	5.69	6.23	6.5	1.64	15.9						
ADA-108	ADA-108-C	3	0-3	< 2 mm	5.77	6.31	8.16	1.51	20						
ADA-119	ADA-119	3	0-3	< 2 mm	5.77	6.31	6.49	3.14	17						
ADA-108	ADA-108-A	4	0-3	< 2 mm	5.66	6.2	7.09	2.71	17.8	1.51	15.9	2.71	20	1.2	4.1
ADA-108	ADA-108-B	4	0-3	< 2 mm	5.69	6.23	6.5	1.64	15.9						
ADA-108	ADA-108-C	4	0-3	< 2 mm	5.77	6.31	8.16	1.51	20						
ADA-109	ADA-109	5	0-3	< 2 mm	5.57	6.11	9.78	0.982	22.5	0.982	10.7	2.04	22.5	1.058	11.8
ADA-110	ADA-110	5	0-3	< 2 mm	5.48	6.02	4.77	2.04	11.6						
ADA-165	ADA-165	5	0-3	< 2 mm	5.28	5.82	4.59	1.92	10.7						
ADA-159	ADA-159-A	6	0-3	< 2 mm	5.55	6.09	6.44	1.41	15.2	1.41	8.02	2.35	18	0.94	9.98
ADA-159	ADA-159-B	6	0-3	< 2 mm	5.61	6.15	7.48	1.85	18						
ADA-159	ADA-159-C	6	0-3	< 2 mm	5.18	5.72	4.36	2.35	10.2						
ADA-160	ADA-160	6	0-3	< 2 mm	5.07	5.61	3.47	2.1	8.02						
ADA-158	ADA-158-A	7	0-3	< 2 mm	5.33	5.87	2.56	2.65	6.86	0.999	6.86	4.02	12.1	3.021	5.24
ADA-158	ADA-158-B	7	0-3	< 2 mm	5.46	6	3.1	2.7	8.26						
ADA-158	ADA-158-C	7	0-3	< 2 mm	5.44	5.98	4.12	2.34	10.3						
ADA-161	ADA-161	7	0-3	< 2 mm	4.28	4.82	5.42	4.02	10.6						
ADA-162	ADA-162	7	0-3	< 2 mm	5.37	5.91	5.4	0.999	12.1						
ADA-164	ADA-164	8	0-3	< 2 mm	5.7	6.24	6.44	0.882	15.4	0.882	8.35	1.17	15.4	0.288	7.05
ADA-168	ADA-168	8	0-3	< 2 mm	5.59	6.13	3.41	1.17	8.35						
ADA-164	ADA-164	9	0-3	< 2 mm	5.7	6.24	6.44	0.882	15.4	0.882	15.4	0.882	15.4	0	0
ADA-092	ADA-092	10	0-3	< 2 mm	5.44	5.98	10.1	2.69	23.5	2.69	23.5	2.69	23.5	0	0
ADA-105	ADA-105	11	0-3	< 2 mm	5.75	6.29	6.18	1.92	15.5	1.92	15.5	1.92	15.5	0	0
ADA-121	ADA-121	12	0-3	< 2 mm	5.74	6.28	6.36	3.74	16.9	3.74	16.9	3.74	16.9	0	0
ADA-101	ADA-101	13	0-3	< 2 mm	7.46	8	7	3.27	24.6	3.27	24.6	3.27	24.6	0	0
	Overall	min						0.882	6.86						
		max						4.53	28.5						
		min-max range						3.648	21.64						

% OC = percent organic carbon
% Clay = percent clay
cmolc/kg = milliequivalents of charge per kilogram
eCEC = effective cation exchange capacity
H2O = water
M CaCl2 = moles calcium chloride

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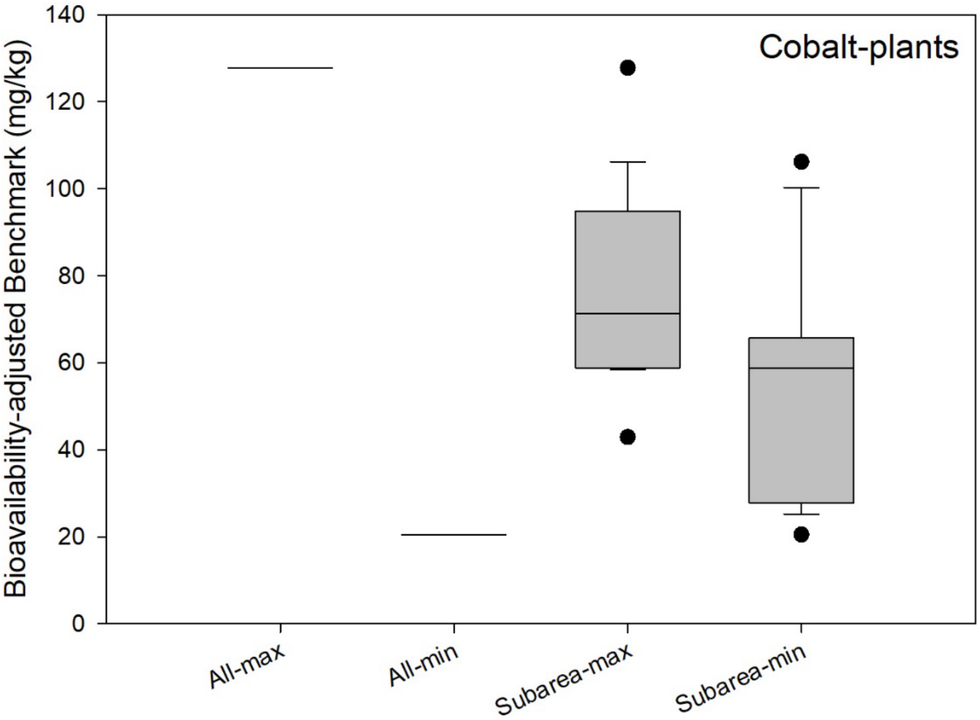

Figure 1. Boxplots displaying the distribution of bioavailability-adjusted soil benchmark values for cobalt for terrestrial plants calculated for all 106 Ecology (2012) soil samples using the threshold calculator for metals in soil (Arche 2020).

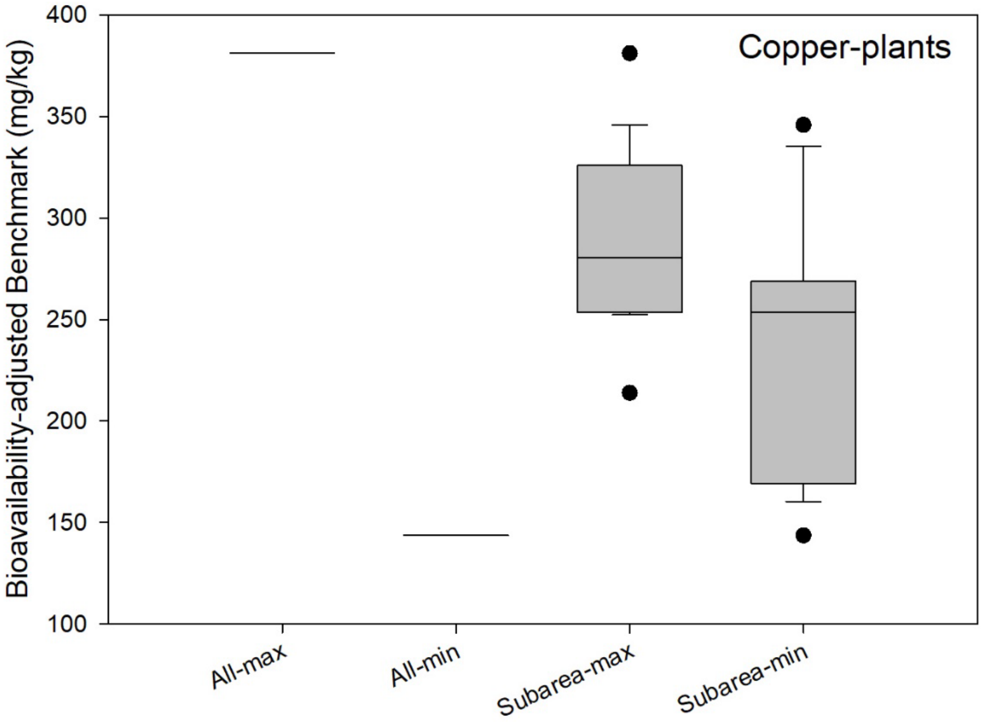

Figure 2. Boxplots displaying the distribution of bioavailability-adjusted soil benchmark values for copper for terrestrial plants calculated for all 106 ecology (2012) soil samples using the threshold calculator for metals in soil (Arche 2020).

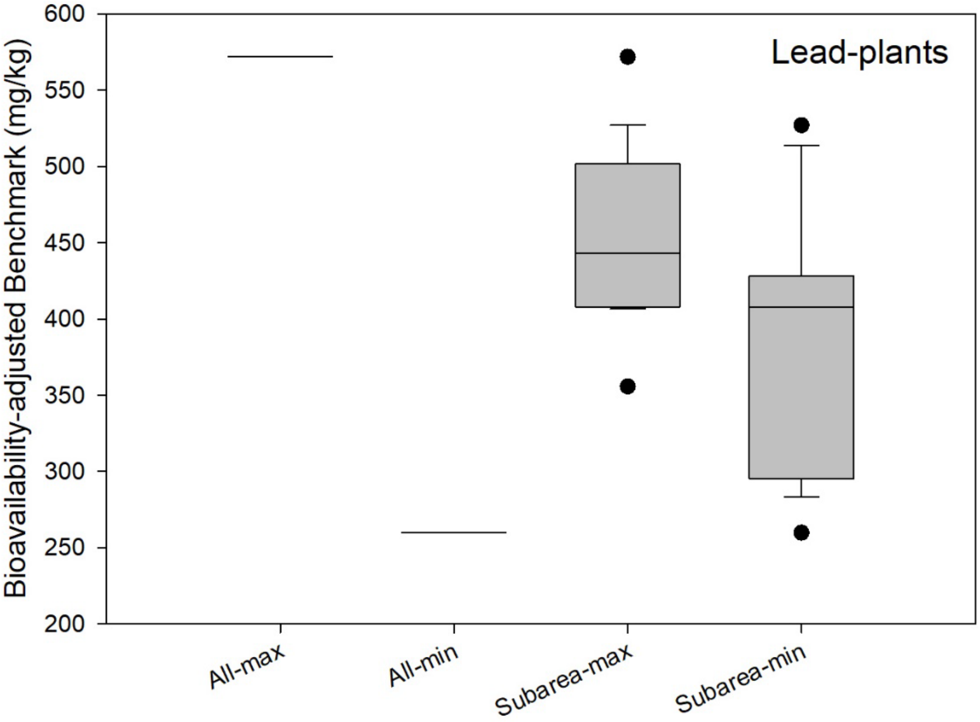

Figure 3. Boxplots displaying the distribution of bioavailability-adjusted soil benchmark values for lead for terrestrial plants calculated for all 106 Ecology (2012) soil samples using the threshold calculator for metals in soil (Arche 2020).

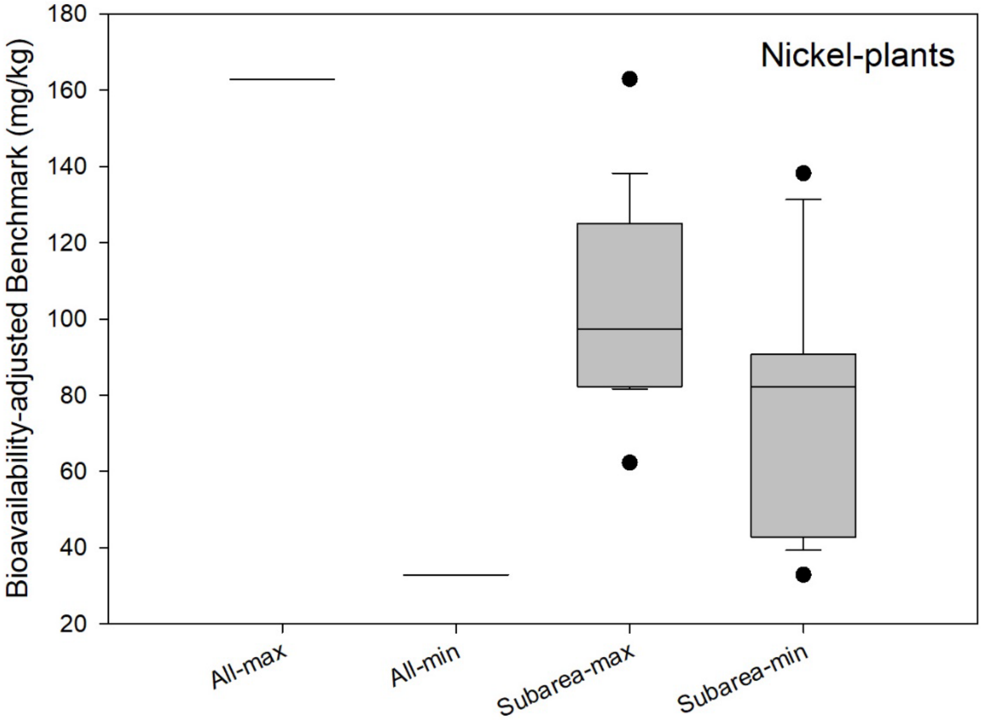

Figure 4. Boxplots displaying the distribution of bioavailability-adjusted soil benchmark values for nickel for terrestrial plants calculated for all 106 Ecology (2012) soil samples using the threshold calculator for metals in soil (Arche 2020).

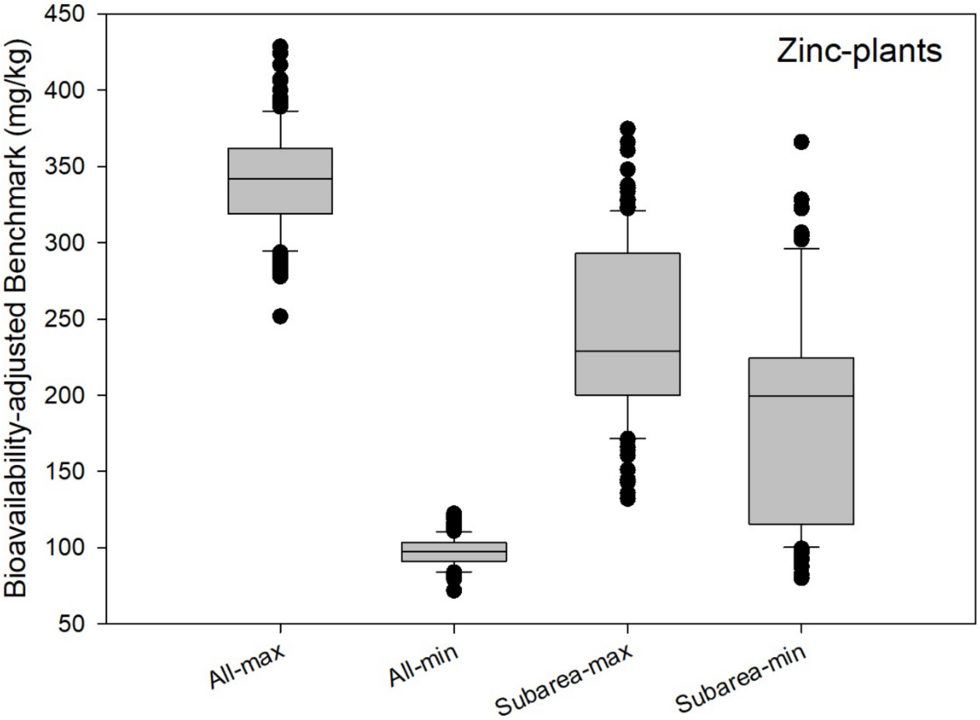

Figure 5. Boxplots displaying the distribution of bioavailability-adjusted soil benchmark values for zinc for terrestrial plants calculated for all 106 Ecology (2012) soil samples using the threshold calculator for metals in soil (Arche 2020).

APPENDIX E

WILDLIFE TOXICITY AND BIOAVAILABILITY METHODS USED IN THE UPLAND BERA

No changes were made to draft final version of Appendix E (Wildlife Toxicity and Bioavailability Methods used in the Upland BERA) presented in the draft final Upland BERA prepared by Teck American Incorporated. The appendix that follows is a reproduction of that previously-submitted document.

UPPER COLUMBIA RIVER

DRAFT FINAL
Appendix E
Wildlife Toxicity and Bioavailability Methods Used in the Upland BERA

Prepared for

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February 2023

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ACRONYMS AND ABBREVIATIONS

95 LCL	95 percent lower confidence limit of the mean
95 UCL	95 percent upper confidence limit of the mean
BERA	baseline ecological risk assessment
COI	chemical of interest
COPC	chemical of potential concern
DU	decision unit
Eco-SSL	ecological soil screening level
ED	effective dose
ED20	effective dose with a 20 percent reduction in the response relative to the control (modeled)
EPA	U.S. Environmental Protection Agency
F1	first filial generation
F2	second filial generation
FIR	food intake rate
HHRA	human health risk assessment
HQ	hazard quotient
IVBA	in vitro bioaccessibility
LOAEL	lowest-observed-adverse-effect level
LOAEL ≥ 20	LOAEL with ≥ 20 percent reduction in the response relative to control
NA	not applicable
na	not available
NR	not reported
RBA	relative bioavailability
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
TAI	Teck American Incorporated
TOC	total organic carbon
TRAP	Toxicity Relationship Analysis Program
TRV	toxicity reference value
UCR	Upper Columbia River

UNITS OF MEASURE

g	gram(s)
mg/kg	milligram(s) per kilogram
mg/kg bw/day	milligram(s) per kilogram of body weight per day

1 INTRODUCTION

Evaluations were conducted by Teck American Incorporated (TAI) to derive wildlife toxicity reference values (TRVs) and soil relative bioavailability (RBA) factors for use in the baseline ecological risk assessment (BERA) for the Terrestrial Study Area[1] of the Upper Columbia River (UCR) site (hereafter, the Site[2]). The BERA for the Terrestrial Study Area is hereafter referred to as the Upland BERA. TRVs are used to evaluate the potential for adverse effects in birds and mammals using dietary dose hazard quotient (HQ) calculations. These HQs provide a line of evidence used to evaluate risk to birds and mammals exposed to chemicals of potential concern (COPCs) in soil, as identified in the U.S. Environmental Protection Agency (EPA)-approved final COPC refinement for terrestrial receptors (TAI 2019, 2020). RBA factors are used in the calculation of daily dietary doses in the Upland BERA to adjust total concentrations of metals in soil to concentrations estimated to be bioavailable for uptake into a receptor's circulatory system.

The objective of this appendix is to present the approach used for deriving TRVs and RBA factors used in the Upland BERA. The TRVs used in the Upland BERA are derived using approaches developed by TAI that have been reviewed and approved by the EPA (TAI 2019; Attachment E1 to this appendix). RBA factors are derived from in vitro bioaccessibility (IVBA) data collected in support of the human health risk assessment (HHRA) for the Site.

Section 2 of this appendix provides an overview of how wildlife TRVs were developed and a summary of findings. Section 3 of this appendix provides an overview of the development of soil RBA factors, and Section 4 of this appendix explains why RBA factors were not developed for food (i.e., plants and prey). The TRV and RBA derivation methods and selected TRVs and RBA factors are presented in Attachments E1 through E3.

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[1] The term "Terrestrial Study Area" refers to the upland terrestrial portions of the UCR Site. The geographical extent of the Terrestrial Study Area will be clarified in the Upland Remedial Investigation (RI) report. However, for the Upland BERA, the Terrestrial Study Area is operationally defined by the spatial extent of the data set, as described in Section 3 of the Upland BERA.

[2] As per the June 2, 2006 Settlement Agreement for Implementation of Remedial Investigation and Feasibility Study (RI/FS) at the Upper Columbia River Site (referred to herein as the UCR Site or Site), the Site consists of the areal extent of hazardous substances contamination within the United States in or adjacent to the Upper Columbia River, including the Franklin D. Roosevelt Lake, from the U.S.-Canada border to the Grand Coulee Dam and all suitable areas in proximity to such contamination necessary for implementation of the response actions (RI/FS) described therein.

2 WILDLIFE TRVS

This section provides a brief overview of how wildlife TRVs were developed for the Upland BERA. Details are presented in the EPA-approved wildlife TRV technical memorandum (TAI 2019), which is provided as Attachment E1 to this appendix, and the Supplemental Wildlife TRV Development Memo (Attachment E2).

2.1 OVERVIEW OF TRV APPROACH

Dietary dose TRVs were developed with the goal of identifying the dose resulting in a 20-percent reduction in response relative to the control for birds and mammals. Specific TRVs for wolves were included because of the endangered status, in the State of Washington, of these animals. TRVs are expressed as daily COPC intake rates normalized for body weight of the organism (i.e., mg/kg bw/day) and include separate values for growth, reproduction, and survival endpoints.

Using conservative assumptions, the Screening-Level Ecological Risk Assessment (TAI 2010) identified a list of chemicals of interest (COIs) to be carried forward for additional analysis as well as a list of COIs to be eliminated from further evaluation. The COPC refinement (TAI 2020) identified soil COPCs[3] to be evaluated further in the Upland BERA. Additionally, the COPC refinement retained soil COIs based on uncertainty.[4] The COIs are carried forward to the Upland BERA and are evaluated alongside COPCs, thus requiring TRVs for the COIs for which soil data are available. For avian receptors, 15 COPCs/COIs required TRVs to be developed, and for mammalian receptors, 12 COPCs/COIs required TRVs (Table E-1). COPCs and COIs are collectively referred to as "metals" for brevity in discussions below.

The wildlife TRV derivation process for five of these metals (i.e., cadmium, copper, lead, manganese, and zinc) is described in the EPA-approved wildlife TRV technical memorandum (TAI 2019; Attachment E1). For the other metals, TRVs were developed

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[3] If more than one detected concentration in the 2014 UCR Upland Soil Study (TAI 2015) data set exceeded the ecological soil screening level (Eco-SSL) or other soil screening-level TRV, then the COI was considered a COPC for the receptor.

[4] Certain COIs were retained based on uncertainty for the following reasons: COIs were not analyzed; COIs had no Eco-SSL or other soil screening-level TRV; the COI's detection limit exceeded the Eco-SSL or other soil screening-level TRV in more than one sample; or there was a single exceedance of the Eco-SSL or other soil screening-level TRV for the COIs in a sample that had at least one other COI exceedance.

using the same approach presented in the aforementioned wildlife TRV document. The TRV derivation process for the remaining metals is presented in Attachment E2. Table E-1 identifies the document in which the TRV derivation process for a particular metal is presented (i.e., Attachment E1 or Attachment E2).

2.2 RESULTS

Bird and mammal TRVs were developed, where appropriate toxicity data were available, for aluminum, antimony, barium (bird only), beryllium (bird only), cadmium, chromium (III), copper, iron, lead, methylmercury, molybdenum, selenium, thallium, vanadium (bird only), and zinc.[5] Dietary TRVs for terrestrial wildlife developed for use in the Upland BERA are presented in Table E-1.

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[5] Because of a lack of data, it was not possible to derive TRVs for all metals and receptor groups; such limitations are shown in Table E-1 and discussed in Attachments E1 and E2.

3 SOIL RELATIVE BIOAVAILABILITY VALUES

Summarized below and presented in Attachment E3 is a comprehensive description of the approach and data set used for developing soil RBA factors, the basis of the selected values, and how the values are applied.

3.1 OVERVIEW OF RBA APPROACH

Soil RBA factors for the Upland BERA were developed using IVBA data collected to support the UCR HHRA (TAI 2015). IVBA analyses simulate the conditions in an organism’s gut to provide an estimate of the fraction of an ingested chemical available for absorption from the gastrointestinal tract. The IVBA data are used in conjunction with regression equations from the literature to calculate RBA factors, if such data are available; otherwise, conservative assumptions are used. In the proceedings of an industry-government workshop on the development of metal clean-up values, Sample et al. (2014) recommended the evaluation of metal bioaccessibility as one component of ecological exposure assessment refinements. For the UCR Site, although IVBA data were generated using a method designed for HHRA purposes, pursuant to Sample et al. (2014), those data are useful for improving wildlife exposure estimates. Bioaccessibility analyses have been used in ecological risk assessments at other sites, including the Coeur d’Alene Superfund site (USEPA 2001).

3.2 RESULTS

RBA factors are calculated on a sample-by-sample and metal-by-metal basis. RBA factors calculated for each metal evaluated in the Upland BERA at each sample location are presented in Table E3.A-1 of Attachment E3.

4 FOOD RELATIVE BIOAVAILABILITY VALUES

As described in Attachment E3, there are no UCR Site-specific wildlife food bioaccessibility data, and development of generic literature-based bioaccessibility estimates entails considerable uncertainty because of the paucity of literature data for metal bioaccessibility in dietary items relevant to UCR wildlife and the high variability in the bioaccessibility results where data are available. In addition, there are uncertainties associated with differences among extraction methodologies for determination of bioaccessibility in different species. There is also a lack of validation studies specific to metals biologically incorporated in the diet from which relative bioavailability can be derived. Therefore, the Upland BERA assumes an RBA of 100 percent for food items in dietary exposures, unless new information becomes available that warrants a less conservative assumption. Uncertainty associated with this conservative assumption will be evaluated as part of the uncertainty analysis for wildlife in the Upland BERA.

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USEPA. 2006. Settlement agreement for implementation of remedial investigation and feasibility study at the Upper Columbia River site. U.S. Environmental Protection Agency. U.S. Environmental Protection Agency, Washington, D.C.

TABLES

Table E-1. Dietary TRVs for Wildlife

		Growth		Reproduction		Survival		
Metal	COPC/COI	TRV (mg/kg bw/day)	TRV Type	TRV (mg/kg bw/day)	TRV Type	TRV (mg/kg bw/day)	TRV Type	Documentation
Birds[a]								
Aluminum	COI	150	ED20	none	NA	560	LOAEL ≥ 20	Attachment E2
Antimony	COI	none	NA	none	NA	none	NA	Attachment E2
Barium	COI	480	ED20	none	NA	890	LOAEL ≥ 20	Attachment E2
Beryllium	COI	none	NA	none	NA	none	NA	Attachment E2
Cadmium	COPC	2.0	ED20	2.3	ED20	7.4	ED20	TAI (2019; Attachment E1)
Chromium (III)	COPC	510	LOAEL ≥ 20	none	NA	none	NA	Attachment E2
Copper	COPC	62	ED20	28	ED20	67	ED20	TAI (2019; Attachment E1)
Iron	COI	160	LOAEL ≥ 20	none	NA	1,100	ED20	Attachment E2
Lead	COPC	29	LOAEL ≥ 20	4.7	geometric mean	11	ED20	TAI (2019; Attachment E1)
Methylmercury	COI	0.97	ED20	0.012	ED20	0.051	LOAEL ≥ 20	Attachment E2
Molybdenum	COI	100	ED20	36	ED20	610	ED20	Attachment E2
Selenium	COPC	0.29	Eco-SSL	0.55	ED20	0.59	LOAEL ≥ 20	Attachment E2
Thallium	COI	none	NA	none	NA	none	NA	Attachment E2
Vanadium	COPC	1.2	ED20	2.1	LOAEL ≥ 20	2.4	ED20	Attachment E2
Zinc	COPC	66	Eco-SSL	77	ED20	250	LOAEL ≥ 20	TAI (2019; Attachment E1)
American Kestrel[a]								
Methylmercury	COI	none	NA	0.25	ED20	none	NA	Attachment E2
Mammals[a]								
Aluminum	COI	400	LOAEL ≥ 20	27	ED20	400	LOAEL ≥ 20	Attachment E2
Antimony	COPC	none	NA	none	NA	none	NA	Attachment E2
Cadmium	COPC	4.2	ED20	2.7	ED20	1.5	ED20	TAI (2019; Attachment E1)
Chromium (III)	COPC	110	LOAEL ≥ 20	91	LOAEL ≥ 20	none	NA	Attachment E2
Copper	COPC	12	ED20	27	LOAEL ≥ 20	8.7	geometric mean	TAI (2019; Attachment E1)
Iron	COI	140	geometric mean	none	NA	870	ED20	Attachment E2
Lead	COPC	20	LOAEL ≥ 20	4.7	Eco-SSL	7.6	ED20	TAI (2019; Attachment E1)
Methylmercury	COI	0.65	LOAEL ≥ 20	0.23	LOAEL ≥ 20	0.24	ED20	Attachment E2
Molybdenum	COI	28	LOAEL ≥ 20	4.5	ED20	none	NA	Attachment E2
Selenium	COPC	0.33	ED20	5.0	LOAEL ≥ 20	0.61	LOAEL ≥ 20	Attachment E2
Thallium	COI	2.6	ED20	none	NA	2.1	ED20	Attachment E2
Zinc	COPC	75	Eco-SSL	75	Eco-SSL	190	geometric mean	TAI (2019; Attachment E1)
Gray Wolf[a]								
Cadmium	COPC	100	LOAEL ≥ 20	none	NA	none	NA	Attachment E2

Notes:

[a] Toxicity reference values (TRVs) for birds and mammals are generic levels applied to all representative receptors in the Upland BERA for which receptor-specific data are not available. American kestrel and gray wolf are representative receptors for which receptor-specific data are available.

COI - chemical of interest

COPC - chemical of potential concern

Eco-SSL - ecological soil screening level

ED20 - effective dose with a 20 percent reduction in the response relative to the control (modeled)

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

TAI - Teck American Incorporated

ATTACHMENT E1

APPROVED WILDLIFE TRV MEMO

UPPER COLUMBIA RIVER

FINAL
Wildlife Toxicity Reference Values for the Baseline Ecological Risk Assessment: Methods and Results for Five Metals

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July 2019

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ACRONYMS AND ABBREVIATIONS

AWQC	ambient water quality criteria
BERA	baseline ecological risk assessment
BMDS	Benchmark Dose Software
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COI	chemical of interest
COPC	chemical of potential concern
DART	Developmental and Reproductive Toxicology
EC	effect concentration
EC5	concentration that causes a 5 percent effect
EC10	concentration that causes a 10 percent effect
EC20	concentration that causes a 20 percent effect
Eco-SSL	ecological soil screening level
ECOTOX	ECOTOXicology knowledgebase
ED	effect dose
ED20	dose that causes a 20 percent effect
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
FIR	food ingestion rate
HQ	hazard quotient
IRIS	Integrated Risk Information System
ITER	International Toxicity Estimates for Risk
LOAEL	lowest-observed-adverse-effect level
LOEC	lowest-observed-effect-concentration
NOAEL	no-observed-adverse-effect level
NOEC	no-observed-effect-concentration
SLERA	screening-level ecological risk assessment

TAI	Teck American Incorporated
TOXLINE	Toxicology Literature Online
TOXNET	Toxicology Data Network
TRAP	Toxicity Relationship Analysis Program
TRV	toxicity reference value
UCR	Upper Columbia River
Windward	Windward Environmental LLC

UNITS OF MEASURE

dw	dry weight
g	gram(s)
kg	kilogram(s)
kg/d	kilogram(s) per day
mg/kg	milligram(s) of metal per kilogram
mg/kg bw/day	milligram(s) of metal per kilogram of body weight per day
ww	wet weight

1 INTRODUCTION

This document presents methods for selecting wildlife toxicity reference values (TRVs) for use in the Upper Columbia River (UCR) baseline ecological risk assessment (BERA). A TRV is a concentration or dose of a substance that, when administered to a test population of organisms in a well-designed experiment (usually conducted under well-controlled laboratory conditions), results in a specified toxic effect on a prescribed number or percentage of the organisms in the exposed test population. A TRV is used in combination with an estimate of the amount and duration of exposure to a substance to determine whether a wildlife receptor may be adversely affected from the exposure. Along with methods for TRV derivation, this document presents the wildlife TRVs selected for cadmium, copper, lead, manganese, and zinc—the five metals that were labeled chemicals[1] of potential concern (COPCs) for the UCR based on preliminary screening assessments (Parametrix et al. 2010a; Windward 2018). The wildlife TRVs identified in this document will be used in the BERA to evaluate whether COPC exposures are sufficient to adversely affect wildlife assessment endpoints. Uncertainties about the strength, relevance, and reliability of the studies used to derive the TRVs are described in this document. This will support the discussion in the BERA about the weight to be placed on the use of hazard quotients for assessing wildlife risk and the weight to be placed on each TRV derived for a particular COPC.

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[1] Metals (i.e., the elements) are identified as COPCs for the sake of expediency, but before any conclusive statements about risk from exposure to metals can be made, the fate of those metals must be adequately understood. The fate of metals is affected by several factors, including the chemical compounds they form in the environment, the transformations they undergo as environmental conditions change, the influence that fate has on the nature and extent of interactions between organisms and metal compounds, and how those interactions and toxicity relate to one another. Metals are natural elements that form chemical compounds. To determine the hazards that a particular compound and its elements pose in the environment, it is important to understand the compound's properties and its elemental composition.

2 APPROACH

Teck American Incorporated (TAI) and the U.S. Environmental Protection Agency (EPA) reached agreement on TRV development methods through a series of written communications (USEPA 2016a, 2015b; TAI 2015) and meetings (conference call on August 14, 2015; meeting on January 20, 2016; and conference call on March 27, 2017).[2] Principles upon which TAI and EPA agree include the following:

- TRVs should be based on data from experiments designed to control other factors that could confound data interpretation, such as the presence of other substances, an unhealthy test population, an incorrect feeding regime, or other factors that create a stressful environment.
- TRVs should be predictive of dietary toxicity (i.e., the measured toxic effect should be reproducible). For the UCR BERA, a 20 percent effect level will be used to set TRVs. The uncertainty regarding lower response levels (i.e., in the tails of the dose-response curves) is generally too high to be able to determine if the effect is statistically different from the control.
- Because 20 percent growth reduction, 20 percent reduction in a reproductive endpoint, and 20 percent mortality are not necessarily equivalent effects, it makes sense to derive TRVs for each type of endpoint (growth, survival, and reproduction).
- Experiments that produce a dose- or concentration-response relationship between the substance tested and the test population are better than experiments that do not. A benchmark dose modeling approach is appropriate to estimate a 20 percent effect level for such experiments.
- If a 20 percent effect level cannot be selected from a modeled dose-response curve and a lowest-observed-adverse-effect level (LOAEL) must be used as a selected TRV, then the level of effect associated with the LOAEL must represent a ≥ 20 percent reduction in the response compared to the control.
- Unbounded no-observed-adverse-effect levels (NOAELs) (i.e., NOAELs from experiments that do not also report a LOAEL) should not be used to set TRVs; however, these data are useful in evaluating the range of exposures over which effects were not

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[2] The purpose of the conference call on August 14, 2015, with TAI, TAI's consultants, and EPA, was to discuss the wildlife TRV strawman approach. At the meeting on January 20, 2016, Windward (on behalf of TAI) gave a presentation to EPA, the Confederated Tribes of the Colville Reservation, the Spokane Tribe of Indians, and other interested agencies on the status of the TRV development approach, and responded to EPA's written comments provided in December 2015. The purpose of the conference call on March 27, 2017, with TAI, TAI's consultants, and EPA, was to provide a status report on wildlife TRV development and respond to EPA's written comments from June 2016.

observed. Unbounded LOAELs (i.e., LOAELs from experiments that did not also report a NOAEL) are considered acceptable for use in deriving TRVs.

- Metals toxicity data for ruminants should not be used to set TRVs for nonruminant mammals because differences in the ruminant and nonruminant digestive tracts significantly affect the fate of consumed metals[3].

The selection of COPCs for TRV development in this document, the approach for dose modeling, and the rationale for the 20 percent effects level are discussed in the sections below.

2.1 CHEMICALS OF POTENTIAL CONCERN

The selection of COPCs for aquatic and terrestrial UCR receptors is in progress. The first step of the COPC identification process was the screening-level ecological risk assessment (SLERA) (Parametrix et al. 2010b), which included an initial evaluation to determine if there were adequate data for a given chemical of interest (COI) to eliminate it from further evaluation. For aquatic wildlife receptors, a draft refined COPC screen was submitted to EPA as an additional screening step after the SLERA to identify the list of COPCs to be carried forward for further analysis in the BERA (Exponent and HDR 2015). A draft final COPC refinement document, including a screen for both aquatic and terrestrial wildlife receptors, was submitted to EPA for review in July 2018 (Windward 2018).

COPCs identified in the draft final refinement document are listed in Table 2-1. As a preliminary effort to prioritize the TRV search, Windward Environmental LLC (Windward) focused on developing TRVs for the following five COPCs:

- Cadmium
- Copper
- Lead
- Manganese
- Zinc.

The path forward for TRV development for the remaining COPCs identified in Table 2-1 will be determined after TAI and EPA have agreed on the TRV development methods, and after the COPC list has been finalized.

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[3] Focal species to represent the herbivorous feeding guild for mammals have not yet been selected; however, the vole was selected as the focal species for the COPC refinement. Metals toxicity data for ruminants will be revisited if a ruminant is selected as a focal species.

2.2 DOSE MODELING APPROACH

Typically, ecological effects thresholds are represented by either published national and regional guidelines or threshold effect screening levels (hereafter referred to as effects thresholds), or NOAEL and LOAEL TRVs derived from toxicological literature. Both NOAELs and LOAELs are commonly used in ecological risk assessments (ERAs) in accordance with EPA guidance (USEPA 1997, 1998).

When data are adequate to define a curve, TRVs may be expressed from a dose-response function wherein the effects threshold is the defined dose resulting in X percent reduction in an endpoint (i.e., effect dose [ED]X) relative to control. TRVs may also be expressed as a concentration response (i.e., effect concentration [EC]X); however, the TRVs developed in this document are expressed as doses rather than concentrations. The approach for determining an EDX involves modeling a dose-response curve for a toxicity dataset to estimate the response at a selected percent reduction. This approach is recommended over the NOAEL/LOAEL approach because NOAELs and LOAELs correspond to inconsistent response levels across studies, endpoints, and chemicals (USEPA 2012b). The EDX modeling approach has been described in recent scientific literature (Mayfield et al. 2013; Allard et al. 2010) and EPA guidance (USEPA 2012b). This approach also has been used in previous EPA Region 10 risk assessments, i.e., for the derivation of TRVs in the Coeur d'Alene BERA (URS and CH2M HILL 2001) and for the evaluation of polychlorinated biphenyls and mink in the Portland Harbor BERA (Windward 2013).

The approach for deriving TRVs described in this document involves modeling toxicity test data to derive an EDX using the Toxicity Relationship Analysis Program (TRAP) software developed by EPA (USEPA 2015c), which is described in more detail in Section 3.5.

2.3 ACCEPTABLE LEVEL OF EFFECT

A 20 percent effect level was selected for deriving modeled dietary toxicity thresholds for wildlife TRVs for the UCR BERA. A 20 percent effect level is consistent with EPA's guidance for a variety of receptors, including wildlife. These guidance examples include ambient water quality criteria (AWQC), ecological soil screening levels (Eco-SSLs), whole-effluent toxicity testing, and ERA, as follows:

- EPA's recent AWQC for ammonia (USEPA 2013) and cadmium (USEPA 2016b) use 20 percent effect concentrations in water (i.e., EC20s [concentrations that cause a 20 percent effect]) to derive chronic criteria for the protection of aquatic organisms; EC20s were also considered acceptable chronic toxicity values in deriving carbaryl AWQC (USEPA 2012a). As noted by EPA (2016b), "The endpoint for chronic exposure is the EC20, which represents a 20 percent effect/inhibition concentration. This is in contrast to concentrations that cause a low level of reduction in response, such as EC5s or EC10s (concentrations that result in 5 and 10 percent effects, respectively), which are rarely statistically significantly different from the control treatment. EPA selected an EC20 to estimate a low level of effect that would be statistically different from control effects, but not severe enough to cause chronic effects at the population level (USEPA 1999). Reported no-observed-effect-concentrations (NOECs) and lowest-observed-effect-concentrations (LOECs) in water were only used for the derivation of chronic criterion when an EC20 could not be calculated for the genus." This quotation refers to the 1999 updated AWQC for ammonia (USEPA 1999) in which EC20 was first used.

- EPA's guidance for developing Eco-SSLs provides the following hierarchy for compiling toxicity endpoints for plants and soil: EC20 > maximum allowable toxicant concentration > EC10 (USEPA 2005).
- In the Eco-SSLs, EPA used a default effect value of 20 percent of the control to evaluate toxicological studies for the purpose of deriving wildlife TRVs, based on the assumption that "most experimental studies cannot detect smaller changes with acceptable power, and that changes of 20 percent or less will often not result in population level impacts, as least for many endpoints" (USEPA 2005).
- Suter and Tsao (1996) used EC20s to define chronic toxicity values for the development of toxicity benchmarks for aquatic life. The authors noted that the benchmarks were intended to be indices of population production, and were chosen as approximately the mean level of effect on individual response parameters observed at chronic values (defined as the geometric mean of the NOEC and LOEC), and as minimum detectable differences in population characteristics in the field.
- Efroymson et al. (1997) used a 20 percent effect level as the threshold for defining NOECs and LOECs for terrestrial plants. The NOEC was defined as the highest concentration of the chemical that produced a reduction of 20 percent or less in a measured response, and the LOEC was defined as the lowest concentration that resulted in a greater than 20 percent reduction in a measured response. The authors noted that concentrations resulting in statistically significant effects relative to the control were generally associated with greater than 20 percent effects, and that the 20 percent effects level was therefore treated as a conservative approximation of the threshold for regulatory concern.

If toxicity test data met the criteria for modeling using the TRAP software (see Section 3.6 for a discussion of conditions under which data were modeled), the ED20 (dose that causes a 20 percent effect) was the effect level selected from the test's response curve. If toxicity test data were not modeled, then the LOAEL from the study, calculated as the effect relative to the control, was used as the effect level if the reduction in the observed response was at least 20 percent.

3 METHODS

This section describes the approach for deriving TRVs using the seven-step process shown in Figure 3-1. An overview of the process is discussed below, followed by detailed descriptions of each step in Sections 3.1 through 3.7. After literature was compiled for dietary toxicity studies measuring growth, reproduction, and survival, acceptability criteria were applied to eliminate studies that were not considered appropriate for use in TRV derivation. A tiered process was applied to identify preferred studies for TRV selection, as well as secondary studies for inclusion if preferred studies were not available. Based on the tiered process, a subset of acceptable studies was reviewed in detail to compile dose-response datasets. For each of these datasets, either an ED20 (from TRAP modeling) or an effect level with at least a 20 percent reduction in the observed response relative to the control (abbreviated as the LOAEL ≥ 20) was derived. The TRV selected for each chemical, receptor group (i.e., birds and mammals), and endpoint (growth, reproduction, and survival) was the lowest ED20 or LOAEL ≥ 20 from the lowest tier (i.e., preferred studies) within each respective group. Uncertainties in the selected TRVs were evaluated to determine reliability in TRVs and potential bias for use in interpreting the risk estimates in the BERA.

3.1 LITERATURE COMPILATION (STEP 1)

The first step in the TRV derivation process was to conduct a thorough literature search for toxicological studies of the five COPCs using birds or mammals. The following sources were searched for studies related to growth, reproduction, and survival to potentially be used in the selection of TRVs for each COPC and receptor group (i.e., bird or mammal):

- EPA's Eco-SSLs—Includes a list of studies reviewed for use in the derivation of screening-level TRVs for avian and mammalian receptors
- Windward TRV database—Includes all studies reviewed and used in TRV development for EPA Region 10 sites (Portland Harbor and the Lower Duwamish Waterway), as well as Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites from other EPA regions[4]

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[4] The Windward TRV database for cadmium, copper, lead, manganese, and zinc includes over 150 dietary toxicity studies evaluating the effects on a variety of bird and mammal receptors. These studies were obtained through 2010 using the same general literature search methods described in this section.

- General literature search—A literature search was conducted using the U.S. National Library of Medicine's Toxicology Data Network (TOXNET),[5] the ECOTOXicology knowledgebase (ECOTOX) database, and Google Scholar, to ensure that sources for the UCR TRV derivation included more recent studies not included in EPA's Eco-SSLs or compiled as part of past Windward projects.

For the ECOTOX and TOXNET database searches, the following keywords and Boolean terms were used: (cadmium OR copper OR lead OR manganese OR zinc) AND (bird OR chicken OR duck OR quail OR bobwhite OR mallard OR turkey OR kestrel OR mammal OR rat OR mouse OR mice OR shrew OR rabbit OR mink OR cat OR monkey OR hamster OR pig OR vole OR dog) AND (diet OR gavage). The titles and abstracts retrieved were reviewed, and if any relevant endpoints (i.e., growth, reproduction, and survival) were identified, the paper was obtained for potential inclusion in the TRV derivation process. If papers could not be obtained from an online source, they were requested through the University of Washington's interlibrary loan service.

3.2 STUDY ACCEPTABILITY (STEP 2)

For the second step in the TRV derivation process, the studies compiled in Step 1 were evaluated to determine whether they could be used to derive TRVs for each COPC and receptor group for use in the UCR BERA. EPA's guidance for use of strength, relevance, and reliability in evaluating the weight of evidence in ERAs (USEPA 2016c) was applied in the process of determining whether the studies reviewed were acceptable for TRV derivation, listed by evaluation category:

Strength

- Studies in which effects were reported for relevant endpoints for the control, and at least one dose level, were considered acceptable. Unbounded NOAELs (i.e., dose levels from studies in which no level produced a statistically significant observed effect) were not included. Unbounded LOAELs (i.e., LOAELs from studies that did not report a NOAEL) were considered acceptable.
- Only toxicity studies based on exposure to a single chemical were included as acceptable. This criterion generally excluded the use of field studies.
- Study exposure duration was not a factor in determining study acceptability, although the Eco-SSL derivation procedure did not include studies that were < 3 days in duration.

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[5] Within TOXNET, the following databases were searched: 1) Developmental and Reproductive Toxicology (DART), 2) Toxicology Literature Online (TOXLINE), 3) Integrated Risk Information System (IRIS), and 4) International Toxicity Estimates for Risk (ITER).

Relevance

- Only studies that included survival, growth, or reproductive endpoints were used to be consistent with assessment endpoints defined in the UCR Expanded Problem Formulation (Exponent and HDR|HydroQual 2012). Studies that considered only endpoints such as behavior, biochemistry, pathology, population dynamics, or physiology were not included. In addition, studies that used reproductive effect measures that are not directly associated with reproductive success (e.g., egg weight, eggshell thickness, testes weight, sperm count) were not included. Table 3-1 lists specific effect measures from Eco-SSL growth, reproduction, and survival studies that were used, as well as those that were excluded.
- All routes of oral exposure were considered acceptable (e.g., dietary, gavage, drinking water); exposures by intraperitoneal injection, egg injection, inhalation, or any other routes were not considered acceptable. However, studies using dietary or gavage exposures were given preference over those using drinking water exposures in Step 3 of the TRV derivation process. Drinking water studies were included only if the number of studies with dietary or gavage exposures was considered insufficient (see Section 3.3).
- Studies with ruminants (i.e., cows, goats, and sheep) were not included because it was not considered appropriate to apply toxicity data for animals with rumens to monogastric animals. Metal uptake and toxicity in ruminants are influenced by the reducing environment in the rumen, which produces sulfur-reducing microorganisms. Excess metals become bound in indigestible sulfides in ruminants, which results in differences in how metals are absorbed and eliminated (NRC 2005). A focal species has not yet been selected to represent herbivorous mammals for the BERA, although vole was used in the COPC refinement (Windward 2018). If a ruminant species is selected, the toxicity data for cows, goats, and sheep will be reviewed to ensure that the selected UCR TRVs are protective of ruminants.

Reliability

- Only studies that could be obtained and reviewed were considered acceptable. Primary data must have been included for a study to be acceptable; review or summary articles that mentioned a study and its results were screened out.
- Only controlled toxicity studies that used standardized or peer-reviewed experiment methods were considered acceptable.

Studies that were not considered acceptable for TRV derivation are documented in Appendix A (Tables A-2 to A-11 for studies from the Eco-SSL documents and Table A-12 for additional studies found), along with the rationale for exclusion.

3.3 STUDY SELECTION PROCESS (STEP 3)

The third step of the TRV derivation process was to narrow the list of studies to be reviewed for the extraction of the most relevant toxicity data for TRV derivation. Preferred studies included:

- Studies that administered the dose by diet or gavage, as opposed to drinking water
- Growth studies conducted during a critical life stage (i.e., while a juvenile or during a reproductive period) or long-term, chronic growth studies (i.e., conducted for at least 10 percent of the species' lifespan).

Drinking water was not a preferred exposure route because chemicals are generally taken up more readily from water than from food in a laboratory setting, and exposure to chemicals in the field is generally substantially higher from food than from water (i.e., two to three orders of magnitude). For example, in the SLERA, the daily dose of individual metals from food ingestion (expressed as mg/kg bw/day) was generally at least three orders of magnitude greater than the daily dose from water (Parametrix et al. 2010a).

Growth studies conducted during a noncritical life stage were not preferred because adult receptors in a nonreproductive phase are not considered as susceptible to effects as are juveniles or reproducing adults (i.e., pregnant or lactating females). In addition, short-term growth studies conducted for less than 10 percent of the species' lifespan do not represent chronic exposures and are less preferable than longer-term studies, which have a greater likelihood of representing potential adverse effects at a population level as a result of a change in body weight over time.

A two-tiered process was applied to select studies for data extraction using the study preferences described above. The studies were classified as follows:

- Tier 1
  - Dietary or gavage exposure (including exposure by capsule—identified as "oral" exposure in the Eco-SSL documents)
  - Growth endpoint exposure period during a critical life stage or for at least 10 percent of the species' lifespan (see Tables 3-2 and 3-3 for toxicity test species' critical life stages and lifespans, respectively, used for this determination)[6]

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[6] The age of an organism used in a specific study was compared to the critical life stage age presented in Table 3-2. If the EcoSSL did not present the age of the organism but indicated that the organism was a juvenile, then it was assumed that the test had been conducted during a critical life stage.

- Tier 2
    - Drinking water exposure
    - Growth endpoint exposure period during a noncritical life stage or for less than 10 percent of the species' lifespan.

After acceptable studies were selected based on Step 2 (described in Section 3.2), a tier was assigned to each acceptable study. For the Eco-SSL studies, information used to assign the tier was obtained from the Eco-SSL documents (see Appendix A, Tables A-2 to A11); the assigned tiers and rationale are provided in Appendix A (Tables A-13 through A-22). Studies that had been obtained from sources other than the Eco-SSL documents were reviewed to determine the tier based on information provided in the paper, as shown in Table A-12 of Appendix A.

Eco-SSL studies were prioritized for selection, first by tier (Tier 1 ranked higher than Tier 2) and then by LOAEL (ranked from lowest to highest). The top five studies for each chemical/receptor/endpoint based on the study prioritization were selected and reviewed to determine if there were at least five datasets with a LOAEL ≥ 20. Additional studies were then selected as necessary in order of ranking until there were at least five datasets with a LOAEL ≥ 20. Each set of dose-response results from a study was considered a separate dataset in cases where multiple tests were conducted with different species, chemical forms, exposure durations, or effect measures. For example, Sutou et al. (1980) described a specific test conducted with rats that evaluated both the number of live fetuses and the fetal body weights. In this case, the dose responses for live fetuses and the dose responses for fetal body weights were reported as separate datasets. In addition, in some growth studies body weights were recorded separately for males and females of the same species. In cases where results differed between sexes, the dose-response curves for males and females were considered unique datasets.

Additional studies selected for data extraction (in addition to the top-ranked studies with a total of at least five datasets with a LOAEL ≥ 20) were as follows:

- Studies that had comparable data that could be pooled in the generation of ED20s or TRV derivation process (i.e., if data were based on the same effect measure, species, chemical form, and method of dose administration; for growth studies, a similar exposure duration).
- Studies conducted with a species not represented in any of the other selected studies; at least one additional study was reviewed for each new species (selected according to rank by tier and LOAEL value).

- Studies that were not included in the Eco-SSL documents were only selected if they were assigned a tier that was included for review based on the above procedure within each specific chemical, receptor, and endpoint group. For example, if review of Eco-SSL studies for lead/birds/growth resulted in the selection of only Tier 1 studies, then only Tier 1 studies for lead/birds/growth were selected from the non-Eco-SSL group.

The number of studies selected for data extraction and the number of acceptable datasets (i.e., LOAEL ≥ 20) for each chemical, receptor, and endpoint group are summarized in Table 3-4. Details on the rationale for determining whether to select a study for data extraction are provided in Appendix A (Tables A-13 to A-22).

3.4 DATA EXTRACTION AND COMPILATION (STEP 4)

The fourth step in the TRV derivation process involved extracting data from each selected toxicological study and compiling the relevant information needed for TRV derivation. Only studies that were selected based on the tiered process described in Step 3 were used to extract data for the derivation of the TRV.

The doses and their corresponding response levels from each unique dataset were compiled into dose-response datasets for each chemical, receptor, and endpoint (growth, survival, and reproduction). The data extracted from the toxicological studies for each dose-response dataset included the following:

- Species and life stage
- Chemical form
- Endpoint detail (i.e., effect measure)
- Exposure mode and duration
- Concentration in food (mg/kg)
- Dose (mg/kg bw/day) as presented by the study, or as calculated from organism body weight and food ingestion rate (FIR) if no dose was reported
- Organism body weight and FIR for conversion of food concentration to a dose if the study did not report the dose; preferably, body weight and FIR came from the study, but a secondary source was used if either or both were not reported in the study
- Sample size
- Effect observed at each dose or concentration, including the control
- Control-normalized effect, calculated as the dose effect divided by the control effect and multiplied by 100
- Standard error, standard deviation, and/or statistical results.

Doses were taken directly from the study, if reported. Otherwise, doses were calculated based on the chemical concentration of ingested media, the ingestion rate, and the body weight of the test organism, according to the following equation:

$$\text{Dose} = (\text{C} \times \text{FIR}) / \text{BW} \qquad \text{Equation 1}$$

Where:

Dose = daily dose of chemical expressed in mg/kg bw/day

C = concentration of chemical in ingested media in mg/kg (dry weight or wet weight)[7]

BW = body weight in kg

FIR = food ingestion rate in kg/day (dry weight or wet weight)[8]

Study-specific ingestion rates and body weights were used when possible for calculating doses. If body weights and ingestion rates were reported in the study, the initial and final values were averaged for animals that began the study as juveniles and ended as adults, and the initial values were used for animals that experienced little growth during the study. When ingestion rates and body weights were not reported in the study, doses were calculated with surrogate data from the scientific literature (Table 3-5).

Concentrations of the target chemical in the basal diet were included in the dose concentrations, when reported. For example, if the concentration of the target chemical in the basal diet was 10 mg/kg, and the amount added to the feed was 100 mg/kg, the amount of chemical in the food was considered to be 110 mg/kg. In cases where the chemical concentration was reported based on the weight of the compound (e.g., cadmium chloride), the weight was converted to that of the element alone (e.g., cadmium) using the molecular weights of the components.

Data extracted from the reviewed toxicological studies, including information used to convert the data to dietary doses, are presented in Appendix B.

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[7] The majority of studies used formulated feed as the diet for the laboratory organism; therefore, reported food concentrations were assumed to be based on dry weight unless otherwise noted in the study report.

[8] The wet or dry weight basis of the FIR used in Equation 1 needed to match the basis of the concentration in ingested media (C).

3.5 GENERATION OF ED20s (STEP 5)

The fifth step of the TRV derivation process was to select appropriate datasets for modeling ED20s and to run these datasets through the TRAP program, as discussed in the subsections below.

3.5.1 Selection of Datasets to Model

A subset of the individual and pooled datasets, as identified through the study selection and review process (i.e., Step 4), was modeled to estimate ED20s. Only the datasets that were expected to have the potential to represent the most sensitive dose-response curves for each receptor group (birds or mammals), endpoint (growth, survival, and reproduction), and COPC were considered for modeling, because these datasets had the potential to be used in TRV derivation. In order to be modeled and for the results to be useful for ED20 generation, datasets needed at least two sequential doses with effects less than those for the control, and at least one dose with an effect ≤ 80 percent relative to the control.[9] Effects data were plotted for all acceptable datasets that went through the study review and data compilation process (i.e., selected datasets as shown in Table 3-4). The plots were used to determine which of the individual and pooled study datasets had the potential to represent the most sensitive dose-response curves, and should therefore be modeled. If the points on the graph indicated that the expected ED20 for a specific dataset would be substantially higher than the expected ED20 for any other dataset, then that dataset was not selected for TRAP modeling. Likewise, if it appeared that the ED20 for a specific dataset would be substantially higher than the LOAEL ≥ 20 for a dataset that was not able to be modeled in TRAP, then that dataset was not selected for TRAP modeling.

Pooled datasets were normalized to the control before modeling in TRAP. Similar to modeling individual datasets, pooled datasets were considered for TRAP modeling only if the points on the graph indicated that there was a possibility that the ED20 could be lower than an ED20 or LOAEL ≥ 20 from another dataset. Datasets that could be pooled were evaluated for selection as a TRV only on a combined basis (i.e., a LOAEL ≥ 20 from an individual dataset was not considered for selection if the dataset was included in a pooled dataset).

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[9] A minimum of three dose levels (including the control) and associated responses is required by TRAP, although a larger number is preferred. At least one dose with an effect ≤ 80 percent relative to the control (and a second dose with a different effect lower than the control) is needed to ensure that estimating the ED20 does not require extrapolation beyond the range of the empirical data.

3.5.2 TRAP Software

TRAP is a software program developed by the EPA Mid-Continent Ecology Division to model dose-response relationships. TRAP generates model parameters, confidence limits, and variance analysis for biological responses to toxic exposures, based on a chosen analysis type and model shape (USEPA 2015d). TRAP software was used instead of EPA's Benchmark Dose Software (BMDS) (USEPA 2015a) because BMDS requires data that were often not available from the toxicity datasets identified (e.g., standard error). In addition, BMDS generates an array of models that cannot be evaluated easily relative to one another due to the limited number of doses (often fewer than six) in many of the toxicity datasets. In contrast, TRAP requires fewer inputs and generates a smaller array of more generic potential models.

TRAP permits analysis of data using least-squares nonlinear regressions or tolerance distributions. Both of these analysis types can be run using untransformed (raw) data or logarithm (log)-transformed data, and several different models are generated from which the user can select. Least-squares nonlinear regression analysis was used for growth and reproduction datasets (i.e., datasets with continuous data), while maximum likelihood tolerance distribution analysis was used for datasets with survival effect measures (i.e., datasets with dichotomous endpoints). Inputs to TRAP for nonlinear regression analysis include the dose, response values, and "weighting factor" (i.e., standard error). Inputs for the tolerance distribution include the dose, number of organisms that did not respond to treatment (i.e., those surviving treatment), and total number of organisms per dose. Both the nonlinear regression and tolerance distribution analyses generate model parameters, a visual display of the toxicity relationship, confidence limits, variance analysis, and a prediction line for several model types.

3.5.3 Running TRAP Model and Compiling Output

Each dataset selected for modeling was entered into TRAP as raw (i.e., untransformed) or log-transformed data. After initially testing the TRAP output using both raw and log-transformed data, it became apparent that log transformation resulted in better model outputs. Therefore, all datasets were log-transformed prior to running TRAP. The tolerance distribution analysis (used for survival effect measures, including reproduction effect measures of offspring survival) generated three model shapes: triangular distribution, Gaussian distribution, and rectangular distribution. The nonlinear regression analysis (used for reproduction measures other than survival of offspring, growth effect measures, and pooled datasets [i.e., datasets considered comparable as described in Section 3.3] regardless of endpoint because the data were normalized prior to pooling) also generated three model shapes: logistic, threshold sigmoid, and piecewise linear. All model parameters, confidence limits, variances, and prediction line data were compiled. The three model shape prediction lines for raw or log-transformed data for each dataset were plotted along with the raw data.

3.5.4 Selection of Model and ED20 from TRAP Output

The models for numerous datasets were reviewed, and the log transformation of the data for nonlinear regression and tolerance distribution analyses appeared to be the most appropriate model (compared to untransformed data) based on the fit to empirical data. In addition, log transformation of the data avoided the problem of generating negative values for the ED20s, which occurred for some datasets.[10] For the nonlinear regression analyses, the sigmoid threshold model generally provided the best fit to empirical data. For the tolerance distribution, the Gaussian model generally provided the best fit to empirical data. In some cases, TRAP was unable to model the data, and in a few cases, the models generated had a very poor fit to the empirical data (i.e., the model predictions were very different from the plotted data); as a result, no model was selected. In most cases, however, a model was selected (the threshold sigmoid log model for nonlinear regression[11] and the Gaussian log model for the tolerance distribution), and the ED20 generated from TRAP for that model was recorded. It is noteworthy that in many cases, the ED20s were very similar for all three model shapes. If pooled data from comparable datasets could not be modeled in TRAP, a geometric mean of the LOAELs ≥ 20 and/or ED20s from the comparable datasets was calculated. Appendix C presents the model results for all studies modeled in TRAP.

3.6 TRV SELECTION PROCESS (STEP 6)

The sixth step of the TRV selection process was to select TRVs for use in the BERA. A TRV was selected for each chemical, each receptor type (birds or mammals), and each endpoint type (growth, reproduction, and survival) from the dose-response datasets. The TRVs were selected as the lowest of the following: 1) LOAEL ≥ 20 from an individual dataset, 2) ED20 from an individual dataset, or 3) ED20 or geometric mean from a pooled dataset selected for modeling because the effect concentration had the potential to be lower than other ED20s and/or LOAELs based on visual inspection of the plotted data. If both Tier 1 and 2 studies were reviewed in Step 4, the TRV was selected from the Tier 1 studies. It should be noted that if an

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[10] Negative values may be derived using TRAP because the program estimates the control value as the asymptote of the modeled curve; this hypothetical exposure point and other points on the curve may be at values that are less than one. Examples of data that resulted in negative values when data were not log-transformed include DiGiulio and Scanlon (1984) and Leach et al. (1979).

[11] For one of the modeled studies, the sigmoid threshold model produced an unrealistic ED20 whereas the piecewise linear model provided a better fit to the empirical data. In this case, the piecewise linear model rather than the sigmoid threshold model was selected.

individual dose-response dataset was modeled and an ED20 was generated, the ED20 was used to represent that dataset, even if it was higher than the LOAEL ≥ 20 for that specific dataset.

If the selected effect level was based on a LOAEL ≥ 20, the study was reviewed to determine if there was any uncertainty in the results due to the lack of statistical evaluation (Figure 3-2). If it was determined that there was substantial uncertainty in the effect level based on best professional judgement, then the study was excluded from selection as an effect level and the selection process was repeated for the next lowest ED20 or LOAEL ≥ 20 from the lowest tier.

Based on the process described above, and as shown in the first set of boxes in Figure 3-2, an effect level representing either a LOAEL ≥ 20 or an ED20 was selected. Two additional steps were then conducted, as follows (Figure 3-2):

- The Eco-SSL documents were reviewed to determine if there were any studies with unbounded NOAELs for comparable dose-response datasets that were higher than the selected effect level. Two studies were found, but were not usable, as described in Section 4.3. If such studies are found during derivation of TRVs for other metals in the future and the data are considered acceptable with no substantial uncertainties due to lack of statistical evaluation, then data will be combined to see if the pooled dataset can be modeled. If so, the ED20 will be selected as the TRV. If not, a geometric mean will be calculated using the NOAEL and the selected LOAELs ≥ 20.
- If the selected effect level was lower than the Eco-SSL TRV, then the Eco-SSL TRV was selected for use in the BERA so that the BERA would not use a TRV lower than the value used as a screening level.

If a dose-response dataset was available for a specific UCR receptor species, then a receptor-specific TRV was also derived from those data (see Tables 3-6 and 3-7 for the toxicity test species compared to the proposed UCR receptors). The receptor-specific TRVs, rather than the TRVs derived using tests conducted with other species, will be used to characterize risk for the applicable UCR receptors.

3.7 UNCERTAINTY EVALUATION (STEP 7)

A qualitative uncertainty evaluation was conducted to identify factors in individual TRV studies that might affect the level of confidence in the TRV when estimating toxicity to UCR receptors, as well as the potential bias these factors could contribute to the overestimation or underestimation of risk. In addition to uncertainties associated with individual studies, uncertainties associated with the amounts and types of available toxicity data were evaluated. The uncertainties discussed in this section will be incorporated into a weight-of-evidence evaluation for the TRV selected for each COPC and receptor group. The following sections discuss these two types of uncertainties, as well as the application of these considerations to the selected TRVs.

The BERA will evaluate uncertainty regarding risk conclusions. Section 1 of this wildlife TRV document briefly discusses the issues associated with extrapolating from evidence of possible TRV exceedances to draw conclusions about ecological risk to wildlife. This section describes the part of the BERA wildlife uncertainty evaluation that is associated with the TRV development process.

3.7.1 Individual Study Considerations

A primary and potentially large uncertainty associated with all individual studies is whether the effects observed in a controlled laboratory environment would also be observed in the natural environment. For example, for the egg production endpoint, chickens are allowed to lay eggs indefinitely in the controlled environment, whereas most birds associated with the UCR are expected to lay a limited number of eggs in one or more clutches during a seasonal reproductive period. Therefore, reduced numbers of eggs laid by domesticated species in the laboratory may or may not translate to reduced numbers of eggs laid by wild birds. Another example of the uncertainty in translating laboratory to field effects is that laboratory animals have no alternate feeding options if they have an aversion to contaminated food, whereas animals in the wild may be able to feed on a variety of prey items, thus avoiding contaminated food. The weight reduction endpoint in single-choice laboratory studies is particularly vulnerable to food aversion (i.e., not directly attributable to chemical toxicity), thus overestimating chemical-specific risk in natural situations where foods of varying degrees of contamination is available.

Individual considerations that vary among studies are described below. The considerations discussed below include the species tested, the type of dose administration, the length of the test if it was a growth study, the egg production endpoint, the chemical form administered, conversion of dietary concentrations to doses, and whether an ED20 could be estimated. The sections for each of these considerations discuss the potential bias in the TRV and the resulting possibility for under- or overestimating risk, as summarized in Table 3-8.

3.7.1.1 Test Species

Metal uptake, absorption, metabolism, and excretion may differ among species, resulting in differences in toxicity associated with the same dose. Therefore, if test species used in the laboratory study are different from UCR receptors, there is greater uncertainty in the TRV. It is not known whether this extrapolation of results from the laboratory species to the species of concern at the site would contribute to an over- or underestimation of risk because there is no way to determine if the receptor species is more or less sensitive than the tested species.

3.7.1.2 Dose Administration

Dose administration by drinking water increases the uncertainty of an effect level (Section 3.3). Some metals may be more bioavailable for gut uptake when provided in a more soluble form (McGeer et al. 2004); therefore, a toxicity threshold based on drinking water studies may be lower than one based on dietary or gavage studies. No drinking water studies were identified as selected effect levels for any chemical/receptor/endpoint combination because of the availability of dietary and/or gavage studies; therefore, this uncertainty does not apply to the TRVs derived in this document, although it could apply to TRVs derived for other metals in the future. An uncertainty associated with dietary studies is the difficulty in monitoring the quantity of chemical ingested, whereas for gavage studies a measured amount of chemical can be administered (although it may be more difficult to determine the exact quantity for birds because of the potential for regurgitation after dosing). Dietary studies are more representative of the form of exposure in the natural environment than are gavage studies, as well as being more representative of the primary exposure route than are drinking water studies. If drinking water studies are used for a selected TRV, the reliability of the TRV decreases and could contribute to an overestimation of risk, depending on the metal and the form of it used in the toxicity study. Uncertainties in gavage and dietary studies could contribute to an under- or overestimation of risk.

3.7.1.3 Growth Study Exposure

Growth reduction that occurs during a critical life stage or for a long period is more likely to result in ecologically relevant effects (i.e., effects at a population level) than for weight reduction that occurs in adult organisms for a short period. Therefore, there is higher uncertainty associated with the prediction of population-level effects using ED20s and LOAELs ≥ 20 based on Tier 2 growth studies (i.e., tests conducted with organisms in a noncritical life stage and for less than 10 percent of the lifespan) than using those based on Tier 1 studies, potentially contributing to an overestimation of risk.

3.7.1.4 Chemical Form

The form of metal administered in the test was noted. If the form used in a test was not expected to occur as a result of metals mining or smelting activities, then the selected TRV could be biased high or low and could contribute to an underestimation or overestimation of risk. The majority of the toxicity studies evaluated used metal salts. The relative bioavailability of metal salts added to food in toxicity tests compared to metals bound to tissue in wildlife food is unknown; therefore, effects on the risk estimates are unknown and could be either underestimated or overestimated.

3.7.1.5 Dose Calculation

In most of the studies reviewed, body weight-normalized doses (i.e., expressed in mg/kg bw/day) were not presented; doses were instead calculated by multiplying the concentration in food (mg/kg) by the FIR (kg/day) divided by the body weight (kg). When body weights and FIRs were not measured as part of the study, they were estimated using data from the literature, ideally for the same species, sex, and age as in the study. Such an estimation results in uncertainty in the calculated dose, particularly in cases where data for the same species and/or age are not available. This uncertainty leads to a lower confidence in the TRV derived for the species used in the study. To evaluate the potential magnitude of this uncertainty, two of the effect levels from studies with LOAELs ≥ 20 used to derive TRVs that did not measure body weights or FIRs were recalculated using a range of potential minimum and maximum values, as follows:

- **Copper/mammal/survival LOAEL ≥ 20 of 17 mg/kg bw/day from Allcroft et al. (1961)**. The body weight and FIR of pigs at 15 weeks old (the average age during the study) of 45 kg and 1.5 kg/day, respectively, were used in this calculation; these values were derived from figures showing body weights and FIRs of pigs at different ages from Cai et al. (2009). If body weights of 35 to 55 kg or FIRs of 1.2 to 1.8 kg/day were used in the dose calculation, LOAELs would range from 14 to 22 mg/kg bw/day, respectively.
- **Zinc/bird/growth LOAEL ≥ 20 of 65 mg/kg bw/day from Lu et al. (1990)**. The body weight of leghorn chickens at 2 weeks old (average age at the start of the 1-week study) was estimated to be 70 g, as derived from growth curves for male and female leghorn chickens presented by EPA (1988). The FIR was calculated as a function of body weight using an allometric equation for chickens; also from EPA (1988). If the estimated body weight of chickens was changed to either 40 or 90 g, the respective LOAELs would be 70 or 61 mg/kg bw/day.

As shown above, the uncertainty in the body weights could result in either a high or low bias in the TRV, potentially contributing to an over- or underestimation of risk.

The conversion of a dietary concentration to a body weight-normalized dose assumes that toxicity among different species is a direct function of the FIR and body weight. If this assumption is incorrect, an additional bias may be introduced when applying the dose calculated for the test animals to a UCR receptor of concern, which could contribute to an underestimation or overestimation of risk.

3.7.1.6 Type of Effect Level

In general, TRVs based on ED20s provide a better understanding of predicted effects than LOAEL ≥ 20-based TRVs. An ED20 derived from modeling results in an estimated dose that represents a 20 percent reduction in the measured response compared to the control, taking into consideration the results from the other doses in the study, whereas a LOAEL is dependent upon the number of individuals at each dose level and the variability in responses of the control group (among other issues). The ED20 modeling uses the number of organisms per treatment and standard deviation or standard error, if available, resulting in a better estimate than a point-based LOAEL ≥ 20. In addition, if the measured effect represented by a LOAEL ≥ 20 is substantially greater than a 20 percent reduction in the response, then the TRV based on that LOAEL ≥ 20 could be biased high and could contribute to an underestimation of risk.

3.7.2 Quantity of Available Toxicity Data

In addition to uncertainties associated with the individual dataset used to derive the TRV, the number of species tested, including the overall number of dose-response datasets available for each COPC and receptor group, affect the reliability of the TRV in evaluating risk to UCR receptors.

The lowest ED20 or LOAEL ≥ 20 was selected from the acceptable studies as the TRV, as a protective measure to ensure that the most sensitive tested species and specific effect measure (e.g., litter size vs. offspring survival within the reproduction endpoint) will be covered in the estimation of the TRV. In general, the more species that have been tested, and the broader the range of taxonomic diversity, the more likely the species in the UCR will be represented in the toxicity testing data. Similarly, the greater the number of dose-response datasets, the more likely the representation of a variety of effects within an endpoint, increasing the likelihood that the most sensitive endpoint was measured.

3.7.3 Application of TRV Uncertainty Evaluation

For each selected TRV, the level of confidence in and bias of the TRV was qualitatively evaluated for the individual study used to derive the TRV, based on the considerations described in Section 3.7.1 and Table 3-8. In addition, the numbers of species and dose-response datasets available from the reviewed toxicity literature were noted for each COPC, receptor group, and endpoint.

The uncertainties addressed in this document will be incorporated into the BERA using a weight-of-evidence framework to evaluate the strength, relevance, and reliability of each selected TRV. For example, a hazard quotient (HQ) calculated using a TRV derived from a long-term test administered by dietary dose will be considered more reliable and relevant than an HQ calculated using a TRV derived from a short-term test administered by gavage. Likewise, an HQ calculated from a TRV based on a LOAEL representing 100 percent mortality compared to the control will be considered a more severe effect than an HQ calculated from a TRV based on an ED20 or a LOAEL representing 20 percent reduction in growth compared to the control derived from a short-term test. The BERA will also include a general discussion of the likelihood that the TRVs represent toxicity thresholds for UCR receptors based on the types of species evaluated in the toxicity tests.

Ideally, a receptor-specific TRV would be developed for each UCR surrogate species identified in the BERA Problem Formulation Plan (Exponent and HDR|HydroQual 2012) using reliable and relevant toxicity data. Because using such TRVs in the risk assessment would not involve interspecies extrapolation, they would result in risk estimates with higher confidence. A few receptor-specific TRVs were derived from the laboratory toxicity tests identified in the literature search that was performed for this wildlife TRV development process; the species associated with these TRVs were mallard, shrew, vole, and mink (Tables 3-6 and 3-7). In most cases, however, receptor-specific toxicity data were not available, and the mammal or bird TRVs were developed based on data for other nonreceptor species (e.g., chickens, rats, mice).

4 RESULTS

This section describes the results of the seven-step TRV derivation process for each COPC for birds and mammals, as described in Sections 3.1 through 3.7 and shown in Figure 3-1.

4.1 LITERATURE SEARCH AND STUDY REVIEW

For Steps 1 and 2 (the literature compilation and study acceptability processes), information on the studies used in the Eco-SSL documents was reviewed to determine whether each growth, reproduction, or survival study was acceptable using the criteria presented in Sections 3.1 and 3.2. Information presented in the Eco-SSL documents was reviewed for over 1,000 study/endpoint combinations (Tables A-2 through A-11 of Appendix A). Approximately 40 percent of the Eco-SSL studies met the acceptability criteria. The acceptability criterion that was most frequently not met in the remaining studies was that there must be an observed effect; most of the studies produced only unbounded NOAELs (Tables A-2 through A-11 of Appendix A).

An additional 61 references that were not included in the Eco-SSL documents were identified in the Windward TRV database or from a directed literature search. Study characteristics for 15 of these 61references met the acceptability criteria; therefore, the data from those studies were included in the TRV derivation process (see Table A-12 of Appendix A). The most common reasons for not using data from the remaining 46 references in the TRV derivation process were 1) only unbounded NOAELs existed, 2) study design concerns, 3) endpoints not being relevant, or 4) the exposure route was via injection.

For Step 3, studies were selected for detailed review based on the tiered process described in Section 3.3, which gave preference to the most relevant studies, i.e., dietary dose administration and long-term growth studies (Table 3-4). Of the 15 COPC/endpoint combinations for deriving bird TRVs, 12 involved the review of only Tier 1 studies, and 1 involved the review of both Tier 1 and Tier 2 studies. For the remaining two COPC/endpoint combinations (reproduction and survival endpoints for manganese), no studies were available for review. Of the 15 COPC/endpoint combinations for deriving mammal TRVs, 11 involved the review of studies from only Tier 1, and 4 involved the review of both Tier 1 and Tier 2 studies (Table 3-4). Four studies identified for review could not be obtained, as noted in Appendix A (one study in Table A-2, and three studies in Table A-4).

Summaries of the data extracted from the toxicological studies for each dose-response dataset (Step 4; see Section 3.4) are presented in Tables 4-1 through 4-5 for cadmium, copper, lead, manganese, and zinc, respectively. Details on the data extracted from the studies are presented in Appendix B.

4.2 TRAP MODELING RESULTS

All dose-response datasets identified through the study selection and review process, as summarized in Table 3-4, were plotted to show the dose vs. effect relative to the control, with separate plots for each chemical, receptor group (bird or mammal), and endpoint (growth, reproduction, and survival). Datasets were selected for TRAP modeling if they were considered most likely to result in the lowest ED20 for a specific chemical/receptor/endpoint combination based on a visual inspection of the plotted dose-response datasets. Figures 4-1 through 4-28 show the dose-response datasets for each COPC evaluated in this document, including the resultant ED20 values for those datasets that could be modeled successfully, as follows:

- Cadmium
    - Birds—Figures 4-1 to 4-3
    - Mammals—Figures 4-4 to 4-6
- Copper
    - Birds—Figures 4-7 to 4-9
    - Mammals—Figures 4-10 to 4-12
- Lead
    - Birds—Figures 4-13 to 4-15
    - Mammals—Figures 4-16 to 4-18
- Manganese
    - Birds—Figure 4-19 (no plots for reproduction or survival)
    - Mammals—Figures 4-20 to 4-22
- Zinc
    - Birds—Figures 4-23 to 4-25
    - Mammals—Figures 4-26 to 4-28

Figures 4-29 to 4-56 show the same data as Figures 4-1 to 4-28, but on a log-transformed basis. Information about the modeling status is presented in Tables 4-1 through 4-5 for each of the COPCs, including the ED20 values, if derived. For each dataset, the modeling status fell into one the following five categories:

1. Data were modeled as an individual dataset in TRAP to derive the ED20.
2. Data were selected for modeling as an individual or pooled dataset, but an ED20 could not be generated, or the ED20 was not used due to poor model fit.
3. Data did not meet the criteria for modeling (e.g., dataset did not have an effect that was at least 20 percent less than the control, lack of two consecutively lower and different effects less than the control, or consecutively lower effects followed by an increased effect, and a lower tier dataset was available).
4. Data were not selected for modeling because the effect concentration was substantially higher than other ED20s and/or LOAELs based on visual inspection of the plotted data.
5. Data were modeled as a pooled dataset in TRAP to derive the ED20.

For birds, usable ED20s were derived for at least one dataset for the following endpoint/metal combinations: growth, reproduction, and survival for cadmium (Table 4-1); growth, reproduction, and survival for copper (Table 4-2); survival for lead (Table 4-3); and growth and reproduction for zinc (Table 4-5). Seven of the bird ED20s were based on pooled datasets: one for survival and cadmium, two for growth and copper, two for reproduction and copper, one for survival and lead, and one for growth and zinc.

ED20s were not used for the following bird datasets because of poor model fit (see Appendix C for modeled curves):

- Lead and growth (Abduljaleel and Shuhaimi-Othman 2013) (Figure C-12)
- Lead and reproduction pooling group D (Figure C-13)
- Zinc and survival for mallard (Gasaway and Buss 1972) (Figure C-18).

For mammals, ED20s were derived for at least one dataset for the following endpoint and metal combinations: growth, reproduction, and survival for cadmium (Table 4-1); growth for copper (Table 4-2); survival for lead (Table 4-3); reproduction and survival for manganese (Table 4-4); and growth for zinc (Table 4-5). The mammal ED20 for cadmium and growth was based on a pooled dataset. The modeled dose-response curves for ED20s that were selected as TRVs are presented in Appendix C.

ED20s were not used for the following mammal datasets because of poor model fit (see Appendix C for modeled curves):

- Cadmium and survival pooling group C (curve could not be generated)
- Copper and growth (Brandt 1983) (Figure C-23)
- Copper and survival pooling group B (Figure C-25)
- Lead and reproduction (Gupta et al. 1995) (Figure C-27)
- Manganese and growth (Rehnberg et al. 1980) (Figure C-29)
- Zinc and reproduction (Khan et al. 2007) (Figure C-33)
- Zinc and survival pooling group D (curve could not be generated).

4.3 TRV SELECTION AND UNCERTAINTY EVALUATION

This section presents the TRVs selected for each chemical, receptor group, and endpoint as well as the uncertainties associated with these TRVs.

4.3.1 Birds

Effect levels for birds were selected as the lowest of the LOAEL ≥ 20, ED20, or geometric mean from Tier 1 for the growth, reproduction, and survival endpoints for cadmium, copper, lead, and zinc (Table 4-6). Effect levels could not be derived for manganese because of the lack of toxicity data for the reproduction and survival endpoints and because no effects representing a ≥ 20 percent reduction in response compared to the control were observed in any of the three growth studies reviewed. Nine of the 12 selected effect levels for all bird endpoints (not including receptor-specific effect levels) are based on ED20s; two are based on LOAEL ≥ 20, and one is based on a geometric mean. UCR receptor-specific avian TRVs were derived for the mallard growth and reproduction endpoints for cadmium, and the mallard growth and survival endpoints for zinc.

Eco-SSL data (presented in Appendix A) were reviewed to determine if there were any unbounded NOAELs from comparable datasets higher than the selected effect levels (see TRV selection process shown in Figure 3-2). One study for birds was identified (Leeson and Summers 1982), but the NOAEL calculated using the body weight and FIR for a 1-week-old chick from NRC (1994) was an order of magnitude lower than the NOAEL from the Eco-SSL document (calculated using adult body weights and FIRs), resulting in an unbounded NOAEL lower than the selected effect level.

As a final step (Figure 3-2), selected effect levels were compared to Eco-SSLs; one effect level was lower than the Eco-SSL (zinc and growth). Therefore, the Eco-SSL was identified as the TRV for zinc and growth, and the selected effect levels shown in Table 4-6 were identified as TRVs for the remaining chemical and endpoint combinations. TRVs derived for birds are compared to TRV derivation plots from the Eco-SSL documents in Appendix D. A selected TRV could be greater than the LOAELs shown on the Eco-SSL plots that are derived from acceptable studies for one or more of the following reasons: 1) the LOAEL was from a Tier 2 study but Tier 1 data were available; 2) the LOAEL response was less than 20 percent different from the control response; 3) body weight or FIR assumptions were used to calculate the LOAEL dose; 4) an ED20 was used instead of the LOAEL; 5) the LOAEL was part of a pooled dataset; or 6) the LOAEL was not reviewed because of the tiered process.[12] In addition, a number of LOAELs from the Eco-SSL plots were excluded because the studies were not considered acceptable for TRV derivation for one or more of the following reasons: 1) the endpoint was not relevant, 2) the study was conducted with ruminants, 3) no LOAEL was identified, 4) there were concerns with the study design, or 5) there were insufficient data to calculate a response relative to the control. The number of LOAELs presented in Eco-SSL documents that are lower than each selected TRV, along with the rationale for not using these LOAELs, are presented in Appendix A (Table A-23). Based on the rationale, inclusion of these studies would not be expected to result in more reliable TRVs.

4.3.2 Mammals

For mammals, effect levels were selected as the lowest of the LOAEL ≥ 20, ED20, or geometric mean from Tier 1 for growth, reproduction, and survival endpoints for all five metals (Table 4-6). Eight of the selected effect levels (not including receptor-specific effect levels) are based on ED20s, five are based on LOAEL ≥ 20, and two are based on geometric means. Four receptor-specific TRVs were derived for mammals: the cadmium growth endpoint for shrew, and the copper growth, reproduction, and survival endpoints for mink.

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[12] For the growth endpoint for copper and birds, although 10 studies were reviewed to obtain at least 5 datasets with a LOAEL ≥ 20, 12 other acceptable studies were not reviewed after following the process described in Section 3.3. Studies that were not reviewed used the same species (chicken and turkey) as those used to derive the TRVs; therefore, it is not expected that inclusion of these additional datasets would substantially affect the selected TRV, as discussed on a conference call with EPA (Bergquist et al. 2019).

The lowest LOAEL ≥ 20 for copper and reproduction was 2.4 mg/kg bw/day, based on a study conducted with pigs in which a dietary copper concentration of 250 mg/kg resulted in a reduced farrowing rate of gilts compared to the control (Cromwell et al. 1993). However, there were no other effects on reproductive endpoints, and the authors stated that "The results indicate that, except for a possible decrease in farrowing rate of gilts, the feeding of 250 ppm of Cu to sows for an extended period of time had no detrimental effect on reproductive performance; in fact, feeding high dietary Cu to sows increased birth and weaning weights of their pigs." The NRC committee (NRC 2005) set maximum tolerable levels for dietary copper at concentrations in food ranging from 250 mg/kg for swine to 2,000 mg/kg for mice, including a consideration of the study by Cromwell et al. (1993). Based on these considerations, the low dose of 2.4 mg/kg bw/day was not selected as the lowest effect level. Instead, the next lowest LOAEL ≥ 20 of 27 mg/kg bw/day from a mink study by Aulerich et al. (1982) was identified as the selected effect level for copper and reproduction (Table 4-2).

Eco-SSL data (presented in Appendix A) were reviewed to determine if there were any unbounded NOAELs from comparable datasets higher than the selected effect levels (see BERA TRV selection process shown in Figure 3-2). One study was identified (Nation et al. 1990), and after reviewing this study, it was found that growth data (i.e., changes in body weight) were not presented in the paper; therefore, effect levels compared to the control could not be calculated.

The final step in deriving TRVs, as shown in Figure 3-2, was to compare selected effect levels to Eco-SSLs; three effect levels were lower than the Eco-SSLs (lead and reproduction, zinc and growth, and zinc and reproduction). Therefore, the Eco-SSLs were identified as the TRVs for these chemical and endpoint combinations, and the selected effect levels shown in Table 4-6 were identified as the TRVs for the remaining combinations (Table 5-1). TRVs derived for mammals are compared to TRV derivation plots from the Eco-SSL documents in Appendix D. A TRV could be greater than the LOAELs shown on the Eco-SSL plots for one or more of the reasons listed for birds in Section 4.3.1. The number of LOAELs presented in Eco-SSL documents that are lower than each selected TRV and the rationale for not using these LOAELs are presented in Appendix A (Table A-23). Based on the rationale, inclusion of these studies would not be expected to result in more reliable TRVs.

4.3.3 Uncertainty Evaluation

For the uncertainty evaluation, each selected effect level was evaluated to determine which considerations could result in a decrease in confidence in the value, and whether these considerations could result in potential biases in the TRV based on the effect level. The considerations in the selected effect levels for each COPC and receptor group are presented in Tables 4-7 to 4-15.

The most common uncertainty considerations listed in Tables 4-7 to 4-15 as affecting confidence in the selected effect levels were the representation of the UCR species by the species used in the toxicity tests, and the dietary and gavage dose administration methods with their separate types of uncertainty. Of the effect levels that were not specific to UCR species, none for birds and only one for mammals were derived from studies that used UCR receptor species. All the studies used to derive TRVs were conducted using either dietary or gavage dose administration methods. The uncertainties associated with test species and method of dose administration could result in a high or low bias of the TRV.

Another common consideration affecting confidence was the use of secondary sources to estimate the body weight and/or FIR for dose calculations. Secondary sources were used to derive 12 of the 16 bird effect levels and 9 of the 19 mammalian effect levels, including UCR receptor species-specific effect levels. It is not known if the use of test species that are not receptors or the use of an estimated body weight or FIR would result in a high or low bias of the TRVs.

For the growth endpoint for non-UCR receptor species, all of the selected effect levels were based on studies that were conducted during a critical life stage or for more than 10 percent of the species' lifespan. For UCR receptor species (mallard and cadmium), one of the selected effect levels was based on a study that was conducted during a noncritical life stage and for less than 10 percent of the species' lifespan, resulting in a potential low bias of the TRV.

Four of the 16 selected effect levels for birds and 7 of the 19 selected effect levels for mammals were based on LOAELs ≥ 20. The percent reductions in the observed responses compared to the controls ranged from 20 to 71 percent. This factor could result in a potential high bias in the TRV, particularly when the effect level represents a high reduction in the response compared to the control.

TRVs used in ERAs are most commonly expressed as daily doses rather than concentrations in food, although there is uncertainty in the dose-based TRV as a result of the conversion from a food concentration to a dose (Sample et al. 2014). Therefore, for comparison purposes and facilitation of potential qualitative discussions about the uncertainty associated with conversion of concentration to dose, plots showing effects as a function of food concentration are presented in Figures 4-57 to 4-84 for the same datasets as the plots showing effects as a function of dose (Figures 4-1 to 4-28).

5 SUMMARY

Bird and mammal TRVs were derived for use in the BERA for five metals (cadmium, copper, lead, manganese, and zinc) that have been identified as COPCs in the UCR based on preliminary terrestrial and aquatic wildlife screening-level risk assessments. A seven-step process was followed to compile toxicological literature; apply acceptability criteria related to study reliability, relevance, and strength; prioritize studies for review using a tiered process; review studies and compile dose-response results; conduct benchmark dose modeling; select effect levels and TRVs; and conduct an uncertainty evaluation.

Studies were compiled from EPA's Eco-SSL list, the Windward database of studies used in other risk assessments, and a general literature search. Only studies that evaluated growth, reproduction, and survival toxicity endpoints were included. A set of acceptability criteria was applied to the compiled studies to eliminate those that were not considered appropriate for use in TRV derivation.

For dose-response datasets from studies considered acceptable, a tiered process was applied to identify preferred studies for TRV derivation (Tier 1) and secondary studies (Tier 2) for inclusion if preferred studies were not available. Secondary studies included growth studies that were conducted during a noncritical life stage or for less than 10 percent of the species' life stage, as well as studies that administered the dose via drinking water. Based on the tiered process, a subset of acceptable studies was reviewed in detail to compile dose-response data for potential modeling and consideration in deriving the TRVs.

For each of the compiled datasets, either an ED20 (from TRAP modeling) or a LOAEL with at least a 20 percent reduction in the observed response relative to the control (abbreviated as LOAEL ≥ 20) was derived. Datasets were modeled if they were considered most likely to result in the lowest ED20 based on a visual inspection of plotted data, and if criteria for modeling were met. Comparable datasets (i.e., datasets with the same effect measure, species, chemical form, method of dose administration, and similar exposure duration for growth studies) were pooled prior to modeling. If pooled datasets could not be modeled, a geometric mean was calculated from the LOAELs ≥ 20.

The TRV derived for each chemical, receptor group (birds and mammals), and endpoint (growth, reproduction, and survival) was the lowest selected effect level (i.e., ED20, LOAEL ≥ 20, or geometric mean of pooled datasets) from Tier 1 studies, or from Tier 2 studies if Tier 1 studies were not available. Studies from the Eco-SSLs were reviewed to determine if there were any unbounded NOAELs from comparable studies that were higher than the selected effect levels. In addition, the selected effect levels were compared to the Eco-SSL TRVs to determine if any of the selected effect levels were lower than those from the Eco-SSLs; if so, the Eco-SSL TRV was selected as the TRV.

The TRVs are summarized in Table 5-1. For birds, effect levels were derived for growth, reproduction, and survival endpoints for cadmium, copper, lead, and zinc. TRVs could not be derived for manganese in birds because of the lack of toxicity data for the reproduction and survival endpoints, and because no effects representing a ≥ 20 percent reduction in response compared to the control were observed in any of the three growth studies reviewed. For mammals, TRVs were derived for growth, reproduction, and survival endpoints for all five metals. A review of studies in the Eco-SSL documents found that there were two unbounded NOAELs from comparable datasets that were higher than the selected effect levels, but a review of these papers did not find any usable data that could be pooled with other datasets. One of the selected effect levels for birds and three of the selected effect levels for mammals were lower than the Eco-SSLs; therefore, the Eco-SSL TRVs were selected as TRVs for these receptor/chemical/endpoint combinations.

Uncertainties in the derived effect levels were evaluated to determine potential bias in the final TRVs, and to identify factors influencing confidence in their use in the BERA for estimating and interpreting risk. The most common factors affecting confidence in the TRVs were the use of laboratory species that were not representative of UCR receptors, uncertainties associated with dose administration, the use of secondary sources to estimate the body weight and/or FIR for dose calculations, and the selection of LOAELs rather than ED20s as effect levels. The effects of these factors on the level of confidence and bias in the risk estimates calculated using these TRVs will be discussed in the BERA.

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FIGURES

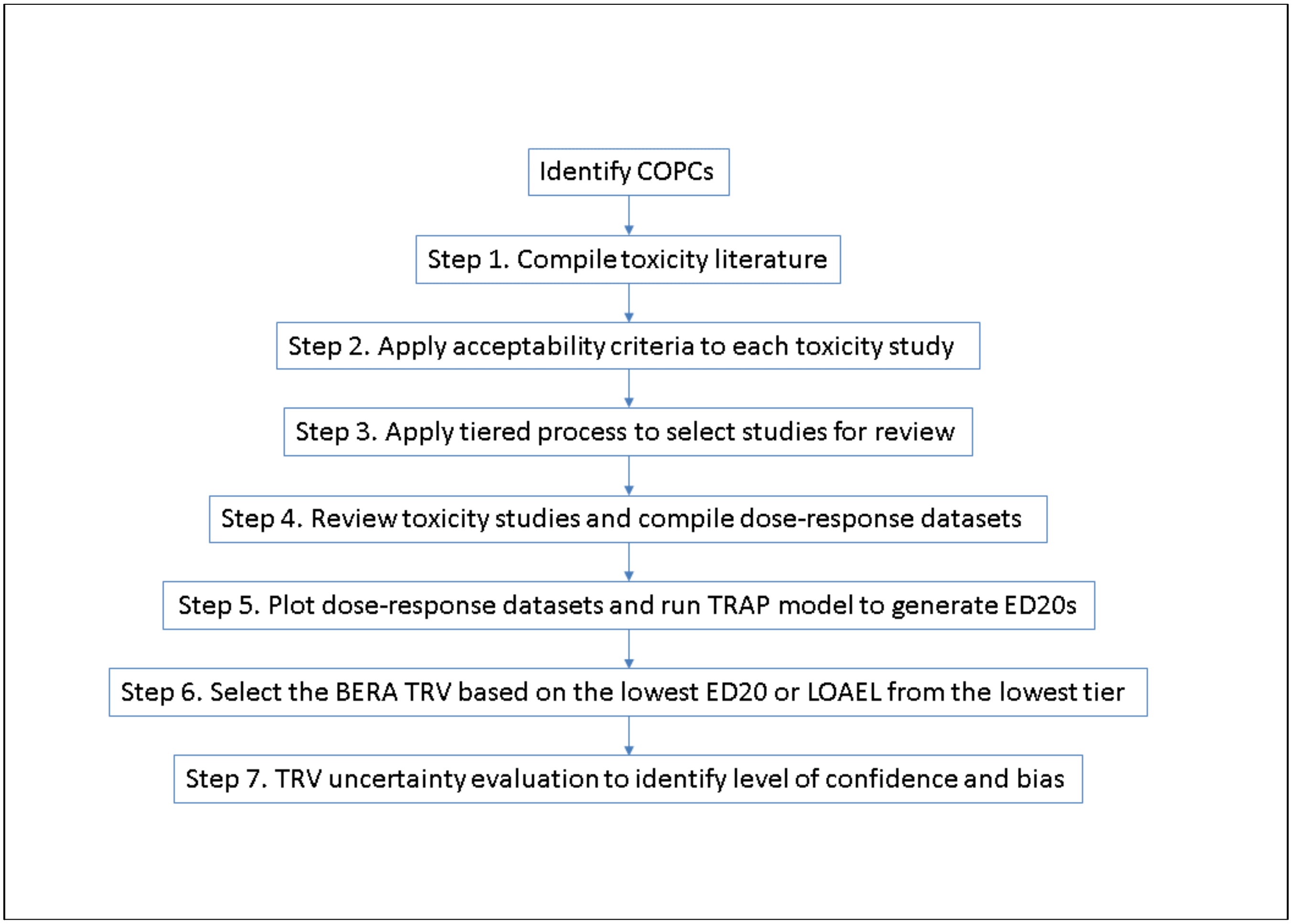
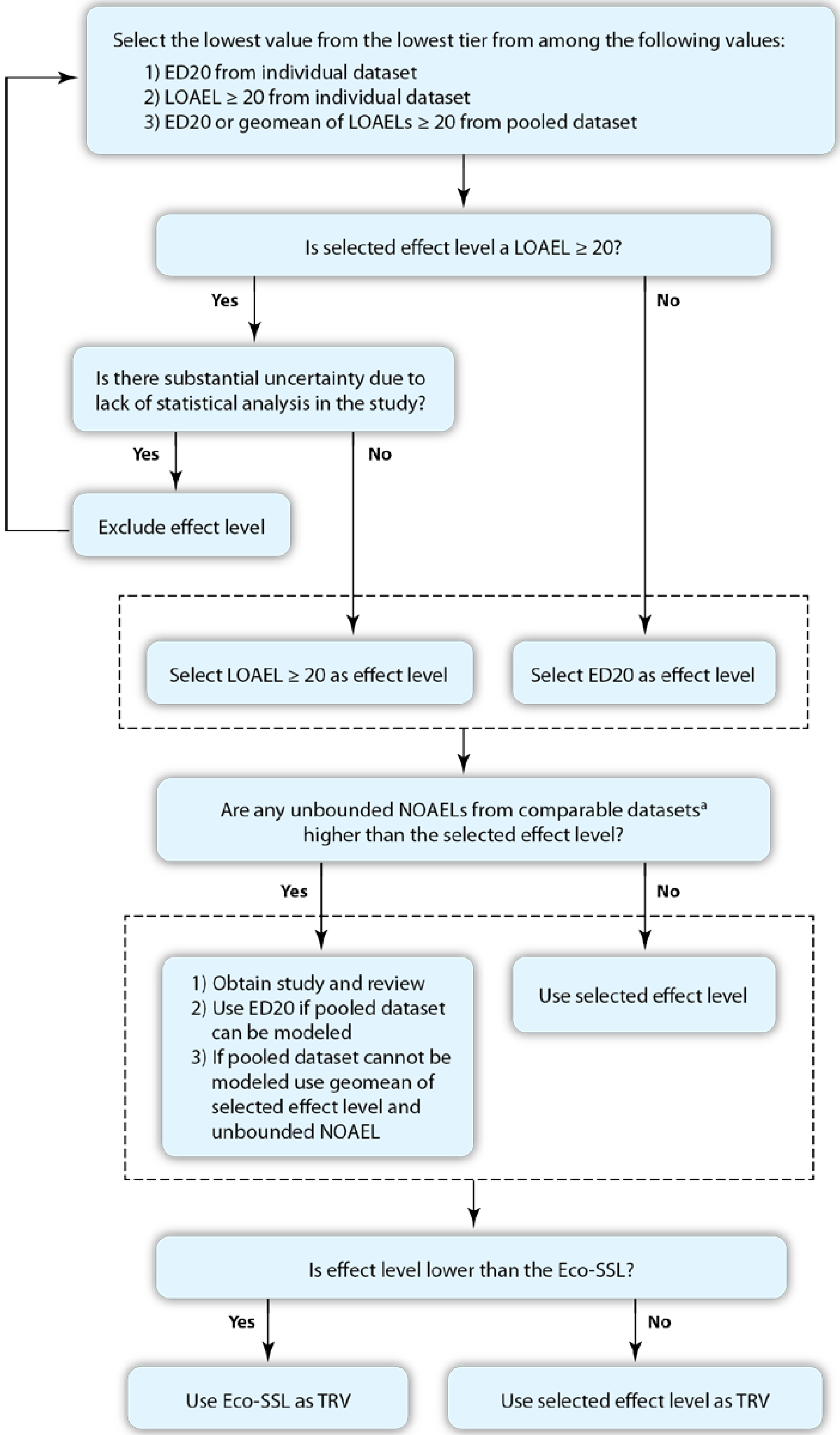


Figure 3-1. Seven-Step Process for Deriving TRVs



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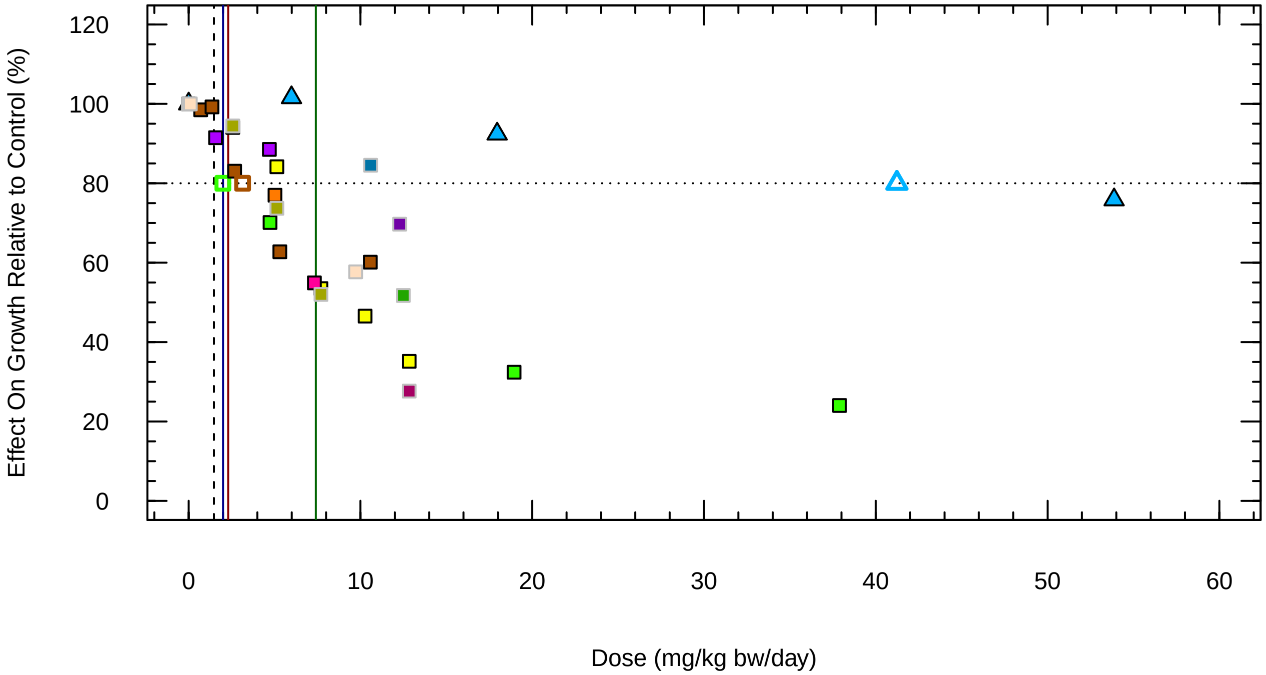
[a] A comparable dataset is one with the same effect measure, species, chemical form, method of dose administration, and similar exposure duration for growth studies.

Figure 3-2. Flow Chart for TRV Selection Process



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Bafundo et al. 1984	chicken	body weight gain	diet	2 weeks	cadmium chloride	
🟩	Bokori et al. 1995a	chicken	body weight	diet	4 weeks	cadmium sulfate	
🟪	Bokori et al. 1996	chicken	body weight	diet	39 weeks	cadmium sulfate	
▲	Di Giulio and Scanlon 1984	mallard	body weight	diet	6 weeks	cadmium chloride	
🟨	Hill 1974a	chicken	body weight gain	diet	2 weeks	cadmium sulfate	A
🟥	Hill 1974b	chicken	body weight gain	diet	2 weeks	cadmium sulfate	A
🟫	Olgun 2015	Japanese quail	body weight	diet	10 weeks	cadmium sulfate	
🟩	Richardson and Fox 1974	Japanese quail	body weight	diet	4 weeks	cadmium chloride	B
🟪	Richardson et al. 1974	Japanese quail	body weight	diet	4 weeks	cadmium chloride	B
🟦	Richardson et al. 1974	Japanese quail	body weight	diet	6 weeks	cadmium chloride	B
🟨	Hill 1979	chicken	body weight gain	diet	2 weeks	cadmium sulfate	A
🟥	Hill 1980	chicken	body weight gain	diet	2 weeks	cadmium sulfate	A
🟧	Rama and Planas 1981	chicken	body weight gain	diet	9 weeks	cadmium sulfate	A
□	ED20 for Bokori et al. 1995a	chicken	body weight	diet	4 weeks	cadmium sulfate	
△	ED20 for Di Giulio and Scanlon 1984	mallard	body weight	diet	6 weeks	cadmium chloride	
□	ED20 for Olgun 2015	Japanese quail	body weight	diet	10 weeks	cadmium sulfate	

□ Tier 1 △ Tier 2

- - - Eco−SSL TRV = 1.47 mg/kg bw/day

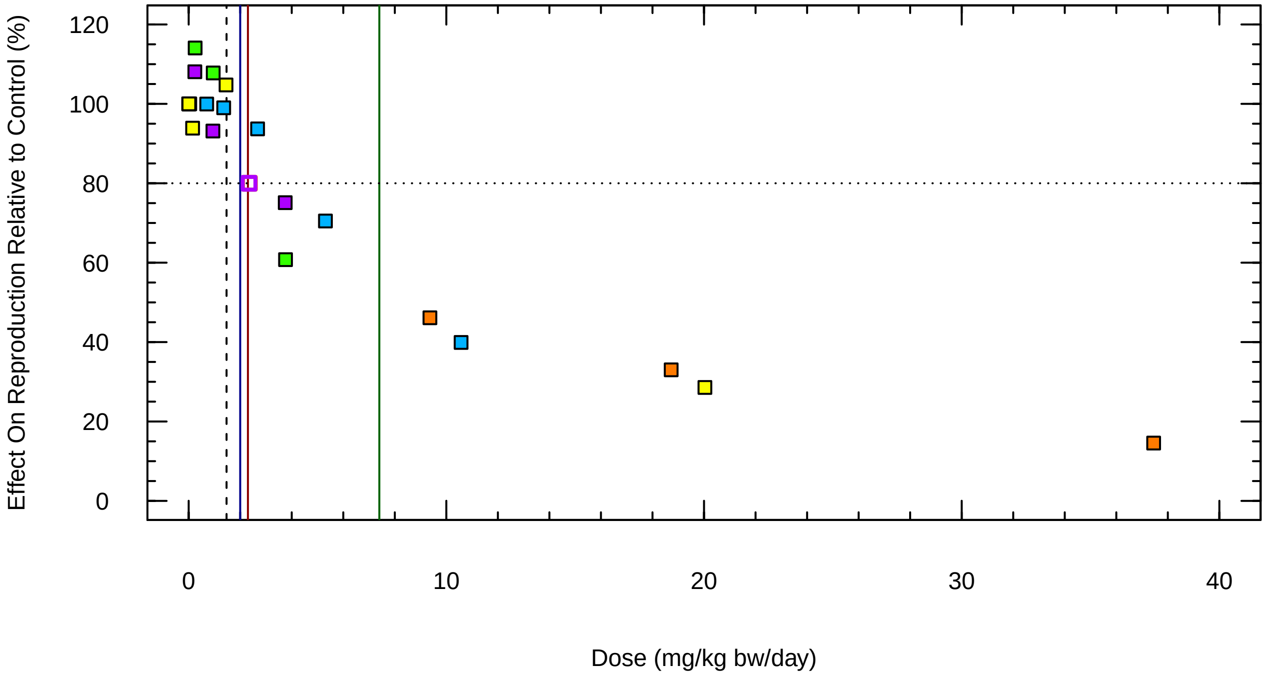
— Selected TRV (Growth) = 2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.3 mg/kg bw/day
— Selected TRV (Survival) = 7.4 mg/kg bw/day

····· 80% effect relative to control

ED20 for Bokori et al. 1995a is 2 mg/kg bw/day
ED20 for Di Giulio and Scanlon 1984 is 41 mg/kg bw/day
ED20 for Olgun 2015 is 3.1 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−1. Dose−Response Data for the Avian Growth Endpoint for Cadmium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Bokori et al. 1995b	Japanese quail	egg production	diet	5.29 weeks	cadmium sulfate	
🟩	Leach et al. 1979	chicken	egg production	diet	48 weeks	cadmium sulfate	
🟪	Leach et al. 1979	chicken	egg production	diet	12 weeks	cadmium sulfate	
🟦	Olgun 2015	Japanese quail	egg production	diet	10 weeks	cadmium sulfate	
🟨	White and Finley 1978	mallard	egg production	diet	4.3−12.8 weeks	cadmium chloride	
□	ED20 for Bokori et al. 1995b	Japanese quail	egg production	diet	5.29 weeks	cadmium sulfate	
□	ED20 for Leach et al. 1979	chicken	egg production	diet	12 weeks	cadmium sulfate	

□ Tier 1

- - - Eco−SSL TRV = 1.47 mg/kg bw/day

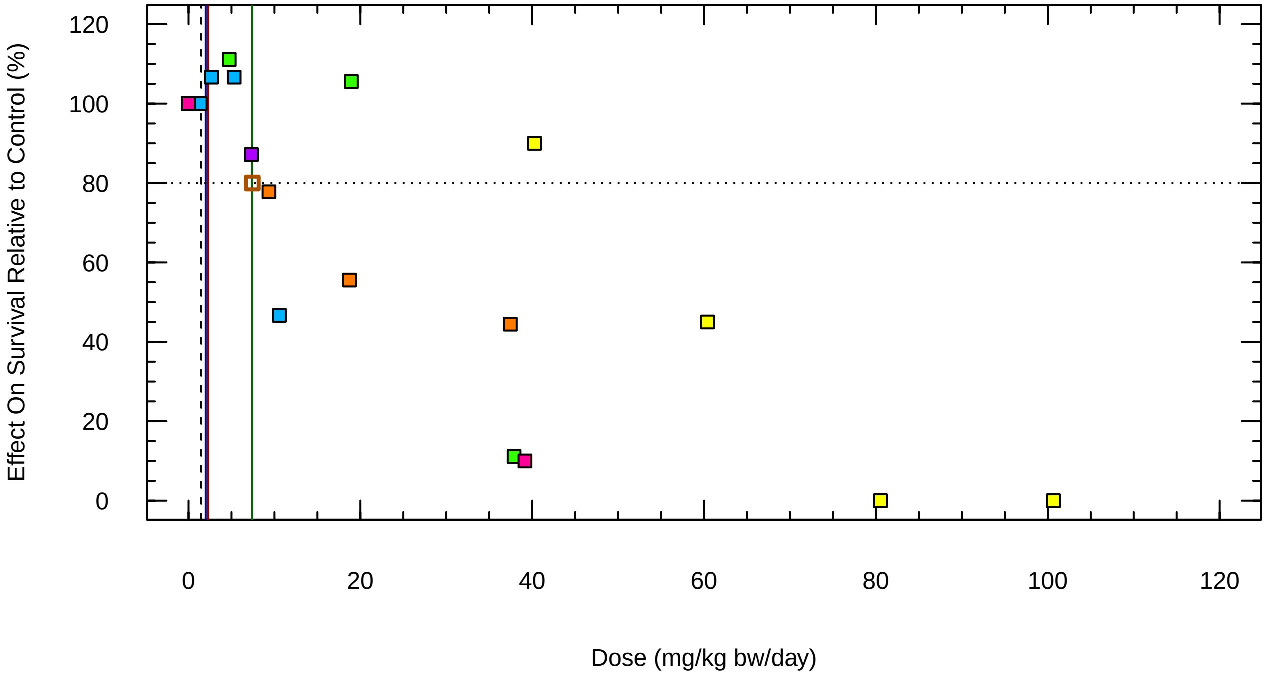
— Selected TRV (Growth) = 2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.3 mg/kg bw/day
— Selected TRV (Survival) = 7.4 mg/kg bw/day

····· 80% effect relative to control

ED20 for Bokori et al. 1995b is 2.4 mg/kg bw/day
ED20 for Leach et al. 1979 is 2.3 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−2. Dose−Response Data for the Avian Reproduction Endpoint for Cadmium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Bokori et al. 1995b	Japanese quail	survival	diet	5.29 weeks	cadmium sulfate	C
🟩	Bokori et al. 1995a	chicken	survival	diet	8 weeks	cadmium sulfate	
🟪	Hill 1974b	chicken	survival	diet	2 weeks	cadmium sulfate	
🟦	Olgun 2015	Japanese quail	survival	diet	10 weeks	cadmium sulfate	C
🟨	Pritzl et al. 1974	chicken	survival	diet	2.86 weeks	cadmium carbonate	
🟥	Van Vleet et al. 1981	Pekin duck	survival	diet	4 weeks	cadmium sulfate	
□	ED20 for pooled dataset C	Japanese quail	survival	diet	5.3−10 weeks	cadmium sulfate	C

□ Tier 1

- - - Eco−SSL TRV = 1.47 mg/kg bw/day

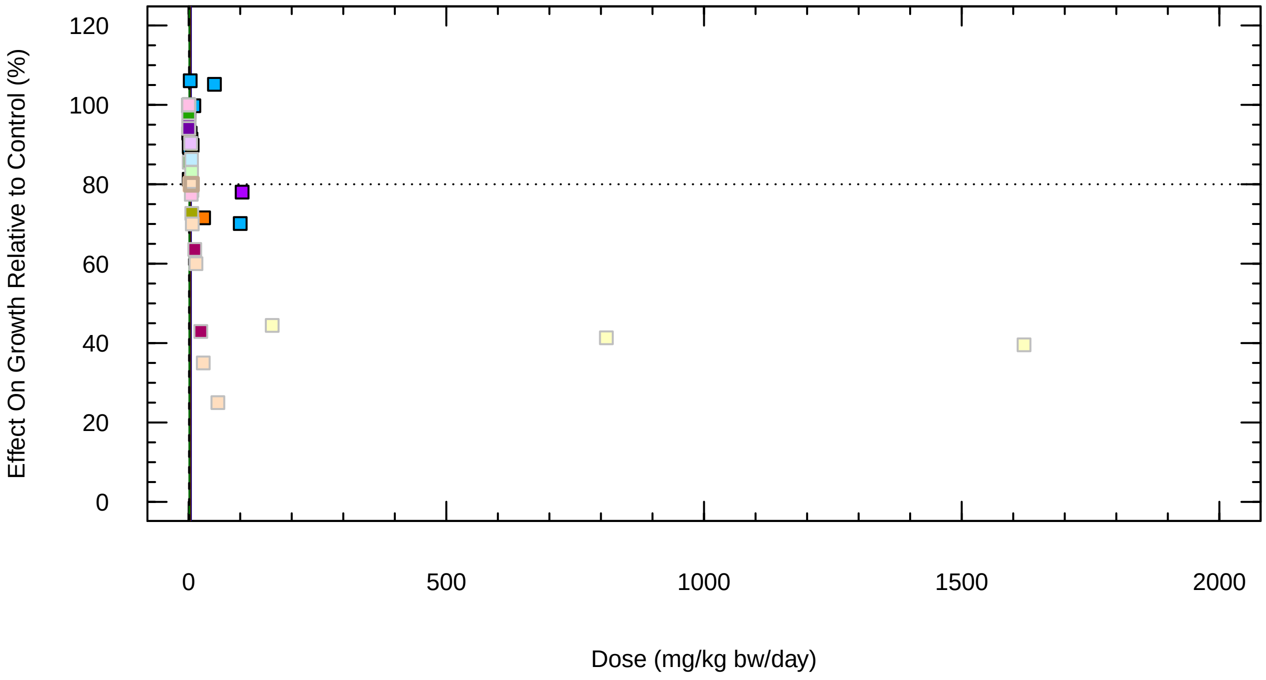
— Selected TRV (Growth) = 2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.3 mg/kg bw/day
— Selected TRV (Survival) = 7.4 mg/kg bw/day

····· 80% effect relative to control

ED20 for pooled dataset C is 7.4 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−3. Dose−Response Data for the Avian Survival Endpoint for Cadmium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
■	Baranski and Sitarek 1987	rat	body weight	gavage	14 weeks	cadmium chloride	
■	Cousins et al. 1977	rat	body weight	diet	14 weeks	cadmium chloride	
■	Dodds−Smith et al. 1992	shrew	body weight	diet	12 weeks	cadmium chloride	
■	Hamada et al. 1991	dog	body weight	diet	8−9 years	cadmium chloride	
■	Rajanna et al. 1984	rat	body weight	diet	25.7 weeks	cadmium chloride	
■	Groten et al. 1991	rat	body weight	diet	8 weeks	cadmium chloride	
■	Rastogi et al 1977	rat	body weight	gavage	4.27 weeks	cadmium chloride	
■	Merali and Singhal 1980	rat	body weight	gavage	6.14 weeks	cadmium chloride	
■	Weigel et al. 1987	rat	body weight	diet	7.86 weeks	cadmium oxide	
■	Pond et al. 1973	pig	body weight	diet	7.14 weeks	cadmium chloride	
■	Suzuki and Yoshida 1979	rat	body weight	diet	2 weeks	cadmium chloride	A
■	Suzuki and Yoshida 1979	rat	body weight	diet	4 weeks	cadmium chloride	A
■	Wilson et al. 1941	rat	body weight	diet	7.14 weeks	cadmium chloride	
■	Suzuki and Yoshida 1978a	rat	body weight (Exp 1)	diet	25.7 weeks	cadmium chloride	
■	Suzuki and Yoshida 1978a	rat	body weight (Exp 2)	diet	25.7 weeks	cadmium chloride	
■	Suzuki and Yoshida 1978b	rat	body weight (Exp 1)	diet	2 weeks	cadmium chloride	A
■	Weber and Reid 1969	mouse	body weight (Exp 1)	diet	3 weeks	cadmium acetate	
■	Suzuki and Yoshida 1977	rat	body weight (Exp 2)	diet	6.43 weeks	cadmium chloride	A
□	ED20 for Wilson et al. 1941	rat	body weight	diet	7.14 weeks	cadmium chloride	
□	ED20 for pooled dataset A	rat	body weight	diet	2−6.4 weeks	cadmium chloride	A

□ Tier 1

- - - Eco−SSL TRV = 0.77 mg/kg bw/day

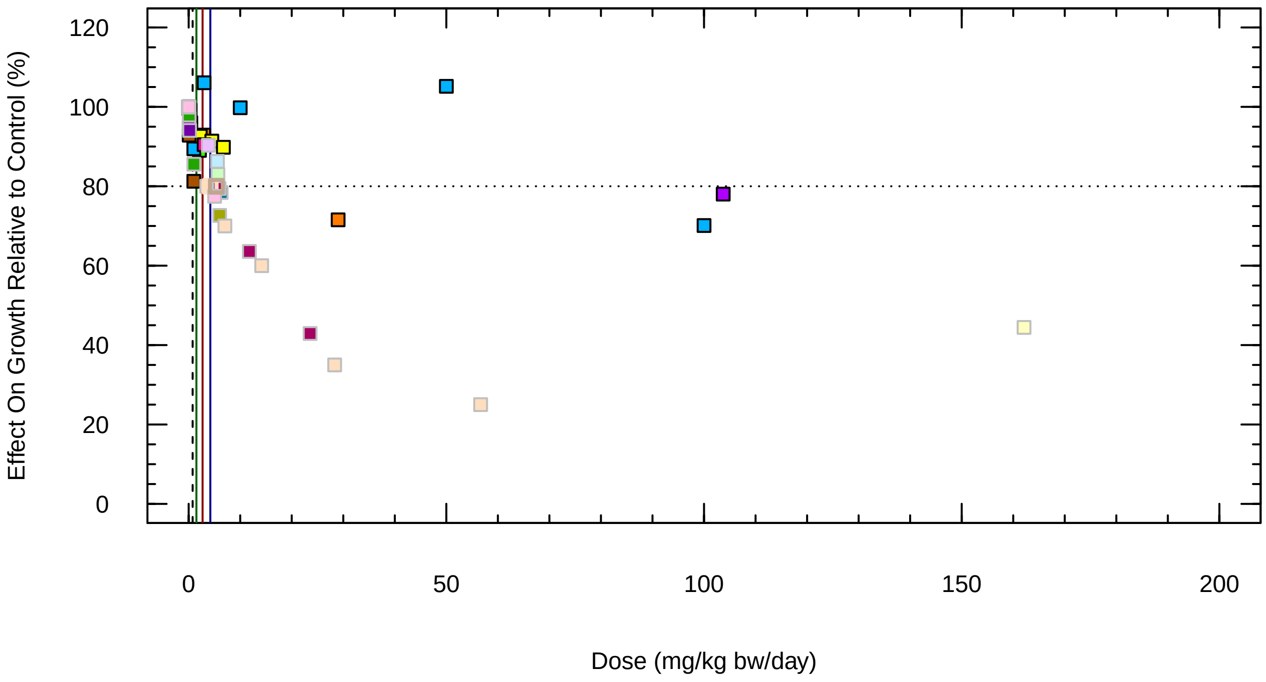
— Selected TRV (Growth) = 4.2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.7 mg/kg bw/day
— Selected TRV (Survival) = 1.5 mg/kg bw/day

····· 80% effect relative to control

ED20 for Wilson et al. 1941 is 4.2 mg/kg bw/day
ED20 for pooled dataset A is 5.4 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−4a. Dose−Response Data for the Mammalian Growth Endpoint for Cadmium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
■	Baranski and Sitarek 1987	rat	body weight	gavage	14 weeks	cadmium chloride	
■	Cousins et al. 1977	rat	body weight	diet	14 weeks	cadmium chloride	
■	Dodds−Smith et al. 1992	shrew	body weight	diet	12 weeks	cadmium chloride	
■	Hamada et al. 1991	dog	body weight	diet	8−9 years	cadmium chloride	
■	Rajanna et al. 1984	rat	body weight	diet	25.7 weeks	cadmium chloride	
■	Groten et al. 1991	rat	body weight	diet	8 weeks	cadmium chloride	
■	Rastogi et al 1977	rat	body weight	gavage	4.27 weeks	cadmium chloride	
■	Merali and Singhal 1980	rat	body weight	gavage	6.14 weeks	cadmium chloride	
■	Weigel et al. 1987	rat	body weight	diet	7.86 weeks	cadmium oxide	
■	Pond et al. 1973	pig	body weight	diet	7.14 weeks	cadmium chloride	
■	Suzuki and Yoshida 1979	rat	body weight	diet	2 weeks	cadmium chloride	A
■	Suzuki and Yoshida 1979	rat	body weight	diet	4 weeks	cadmium chloride	A
■	Wilson et al. 1941	rat	body weight	diet	7.14 weeks	cadmium chloride	
■	Suzuki and Yoshida 1978a	rat	body weight (Exp 1)	diet	25.7 weeks	cadmium chloride	
■	Suzuki and Yoshida 1978a	rat	body weight (Exp 2)	diet	25.7 weeks	cadmium chloride	
■	Suzuki and Yoshida 1978b	rat	body weight (Exp 1)	diet	2 weeks	cadmium chloride	A
■	Weber and Reid 1969	mouse	body weight (Exp 1)	diet	3 weeks	cadmium acetate	
■	Suzuki and Yoshida 1977	rat	body weight (Exp 2)	diet	6.43 weeks	cadmium chloride	A
☐	ED20 for Wilson et al. 1941	rat	body weight	diet	7.14 weeks	cadmium chloride	
☐	ED20 for pooled dataset A	rat	body weight	diet	2−6.4 weeks	cadmium chloride	A

☐ Tier 1

- - - Eco−SSL TRV = 0.77 mg/kg bw/day

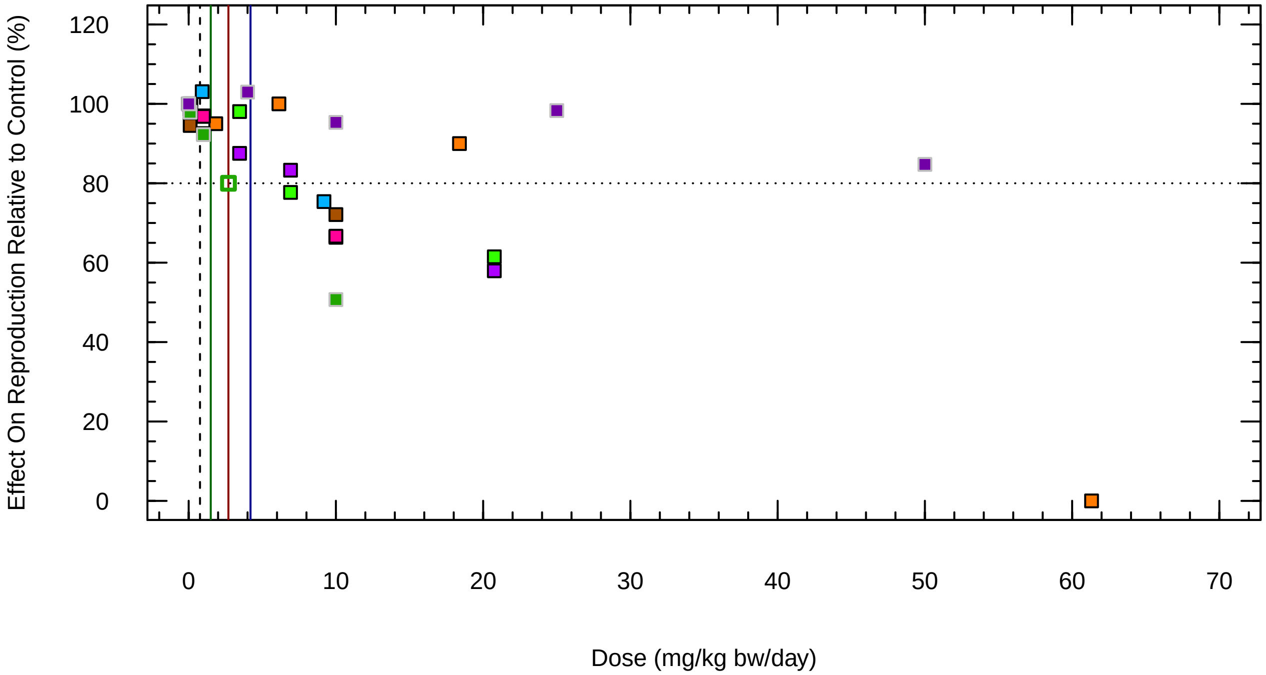
— Selected TRV (Growth) = 4.2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.7 mg/kg bw/day
— Selected TRV (Survival) = 1.5 mg/kg bw/day

····· 80% effect relative to control

ED20 for Wilson et al. 1941 is 4.2 mg/kg bw/day
ED20 for pooled dataset A is 5.4 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−4b. Dose−Response Data for the Mammalian Growth Endpoint for Cadmium (Truncated X−Axis)



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Machemer and Lorke 1981	rat	pregnancy success	gavage	1.43 weeks	cadmium chloride	
🟩	Sawicka−Kapusta et al. 1994	mouse	offspring growth	diet	5 weeks	cadmium chloride	
🟪	Sawicka−Kapusta et al. 1994	mouse	offspring survival	diet	5 weeks	cadmium chloride	
🟦	Whelton et al. 1988	mouse	offspring growth	diet	36 weeks	cadmium chloride	
🟨	Sutou et al. 1980	rat	fetal weight (male)	gavage	9 weeks	cadmium chloride	B
🟥	Sutou et al. 1980	rat	fetal weight (female)	gavage	9 weeks	cadmium chloride	B
🟫	Sutou et al. 1980	rat	fetal implants	gavage	>9 weeks	cadmium chloride	
🟩	Sutou et al. 1980	rat	live fetuses	gavage	>9 weeks	cadmium chloride	
🟪	Wardell et al. 1982	rat	litter weight	gavage	1.86 weeks	not specified	
☐	ED20 for Sutou et al. 1980	rat	live fetuses	gavage	>9 weeks	cadmium chloride	

☐ Tier 1

- - - Eco−SSL TRV = 0.77 mg/kg bw/day

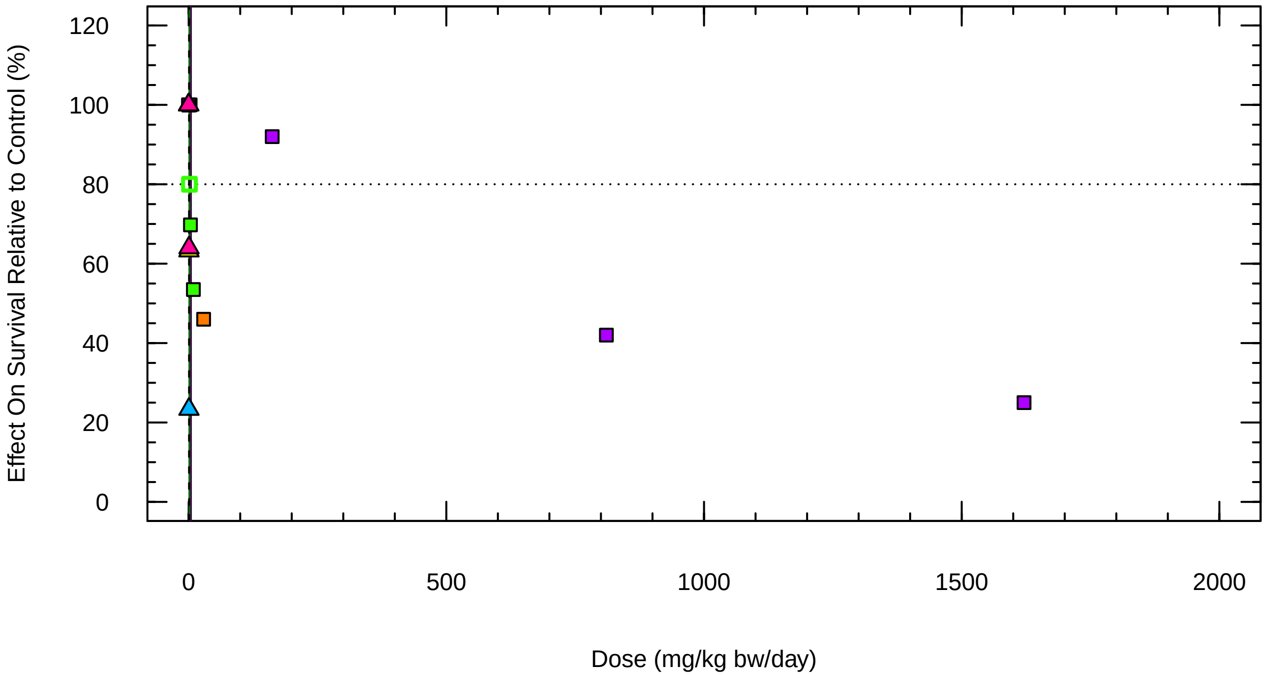
— Selected TRV (Growth) = 4.2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.7 mg/kg bw/day
— Selected TRV (Survival) = 1.5 mg/kg bw/day

····· 80% effect relative to control

ED20 for Sutou et al. 1980 is 2.7 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−5. Dose−Response Data for the Mammalian Reproduction Endpoint for Cadmium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Baranski and Sitarek 1987	rat	survival	gavage	14 weeks	cadmium chloride	
🟩	Swiergosz et al. 1998	vole	survival	diet	24 weeks	cadmium chloride	
🟪	Weber and Reid 1969	mouse	survival	diet	3 weeks	cadmium acetate	
▲	Schroeder et al. 1963	rat	survival (male)	drinking water	92 weeks	not specified	C
▲	Schroeder et al. 1963	rat	survival (female)	drinking water	92 weeks	not specified	C
▲	Schroeder et al. 1964	mouse	survival (male)	drinking water	78 weeks	not specified	
□	ED20 for Swiergosz et al. 1998	vole	survival	diet	24 weeks	cadmium chloride	

□ Tier 1 △ Tier 2

- - - Eco−SSL TRV = 0.77 mg/kg bw/day

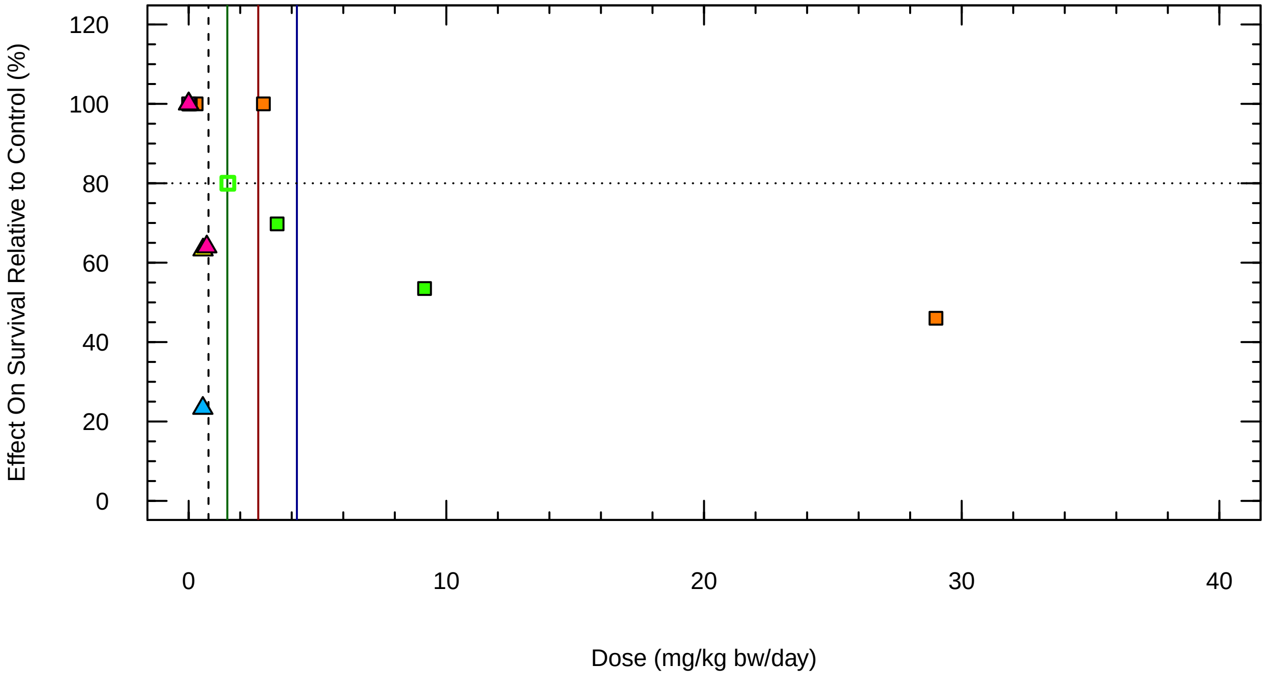
— Selected TRV (Growth) = 4.2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.7 mg/kg bw/day
— Selected TRV (Survival) = 1.5 mg/kg bw/day

····· 80% effect relative to control

ED20 for Swiergosz et al. 1998 is 1.5 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−6a. Dose−Response Data for the Mammalian Survival Endpoint for Cadmium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Baranski and Sitarek 1987	rat	survival	gavage	14 weeks	cadmium chloride	
🟩	Swiergosz et al. 1998	vole	survival	diet	24 weeks	cadmium chloride	
🟪	Weber and Reid 1969	mouse	survival	diet	3 weeks	cadmium acetate	
▲	Schroeder et al. 1963	rat	survival (male)	drinking water	92 weeks	not specified	C
▲	Schroeder et al. 1963	rat	survival (female)	drinking water	92 weeks	not specified	C
▲	Schroeder et al. 1964	mouse	survival (male)	drinking water	78 weeks	not specified	
□	ED20 for Swiergosz et al. 1998	vole	survival	diet	24 weeks	cadmium chloride	

☐ Tier 1 △ Tier 2

- - - Eco−SSL TRV = 0.77 mg/kg bw/day

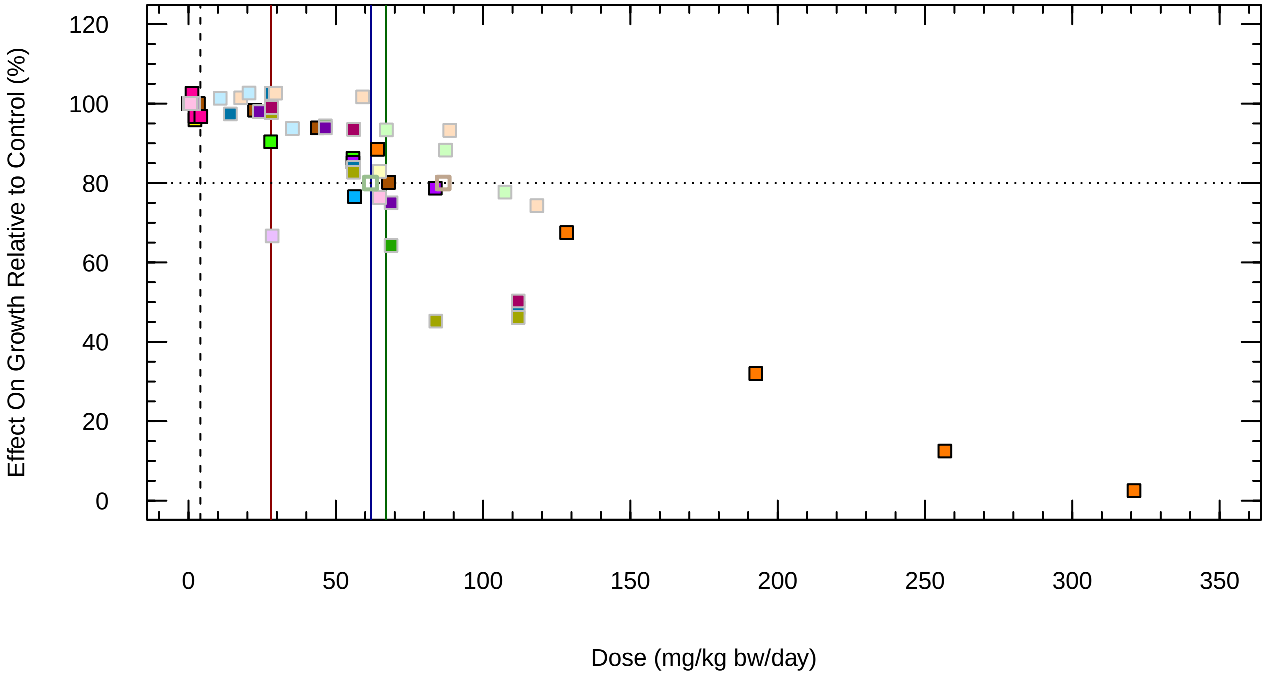
— Selected TRV (Growth) = 4.2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.7 mg/kg bw/day
— Selected TRV (Survival) = 1.5 mg/kg bw/day

····· 80% effect relative to control

ED20 for Swiergosz et al. 1998 is 1.5 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−6b. Dose−Response Data for the Mammalian Survival Endpoint for Cadmium (Truncated X−Axis)



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Hill 1974a	chicken	body weight	diet	2 weeks	copper sulfate	C
🟩	Jensen and Maurice 1978	chicken	body weight (Exp 1)	diet	4 weeks	copper sulfate	C
🟪	Jensen and Maurice 1978	chicken	body weight (Exp 2)	diet	4 weeks	copper sulfate	C
🟦	Jensen and Maurice 1979	chicken	body weight (Exp 2)	diet	4 weeks	copper sulfate	C
🟨	Kashani et al. 1986	turkey	body weight (Exp 1)	diet	24 weeks	cupric sulfate	
🟥	Kashani et al. 1986	turkey	body weight (Exp 2)	diet	24 weeks	cupric sulfate	
🟫	Miles et al. 1998	chicken	body weight (Exp 1)	diet	3 weeks	copper sulfate	
🟩	Miles et al. 1998	chicken	body weight (Exp 2)	diet	6 weeks	dicopper chloride	
🟪	Miles et al. 1998	chicken	body weight (Exp 2)	diet	6 weeks	copper sulfate	
🟦	Poupoulis and Jensen 1976	chicken	body weight gain (Exp 1)	diet	4 weeks	copper sulfate	D
🟨	Poupoulis and Jensen 1976	chicken	body weight gain (Exp 2)	diet	4 weeks	copper sulfate	D
🟥	Poupoulis and Jensen 1976	chicken	body weight gain (Exp 5)	diet	4 weeks	copper sulfate	D
🟧	Persia et al. 2004	chicken	body weight (Exp 2)	diet	2.14 weeks	copper chloride	E
🟩	Persia et al. 2004	chicken	body weight (Exp 3)	diet	2 weeks	copper chloride	E
🟪	Latymer and Cotes 1981	chicken	body weight	diet	3.43 weeks	copper sulfate	C
🟦	Smith 1969	chicken	body weight	diet	3.57 weeks	copper sulfate	C
🟨	Wang et al. 1987	chicken	body weight gain (Exp 2)	diet	2.86 weeks	copper sulfate	D
🟥	Wang et al. 1987	chicken	body weight gain (Exp 1)	diet	2.86 weeks	copper sulfate	D
☐	ED20 for pooled dataset C	chicken	body weight	diet	3.4−4 weeks	copper sulfate	C
☐	ED20 for pooled dataset D	chicken	body weight gain	diet	2.9−4 weeks	copper sulfate	D

☐ Tier 1

- - - Eco−SSL TRV = 4.05 mg/kg bw/day

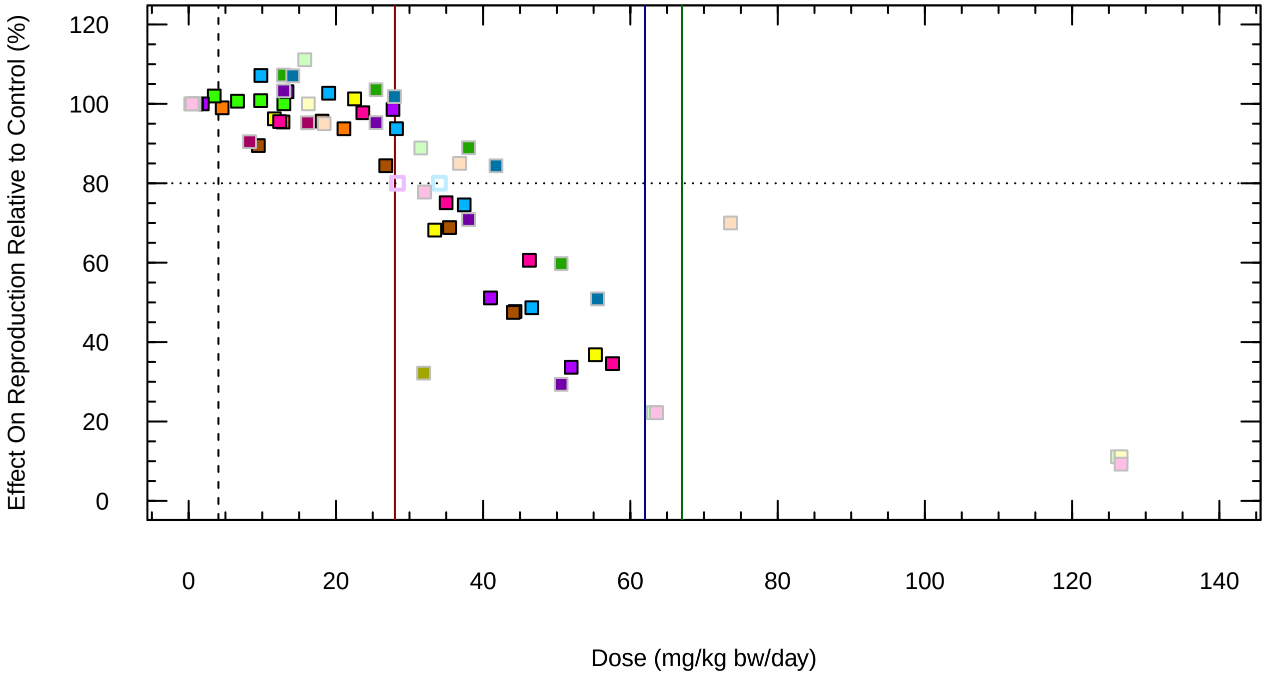
── Selected TRV (Growth) = 62 mg/kg bw/day
── Selected TRV (Reproduction) = 28 mg/kg bw/day
── Selected TRV (Survival) = 67 mg/kg bw/day

····· 80% effect relative to control

ED20 for pooled dataset C is 86 mg/kg bw/day
ED20 for pooled dataset D is 62 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−7. Dose−Response Data for the Avian Growth Endpoint for Copper



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
■	Al Ankari et al. 1998	chicken	egg production	diet	12 weeks	copper sulfate/acetate	
■	Balevi and Coskun 2004	chicken	egg production	diet	4−9 weeks	copper sulfate	A
■	Chiou et al. 1997	chicken	egg production	diet	4 weeks	copper sulfate	A
■	Jackson and Stevenson 1981a	chicken	egg production (breed 1)	diet	40 weeks	copper sulfate	B
■	Jackson and Stevenson 1981a	chicken	egg production (breed 2)	diet	40 weeks	copper sulfate	B
■	Jackson and Stevenson 1981b	chicken	egg production (breed 1)	diet	48 weeks	copper sulfate	B
■	Jackson and Stevenson 1981b	chicken	egg production (breed 2)	diet	48 weeks	copper sulfate	B
■	Jackson et al. 1979	chicken	egg production (breed 1)	diet	32 weeks	copper sulfate	B
■	Jackson et al. 1979	chicken	egg production (breed 2)	diet	32 weeks	copper sulfate	B
■	Jackson et al. 1979	chicken	egg production	diet	48 weeks	copper sulfate	B
■	Harms and Buresh 1986	chicken	egg production (Exp 3)	diet	6 weeks	copper sulfate	A
■	Lien et al. 2004	chicken	egg production	diet	4 weeks	copper sulfate	A
■	Stevenson et al. 1983	chicken	egg production	diet	0.714 weeks	copper sulfate	
■	Pearce et al. 1983	chicken	egg production	diet	6.86 weeks	copper sulfate	A
■	Stevenson and Jackson 1980a	chicken	egg production	diet	6.86 weeks	copper sulfate	A
■	Stevenson and Jackson 1980b	chicken	egg production	diet	8 weeks	copper sulfate	A
□	ED20 for pooled dataset A	chicken	egg production	diet	4−8 weeks	copper sulfate	A
□	ED20 for pooled dataset B	chicken	egg production	diet	32−48 weeks	copper sulfate	B

□ Tier 1

- - - Eco−SSL TRV = 4.05 mg/kg bw/day

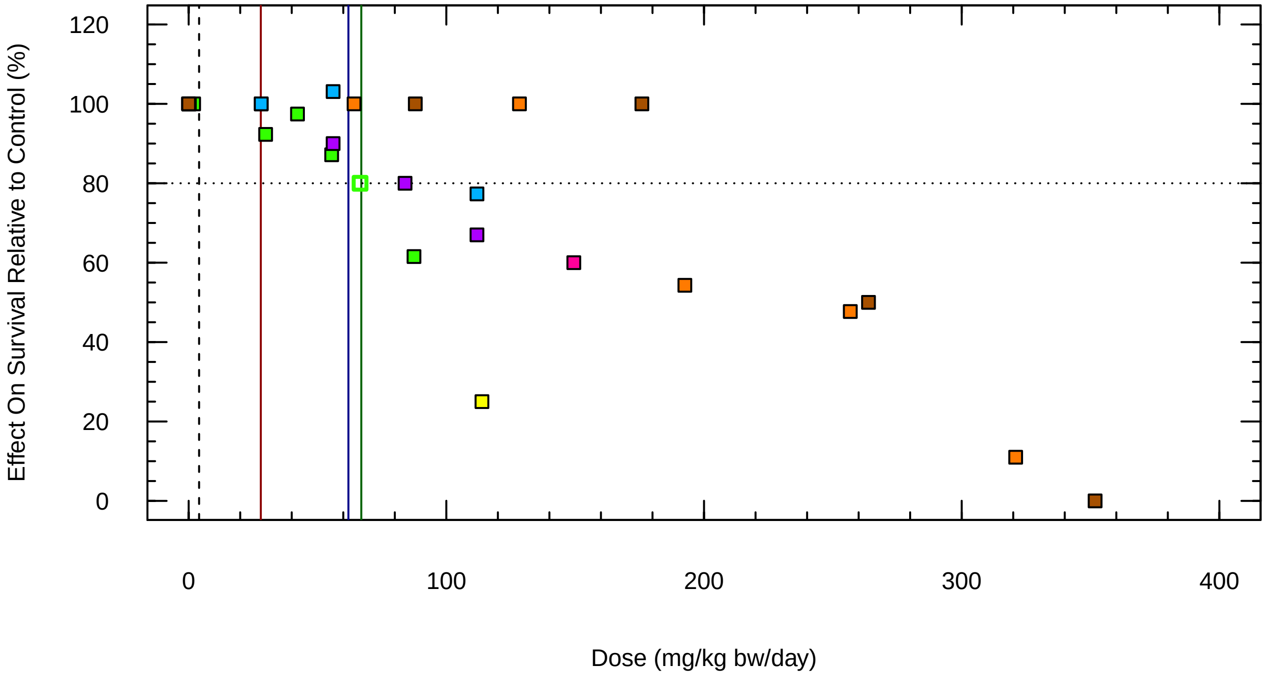
— Selected TRV (Growth) = 62 mg/kg bw/day
— Selected TRV (Reproduction) = 28 mg/kg bw/day
— Selected TRV (Survival) = 67 mg/kg bw/day

····· 80% effect relative to control

ED20 for pooled dataset A is 28 mg/kg bw/day
ED20 for pooled dataset B is 34 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−8. Dose−Response Data for the Avian Reproduction Endpoint for Copper



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Hill 1974a	chicken	survival	diet	2 weeks	copper sulfate	G
🟩	Mehring et al. 1960	chicken	survival	diet	10 weeks	copper oxide	
🟪	Poupoulis and Jensen 1976	chicken	survival (Exp 2)	diet	4 weeks	copper sulfate	G
🟦	Poupoulis and Jensen 1976	chicken	survival (Exp 5)	diet	4 weeks	copper sulfate	G
🟨	Van Vleet et al. 1981	Pekin duck	survival	diet	4 weeks	copper sulfate	F
🟥	Van Vleet et al. 1981	Pekin duck	survival	diet	2.14 weeks	copper sulfate	F
🟫	Vohra and Kratzer 1968	turkey	survival	diet	3 weeks	copper sulfate	
▢	ED20 for Mehring et al. 1960	chicken	survival	diet	10 weeks	copper oxide	

☐ Tier 1

- - - Eco−SSL TRV = 4.05 mg/kg bw/day

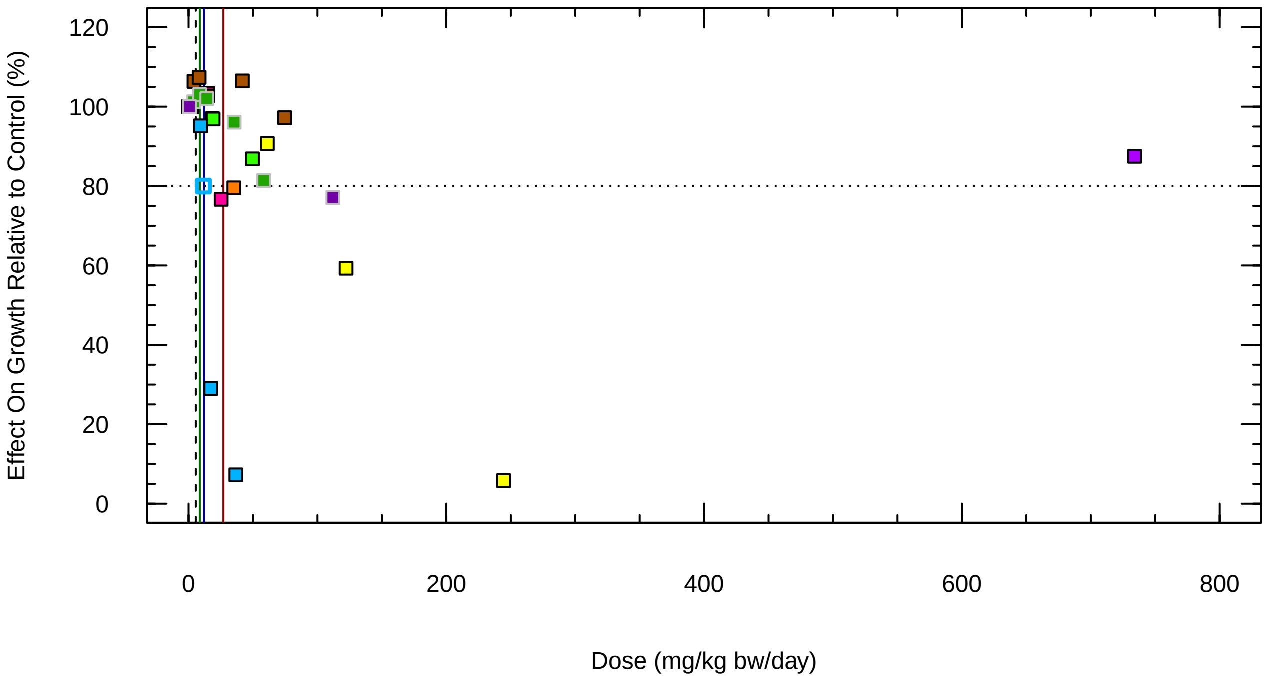
— Selected TRV (Growth) = 62 mg/kg bw/day
— Selected TRV (Reproduction) = 28 mg/kg bw/day
— Selected TRV (Survival) = 67 mg/kg bw/day

····· 80% effect relative to control

ED20 for Mehring et al. 1960 is 67 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−9. Dose−Response Data for the Avian Survival Endpoint for Copper



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Brandt 1983	mink	body weight	diet	~12 weeks	copper sulfate	
🟩	Edmonds and Baker 1986	pig	body weight (Exp 3)	diet	4 weeks	copper sulfate	
🟪	Petterson et al. 2002	mouse	body weight	diet	3 weeks	copper chloride	
🟦	Allcroft et al. 1961	pig	body weight gain	diet	21 weeks	copper sulfate	
🟨	Boyden et al. 1938	rat	body weight gain	diet	4 weeks	copper sulfate	
🟥	Suttle and Mills 1966	pig	body weight (Exp 2)	diet	5.71 weeks	copper sulfate	
🟫	Grobner et al. 1986	rabbit	body weight (Exp 2)	diet	4 weeks	copper sulfate	
🟩	Grobner et al. 1986	rabbit	body weight (Exp 2)	diet	4 weeks	copper sulfate	
🟪	Llewellyn et al. 1985	rat	body weight	diet	21 weeks	copper acetate	
☐	ED20 for Allcroft et al. 1961	pig	body weight gain	diet	21 weeks	copper sulfate	

☐ Tier 1

- - - Eco−SSL TRV = 5.6 mg/kg bw/day

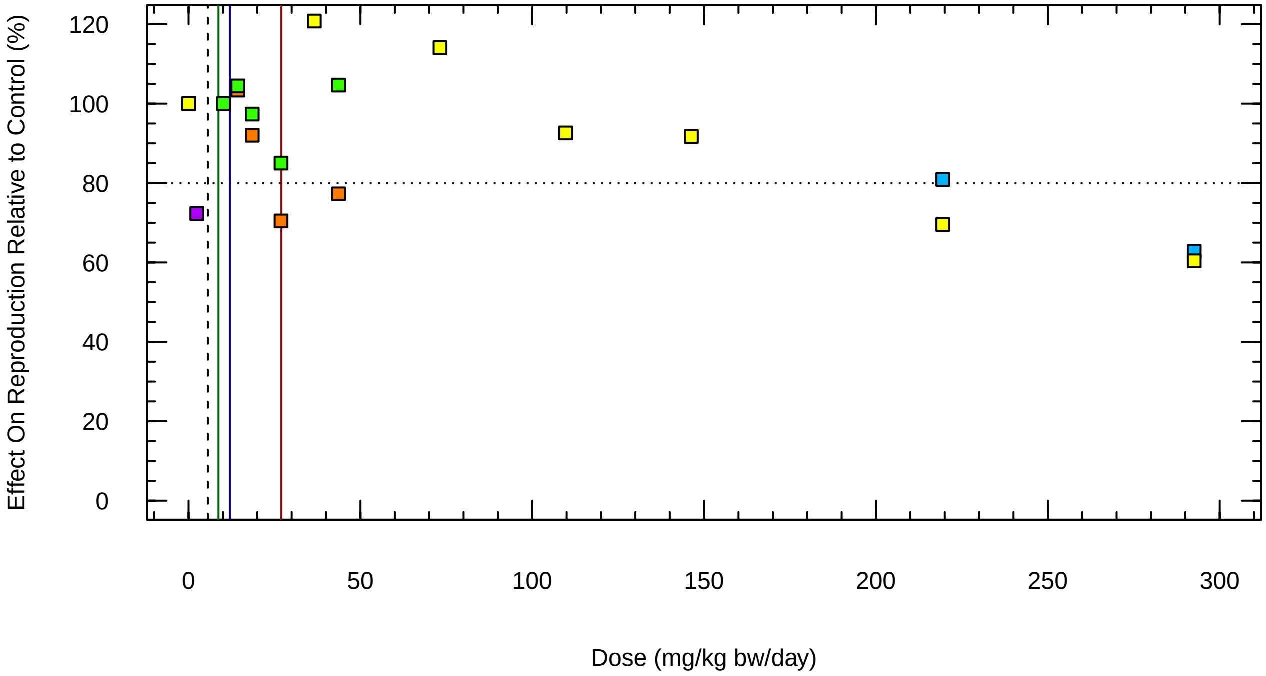
— Selected TRV (Growth) = 12 mg/kg bw/day
— Selected TRV (Reproduction) = 27 mg/kg bw/day
— Selected TRV (Survival) = 8.7 mg/kg bw/day

····· 80% effect relative to control

ED20 for Allcroft et al. 1961 is 12 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−10. Dose−Response Data for the Mammalian Growth Endpoint for Copper



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Aulerich et al. 1982	mink	offspring survival	diet	20 weeks	copper sulfate	
🟩	Aulerich et al. 1982	mink	offspring growth	diet	20 weeks	copper sulfate	
🟪	Cromwell et al. 1993	pig	farrowing success	diet	2.1 years	copper sulfate	
🟦	Lecyk 1980	mouse	litter size (breed 1)	diet	7 weeks	copper sulfate	A
🟨	Lecyk 1980	mouse	litter size (breed 2)	diet	7 weeks	copper sulfate	A

☐ Tier 1

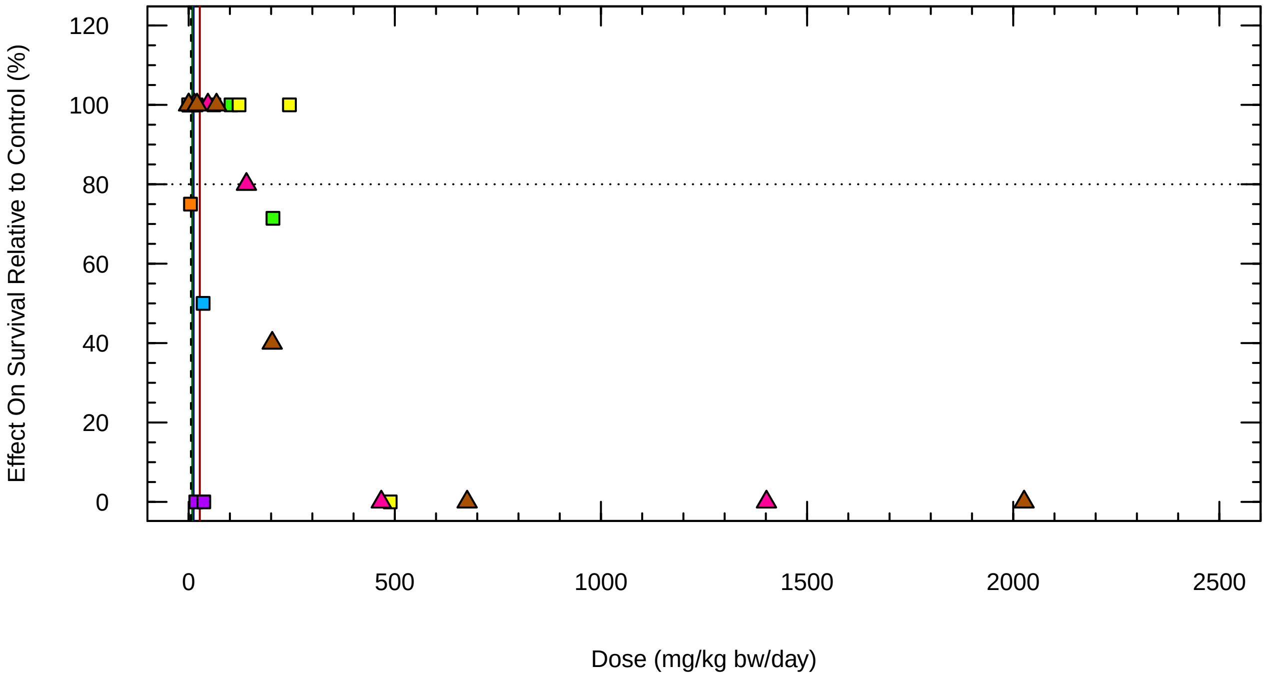
- - - Eco−SSL TRV = 5.6 mg/kg bw/day

— Selected TRV (Growth) = 12 mg/kg bw/day
— Selected TRV (Reproduction) = 27 mg/kg bw/day
— Selected TRV (Survival) = 8.7 mg/kg bw/day

····· 80% effect relative to control

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−11. Dose−Response Data for the Mammalian Reproduction Endpoint for Copper



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Ritchie et al. 1963	pig	survival	diet	15 weeks	copper sulfate	B
🟩	Keen et al. 1982	rat	survival	diet	6.71 weeks	copper sulfate	
🟪	Allcroft et al. 1961	pig	survival	diet	21 weeks	copper sulfate	B
🟦	Brandt 1983	mink	survival	diet	~12 weeks	copper sulfate	
🟨	Boyden et al. 1938	rat	survival	diet	4 weeks	copper sulfate	
▲	NTP 1993a	mouse	survival (male)	drinking water	2 weeks	copper sulfate	
▲	NTP 1993a	mouse	survival (female)	drinking water	2 weeks	copper sulfate	
□	Geomean for pooled dataset B	pig	survival	diet	15−21 weeks	copper sulfate	B

□ Tier 1 △ Tier 2

- - - Eco−SSL TRV = 5.6 mg/kg bw/day

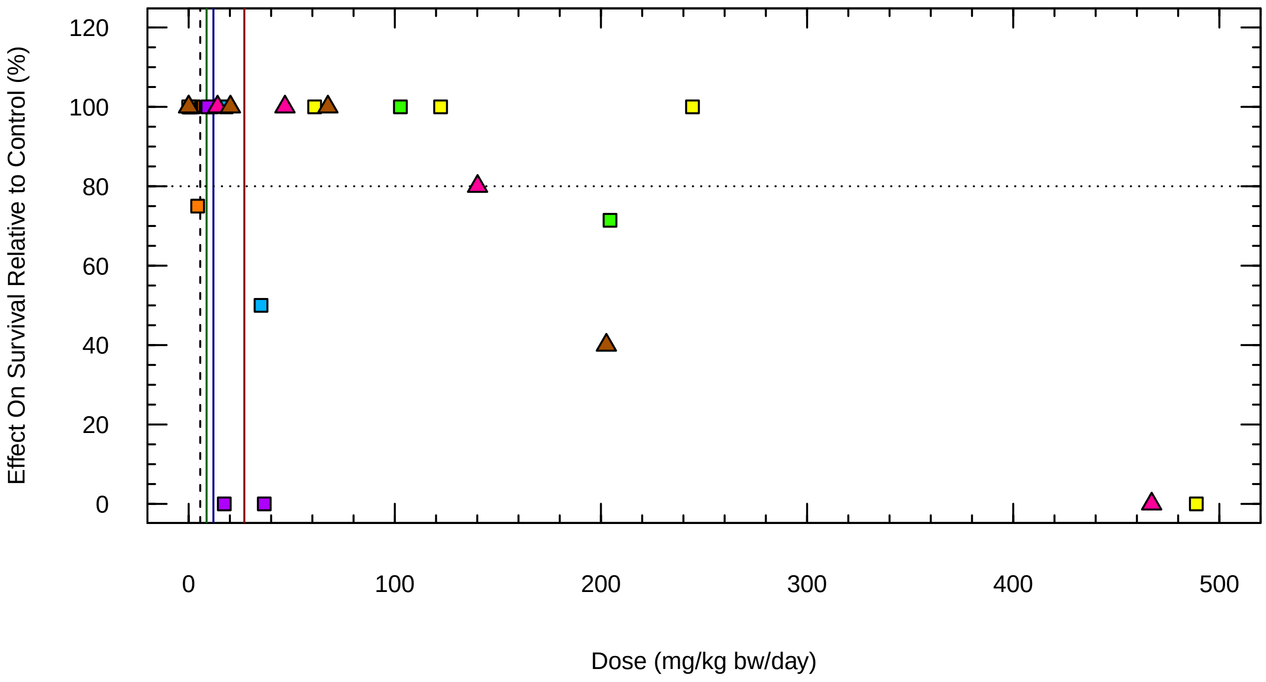
— Selected TRV (Growth) = 12 mg/kg bw/day
— Selected TRV (Reproduction) = 27 mg/kg bw/day
— Selected TRV (Survival) = 8.7 mg/kg bw/day

····· 80% effect relative to control

Geomean for pooled dataset B is 8.7 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−12a. Dose−Response Data for the Mammalian Survival Endpoint for Copper



Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧 Ritchie et al. 1963	pig	survival	diet	15 weeks	copper sulfate	B
🟩 Keen et al. 1982	rat	survival	diet	6.71 weeks	copper sulfate	
🟪 Allcroft et al. 1961	pig	survival	diet	21 weeks	copper sulfate	B
🟦 Brandt 1983	mink	survival	diet	~12 weeks	copper sulfate	
🟨 Boyden et al. 1938	rat	survival	diet	4 weeks	copper sulfate	
▲ NTP 1993a	mouse	survival (male)	drinking water	2 weeks	copper sulfate	
▲ NTP 1993a	mouse	survival (female)	drinking water	2 weeks	copper sulfate	
☐ Geomean for pooled dataset B	pig	survival	diet	15−21 weeks	copper sulfate	B

☐ Tier 1 △ Tier 2

- - - Eco−SSL TRV = 5.6 mg/kg bw/day

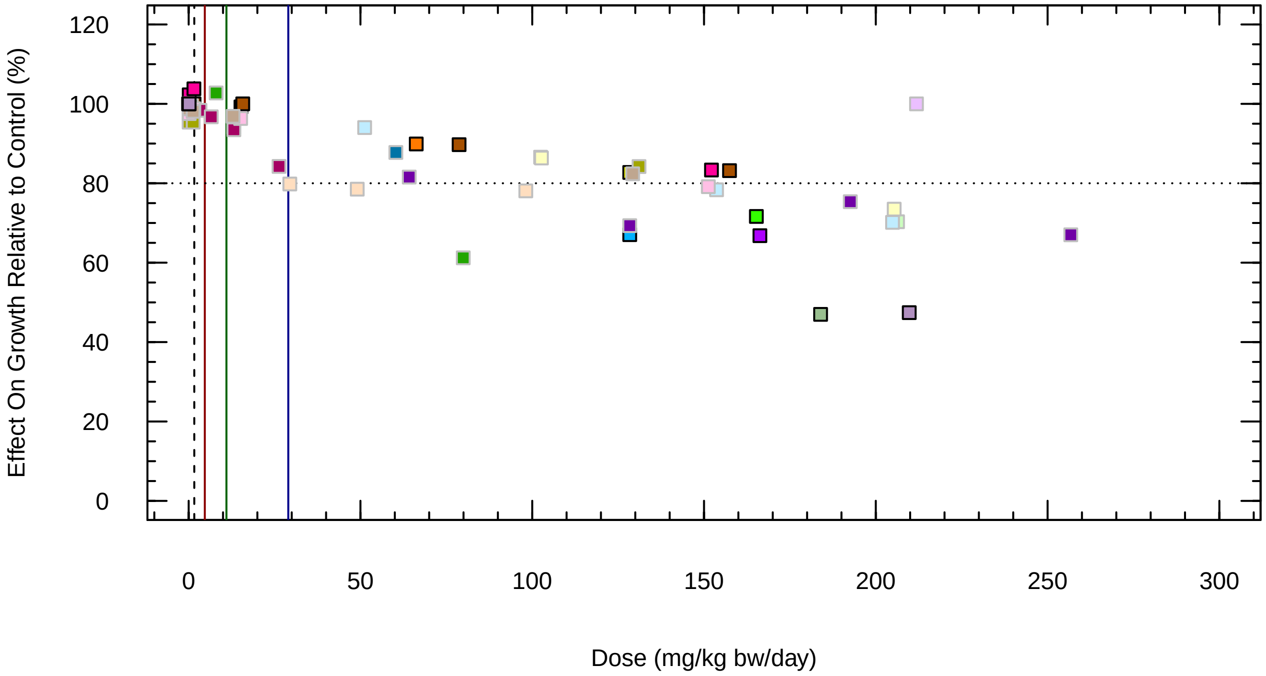
— Selected TRV (Growth) = 12 mg/kg bw/day
— Selected TRV (Reproduction) = 27 mg/kg bw/day
— Selected TRV (Survival) = 8.7 mg/kg bw/day

····· 80% effect relative to control

Geomean for pooled dataset B is 8.7 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−12b. Dose−Response Data for the Mammalian Survival Endpoint for Copper (Truncated X−Axis)



Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧 Edens and Melvin 1989	Japanese quail	body weight (breed 2)	diet	21 weeks	lead acetate	
🟩 Donaldson 1986	chicken	body weight (Exp 1)	diet	2.9 weeks	lead acetate trihydrate	A
🟪 Donaldson 1986	chicken	body weight (Exp 2)	diet	2.9 weeks	lead acetate trihydrate	A
🟦 Latta and Donaldson 1986	chicken	body weight gain	diet	2.7 weeks	lead acetate	
🟨 Leeming and Donaldson 1984	chicken	body weight gain	diet	2.71 weeks	lead acetate trihydrate	
🟥 Morgan et al. 1975	Japanese quail	body weight (Trial 1)	diet	5 weeks	lead acetate	
🟫 Morgan et al. 1975	Japanese quail	body weight (Trial 2)	diet	5 weeks	lead acetate	
🟩 Damron et al. 1969	chicken	body weight	diet	4 weeks	lead acetate	
🟪 Donaldson and McGowan 1989	chicken	body weight	diet	2.9 weeks	lead acetate trihydrate	A
🟦 Edens and Melvin 1989	Japanese quail	body weight (breed 1)	diet	21 weeks	lead acetate	
🟨 Edens and Melvin 1989	Japanese quail	body weight (female)	diet	15 weeks	lead acetate	
🟥 Edens and Garlich 1983	chicken	body weight	diet	10 weeks	lead acetate	
🟧 Abduljaleel & Shuhaimi−Othman 2013	chicken	body weight	diet	4 weeks	lead nitrate	
🟩 Berg et al. 1980	chicken	body weight (Exp 1)	diet	2 weeks	lead carbonate	C
🟪 Berg et al. 1980	chicken	body weight (Exp 1)	diet	2 weeks	lead carbonate	C
🟦 Berg et al. 1980	chicken	body weight (Exp 2)	diet	2 weeks	lead carbonate	C
🟨 Berg et al. 1980	chicken	body weight (Exp 3)	diet	2 weeks	lead carbonate	C
🟥 Edens et al. 1976	Japanese quail	body weight	diet	12 weeks	lead acetate	B
🟫 Edens 1985	Japanese quail	body weight	diet	12 weeks	lead acetate	B
🟩 Cupo and Donaldson 1988	chicken	body weight	diet	3 weeks	lead acetate	C
🟪 Franson and Custer 1982	chicken	body weight	diet	4 weeks	lead acetate	C

☐ Tier 1

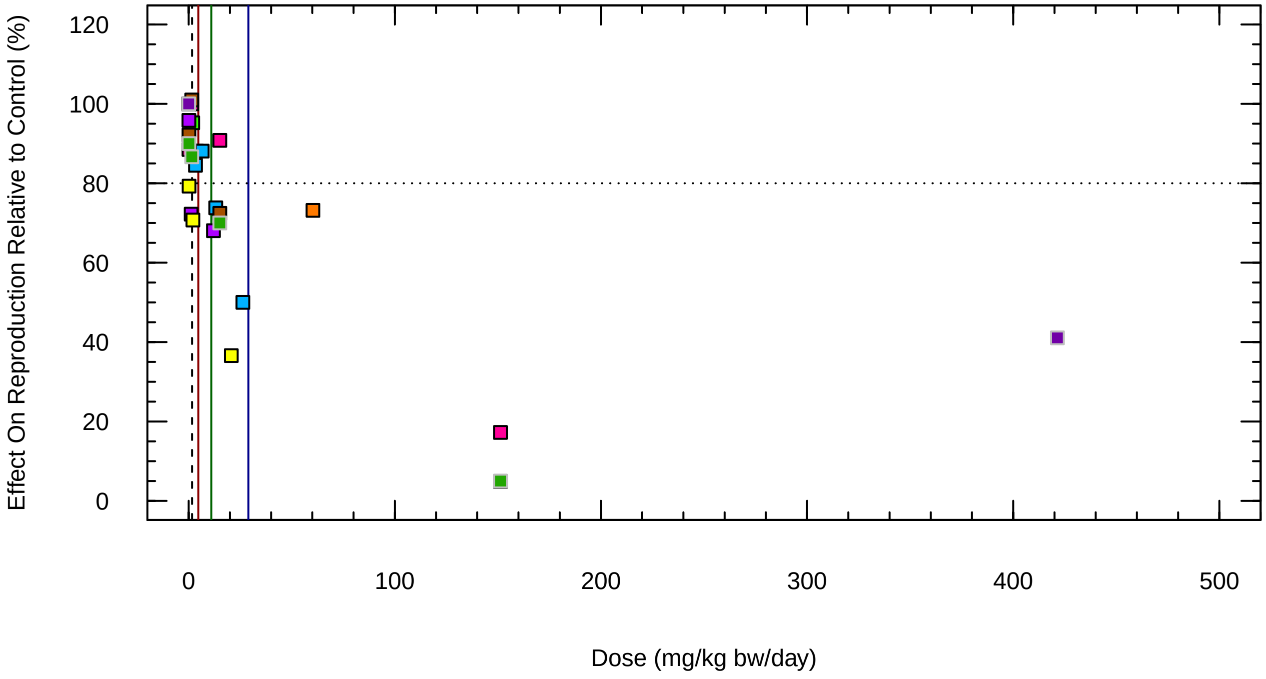
- - - Eco−SSL TRV = 1.63 mg/kg bw/day

— Selected TRV (Growth) = 29 mg/kg bw/day
— Selected TRV (Reproduction) = 4.7 mg/kg bw/day
— Selected TRV (Survival) = 11 mg/kg bw/day

····· 80% effect relative to control

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−13. Dose−Response Data for the Avian Growth Endpoint for Lead



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Edens and Melvin 1989	Japanese quail	egg production	diet	21 weeks	lead acetate	
🟩	Edens and Garlich 1983	chicken	egg production (Exp 1)	diet	4 weeks	lead acetate	
🟪	Edens and Garlich 1983	Japanese quail	egg production (Exp 2)	diet	5 weeks	lead acetate	D
🟦	Edens and Garlich 1983	chicken	egg production (Exp 3)	diet	10 weeks	lead acetate	
🟨	Edens and Garlich 1983	Japanese quail	egg production (Exp 4)	diet	5 weeks	lead acetate	D
🟥	Edens et al. 1976	Japanese quail	egg production	diet	12 weeks	lead acetate	E
🟫	Edens et al. 1976	Japanese quail	egg hatchability	diet	12 weeks	lead acetate	
🟩	Edens et al. 1976	Japanese quail	egg production	diet	12 weeks	lead acetate	E
🟪	Stone and Soares 1976	Japanese quail	egg production	diet	3.86 weeks	lead acetate	D
□	Geomean for pooled dataset D	Japanese quail	egg production	diet	3.9−5 weeks	lead acetate	D

□ Tier 1

- - - Eco−SSL TRV = 1.63 mg/kg bw/day

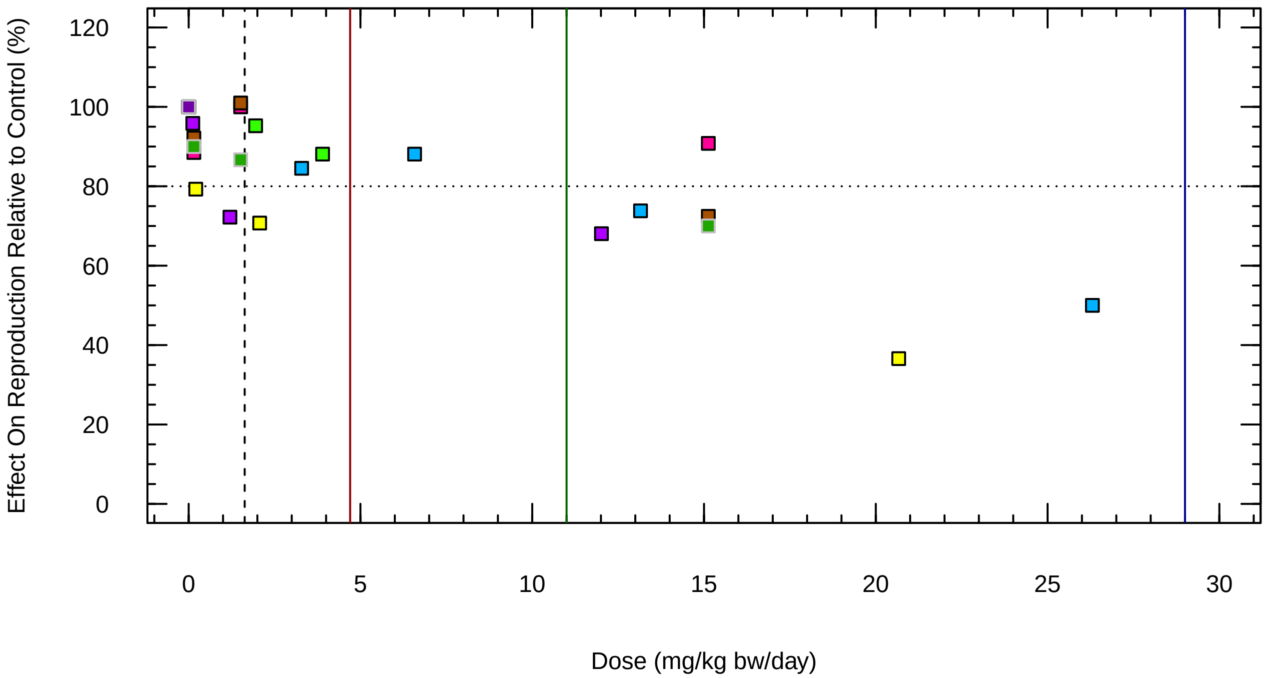
— Selected TRV (Growth) = 29 mg/kg bw/day
— Selected TRV (Reproduction) = 4.7 mg/kg bw/day
— Selected TRV (Survival) = 11 mg/kg bw/day

····· 80% effect relative to control

Geomean for pooled dataset D is 4.7 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−14a. Dose−Response Data for the Avian Reproduction Endpoint for Lead



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Edens and Melvin 1989	Japanese quail	egg production	diet	21 weeks	lead acetate	
🟩	Edens and Garlich 1983	chicken	egg production (Exp 1)	diet	4 weeks	lead acetate	
🟪	Edens and Garlich 1983	Japanese quail	egg production (Exp 2)	diet	5 weeks	lead acetate	D
🟦	Edens and Garlich 1983	chicken	egg production (Exp 3)	diet	10 weeks	lead acetate	
🟨	Edens and Garlich 1983	Japanese quail	egg production (Exp 4)	diet	5 weeks	lead acetate	D
🟥	Edens et al. 1976	Japanese quail	egg production	diet	12 weeks	lead acetate	E
🟫	Edens et al. 1976	Japanese quail	egg hatchability	diet	12 weeks	lead acetate	
🟩	Edens et al. 1976	Japanese quail	egg production	diet	12 weeks	lead acetate	E
🟪	Stone and Soares 1976	Japanese quail	egg production	diet	3.86 weeks	lead acetate	D
□	Geomean for pooled dataset D	Japanese quail	egg production	diet	3.9−5 weeks	lead acetate	D

□ Tier 1

- - - Eco−SSL TRV = 1.63 mg/kg bw/day

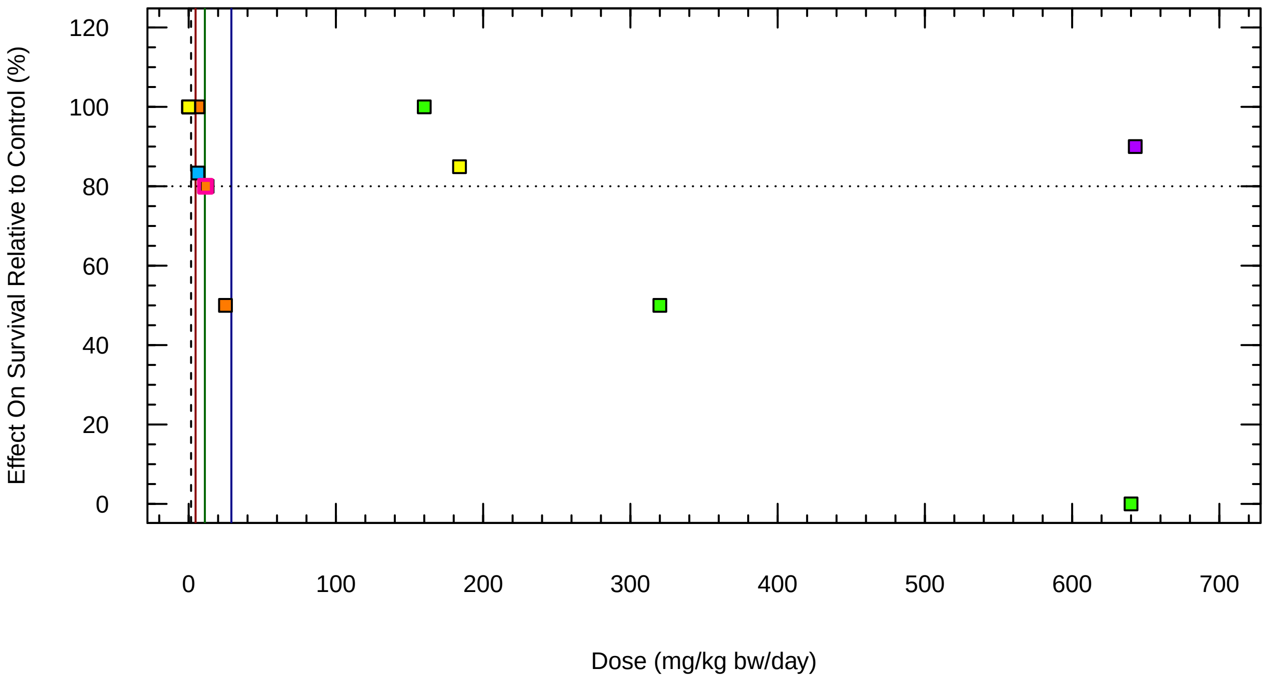
── Selected TRV (Growth) = 29 mg/kg bw/day
── Selected TRV (Reproduction) = 4.7 mg/kg bw/day
── Selected TRV (Survival) = 11 mg/kg bw/day

····· 80% effect relative to control

Geomean for pooled dataset D is 4.7 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−14b. Dose−Response Data for the Avian Reproduction Endpoint for Lead (Truncated X−Axis)



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Barthalmus et al. 1977	pigeon	survival	gavage	varied	lead acetate	F
🟩	Vengris and Mare 1974	chicken	survival	gavage	5 weeks	lead acetate	
🟪	Khan et al. 1993	chicken	survival	gavage	1 weeks	lead acetate	
🟦	Anders et al. 1982	pigeon	survival	gavage	5 weeks	lead acetate	F
🟨	Cupo and Donaldson 1988	chicken	survival	diet	3 weeks	lead acetate	
▣	ED20 for pooled dataset F	pigeon	survival	gavage	varied	lead acetate	F

☐ Tier 1

- - - Eco−SSL TRV = 1.63 mg/kg bw/day

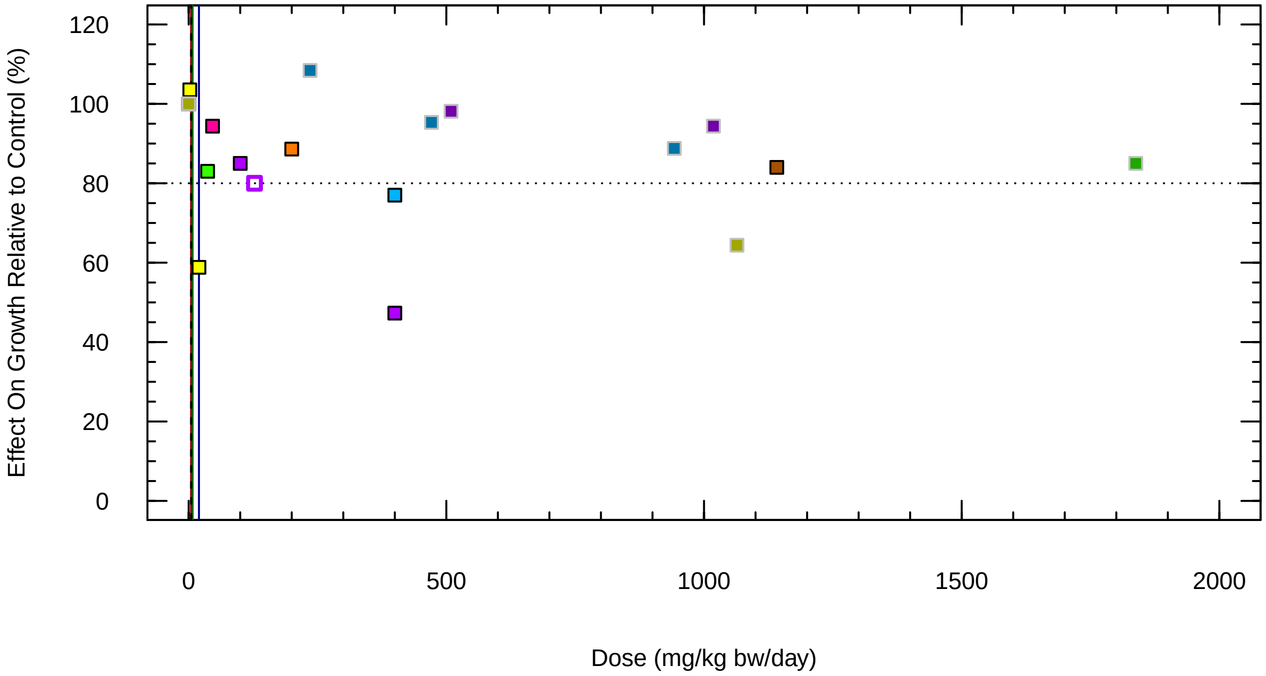
— Selected TRV (Growth) = 29 mg/kg bw/day
— Selected TRV (Reproduction) = 4.7 mg/kg bw/day
— Selected TRV (Survival) = 11 mg/kg bw/day

····· 80% effect relative to control

ED20 for pooled dataset F is 11 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−15. Dose−Response Data for the Avian Survival Endpoint for Lead



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Harry et al. 1985	rat	body weight	gavage	3.71 weeks	lead acetate	A
🟩	Hsu et al. 1975	pig	body weight	diet	13 weeks	lead acetate	
🟪	Kumar and Desiraju 1990	rat	body weight	gavage	8.43 weeks	lead acetate	
🟦	Toews et al. 1983	rat	body weight	gavage	4 weeks	lead acetate	A
🟨	Lorenzo et al. 1978	rabbit	% weight gain	gavage	4.29 weeks	lead nitrate	
🟥	Al−Omar et al. 2000	mouse	body weight gain	gavage	5 weeks	lead oxide	
🟫	Barlow et al. 1977	rat	maternal body weight	diet	3 weeks	lead acetate	
🟩	Maker et al. 1973	mouse	body weight	diet	4.29 weeks	lead carbonate	
🟪	Mykkanen et al. 1980	rat	weight gain	diet	3 weeks	lead acetate	
🟦	Mykkanen et al. 1980	rat	weight gain	diet	3 weeks	lead acetate	
🟨	Gerber et al. 1978	rat	body weight	diet	52 weeks	lead acetate	
☐	ED20 for Kumar and Desiraju 1990	rat	body weight	gavage	8.43 weeks	lead acetate	

☐ Tier 1

- - - Eco−SSL TRV = 4.7 mg/kg bw/day

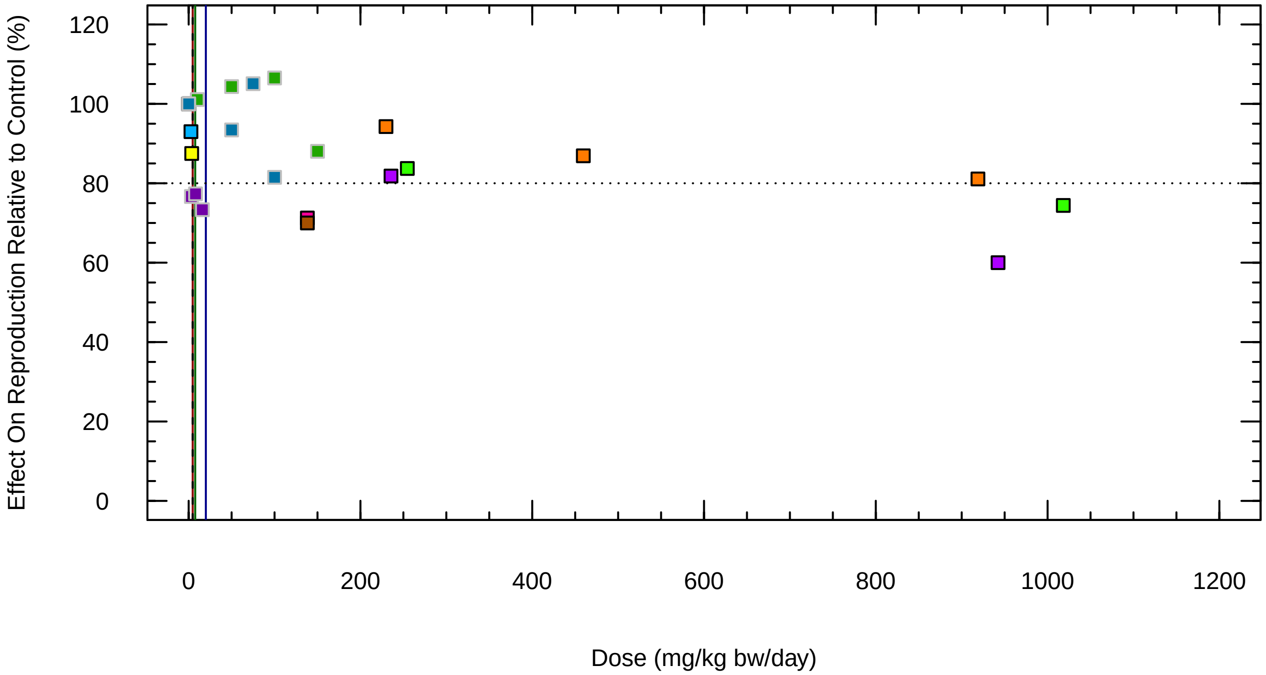
— Selected TRV (Growth) = 20 mg/kg bw/day
— Selected TRV (Reproduction) = 4.7 mg/kg bw/day
— Selected TRV (Survival) = 7.6 mg/kg bw/day

····· 80% effect relative to control

ED20 for Kumar and Desiraju 1990 is 130 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−16. Dose−Response Data for the Mammalian Growth Endpoint for Lead



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Jacquet et al. 1977	mouse	embryo weight	diet	2.57 weeks	not specified	
🟩	Mykkanen et al. 1980	rat	pup weight (breed 1)	diet	3 weeks	lead acetate	B
🟪	Mykkanen et al. 1980	rat	pup weight (breed 2)	diet	3 weeks	lead acetate	B
🟦	Schroeder and Mitchener 1971	rat	offspring survival	diet and drinking water	3 generations	soluble lead	
🟨	Schroeder and Mitchener 1971	mouse	offspring survival	diet and drinking water	3 generations	soluble lead	
🟥	Winneke et al. 1977	rat	litter size	diet	18.6 weeks	lead acetate	
🟫	Winneke et al. 1977	rat	pregnancy success	diet	18.6 weeks	lead acetate	
🟩	Wardell et al. 1982	rat	fetal mortality (resorptions)	gavage	1.86 weeks	lead acetate	
🟪	Gupta et al. 1995	mouse	living embryos per mother	gavage	4 weeks	lead acetate	
🟦	Miller et al. 1982	rat	embryo weight	gavage	5.86 weeks	lead acetate	

☐ Tier 1

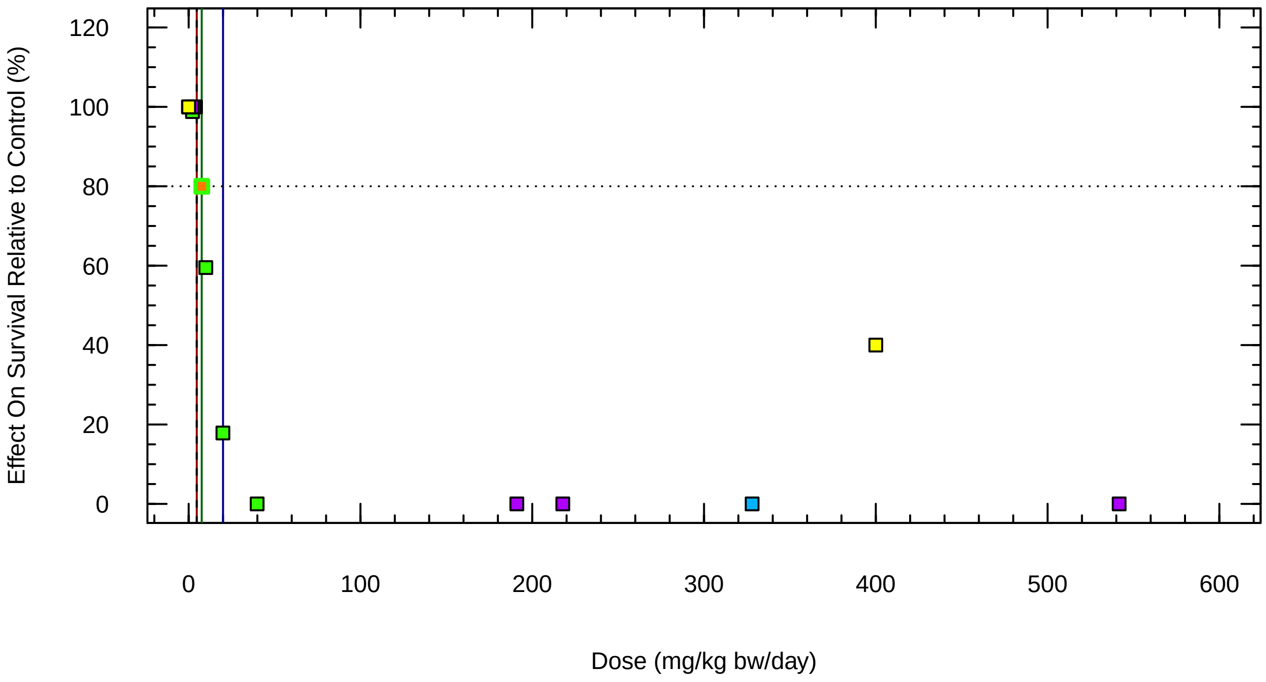
- - - Eco−SSL TRV = 4.7 mg/kg bw/day

— Selected TRV (Growth) = 20 mg/kg bw/day
— Selected TRV (Reproduction) = 4.7 mg/kg bw/day
— Selected TRV (Survival) = 7.6 mg/kg bw/day

····· 80% effect relative to control

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−17. Dose−Response Data for the Mammalian Reproduction Endpoint for Lead



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Junaid et al. 1997	mouse	survival	gavage	8.57 weeks	lead acetate	
🟩	Lorenzo et al. 1978	rabbit	survival	gavage	4.29 weeks	lead nitrate	
🟪	Pankakoski et al. 1994	shrew	survival	diet	0.6 weeks	lead in earthworm prey	
🟦	Press 1977	rat	survival	gavage	2.14 weeks	lead acetate	
🟨	Kumar and Desiraju 1990	rat	survival	gavage	8.43 weeks	lead acetate	
□	ED20 for Lorenzo et al. 1978	rabbit	survival	gavage	4.29 weeks	lead nitrate	

□ Tier 1

- - - Eco−SSL TRV = 4.7 mg/kg bw/day

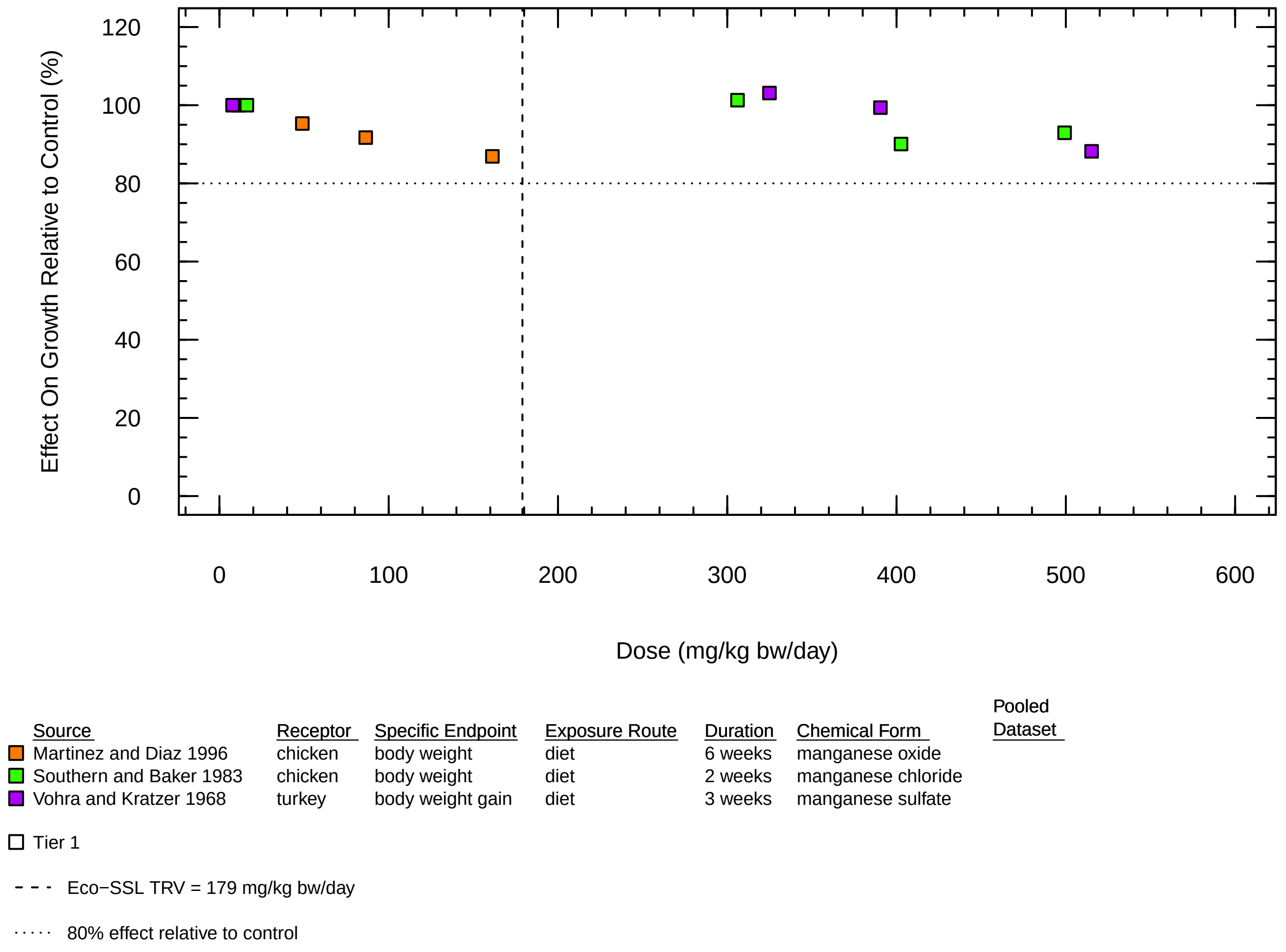
— Selected TRV (Growth) = 20 mg/kg bw/day
— Selected TRV (Reproduction) = 4.7 mg/kg bw/day
— Selected TRV (Survival) = 7.6 mg/kg bw/day

····· 80% effect relative to control

ED20 for Lorenzo et al. 1978 is 7.6 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−18. Dose−Response Data for the Mammalian Survival Endpoint for Lead



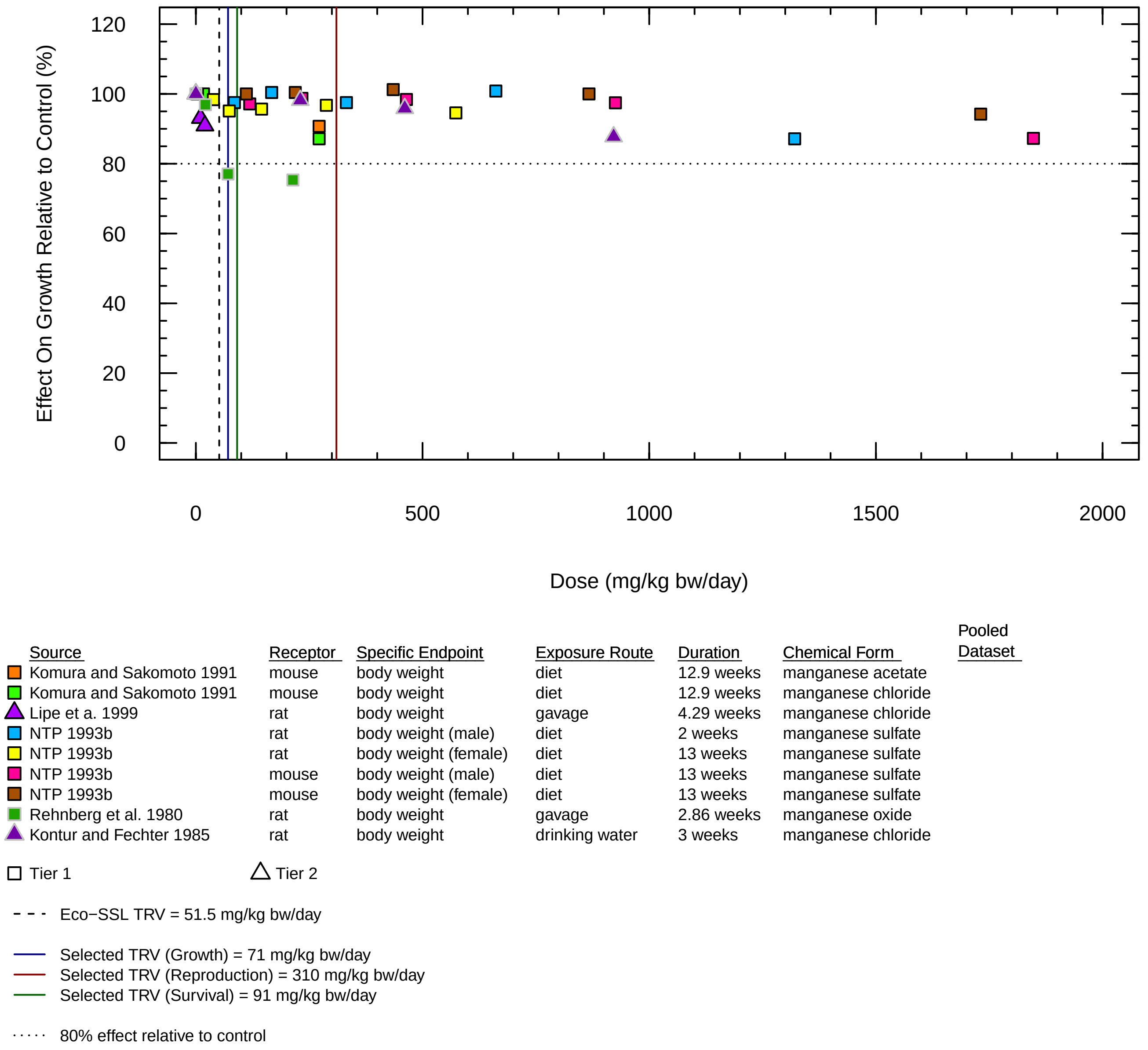
	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Martinez and Diaz 1996	chicken	body weight	diet	6 weeks	manganese oxide	
🟩	Southern and Baker 1983	chicken	body weight	diet	2 weeks	manganese chloride	
🟪	Vohra and Kratzer 1968	turkey	body weight gain	diet	3 weeks	manganese sulfate	

☐ Tier 1

- - - Eco−SSL TRV = 179 mg/kg bw/day

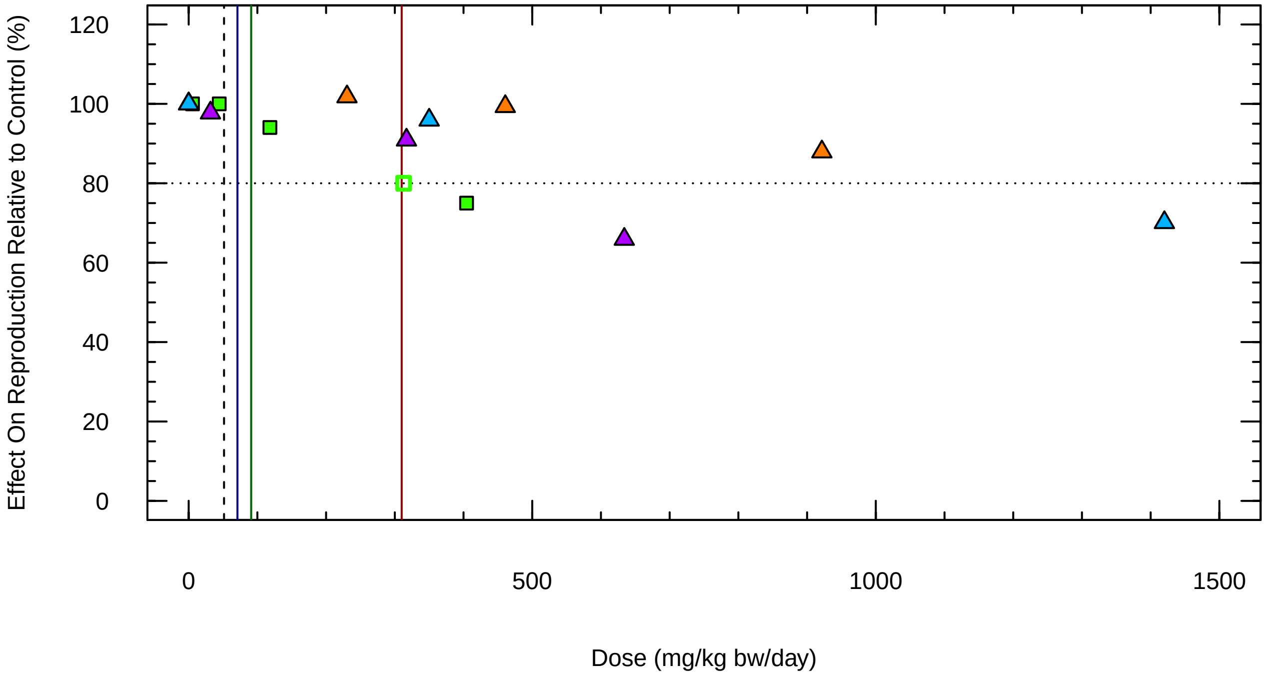
····· 80% effect relative to control

Figure 4−19. Dose−Response Data for the Avian Growth Endpoint for Manganese



Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−20. Dose−Response Data for the Mammalian Growth Endpoint for Manganese



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
▲	Kontur and Fechter 1985	rat	litter size	drinking water	3 weeks	manganese chloride	
■	Laskey et al. 1982	rat	pregnancy success	diet	gestation to 32 weeks	manganese oxide	
▲	Leung et al. 1982	rat	offspring body weight	drinking water	3.71 weeks	manganese chloride	A
▲	Pappas et al. 1997	rat	offspring body weight	drinking water	gestation to post−natal day 30	manganese chloride	A
□	ED20 for Laskey et al. 1982	rat	pregnancy success	diet	gestation to 32 weeks	manganese oxide	

☐ Tier 1 △ Tier 2

- - - Eco−SSL TRV = 51.5 mg/kg bw/day

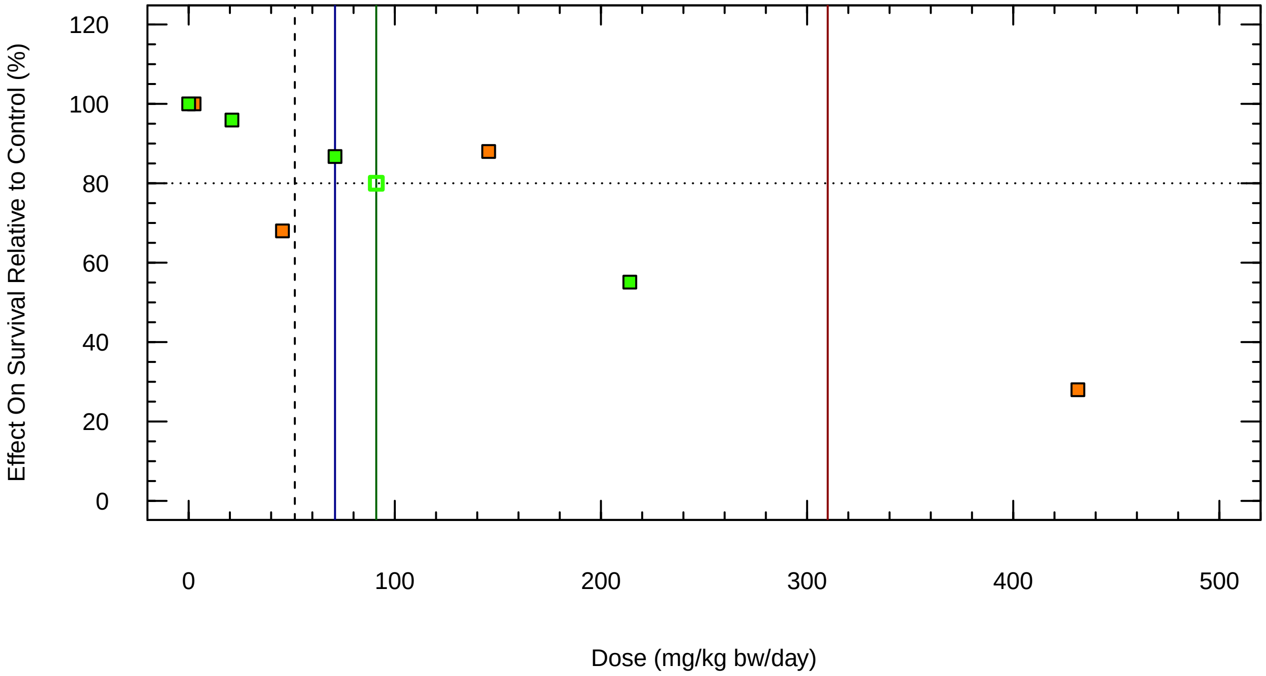
— Selected TRV (Growth) = 71 mg/kg bw/day
— Selected TRV (Reproduction) = 310 mg/kg bw/day
— Selected TRV (Survival) = 91 mg/kg bw/day

····· 80% effect relative to control

ED20 for Laskey et al. 1982 is 310 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−21. Dose−Response Data for the Mammalian Reproduction Endpoint for Manganese



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	NTP 1993b	rat	suvival (male)	diet	2 years	manganese sulfate	
🟩	Rehnberg et al. 1980	rat	survival	gavage	2.86 weeks	manganese oxide	
□	ED20 for Rehnberg et al. 1980	rat	survival	gavage	2.86 weeks	manganese oxide	

☐ Tier 1

- - - Eco−SSL TRV = 51.5 mg/kg bw/day

— Selected TRV (Growth) = 71 mg/kg bw/day
— Selected TRV (Reproduction) = 310 mg/kg bw/day
— Selected TRV (Survival) = 91 mg/kg bw/day

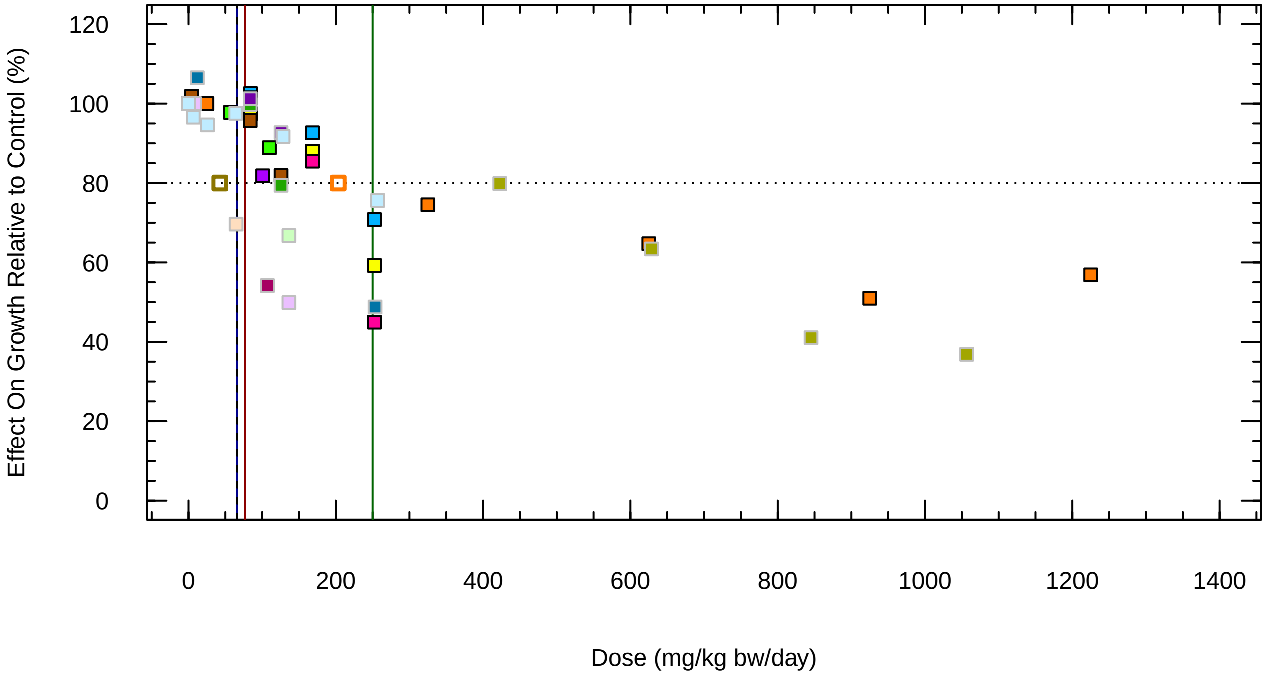
····· 80% effect relative to control

ED20 for Rehnberg et al. 1980 is 91 mg/kg bw/day

* Survival at this dose was not significantly different from the control

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−22. Dose−Response Data for the Mammalian Survival Endpoint for Manganese



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Gasaway and Buss 1972	mallard	body weight gain	diet	5.71 weeks	zinc carbonate	
🟩	Hamilton et al. 1981	Japanese quail	body weight (Exp 2)	diet	2 weeks	zinc carbonate	
🟪	Hamilton et al. 1981	Japanese quail	body weight (Exp 5)	diet	2 weeks	zinc carbonate	
🟦	Roberson and Schaible 1960	chicken	body weight (Exp 2)	diet	4 weeks	zinc oxide	D
🟨	Roberson and Schaible 1960	chicken	body weight (Exp 2)	diet	4 weeks	zinc sulfate	C
🟥	Roberson and Schaible 1960	chicken	body weight (Exp 2)	diet	4 weeks	zinc carbonate	B
🟫	Roberson and Schaible 1960	chicken	body weight (Exp 3)	diet	4 weeks	zinc sulfate	C
🟩	Roberson and Schaible 1960	chicken	body weight (Exp 3)	diet	4 weeks	zinc carbonate	B
🟪	Roberson and Schaible 1960	chicken	body weight (Exp 3)	diet	4 weeks	zinc oxide	D
🟦	Stahl et al. 1989	chicken	body weight gain	diet	3 weeks	zinc carbonate	
🟨	Vohra and Kratzer 1968	turkey	body weight gain	diet	3 weeks	zinc oxide	
🟥	Lu and Combs 1988	chicken	body weight gain (Exp 3)	diet	3 weeks	zinc oxide	A
🟧	Lu et al. 1990	chicken	body weight gain (Exp 1)	diet	1 weeks	zinc oxide	A
🟩	Sandoval et al. 1988	chicken	body weight gain (Exp 2)	diet	3 weeks	zinc sulfate	E
🟪	Sandoval et al. 1988	chicken	body weight gain (Exp 2)	diet	3 weeks	zinc gluconate	
🟦	Hill 1974a	chicken	body weight gain	diet	2 weeks	zinc sulfate	E
□	ED20 for Gasaway and Buss 1972	mallard	body weight gain	diet	5.71 weeks	zinc carbonate	
□	ED20 for pooled dataset A	chicken	body weight gain	diet	1−3 weeks	zinc oxide	A

□ Tier 1

- - - Eco−SSL TRV = 66.1 mg/kg bw/day

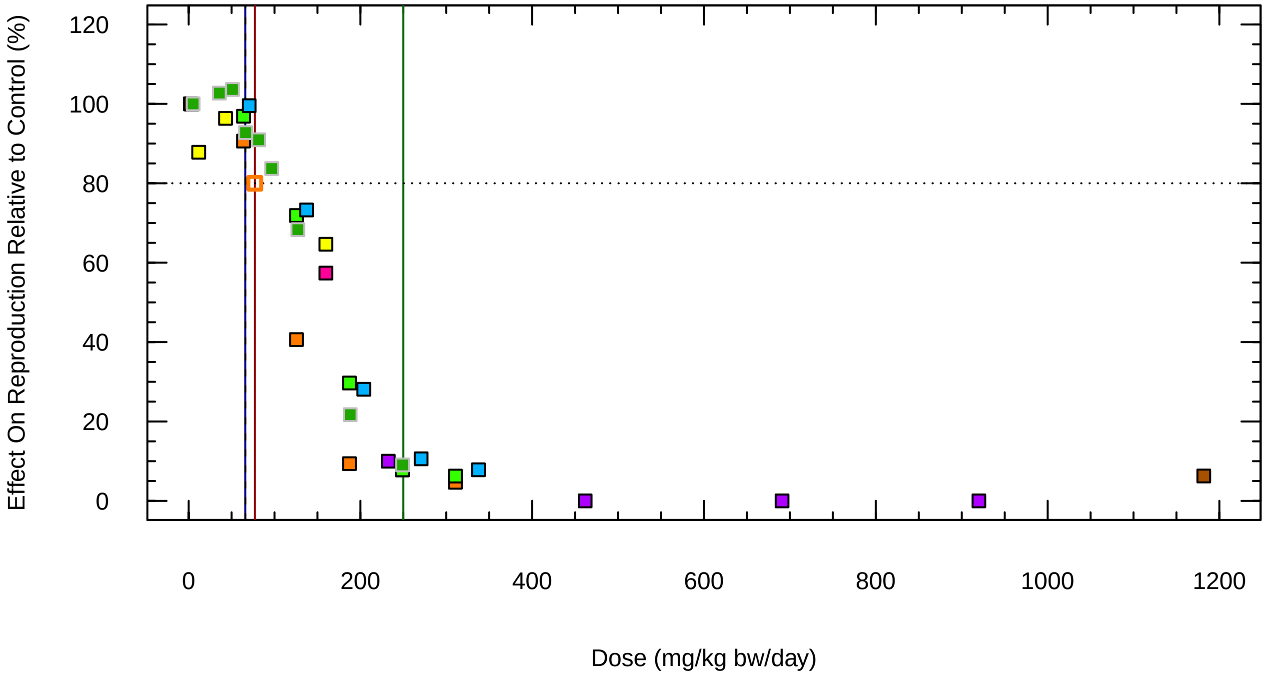
— Selected TRV (Growth) = 66 mg/kg bw/day
— Selected TRV (Reproduction) = 77 mg/kg bw/day
— Selected TRV (Survival) = 250 mg/kg bw/day

····· 80% effect relative to control

ED20 for Gasaway and Buss 1972 is 200 mg/kg bw/day
ED20 for pooled dataset A is 43 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−23. Dose−Response Data for the Avian Growth Endpoint for Zinc



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Gibson et al. 1986	chicken	egg production	diet	10 weeks	zinc acetate dihydrate	
🟩	Gibson et al. 1986	chicken	egg production	diet	10 weeks	zinc oxide	
🟪	Jackson et al. 1986	chicken	egg production	diet	3 weeks	zinc oxide	
🟦	Jackson et al. 1986	chicken	egg production	diet	20 weeks	zinc oxide	F
🟨	Jensen and Maurice 1980	chicken	egg production (Exp 4)	diet	6 weeks	zinc sulfate	G
🟥	Jensen and Maurice 1980	chicken	egg production (Exp 3)	diet	6 weeks	zinc sulfate	G
🟫	Stepinska et al. 1987	chicken	egg production	diet	0.714 weeks	zinc oxide	
🟩	Stevenson et al. 1987	chicken	egg production	diet	20 weeks	zinc oxide	F
□	ED20 for Gibson et al. 1986	chicken	egg production	diet	10 weeks	zinc acetate dihydrate	

□ Tier 1

- - - Eco−SSL TRV = 66.1 mg/kg bw/day

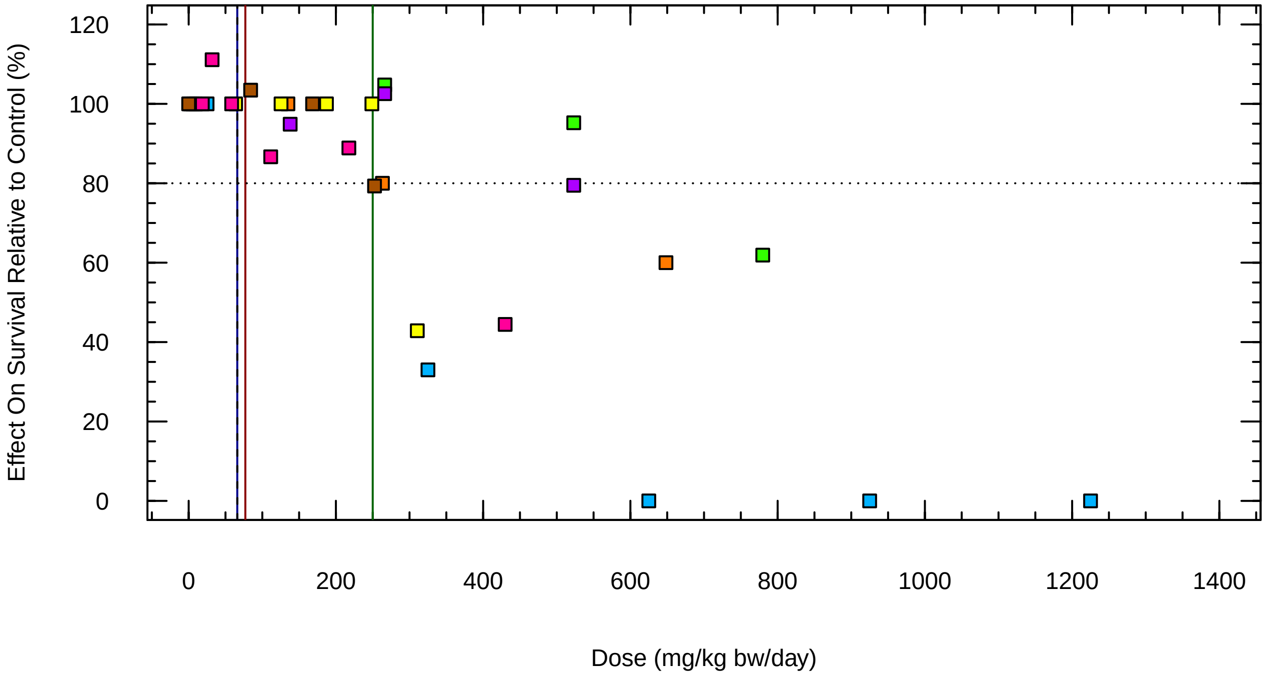
— Selected TRV (Growth) = 66 mg/kg bw/day
— Selected TRV (Reproduction) = 77 mg/kg bw/day
— Selected TRV (Survival) = 250 mg/kg bw/day

····· 80% effect relative to control

ED20 for Gibson et al. 1986 is 77 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−24. Dose−Response Data for the Avian Reproduction Endpoint for Zinc



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Blalock and Hill 1988	chicken	survival	diet	2 weeks	zinc oxide	H
🟩	Dewar et al. 1983	chicken	survival (Exp 1)	diet	4 weeks	zinc oxide	
🟪	Dewar et al. 1983	chicken	survival (Exp 2)	diet	4 weeks	zinc oxide	H
🟦	Gasaway and Buss 1972	mallard	survival	diet	8.57 weeks	zinc carbonate	
🟨	Gibson et al. 1986	chicken	survival	diet	10 weeks	zinc acetate	
🟥	Hamilton et al. 1979	Japanese quail	survival	diet	2 weeks	zinc carbonate	
🟫	Roberson and Schaible 1960	chicken	survival (Exp 2)	diet	4 weeks	zinc carbonate	

☐ Tier 1

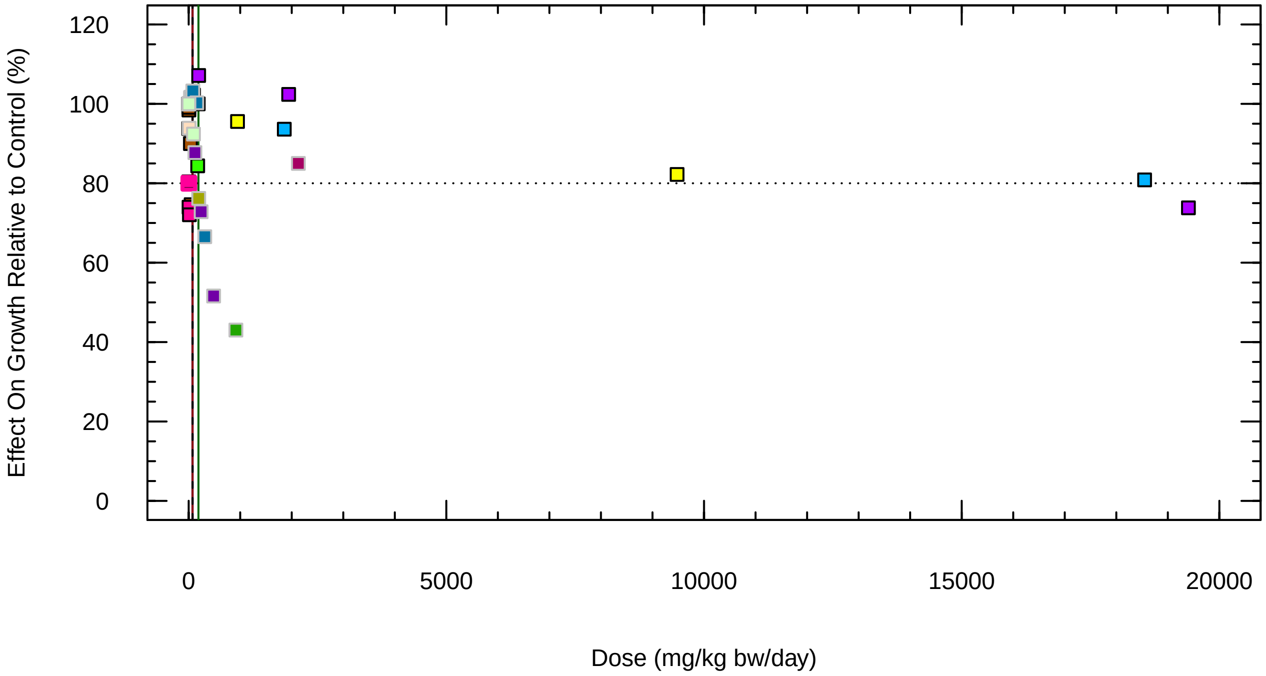
- - - Eco−SSL TRV = 66.1 mg/kg bw/day

— Selected TRV (Growth) = 66 mg/kg bw/day
— Selected TRV (Reproduction) = 77 mg/kg bw/day
— Selected TRV (Survival) = 250 mg/kg bw/day

····· 80% effect relative to control

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−25. Dose−Response Data for the Avian Survival Endpoint for Zinc



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Hill et al. 1983	pig	body weight	diet	to 18 months old	zinc oxide	
🟩	Hsu et al. 1975	pig	body weight	diet	9−13 weeks	zinc oxide	
🟪	Maita et al. 1981	mouse	body weight (female)	diet	13 weeks	zinc sulfate	
🟦	Maita et al. 1981	mouse	body weight (male)	diet	13 weeks	zinc sulfate	
🟨	Maita et al. 1981	rat	body weight (male)	diet	13 weeks	zinc sulfate	
🟥	Khan et al. 2007	rat	male body weight	gavage	14 weeks	zinc chloride	
🟫	Subramanian et al. 2000	rat	body weight	diet	6 weeks	zinc oxide	
🟩	Settlemire and Matrone 1967	rat	body weight gain	diet	5 weeks	zinc carbonate	
🟪	Brink et al. 1959	pig	body weight (Exp 1)	diet	6 weeks	not specified	A
🟦	Brink et al. 1959	pig	body weight (Exp 2)	diet	5 weeks	not specified	A
🟨	Brink et al. 1959	pig	body weight (Exp 3)	diet	6 weeks	not specified	A
🟥	Petterson et al. 2002	mouse	body weight	diet	3 weeks	zinc chloride	
🟧	Nakamura et al. 1983	rat	body weight	diet	11 weeks	zinc acetate	
🟩	Barone et al. 1998	rat	body weight	diet	gestation	not specified	
□	ED20 for Khan et al. 2007	rat	male body weight	gavage	14 weeks	zinc chloride	

□ Tier 1

- - - Eco−SSL TRV = 75.4 mg/kg bw/day

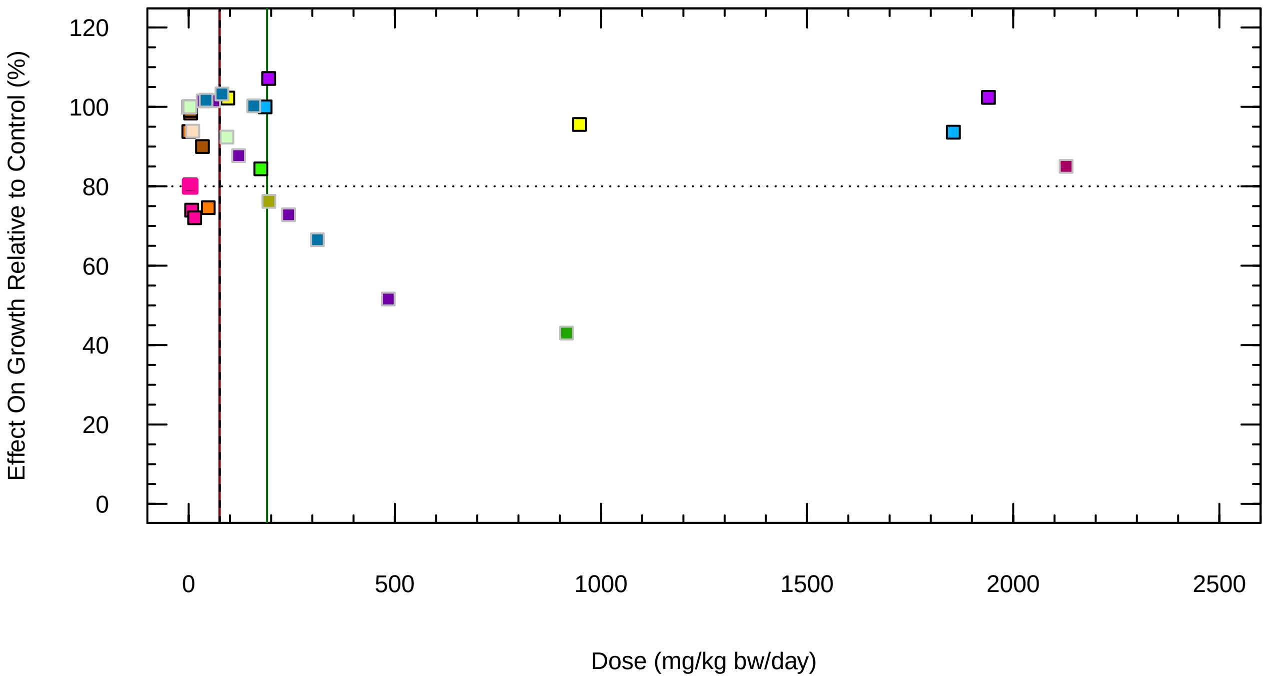
── Selected TRV (Growth) = 75 mg/kg bw/day
── Selected TRV (Reproduction) = 75 mg/kg bw/day
── Selected TRV (Survival) = 190 mg/kg bw/day

····· 80% effect relative to control

ED20 for Khan et al. 2007 is 3.7 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−26a. Dose−Response Data for the Mammalian Growth Endpoint for Zinc



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Hill et al. 1983	pig	body weight	diet	to 18 months old	zinc oxide	
🟩	Hsu et al. 1975	pig	body weight	diet	9−13 weeks	zinc oxide	
🟪	Maita et al. 1981	mouse	body weight (female)	diet	13 weeks	zinc sulfate	
🟦	Maita et al. 1981	mouse	body weight (male)	diet	13 weeks	zinc sulfate	
🟨	Maita et al. 1981	rat	body weight (male)	diet	13 weeks	zinc sulfate	
🟥	Khan et al. 2007	rat	male body weight	gavage	14 weeks	zinc chloride	
🟫	Subramanian et al. 2000	rat	body weight	diet	6 weeks	zinc oxide	
🟩	Settlemire and Matrone 1967	rat	body weight gain	diet	5 weeks	zinc carbonate	
🟪	Brink et al. 1959	pig	body weight (Exp 1)	diet	6 weeks	not specified	A
🟦	Brink et al. 1959	pig	body weight (Exp 2)	diet	5 weeks	not specified	A
🟨	Brink et al. 1959	pig	body weight (Exp 3)	diet	6 weeks	not specified	A
🟥	Petterson et al. 2002	mouse	body weight	diet	3 weeks	zinc chloride	
🟧	Nakamura et al. 1983	rat	body weight	diet	11 weeks	zinc acetate	
🟩	Barone et al. 1998	rat	body weight	diet	gestation	not specified	
□	ED20 for Khan et al. 2007	rat	male body weight	gavage	14 weeks	zinc chloride	

□ Tier 1

- - - Eco−SSL TRV = 75.4 mg/kg bw/day

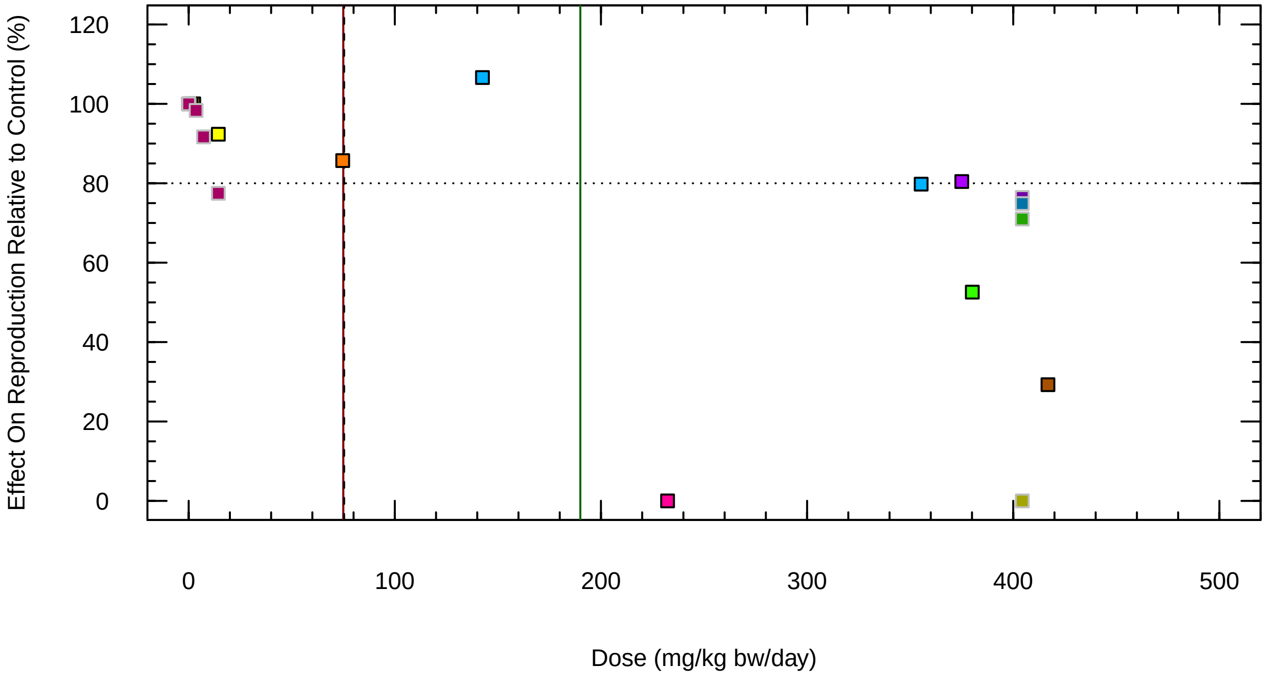
— Selected TRV (Growth) = 75 mg/kg bw/day
— Selected TRV (Reproduction) = 75 mg/kg bw/day
— Selected TRV (Survival) = 190 mg/kg bw/day

····· 80% effect relative to control

ED20 for Khan et al. 2007 is 3.7 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−26b. Dose−Response Data for the Mammalian Growth Endpoint for Zinc (Truncated X−Axis)



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Barone et al. 1998	rat	litter size	diet	gestation	not specified	
🟩	Chu and Cox 1972	rat	offspring growth	diet	3 weeks	not specified	
🟪	Cox et al. 1969	rat	fetal growth	diet	3.14 weeks	zinc oxide	B
🟦	Ketcheson et al. 1969	rat	offspring growth	diet	gestation to 14 days lactation	zinc oxide	
🟨	Kumar 1976	rat	fetal survival	diet	2.57 weeks	zinc sulfate	
🟥	Newman et al. 2002	rat	offspring survival	diet	gestation to post−natal day 40	zinc acetate dihydrate	
🟫	Pal and Pal 1987	rat	normal fetuses	diet	2.57 weeks	zinc sulfate	
🟩	Schlicker and Cox 1968	rat	fetal survival	diet	2.14 weeks	zinc oxide	C
🟪	Schlicker and Cox 1968	rat	fetal growth	diet	2.14 weeks	zinc oxide	B
🟦	Schlicker and Cox 1968	rat	fetal growth	diet	2.57 weeks	zinc oxide	B
🟨	Schlicker and Cox 1968	rat	fetal survival	diet	5.14 weeks	zinc oxide	C
🟥	Khan et al. 2007	rat	offspring survival	gavage	20 weeks	zinc chloride	

☐ Tier 1

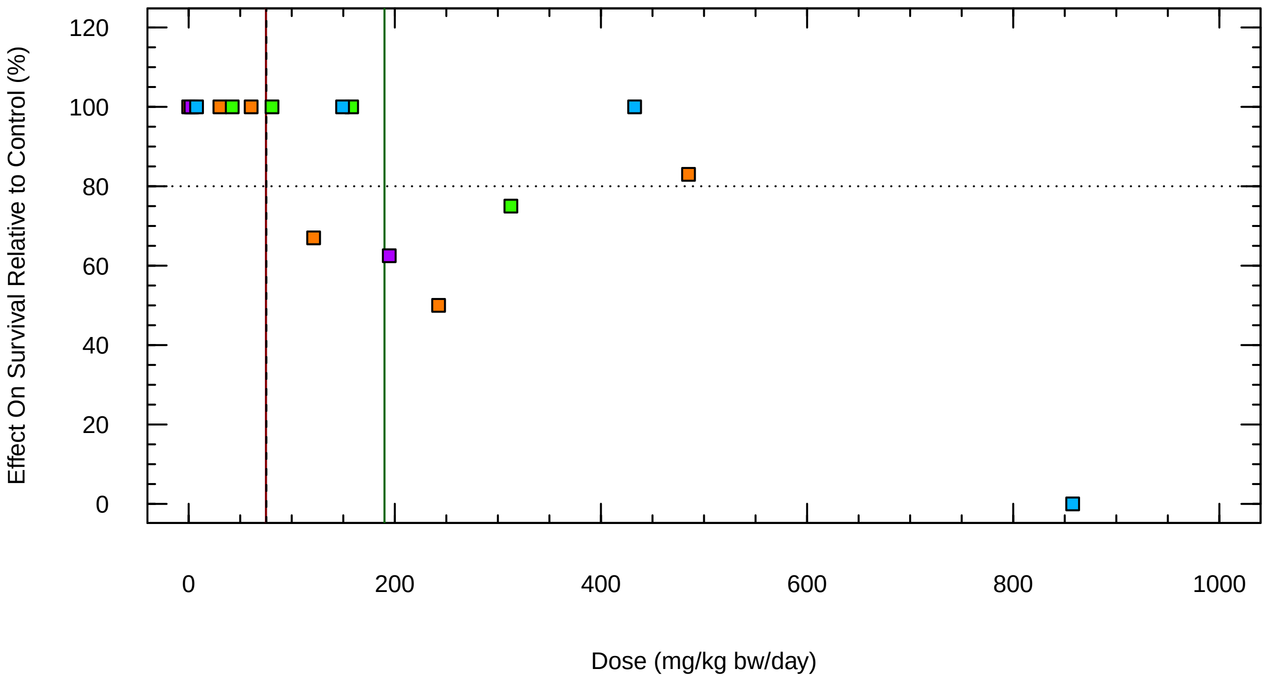
- - - Eco−SSL TRV = 75.4 mg/kg bw/day

— Selected TRV (Growth) = 75 mg/kg bw/day
— Selected TRV (Reproduction) = 75 mg/kg bw/day
— Selected TRV (Survival) = 190 mg/kg bw/day

····· 80% effect relative to control

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−27. Dose−Response Data for the Mammalian Reproduction Endpoint for Zinc



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Brink et al. 1959	pig	survival (Exp 1)	diet	6 weeks	zinc carbonate	D
🟩	Brink et al. 1959	pig	survival (Exp 2)	diet	5 weeks	zinc carbonate	D
🟪	Brink et al. 1959	pig	survival (Exp 3)	diet	6 weeks	zinc carbonate	D
🟦	Straube et al. 1980	ferret	survival	diet	2−24 weeks	zinc oxide	
☐	Geomean for pooled dataset D	pig	survival	diet	5−6 weeks	zinc carbonate	D

☐ Tier 1

- - - Eco−SSL TRV = 75.4 mg/kg bw/day

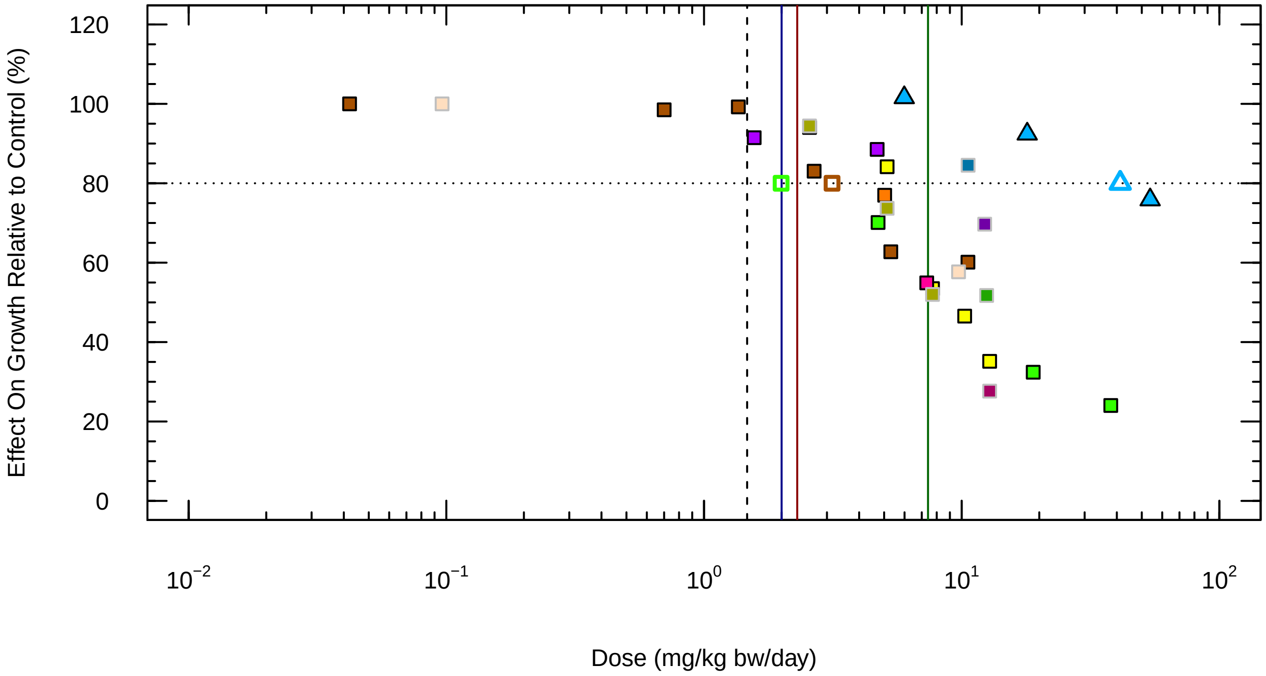
— Selected TRV (Growth) = 75 mg/kg bw/day
— Selected TRV (Reproduction) = 75 mg/kg bw/day
— Selected TRV (Survival) = 190 mg/kg bw/day

····· 80% effect relative to control

Geomean for pooled dataset D is 190 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−28. Dose−Response Data for the Mammalian Survival Endpoint for Zinc



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
■	Bafundo et al. 1984	chicken	body weight gain	diet	2 weeks	cadmium chloride	
■	Bokori et al. 1995a	chicken	body weight	diet	4 weeks	cadmium sulfate	
■	Bokori et al. 1996	chicken	body weight	diet	39 weeks	cadmium sulfate	
▲	Di Giulio and Scanlon 1984	mallard	body weight	diet	6 weeks	cadmium chloride	
■	Hill 1974a	chicken	body weight gain	diet	2 weeks	cadmium sulfate	A
■	Hill 1974b	chicken	body weight gain	diet	2 weeks	cadmium sulfate	A
■	Olgun 2015	Japanese quail	body weight	diet	10 weeks	cadmium sulfate	
■	Richardson and Fox 1974	Japanese quail	body weight	diet	4 weeks	cadmium chloride	B
■	Richardson et al. 1974	Japanese quail	body weight	diet	4 weeks	cadmium chloride	B
■	Richardson et al. 1974	Japanese quail	body weight	diet	6 weeks	cadmium chloride	B
■	Hill 1979	chicken	body weight gain	diet	2 weeks	cadmium sulfate	A
■	Hill 1980	chicken	body weight gain	diet	2 weeks	cadmium sulfate	A
■	Rama and Planas 1981	chicken	body weight gain	diet	9 weeks	cadmium sulfate	A
□	ED20 for Bokori et al. 1995a	chicken	body weight	diet	4 weeks	cadmium sulfate	
△	ED20 for Di Giulio and Scanlon 1984	mallard	body weight	diet	6 weeks	cadmium chloride	
□	ED20 for Olgun 2015	Japanese quail	body weight	diet	10 weeks	cadmium sulfate	

□ Tier 1 △ Tier 2

- - - Eco−SSL TRV = 1.47 mg/kg bw/day

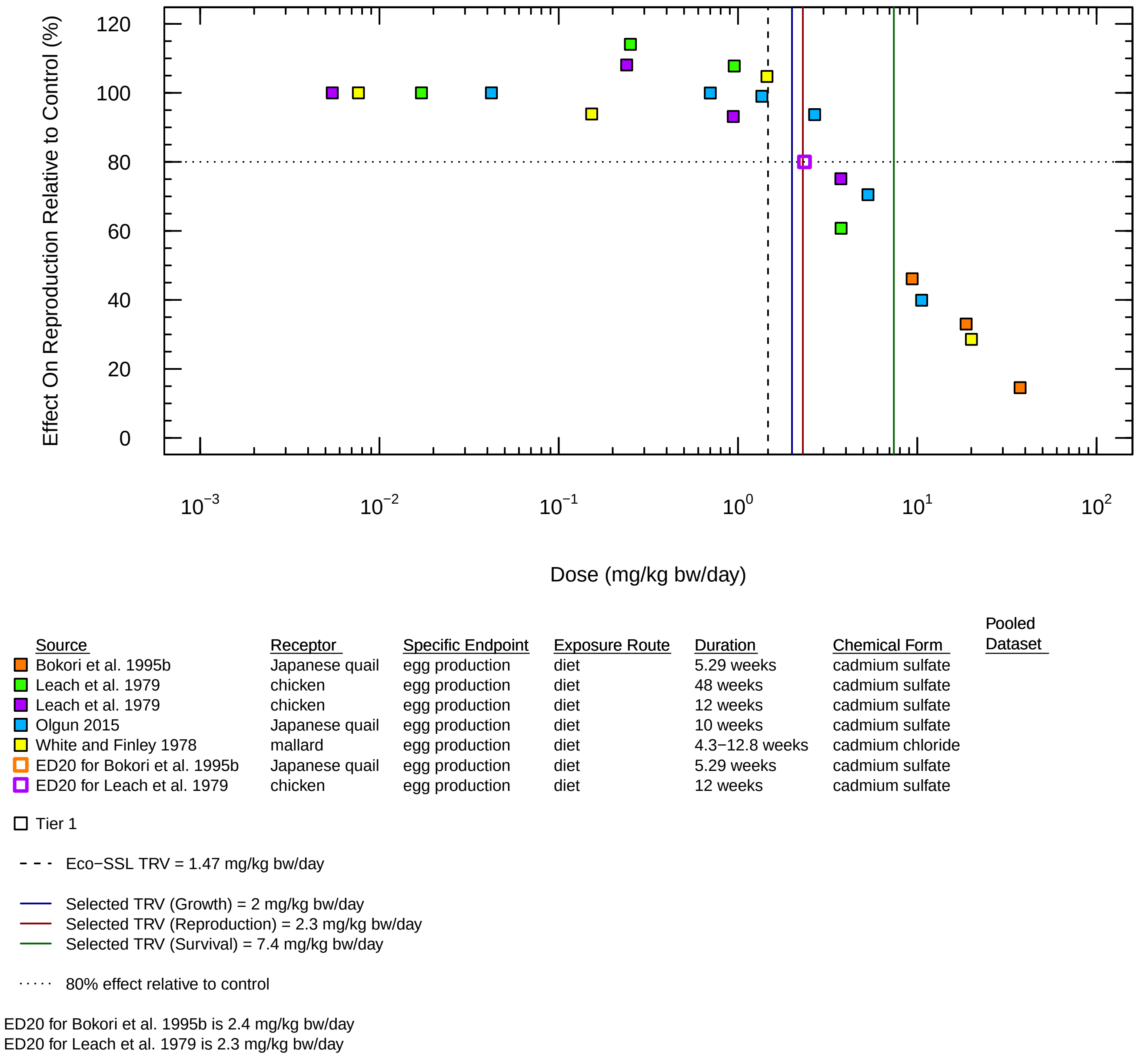
— Selected TRV (Growth) = 2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.3 mg/kg bw/day
— Selected TRV (Survival) = 7.4 mg/kg bw/day

····· 80% effect relative to control

ED20 for Bokori et al. 1995a is 2 mg/kg bw/day
ED20 for Di Giulio and Scanlon 1984 is 41 mg/kg bw/day
ED20 for Olgun 2015 is 3.1 mg/kg bw/day

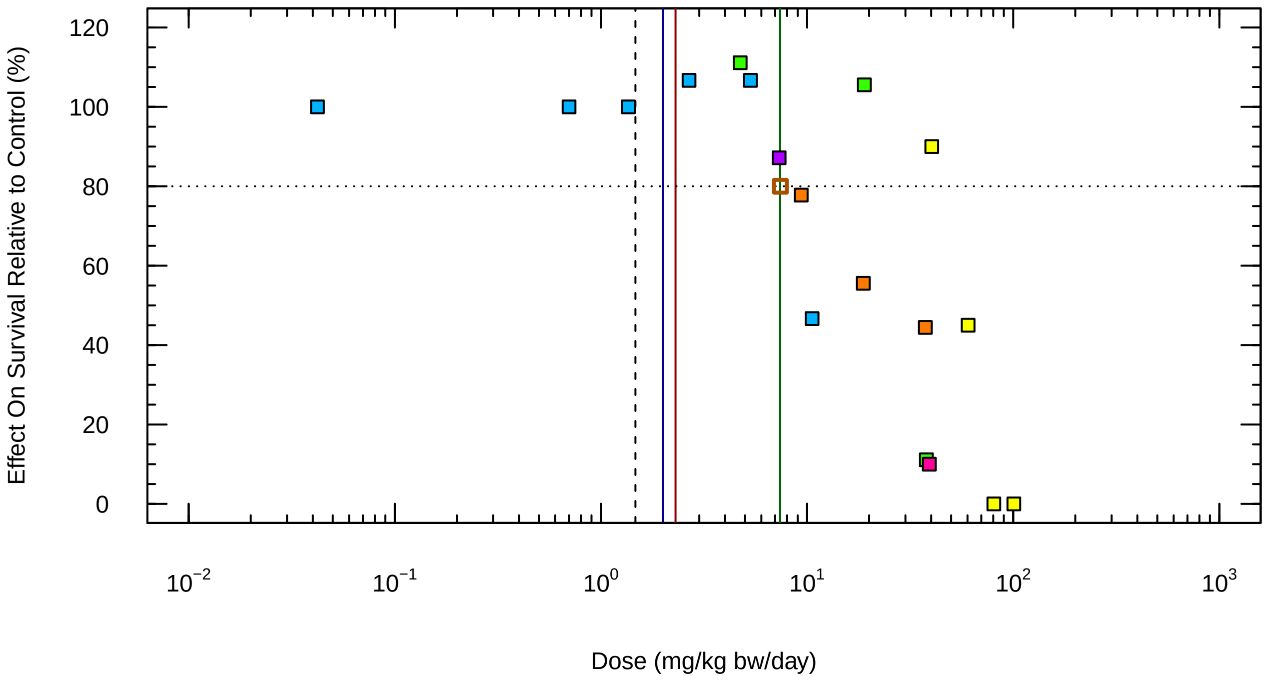
Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−29. Dose−Response Data for the Avian Growth Endpoint for Cadmium, Log−Transformed



Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−30. Dose−Response Data for the Avian Reproduction Endpoint for Cadmium, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Bokori et al. 1995b	Japanese quail	survival	diet	5.29 weeks	cadmium sulfate	C
🟩	Bokori et al. 1995a	chicken	survival	diet	8 weeks	cadmium sulfate	
🟪	Hill 1974b	chicken	survival	diet	2 weeks	cadmium sulfate	
🟦	Olgun 2015	Japanese quail	survival	diet	10 weeks	cadmium sulfate	C
🟨	Pritzl et al. 1974	chicken	survival	diet	2.86 weeks	cadmium carbonate	
🟥	Van Vleet et al. 1981	Pekin duck	survival	diet	4 weeks	cadmium sulfate	
☐	ED20 for pooled dataset C	Japanese quail	survival	diet	5.3−10 weeks	cadmium sulfate	C

☐ Tier 1

- - - Eco−SSL TRV = 1.47 mg/kg bw/day

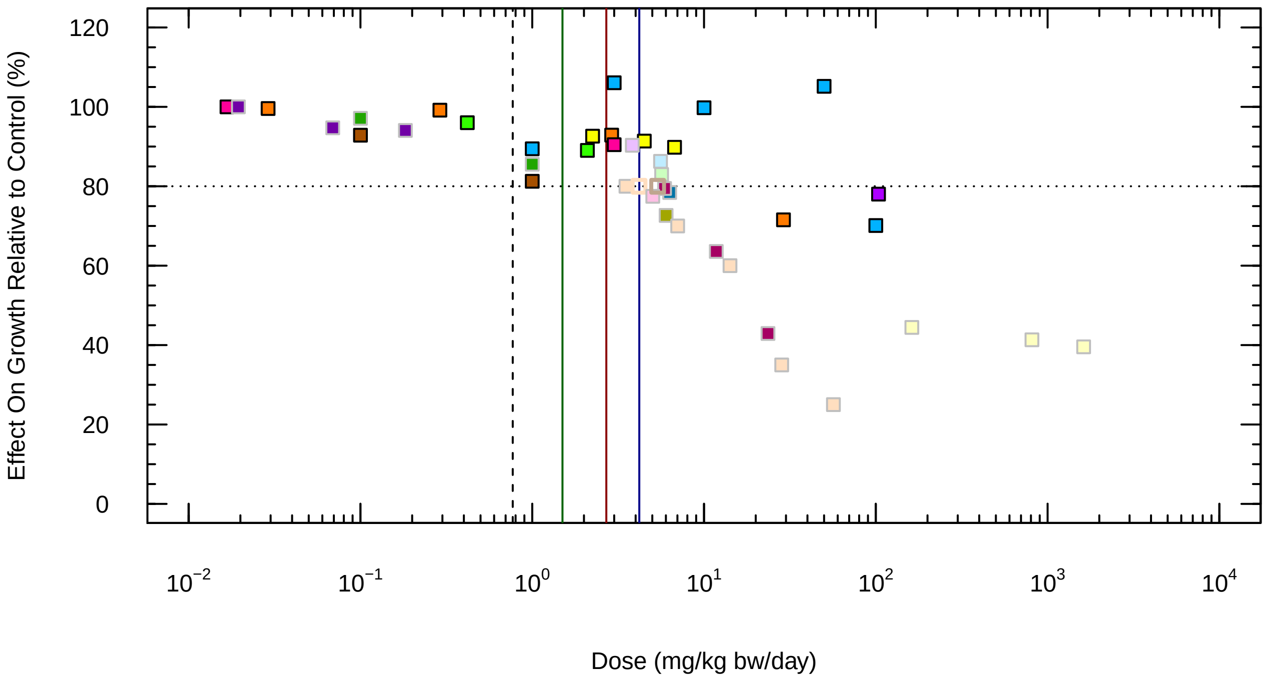
— Selected TRV (Growth) = 2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.3 mg/kg bw/day
— Selected TRV (Survival) = 7.4 mg/kg bw/day

····· 80% effect relative to control

ED20 for pooled dataset C is 7.4 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−31. Dose−Response Data for the Avian Survival Endpoint for Cadmium, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
■	Baranski and Sitarek 1987	rat	body weight	gavage	14 weeks	cadmium chloride	
■	Cousins et al. 1977	rat	body weight	diet	14 weeks	cadmium chloride	
■	Dodds−Smith et al. 1992	shrew	body weight	diet	12 weeks	cadmium chloride	
■	Hamada et al. 1991	dog	body weight	diet	8−9 years	cadmium chloride	
■	Rajanna et al. 1984	rat	body weight	diet	25.7 weeks	cadmium chloride	
■	Groten et al. 1991	rat	body weight	diet	8 weeks	cadmium chloride	
■	Rastogi et al 1977	rat	body weight	gavage	4.27 weeks	cadmium chloride	
■	Merali and Singhal 1980	rat	body weight	gavage	6.14 weeks	cadmium chloride	
■	Weigel et al. 1987	rat	body weight	diet	7.86 weeks	cadmium oxide	
■	Pond et al. 1973	pig	body weight	diet	7.14 weeks	cadmium chloride	
■	Suzuki and Yoshida 1979	rat	body weight	diet	2 weeks	cadmium chloride	A
■	Suzuki and Yoshida 1979	rat	body weight	diet	4 weeks	cadmium chloride	A
■	Wilson et al. 1941	rat	body weight	diet	7.14 weeks	cadmium chloride	
■	Suzuki and Yoshida 1978a	rat	body weight (Exp 1)	diet	25.7 weeks	cadmium chloride	
■	Suzuki and Yoshida 1978a	rat	body weight (Exp 2)	diet	25.7 weeks	cadmium chloride	
■	Suzuki and Yoshida 1978b	rat	body weight (Exp 1)	diet	2 weeks	cadmium chloride	A
■	Weber and Reid 1969	mouse	body weight (Exp 1)	diet	3 weeks	cadmium acetate	
■	Suzuki and Yoshida 1977	rat	body weight (Exp 2)	diet	6.43 weeks	cadmium chloride	A
□	ED20 for Wilson et al. 1941	rat	body weight	diet	7.14 weeks	cadmium chloride	
□	ED20 for pooled dataset A	rat	body weight	diet	2−6.4 weeks	cadmium chloride	A

□ Tier 1

- - - Eco−SSL TRV = 0.77 mg/kg bw/day

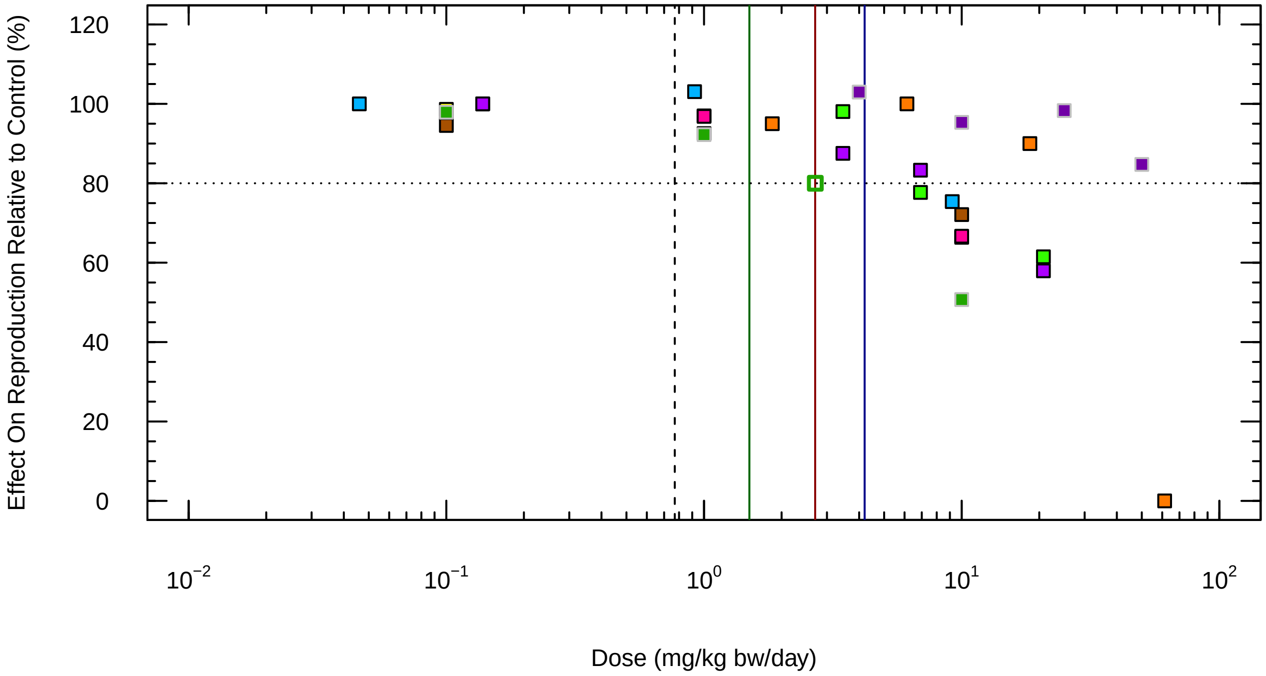
— Selected TRV (Growth) = 4.2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.7 mg/kg bw/day
— Selected TRV (Survival) = 1.5 mg/kg bw/day

····· 80% effect relative to control

ED20 for Wilson et al. 1941 is 4.2 mg/kg bw/day
ED20 for pooled dataset A is 5.4 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−32. Dose−Response Data for the Mammalian Growth Endpoint for Cadmium, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Machemer and Lorke 1981	rat	pregnancy success	gavage	1.43 weeks	cadmium chloride	
🟩	Sawicka−Kapusta et al. 1994	mouse	offspring growth	diet	5 weeks	cadmium chloride	
🟪	Sawicka−Kapusta et al. 1994	mouse	offspring survival	diet	5 weeks	cadmium chloride	
🟦	Whelton et al. 1988	mouse	offspring growth	diet	36 weeks	cadmium chloride	
🟨	Sutou et al. 1980	rat	fetal weight (male)	gavage	9 weeks	cadmium chloride	B
🟥	Sutou et al. 1980	rat	fetal weight (female)	gavage	9 weeks	cadmium chloride	B
🟫	Sutou et al. 1980	rat	fetal implants	gavage	>9 weeks	cadmium chloride	
🟩	Sutou et al. 1980	rat	live fetuses	gavage	>9 weeks	cadmium chloride	
🟪	Wardell et al. 1982	rat	litter weight	gavage	1.86 weeks	not specified	
□	ED20 for Sutou et al. 1980	rat	live fetuses	gavage	>9 weeks	cadmium chloride	

□ Tier 1

- - - Eco−SSL TRV = 0.77 mg/kg bw/day

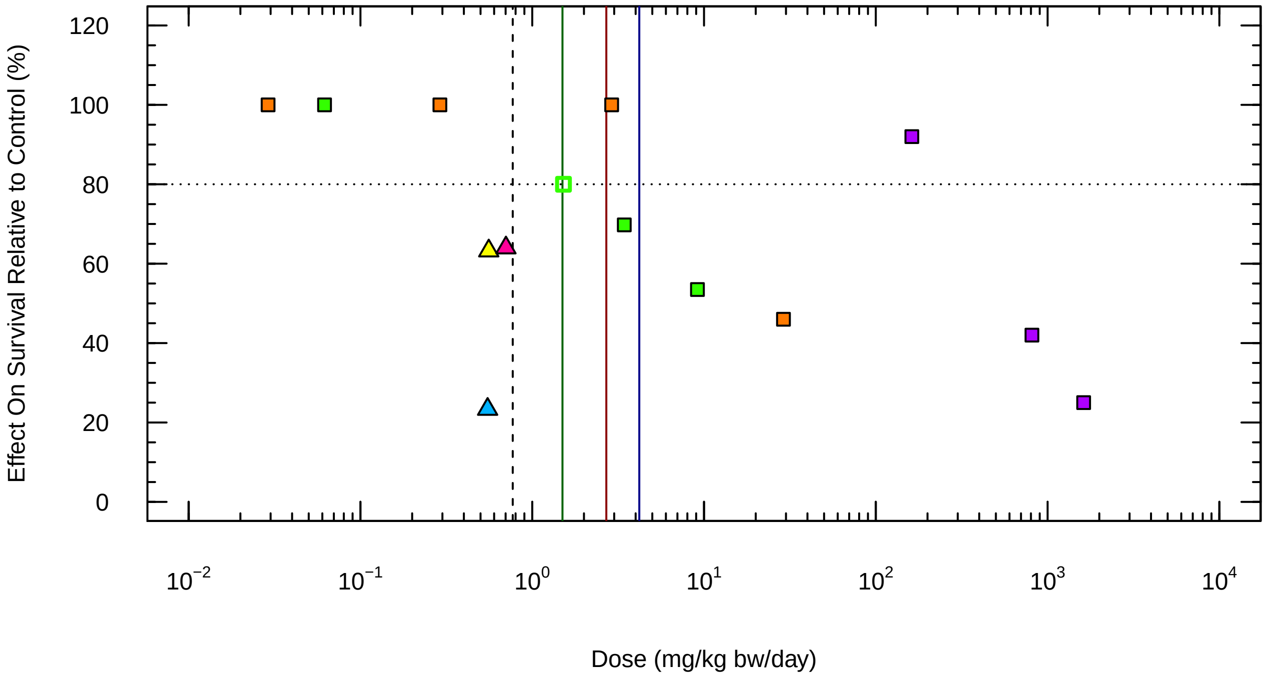
— Selected TRV (Growth) = 4.2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.7 mg/kg bw/day
— Selected TRV (Survival) = 1.5 mg/kg bw/day

····· 80% effect relative to control

ED20 for Sutou et al. 1980 is 2.7 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−33. Dose−Response Data for the Mammalian Reproduction Endpoint for Cadmium, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Baranski and Sitarek 1987	rat	survival	gavage	14 weeks	cadmium chloride	
🟩	Swiergosz et al. 1998	vole	survival	diet	24 weeks	cadmium chloride	
🟪	Weber and Reid 1969	mouse	survival	diet	3 weeks	cadmium acetate	
▲	Schroeder et al. 1963	rat	survival (male)	drinking water	92 weeks	not specified	C
▲	Schroeder et al. 1963	rat	survival (female)	drinking water	92 weeks	not specified	C
▲	Schroeder et al. 1964	mouse	survival (male)	drinking water	78 weeks	not specified	
□	ED20 for Swiergosz et al. 1998	vole	survival	diet	24 weeks	cadmium chloride	

□ Tier 1 △ Tier 2

- - - Eco−SSL TRV = 0.77 mg/kg bw/day

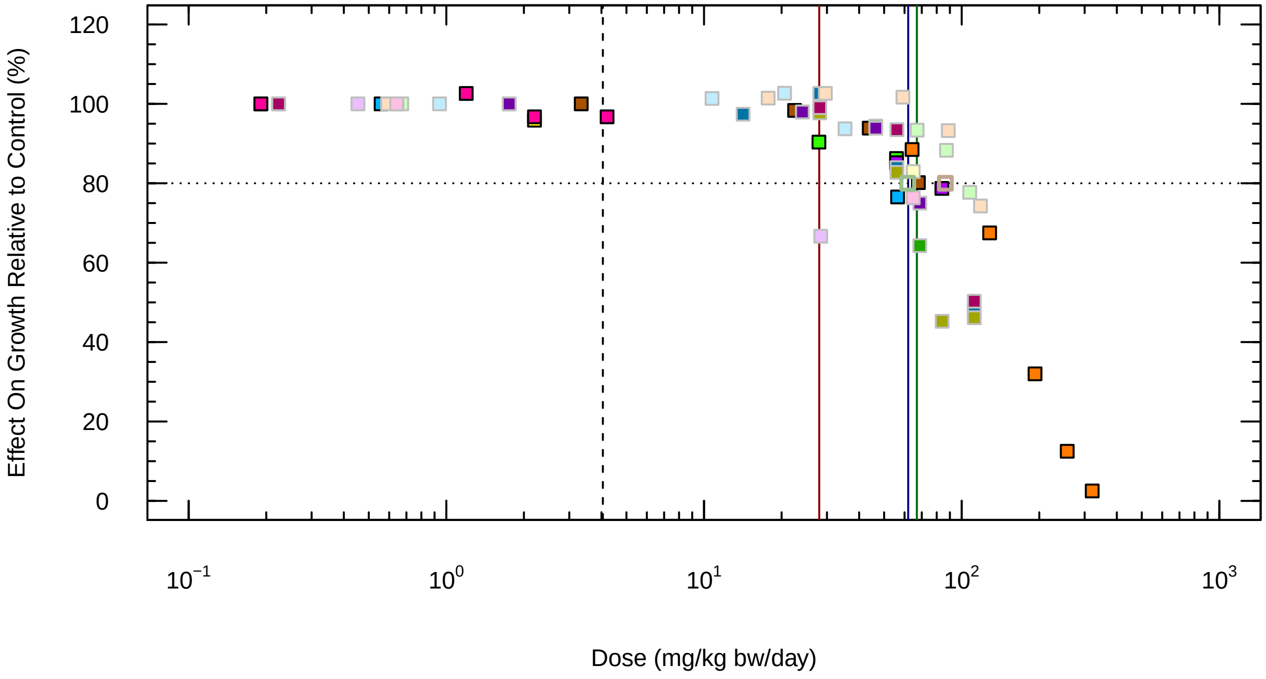
— Selected TRV (Growth) = 4.2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.7 mg/kg bw/day
— Selected TRV (Survival) = 1.5 mg/kg bw/day

· · · · · 80% effect relative to control

ED20 for Swiergosz et al. 1998 is 1.5 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−34. Dose−Response Data for the Mammalian Survival Endpoint for Cadmium, Log−Transformed



Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧 Hill 1974a	chicken	body weight	diet	2 weeks	copper sulfate	C
🟩 Jensen and Maurice 1978	chicken	body weight (Exp 1)	diet	4 weeks	copper sulfate	C
🟪 Jensen and Maurice 1978	chicken	body weight (Exp 2)	diet	4 weeks	copper sulfate	C
🟦 Jensen and Maurice 1979	chicken	body weight (Exp 2)	diet	4 weeks	copper sulfate	C
🟨 Kashani et al. 1986	turkey	body weight (Exp 1)	diet	24 weeks	cupric sulfate	
🟥 Kashani et al. 1986	turkey	body weight (Exp 2)	diet	24 weeks	cupric sulfate	
🟫 Miles et al. 1998	chicken	body weight (Exp 1)	diet	3 weeks	copper sulfate	
🟩 Miles et al. 1998	chicken	body weight (Exp 2)	diet	6 weeks	dicopper chloride	
🟪 Miles et al. 1998	chicken	body weight (Exp 2)	diet	6 weeks	copper sulfate	
🟦 Poupoulis and Jensen 1976	chicken	body weight gain (Exp 1)	diet	4 weeks	copper sulfate	D
🟨 Poupoulis and Jensen 1976	chicken	body weight gain (Exp 2)	diet	4 weeks	copper sulfate	D
🟥 Poupoulis and Jensen 1976	chicken	body weight gain (Exp 5)	diet	4 weeks	copper sulfate	D
🟧 Persia et al. 2004	chicken	body weight (Exp 2)	diet	2.14 weeks	copper chloride	E
🟩 Persia et al. 2004	chicken	body weight (Exp 3)	diet	2 weeks	copper chloride	E
🟪 Latymer and Cotes 1981	chicken	body weight	diet	3.43 weeks	copper sulfate	C
🟦 Smith 1969	chicken	body weight	diet	3.57 weeks	copper sulfate	C
🟨 Wang et al. 1987	chicken	body weight gain (Exp 2)	diet	2.86 weeks	copper sulfate	D
🟥 Wang et al. 1987	chicken	body weight gain (Exp 1)	diet	2.86 weeks	copper sulfate	D
□ ED20 for pooled dataset C	chicken	body weight	diet	3.4−4 weeks	copper sulfate	C
□ ED20 for pooled dataset D	chicken	body weight gain	diet	2.9−4 weeks	copper sulfate	D

□ Tier 1

- - - Eco−SSL TRV = 4.05 mg/kg bw/day

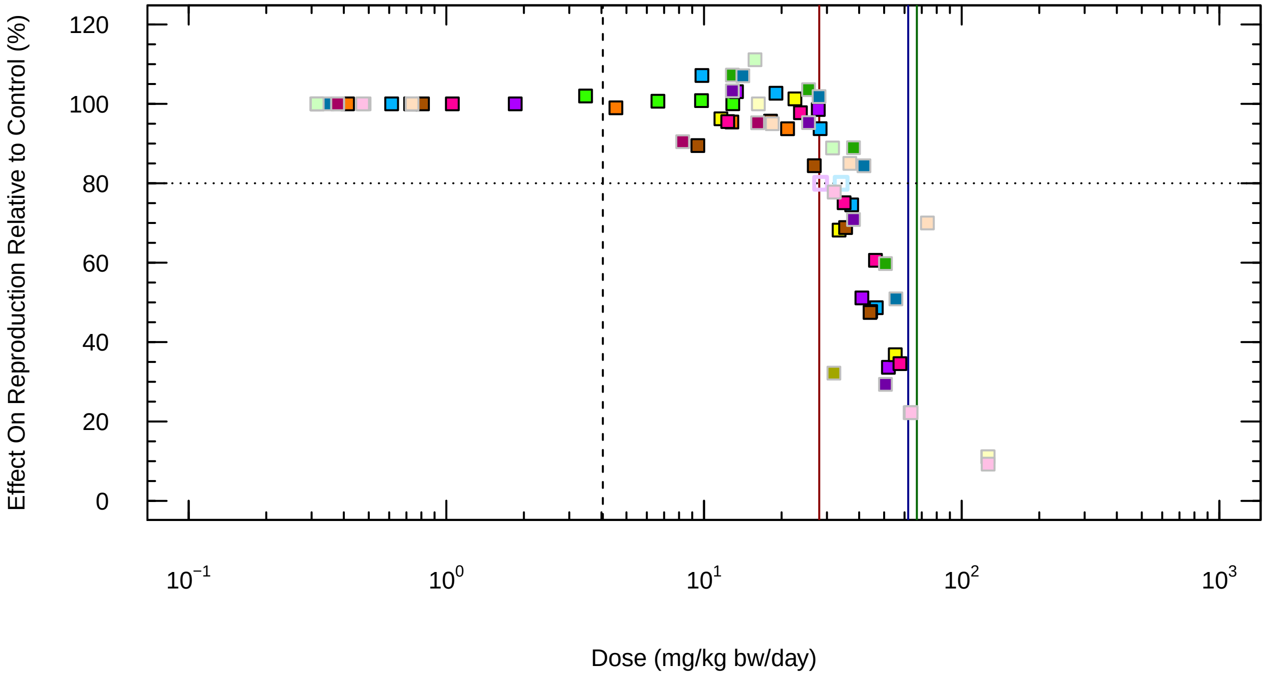
— Selected TRV (Growth) = 62 mg/kg bw/day
— Selected TRV (Reproduction) = 28 mg/kg bw/day
— Selected TRV (Survival) = 67 mg/kg bw/day

····· 80% effect relative to control

ED20 for pooled dataset C is 86 mg/kg bw/day
ED20 for pooled dataset D is 62 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−35. Dose−Response Data for the Avian Growth Endpoint for Copper, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Al Ankari et al. 1998	chicken	egg production	diet	12 weeks	copper sulfate/acetate	
🟩	Balevi and Coskun 2004	chicken	egg production	diet	4−9 weeks	copper sulfate	A
🟪	Chiou et al. 1997	chicken	egg production	diet	4 weeks	copper sulfate	A
🟦	Jackson and Stevenson 1981a	chicken	egg production (breed 1)	diet	40 weeks	copper sulfate	B
🟨	Jackson and Stevenson 1981a	chicken	egg production (breed 2)	diet	40 weeks	copper sulfate	B
🟥	Jackson and Stevenson 1981b	chicken	egg production (breed 1)	diet	48 weeks	copper sulfate	B
🟫	Jackson and Stevenson 1981b	chicken	egg production (breed 2)	diet	48 weeks	copper sulfate	B
🟩	Jackson et al. 1979	chicken	egg production (breed 1)	diet	32 weeks	copper sulfate	B
🟪	Jackson et al. 1979	chicken	egg production (breed 2)	diet	32 weeks	copper sulfate	B
🟦	Jackson et al. 1979	chicken	egg production	diet	48 weeks	copper sulfate	B
🟩	Harms and Buresh 1986	chicken	egg production (Exp 3)	diet	6 weeks	copper sulfate	A
🟥	Lien et al. 2004	chicken	egg production	diet	4 weeks	copper sulfate	A
🟧	Stevenson et al. 1983	chicken	egg production	diet	0.714 weeks	copper sulfate	
🟩	Pearce et al. 1983	chicken	egg production	diet	6.86 weeks	copper sulfate	A
🟨	Stevenson and Jackson 1980a	chicken	egg production	diet	6.86 weeks	copper sulfate	A
🟪	Stevenson and Jackson 1980b	chicken	egg production	diet	8 weeks	copper sulfate	A
☐	ED20 for pooled dataset A	chicken	egg production	diet	4−8 weeks	copper sulfate	A
☐	ED20 for pooled dataset B	chicken	egg production	diet	32−48 weeks	copper sulfate	B

☐ Tier 1

- - - Eco−SSL TRV = 4.05 mg/kg bw/day

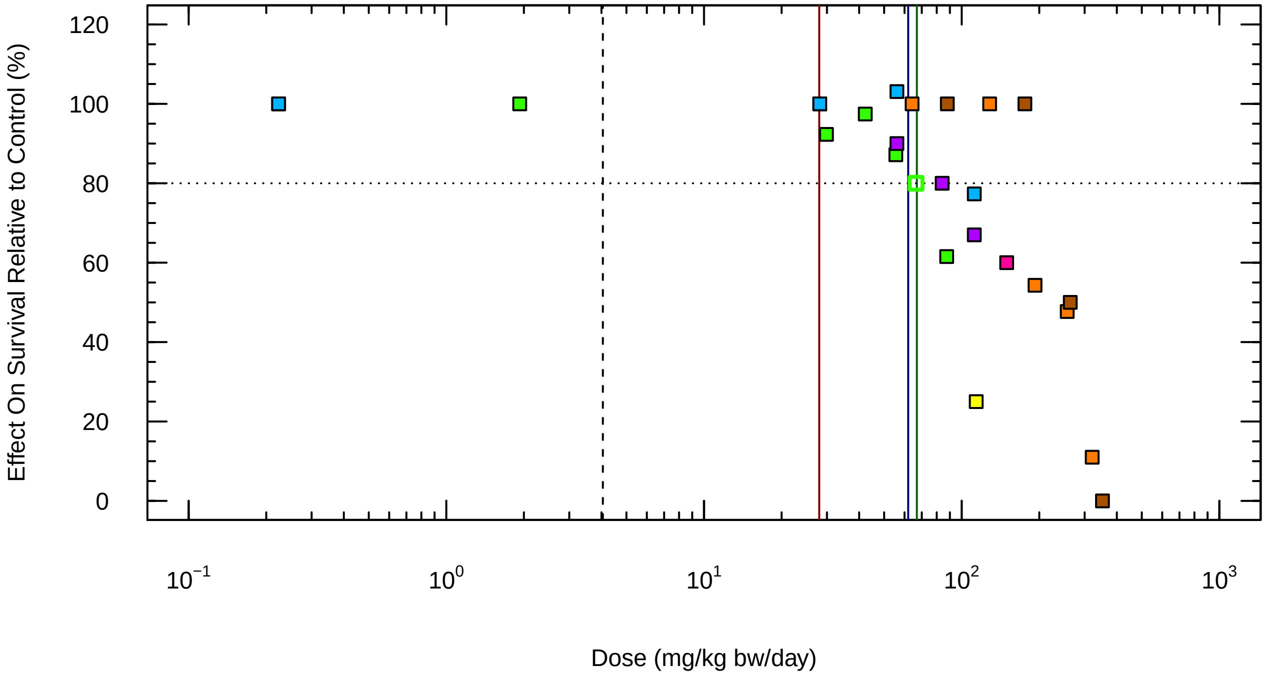
— Selected TRV (Growth) = 62 mg/kg bw/day
— Selected TRV (Reproduction) = 28 mg/kg bw/day
— Selected TRV (Survival) = 67 mg/kg bw/day

····· 80% effect relative to control

ED20 for pooled dataset A is 28 mg/kg bw/day
ED20 for pooled dataset B is 34 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−36. Dose−Response Data for the Avian Reproduction Endpoint for Copper, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Hill 1974a	chicken	survival	diet	2 weeks	copper sulfate	G
🟩	Mehring et al. 1960	chicken	survival	diet	10 weeks	copper oxide	
🟪	Poupoulis and Jensen 1976	chicken	survival (Exp 2)	diet	4 weeks	copper sulfate	G
🟦	Poupoulis and Jensen 1976	chicken	survival (Exp 5)	diet	4 weeks	copper sulfate	G
🟨	Van Vleet et al. 1981	Pekin duck	survival	diet	4 weeks	copper sulfate	F
🟥	Van Vleet et al. 1981	Pekin duck	survival	diet	2.14 weeks	copper sulfate	F
🟫	Vohra and Kratzer 1968	turkey	survival	diet	3 weeks	copper sulfate	
☐	ED20 for Mehring et al. 1960	chicken	survival	diet	10 weeks	copper oxide	

☐ Tier 1

- - - Eco−SSL TRV = 4.05 mg/kg bw/day

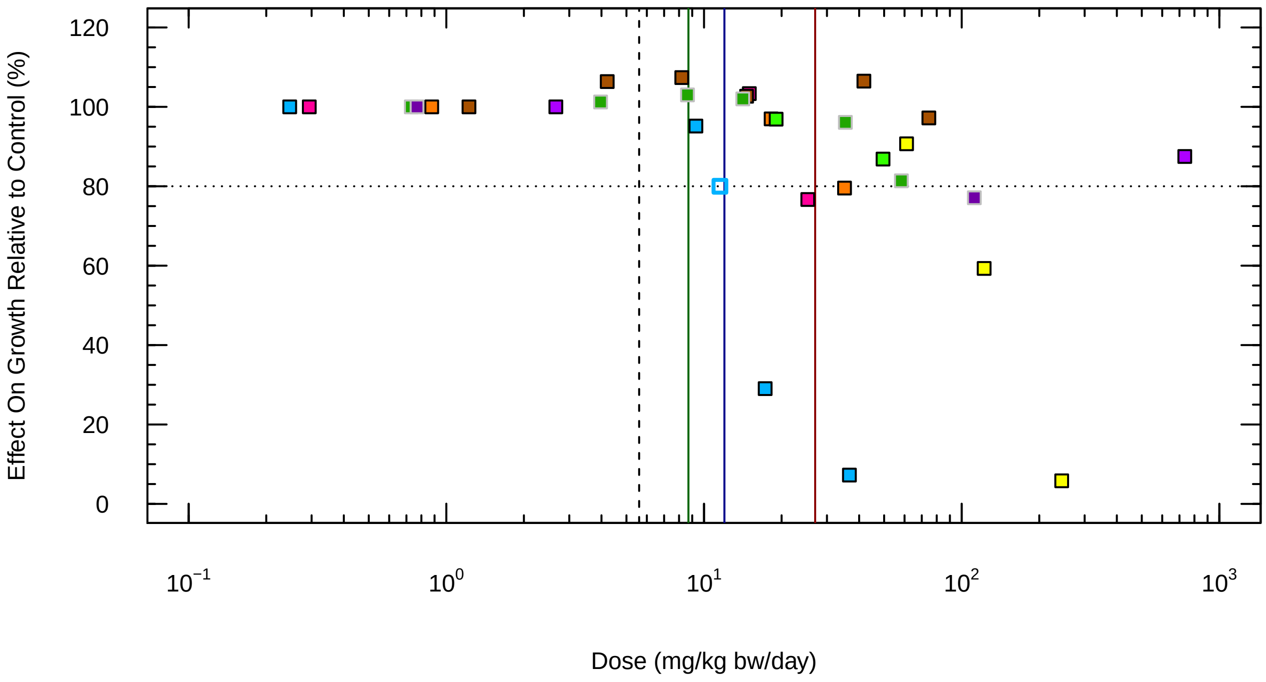
— Selected TRV (Growth) = 62 mg/kg bw/day
— Selected TRV (Reproduction) = 28 mg/kg bw/day
— Selected TRV (Survival) = 67 mg/kg bw/day

····· 80% effect relative to control

ED20 for Mehring et al. 1960 is 67 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−37. Dose−Response Data for the Avian Survival Endpoint for Copper, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Brandt 1983	mink	body weight	diet	~12 weeks	copper sulfate	
🟩	Edmonds and Baker 1986	pig	body weight (Exp 3)	diet	4 weeks	copper sulfate	
🟪	Petterson et al. 2002	mouse	body weight	diet	3 weeks	copper chloride	
🟦	Allcroft et al. 1961	pig	body weight gain	diet	21 weeks	copper sulfate	
🟨	Boyden et al. 1938	rat	body weight gain	diet	4 weeks	copper sulfate	
🟥	Suttle and Mills 1966	pig	body weight (Exp 2)	diet	5.71 weeks	copper sulfate	
🟫	Grobner et al. 1986	rabbit	body weight (Exp 2)	diet	4 weeks	copper sulfate	
🟩	Grobner et al. 1986	rabbit	body weight (Exp 2)	diet	4 weeks	copper sulfate	
🟪	Llewellyn et al. 1985	rat	body weight	diet	21 weeks	copper acetate	
□	ED20 for Allcroft et al. 1961	pig	body weight gain	diet	21 weeks	copper sulfate	

☐ Tier 1

- - - Eco−SSL TRV = 5.6 mg/kg bw/day

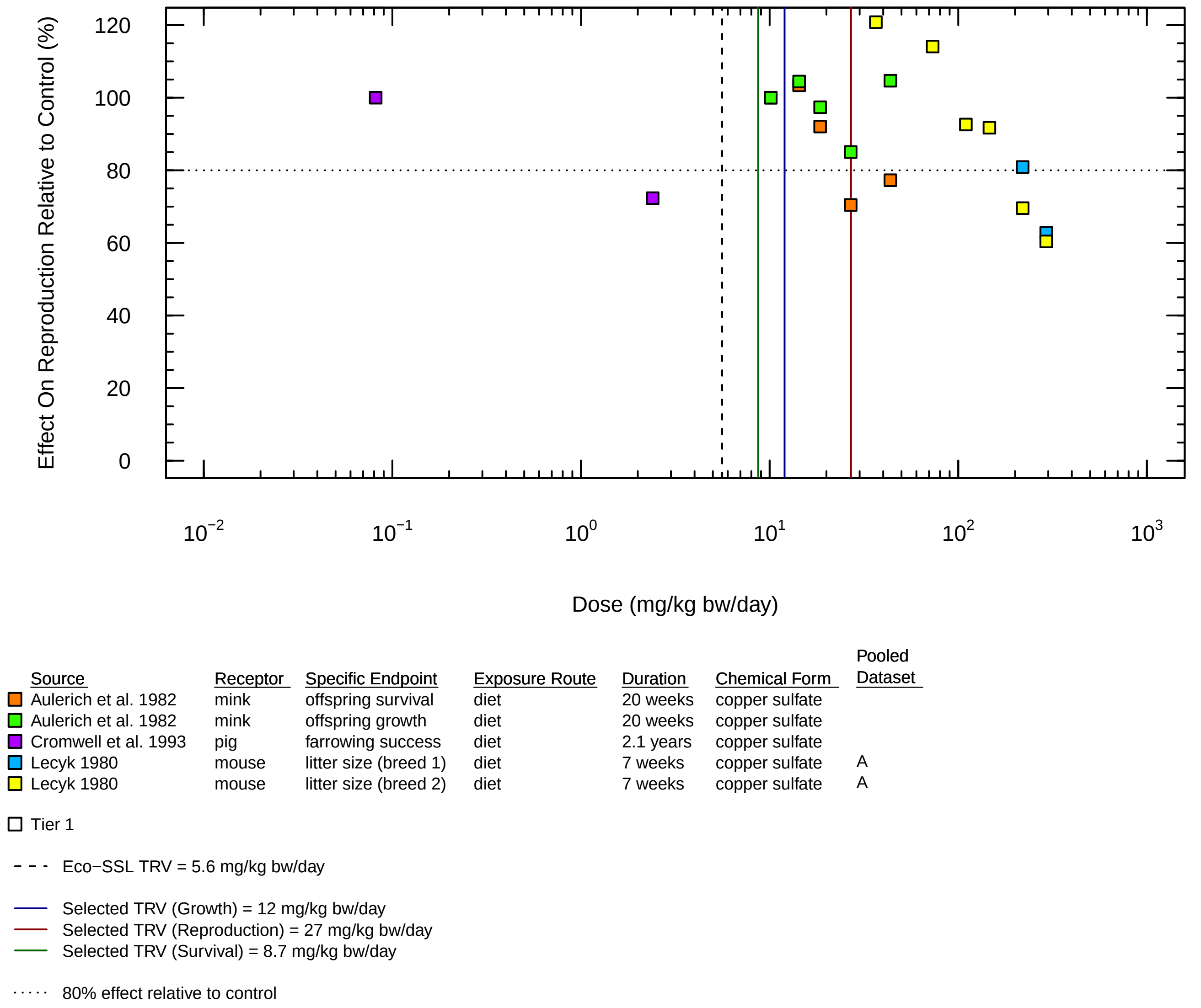
— Selected TRV (Growth) = 12 mg/kg bw/day
— Selected TRV (Reproduction) = 27 mg/kg bw/day
— Selected TRV (Survival) = 8.7 mg/kg bw/day

····· 80% effect relative to control

ED20 for Allcroft et al. 1961 is 12 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−38. Dose−Response Data for the Mammalian Growth Endpoint for Copper, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Aulerich et al. 1982	mink	offspring survival	diet	20 weeks	copper sulfate	
🟩	Aulerich et al. 1982	mink	offspring growth	diet	20 weeks	copper sulfate	
🟪	Cromwell et al. 1993	pig	farrowing success	diet	2.1 years	copper sulfate	
🟦	Lecyk 1980	mouse	litter size (breed 1)	diet	7 weeks	copper sulfate	A
🟨	Lecyk 1980	mouse	litter size (breed 2)	diet	7 weeks	copper sulfate	A

☐ Tier 1

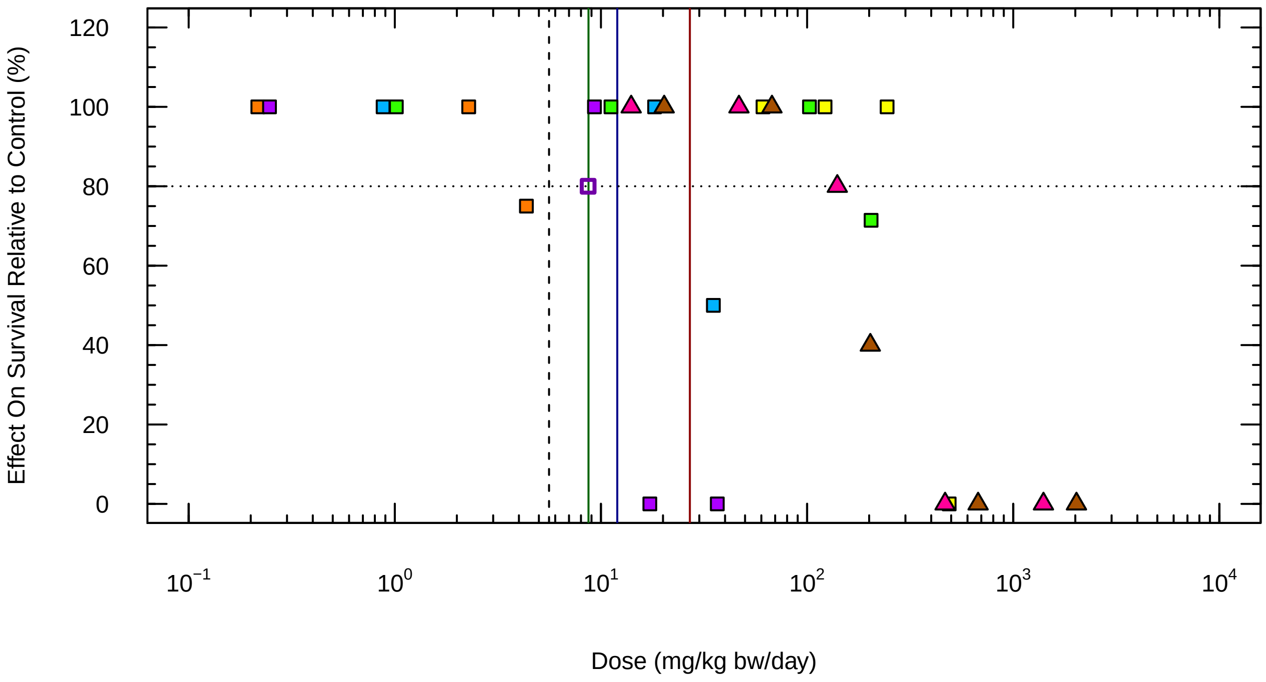
- - - Eco−SSL TRV = 5.6 mg/kg bw/day

— Selected TRV (Growth) = 12 mg/kg bw/day
— Selected TRV (Reproduction) = 27 mg/kg bw/day
— Selected TRV (Survival) = 8.7 mg/kg bw/day

····· 80% effect relative to control

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−39. Dose−Response Data for the Mammalian Reproduction Endpoint for Copper, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Ritchie et al. 1963	pig	survival	diet	15 weeks	copper sulfate	B
🟩	Keen et al. 1982	rat	survival	diet	6.71 weeks	copper sulfate	
🟪	Allcroft et al. 1961	pig	survival	diet	21 weeks	copper sulfate	B
🟦	Brandt 1983	mink	survival	diet	~12 weeks	copper sulfate	
🟨	Boyden et al. 1938	rat	survival	diet	4 weeks	copper sulfate	
▲	NTP 1993a	mouse	survival (male)	drinking water	2 weeks	copper sulfate	
▲	NTP 1993a	mouse	survival (female)	drinking water	2 weeks	copper sulfate	
□	Geomean for pooled dataset B	pig	survival	diet	15−21 weeks	copper sulfate	B

□ Tier 1 △ Tier 2

- - - Eco−SSL TRV = 5.6 mg/kg bw/day

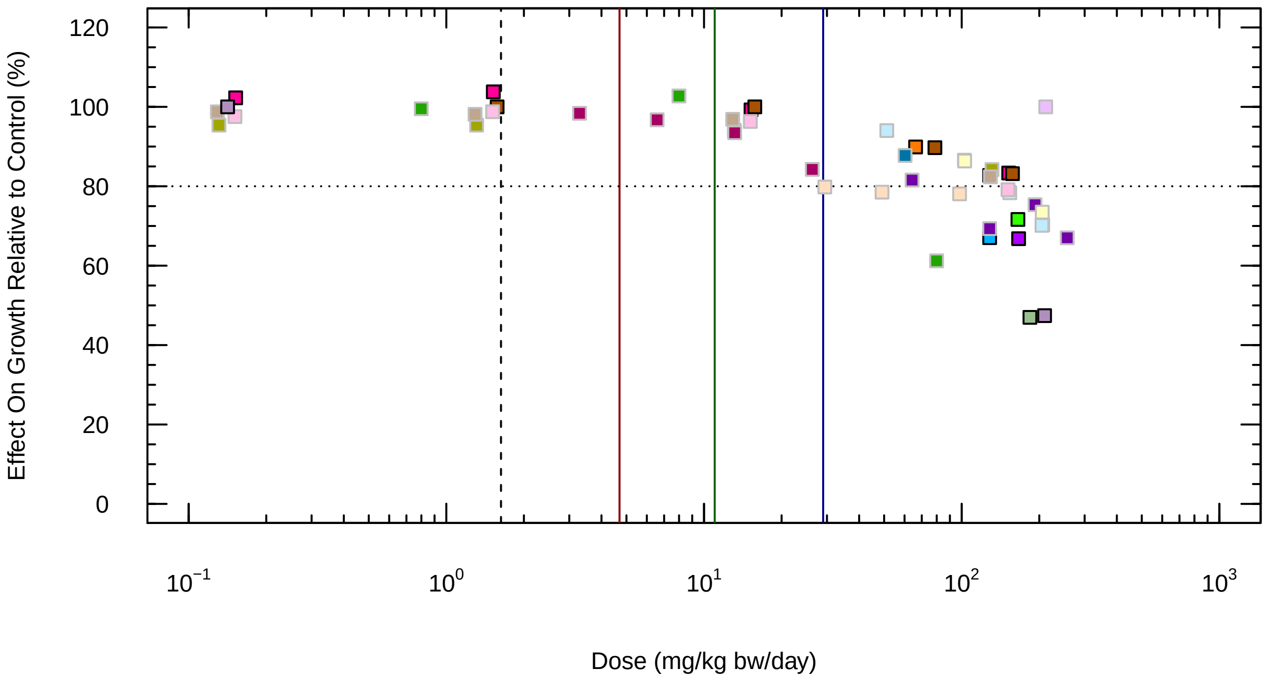
— Selected TRV (Growth) = 12 mg/kg bw/day
— Selected TRV (Reproduction) = 27 mg/kg bw/day
— Selected TRV (Survival) = 8.7 mg/kg bw/day

····· 80% effect relative to control

Geomean for pooled dataset B is 8.7 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−40. Dose−Response Data for the Mammalian Survival Endpoint for Copper, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Edens and Melvin 1989	Japanese quail	body weight (breed 2)	diet	21 weeks	lead acetate	
🟩	Donaldson 1986	chicken	body weight (Exp 1)	diet	2.9 weeks	lead acetate trihydrate	A
🟪	Donaldson 1986	chicken	body weight (Exp 2)	diet	2.9 weeks	lead acetate trihydrate	A
🟦	Latta and Donaldson 1986	chicken	body weight gain	diet	2.7 weeks	lead acetate	
🟨	Leeming and Donaldson 1984	chicken	body weight gain	diet	2.71 weeks	lead acetate trihydrate	
🟥	Morgan et al. 1975	Japanese quail	body weight (Trial 1)	diet	5 weeks	lead acetate	
🟫	Morgan et al. 1975	Japanese quail	body weight (Trial 2)	diet	5 weeks	lead acetate	
🟩	Damron et al. 1969	chicken	body weight	diet	4 weeks	lead acetate	
🟪	Donaldson and McGowan 1989	chicken	body weight	diet	2.9 weeks	lead acetate trihydrate	A
🟦	Edens and Melvin 1989	Japanese quail	body weight (breed 1)	diet	21 weeks	lead acetate	
🟨	Edens and Melvin 1989	Japanese quail	body weight (female)	diet	15 weeks	lead acetate	
🟥	Edens and Garlich 1983	chicken	body weight	diet	10 weeks	lead acetate	
🟧	Abduljaleel & Shuhaimi−Othman 2013	chicken	body weight	diet	4 weeks	lead nitrate	
🟩	Berg et al. 1980	chicken	body weight (Exp 1)	diet	2 weeks	lead carbonate	C
🟪	Berg et al. 1980	chicken	body weight (Exp 1)	diet	2 weeks	lead carbonate	C
🟦	Berg et al. 1980	chicken	body weight (Exp 2)	diet	2 weeks	lead carbonate	C
🟨	Berg et al. 1980	chicken	body weight (Exp 3)	diet	2 weeks	lead carbonate	C
🟥	Edens et al. 1976	Japanese quail	body weight	diet	12 weeks	lead acetate	B
🟫	Edens 1985	Japanese quail	body weight	diet	12 weeks	lead acetate	B
🟩	Cupo and Donaldson 1988	chicken	body weight	diet	3 weeks	lead acetate	C
🟪	Franson and Custer 1982	chicken	body weight	diet	4 weeks	lead acetate	C

☐ Tier 1

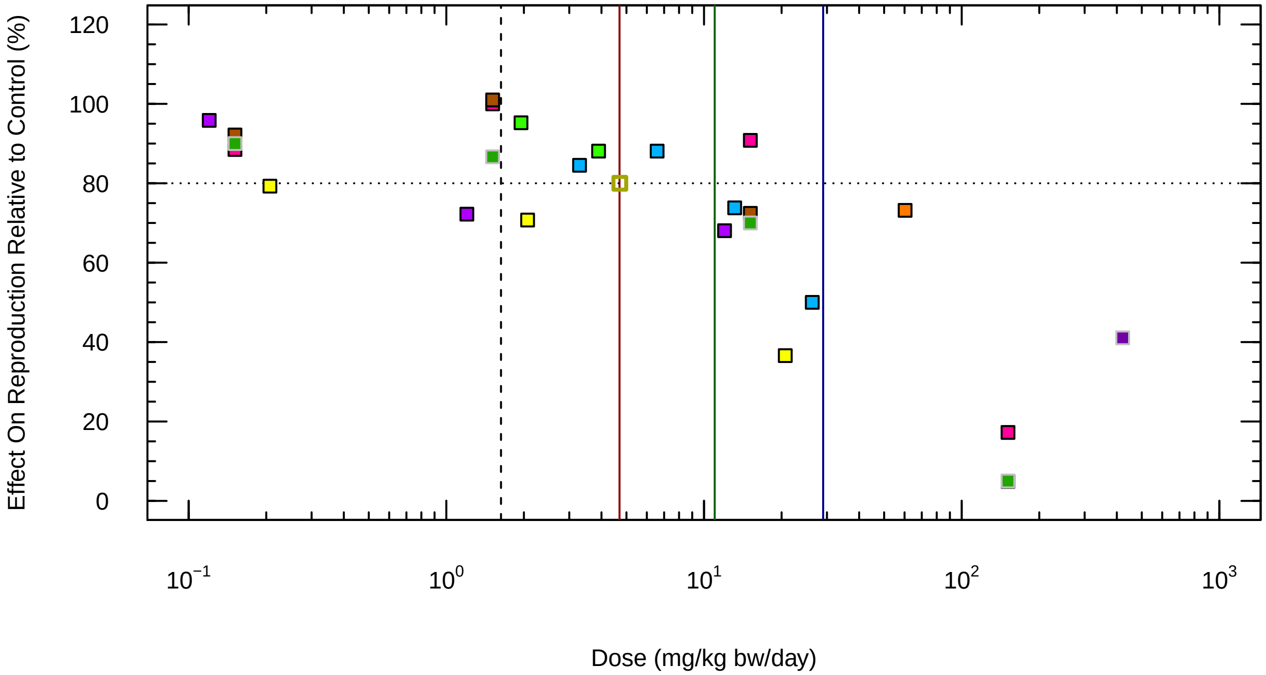
- - - Eco−SSL TRV = 1.63 mg/kg bw/day

— Selected TRV (Growth) = 29 mg/kg bw/day
— Selected TRV (Reproduction) = 4.7 mg/kg bw/day
— Selected TRV (Survival) = 11 mg/kg bw/day

····· 80% effect relative to control

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−41. Dose−Response Data for the Avian Growth Endpoint for Lead, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Edens and Melvin 1989	Japanese quail	egg production	diet	21 weeks	lead acetate	
🟩	Edens and Garlich 1983	chicken	egg production (Exp 1)	diet	4 weeks	lead acetate	
🟪	Edens and Garlich 1983	Japanese quail	egg production (Exp 2)	diet	5 weeks	lead acetate	D
🟦	Edens and Garlich 1983	chicken	egg production (Exp 3)	diet	10 weeks	lead acetate	
🟨	Edens and Garlich 1983	Japanese quail	egg production (Exp 4)	diet	5 weeks	lead acetate	D
🟥	Edens et al. 1976	Japanese quail	egg production	diet	12 weeks	lead acetate	E
🟫	Edens et al. 1976	Japanese quail	egg hatchability	diet	12 weeks	lead acetate	
🟩	Edens et al. 1976	Japanese quail	egg production	diet	12 weeks	lead acetate	E
🟪	Stone and Soares 1976	Japanese quail	egg production	diet	3.86 weeks	lead acetate	D
□	Geomean for pooled dataset D	Japanese quail	egg production	diet	3.9−5 weeks	lead acetate	D

□ Tier 1

- - - Eco−SSL TRV = 1.63 mg/kg bw/day

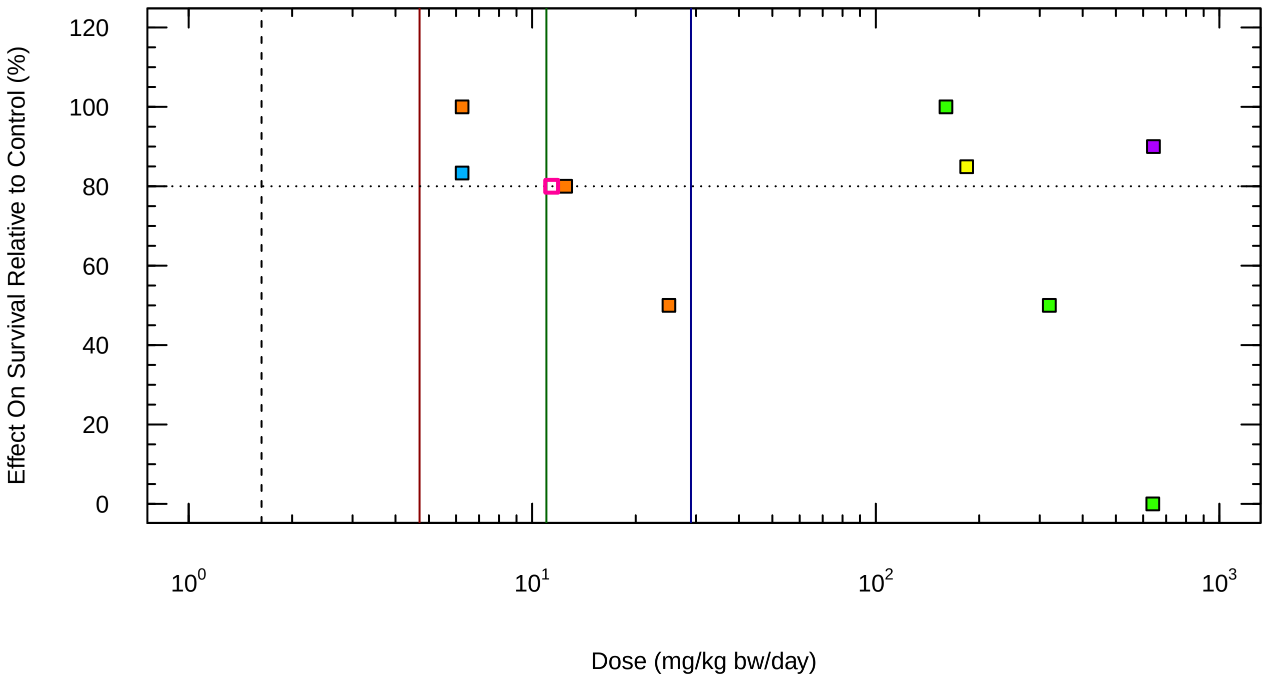
— Selected TRV (Growth) = 29 mg/kg bw/day
— Selected TRV (Reproduction) = 4.7 mg/kg bw/day
— Selected TRV (Survival) = 11 mg/kg bw/day

····· 80% effect relative to control

Geomean for pooled dataset D is 4.7 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−42. Dose−Response Data for the Avian Reproduction Endpoint for Lead, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Barthalmus et al. 1977	pigeon	survival	gavage	varied	lead acetate	F
🟩	Vengris and Mare 1974	chicken	survival	gavage	5 weeks	lead acetate	
🟪	Khan et al. 1993	chicken	survival	gavage	1 weeks	lead acetate	
🟦	Anders et al. 1982	pigeon	survival	gavage	5 weeks	lead acetate	F
🟨	Cupo and Donaldson 1988	chicken	survival	diet	3 weeks	lead acetate	
□	ED20 for pooled dataset F	pigeon	survival	gavage	varied	lead acetate	F

□ Tier 1

- - - Eco−SSL TRV = 1.63 mg/kg bw/day

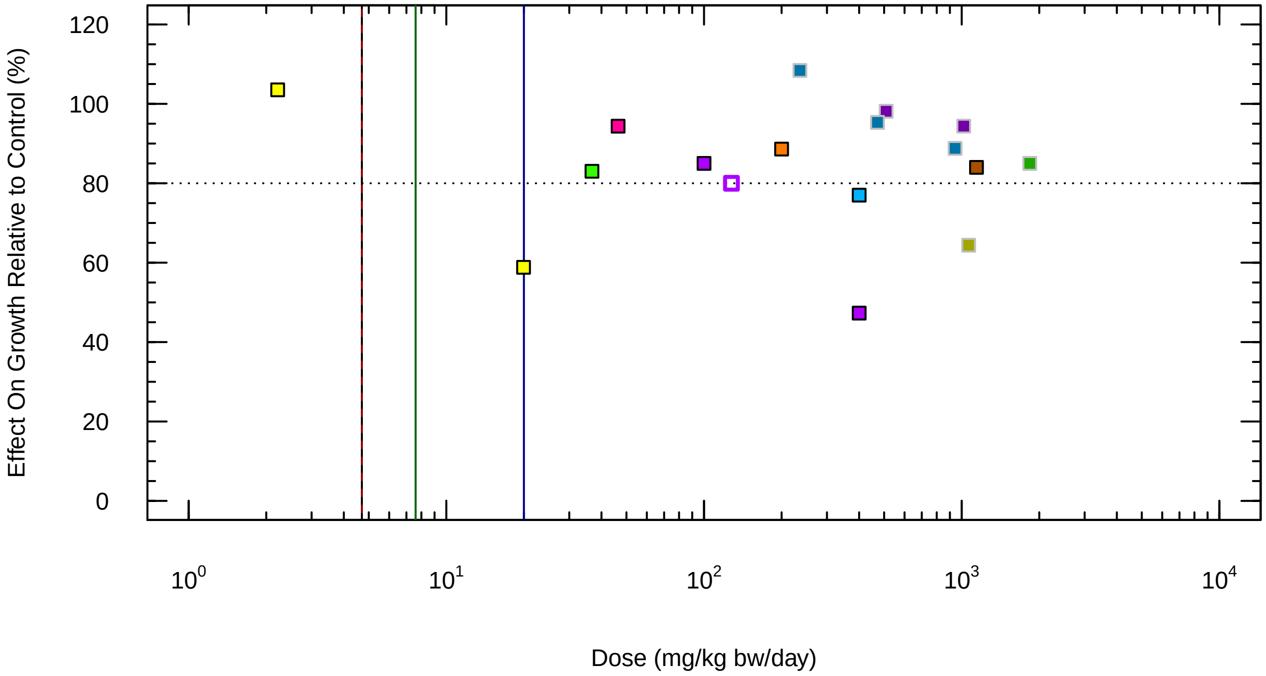
— Selected TRV (Growth) = 29 mg/kg bw/day
— Selected TRV (Reproduction) = 4.7 mg/kg bw/day
— Selected TRV (Survival) = 11 mg/kg bw/day

····· 80% effect relative to control

ED20 for pooled dataset F is 11 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−43. Dose−Response Data for the Avian Survival Endpoint for Lead, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Harry et al. 1985	rat	body weight	gavage	3.71 weeks	lead acetate	A
🟩	Hsu et al. 1975	pig	body weight	diet	13 weeks	lead acetate	
🟪	Kumar and Desiraju 1990	rat	body weight	gavage	8.43 weeks	lead acetate	
🟦	Toews et al. 1983	rat	body weight	gavage	4 weeks	lead acetate	A
🟨	Lorenzo et al. 1978	rabbit	% weight gain	gavage	4.29 weeks	lead nitrate	
🟥	Al−Omar et al. 2000	mouse	body weight gain	gavage	5 weeks	lead oxide	
🟫	Barlow et al. 1977	rat	maternal body weight	diet	3 weeks	lead acetate	
🟩	Maker et al. 1973	mouse	body weight	diet	4.29 weeks	lead carbonate	
🟪	Mykkanen et al. 1980	rat	weight gain	diet	3 weeks	lead acetate	
🟦	Mykkanen et al. 1980	rat	weight gain	diet	3 weeks	lead acetate	
🟨	Gerber et al. 1978	rat	body weight	diet	52 weeks	lead acetate	
☐	ED20 for Kumar and Desiraju 1990	rat	body weight	gavage	8.43 weeks	lead acetate	

☐ Tier 1

- - - Eco−SSL TRV = 4.7 mg/kg bw/day

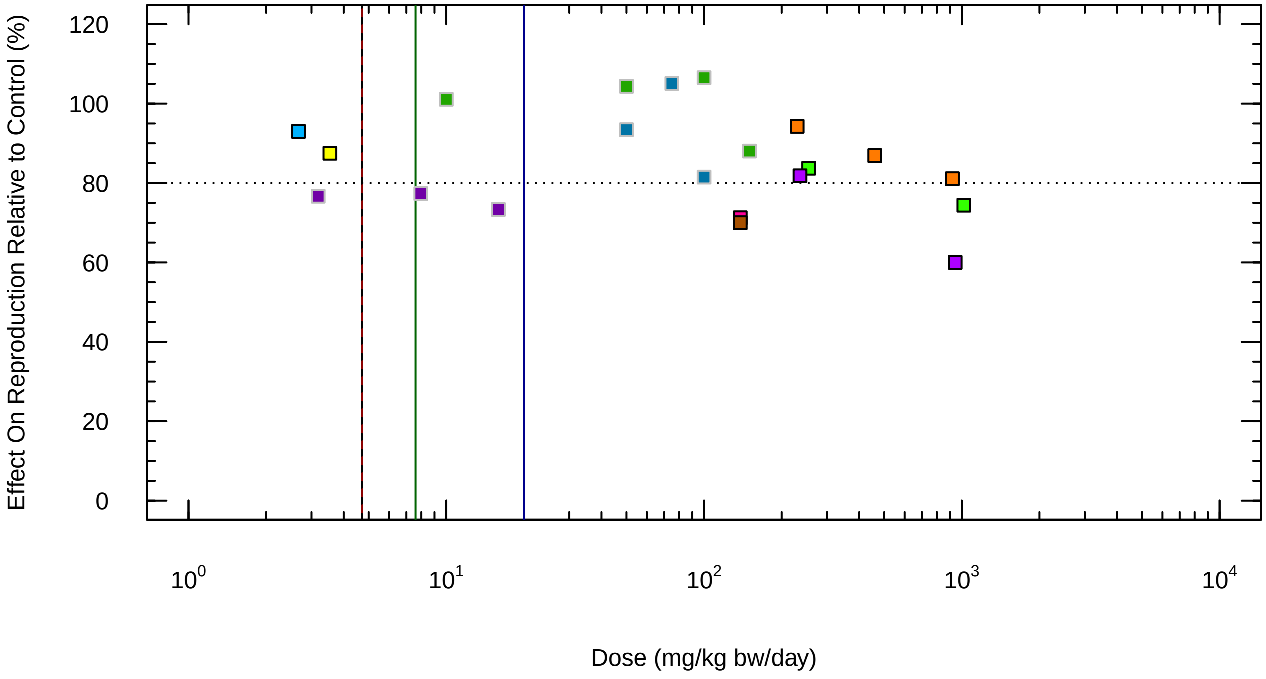
— Selected TRV (Growth) = 20 mg/kg bw/day
— Selected TRV (Reproduction) = 4.7 mg/kg bw/day
— Selected TRV (Survival) = 7.6 mg/kg bw/day

····· 80% effect relative to control

ED20 for Kumar and Desiraju 1990 is 130 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−44. Dose−Response Data for the Mammalian Growth Endpoint for Lead, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Jacquet et al. 1977	mouse	embryo weight	diet	2.57 weeks	not specified	
🟩	Mykkanen et al. 1980	rat	pup weight (breed 1)	diet	3 weeks	lead acetate	B
🟪	Mykkanen et al. 1980	rat	pup weight (breed 2)	diet	3 weeks	lead acetate	B
🟦	Schroeder and Mitchener 1971	rat	offspring survival	diet and drinking water	3 generations	soluble lead	
🟨	Schroeder and Mitchener 1971	mouse	offspring survival	diet and drinking water	3 generations	soluble lead	
🟥	Winneke et al. 1977	rat	litter size	diet	18.6 weeks	lead acetate	
🟫	Winneke et al. 1977	rat	pregnancy success	diet	18.6 weeks	lead acetate	
🟩	Wardell et al. 1982	rat	fetal mortality (resorptions)	gavage	1.86 weeks	lead acetate	
🟪	Gupta et al. 1995	mouse	living embryos per mother	gavage	4 weeks	lead acetate	
🟦	Miller et al. 1982	rat	embryo weight	gavage	5.86 weeks	lead acetate	

☐ Tier 1

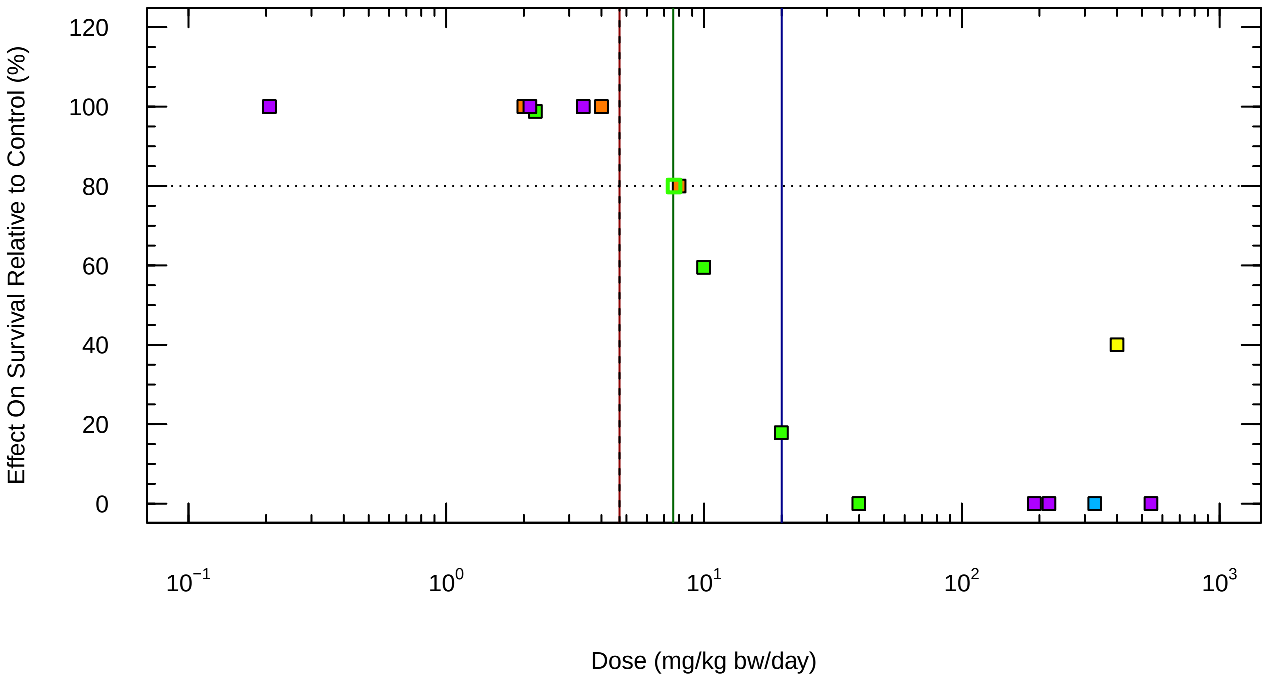
- - - Eco−SSL TRV = 4.7 mg/kg bw/day

— Selected TRV (Growth) = 20 mg/kg bw/day
— Selected TRV (Reproduction) = 4.7 mg/kg bw/day
— Selected TRV (Survival) = 7.6 mg/kg bw/day

····· 80% effect relative to control

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−45. Dose−Response Data for the Mammalian Reproduction Endpoint for Lead, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Junaid et al. 1997	mouse	survival	gavage	8.57 weeks	lead acetate	
🟩	Lorenzo et al. 1978	rabbit	survival	gavage	4.29 weeks	lead nitrate	
🟪	Pankakoski et al. 1994	shrew	survival	diet	0.6 weeks	lead in earthworm prey	
🟦	Press 1977	rat	survival	gavage	2.14 weeks	lead acetate	
🟨	Kumar and Desiraju 1990	rat	survival	gavage	8.43 weeks	lead acetate	
☐	ED20 for Lorenzo et al. 1978	rabbit	survival	gavage	4.29 weeks	lead nitrate	

☐ Tier 1

- - - Eco−SSL TRV = 4.7 mg/kg bw/day

— Selected TRV (Growth) = 20 mg/kg bw/day
— Selected TRV (Reproduction) = 4.7 mg/kg bw/day
— Selected TRV (Survival) = 7.6 mg/kg bw/day

····· 80% effect relative to control

ED20 for Lorenzo et al. 1978 is 7.6 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−46. Dose−Response Data for the Mammalian Survival Endpoint for Lead, Log−Transformed

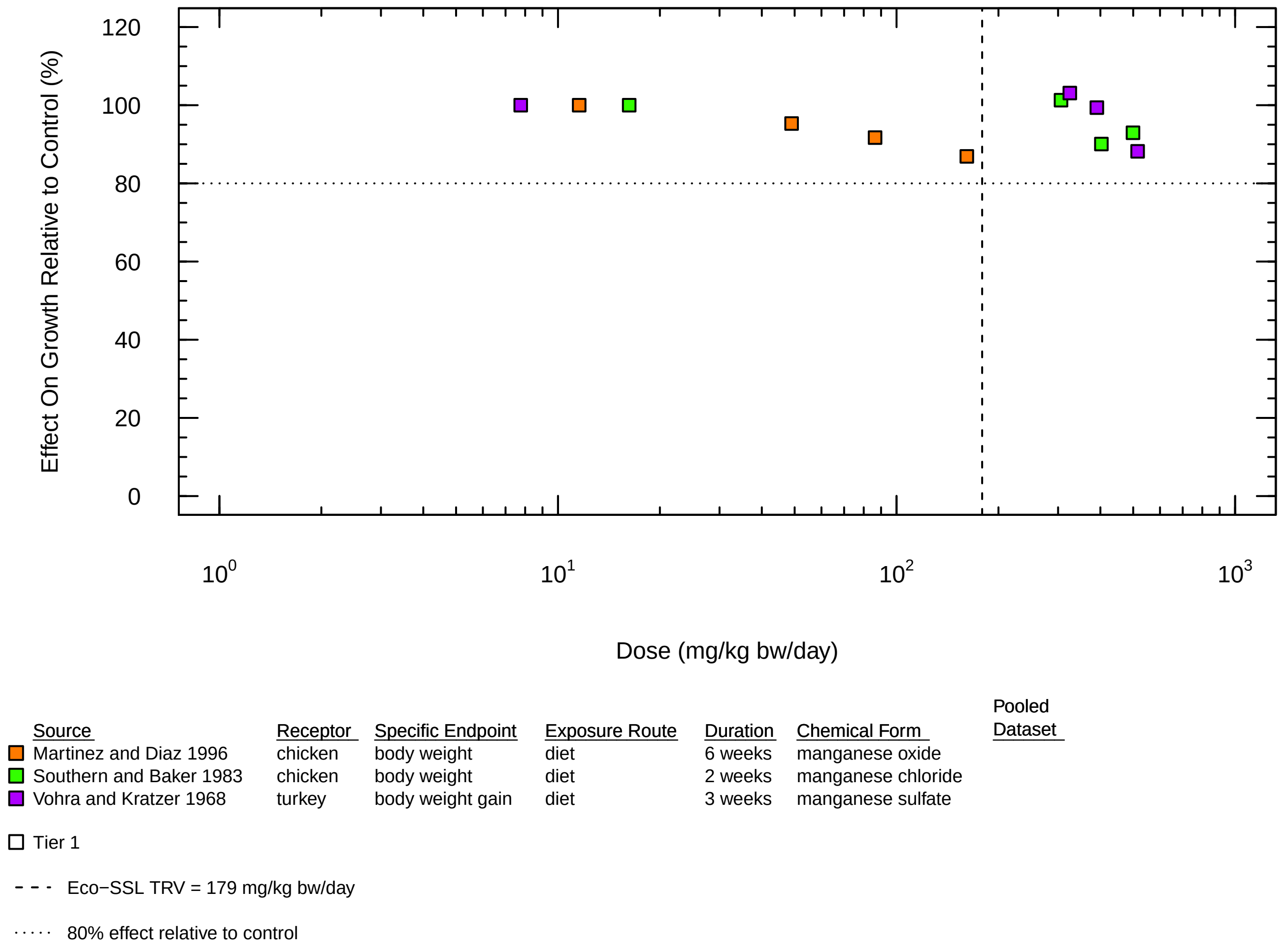
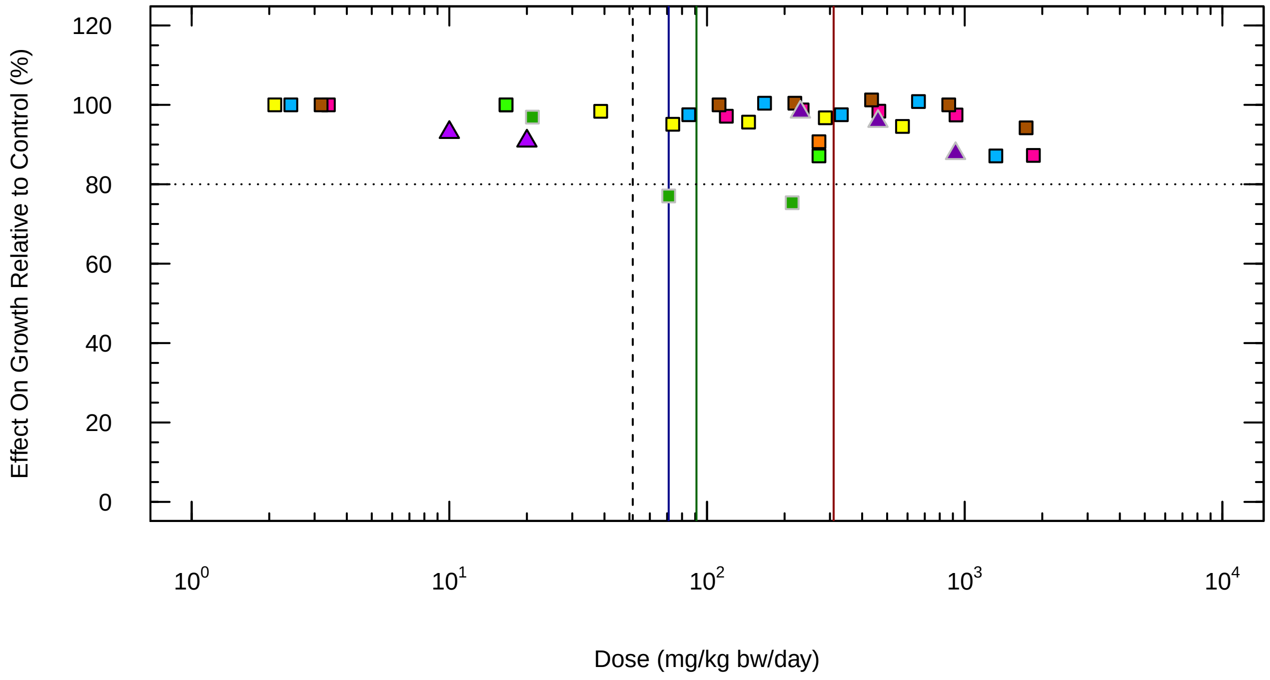


Figure 4−47. Dose−Response Data for the Avian Growth Endpoint for Manganese, Log−Transformed



Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧 Komura and Sakomoto 1991	mouse	body weight	diet	12.9 weeks	manganese acetate	
🟩 Komura and Sakomoto 1991	mouse	body weight	diet	12.9 weeks	manganese chloride	
▲ Lipe et a. 1999	rat	body weight	gavage	4.29 weeks	manganese chloride	
🟦 NTP 1993b	rat	body weight (male)	diet	2 weeks	manganese sulfate	
🟨 NTP 1993b	rat	body weight (female)	diet	13 weeks	manganese sulfate	
🟥 NTP 1993b	mouse	body weight (male)	diet	13 weeks	manganese sulfate	
🟫 NTP 1993b	mouse	body weight (female)	diet	13 weeks	manganese sulfate	
🟩 Rehnberg et al. 1980	rat	body weight	gavage	2.86 weeks	manganese oxide	
▲ Kontur and Fechter 1985	rat	body weight	drinking water	3 weeks	manganese chloride	

☐ Tier 1 △ Tier 2

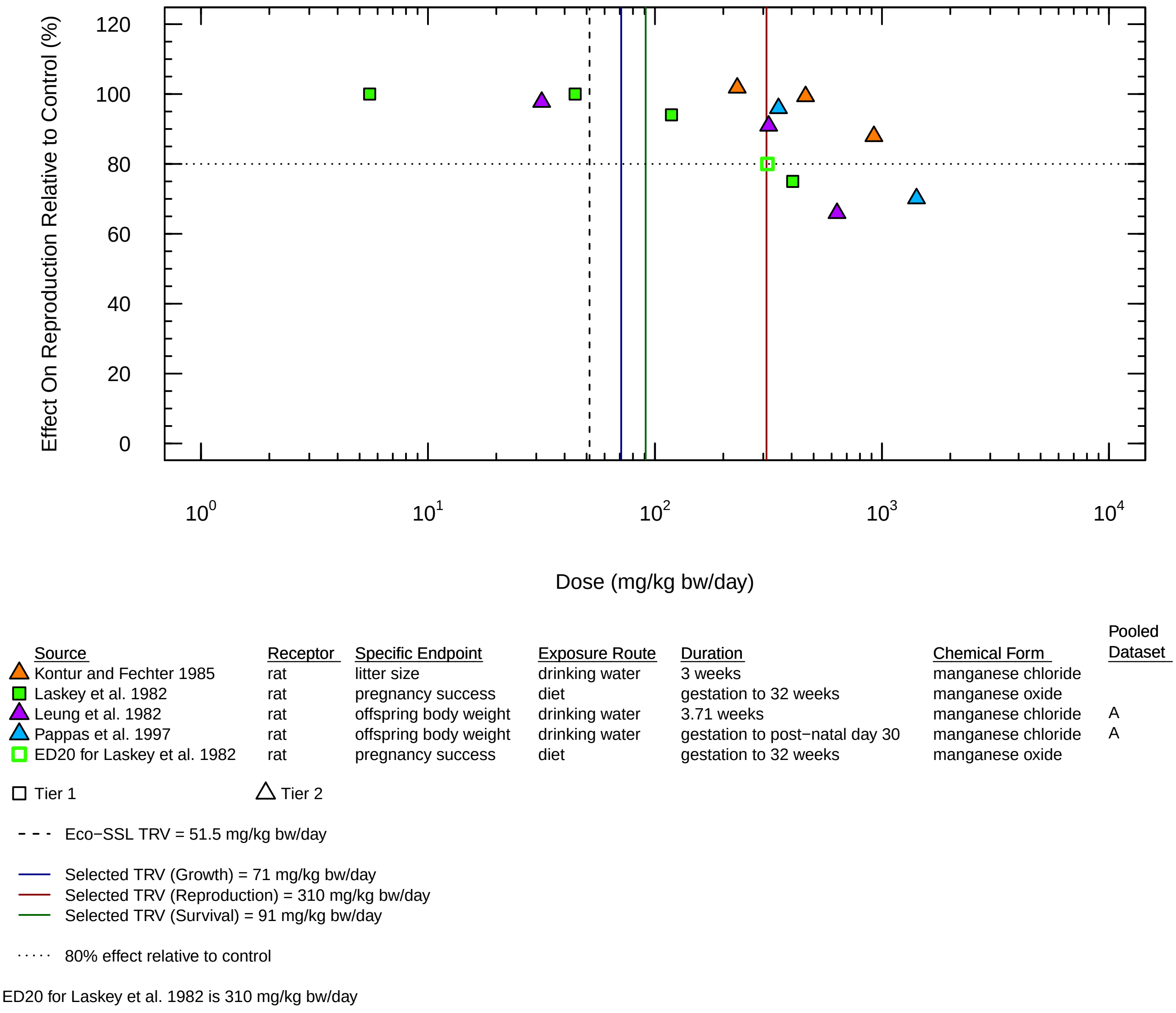
- - - Eco−SSL TRV = 51.5 mg/kg bw/day

— Selected TRV (Growth) = 71 mg/kg bw/day
— Selected TRV (Reproduction) = 310 mg/kg bw/day
— Selected TRV (Survival) = 91 mg/kg bw/day

····· 80% effect relative to control

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−48. Dose−Response Data for the Mammalian Growth Endpoint for Manganese, Log−Transformed



Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
▲ Kontur and Fechter 1985	rat	litter size	drinking water	3 weeks	manganese chloride	
■ Laskey et al. 1982	rat	pregnancy success	diet	gestation to 32 weeks	manganese oxide	
▲ Leung et al. 1982	rat	offspring body weight	drinking water	3.71 weeks	manganese chloride	A
▲ Pappas et al. 1997	rat	offspring body weight	drinking water	gestation to post−natal day 30	manganese chloride	A
□ ED20 for Laskey et al. 1982	rat	pregnancy success	diet	gestation to 32 weeks	manganese oxide	

□ Tier 1 △ Tier 2

- - - Eco−SSL TRV = 51.5 mg/kg bw/day

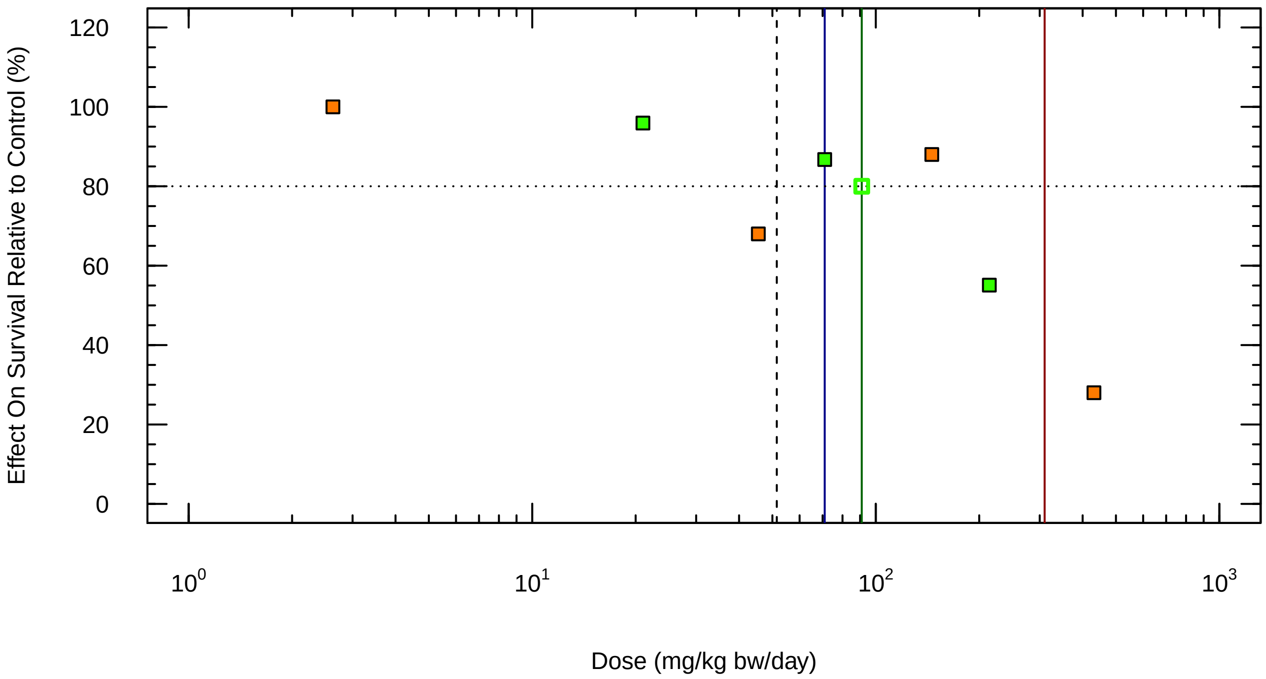
Selected TRV (Growth) = 71 mg/kg bw/day
Selected TRV (Reproduction) = 310 mg/kg bw/day
Selected TRV (Survival) = 91 mg/kg bw/day

····· 80% effect relative to control

ED20 for Laskey et al. 1982 is 310 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−49. Dose−Response Data for the Mammalian Reproduction Endpoint for Manganese, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	NTP 1993b	rat	suvival (male)	diet	2 years	manganese sulfate	
🟩	Rehnberg et al. 1980	rat	survival	gavage	2.86 weeks	manganese oxide	
☐	ED20 for Rehnberg et al. 1980	rat	survival	gavage	2.86 weeks	manganese oxide	

☐ Tier 1

- - - Eco−SSL TRV = 51.5 mg/kg bw/day

— Selected TRV (Growth) = 71 mg/kg bw/day
— Selected TRV (Reproduction) = 310 mg/kg bw/day
— Selected TRV (Survival) = 91 mg/kg bw/day

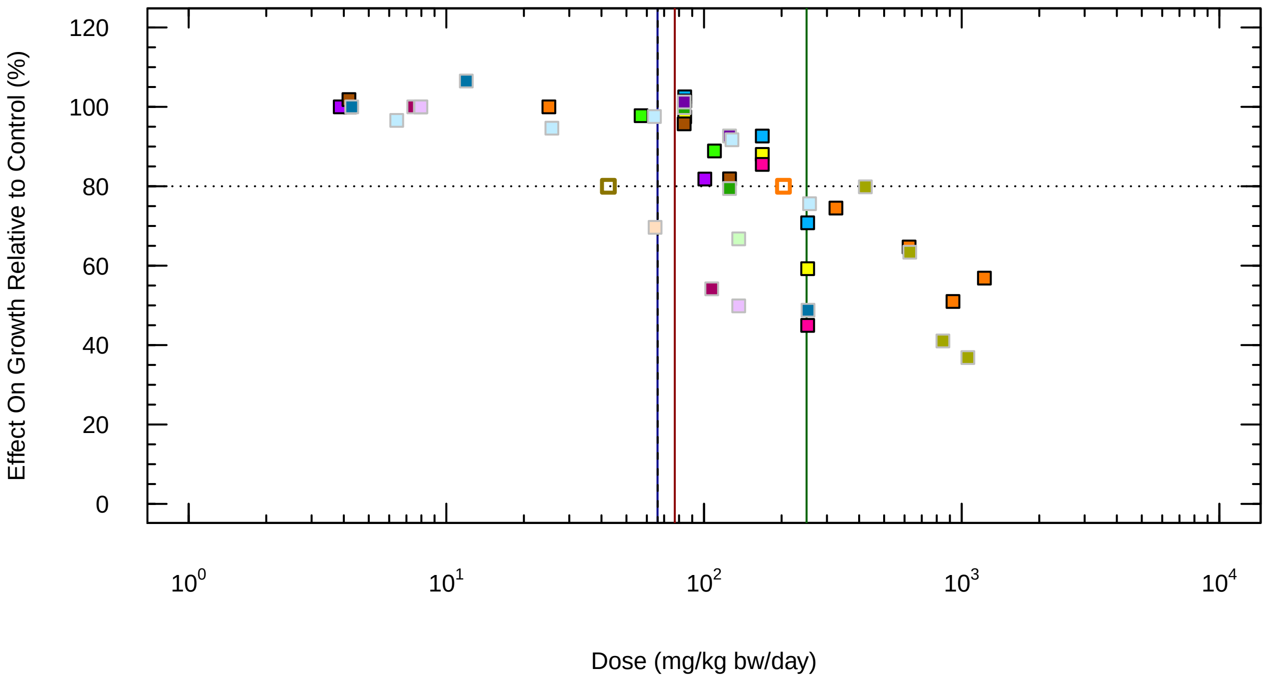
····· 80% effect relative to control

ED20 for Rehnberg et al. 1980 is 91 mg/kg bw/day

* Survival at this dose was not significantly different from the control

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−50. Dose−Response Data for the Mammalian Survival Endpoint for Manganese, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Gasaway and Buss 1972	mallard	body weight gain	diet	5.71 weeks	zinc carbonate	
🟩	Hamilton et al. 1981	Japanese quail	body weight (Exp 2)	diet	2 weeks	zinc carbonate	
🟪	Hamilton et al. 1981	Japanese quail	body weight (Exp 5)	diet	2 weeks	zinc carbonate	
🟦	Roberson and Schaible 1960	chicken	body weight (Exp 2)	diet	4 weeks	zinc oxide	D
🟨	Roberson and Schaible 1960	chicken	body weight (Exp 2)	diet	4 weeks	zinc sulfate	C
🟥	Roberson and Schaible 1960	chicken	body weight (Exp 2)	diet	4 weeks	zinc carbonate	B
🟫	Roberson and Schaible 1960	chicken	body weight (Exp 3)	diet	4 weeks	zinc sulfate	C
🟩	Roberson and Schaible 1960	chicken	body weight (Exp 3)	diet	4 weeks	zinc carbonate	B
🟪	Roberson and Schaible 1960	chicken	body weight (Exp 3)	diet	4 weeks	zinc oxide	D
🟦	Stahl et al. 1989	chicken	body weight gain	diet	3 weeks	zinc carbonate	
🟨	Vohra and Kratzer 1968	turkey	body weight gain	diet	3 weeks	zinc oxide	
🟥	Lu and Combs 1988	chicken	body weight gain (Exp 3)	diet	3 weeks	zinc oxide	A
🟧	Lu et al. 1990	chicken	body weight gain (Exp 1)	diet	1 weeks	zinc oxide	A
🟩	Sandoval et al. 1988	chicken	body weight gain (Exp 2)	diet	3 weeks	zinc sulfate	E
🟪	Sandoval et al. 1988	chicken	body weight gain (Exp 2)	diet	3 weeks	zinc gluconate	
🟦	Hill 1974a	chicken	body weight gain	diet	2 weeks	zinc sulfate	E
☐	ED20 for Gasaway and Buss 1972	mallard	body weight gain	diet	5.71 weeks	zinc carbonate	
☐	ED20 for pooled dataset A	chicken	body weight gain	diet	1−3 weeks	zinc oxide	A

☐ Tier 1

– – – Eco−SSL TRV = 66.1 mg/kg bw/day

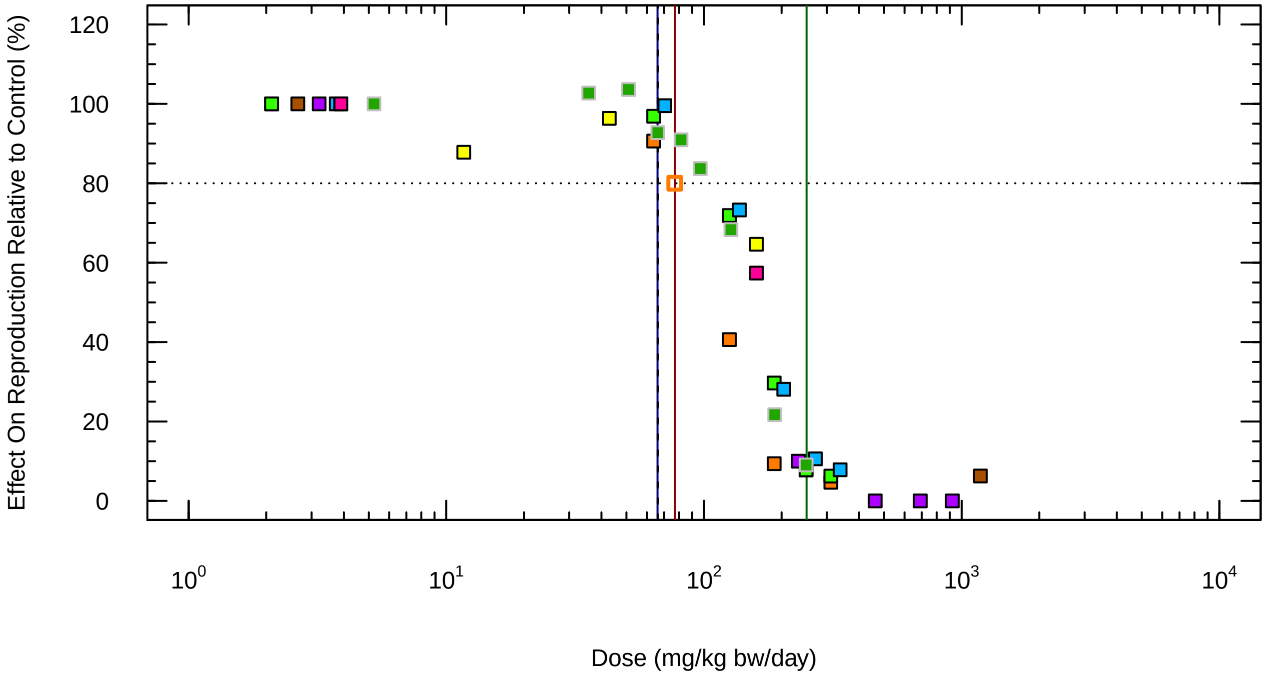
— Selected TRV (Growth) = 66 mg/kg bw/day
— Selected TRV (Reproduction) = 77 mg/kg bw/day
— Selected TRV (Survival) = 250 mg/kg bw/day

····· 80% effect relative to control

ED20 for Gasaway and Buss 1972 is 200 mg/kg bw/day
ED20 for pooled dataset A is 43 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−51. Dose−Response Data for the Avian Growth Endpoint for Zinc, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Gibson et al. 1986	chicken	egg production	diet	10 weeks	zinc acetate dihydrate	
🟩	Gibson et al. 1986	chicken	egg production	diet	10 weeks	zinc oxide	
🟪	Jackson et al. 1986	chicken	egg production	diet	3 weeks	zinc oxide	
🟦	Jackson et al. 1986	chicken	egg production	diet	20 weeks	zinc oxide	F
🟨	Jensen and Maurice 1980	chicken	egg production (Exp 4)	diet	6 weeks	zinc sulfate	G
🟥	Jensen and Maurice 1980	chicken	egg production (Exp 3)	diet	6 weeks	zinc sulfate	G
🟫	Stepinska et al. 1987	chicken	egg production	diet	0.714 weeks	zinc oxide	
🟩	Stevenson et al. 1987	chicken	egg production	diet	20 weeks	zinc oxide	F
☐	ED20 for Gibson et al. 1986	chicken	egg production	diet	10 weeks	zinc acetate dihydrate	

☐ Tier 1

- - - Eco−SSL TRV = 66.1 mg/kg bw/day

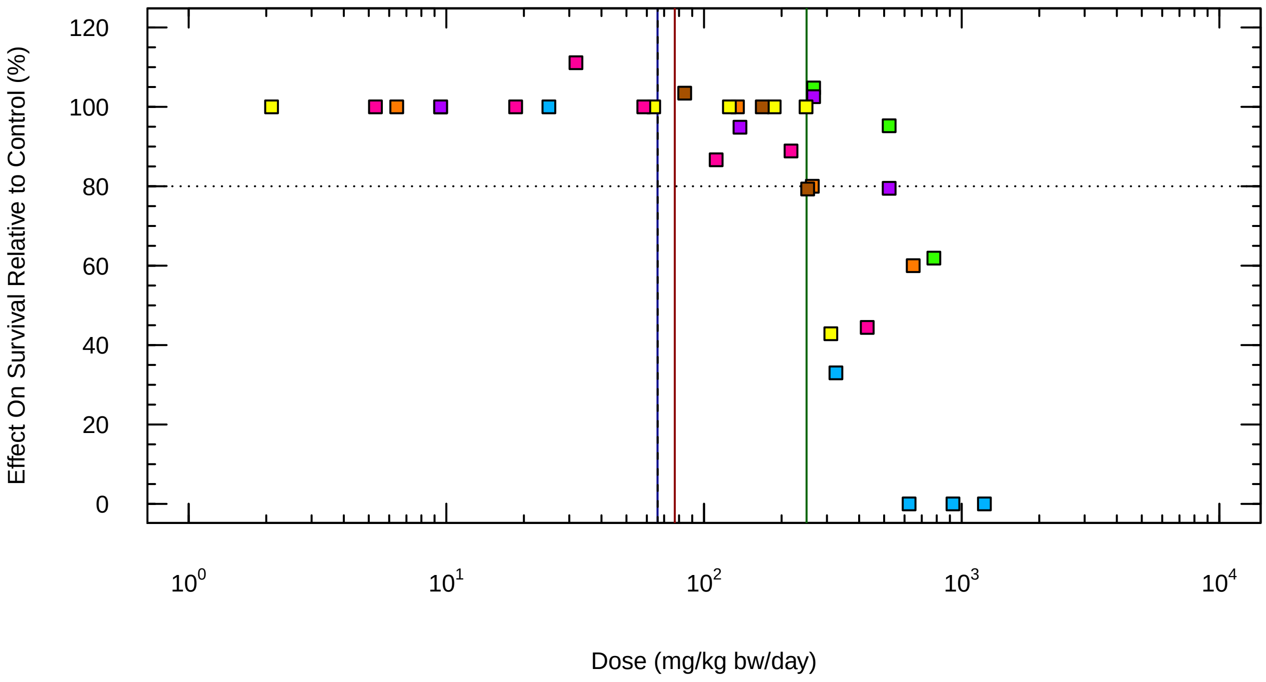
—— Selected TRV (Growth) = 66 mg/kg bw/day
—— Selected TRV (Reproduction) = 77 mg/kg bw/day
—— Selected TRV (Survival) = 250 mg/kg bw/day

····· 80% effect relative to control

ED20 for Gibson et al. 1986 is 77 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−52. Dose−Response Data for the Avian Reproduction Endpoint for Zinc, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Blalock and Hill 1988	chicken	survival	diet	2 weeks	zinc oxide	H
🟩	Dewar et al. 1983	chicken	survival (Exp 1)	diet	4 weeks	zinc oxide	
🟪	Dewar et al. 1983	chicken	survival (Exp 2)	diet	4 weeks	zinc oxide	H
🟦	Gasaway and Buss 1972	mallard	survival	diet	8.57 weeks	zinc carbonate	
🟨	Gibson et al. 1986	chicken	survival	diet	10 weeks	zinc acetate	
🟥	Hamilton et al. 1979	Japanese quail	survival	diet	2 weeks	zinc carbonate	
🟫	Roberson and Schaible 1960	chicken	survival (Exp 2)	diet	4 weeks	zinc carbonate	

☐ Tier 1

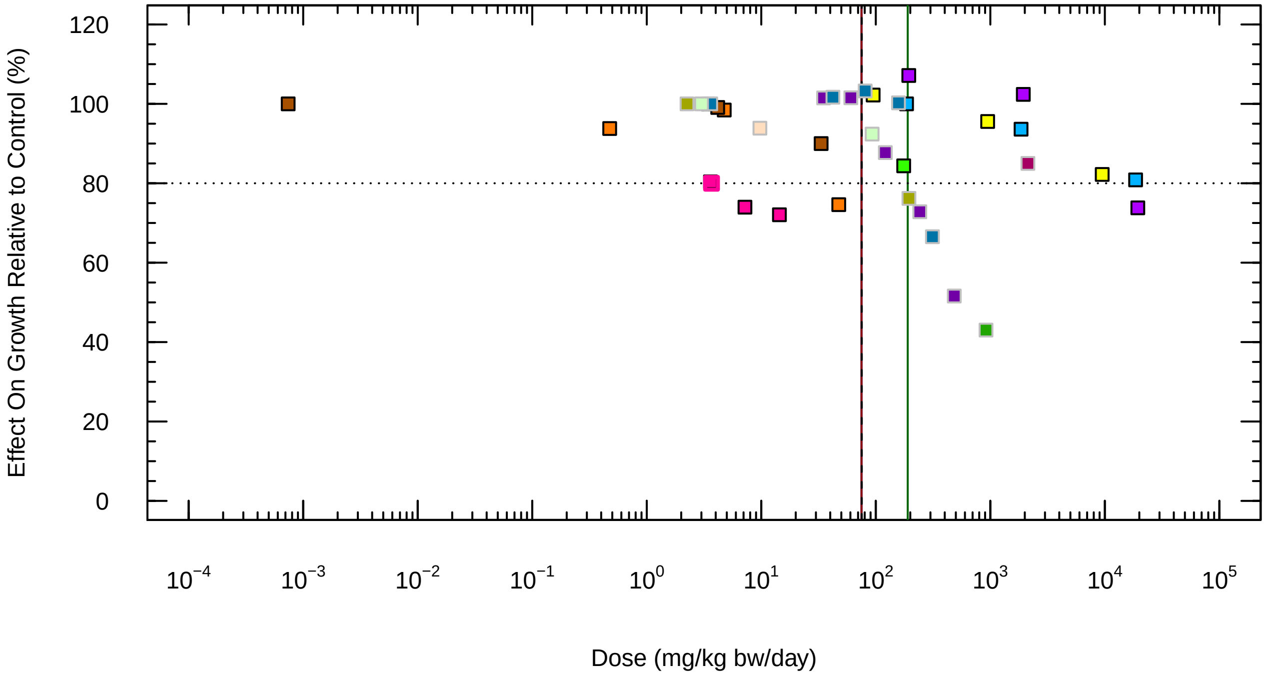
- - - Eco−SSL TRV = 66.1 mg/kg bw/day

— Selected TRV (Growth) = 66 mg/kg bw/day
— Selected TRV (Reproduction) = 77 mg/kg bw/day
— Selected TRV (Survival) = 250 mg/kg bw/day

····· 80% effect relative to control

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−53. Dose−Response Data for the Avian Survival Endpoint for Zinc, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
■	Hill et al. 1983	pig	body weight	diet	to 18 months old	zinc oxide	
■	Hsu et al. 1975	pig	body weight	diet	9−13 weeks	zinc oxide	
■	Maita et al. 1981	mouse	body weight (female)	diet	13 weeks	zinc sulfate	
■	Maita et al. 1981	mouse	body weight (male)	diet	13 weeks	zinc sulfate	
■	Maita et al. 1981	rat	body weight (male)	diet	13 weeks	zinc sulfate	
■	Khan et al. 2007	rat	male body weight	gavage	14 weeks	zinc chloride	
■	Subramanian et al. 2000	rat	body weight	diet	6 weeks	zinc oxide	
■	Settlemire and Matrone 1967	rat	body weight gain	diet	5 weeks	zinc carbonate	
■	Brink et al. 1959	pig	body weight (Exp 1)	diet	6 weeks	not specified	A
■	Brink et al. 1959	pig	body weight (Exp 2)	diet	5 weeks	not specified	A
■	Brink et al. 1959	pig	body weight (Exp 3)	diet	6 weeks	not specified	A
■	Petterson et al. 2002	mouse	body weight	diet	3 weeks	zinc chloride	
■	Nakamura et al. 1983	rat	body weight	diet	11 weeks	zinc acetate	
■	Barone et al. 1998	rat	body weight	diet	gestation	not specified	
□	ED20 for Khan et al. 2007	rat	male body weight	gavage	14 weeks	zinc chloride	

□ Tier 1

- - - Eco−SSL TRV = 75.4 mg/kg bw/day

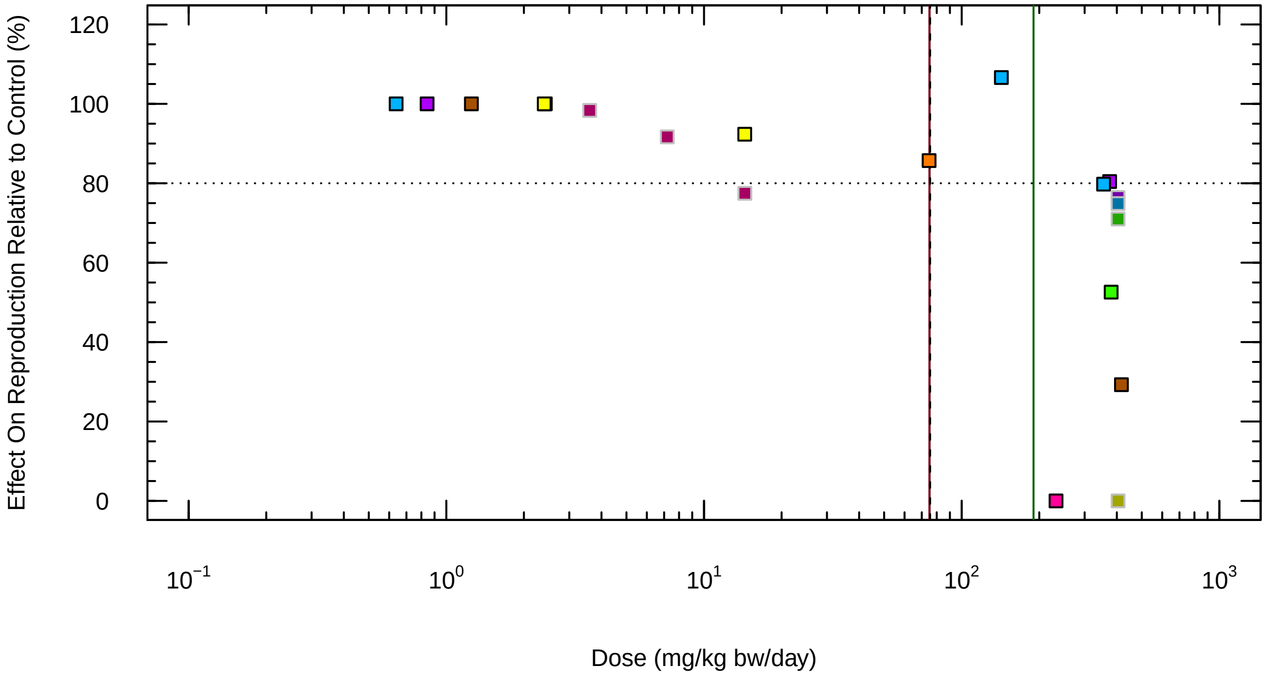
— Selected TRV (Growth) = 75 mg/kg bw/day
— Selected TRV (Reproduction) = 75 mg/kg bw/day
— Selected TRV (Survival) = 190 mg/kg bw/day

····· 80% effect relative to control

ED20 for Khan et al. 2007 is 3.7 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−54. Dose−Response Data for the Mammalian Growth Endpoint for Zinc, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Barone et al. 1998	rat	litter size	diet	gestation	not specified	
🟩	Chu and Cox 1972	rat	offspring growth	diet	3 weeks	not specified	
🟪	Cox et al. 1969	rat	fetal growth	diet	3.14 weeks	zinc oxide	B
🟦	Ketcheson et al. 1969	rat	offspring growth	diet	gestation to 14 days lactation	zinc oxide	
🟨	Kumar 1976	rat	fetal survival	diet	2.57 weeks	zinc sulfate	
🟥	Newman et al. 2002	rat	offspring survival	diet	gestation to post−natal day 40	zinc acetate dihydrate	
🟫	Pal and Pal 1987	rat	normal fetuses	diet	2.57 weeks	zinc sulfate	
🟩	Schlicker and Cox 1968	rat	fetal survival	diet	2.14 weeks	zinc oxide	C
🟪	Schlicker and Cox 1968	rat	fetal growth	diet	2.14 weeks	zinc oxide	B
🟦	Schlicker and Cox 1968	rat	fetal growth	diet	2.57 weeks	zinc oxide	B
🟨	Schlicker and Cox 1968	rat	fetal survival	diet	5.14 weeks	zinc oxide	C
🟥	Khan et al. 2007	rat	offspring survival	gavage	20 weeks	zinc chloride	

☐ Tier 1

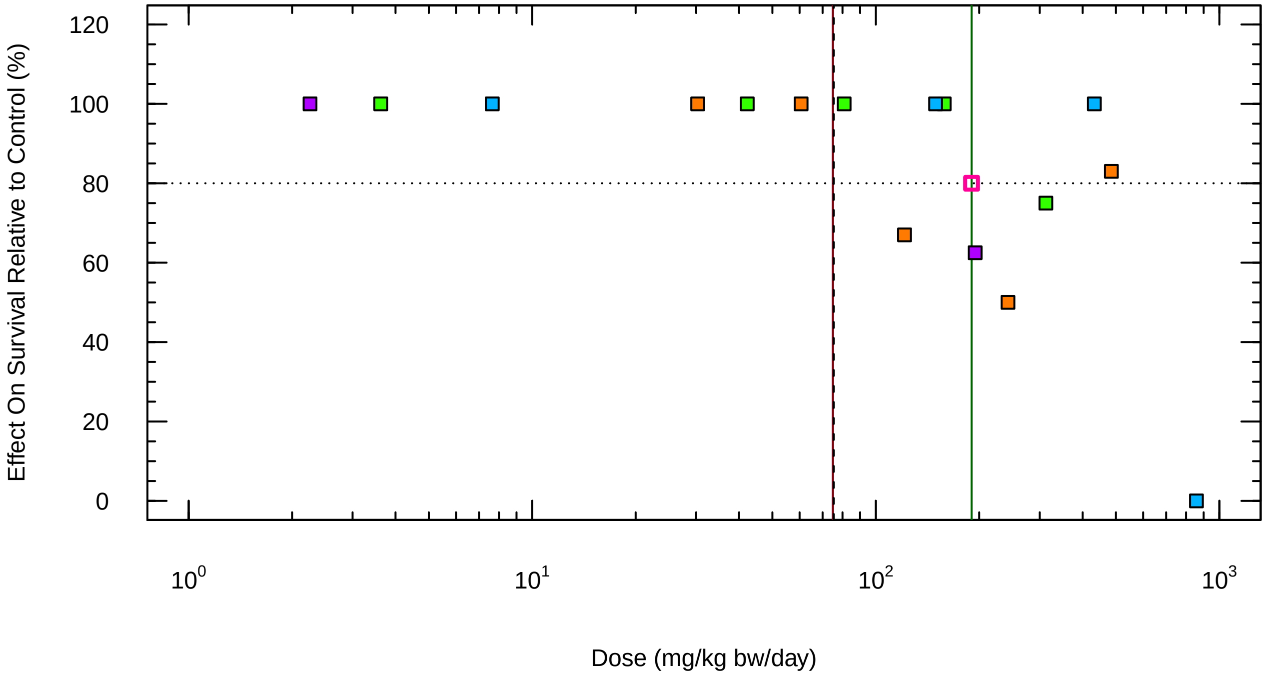
- - - Eco−SSL TRV = 75.4 mg/kg bw/day

— Selected TRV (Growth) = 75 mg/kg bw/day
— Selected TRV (Reproduction) = 75 mg/kg bw/day
— Selected TRV (Survival) = 190 mg/kg bw/day

····· 80% effect relative to control

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure 4−55. Dose−Response Data for the Mammalian Reproduction Endpoint for Zinc, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Brink et al. 1959	pig	survival (Exp 1)	diet	6 weeks	zinc carbonate	D
🟩	Brink et al. 1959	pig	survival (Exp 2)	diet	5 weeks	zinc carbonate	D
🟪	Brink et al. 1959	pig	survival (Exp 3)	diet	6 weeks	zinc carbonate	D
🟦	Straube et al. 1980	ferret	survival	diet	2−24 weeks	zinc oxide	
☐	Geomean for pooled dataset D	pig	survival	diet	5−6 weeks	zinc carbonate	D

☐ Tier 1

- - - Eco−SSL TRV = 75.4 mg/kg bw/day

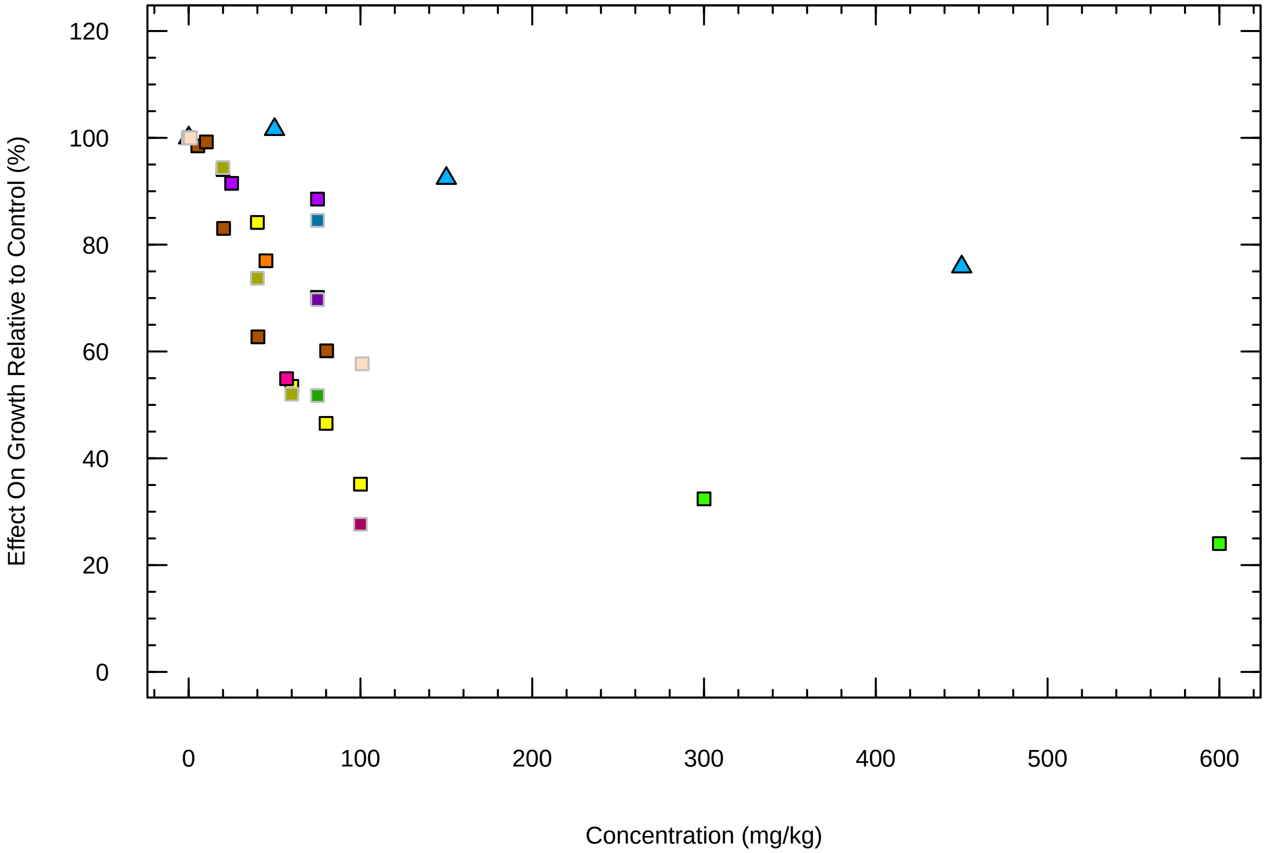
— Selected TRV (Growth) = 75 mg/kg bw/day
— Selected TRV (Reproduction) = 75 mg/kg bw/day
— Selected TRV (Survival) = 190 mg/kg bw/day

····· 80% effect relative to control

Geomean for pooled dataset D is 190 mg/kg bw/day

Note: All selected TRVs for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

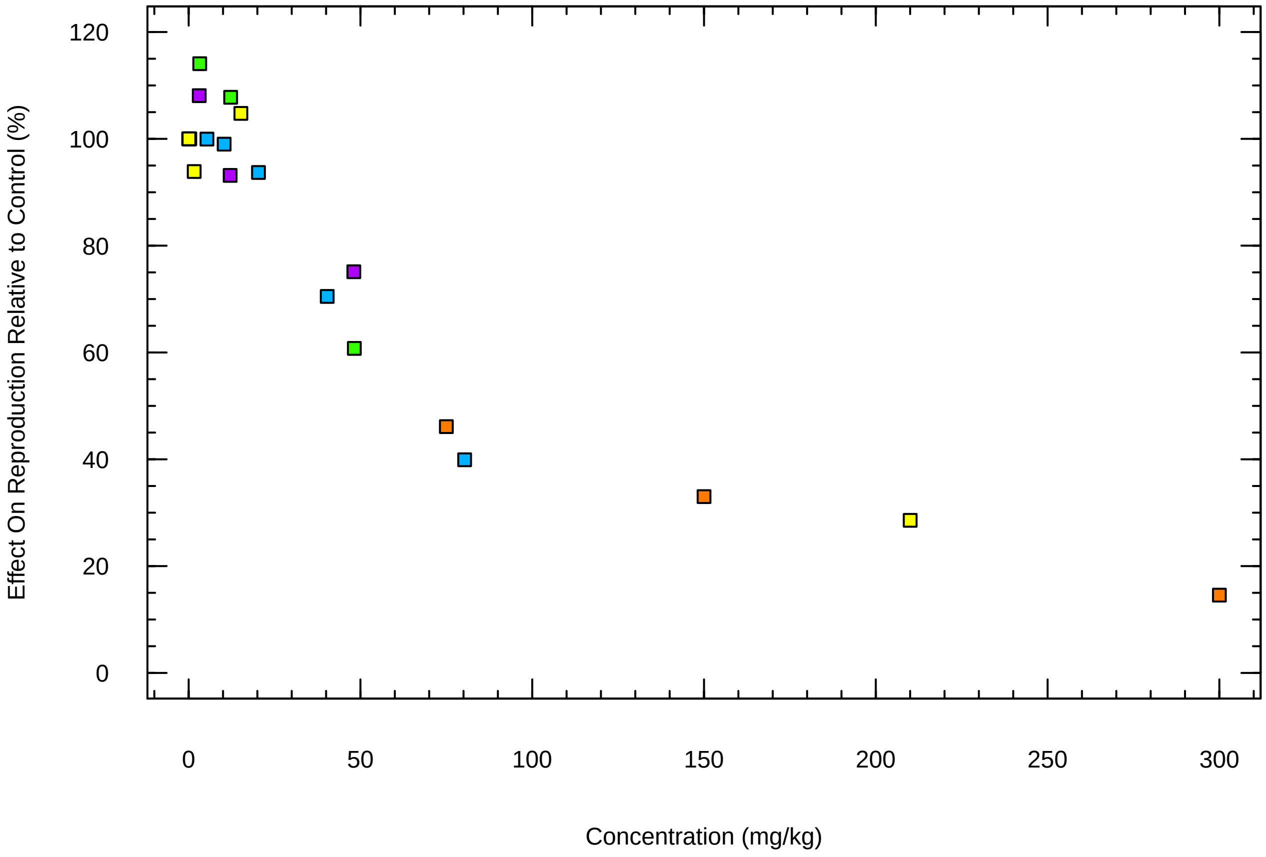
Figure 4−56. Dose−Response Data for the Mammalian Survival Endpoint for Zinc, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
■	Bafundo et al. 1984	chicken	body weight gain	diet	2 weeks	cadmium chloride	
■	Bokori et al. 1995a	chicken	body weight	diet	4 weeks	cadmium sulfate	
■	Bokori et al. 1996	chicken	body weight	diet	39 weeks	cadmium sulfate	
▲	Di Giulio and Scanlon 1984	mallard	body weight	diet	6 weeks	cadmium chloride	
■	Hill 1974a	chicken	body weight gain	diet	2 weeks	cadmium sulfate	A
■	Hill 1974b	chicken	body weight gain	diet	2 weeks	cadmium sulfate	A
■	Olgun 2015	Japanese quail	body weight	diet	10 weeks	cadmium sulfate	
■	Richardson and Fox 1974	Japanese quail	body weight	diet	4 weeks	cadmium chloride	B
■	Richardson et al. 1974	Japanese quail	body weight	diet	4 weeks	cadmium chloride	B
■	Richardson et al. 1974	Japanese quail	body weight	diet	6 weeks	cadmium chloride	B
■	Hill 1979	chicken	body weight gain	diet	2 weeks	cadmium sulfate	A
■	Hill 1980	chicken	body weight gain	diet	2 weeks	cadmium sulfate	A
■	Rama and Planas 1981	chicken	body weight gain	diet	9 weeks	cadmium sulfate	A

□ Tier 1 △ Tier 2

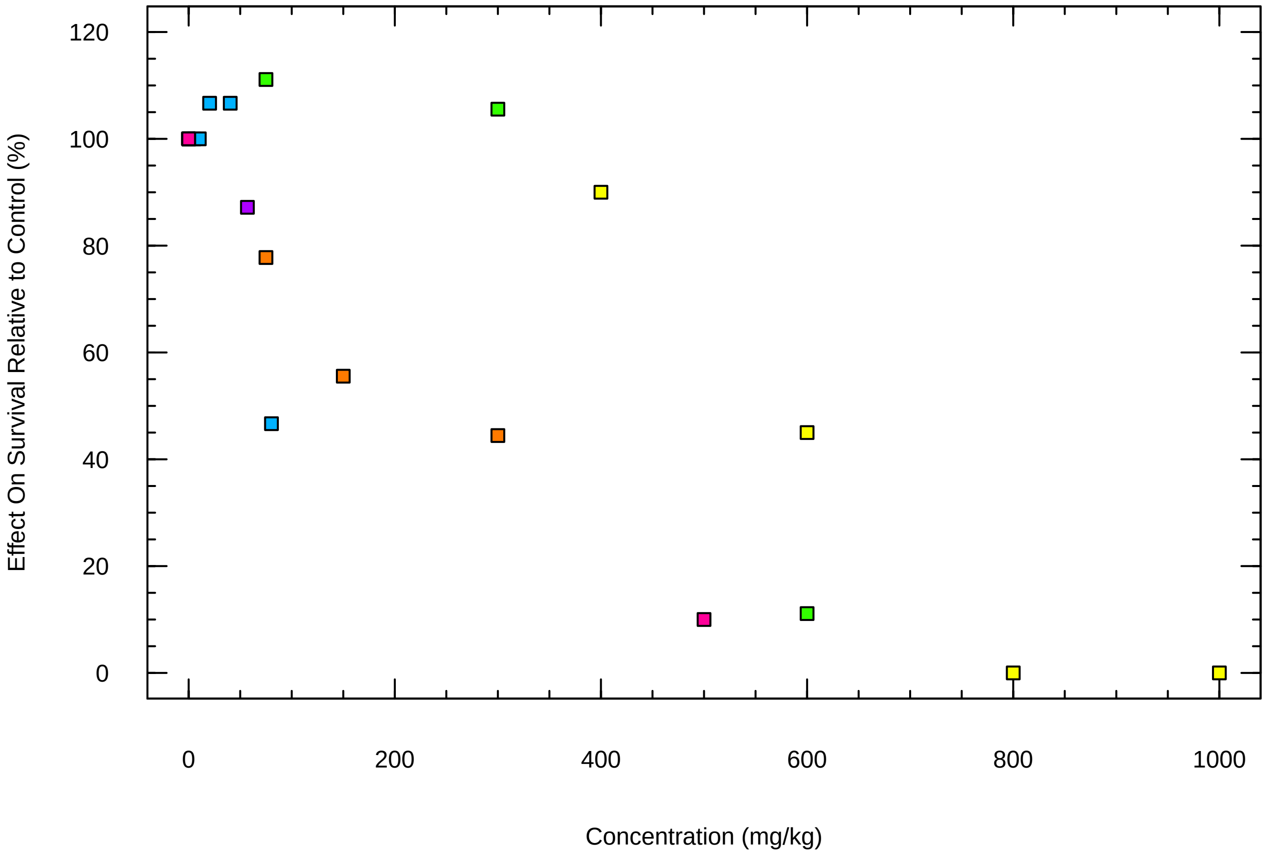
Figure 4−57. Concentration−Response Data for the Avian Growth Endpoint for Cadmium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Bokori et al. 1995b	Japanese quail	egg production	diet	5.29 weeks	cadmium sulfate	
🟩	Leach et al. 1979	chicken	egg production	diet	48 weeks	cadmium sulfate	
🟪	Leach et al. 1979	chicken	egg production	diet	12 weeks	cadmium sulfate	
🟦	Olgun 2015	Japanese quail	egg production	diet	10 weeks	cadmium sulfate	
🟨	White and Finley 1978	mallard	egg production	diet	4.3−12.8 weeks	cadmium chloride	

☐ Tier 1

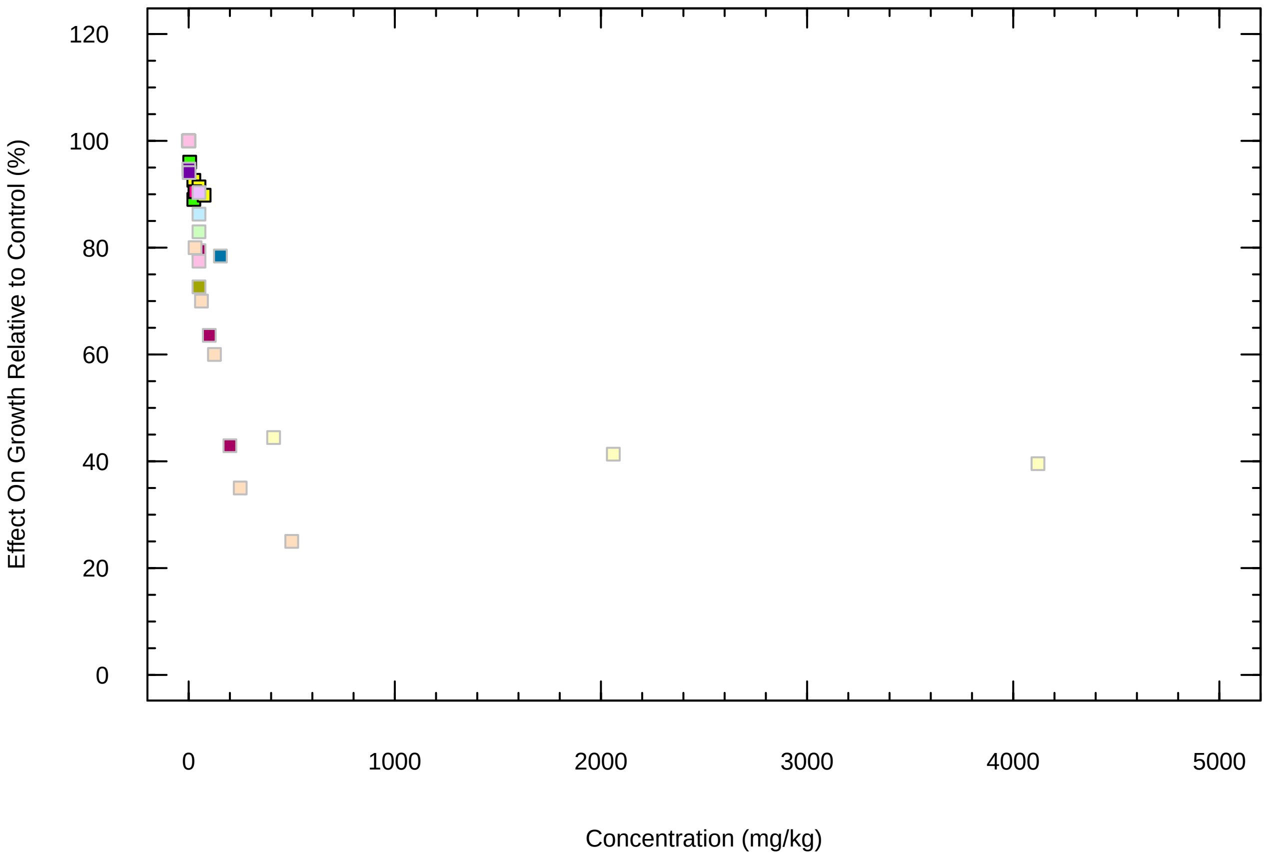
Figure 4−58. Concentration−Response Data for the Avian Reproduction Endpoint for Cadmium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Bokori et al. 1995b	Japanese quail	survival	diet	5.29 weeks	cadmium sulfate	C
🟩	Bokori et al. 1995a	chicken	survival	diet	8 weeks	cadmium sulfate	
🟪	Hill 1974b	chicken	survival	diet	2 weeks	cadmium sulfate	
🟦	Olgun 2015	Japanese quail	survival	diet	10 weeks	cadmium sulfate	C
🟨	Pritzl et al. 1974	chicken	survival	diet	2.86 weeks	cadmium carbonate	
🟥	Van Vleet et al. 1981	Pekin duck	survival	diet	4 weeks	cadmium sulfate	

☐ Tier 1

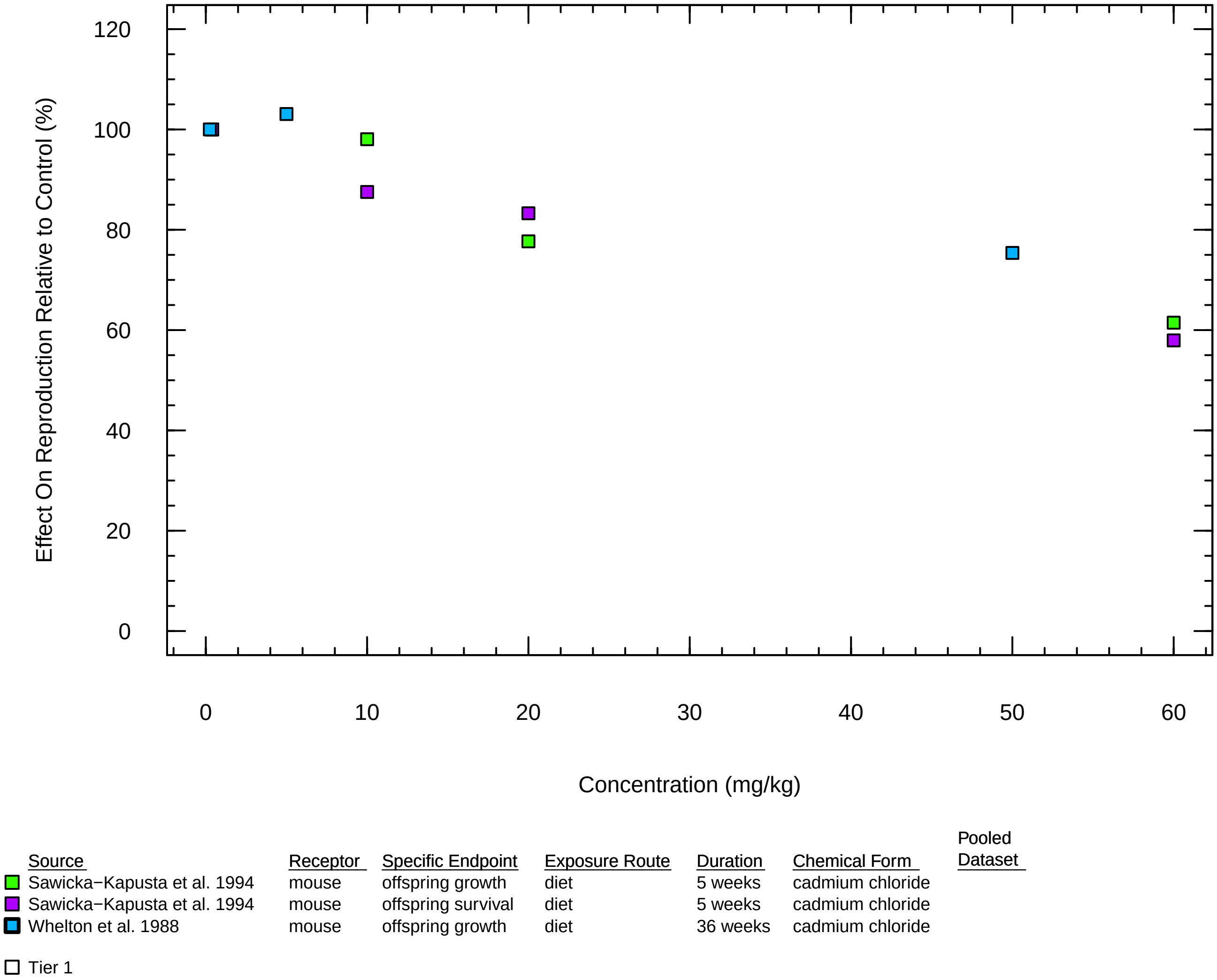
Figure 4−59. Concentration−Response Data for the Avian Survival Endpoint for Cadmium



Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟩 Cousins et al. 1977	rat	body weight	diet	14 weeks	cadmium chloride	
🟨 Rajanna et al. 1984	rat	body weight	diet	25.7 weeks	cadmium chloride	
🟥 Groten et al. 1991	rat	body weight	diet	8 weeks	cadmium chloride	
🟪 Weigel et al. 1987	rat	body weight	diet	7.86 weeks	cadmium oxide	
🟦 Pond et al. 1973	pig	body weight	diet	7.14 weeks	cadmium chloride	
🟫 Suzuki and Yoshida 1979	rat	body weight	diet	2 weeks	cadmium chloride	A
🟥 Suzuki and Yoshida 1979	rat	body weight	diet	4 weeks	cadmium chloride	A
🟧 Wilson et al. 1941	rat	body weight	diet	7.14 weeks	cadmium chloride	
🟩 Suzuki and Yoshida 1978a	rat	body weight (Exp 1)	diet	25.7 weeks	cadmium chloride	
🟪 Suzuki and Yoshida 1978a	rat	body weight (Exp 2)	diet	25.7 weeks	cadmium chloride	
🟦 Suzuki and Yoshida 1978b	rat	body weight (Exp 1)	diet	2 weeks	cadmium chloride	A
🟨 Weber and Reid 1969	mouse	body weight (Exp 1)	diet	3 weeks	cadmium acetate	
🟥 Suzuki and Yoshida 1977	rat	body weight (Exp 2)	diet	6.43 weeks	cadmium chloride	A

☐ Tier 1

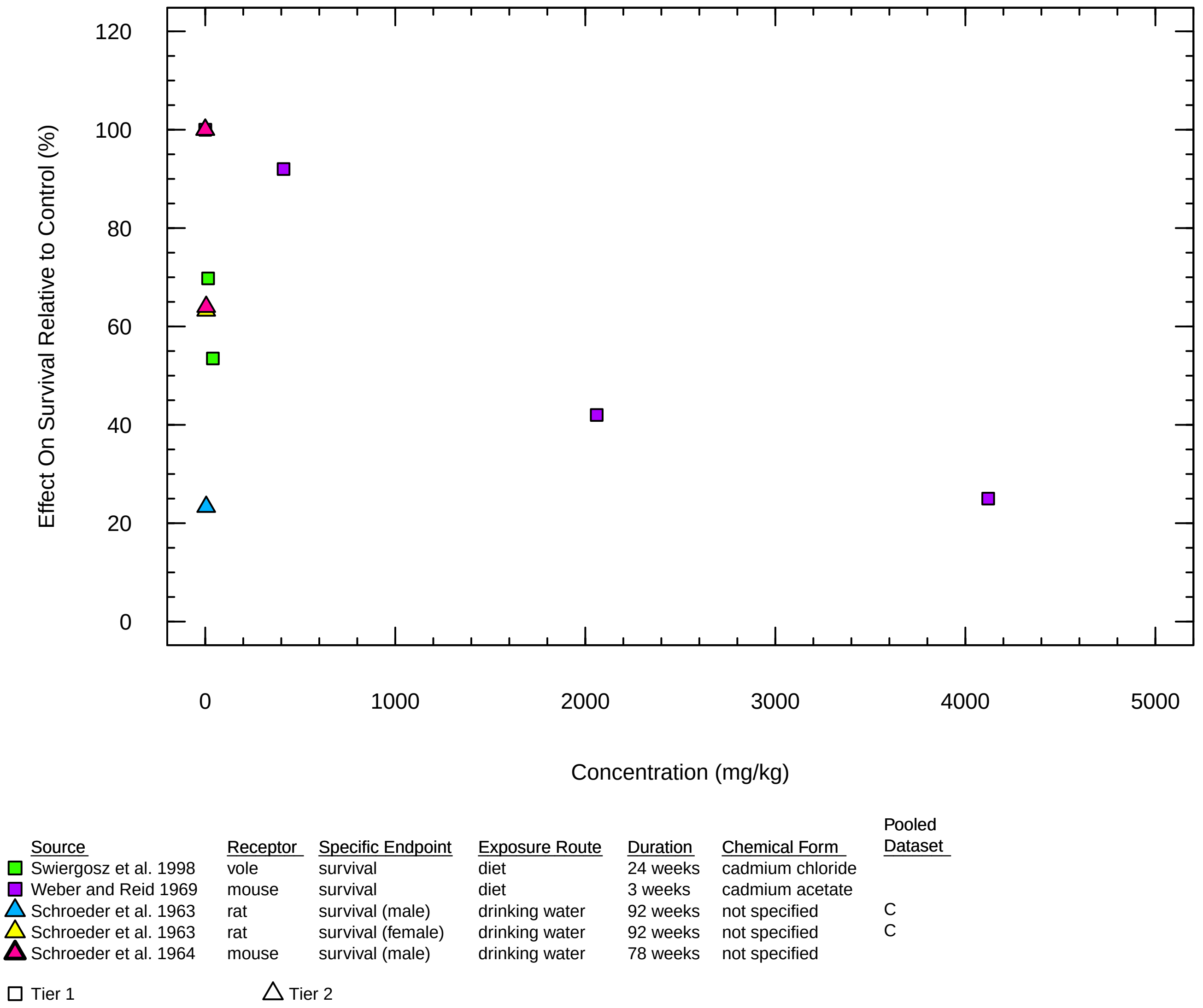
Figure 4−60. Concentration−Response Data for the Mammalian Growth Endpoint for Cadmium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟩	Sawicka−Kapusta et al. 1994	mouse	offspring growth	diet	5 weeks	cadmium chloride	
🟪	Sawicka−Kapusta et al. 1994	mouse	offspring survival	diet	5 weeks	cadmium chloride	
🟦	Whelton et al. 1988	mouse	offspring growth	diet	36 weeks	cadmium chloride	

☐ Tier 1

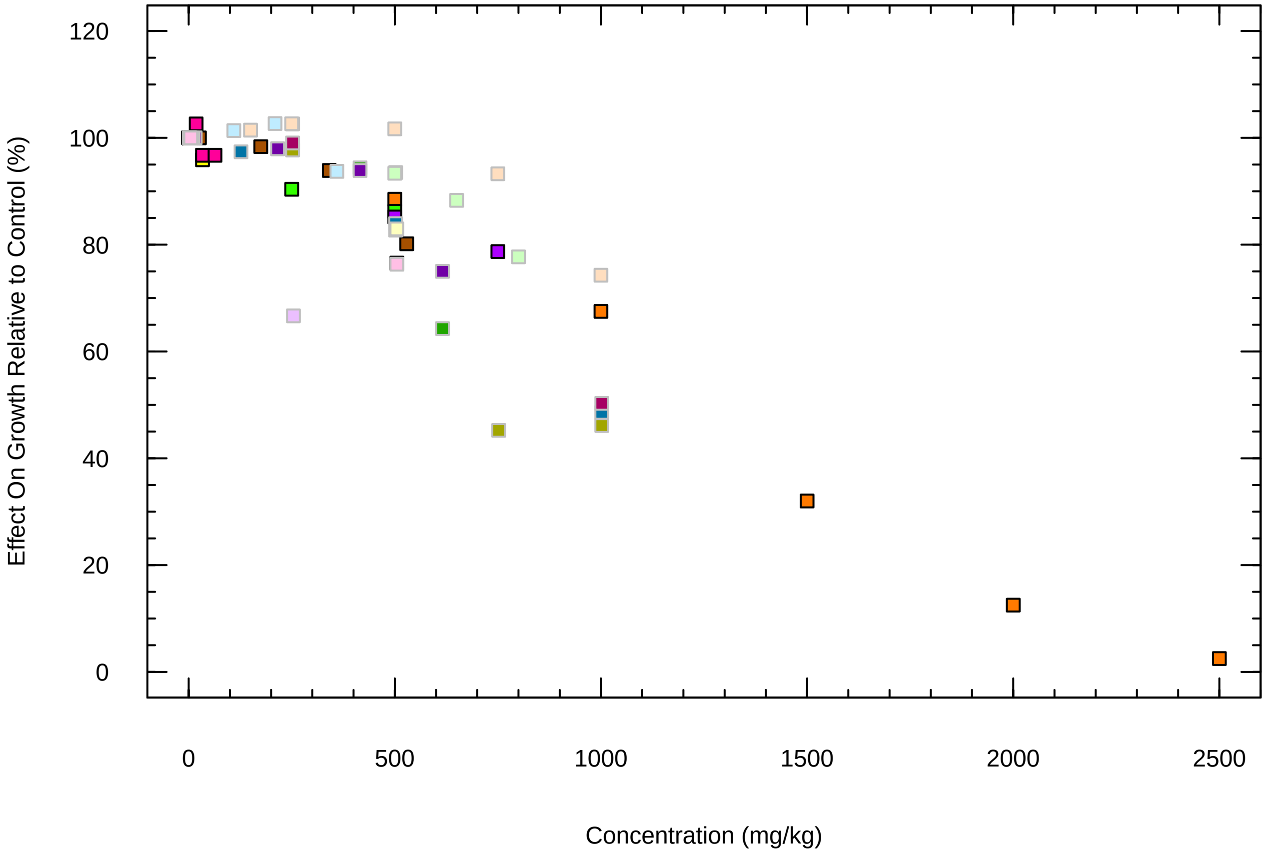
Figure 4−61. Concentration−Response Data for the Mammalian Reproduction Endpoint for Cadmium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟩	Swiergosz et al. 1998	vole	survival	diet	24 weeks	cadmium chloride	
🟪	Weber and Reid 1969	mouse	survival	diet	3 weeks	cadmium acetate	
▲	Schroeder et al. 1963	rat	survival (male)	drinking water	92 weeks	not specified	C
▲	Schroeder et al. 1963	rat	survival (female)	drinking water	92 weeks	not specified	C
▲	Schroeder et al. 1964	mouse	survival (male)	drinking water	78 weeks	not specified	

□ Tier 1 △ Tier 2

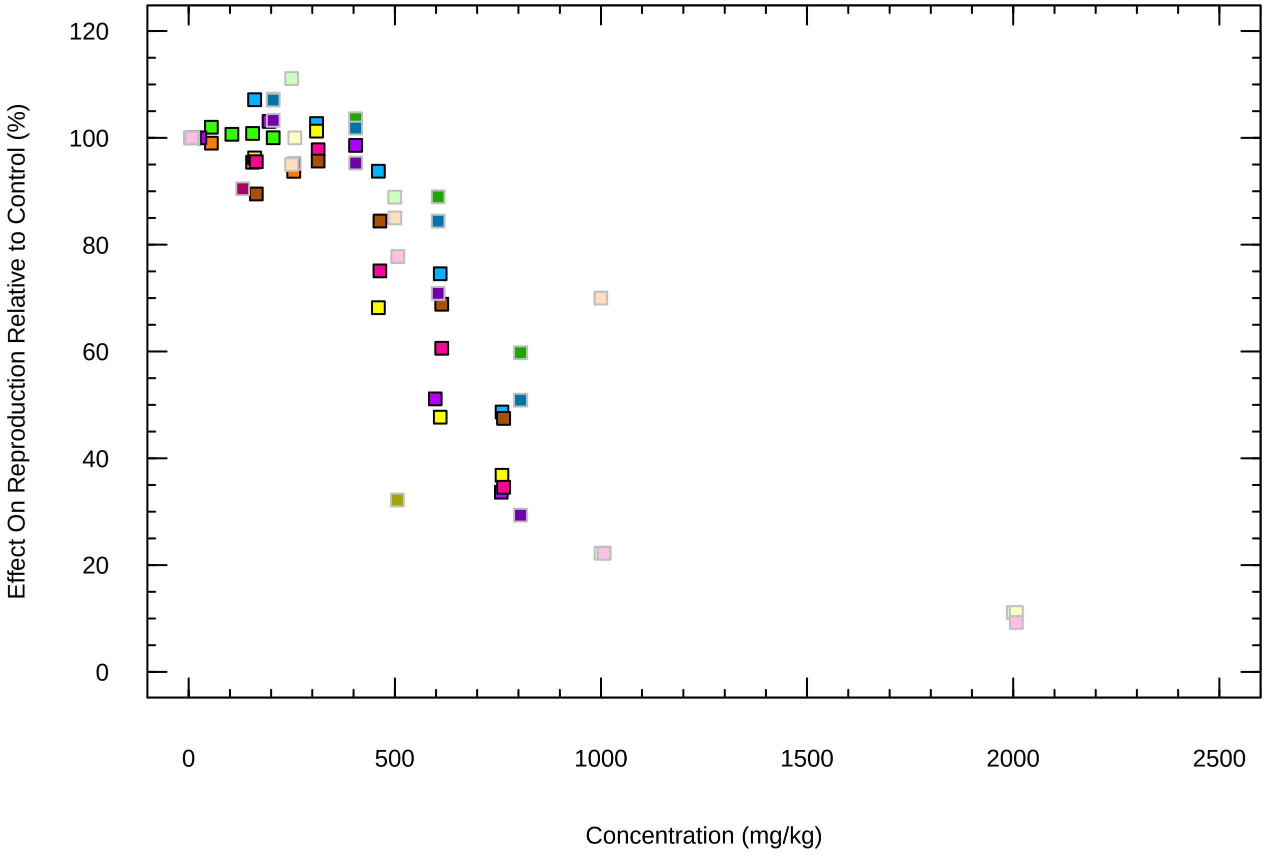
Figure 4−62. Concentration−Response Data for the Mammalian Survival Endpoint for Cadmium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Hill 1974a	chicken	body weight	diet	2 weeks	copper sulfate	C
🟩	Jensen and Maurice 1978	chicken	body weight (Exp 1)	diet	4 weeks	copper sulfate	C
🟪	Jensen and Maurice 1978	chicken	body weight (Exp 2)	diet	4 weeks	copper sulfate	C
🟦	Jensen and Maurice 1979	chicken	body weight (Exp 2)	diet	4 weeks	copper sulfate	C
🟨	Kashani et al. 1986	turkey	body weight (Exp 1)	diet	24 weeks	cupric sulfate	
🟥	Kashani et al. 1986	turkey	body weight (Exp 2)	diet	24 weeks	cupric sulfate	
🟫	Miles et al. 1998	chicken	body weight (Exp 1)	diet	3 weeks	copper sulfate	
🟩	Miles et al. 1998	chicken	body weight (Exp 2)	diet	6 weeks	dicopper chloride	
🟪	Miles et al. 1998	chicken	body weight (Exp 2)	diet	6 weeks	copper sulfate	
🟦	Poupoulis and Jensen 1976	chicken	body weight gain (Exp 1)	diet	4 weeks	copper sulfate	D
🟨	Poupoulis and Jensen 1976	chicken	body weight gain (Exp 2)	diet	4 weeks	copper sulfate	D
🟥	Poupoulis and Jensen 1976	chicken	body weight gain (Exp 5)	diet	4 weeks	copper sulfate	D
🟧	Persia et al. 2004	chicken	body weight (Exp 2)	diet	2.14 weeks	copper chloride	E
🟩	Persia et al. 2004	chicken	body weight (Exp 3)	diet	2 weeks	copper chloride	E
🟪	Latymer and Cotes 1981	chicken	body weight	diet	3.43 weeks	copper sulfate	C
🟦	Smith 1969	chicken	body weight	diet	3.57 weeks	copper sulfate	C
🟨	Wang et al. 1987	chicken	body weight gain (Exp 2)	diet	2.86 weeks	copper sulfate	D
🟥	Wang et al. 1987	chicken	body weight gain (Exp 1)	diet	2.86 weeks	copper sulfate	D

☐ Tier 1

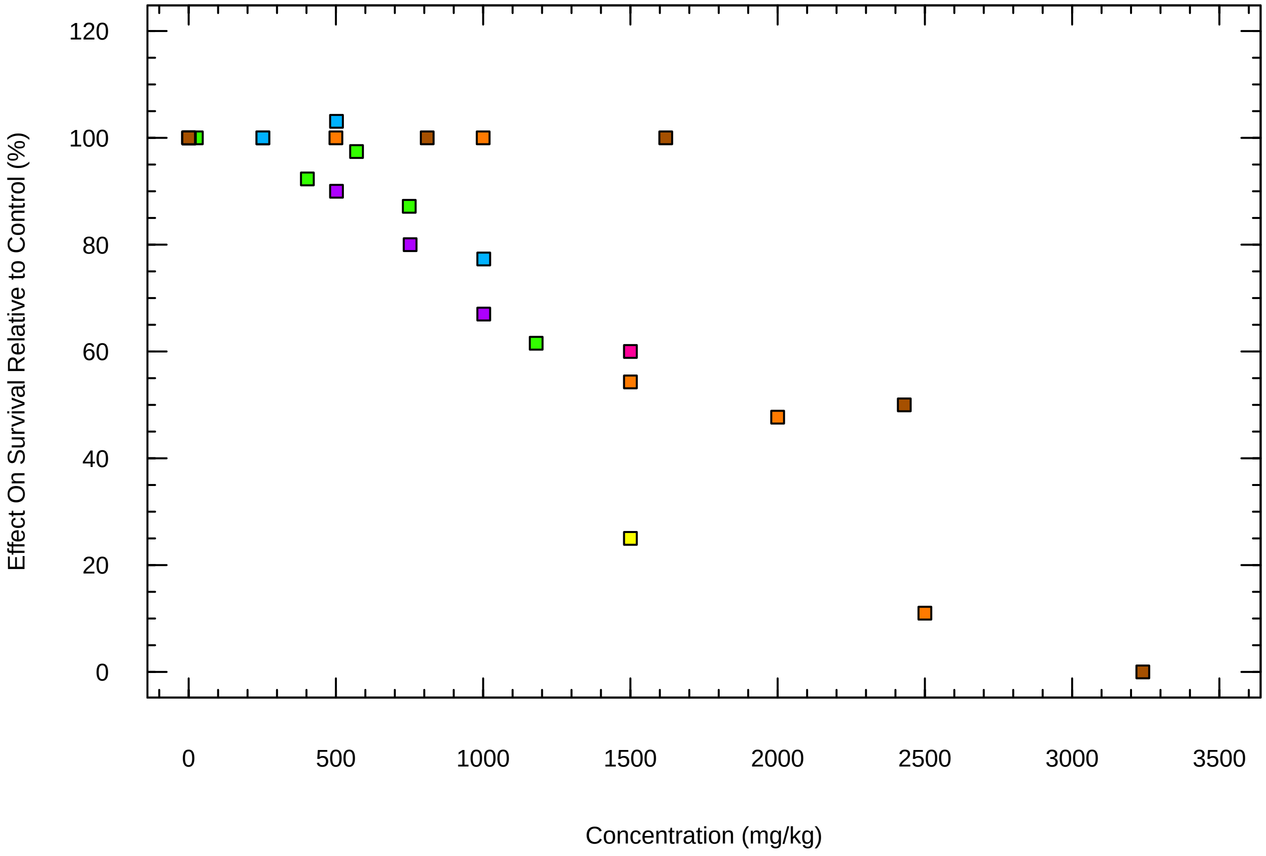
Figure 4−63. Concentration−Response Data for the Avian Growth Endpoint for Copper



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
■	Al Ankari et al. 1998	chicken	egg production	diet	12 weeks	copper sulfate/acetate	
■	Balevi and Coskun 2004	chicken	egg production	diet	4−9 weeks	copper sulfate	A
■	Chiou et al. 1997	chicken	egg production	diet	4 weeks	copper sulfate	A
■	Jackson and Stevenson 1981a	chicken	egg production (breed 1)	diet	40 weeks	copper sulfate	B
■	Jackson and Stevenson 1981a	chicken	egg production (breed 2)	diet	40 weeks	copper sulfate	B
■	Jackson and Stevenson 1981b	chicken	egg production (breed 1)	diet	48 weeks	copper sulfate	B
■	Jackson and Stevenson 1981b	chicken	egg production (breed 2)	diet	48 weeks	copper sulfate	B
■	Jackson et al. 1979	chicken	egg production (breed 1)	diet	32 weeks	copper sulfate	B
■	Jackson et al. 1979	chicken	egg production (breed 2)	diet	32 weeks	copper sulfate	B
■	Jackson et al. 1979	chicken	egg production	diet	48 weeks	copper sulfate	B
■	Harms and Buresh 1986	chicken	egg production (Exp 3)	diet	6 weeks	copper sulfate	A
■	Lien et al. 2004	chicken	egg production	diet	4 weeks	copper sulfate	A
■	Stevenson et al. 1983	chicken	egg production	diet	0.714 weeks	copper sulfate	
■	Pearce et al. 1983	chicken	egg production	diet	6.86 weeks	copper sulfate	A
■	Stevenson and Jackson 1980a	chicken	egg production	diet	6.86 weeks	copper sulfate	A
■	Stevenson and Jackson 1980b	chicken	egg production	diet	8 weeks	copper sulfate	A

□ Tier 1

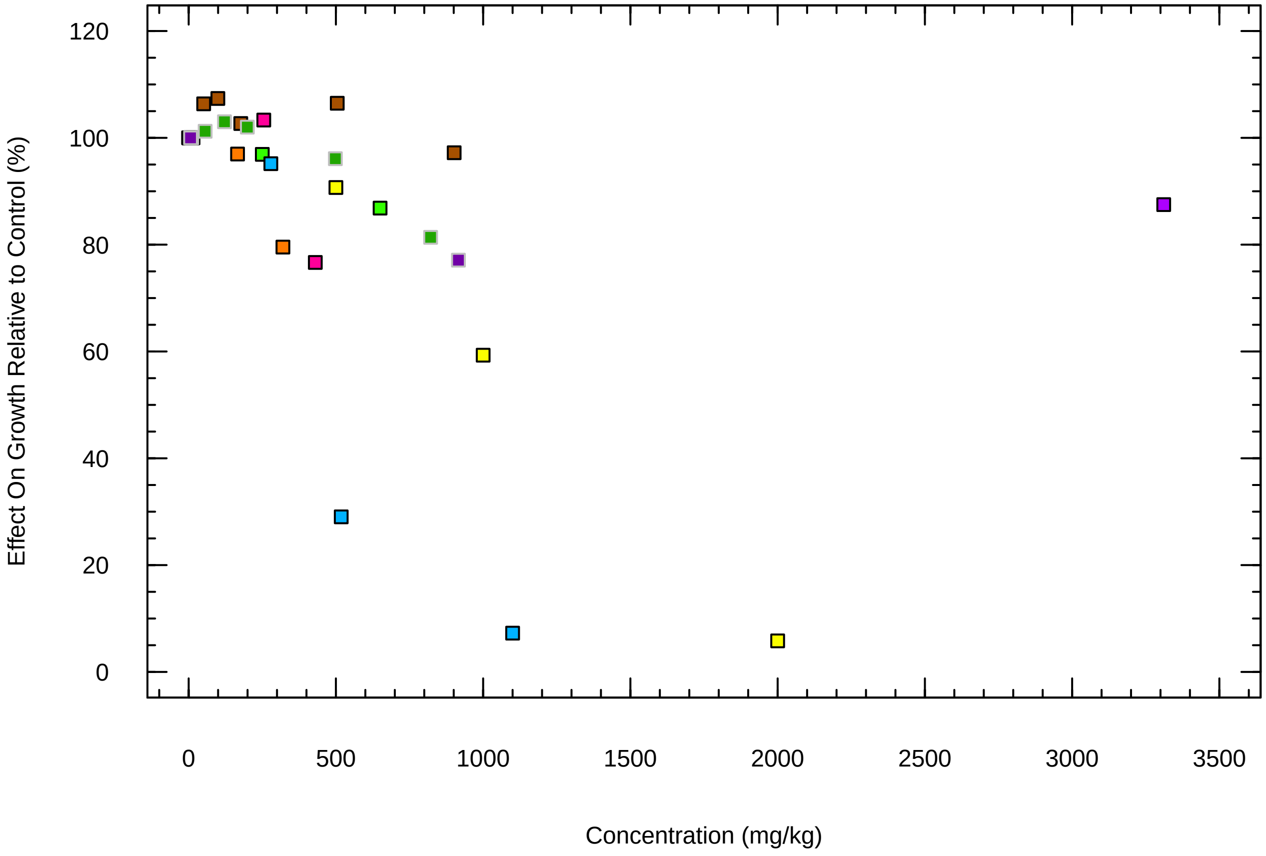
Figure 4−64. Concentration−Response Data for the Avian Reproduction Endpoint for Copper



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Hill 1974a	chicken	survival	diet	2 weeks	copper sulfate	G
🟩	Mehring et al. 1960	chicken	survival	diet	10 weeks	copper oxide	
🟪	Poupoulis and Jensen 1976	chicken	survival (Exp 2)	diet	4 weeks	copper sulfate	G
🟦	Poupoulis and Jensen 1976	chicken	survival (Exp 5)	diet	4 weeks	copper sulfate	G
🟨	Van Vleet et al. 1981	Pekin duck	survival	diet	4 weeks	copper sulfate	F
🟥	Van Vleet et al. 1981	Pekin duck	survival	diet	2.14 weeks	copper sulfate	F
🟫	Vohra and Kratzer 1968	turkey	survival	diet	3 weeks	copper sulfate	

☐ Tier 1

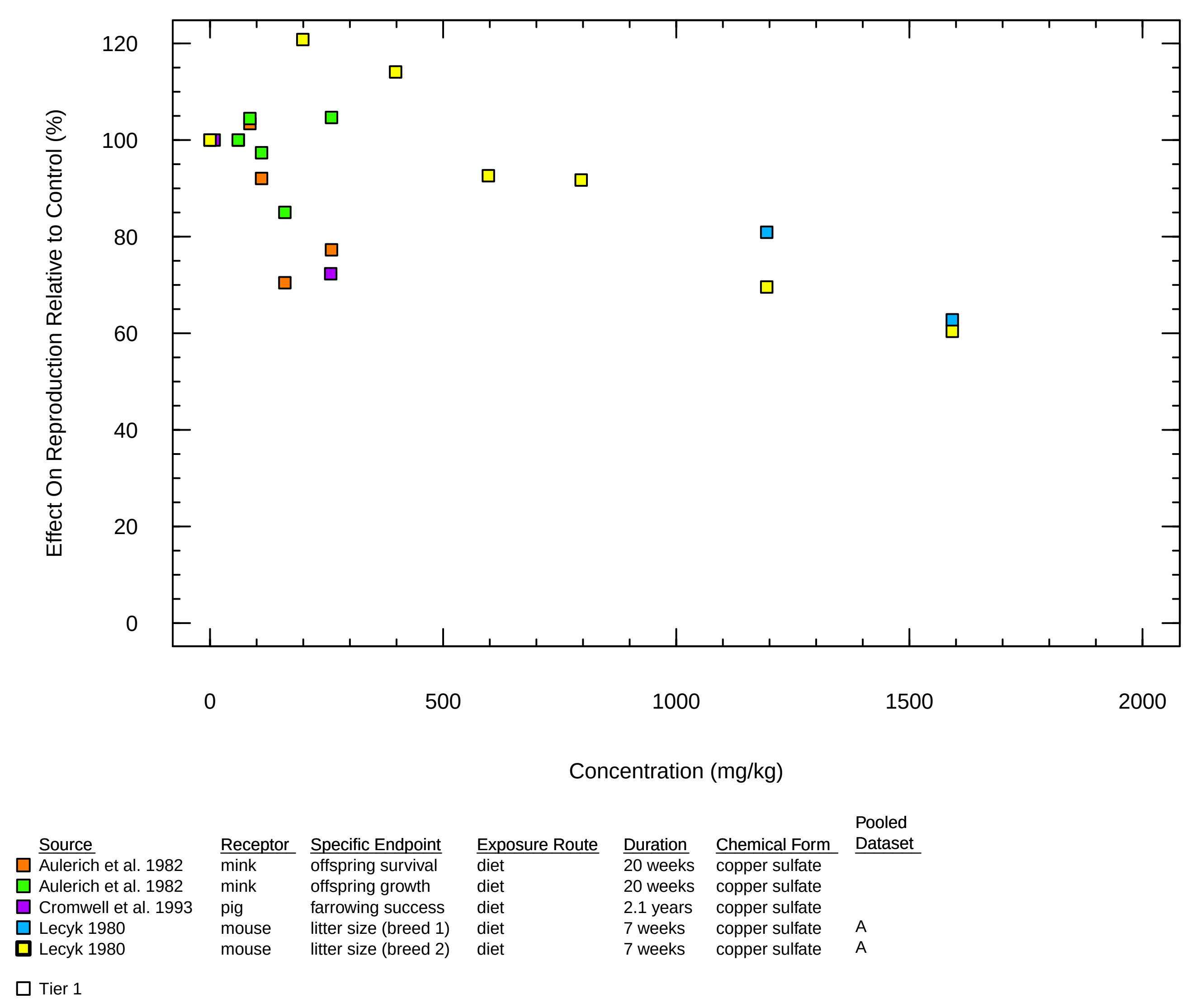
Figure 4−65. Concentration−Response Data for the Avian Survival Endpoint for Copper



Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧 Brandt 1983	mink	body weight	diet	~12 weeks	copper sulfate	
🟩 Edmonds and Baker 1986	pig	body weight (Exp 3)	diet	4 weeks	copper sulfate	
🟪 Petterson et al. 2002	mouse	body weight	diet	3 weeks	copper chloride	
🟦 Allcroft et al. 1961	pig	body weight gain	diet	21 weeks	copper sulfate	
🟨 Boyden et al. 1938	rat	body weight gain	diet	4 weeks	copper sulfate	
🟥 Suttle and Mills 1966	pig	body weight (Exp 2)	diet	5.71 weeks	copper sulfate	
🟫 Grobner et al. 1986	rabbit	body weight (Exp 2)	diet	4 weeks	copper sulfate	
🟩 Grobner et al. 1986	rabbit	body weight (Exp 2)	diet	4 weeks	copper sulfate	
🟪 Llewellyn et al. 1985	rat	body weight	diet	21 weeks	copper acetate	

□ Tier 1

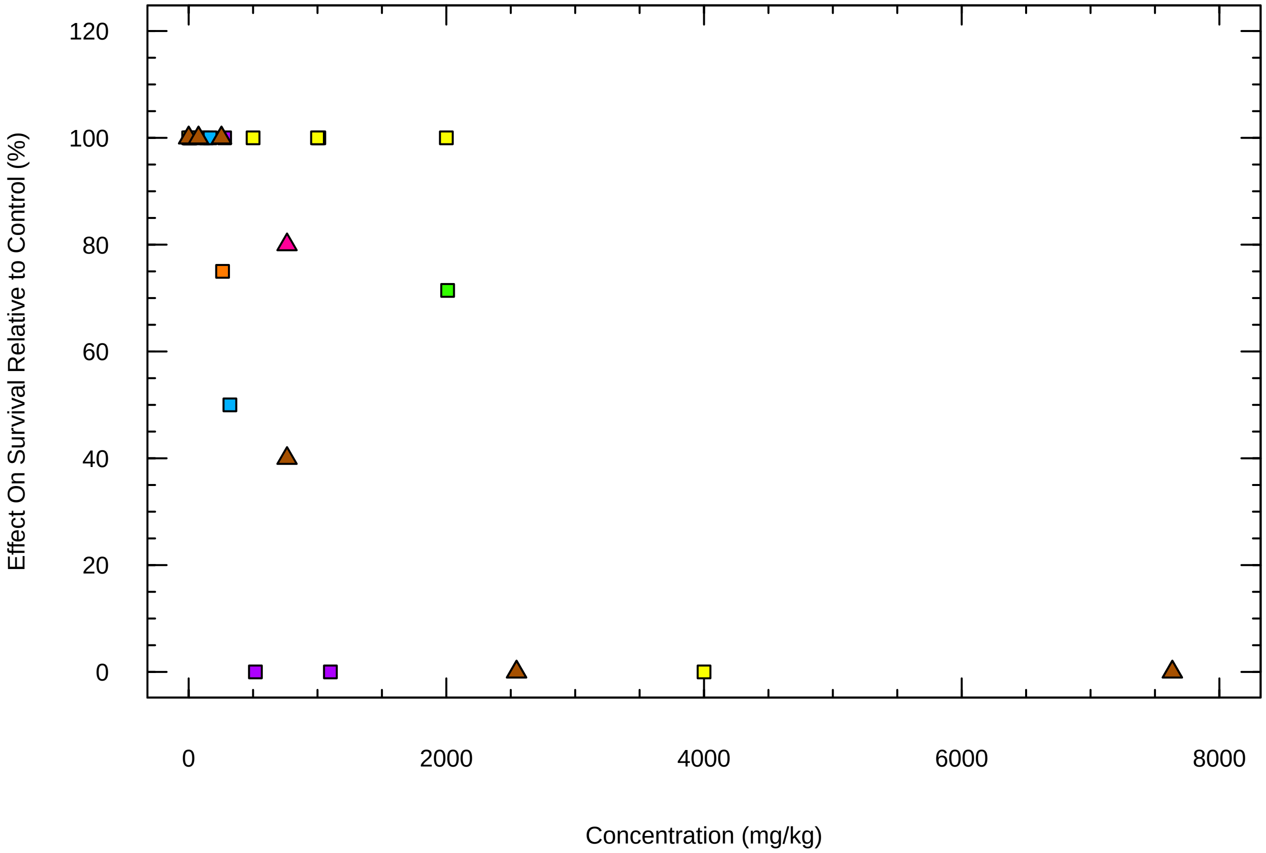
Figure 4−66. Concentration−Response Data for the Mammalian Growth Endpoint for Copper



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Aulerich et al. 1982	mink	offspring survival	diet	20 weeks	copper sulfate	
🟩	Aulerich et al. 1982	mink	offspring growth	diet	20 weeks	copper sulfate	
🟪	Cromwell et al. 1993	pig	farrowing success	diet	2.1 years	copper sulfate	
🟦	Lecyk 1980	mouse	litter size (breed 1)	diet	7 weeks	copper sulfate	A
🟨	Lecyk 1980	mouse	litter size (breed 2)	diet	7 weeks	copper sulfate	A

☐ Tier 1

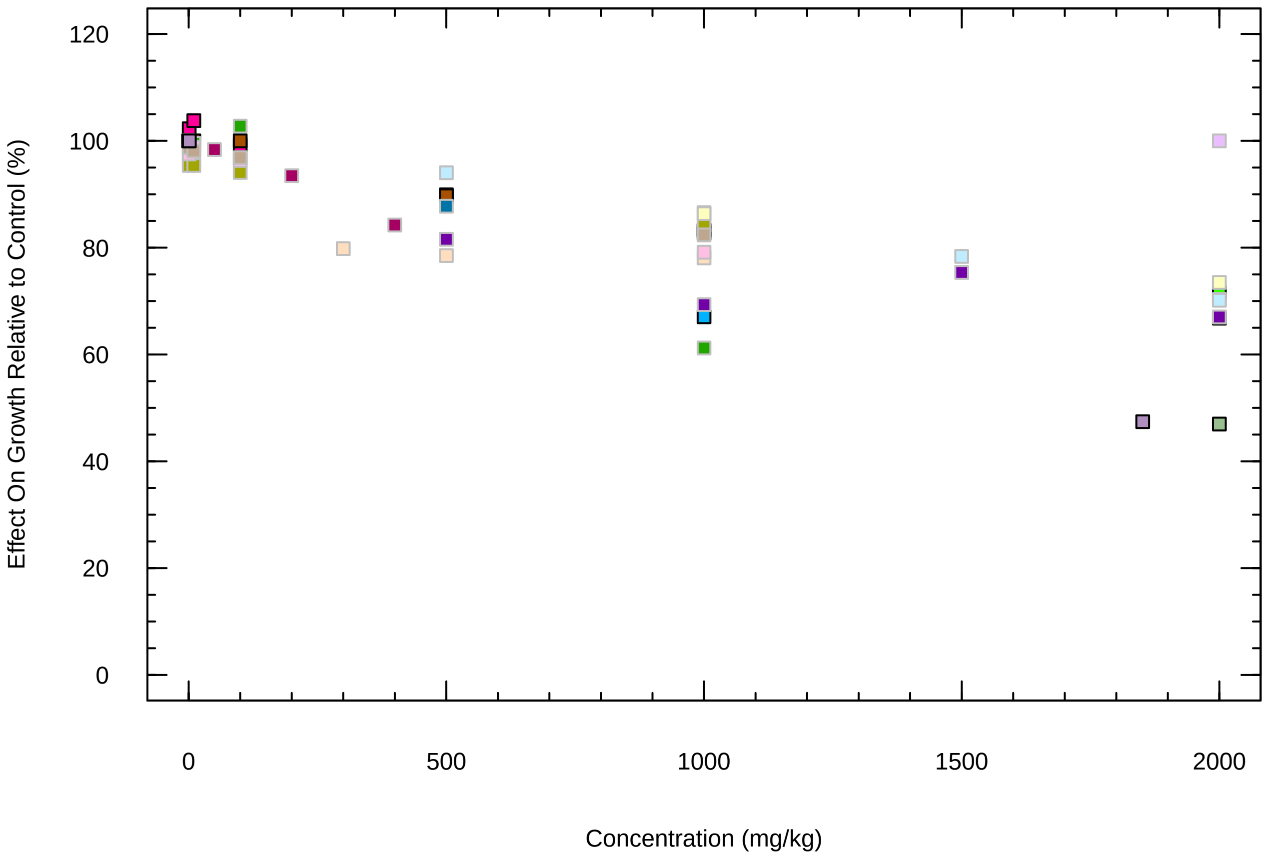
Figure 4−67. Concentration−Response Data for the Mammalian Reproduction Endpoint for Copper



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Ritchie et al. 1963	pig	survival	diet	15 weeks	copper sulfate	B
🟩	Keen et al. 1982	rat	survival	diet	6.71 weeks	copper sulfate	
🟪	Allcroft et al. 1961	pig	survival	diet	21 weeks	copper sulfate	B
🟦	Brandt 1983	mink	survival	diet	~12 weeks	copper sulfate	
🟨	Boyden et al. 1938	rat	survival	diet	4 weeks	copper sulfate	
▲	NTP 1993a	mouse	survival (male)	drinking water	2 weeks	copper sulfate	
▲	NTP 1993a	mouse	survival (female)	drinking water	2 weeks	copper sulfate	

☐ Tier 1 △ Tier 2

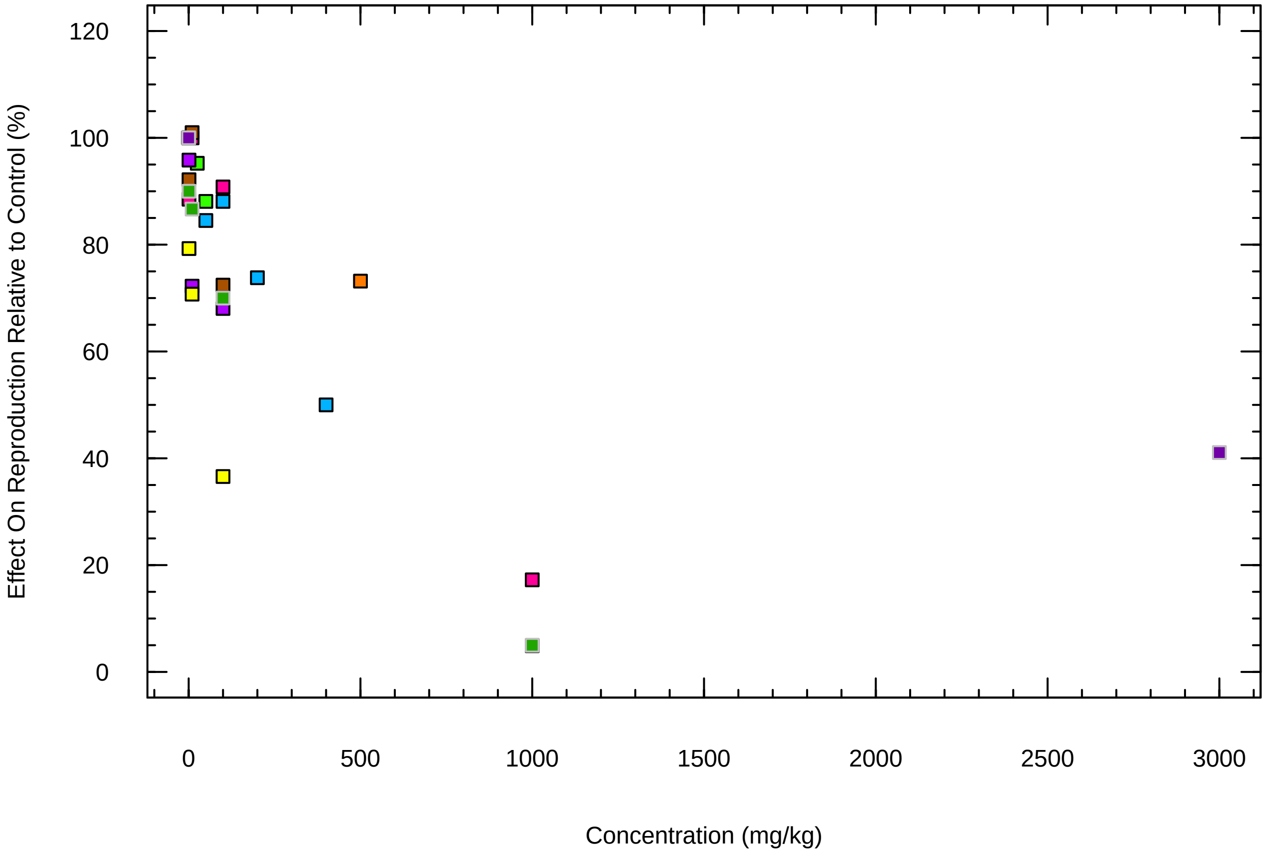
Figure 4−68. Concentration−Response Data for the Mammalian Survival Endpoint for Copper



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
■	Edens and Melvin 1989	Japanese quail	body weight (breed 2)	diet	21 weeks	lead acetate	
■	Donaldson 1986	chicken	body weight (Exp 1)	diet	2.9 weeks	lead acetate trihydrate	A
■	Donaldson 1986	chicken	body weight (Exp 2)	diet	2.9 weeks	lead acetate trihydrate	A
■	Latta and Donaldson 1986	chicken	body weight gain	diet	2.7 weeks	lead acetate	
■	Leeming and Donaldson 1984	chicken	body weight gain	diet	2.71 weeks	lead acetate trihydrate	
■	Morgan et al. 1975	Japanese quail	body weight (Trial 1)	diet	5 weeks	lead acetate	
■	Morgan et al. 1975	Japanese quail	body weight (Trial 2)	diet	5 weeks	lead acetate	
■	Damron et al. 1969	chicken	body weight	diet	4 weeks	lead acetate	
■	Donaldson and McGowan 1989	chicken	body weight	diet	2.9 weeks	lead acetate trihydrate	A
■	Edens and Melvin 1989	Japanese quail	body weight (breed 1)	diet	21 weeks	lead acetate	
■	Edens and Melvin 1989	Japanese quail	body weight (female)	diet	15 weeks	lead acetate	
■	Edens and Garlich 1983	chicken	body weight	diet	10 weeks	lead acetate	
■	Abduljaleel & Shuhaimi−Othman 2013	chicken	body weight	diet	4 weeks	lead nitrate	
■	Berg et al. 1980	chicken	body weight (Exp 1)	diet	2 weeks	lead carbonate	C
■	Berg et al. 1980	chicken	body weight (Exp 1)	diet	2 weeks	lead carbonate	C
■	Berg et al. 1980	chicken	body weight (Exp 2)	diet	2 weeks	lead carbonate	C
■	Berg et al. 1980	chicken	body weight (Exp 3)	diet	2 weeks	lead carbonate	C
■	Edens et al. 1976	Japanese quail	body weight	diet	12 weeks	lead acetate	B
■	Edens 1985	Japanese quail	body weight	diet	12 weeks	lead acetate	B
■	Cupo and Donaldson 1988	chicken	body weight	diet	3 weeks	lead acetate	C
■	Franson and Custer 1982	chicken	body weight	diet	4 weeks	lead acetate	C

□ Tier 1

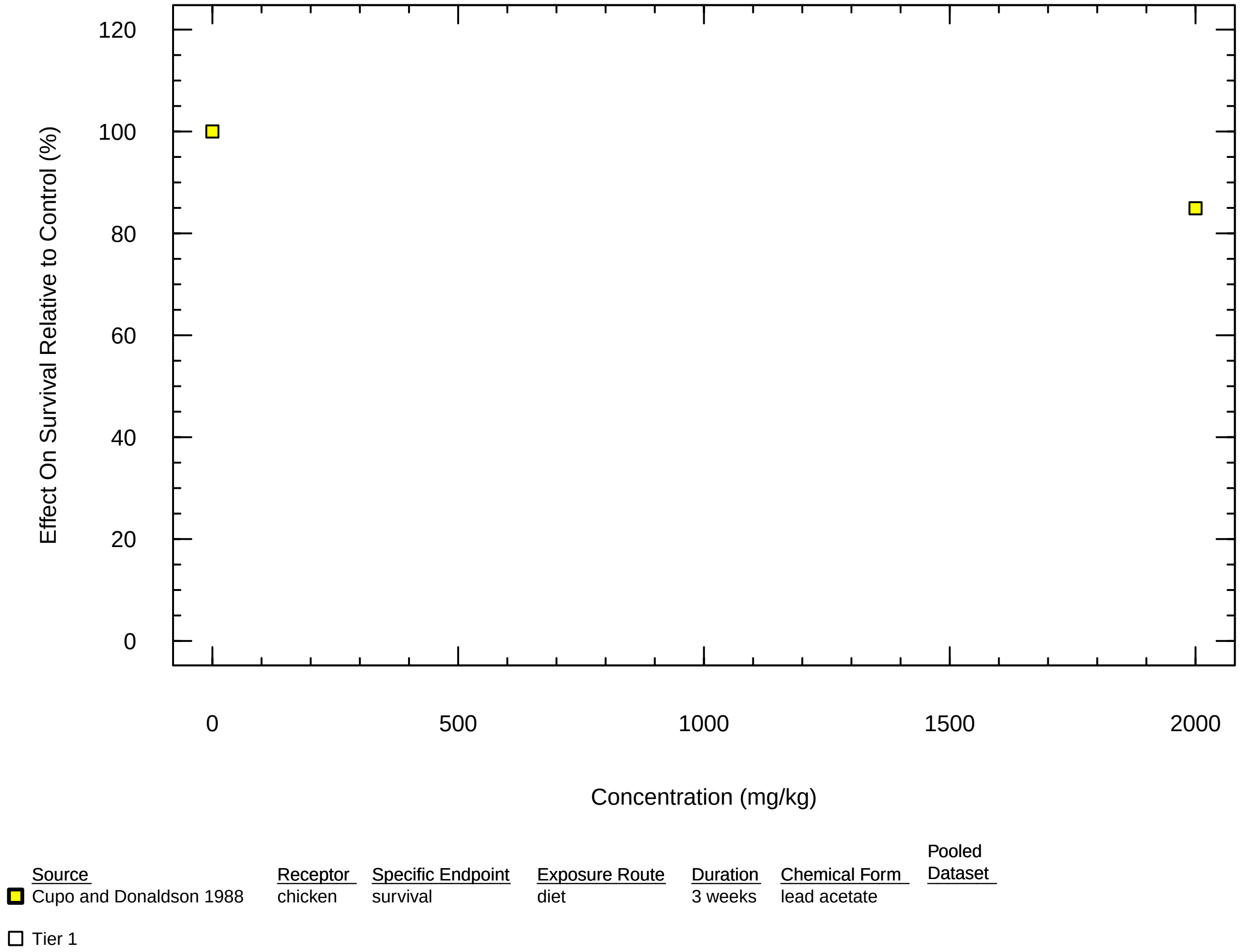
Figure 4−69. Concentration−Response Data for the Avian Growth Endpoint for Lead



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Edens and Melvin 1989	Japanese quail	egg production	diet	21 weeks	lead acetate	
🟩	Edens and Garlich 1983	chicken	egg production (Exp 1)	diet	4 weeks	lead acetate	
🟪	Edens and Garlich 1983	Japanese quail	egg production (Exp 2)	diet	5 weeks	lead acetate	D
🟦	Edens and Garlich 1983	chicken	egg production (Exp 3)	diet	10 weeks	lead acetate	
🟨	Edens and Garlich 1983	Japanese quail	egg production (Exp 4)	diet	5 weeks	lead acetate	D
🟥	Edens et al. 1976	Japanese quail	egg production	diet	12 weeks	lead acetate	E
🟫	Edens et al. 1976	Japanese quail	egg hatchability	diet	12 weeks	lead acetate	
🟩	Edens et al. 1976	Japanese quail	egg production	diet	12 weeks	lead acetate	E
🟪	Stone and Soares 1976	Japanese quail	egg production	diet	3.86 weeks	lead acetate	D

☐ Tier 1

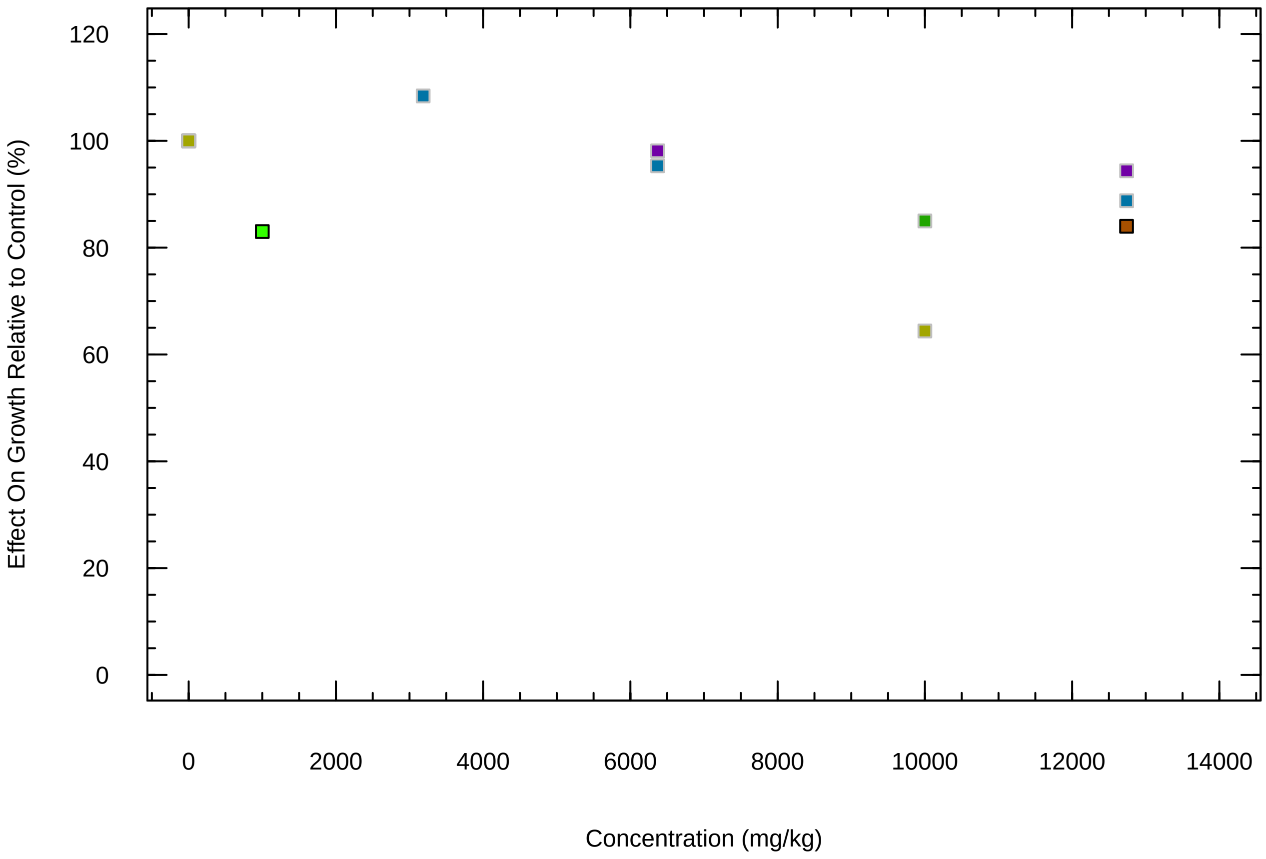
Figure 4−70. Concentration−Response Data for the Avian Reproduction Endpoint for Lead



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟨	Cupo and Donaldson 1988	chicken	survival	diet	3 weeks	lead acetate	

☐ Tier 1

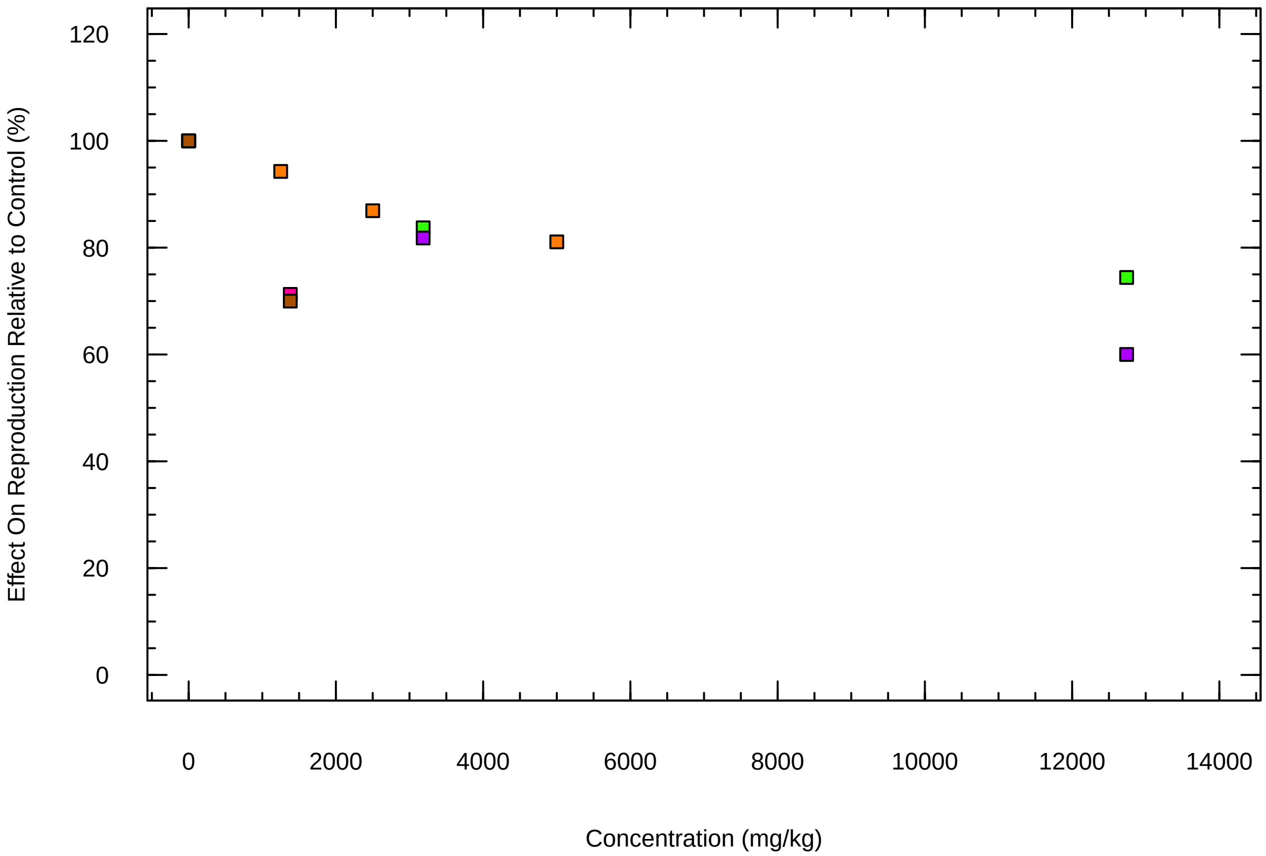
Figure 4−71. Concentration−Response Data for the Avian Survival Endpoint for Lead



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟩	Hsu et al. 1975	pig	body weight	diet	13 weeks	lead acetate	
🟫	Barlow et al. 1977	rat	maternal body weight	diet	3 weeks	lead acetate	
🟩	Maker et al. 1973	mouse	body weight	diet	4.29 weeks	lead carbonate	
🟪	Mykkanen et al. 1980	rat	weight gain	diet	3 weeks	lead acetate	
🟦	Mykkanen et al. 1980	rat	weight gain	diet	3 weeks	lead acetate	
🟨	Gerber et al. 1978	rat	body weight	diet	52 weeks	lead acetate	

☐ Tier 1

Figure 4−72. Concentration−Response Data for the Mammalian Growth Endpoint for Lead



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Jacquet et al. 1977	mouse	embryo weight	diet	2.57 weeks	not specified	
🟩	Mykkanen et al. 1980	rat	pup weight (breed 1)	diet	3 weeks	lead acetate	B
🟪	Mykkanen et al. 1980	rat	pup weight (breed 2)	diet	3 weeks	lead acetate	B
🟥	Winneke et al. 1977	rat	litter size	diet	18.6 weeks	lead acetate	
🟫	Winneke et al. 1977	rat	pregnancy success	diet	18.6 weeks	lead acetate	

☐ Tier 1

Figure 4−73. Concentration−Response Data for the Mammalian Reproduction Endpoint for Lead

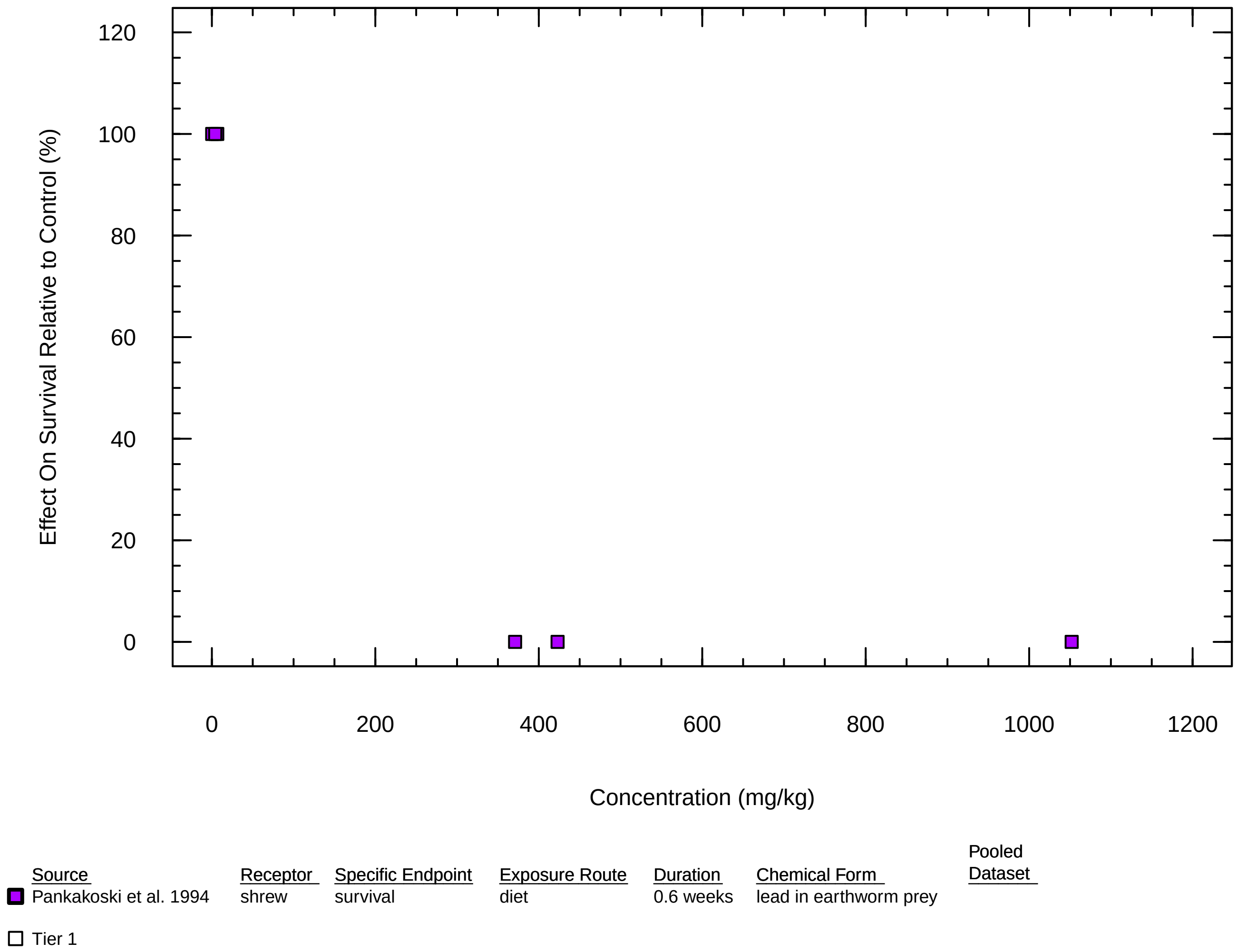
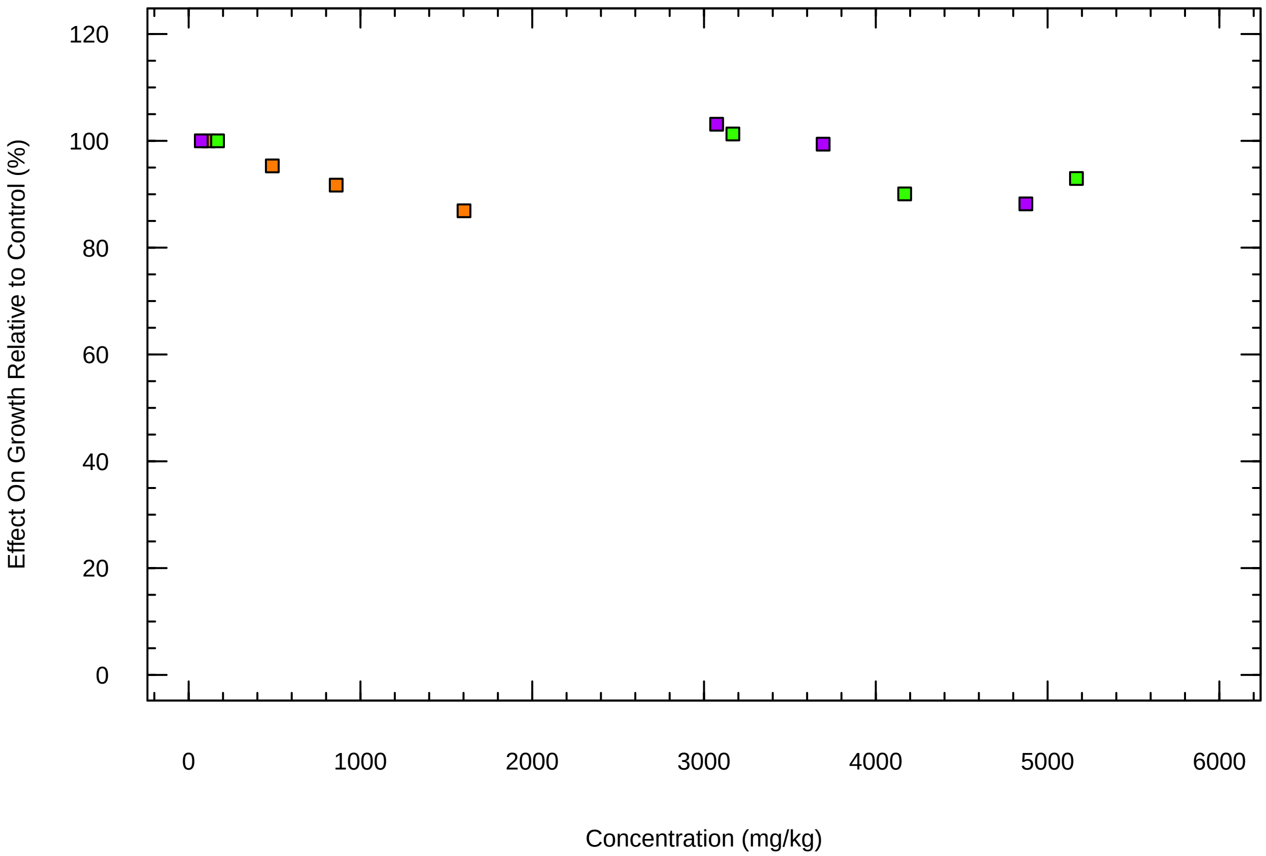


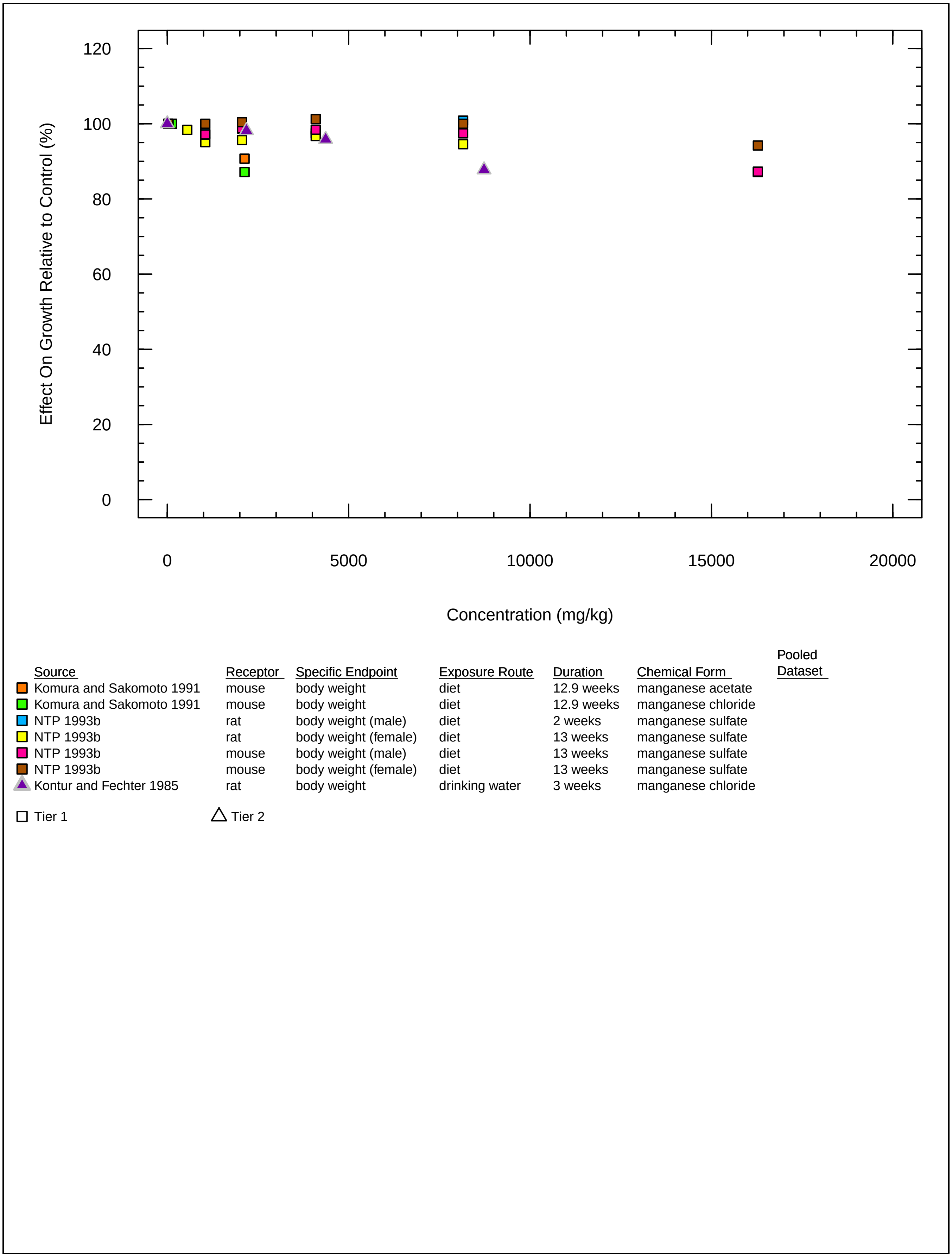
Figure 4−74. Concentration−Response Data for the Mammalian Survival Endpoint for Lead



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Martinez and Diaz 1996	chicken	body weight	diet	6 weeks	manganese oxide	
🟩	Southern and Baker 1983	chicken	body weight	diet	2 weeks	manganese chloride	
🟪	Vohra and Kratzer 1968	turkey	body weight gain	diet	3 weeks	manganese sulfate	

☐ Tier 1

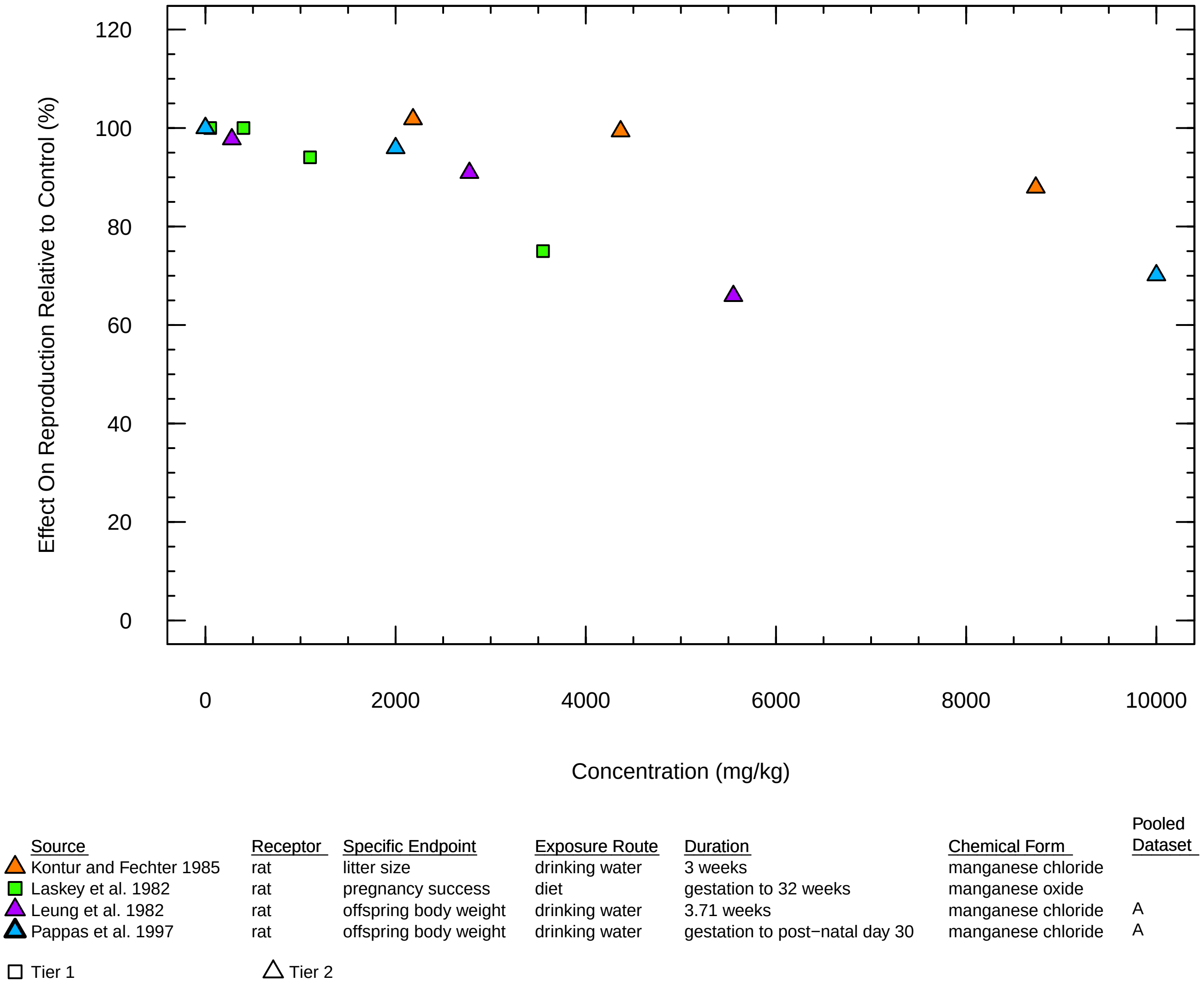
Figure 4−75. Concentration−Response Data for the Avian Growth Endpoint for Manganese



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Komura and Sakomoto 1991	mouse	body weight	diet	12.9 weeks	manganese acetate	
🟩	Komura and Sakomoto 1991	mouse	body weight	diet	12.9 weeks	manganese chloride	
🟦	NTP 1993b	rat	body weight (male)	diet	2 weeks	manganese sulfate	
🟨	NTP 1993b	rat	body weight (female)	diet	13 weeks	manganese sulfate	
🟥	NTP 1993b	mouse	body weight (male)	diet	13 weeks	manganese sulfate	
🟫	NTP 1993b	mouse	body weight (female)	diet	13 weeks	manganese sulfate	
▲	Kontur and Fechter 1985	rat	body weight	drinking water	3 weeks	manganese chloride	

☐ Tier 1 △ Tier 2

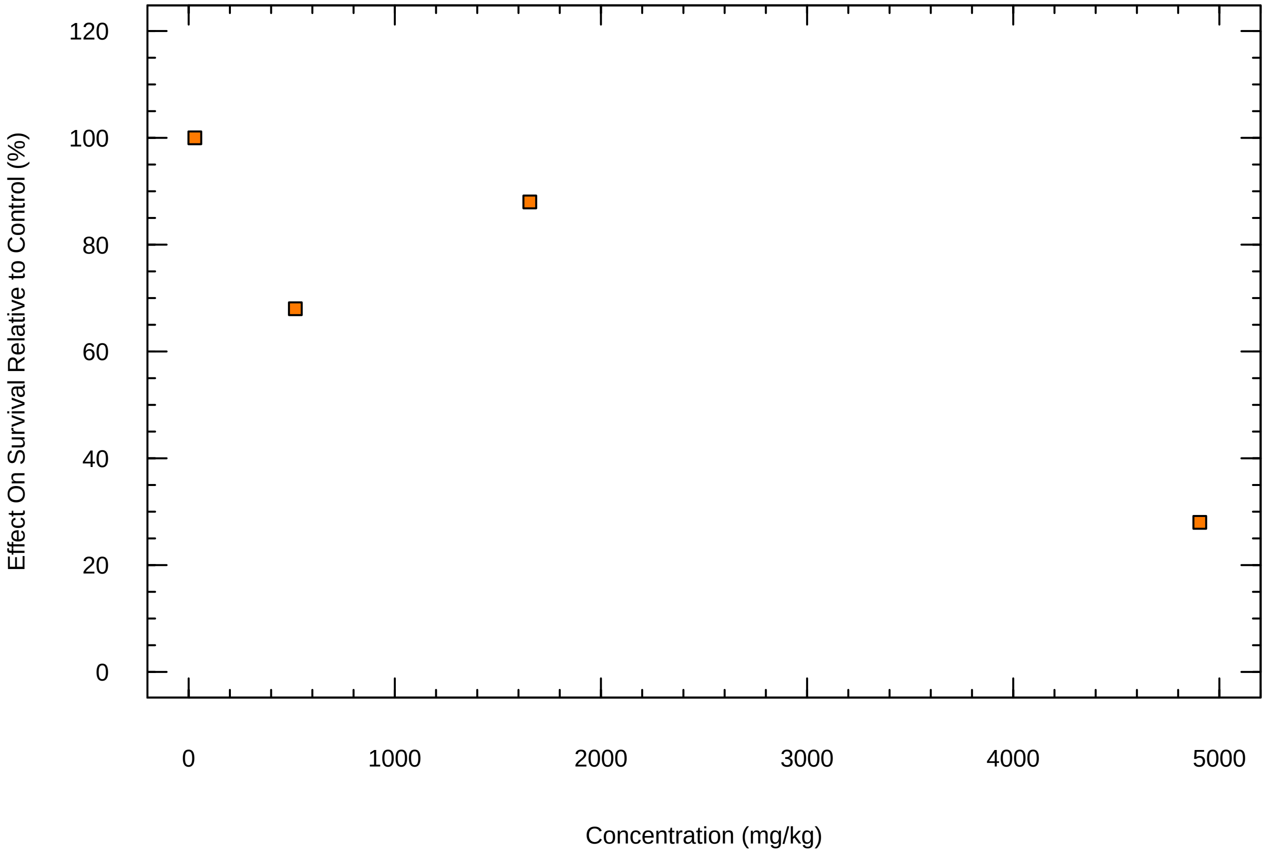
Figure 4−76. Concentration−Response Data for the Mammalian Growth Endpoint for Manganese



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
▲	Kontur and Fechter 1985	rat	litter size	drinking water	3 weeks	manganese chloride	
■	Laskey et al. 1982	rat	pregnancy success	diet	gestation to 32 weeks	manganese oxide	
▲	Leung et al. 1982	rat	offspring body weight	drinking water	3.71 weeks	manganese chloride	A
▲	Pappas et al. 1997	rat	offspring body weight	drinking water	gestation to post−natal day 30	manganese chloride	A

☐ Tier 1 △ Tier 2

Figure 4−77. Concentration−Response Data for the Mammalian Reproduction Endpoint for Manganese

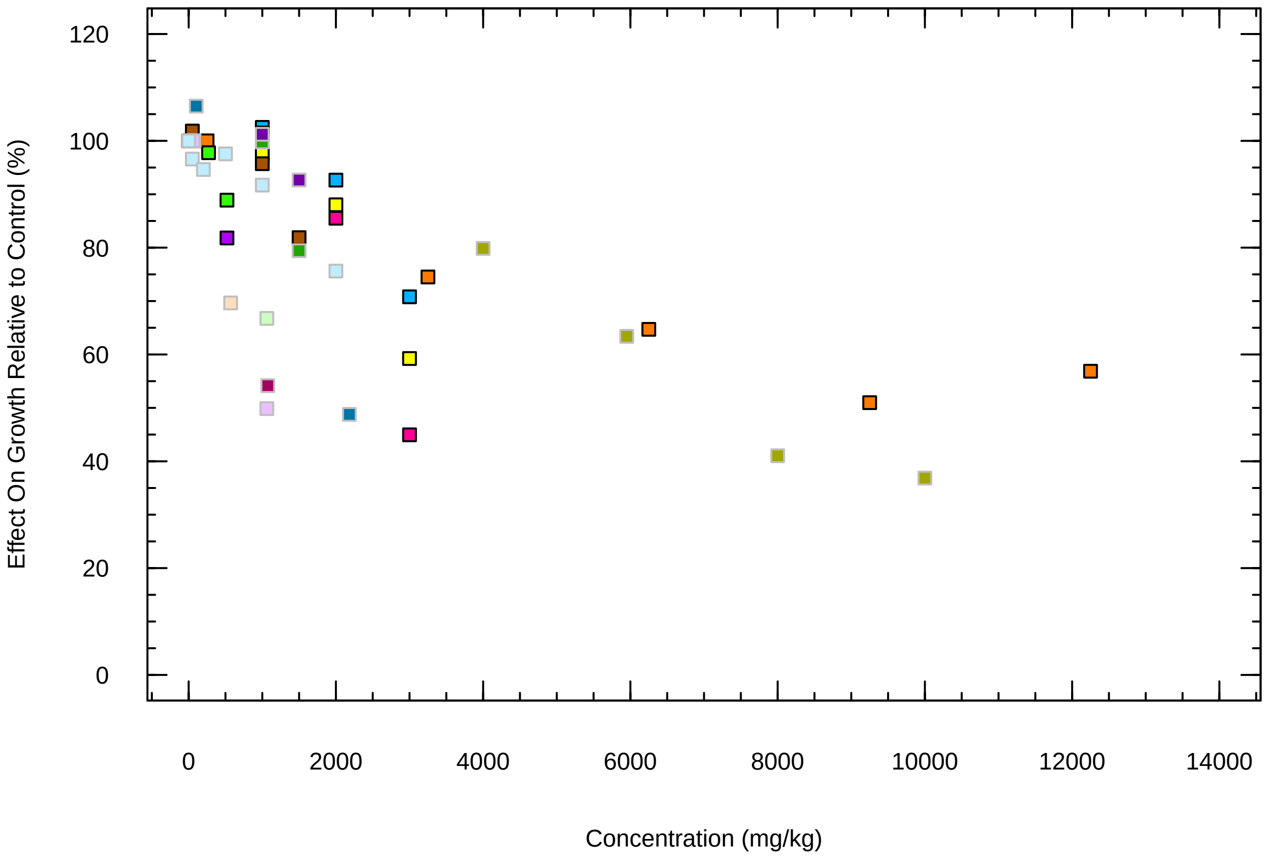


	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	NTP 1993b	rat	suvival (male)	diet	2 years	manganese sulfate	

☐ Tier 1

* Survival at this dose was not significantly different from the control

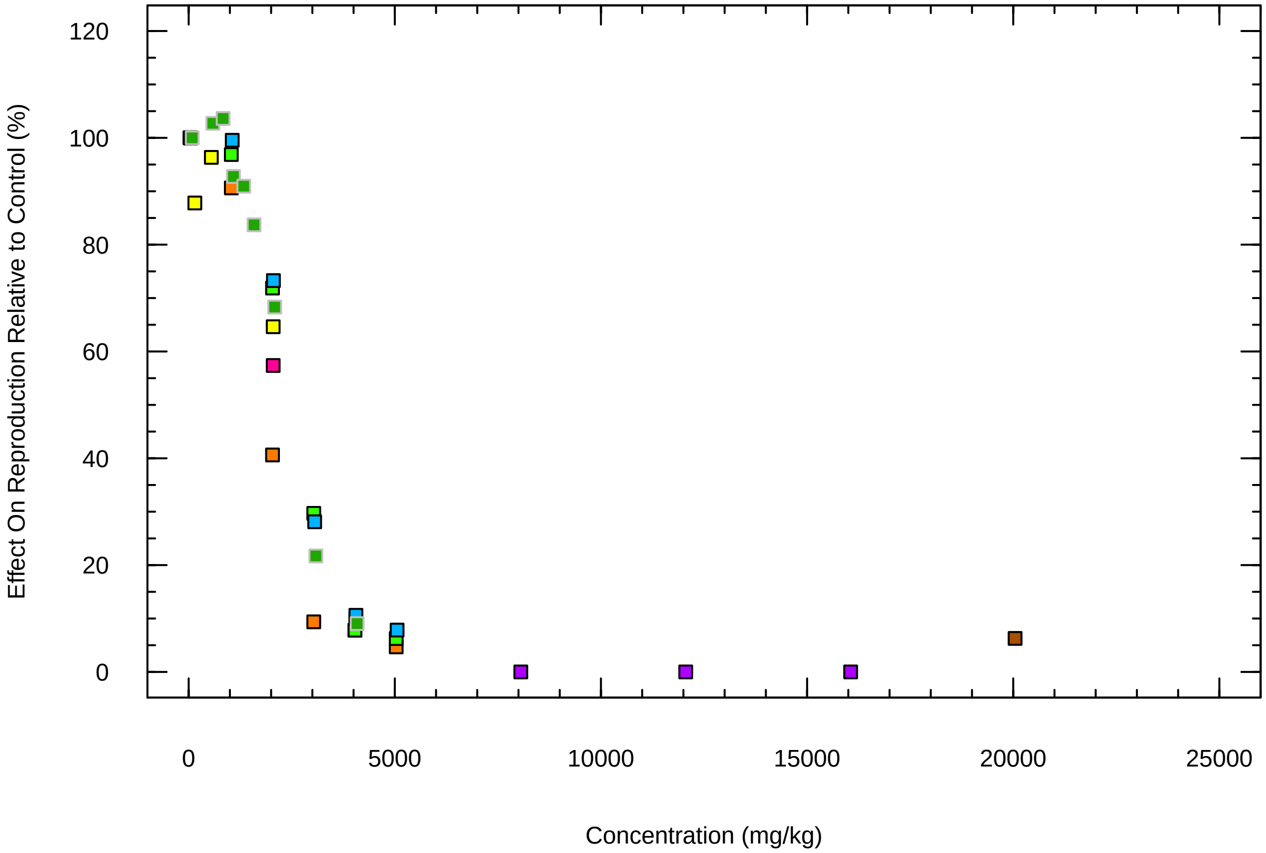
Figure 4−78. Concentration−Response Data for the Mammalian Survival Endpoint for Manganese



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Gasaway and Buss 1972	mallard	body weight gain	diet	5.71 weeks	zinc carbonate	
🟩	Hamilton et al. 1981	Japanese quail	body weight (Exp 2)	diet	2 weeks	zinc carbonate	
🟪	Hamilton et al. 1981	Japanese quail	body weight (Exp 5)	diet	2 weeks	zinc carbonate	
🟦	Roberson and Schaible 1960	chicken	body weight (Exp 2)	diet	4 weeks	zinc oxide	D
🟨	Roberson and Schaible 1960	chicken	body weight (Exp 2)	diet	4 weeks	zinc sulfate	C
🟥	Roberson and Schaible 1960	chicken	body weight (Exp 2)	diet	4 weeks	zinc carbonate	B
🟫	Roberson and Schaible 1960	chicken	body weight (Exp 3)	diet	4 weeks	zinc sulfate	C
🟩	Roberson and Schaible 1960	chicken	body weight (Exp 3)	diet	4 weeks	zinc carbonate	B
🟪	Roberson and Schaible 1960	chicken	body weight (Exp 3)	diet	4 weeks	zinc oxide	D
🟦	Stahl et al. 1989	chicken	body weight gain	diet	3 weeks	zinc carbonate	
🟨	Vohra and Kratzer 1968	turkey	body weight gain	diet	3 weeks	zinc oxide	
🟥	Lu and Combs 1988	chicken	body weight gain (Exp 3)	diet	3 weeks	zinc oxide	A
🟧	Lu et al. 1990	chicken	body weight gain (Exp 1)	diet	1 weeks	zinc oxide	A
🟩	Sandoval et al. 1988	chicken	body weight gain (Exp 2)	diet	3 weeks	zinc sulfate	E
🟪	Sandoval et al. 1988	chicken	body weight gain (Exp 2)	diet	3 weeks	zinc gluconate	
🟦	Hill 1974a	chicken	body weight gain	diet	2 weeks	zinc sulfate	E

☐ Tier 1

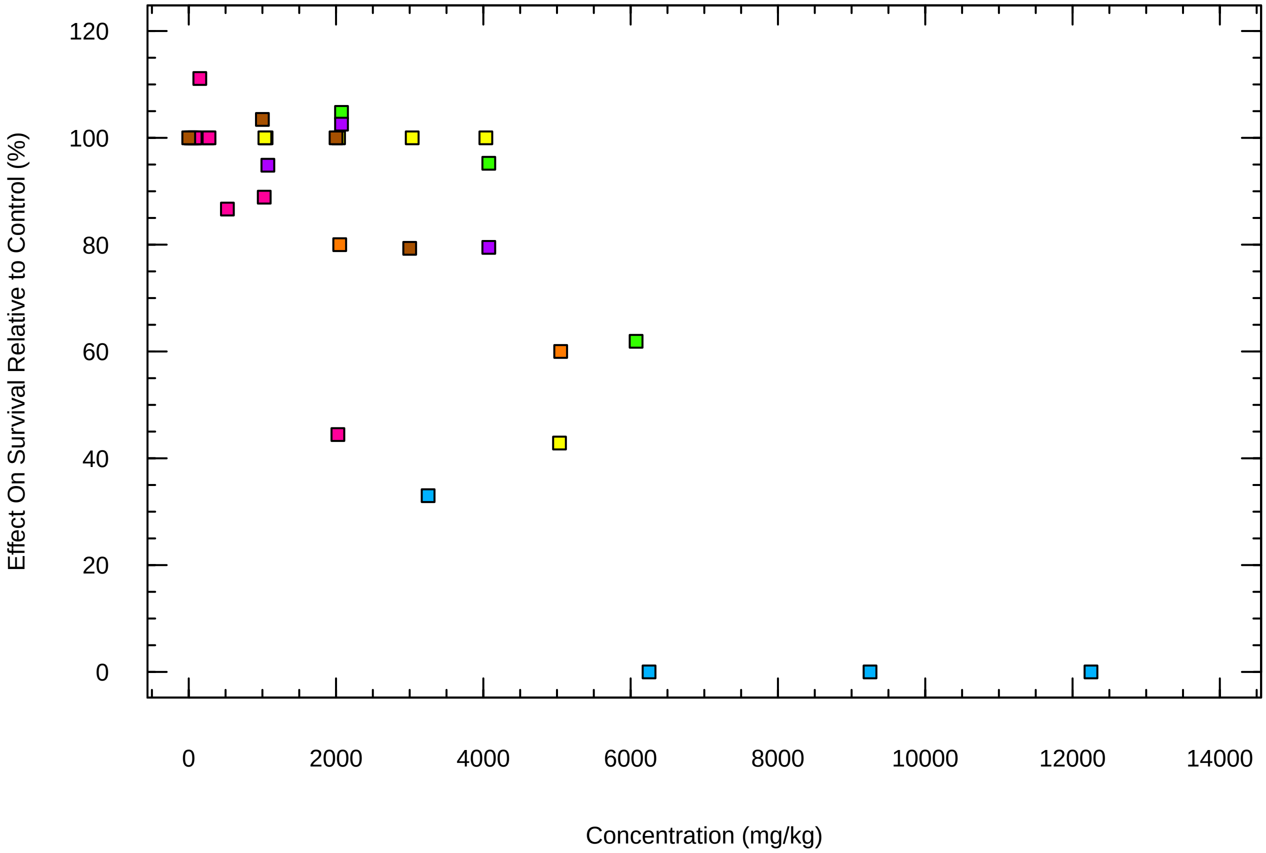
Figure 4−79. Concentration−Response Data for the Avian Growth Endpoint for Zinc



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Gibson et al. 1986	chicken	egg production	diet	10 weeks	zinc acetate dihydrate	
🟩	Gibson et al. 1986	chicken	egg production	diet	10 weeks	zinc oxide	
🟪	Jackson et al. 1986	chicken	egg production	diet	3 weeks	zinc oxide	
🟦	Jackson et al. 1986	chicken	egg production	diet	20 weeks	zinc oxide	F
🟨	Jensen and Maurice 1980	chicken	egg production (Exp 4)	diet	6 weeks	zinc sulfate	G
🟥	Jensen and Maurice 1980	chicken	egg production (Exp 3)	diet	6 weeks	zinc sulfate	G
🟫	Stepinska et al. 1987	chicken	egg production	diet	0.714 weeks	zinc oxide	
🟩	Stevenson et al. 1987	chicken	egg production	diet	20 weeks	zinc oxide	F

☐ Tier 1

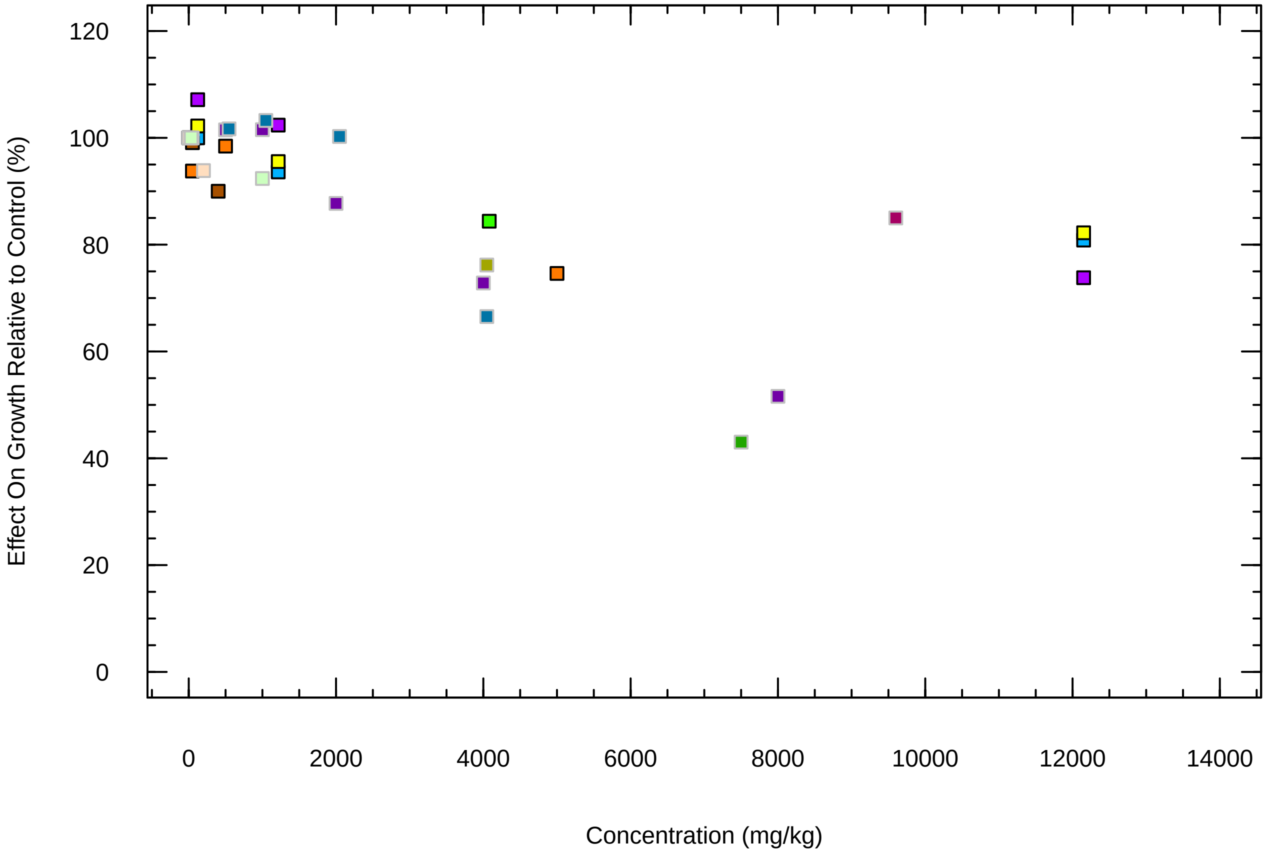
Figure 4−80. Concentration−Response Data for the Avian Reproduction Endpoint for Zinc



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Blalock and Hill 1988	chicken	survival	diet	2 weeks	zinc oxide	H
🟩	Dewar et al. 1983	chicken	survival (Exp 1)	diet	4 weeks	zinc oxide	
🟪	Dewar et al. 1983	chicken	survival (Exp 2)	diet	4 weeks	zinc oxide	H
🟦	Gasaway and Buss 1972	mallard	survival	diet	8.57 weeks	zinc carbonate	
🟨	Gibson et al. 1986	chicken	survival	diet	10 weeks	zinc acetate	
🟥	Hamilton et al. 1979	Japanese quail	survival	diet	2 weeks	zinc carbonate	
🟫	Roberson and Schaible 1960	chicken	survival (Exp 2)	diet	4 weeks	zinc carbonate	

☐ Tier 1

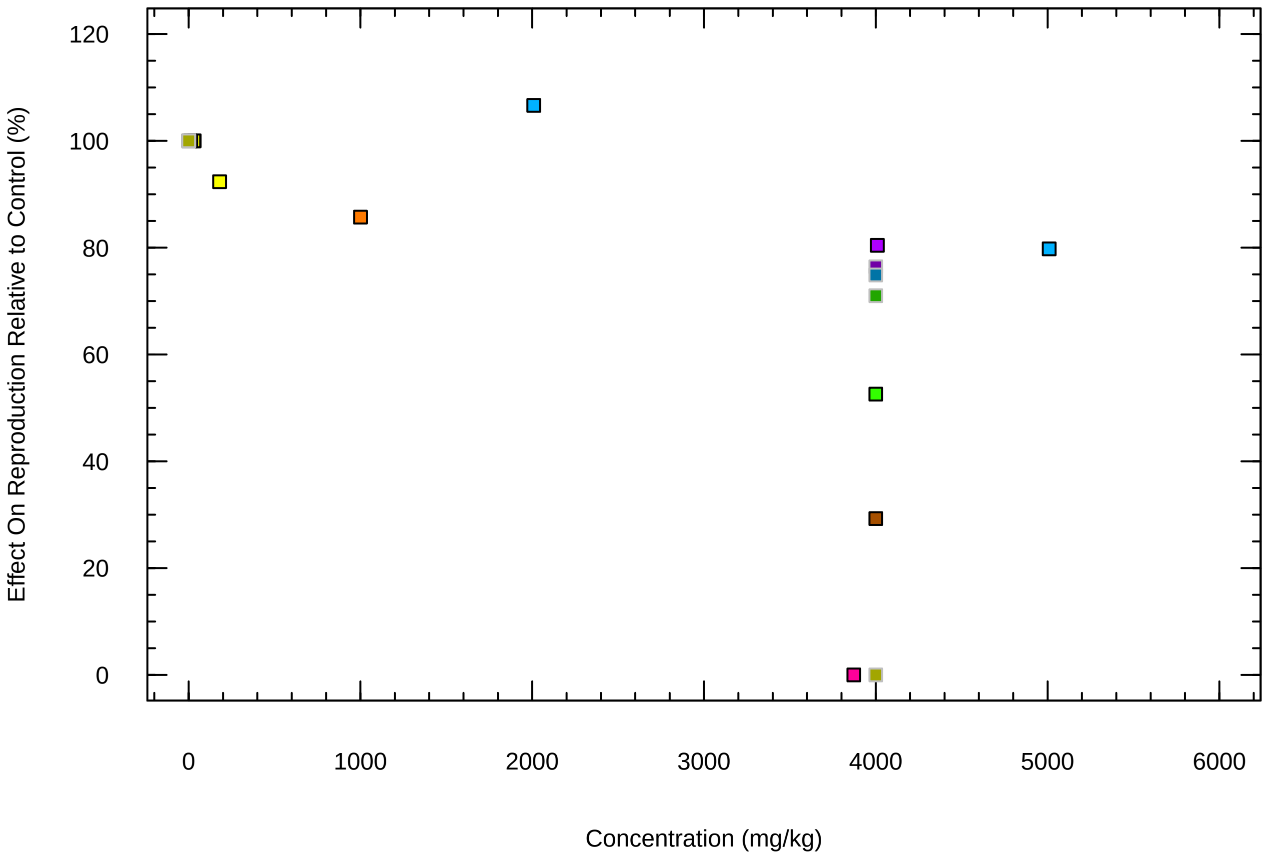
Figure 4−81. Concentration−Response Data for the Avian Survival Endpoint for Zinc



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Hill et al. 1983	pig	body weight	diet	to 18 months old	zinc oxide	
🟩	Hsu et al. 1975	pig	body weight	diet	9−13 weeks	zinc oxide	
🟪	Maita et al. 1981	mouse	body weight (female)	diet	13 weeks	zinc sulfate	
🟦	Maita et al. 1981	mouse	body weight (male)	diet	13 weeks	zinc sulfate	
🟨	Maita et al. 1981	rat	body weight (male)	diet	13 weeks	zinc sulfate	
🟫	Subramanian et al. 2000	rat	body weight	diet	6 weeks	zinc oxide	
🟩	Settlemire and Matrone 1967	rat	body weight gain	diet	5 weeks	zinc carbonate	
🟪	Brink et al. 1959	pig	body weight (Exp 1)	diet	6 weeks	not specified	A
🟦	Brink et al. 1959	pig	body weight (Exp 2)	diet	5 weeks	not specified	A
🟨	Brink et al. 1959	pig	body weight (Exp 3)	diet	6 weeks	not specified	A
🟥	Petterson et al. 2002	mouse	body weight	diet	3 weeks	zinc chloride	
🟧	Nakamura et al. 1983	rat	body weight	diet	11 weeks	zinc acetate	
🟩	Barone et al. 1998	rat	body weight	diet	gestation	not specified	

☐ Tier 1

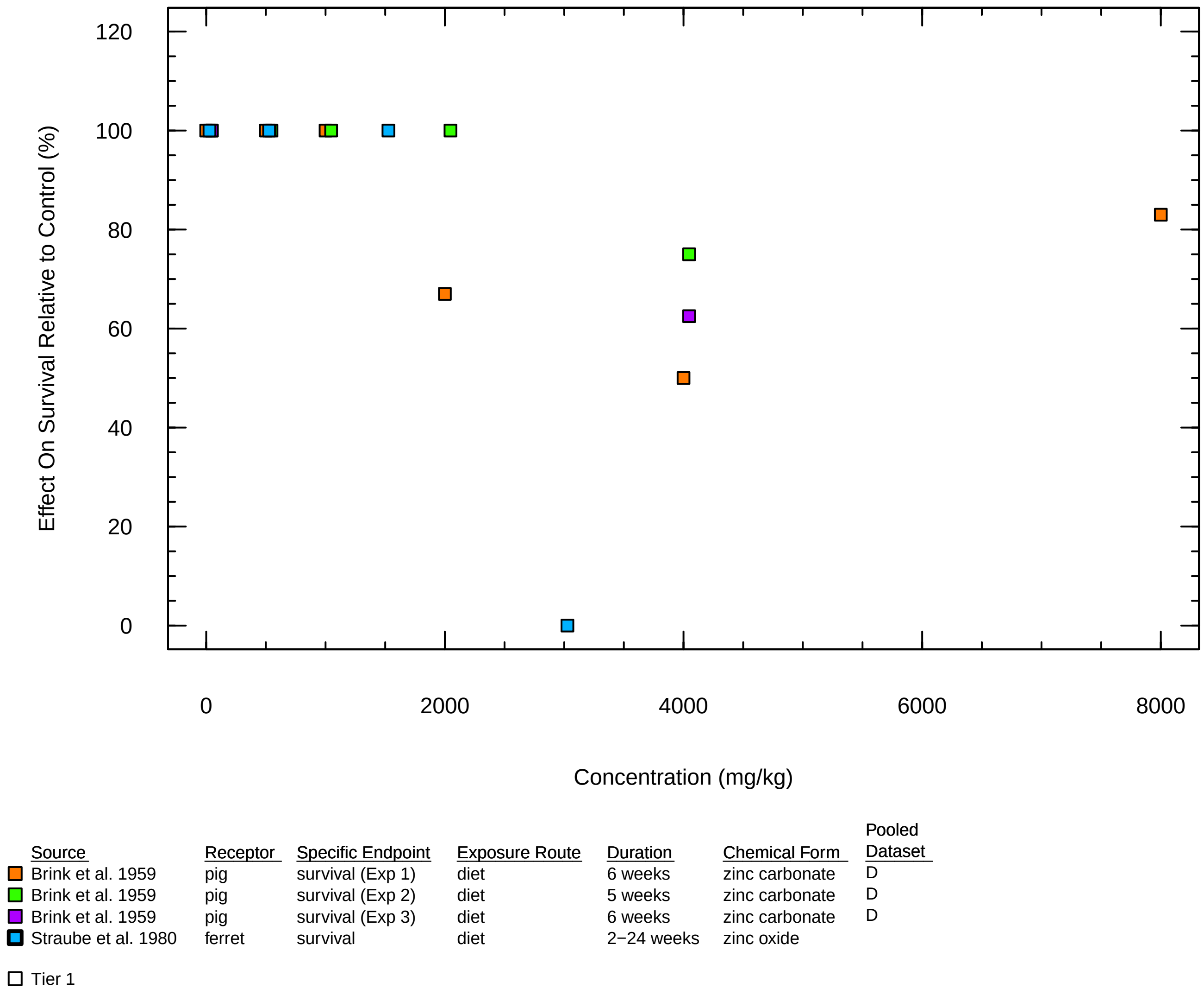
Figure 4−82. Concentration−Response Data for the Mammalian Growth Endpoint for Zinc



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Barone et al. 1998	rat	litter size	diet	gestation	not specified	
🟩	Chu and Cox 1972	rat	offspring growth	diet	3 weeks	not specified	
🟪	Cox et al. 1969	rat	fetal growth	diet	3.14 weeks	zinc oxide	B
🟦	Ketcheson et al. 1969	rat	offspring growth	diet	gestation to 14 days lactation	zinc oxide	
🟨	Kumar 1976	rat	fetal survival	diet	2.57 weeks	zinc sulfate	
🟥	Newman et al. 2002	rat	offspring survival	diet	gestation to post−natal day 40	zinc acetate dihydrate	
🟫	Pal and Pal 1987	rat	normal fetuses	diet	2.57 weeks	zinc sulfate	
■	Schlicker and Cox 1968	rat	fetal survival	diet	2.14 weeks	zinc oxide	C
■	Schlicker and Cox 1968	rat	fetal growth	diet	2.14 weeks	zinc oxide	B
■	Schlicker and Cox 1968	rat	fetal growth	diet	2.57 weeks	zinc oxide	B
■	Schlicker and Cox 1968	rat	fetal survival	diet	5.14 weeks	zinc oxide	C

☐ Tier 1

Figure 4−83. Concentration−Response Data for the Mammalian Reproduction Endpoint for Zinc



	Source	Receptor	Specific Endpoint	Exposure Route	Duration	Chemical Form	Pooled Dataset
🟧	Brink et al. 1959	pig	survival (Exp 1)	diet	6 weeks	zinc carbonate	D
🟩	Brink et al. 1959	pig	survival (Exp 2)	diet	5 weeks	zinc carbonate	D
🟪	Brink et al. 1959	pig	survival (Exp 3)	diet	6 weeks	zinc carbonate	D
🟦	Straube et al. 1980	ferret	survival	diet	2−24 weeks	zinc oxide	

☐ Tier 1

Figure 4−84. Concentration−Response Data for the Mammalian Survival Endpoint for Zinc

TABLES

Table 2-1. Preliminary COPCs Selected for UCR Birds and Mammals

	Aquatic Wildlife		Terrestrial Wildlife	
Chemical[a]	Birds	Mammals	Birds	Mammals
Aluminum	✓	✓	ns	ns
Antimony	ns	✓	ns	✓
Arsenic	X	X	X	X
Barium	✓	✓	ns	X
Beryllium	ns	X	ns	X
Cadmium	✓	✓	✓	✓
Chromium	✓	✓	✓	✓
Cobalt	X	X	X	X
Copper	✓	✓	✓	✓
Iron	ns	ns	ns	ns
Lead	✓	✓	✓	✓
Manganese	✓	✓	X	X
Mercury	✓	✓	ns	ns
Molybdenum	✓	✓	ns	ns
Nickel	X	X	X	X
Selenium	✓	✓	✓	✓
Silver	X	X	X	X
Vanadium	✓	X	✓	X
Zinc	✓	✓	✓	✓

Notes:

Shaded cells indicate chemicals selected as (chemicals of potential concern) COPCs.

[a] COPCs for terrestrial and aquatic wildlife are based on comparison of doses based on upper confidence limits to no-observed-adverse-effect levels.

✓ - selected

X - not selected

ns - not screened

Table 3-1. Use of Effect Measures from Eco-SSL Documents for TRV Development

Effect Type	Effect Measure	Effect Measure Definition	Used for TRV Development?
Bird and Mammal Growth			
GRO	BDWT	body weight	yes
GRO	GGRO	general growth	yes
DVP	GDPV	general development	no[a]
MPH	GMPH	general morphology	no
MPH	MUSC	muscle changes	no
MPH	Other	NA	no
Bird and Mammal Survival			
MOR	LFSP	lifespan	yes
MOR	MORT	mortality	yes
MOR	SURV	survival	yes
Bird Reproduction			
REP	ALWT	albumin weight	no
REP	EGPN	egg production	yes
REP	EGWT	egg weight	no
REP	ESQU	eggshell quality	no
REP	ESTH	eggshell thickness	no
REP	ORWT	organ weight changes	no
REP	PROG	progeny counts/numbers	yes
REP	RHIS	reproductive organ histology	no
REP	SPCV	sperm cell viability	no
REP	TEDG	testes degeneration	no
REP	TEWT	testes weight	no
REP	TPRD	total production	yes
Mammal Reproduction			
REP	DEYO	death of young	yes
REP	FERT	fertility	yes
REP	GREP	general reproductive effect	yes[b]
REP	ODVP	offpsring development	no
REP	ORWT	organ weight changes	no
REP	Other	NA	no[c]
REP	PRFM	pregnant females in a population	no
REP	PROG	progeny counts/numbers	yes
REP	PRWT	progeny weight	yes
REP	RBEH	reproductive behavior	no
REP	RHIS	reproductive organ histology	no
REP	RPRD	reproductive capacity	no
REP	RSEM	resorbed embryos	yes
REP	RSUC	reproductive success	yes
REP	SPCL	sperm cell counts	no
REP	SPCV	sperm cell viability	no
REP	TEDG	testes degeneration	no
REP	TEWT	testes weight	no

Notes:

[a] Not used because response site was the eye.

[b] This endpoint was used with the exception of Baranski and Sitarek (1987) because the specific endpoint was oestrous duration.

[c] Not used because response site was the seminal vesicle.

DVP - development
Eco-SSL - ecological soil screening level
GRO - growth
MOR - mortality
MPH - morphology
NA - not applicable
REP - reproduction
TRV - toxicity reference value

Table 3-2. Juvenile Life Stages for Bird and Mammal Test Species

Test Species	Age at End of Juvenile Life Stage	Basis	Source
Birds			
Bobwhite quail	9 weeks	juvenal plumage fully developed	Brennan et al. 2014
Chicken	3 months	age at first egg	Podisi et al. 2011
Japanese quail	8 weeks	end of first juvenal plumage; sexual maturity	Ipek et al. 2004; Lyon 1962
Mallard	10 weeks	fledging (i.e., independent stage)	Drilling et al. 2002
Turkey	7.5 months	juvenile plumage fully developed; cessation of parental care	McRoberts et al. 2014
Wood duck	10 weeks	most birds flyng and juvenile plumage almost complete	Hepp and Bellrose 2013
Mammals			
Cat	240 days	sexual maturity	USEPA 1988
Dog	240 days	sexual maturity	USEPA 1988
Guinea pig	10 weeks	sexual maturity	USEPA 1988
Hamster	60 days	sexual maturity	USEPA 1988
Mink	300 days	sexual maturity	USEPA 1988
Mouse	50 days	sexual maturity	USEPA 1988
Pig	150 days	sexual maturity	USEPA 1988
Rabbit	4.5 months	sexual maturity	USEPA 1988
Rat	56 days	sexual maturity	USEPA 1988
Shrew	50 days	sexual maturity	George et al. 1986
Vole	40 days	sexual maturity	USEPA 1988

Table 3-3. Lifespans for Bird and Mammal Test Species

Test Species	Lifespan (years)
Mammals	
Cat	15
Dog	15
Guinea pig	6
Hamster	2.5
Mink	9
Mouse	2
Pig	2[a]
Rabbit	6
Rat	2
Shrew	1.04
Vole	0.25
Birds	
Bobwhite quail	6.5
Chicken	8[a]
Japanese quail	3
Mallard	1.8[a]
Turkey	1.6[a]
Wood duck	4[b]

Notes:

All values based on information provided by USEPA (2007) except where noted.

[a] Derived in agreement with EPA based on review of a variety of sources; for birds preference was given to data from the British Trust for Ornithology website (www.bto.org/about-birds/birdfacts) and the Cornell Lab of Ornithology (www.birdsna.org).

[b] Based on information provided by the National Wildlife Federation (2018)

Table 3-4. Number of Wildlife Studies Reviewed and Usable Dose-Response Datasets

		Number of Studies Reviewed[a]			Number of Usable Datasets[a]		
Receptor Group	Endpoint	Tier 1[b]	Tier 2[c]	Total	Tier 1[b]	Tier 2[c]	Total
Cadmium							
Bird	growth	12	1	13	10	1	11
Bird	reproduction	4	0	4	5	0	5
Bird	survival	6	0	6	5	0	5
Mammal	growth	16	0	16	9	0	9
Mammal	reproduction	5	0	5	8	0	8
Mammal	survival	3	2	5	3	3	6
Copper							
Bird	growth	10	0	10	12	0	12
Bird	reproduction	10	0	10	13	0	13
Bird	survival	5	0	5	7	0	7
Mammal	growth	8	0	8	5	0	5
Mammal	reproduction	3	0	3	4	0	4
Mammal	survival	5	1	6	5	2	7
Lead							
Bird	growth	14	0	14	12	0	12
Bird	reproduction	4	0	4	8	0	8
Bird	survival	5	0	5	2	0	2
Mammal	growth	10	0	10	4	0	4
Mammal	reproduction	7	0	7	5	0	5
Mammal	survival	5	0	5	5	0	5
Manganese							
Bird	growth	3	0	3	0	0	0
Bird	reproduction	0	0	0	0	0	0
Bird	survival	0	0	0	0	0	0
Mammal	growth	3	2	5	1	0	1
Mammal	reproduction	1	3	4	1	2	3
Mammal	survival	2	0	2	2	0	2
Zinc							
Bird	growth	9	0	9	12	0	12
Bird	reproduction	5	0	5	8	0	8
Bird	survival	6	0	6	7	0	7
Mammal	growth	10	0	10	7	0	7
Mammal	reproduction	9	0	9	9	0	9
Mammal	survival	2	0	2	4	0	4

Notes:

[a] Number of studies and usable datasets includes those reviewed for the purposes of pooling and for inclusion of unique receptors. The number of usable datasets may be higher than the number of unique studies because some studies included multiple experiments and/or measurements.

[b] Tier 1 includes growth studies with exposure during the critical lifestage or with a duration of at least 10 percent of the lifespan, and all survival and reproduction studies regardless of exposure duration. The exposure route for all Tier 1 data is diet or gavage.

[c] Tier 2 includes studies with drinking water exposure or studies for the growth endpoint if exposure was not during the critical lifestage or if the study duration was less than 10 percent of the lifespan.

Table 3-5. Source of Body Weights and Food Ingestion Rates for Dose Calculations

Test Organism[a]	BW[b] (kg)	BW Source	FIR (kg/d dw)[c]	FIR (kg/d ww)	Receptor Type for FIR Application	FIR Source
Mammals						
Mink	NA	NA	based on sex		mink	Bleavins and Aulerich 1981
Mouse[d]	based on sex and age	USEPA 1988	$0.056*(BW^{0.6611})$	NA	lab mammals	USEPA 1988
Pig[e]	based on age	Cai et al. 2009	based on age	NA	pig	Cai et al. 2009
Rabbit	based on sex and age	USEPA 1988	NA	NA	NA	NA
Rat[d]	based on sex and age	USEPA 1988	$0.056*(BW^{0.6611})$	NA	lab mammals	USEPA 1988
Shrew	NA	NA	NA	$1.13*((BW*1000)^{0.622})/1000$	insectivores	Nagy 2001
Birds						
Chicken (broiler)	based on age and sex	NRC 1994	based on age and sex	NA	chicken (broiler)	NRC 1994
Chicken[f]	based on age and sex	USEPA 1988	$0.075*(BW^{0.8449})$	NA	chicken	USEPA 1988
Duck, mallard	1.082	Dunning 1993	BW/10	NA	duck (mallard)	Heinz et al. 1987
Duck, Pekin	based on sex and age	NRC 1994	(0.638*((BW*1000)0.685))/1000	$(2.065*((BW*1000)^{0.689}))/1000$	birds	Nagy 2001
Quail, Japanese	based on age	based on age[g]	(0.638*((BW*1000)0.685))/1000	$(2.065*((BW*1000)^{0.689}))/1000$	birds	Nagy 2001
Turkey	based on age and sex	NRC 1994	based on age and sex	NA	turkey	NRC 1994

Notes:

[a] Organisms are not listed in this table if body weights (BWs) and food ingestion rates (FIRs) from the study were available.

[b] When possible, growth curves based on organism age were used to estimate BW.

[c] If wet weight or dry weight basis was not reported, FIRs were assumed to be reported on a dry weight basis (based on typical feed type for laboratory mammals, chickens, and turkeys).

[d] When a secondary source for drinking water ingestion was needed for mouse and rat, the equation from Calder and Braun (1983) was used: $0.099*(BW^{0.9})$

[e] When both a BW and a FIR were needed for pigs, values were taken from Cai et al. (2009). If only a FIR was needed, the equation for omnivores from Nagy (2001) was used.

[f] Used for chickens other than broiler

[g] Narinc et al. (2010) or Vos et al. (1971) was used, depending on age.

NA - not applicable (no secondary source needed)

Table 3-6. UCR Avian Receptors and Toxicity Test Species

UCR Receptors	Chicken	Mallard Duck	Other Duck	Kestrel	Pigeon	Quail	Turkey
Aquatic							
Belted kingfisher							
Canada goose							
Great blue heron							
Mallard duck		*					
Spotted sandpiper							
Tree swallow							
Terrestrial							
American kestrel				*			
American robin							
Bald eagle							
Blue grouse							
Red-tailed hawk							
Tree swallow							

Green shading with asterisk indicates species match for receptor-specific toxicity reference value.

Blank cells indicate there was no match between the UCR receptor and the receptor species used in toxicity tests.

Table 3-7. UCR Mammalian Receptors and Toxicity Test Species

UCR Receptors	Dog	Ferret	Mink	Mouse	Pig	Rabbit	Rat	Shrew	Vole
Aquatic									
Little brown bat									
Mink			*						
Muskrat									
River otter									
Shrew								*	
Terrestrial									
Little brown bat									
Meadow vole									*
Mink			*						
Raccoon									
Red fox									
Shrew								*	

Notes:

Green shading with asterisk indicates species match for receptor-specific toxicity reference value.

Blank cells indicate there was no match between the UCR receptor and the receptor species used in toxicity tests.

Table 3-8. Potential Bias Associated with Uncertainty Considerations

Consideration	Potential Bias in TRV	Potential Effect on Risk Estimate
Test species is not a UCR receptor	high or low	possible under- or overestimation because it is not known how sensitive the UCR receptor would be compared to the test species
Dose administration	high or low	possible overestimation for drinking water studies because chemicals are expected to be more bioavailable than when administered by diet or gavage; possible under- or overestimation of risk based on uncertainties in administration by diet or gavage
Growth study conducted during a non-critical life stage and for less than 10% of species' lifespan	low	possible overestimation because of uncertainty that growth effects during a noncritical life stage for a relatively short time period would result in ecologically relevant effects
Chemical form	high or low	possible under- or overestimation if chemical form used in the toxicity test is more or less toxic or bioavailable than the form present in dietary items of UCR wildlife
Dose calculated with estimated body weight and/or food ingestion rate	high or low	possible under- or overestimation because it is not known if estimated body weights and/or food ingestion rates are biased high or low
LOAEL ≥ 20 rather than ED20	high	possible underestimation because the value represents a level at which adverse effects are expected to be higher than 20% of the control

Notes:

Potential bias was based on whether the uncertainties in the toxicity reference value (TRV) derivation may have resulted in higher or lower estimates of the TRV than might otherwise have been derived, as discussed in Section 3.7

ED20 – effective dose with a 20% reduction in the response relative to the control (modeled)

LOAEL ≥ 20 – lowest observed adverse effect level with ≥20% reduction in the response relative to the control

Table 4-1. Summary of Cadmium Dose-Response Datasets

Source	Effect Dose (mg/kg bw/day)	Type of Effect Level	LOAEL Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group[a]	Modeling Category[b]
Bird Growth												
Bafundo et al. 1984	5.0	LOAEL ≥ 20	77.0	chicken	1 week	cadmium chloride	body weight gain	diet	2	1	none	3
Bokori et al. 1995b	**2.0**	**ED20**	**70.1**	**chicken**	**21 days**	**cadmium sulfate**	**body weight**	**diet**	**4**	**1**	**none**	**1**
Bokori et al. 1996	NA	NA	NA	chicken	chick to adult	cadmium sulfate	body weight	diet	39	1	none	3
DiGiulio and Scanlon 1984	*41*	*ED20*	*75.9*	*mallard duck*	*11 months*	*cadmium chloride*	*body weight*	*diet*	*6*	*2*	*none*	*1*
Hill 1974a	7.7	LOAEL ≥ 20	53.5	chicken	1 day	cadmium sulfate	body weight gain	diet	2	1	A	4
Hill 1974b	7.3	LOAEL ≥ 20	54.9	chicken	1 day	cadmium sulfate	body weight gain	diet	2	1	A	4
Hill 1979	5.1	LOAEL ≥ 20	73.7	chicken	1 day	cadmium sulfate	body weight gain	diet	2	1	A	4
Hill 1980	13	LOAEL ≥ 20	27.6	chicken	1 day	cadmium sulfate	body weight gain	diet	2	1	A	4
Rama and Planas 1981	9.7	LOAEL ≥ 20	57.7	chicken	1 day	cadmium sulfate	body weight gain	diet	9	1	A	4
Olgun 2015	3.1	ED20	62.7	Japanese quail	21 weeks	cadmium sulfate	body weight gain	diet	10	1	none	1
Richardson and Fox 1974	12	LOAEL ≥ 20	51.7	Japanese quail	1 day	cadmium chloride	body weight	diet	4	1	B	4
Richardson et al. 1974	12	LOAEL ≥ 20	69.7	Japanese quail	1 day	cadmium chloride	body weight	diet	4	1	B	4
Richardson et al. 1974	NA	NA	NA	Japanese quail	1 day	cadmium chloride	male body weight	diet	6	1	B	4
Bird Reproduction												
Bokori et al. 1995a	2.4	ED20	46.1	Japanese quail	adult	cadmium sulfate	egg production	diet	5.3	1	none	1
Leach et al. 1979	3.8	LOAEL ≥ 20	60.8	chicken	adult	cadmium sulfate	egg production	diet	48	1	none	3
Leach et al. 1979	**2.3**	**ED20**	**75.1**	**chicken**	**adult**	**cadmium sulfate**	**egg production**	**diet**	**12**	**1**	**none**	**1**
Olgun 2015	5.3	LOAEL ≥ 20	70.5	Japanese quail	22 weeks	cadmium sulfate	egg production	diet	10	1	none	4
White and Finley 1978	*20*	*LOAEL ≥ 20*	*28.6*	*mallard duck*	*adult*	*cadmium chloride*	*egg production*	*diet*	*4.3-12.9*	*1*	*none*	*3*
Bird Survival												
Pooled dataset:	**7.4**	**ED20**	**NA**	**Japanese quail**	**23 weeks to adult**	**cadmium sulfate**	**survival**	**diet**	**5.3 - 10**	**1**	**C**	5
Bokori et al. 1995a	9.4	LOAEL ≥ 20	77.8	Japanese quail	adult	cadmium sulfate	survival	diet	5.3	1	C	5
Olgun 2015	10.6	LOAEL ≥ 20	46.7	Japanese quail	23 weeks	cadmium sulfate	survival	diet	10	1	C	5
Bokori et al. 1995b	42	LOAEL ≥ 20	11.1	chicken	21 days	cadmium sulfate	survival	diet	8	1	none	3
Hill 1974b	NA	NA	NA	chicken	1 day	cadmium sulfate	survival	diet	2	1	none	3
Pritzl et al. 1974	65	LOAEL ≥ 20	45.0	chicken	2 week	cadmium carbonate	survival	diet	2.9	1	none	4
Van Vleet et al. 1981	130	LOAEL ≥ 20	10.0	Pekin duck	1 day	cadmium sulfate	survival	diet	4	1	none	4
Mammal Growth												
Baranski and Sitarek 1987	29	LOAEL ≥ 20	71.5	rat	3 months	cadmium chloride	body weight	gavage	14	1	none	4
Cousins et al. 1977	NA	NA	NA	rat	juvenile	cadmium chloride	body weight	diet	14	1	none	3
Dodds-Smith et al. 1992	*104*	*LOAEL ≥ 20*	*78.0*	*shrew*	*weanling*	*cadmium chloride*	*body weight*	*diet*	*12*	*1*	*none*	*3*
Groten et al. 1991	NA	NA	NA	rat	5 weeks	cadmium chloride	body weight	diet	8	1	none	3
Hamada et al. 1991	100	LOAEL ≥ 20	70.1	dog	6 to 8 months	cadmium chloride	body weight	diet	8-9 years	1	none	3
Merali and Singhal 1980	NA	NA	NA	rat	1 day	cadmium chloride	body weight	gavage	6.1	1	none	3
Pond et al. 1973	6.3	LOAEL ≥ 20	78.4	pig	weanling	cadmium chloride	body weight	diet	7.1	1	none	3
Rajanna et al. 1984	NA	NA	NA	rat	6 weeks	cadmium chloride	body weight	diet	25.7	1	none	3
Rastogi et al 1977	NA	NA	NA	rat	1 day	cadmium chloride	body weight	gavage	4.3	1	none	3
Pooled dataset:	5.4	ED20	NA	rat	juvenile	cadmium chloride	body weight	diet	2.0 - 6.4	1	A	5
Suzuki and Yoshida 1977	5.0	LOAEL ≥ 20	77.5	rat	juvenile	cadmium chloride	body weight	diet	6.4	1	A	5
Suzuki and Yoshida 1978a	NA	NA	NA	rat	juvenile	cadmium chloride	body weight	diet	2	1	A	5
Suzuki and Yoshida 1979	6.0	LOAEL ≥ 20	72.7	rat	juvenile	cadmium chloride	body weight	diet	2	1	A	5
Suzuki and Yoshida 1979	5.9	LOAEL ≥ 20	79.4	rat	juvenile	cadmium chloride	body weight	diet	4	1	A	5
Suzuki and Yoshida 1978b	NA	NA	NA	rat	juvenile	cadmium chloride	body weight	diet	25.7	1	none	3
Suzuki and Yoshida 1978b	NA	NA	NA	rat	juvenile	cadmium chloride	body weight	diet	25.7	1	none	3
Weber and Reid 1969	160	LOAEL ≥ 20	44.4	mouse	weanling	cadmium acetate	body weight	diet	3	1	none	4
Weigel et al. 1987	NA	NA	NA	rat	weanling	cadmium oxide	body weight	diet	7.9	1	none	3
Wilson et al. 1941	**4.2**	**ED20**	**80.0**	**rat**	**juvenile**	**cadmium chloride**	**body weight**	**diet**	**7.1**	**1**	**none**	**1**
Mammal Reproduction												
Machemer and Lorke 1981	61	LOAEL ≥ 20	0.0	rat	adult	cadmium chloride	pregancy success	gavage	1.4	1	none	4
Sawicka-Kapusta et al. 1994	6.9	LOAEL ≥ 20	77.7	mouse	15 days pregnant	cadmium chloride	offspring growth	diet	5	1	none	4
Sawicka-Kapusta et al. 1994	21	LOAEL ≥ 20	57.9	mouse	15 days pregnant	cadmium chloride	offspring survival	diet	5	1	none	4
Sutou et al. 1980	10	LOAEL ≥ 20	66.4	rat	4 weeks	cadmium chloride	male fetal body weight	gavage	9	1	B	4
Sutou et al. 1980	10	LOAEL ≥ 20	66.7	rat	4 weeks	cadmium chloride	female fetal body weight	gavage	9	1	B	4
Sutou et al. 1980	10	LOAEL ≥ 20	72.1	rat	4 weeks	cadmium chloride	fetal implants	gavage	>9	1	none	4
Sutou et al. 1980	**2.7**	**ED20**	**50.7**	**rat**	**4 weeks**	**cadmium chloride**	**live fetuses**	**gavage**	**>9**	**1**	**none**	**1**
Wardell et al. 1982	NA	NA	NA	rat	adult	not specified	litter weight	gavage	1.9	1	none	3
Whelton et al. 1988	9.2	LOAEL ≥ 20	75.4	mouse	adult	cadmium chloride	offspring growth	diet	36	1	none	3

Table 4-1. Summary of Cadmium Dose-Response Datasets

Source	Effect Dose (mg/kg bw/day)	Type of Effect Level	LOAEL Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group[a]	Modeling Category[b]
Mammal Survival												
Baranski and Sitarek 1987	29	LOAEL ≥ 20	46.0	rat	adult	cadmium chloride	survival	gavage	14	1	none	3
Schroeder et al. 1963	0.55	LOAEL ≥ 20	23.3	rat	weaning	not specified	male survival	drinking water	92	2	C	2
Schroeder et al. 1963	0.56	LOAEL ≥ 20	63.2	rat	weaning	not specified	female survival	drinking water	92	2	C	2
Schroeder et al. 1964	0.70	LOAEL ≥ 20	64.0	mouse	weaning	not specified	male survival	drinking water	78	2	none	3
Swiergosz et al. 1998	***1.5***	***ED20***	***69.8***	***vole***	***adult***	***cadmium chloride***	***survival***	***diet***	***24***	***1***	***none***	***1***
Weber and Reid 1969	810	LOAEL ≥ 20	42.0	mouse	adult	cadmium acetate	survival	diet	3	1	none	4

Notes:

Bold indicates the lowest effect level, selected from the lowest tier evaluated, and as the lowest value from the following: 1) LOAEL ≥ 20 from an individual dataset, 2) ED20 from an individual dataset, or 3) ED20 or geomean from a pooled dataset that was selected for modeling because the effect concentration had the potential for being lower than other ED20s and/or LOAELs based on visual inspection of the plotted data (i.e., Category 2 or 5).

Italics indicate UCR receptor-specific toxicity reference value (TRV) dataset.

Bold and italics together indicate data were used to derive both the selected TRV and the receptor-specific TRV.

Yellow highlights indicate pooled datasets modeled in the toxicity relationship analysis program (TRAP).

[a] Pooling groups were evaluated only as a group and not on an individual basis for the purposes of selecting data to model in TRAP. Not all pooling groups were run in TRAP.

[b] Modeling categories are defined as follows:

1. Data were modeled in TRAP as an individual dataset to derive the ED20 presented in this table.
2. Data were selected for modeling as an individual or pooled dataset but an ED20 could not be generated or the ED20 was not used due to poor model fit.
3. Data do not meet criteria for modeling as an individual dataset (e.g., no effect with a ≥20 percent reduction in response relative to control, lack of two consecutively lower and different effects less than the control or consecutively lower effects are followed by an increased effect, a lower tier dataset is available).
4. Not selected for modeling because the effect concentration for the individual or pooled dataset is substantially higher than other ED20s and/or LOAELs.
5. Modeled in TRAP as part of a pooled dataset.

ED20 – effective dose with a 20% reduction in the response relative to the control (modeled)

LOAEL ≥ 20 – lowest observed adverse effect level with ≥20% reduction in the response relative to the control

NA - not applicable because the effect level is an ED20 or reduction in response was <20 percent relative to the control

Table 4-2. Summary of Copper Dose-Response Datasets

Source	Effect Dose (mg/kg bw/day)	Type of Effect Level	LOAEL Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group[a]	Modeling Category[b]
Bird Growth												
Pooled dataset C:	86	ED20	NA	chicken	1 day/chick	copper sulfate	body weight	diet	2 to 4	1	C	5
Hill 1974a	130	LOAEL ≥ 20	67.5	chicken	1 day	copper sulfate	body weight	diet	2	1	C	5
Jensen and Maurice 1978	NA	NA	NA	chicken	chick	copper sulfate	body weight	diet	4	1	C	5
Jensen and Maurice 1978	84	LOAEL ≥ 20	78.7	chicken	chick	copper sulfate	body weight	diet	4	1	C	5
Jensen and Maurice 1979	56	LOAEL ≥ 20	76.5	chicken	1 day	copper sulfate	body weight	diet	4	1	C	5
Latymer and Cotes 1981	28	LOAEL ≥ 20	66.7	chicken	1 day	copper sulfate	body weight	diet	3.4	1	C	5
Smith 1969	NA	NA	NA	chicken	1 day	copper sulfate	body weight	diet	3.6	1	C	5
Kashani et al. 1986	NA	NA	NA	turkey	1 day	cupric sulfate pentahydrate	body weight	diet	24	1	none	3
Kashani et al. 1986	NA	NA	NA	turkey	1 day	cupric sulfate pentahydrate	body weight	diet	24	1	none	3
Miles et al. 1998	NA	NA	NA	chicken	1 day	cupric sulfate pentahydrate	body weight	diet	3	1	none	3
Miles et al. 1998	69	LOAEL ≥ 20	64.3	chicken	1 day	dicopper chloride trihydroxide	body weight	diet	6	1	none	4
Miles et al. 1998	69	LOAEL ≥ 20	75.0	chicken	1 day	cupric sulfate pentahydrate	body weight	diet	6	1	none	4
Persia et al. 2004	120	LOAEL ≥ 20	74.3	chicken	8 days	copper chloride	body weight	diet	2.1	1	E	4
Persia et al. 2004	67	LOAEL ≥ 20	77.7	chicken	8 days	copper chloride	body weight	diet	2	1	E	4
Pooled dataset D:	**62**	**ED20**	**NA**	**chicken**	**1 day**	**copper sulfate**	**body weight gain**	**diet**	**2.9 to 4**	**1**	**D**	**5**
Poupoulis and Jensen 1976	110	LOAEL ≥ 20	48.6	chicken	1 day	copper sulfate	body weight gain	diet	4	1	D	5
Poupoulis and Jensen 1976	84	LOAEL ≥ 20	45.2	chicken	1 day	copper sulfate	body weight gain	diet	4	1	D	5
Poupoulis and Jensen 1976	110	LOAEL ≥ 20	50.3	chicken	1 day	copper sulfate	body weight gain	diet	4	1	D	5
Wang et al. 1987	NA	NA	NA	chicken	1 day	copper sulfate	body weight gain	diet	2.9	1	D	5
Wang et al. 1987	65	LOAEL ≥ 20	76.3	chicken	1 day	copper sulfate	body weight gain	diet	2.9	1	D	5
Bird Reproduction												
Al Ankari et al. 1998	NA	NA	NA	chicken	25 weeks	copper sulfate/acetate	egg production	diet	12	1	none	3
Pooled dataset A:	**28**	**ED20**	**NA**	**chicken**	**24 to 68 weeks**	**copper sulfate**	**egg production**	**diet**	**4 to 8**	**1**	**A**	**5**
Chiou et al. 1997	41	LOAEL ≥ 20	51.4	chicken	28 weeks	copper sulfate	egg production	diet	4	1	A	5
Harms and Buresh 1986	32	LOAEL ≥ 20	32.2	chicken	68 weeks	copper sulfate	egg production	diet	6	1	A	5
Pearce et al. 1983	63	LOAEL ≥ 20	22.2	chicken	26 weeks	copper sulfate	egg production	diet	6.9	1	A	5
Stevenson and Jackson 1980b	32	LOAEL ≥ 20	77.8	chicken	24 weeks	copper sulfate	egg production	diet	8	1	A	5
Stevenson and Jackson 1980a	32	LOAEL ≥ 20	77.8	chicken	24 weeks	copper sulfate pentahydrate	egg production	diet	6.9	1	A	5
Pooled dataset B:	34	ED20	NA	chicken	24 to 27 weeks	copper sulfate	egg production	diet	32 to 48	1	B	5
Jackson et al. 1979	51	LOAEL ≥ 20	59.8	chicken	24 weeks	copper sulfate	egg production	diet	32	1	B	5
Jackson et al. 1979	38	LOAEL ≥ 20	70.9	chicken	24 weeks	copper sulfate	egg production	diet	32	1	B	5
Jackson et al. 1979	56	LOAEL ≥ 20	50.9	chicken	24 weeks	copper sulfate	egg production	diet	48	1	B	5
Jackson and Stevenson 1981a	37	LOAEL ≥ 20	74.6	chicken	27 weeks	copper sulfate	egg production	diet	40	1	B	5
Jackson and Stevenson 1981a	33	LOAEL ≥ 20	68.2	chicken	27 weeks	copper sulfate	egg production	diet	40	1	B	5
Jackson and Stevenson 1981b	35	LOAEL ≥ 20	75.1	chicken	26 weeks	copper sulfate	egg production	diet	48	1	B	5
Jackson and Stevenson 1981b	35	LOAEL ≥ 20	68.8	chicken	26 weeks	copper sulfate	egg production	diet	48	1	B	5
Stevenson et al. 1983	74	LOAEL ≥ 20	70.0	chicken	27 weeks	copper sulfate	egg production	diet	0.7	1	none	4
Bird Survival												
Mehring et al. 1960	**67**	**ED20**	**61.5**	**chicken**	**1 day**	**copper oxide**	**survival**	**diet**	**10**	**1**	**none**	**1**
Hill 1974a	190	LOAEL ≥ 20	54.3	chicken	1 day	copper sulfate	survival	diet	2	1	G	4
Poupoulis and Jensen 1976	84	LOAEL ≥ 20	80.0	chicken	chick	copper sulfate	survival	diet	4	1	G	4
Poupoulis and Jensen 1976	110	LOAEL ≥ 20	77.3	chicken	1 day	copper sulfate	survival	diet	4	1	G	4
Van Vleet et al. 1981	110	LOAEL ≥ 20	25.0	Pekin duck	duckling	copper sulfate	survival	diet	4	1	F	4
Van Vleet et al. 1981	150	LOAEL ≥ 20	60.0	Pekin duck	duckling	copper sulfate	survival	diet	2.1	1	F	4
Vohra and Kratzer 1968	260	LOAEL ≥ 20	50.0	turkey	juvenile	copper sulfate	survival	diet	3	1	none	4
Mammal Growth												
Allcroft et al. 1961	**12**	**ED20**	**29.0**	**pig**	**8 to 10 weeks**	**copper sulfate**	**body weight gain**	**diet**	**21**	**1**	**none**	**1**
Boyden et al. 1938	120	LOAEL ≥ 20	59.3	rat	4 weeks	copper sulfate	body weight gain	diet	4	1	none	4
Brandt 1983	*35*	*LOAEL ≥ 20*	*79.5*	*mink*	*90 days*	*copper sulfate*	*body weight*	*diet*	*from 90 days after birth to pelting*[c]	*1*	*none*	*2*
Edmonds and Baker 1986	NA	NA	NA	pig	4 weeks	copper sulfate	body weight	diet	4	1	none	3

Table 4-2. Summary of Copper Dose-Response Datasets

Source	Effect Dose (mg/kg bw/day)	Type of Effect Level	LOAEL Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group[a]	Modeling Category[b]
Grobner et al. 1986	NA	NA	NA	rabbit	weanling	copper sulfate	body weight	diet	4	1	none	3
Mammal Growth (continued)												
Grobner et al. 1986	NA	NA	NA	rabbit	weanling	copper sulfate	body weight	diet	4	1	none	3
Llewellyn et al. 1985	110	LOAEL ≥ 20	77.1	rat	weanling	copper acetate	body weight	diet	21	1	none	3
Pettersen et al. 2002	NA	NA	NA	mouse	4.5 weeks	copper chloride	body weight	diet	3	1	none	3
Suttle and Mills 1966	25	LOAEL ≥ 20	76.7	pig	weanling	copper sulfate	body weight	diet	5.7	1	none	3
Mammal Reproduction												
Aulerich et al. 1982	***27***	***LOAEL ≥ 20***	***70.5***	***mink***	***kit***	***copper sulfate***	***kit survival***	***diet***	***20***	***1***	***none***	***3***
Aulerich et al. 1982	NA	NA	NA	mink	kit	copper sulfate	kit body weight	diet	20	1	none	3
Cromwell et al. 1993[d]	2.4	LOAEL ≥ 20	72.3	pig	multigenerational	copper sulfate	farrowing success	diet	2.1 years	1	none	3
Lecyk 1980	290	LOAEL ≥ 20	62.8	mouse	adult	copper sulfate	litter size (breed 1)	diet	7	1	A	4
Lecyk 1980	220	LOAEL ≥ 20	69.6	mouse	adult	copper sulfate	litter size (breed 2)	diet	7	1	A	4
Mammal Survival												
Pooled dataset:	**8.7**	**geometric mean**	**NA**	**pig**	**7 to 10 weeks**	**copper sulfate**	**survival**	**diet**	**15 to 21**	**1**	**B**	2
Allcroft et al. 1961	17	LOAEL ≥ 20	0.0	pig	8 to10 weeks	copper sulfate	survival	diet	21	1	B	2
Ritchie et al. 1963	4.3	LOAEL ≥ 20	75.0	pig	7 weeks	copper sulfate	survival	diet	15	1	B	2
Boyden et al. 1938	490	LOAEL ≥ 20	0.0	rat	4 weeks	copper sulfate	survival	diet	4	1	none	3
Brandt 1983	*35*	*LOAEL ≥ 20*	*50.0*	*mink*	*90 days*	*copper sulfate*	*survival*	*diet*	*from 90 days after birth to pelting*	*1*	*none*	*3*
NTP 1993a	140	LOAEL ≥ 20	80.0	mouse	6 weeks	copper sulfate	male survival	drinking water	2	2	none	4
NTP 1993a	200	LOAEL ≥ 20	40.0	mouse	6 weeks	copper sulfate	female survival	drinking water	2	2	none	4
Keen et al. 1982	200	LOAEL ≥ 20	71.4	rat	juvenile	copper sulfate	survival	diet	6.7	1	none	3

Notes:

Bold indicates the lowest effect level, selected from the lowest tier evaluated, and as the lowest value from the following: 1) LOAEL ≥ 20 from an individual dataset, 2) ED20 from an individual dataset, or 3) ED20 or geomean from a pooled dataset that was selected for modeling because the effect concentration had the potential for being lower than other ED20s and/or LOAELs based on visual inspection of the plotted data (i.e., Category 2 or 5).

Italics indicate UCR receptor-specific toxicity reference value (TRV) dataset.

Yellow and blue highlights indicate pooled datasets modeled in the toxicity relationship analysis program (TRAP).

[a] Pooling groups were evaluated only as a group and not on an individual basis for the purposes of selecting data to model in TRAP. Not all pooling groups were run in TRAP.

[b] Modeling categories are defined as follows:

1. Data were modeled in TRAP as an individual dataset to derive the ED20 presented in this table.
2. Data were selected for modeling as an individual or pooled dataset but an ED20 could not be generated or the ED20 was not used due to poor model fit.
3. Data do not meet criteria for modeling as an individual dataset (e.g., no effect with a ≥20 percent reduction in response relative to control, lack of two consecutively lower and different effects less than the control or consecutively lower effects are followed by an increased effect, a lower tier dataset is available).
4. Not selected for modeling because the effect concentration for the individual or pooled dataset is substantially higher than other ED20s and/or LOAELs.
5. Modeled in TRAP as part of a pooled dataset.

[c] The exposure duration was not provided in the paper; 12 weeks was used as an estimate based on general mink pelting information.

[d] This study resulted in the lowest LOAEL ≥ 20 for mammal reproduction, but was not selected as the lowest effect level for reasons described in Section 4.3.2.

ED20 – effective dose with a 20% reduction in the response relative to the control (modeled)

LOAEL≥20 – lowest observed adverse effect level with ≥20% reduction in the response relative to the control

NA - not applicable because the effect level is an ED20 or reduction in response was <20 percent relative to the control.

Table 4-3. Summary of Lead Dose-Response Datasets

Source	Effect Dose (mg/kg bw/day)	Type of Effect Level	LOAEL Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group[a]	Modeling Category[b]
Bird Growth												
Abduljaleel and Shuhaimi-Othman 2013	**29**	**LOAEL ≥ 20**	**79.8**	**chicken**	**1 day**	**lead nitrate**	**body weight**	**diet**	**4**	**1**	**none**	**2**
Berg et al. 1980	NA	NA	NA	chicken	1 day	lead carbonate	body weight	diet	2	1	C	4
Berg et al. 1980	150	LOAEL ≥ 20	78.4	chicken	1 day	lead carbonate	body weight	diet	2	1	C	4
Berg et al. 1980	200	LOAEL ≥ 20	73.5	chicken	1 day	lead carbonate	body weight	diet	2	1	C	4
Berg et al. 1980	200	LOAEL ≥ 20	70.3	chicken	1 day	lead carbonate	body weight	diet	2	1	C	4
Cupo and Donaldson 1988	180	LOAEL ≥ 20	47.0	chicken	1 day	lead acetate	body weight	diet	3	1	C	4
Franson and Custer 1982	210	LOAEL ≥ 20	47.4	chicken	1 day	lead acetate	body weight	diet	4	1	C	4
Damron et al. 1969	80	LOAEL ≥ 20	61.2	chicken	4 weeks	lead acetate	body weight	diet	4	1	none	3
Donaldson 1986	170	LOAEL ≥ 20	71.6	chicken	1 day	lead acetate trihydrate	body weight	diet	2.9	1	A	4
Donaldson 1986	170	LOAEL ≥ 20	66.8	chicken	1 day	lead acetate trihydrate	body weight	diet	2.9	1	A	4
Donaldson and McGowan 1989	130	LOAEL ≥ 20	69.3	chicken	1 day	lead acetate trihydrate	body weight	diet	2.9	1	A	4
Edens 1985	NA	NA	NA	Japanese quail	1 day	lead acetate	body weight	diet	12	1	B	4
Edens et al. 1976	150	LOAEL ≥ 20	79.1	Japanese quail	1 day	lead acetate	body weight	diet	12	1	B	4
Edens and Garlich 1983	NA	NA	NA	chicken	producing eggs for about 15 weeks	lead acetate	body weight	diet	10	1	none	3
Edens and Melvin 1989	NA	NA	NA	Japanese quail	1 day	lead acetate	body weight (breed 1)	diet	21	1	none	3
Edens and Melvin 1989	NA	NA	NA	Japanese quail	1 day	lead acetate	body weight (breed 2)	diet	21	1	none	3
Edens and Melvin 1989	NA	NA	NA	Japanese quail	1 day	lead acetate	female body weight (breed 1)	diet	15	1	none	3
Latta and Donaldson 1986	130	LOAEL ≥ 20	67.1	chicken	1 day	lead acetate	body weight gain	diet	2.7	1	none	3
Leeming and Donaldson 1984	NA	NA	NA	chicken	1 day	lead acetate trihydrate	body weight gain	diet	2.7	1	none	3
Morgan et al. 1975	NA	NA	NA	Japanese quail	6 days	lead acetate	body weight (trial 1)	diet	5	1	none	3
Morgan et al. 1975	NA	NA	NA	Japanese quail	hatchling	lead acetate	body weight (trial 2)	diet	5	1	none	3
Bird Reproduction												
Edens et al. 1976	15	LOAEL ≥ 20	72.4	Japanese quail	1 day	lead acetate	egg hatchability	diet	12	1	none	4
Edens et al. 1976	15	LOAEL ≥ 20	70.0	Japanese quail	1 day	lead acetate	egg production	diet	12	1	E	4
Edens et al. 1976	500	LOAEL ≥ 20	17.2	Japanese quail	1 day	lead acetate	egg production	diet	12	1	E	4
Pooling group:	**4.7**	**geometric mean**	**NA**	**Japanese quail**	**1 day to adult**	**lead acetate**	**egg production**	**diet**	**3.8 - 5**	**1**	**D**	2
Edens and Garlich 1983	1.2	LOAEL ≥ 20	72.2	Japanese quail	6 weeks	lead acetate	egg production	diet	5	1	D	2
Edens and Garlich 1983	0.21	LOAEL ≥ 20	79.3	Japanese quail	1 day	lead acetate	egg production	diet	5	1	D	2
Stone and Soares 1976	420	LOAEL ≥ 20	41.1	Japanese quail	adult	lead acetate	egg production	diet	3.9	1	D	2
Edens and Garlich 1983	NA	NA	NA	chicken	at ~78% egg production	lead acetate	egg production	diet	4	1	none	3
Edens and Garlich 1983	13	LOAEL ≥ 20	73.8	chicken	producing eggs for 15 weeks	lead acetate	egg production	diet	10	1	none	4
Edens and Melvin 1989	200	LOAEL ≥ 20	73.2	Japanese quail	1 day	lead acetate	egg production	diet	21	1	none	3
Bird Survival												
Pooling group:	**11**	**ED20**	**NA**	**pigeon**	**adult**	**lead acetate**	**survival**	**gavage**	**varied**	**1**	**F**	5
Anders et al. 1982	NA	NA	NA	pigeon	adult	lead acetate	survival	gavage	5	1	F	5
Barthalmus et al. 1977	13	LOAEL ≥ 20	80.0	pigeon	adult	lead acetate	survival	gavage	varied	1	F	5
Cupo and Donaldson 1988	NA	NA	NA	chicken	1 day	lead acetate	survival	diet	3	1	none	3
Khan et al. 1993	NA	NA	NA	chicken	1 day	lead acetate	survival	gavage	1	1	none	3
Vengris and Mare 1974	320	LOAEL ≥ 20	50.0	chicken	6 weeks	lead acetate	survival	gavage	5	1	none	4
Mammal Growth												
Al-Omar et al. 2000	NA	NA	NA	mouse	adult	lead oxide	body weight gain	gavage	5	1	none	3
Barlow et al. 1977	NA	NA	NA	rat	adult	lead acetate	body weight	diet	3	1	none	3
Gerber et al. 1978	1100	LOAEL ≥ 20	64.4	rat	infant	lead acetate	body weight	diet	52	1	none	3
Harry et al. 1985	NA	NA	NA	rat	2 days	lead acetate	body weight	gavage	3.7	1	A	4
Toews et al. 1983	400	LOAEL ≥ 20	77.0	rat	pup	lead acetate	body weight	gavage	4	1	A	4
Hsu et al. 1975	NA	NA	NA	pig	4 weeks	lead acetate	body weight	diet	13	1	none	3
Lorenzo et al. 1978	**20**	**LOAEL ≥ 20**	**58.8**	**rabbit**	**1 day**	**lead nitrate**	**body weight gain**	**gavage**	**4.3**	**1**	**none**	**3**
Maker et al. 1973	NA	NA	NA	mouse	adult	lead carbonate	body weight	diet	4.3	1	none	3
Mykkanen et al. 1980	NA	NA	NA	rat	adult	lead acetate	body weight gain	diet	3	1	none	3
Mykkanen et al. 1980	NA	NA	NA	rat	adult	lead acetate	body weight gain	diet	3	1	none	3
Kumar and Desiraju 1990	130	ED20	47.3	rat	2 days	lead acetate	body weight	gavage	8.4	1	none	1
Mammal Reproduction												
Gupta et al. 1995	**3.2**	**LOAEL ≥ 20**	**76.7**	**mouse**	**adult**	**lead acetate**	**number living embryos**	**gavage**	**4**	**1**	**none**	**2**
Jacquet et al. 1977	NA	NA	NA	mouse	adult	not specified	embryo weight	diet	2.6	1	none	3
Miller et al. 1982	NA	NA	NA	rat	adult	lead acetate	embryo weight	gavage	5.9	1	none	3

Table 4-3. Summary of Lead Dose-Response Datasets

Source	Effect Dose (mg/kg bw/day)	Type of Effect Level	LOAEL Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group[a]	Modeling Category[b]
Mammal Reproduction (continued)												
Mykkanen et al. 1980	1000	LOAEL ≥ 20	74.4	rat	adult	lead acetate	offspring weight (breed 1)	diet	3	1	B	4
Mykkanen et al. 1980	940	LOAEL ≥ 20	60.0	rat	adult	lead acetate	offspring weight (breed 2)	diet	3	1	B	4
Schroeder and Mitchener 1971	NA	NA	NA	rat	multigenerational	soluble lead	offspring survival	diet and drinking water	3 generations	1	none	3
Schroeder and Mitchener 1971	NA	NA	NA	mouse	multigenerational	soluble lead	offspring survival	diet and drinking water	3 generations	1	none	3
Wardell et al. 1982	NA	NA	NA	rat	adult	lead acetate	fetal mortality	gavage	1.9	1	none	3
Winneke et al. 1977	140	LOAEL ≥ 20	71.3	rat	adult	lead acetate	litter size	diet	18.6	1	none	3
Winneke et al. 1977	140	LOAEL ≥ 20	70.0	rat	adult	lead acetate	number pregnant	diet	18.6	1	none	3
Mammal Survival												
Junaid et al. 1997	8.0	LOAEL ≥ 20	80.0	mouse	adult	lead acetate	survival	gavage	8.6	1	none	3
Lorenzo et al. 1978	**7.6**	**ED20**	**59.5**	**rabbit**	**1 day**	**lead nitrate**	**survival**	**gavage**	**4.3**	**1**	**none**	**1**
Pankakoski et al. 1994	190[c]	LOAEL ≥ 20	0.0	shrew	juvenile	lead in earthworm prey	survival	diet	0.6	1	none	3
Press 1977	330	LOAEL ≥ 20	0.0	rat	1 day	lead acetate	survival	gavage	2.1	1	none	3
Kumar and Desiraju 1990	400	LOAEL ≥ 20	40.0	rat	2 days	lead acetate	survival	gavage	8.4	1	none	3

Notes:

Bold indicates the lowest effect level, selected from the lowest tier evaluated, and as the lowest value from the following: 1) LOAEL ≥ 20 from an individual dataset, 2) ED20 from an individual dataset, or 3) ED20 or geomean from a pooled dataset that was selected for modeling because the effect concentration had the potential for being lower than other ED20s and/or LOAELs based on visual inspection of the plotted data (i.e., Category 2 or 5).

Bold and italics together indicate data were used to derive both the selected toxicity reference value (TRV) and the receptor-specific TRV.

Yellow highlights indicate pooled datasets modeled in the toxicity relationship analysis program (TRAP).

[a] Pooling groups were evaluated only as a group and not on an individual basis for the purposes of selecting data to model in TRAP. Not all pooling groups were run in TRAP.

[b] Modeling categories are defined as follows:

1. Data were modeled in TRAP as an individual dataset to derive the ED20 presented in this table.
2. Data were selected for modeling as an individual or pooled dataset but an ED20 could not be generated or the ED20 was not used due to poor model fit.
3. Data do not meet criteria for modeling as an individual dataset (e.g., no effect with a ≥20 percent reduction in response relative to control, lack of two consecutively lower and different effects less than the control or consecutively lower effects are followed by an increased effect, a lower tier dataset is available).
4. Not selected for modeling because the effect concentration for the individual or pooled dataset is substantially higher than other ED20s and/or LOAELs.
5. Modeled in TRAP as part of a pooled dataset.

[c] Not selected as a receptor-specific TRV because the LOAEL is based on 100 percent mortality.

ED20 – effective dose with a 20% reduction in the response relative to the control (modeled)

LOAEL≥20 – lowest observed adverse effect level with ≥20% reduction in the response relative to the control

NA - not applicable because the effect level is an ED20 or reduction in response was <20 percent relative to the control.

Table 4-4. Summary of Manganese Dose-Response Datasets

Source	Effect Dose (mg/kg bw/day)	Type of Effect Level	LOAEL Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group[a]	Modeling Category[b]
Bird Growth												
Martinez and Diaz 1996	NA	NA	NA	chicken	1 day	manganese oxide	body weight	diet	6	1	none	3
Southern and Baker 1983	NA	NA	NA	chicken	8 days	manganese chloride	body weight	diet	2	1	none	3
Vohra and Kratzer 1968	NA	NA	NA	turkey	juvenile	manganese sulfate	body weight gain	diet	3	1	none	3
Mammal Growth												
Komura and Sakomoto 1991	NA	NA	NA	mouse	6 weeks	manganese acetate	body weight	diet	12.9	1	none	3
Komura and Sakomoto 1991	NA	NA	NA	mouse	6 weeks	manganese chloride	body weight	diet	12.9	1	none	3
Lipe et al. 1999	NA	NA	NA	rat	90 days	manganese chloride	body weight	gavage	4.3	2	none	3
NTP 1993b	NA	NA	NA	rat	50 days	manganese sulfate	male body weight	diet	2	1	none	3
NTP 1993b	NA	NA	NA	rat	50 days	manganese sulfate	female body weight	diet	13	1	none	3
NTP 1993b	NA	NA	NA	mouse	63 days	manganese sulfate	male body weight	diet	13	1	none	3
NTP 1993b	NA	NA	NA	mouse	63 days	manganese sulfate	female body weight	diet	13	1	none	3
Rehnberg et al. 1980	**71**	**LOAEL ≥ 20**	**77.1**	**rat**	**1 day**	**manganese oxide**	**body weight**	**gavage**	**2.9**	**1**	**none**	**2**
Kontur and Fechter 1985	NA	NA	NA	rat	adult	manganese chloride	body weight	drinking water	3	2	none	3
Mammal Reproduction												
Kontur and Fechter 1985	NA	NA	NA	rat	adult	manganese chloride	litter size	drinking water	3	2	none	3
Laskey et al. 1982	**310**	**ED20**	**75.0**	**rat**	**adult**	**manganese oxide**	**% pregnant**	**diet**	**gestation to 224 days**	**1**	**none**	**1**
Leung et al. 1982	630	LOAEL ≥ 20	65.9	rat	adult	manganese chloride	offspring weight	drinking water	3.7	2	none	3
Pappas et al. 1997	1400	LOAEL ≥ 20	70.1	rat	adult	manganese chloride	offspring weight	drinking water	gestation to post-natal day 30	2	none	3
Mammal Survival												
NTP 1993b	430[c]	LOAEL ≥ 20	28.0	rat	41 days	manganese sulfate	male suvival	diet	2 years	1	none	4
Rehnberg et al. 1980	**91**	**ED20**	**55.1**	**rat**	**1 day**	**manganese oxide**	**survival**	**gavage**	**2.9**	**1**	**none**	**1**

Notes:

Bold indicates the lowest effect level, selected from the lowest tier evaluated, and as the lowest value from the following: 1) LOAEL≥ 20 from an individual dataset, 2) ED20 from an individual dataset, or 3) ED20 or geomean from a pooled dataset that was selected for modeling because the effect concentration had the potential for being lower than other ED20s and/or LOAELs based on visual inspection of the plotted data (i.e., Category 2 or 5).

[a] Pooling groups were evaluated only as a group and not on an individual basis for the purposes of selecting data to model in the toxicity relationship analysis program (TRAP). Not all pooling groups were run in TRAP.

[b] Modeling categories are defined as follows:

1. Data were modeled in TRAP as an individual dataset to derive the ED20 presented in this table.
2. Data were selected for modeling as an individual or pooled dataset but an ED20 could not be generated or the ED20 was not used due to poor model fit.
3. Data do not meet criteria for modeling as an individual dataset (e.g., no effect with a≥20 percent reduction in response relative to control, lack of two consecutively lower and different effects less than the control or consecutively lower effects are followed by an increased effect, a lower tier dataset is available).
4. Not selected for modeling because the effect concentration for the individual or pooled dataset is substantially higher than other ED20s and/or LOAELs.

[c] Effect doses of 46 and 150 mg/kg bw/day from this study also resulted in a≥20% reduction in response compared to the control, but the results were not significantly different from the control, so they were not selected as the LOAEL ≥ 20.

ED20 – effective dose with a 20% reduction in the response relative to the control (modeled)

LOAEL≥20 – lowest observed adverse effect level with ≥20% reduction in the response relative to the control

NA - not applicable because the reduction in response was <20 percent relative to the control

Table 4-5. Summary of Zinc Dose-Response Datasets

Source	Effect Dose (mg/kg bw/day)	Type of Effect Level	LOAEL Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group[a]	Modeling Category[b]
Bird Growth												
Gasaway and Buss 1972	*200*	*ED20*	*74.5*	*mallard duck*	*7 weeks*	*zinc carbonate*	*body weight gain*	*diet*	*5.7*	*1*	*none*	*1*
Hamilton et al. 1981	NA	NA	NA	Japanese quail	hatchling	zinc carbonate	body weight (Exp. 2)	diet	2	1	none	3
Hamilton et al. 1981	NA	NA	NA	Japanese quail	hatchling	zinc carbonate	body weight (Exp. 5)	diet	2	1	none	3
<u>Pooled dataset A:</u>	**43**	**ED20**	**NA**	**chicken**	**14 to 20 days**	**zinc oxide**	**body weight gain**	**diet**	**1 to 3**	**1**	**A**	5
Lu and Combs 1988	110	LOAEL ≥ 20	54.2	chicken	20 days	zinc oxide	body weight gain	diet	3	1	A	5
Lu et al. 1990	65	LOAEL ≥ 20	69.7	chicken	2 weeks	zinc oxide	body weight gain	diet	1	1	A	5
Roberson and Schaible 1960	250	LOAEL ≥ 20	45.0	chicken	1 day	zinc carbonate	body weight (Exp. 2)	diet	4	1	B	4
Roberson and Schaible 1960	130	LOAEL ≥ 20	79.4	chicken	1 day	zinc carbonate	body weight (Exp. 3)	diet	4	1	B	4
Roberson and Schaible 1960	250	LOAEL ≥ 20	59.2	chicken	1 day	zinc sulfate	body weight (Exp. 2)	diet	4	1	C	4
Roberson and Schaible 1960	NA	NA	NA	chicken	1 day	zinc sulfate	body weight (Exp. 3)	diet	4	1	C	4
Roberson and Schaible 1960	250	LOAEL ≥ 20	70.8	chicken	1 day	zinc oxide	body weight (Exp. 2)	diet	4	1	D	4
Roberson and Schaible 1960	NA	NA	NA	chicken	1 day	zinc oxide	body weight (Exp. 3)	diet	4	1	D	4
Sandoval et al. 1988	140	LOAEL ≥ 20	66.8	chicken	1 day	zinc sulfate	body weight gain	diet	3	1	E	4
Hill 1974a	260	LOAEL ≥ 20	75.6	chicken	1 day	zinc sulfate	body weight gain	diet	2	1	E	4
Sandoval et al. 1988	140	LOAEL ≥ 20	49.9	chicken	1 day	zinc gluconate	body weight gain	diet	3	1	none	3
Stahl et al. 1989	250	LOAEL ≥ 20	48.8	chicken	hatchling	zinc carbonate	body weight gain	diet	3	1	none	3
Vohra and Kratzer 1968	420	LOAEL ≥ 20	79.9	turkey	chick	zinc oxide	body weight gain	diet	3	1	none	4
Bird Reproduction												
Gibson et al. 1986	**77**	**ED20**	**40.6**	**chicken**	**30 weeks**	**zinc acetate dihydrate**	**egg production**	**diet**	**10**	**1**	**none**	**1**
Gibson et al. 1986	130	LOAEL ≥ 20	71.9	chicken	30 weeks	zinc oxide	egg production	diet	10	1	none	4
Jackson et al. 1986	230	LOAEL ≥ 20	10.0	chicken	40 weeks	zinc oxide	egg production	diet	3	1	none	4
Stepinska et al. 1987	1200	LOAEL ≥ 20	6.27	chicken	71 weeks	zinc oxide	egg production	diet	0.7	1	none	3
Jensen and Maurice 1980	160	LOAEL ≥ 20	57.4	chicken	adult	zinc sulfate	egg production (Exp. 3)	diet	6	1	G	4
Jensen and Maurice 1980	160	LOAEL ≥ 20	64.6	chicken	adult	zinc sulfate	egg production (Exp. 4)	diet	6	1	G	4
Jackson et al. 1986	140	LOAEL ≥ 20	73.3	chicken	40 weeks	zinc oxide	egg production	diet	20	1	F	4
Stevenson et al. 1987	130	LOAEL ≥ 20	68.3	chicken	28 weeks	zinc oxide	egg production	diet	20	1	F	4
Bird Survival												
Blalock and Hill 1988	260	LOAEL ≥ 20	80	chicken	1 day	zinc oxide	survival	diet	2	1	H	4
Dewar et al. 1983	520	LOAEL ≥ 20	79.5	chicken	1 day	zinc oxide	survival (Exp. 2)	diet	4	1	H	4
Dewar et al. 1983	780	LOAEL ≥ 20	61.9	chicken	15 days	zinc oxide	survival (Exp. 1)	diet	4	1	none	4
Gasaway and Buss 1972	*330*	*LOAEL ≥ 20*	*33*	*mallard duck*	*7 weeks*	*zinc carbonate*	*survival*	*diet*	*8.6*	*1*	*none*	*2*
Gibson et al. 1986	310	LOAEL ≥ 20	42.9	chicken	30 weeks	zinc acetate	survival	diet	10	1	none	3
Hamilton et al. 1979	430	LOAEL ≥ 20	44.4	Japanese quail	1 day	zinc carbonate	survival	diet	2	1	none	4
Roberson and Schaible 1960	**250**	**LOAEL ≥ 20**	**79.3**	**chicken**	**1 day**	**zinc carbonate**	**survival**	**diet**	**4**	**1**	**none**	**3**
Mammal Growth												
Barone et al. 1998	NA	NA	NA	rat	adult	not specified	body weight	diet	Day 11 of gestation to day before expected delivery	1	none	3
Brink et al. 1959	240	LOAEL ≥ 20	72.8	pig	weanling	not specified	body weight (Exp. 1)	diet	6	1	A	4
Brink et al. 1959	310	LOAEL ≥ 20	66.5	pig	weanling	not specified	body weight (Exp. 2)	diet	5	1	A	4
Brink et al. 1959	200	LOAEL ≥ 20	76.2	pig	weanling	not specified	body weight (Exp. 3)	diet	6	1	A	4
Hill et al. 1983	47	LOAEL ≥ 20	74.6	pig	30 kg	zinc oxide	body weight	diet	30 kg to 18 months old	1	none	4
Hsu et al. 1975	NA	NA	NA	pig	4 weeks	zinc oxide	body weight	diet	9 to13	1	none	3
Khan et al. 2007	**3.7**	**ED20**	**74.0**	**rat**	**adult**	**zinc chloride**	**male body weight**	**gavage**	**14**	**1**	**none**	**1**
Maita et al. 1981	19000	LOAEL ≥ 20	73.8	mouse	5 weeks	zinc sulfate	female body weight	diet	13	1	none	3
Maita et al. 1981	NA	NA	NA	mouse	5 weeks	zinc sulfate	male body weight	diet	13	1	none	3
Maita et al. 1981	NA	NA	NA	rat	5 weeks	zinc sulfate	male body weight	diet	13	1	none	3
Nakamura et al. 1983	NA	NA	NA	rat	not specified	zinc acetate	body weight	diet	11	1	none	3
Pettersen et al. 2002	NA	NA	NA	mouse	4.5 weeks	zinc chloride	body weight	diet	3	1	none	3
Settlemire and Matrone 1967	920	LOAEL ≥ 20	43.0	rat	4 to 6 weeks	zinc carbonate	body weight gain	diet	5	1	none	3
Subramanian et al. 2000	NA	NA	NA	rat	adult	zinc oxide	body weight	diet	6	1	none	3
Mammal Reproduction												
Barone et al. 1998	NA	NA	NA	rat	adult	not specified	litter size	diet	gestation	1	none	3
Chu and Cox 1972	380	LOAEL ≥ 20	52.6	rat	adult	not specified	offspring growth	diet	3	1	none	3
Ketcheson et al. 1969	360	LOAEL ≥ 20	78.9	rat	adult	zinc oxide	offspring growth	diet	gestation to 14 days lactation	1	none	3
Khan et al. 2007	**14**	**LOAEL ≥ 20**	**77.5**	**rat**	**adult**	**zinc chloride**	**offspring survival**	**gavage**	**20**	**1**	**none**	**2**

Table 4-5. Summary of Zinc Dose-Response Datasets

Source	Effect Dose (mg/kg bw/day)	Type of Effect Level	LOAEL Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group[a]	Modeling Category[b]
Mammal Reproduction (continued)												
Kumar 1976	NA	NA	NA	rat	100 days	zinc sulfate	fetal survival	diet	2.6	1	none	3
Newman et al. 2002	230	LOAEL ≥ 20	0.0	rat	adult	zinc acetate dihydrate	offspring survival	diet	gestation day 5 to post-natal day 40	1	none	3
Pal and Pal 1987	420	LOAEL ≥ 20	29.3	rat	120 to 130 days	zinc sulfate	number of normal fetuses	diet	2.6	1	none	3
Cox et al. 1969	NA	NA	NA	rat	adult	zinc oxide	fetal growth	diet	3.1	1	B	4
Schlicker and Cox 1968	400	LOAEL ≥ 20	76.4	rat	adult	zinc oxide	fetal growth	diet	2.1	1	B	4
Schlicker and Cox 1968	400	LOAEL ≥ 20	74.9	rat	adult	zinc oxide	fetal growth	diet	2.6	1	B	4
Schlicker and Cox 1968	400	LOAEL ≥ 20	71.0	rat	adult	zinc oxide	fetal survival	diet	2.1	1	C	4
Schlicker and Cox 1968	400	LOAEL ≥ 20	0.0	rat	adult	zinc oxide	fetal survival	diet	5.1	1	C	4
Mammal Survival												
Straube et al. 1980	860	LOAEL ≥ 20	0.0	ferret	adult	zinc oxide	survival	diet	2 to 24	1	none	3
Pooled dataset	**190**	**geometric mean**	**NA**	**pig**	**weanling**	**zinc carbonate**	**survival**	**diet**	**5 to 6**	**1**	**D**	2
Brink et al. 1959	120	LOAEL ≥ 20	67.0	pig	weanling	zinc carbonate	survival	diet	6	1	D	2
Brink et al. 1959	310	LOAEL ≥ 20	75.0	pig	weanling	zinc carbonate	survival	diet	5	1	D	2
Brink et al. 1959	190	LOAEL ≥ 20	62.5	pig	weanling	zinc carbonate	survival	diet	6	1	D	2

Notes:

Bold indicates the lowest effect level, selected from the lowest tier evaluated, and as the lowest value from the following: 1) LOAEL ≥ 20 from an individual dataset, 2) ED20 from an individual dataset, or 3) ED20 or geomean from a pooled dataset that was selected for modeling because the effect concentration had the potential for being lower than other ED20s and/or LOAELs based on visual inspection of the plotted data (i.e., Category 2 or 5).

Italics indicate UCR receptor-specific toxicity reference value (TRV) dataset.

Yellow highlights indicate pooled datasets modeled in the toxicity relationship analysis program (TRAP).

[a] Pooling groups were evaluated only as a group and not on an individual basis for the purposes of selecting data to model in TRAP. Not all pooling groups were run in TRAP.

[b] Modeling categories are defined as follows:

1. Data were modeled in TRAP as an individual dataset to derive the ED20 presented in this table.
2. Data were selected for modeling as an individual or pooled dataset but an ED20 could not be generated or the ED20 was not used due to poor model fit.
3. Data do not meet criteria for modeling as an individual dataset (e.g., no effect with a ≥20 percent reduction in response relative to control, lack of two consecutively lower and different effects less than the control or consecutively lower effects are followed by an increased effect, a lower tier dataset is available).
4. Not selected for modeling because the effect concentration for the individual or pooled dataset is substantially higher than other ED20s and/or LOAELs.
5. Modeled in TRAP as part of a pooled dataset.

ED20 – effective dose with a 20% reduction in the response relative to the control (modeled)

LOAEL ≥ 20 – lowest observed adverse effect level with ≥20% reduction in the response relative to the control

NA - not applicable because the effect level is an ED20 or reduction in response was <20 percent relative to the control

Table 4-6. Summary of Selected Effect Levels

		Growth					Reproduction					Survival				
Metal	Eco-SSL	Selected Effect Level (mg/kg bw/day)	Effect Level Type	LOAEL Effect Level (%)	Tier	Citation	Selected Effect Level (mg/kg bw/day)	Effect Level Type	LOAEL Effect Level (%)	Tier	Citation	Selected Effect Level (mg/kg bw/day)	Effect Level Type	LOAEL Effect Level (%)	Tier	Citation
Bird TRVs																
Cadmium	1.47	2.0	ED20	NA	1	Bokori et al. 1995b	2.3	ED20	NA	1	Leach et al. 1979	7.4	ED20	NA	1	Bokori et al. 1995a, Olgun 2015 (pooled)
Copper	4.05	62	ED20	NA	1	Poupoulis and Jenson 1976, Wang et al. 1987 (pooled)	28	ED20	NA	1	Chiou et al. 1997, Harms and Buresh 1986, Pearce et al. 1983, Stevenson and Jackson 1980a, Stevenson and Jackson 1980b (pooled)	67	ED20	NA	1	Mehring et al. 1960
Lead	1.63	29	LOAEL≥20	20	1	Abduljaleel and Shuhaimi-Othman 2013	4.7	geomean	NA	1	Edens and Garlich 1983, Stone and Soares 1976 (pooled)	11	ED20	NA	1	Anders et al. 1982, Barthalmus et al. 1977 (pooled)
Manganese	179	none	NA		NA	NA	none	NA	NA	NA	NA	none	NA	NA	NA	NA
Zinc	66.1	43	ED20	NA	1	Lu and Combs 1988, Lu et al. 1990 (pooled)	77	ED20	NA	1	Gibson et al. 1986	250	LOAEL≥20	21	1	Roberson and Schaible 1960
UCR Receptor-Specific Bird TRVs																
Cadmium - mallard	1.47	41	ED20	NA	2	DiGiulio and Scanlon 1985	20	LOAEL≥20	71	1	White and Finley 1978	none	NA	NA	NA	NA
Zinc - mallard	66.1	200	ED20	NA	1	Gasaway and Buss 1972	none	NA	NA	NA	NA	330	LOAEL≥20	67	1	Gasaway and Buss 1972
Mammal TRVs																
Cadmium	0.77	4.2	ED20	NA	1	Wilson et al. 1941	2.7	ED20	NA	1	Sutou et al. 1980b	1.5	ED20	NA	1	Swiergosz et al. 1998
Copper	5.6	12	ED20	NA	1	Allcroft et al. 1961	27	LOAEL≥20	30	1	Aulerich et al. 1982	8.7	geometric mean	NA	1	Allcroft et al. 1961, Ritchie et al. 1963 (pooled)
Lead	4.7	20	LOAEL≥20	41	1	Lorenzo et al. 1978	3.2	LOAEL≥20	23	1	Gupta et al. 1995	7.6	ED20	NA	1	Lorenzo et al. 1978
Manganese	51.5	71	LOAEL≥20	23	1	Rehnberg et al. 1980	310	ED20	NA	1	Laskey et al. 1982	91	ED20	NA	1	Rehnberg et al. 1980
Zinc	75.4	3.7	ED20	NA	1	Khan et al. 2007	14	LOAEL≥20	23	1	Khan et al. 2007	190	geometric mean	NA	1	Brink et al. 1959 (pooled)
UCR Receptor-Specific Mammal TRVs																
Cadmium - shrew	0.77	104	LOAEL≥20	22	1	Dodds-Smith et al. 1982	none	NA	NA	NA	NA	none	NA	NA	NA	NA
Copper - mink	5.6	35	LOAEL≥20	21	1	Brandt 1983	27	LOAEL≥20	30	1	Aulerich et al. 1982	35	LOAEL≥20	50	1	Brandt 1983

Notes:

Green shading indicates selected effect levels, which were derived from the ED20 or the lowest LOAEL ≥ 20 from the lowest tier study reviewed, with the exception of the copper mammal reproduction effect level which was based on the second lowest LOAEL ≥ 20 as discussed in Section 4.3.

Eco-SSL – ecological soil screening level

ED20 – effective dose with a 20% reduction in the response relative to the control (modeled)

LOAEL ≥ 20 – lowest observed adverse effect level with ≥20% reduction in the response relative to the control

NA - not applicable

TRV - toxicity reference value

Table 4-7. Uncertainty Considerations for Avian Selected Effect Levels for Cadmium

	Growth	Growth - Mallard [a]	Reproduction	Reproduction - Mallard [a]	Survival
Selected Effect Level Details					
Dose (mg/kg bw/day)	2.0	41	2.3	20	7.4
Reference	Bokori et al. 1995a	DiGiulio and Scanlon 1985	Leach et al. 1979	White and Finley 1978	pooled dataset[b]
Receptor used in study	chicken	mallard duck	chicken	mallard duck	Japanese quail
Considerations in Study Used to Derive Selected Effect Level					
Is species a UCR receptor?	no	yes	no	yes	no
Dose administration	diet	diet	diet	diet	diet
Growth study exposure	critical lifestage	non-critical lifestage, <10% of lifespan	NA	NA	NA
Chemical form	cadmium sulfate	cadmium chloride	cadmium sulfate	cadmium chloride	cadmium sulfate
Source of BW and FIR	BW – study; FIR – secondary source	BW and FIR – study	BW and FIR – secondary source	BW and FIR – study	BW – study and secondary sources; FIR – secondary sources
Type of effect level	ED20	ED20	ED20	LOAEL ≥ 20 (71% reduction in response relative to the control)	ED20
Level of Confidence and Bias					
Considerations decreasing the level of confidence in effect level (potential bias)	not a UCR receptor (unknown) dose administration (unknown) estimated FIR (unknown)	dose administration (unknown) exposure life stage and duration (unknown)	not a UCR receptor (unknown) dose administration (unknown) estimated BW and FIR (unknown)	dose administration (unknown) effect level based on LOAEL ≥ 20 (high)	not a UCR receptor (unknown) dose administration (unknown) estimated BW and FIR (unknown)
Considerations Associated with Available Literature					
Number of species with LOAEL ≥ 20 or ED20	three (chicken, Japanese quail, mallard)	NA	three (chicken, Japanese quail, mallard)	NA	three (chicken, mallard, Pekin duck)
Number of dose-response datasets evaluated	12 - Tier 1, 1 - Tier 2	1 - Tier 1	5 - Tier 1	1 - Tier 1	6 - Tier 1

Notes:

[a] Effect levels for the growth and reproduction endpoints from mallard studies are receptor-specific and will be used to evaluate risk to mallards in the UCR.

[b] Pooled datasets included Bokori et al. 1995a and Olgun 2015

BW – body weight

ED20 – effect dose with a 20% reduction in the response relative to the control (modeled)

FIR – food ingestion rate

LOAEL ≥ 20 – lowest observed adverse effect level with ≥20% reduction in the response relative to the control

NA – not applicable

Table 4-8. Uncertainty Considerations for Mammalian Selected Effect Levels for Cadmium

	Growth	Growth - Shrew[a]	Reproduction	Survival[b]
Selected Effect Level Details				
Dose (mg/kg bw/day)	4.2	104	2.7	1.5
Reference	Wilson et al. 1941	Dodds-Smith et al. 1992	Sutou et al. 1980	Swiergosz et al. 1998
Receptor used in study	rat	shrew	rat	vole
Considerations in Study Used to Derive Selected Effect Level				
Is species a UCR receptor?	no	yes	no	no
Dose administration	diet	diet	gavage	diet
Growth study exposure	critical lifestage	critical lifestage	NA	NA
Chemical form	cadmium chloride	cadmium chloride	cadmium chloride	cadmium chloride
Source of BW and FIR	BW – study; FIR – secondary source	NA (doses reported in the study)	NA (doses reported in the paper)	BW – study; FIR – secondary source
Type of effect level	ED20	LOAEL ≥ 20 (22% reduction in response relative to the control)	ED20	ED20
Level of Confidence and Bias				
Considerations decreasing the level of confidence in effect level (potential bias)	Not a UCR receptor (unknown) Dose administration) estimated FIR (unknown)	dose administration (unknown) effect level based on LOAEL ≥ 20 (high)	not a UCR receptor (unknown) dose administration (unknown)	dose administration (unknown) estimated FIR (unknown)
Considerations Associated with Available Literature				
Number of species with LOAEL ≥ 20 or ED20	five (dog, mouse, pig, rat, shrew)	NA	two (mouse, rat)	three (mouse, rat, vole)
Number of dose-response datasets evaluated	18 - Tier 1	1 - Tier 1	9 - Tier 1	3 - Tier 1, 3 - Tier 2

Notes:

[a] Effect level for the growth endpoint from the shrew study is receptor-specific and will be used to evaluate risk to shrews in the UCR.

[b] The selected survival effect level is receptor-specific for vole.

BW – body weight

ED20 – effect dose with 20% reduction in observed response relative to the control (modeled)

FIR – food ingestion rate

LOAEL ≥ 20 – lowest observed adverse effect level with a 20% or more reduction in response compared to the control

NA – not applicable

Table 4-9. Uncertainty Considerations for Avian Selected Effect Levels for Copper

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	62	28	67
Reference	pooled dataset[a]	pooled dataset[b]	Mehring et al. 1960
Receptor used in study	chicken	chicken	chicken
Considerations in Study Used to Derive Selected Effect Level			
Is species a UCR receptor?	no	no	no
Dose administration	diet	diet	diet
Growth study exposure	critical lifestage	NA	NA
Chemical form	copper sulfate	copper sulfate	copper oxide
Source of BW and FIR	BW and FIR – secondary sources	BW and FIR – study and secondary sources	BW – study; FIR – secondary source
Type of effect level	ED20	ED20	ED20
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias)	not a UCR receptor (unknown) dose administration (unknown) estimated BW and FIR (unknown)	not a UCR receptor (unknown) dose administration (unknown)) egg production endpoint (low) estimated BW and FIR (unknown)	not a UCR receptor (unknown) dose administration (unknown)) estimated FIR (unknown)
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	two (chicken, turkey)	one (chicken)	three (chicken, Pekin duck, turkey)
Number of dose-response datasets evaluated	18 - Tier 1	14 - Tier 1	7 - Tier 1

Notes:

[a] Pooled datasets included Poupoulis and Jensen 1976 (3 datasets), and Wang et al. 1987 (2 datasets)

[b] Pooled datasets included Chiou et al. (1997), Harms and Buresh (1986), Lien et al. (2004), Pearce et al. (1983), and Stevenson and Jackson (1980a,b) (2 datasets)

BW – body weight

ED20 – effect dose with 20% reduction in observed response relative to the control (modeled)

FIR – food ingestion rate

LOAEL ≥ 20 – lowest observed adverse effect level with a 20% or more reduction in response compared to the control

NA – not applicable

Table 4-10. Uncertainty Considerations for Mammalian Selected Effect Levels for Copper

	Growth	Growth - Mink[a]	Reproduction[b]	Survival	Survival - Mink[a]
Selected Effect Level Details					
Dose (mg/kg bw/day)	12	35	27	8.7	35
Reference	Allcroft et al. 1961	Brandt 1983	Aulerich et al. 1982	Ritchie et al. 1963 and Allcroft et al. 1961 (pooled dataset)	Brandt 1983
Receptor used in study	pig	mink	mink	pig	mink
Considerations in Study Used to Derive Selected Effect Level					
Is species a UCR receptor?	no	yes	yes	no	yes
Dose administration	diet	diet	diet	diet	diet
Growth study exposure	critical lifestage	critical lifestage	NA	NA	NA
Chemical form	copper sulfate	copper sulfate	copper sulfate	copper sulfate	copper sulfate
Source of BW and FIR	BW and FIR – secondary sources	BW – study; FIR – secondary source	BW – study; FIR – secondary source	BW – study and secondary source; FIR – secondary source	BW – study; FIR – secondary source
Type of effect level	ED20	LOAEL ≥ 20 (21% reduction in response relative to the control)	LOAEL ≥ 20 (30% reduction in response relative to the control)	geometric mean	LOAEL ≥ 20 (50% reduction in response relative to the control)
Level of Confidence and Bias					
Considerations decreasing the level of confidence in effect level (potential bias)	not a UCR receptor (unknown) dose administration (unknown) estimated BW and FIR (unknown)	Dose administration (unknown) estimated FIR (unknown) effect level based on LOAEL ≥ 20 (high)	estimated FIR (unknown) dose administration (unknown) estimated FIR (unknown) effect level based on LOAEL ≥ 20 (high)	not a UCR receptor (unknown) dose administration (unknown) estimated BW and FIR (unknown)	dose administration (unknown) estimated BW and FIR (unknown) effect level based on LOAEL ≥ 20 (high)
Considerations Associated with Available Literature					
Number of species with LOAEL ≥ 20 or ED20	five (mink, mouse, pig, rabbit, rat)	NA	NA	four (mink, mouse, pig, rat)	NA
Number of dose-response datasets evaluated	9 - Tier 1	1 - Tier 1	1 - Tier 1	5 -Tier 1, 2 - Tier 2	1 - Tier 1

Notes:

[a] Effect levels for the growth and survival endpoints from mink studies are receptor-specific and will be used only to evaluate risk to mink in the UCR.

BW – body weight

ED20 – effect dose with 20% reduction in observed response relative to the control (modeled)

FIR – food ingestion rate

LOAEL ≥ 20 – lowest observed adverse effect level with a 20% or more reduction in response compared to the control

NA – not applicable

Table 4-11. Uncertainty Considerations for Avian Selected Effect Levels for Lead

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	29	4.7	11
Reference	Abduljaleel and Shuhaimi-Othman 2013	pooled dataset[a]	pooled dataset[b]
Receptor used in study	chicken	Japanese quail	pigeon
Considerations in Study Used to Derive Selected Effect Level			
Is species a UCR receptor?	no	no	no
Dose administration	diet	diet	gavage
Growth study exposure	critical lifestage	NA	NA
Chemical form	lead nitrate	lead acetate	lead acetate
Source of BW and FIR	BW and FIR – secondary sources	BW and FIR – study and secondary sources	NA (doses reported in the paper)
Type of effect level	LOAEL ≥ 20 (20% reduction in response relative to the control)	geometric mean	ED20
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias)	not a UCR receptor (unknown) dose administration (unknown) estimated BW and FIR (unknown) effect level based on LOAEL ≥ 20 (high)	not a UCR receptor (unknown) dose administration (unknown) estimated BW and FIR (unknown)	not a UCR receptor (unknown) dose administration (unknown)
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	two (chicken, Japanese quail)	two (chicken, Japanese quail)	two (chicken, pigeon)
Number of dose-response datasets evaluated	20 - Tier 1	9 - Tier 1	5 - Tier 1

Notes:

[a] Pooled datasets included Edens and Garlich 1983 (2 datasets) and Stone and Soares 1976

[b] Pooled datasets included Anders et al. 1982 and Barthalmus et al. 1977

BW – body weight

ED20 – effect dose with 20% reduction in observed response relative to the control (modeled)

FIR – food ingestion rate

LOAEL ≥ 20 – lowest observed adverse effect level with a 20% or more reduction in response compared to the control

NA – not applicable

Table 4-12. Uncertainty Considerations for Mammalian Selected Effect Levels for Lead

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	20	3.2	7.6
Reference	Lorenzo et al. 1978	Gupta et al. 1995	Lorenzo et al. 1978
Receptor used in study	rabbit	mouse	rabbit
Considerations in Study Used to Derive Selected Effect Level			
Is species a UCR receptor?	no	no	no
Dose administration	gavage	gavage	gavage
Growth study exposure	critical lifestage	NA	NA
Chemical form	lead nitrate	lead acetate	lead nitrate
Source of BW and FIR	NA (doses reported in paper)	NA (doses reported in paper)	NA (doses reported in paper)
Type of effect level	LOAEL ≥ 20 (41% reduction in response relative to the control)	LOAEL ≥ 20 (23% reduction in response relative to the control)	ED20
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias)	not a UCR receptor (unknown) dose administration (unknown) effect level based on LOAEL ≥ 20 (high)	not a UCR receptor (unknown) dose administration (unknown) effect level based on LOAEL ≥ 20 (high)	not a UCR receptor (unknown) dose administration (unknown)
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	four (mouse, pig, rat, rabbit)	two (mouse, rat)	four (mouse, rabbit, rat, shrew)
Number of dose-response datasets evaluated	11 - Tier 1	10 - Tier 1	5 - Tier 1

Notes:

BW – body weight

ED20 – effect dose with 20% reduction in observed response relative to the control (modeled)

FIR – food ingestion rate

LOAEL ≥ 20 – lowest observed adverse effect level with a 20% or more reduction in response compared to the control

NA – not applicable

Table 4-13. Uncertainty Considerations for Mammalian Selected Effect Levels for Manganese

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	71	310	91
Reference	Rehnberg et al. 1980	Laskey et al. 1982	Rehnberg et al. 1980
Receptor used in study	rat	rat	rat
Considerations in Study Used to Derive Selected Effect Level			
Is species a UCR receptor?	no	no	no
Dose administration	gavage	diet	gavage
Growth study exposure	critical lifestage	NA	NA
Chemical form	manganese oxide	manganese oxide	manganese oxide
Source of BW and FIR	NA (doses provided in the paper)	BW - study; FIR - secondary source	NA (doses provided in the paper)
Type of effect level	LOAEL ≥ 20 (23% reduction in response relative to the control)	ED20	ED20
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias)	not a UCR receptor (unknown) dose administration (unknown) short-term growth study (low) effect level based on LOAEL ≥ 20 (high)	not a UCR receptor (unknown) dose administration (unknown) estimated FIR (unknown)	not a UCR receptor (unknown) dose administration (unknown)
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	two (mouse, rat)	one (rat)	one (rat)
Number of dose-response datasets evaluated	8 - Tier 1, 1 - Tier 2	1 - Tier 1, 3 - Tier 2	2 - Tier 1

Notes:

BW – body weight

ED20 – effect dose with 20% reduction in observed response relative to the control (modeled)

FIR – food ingestion rate

LOAEL ≥ 20 – lowest observed adverse effect level with a 20% or more reduction in response compared to the control

NA – not applicable

Table 4-14. Uncertainty Considerations for Avian Selected Effect Levels for Zinc

	Growth	Growth - Mallard[a]	Reproduction	Survival	Survival - Mallard[a]
Selected Effect Level Details					
Dose (mg/kg bw/day)	43	200	77	250	330
Reference	pooled dataset[b]	Gasaway and Buss 1972	Gibson et al. 1986	Roberson and Schaible 1960	Gasaway and Buss 1972
Receptor used in study	chicken	mallard duck	chicken	chicken	mallard duck
Considerations in Study Used to Derive Selected Effect Level					
Is species a UCR receptor?	no	yes	no	no	yes
Dose administration	diet	diet	diet	diet	diet
Growth study exposure	critical lifestage	critical lifestage	NA	NA	NA
Chemical form	zinc oxide	zinc carbonate	zinc acetate dihydrate	zinc carbonate	zinc carbonate
Source of BW and FIR	BW and FIR – secondary sources	BW and FIR – secondary sources	BW and FIR – study	BW - study; FIR - secondary source	BW and FIR – secondary sources
Type of effect level	ED20	ED20	ED20	LOAEL ≥ 20 (21% reduction in response relative to the control)	LOAEL ≥ 20 (67% reduction in response relative to the control)
Level of Confidence and Bias					
Considerations decreasing the level of confidence in effect level (potential bias)	not a UCR receptor (unknown) dose administration (unknown) estimated BW and FIR (unknown)	dose administration (unknown) estimated BW and FIR (unknown)	not a UCR receptor (unknown) dose administration (unknown) egg production endpoint (low)	not a UCR receptor (unknown) dose administration (unknown) estimated BW and FIR (unknown) effect level based on LOAEL ≥ 20 (high)	dose administration (unknown) estimated BW and FIR (unknown) effect level based on LOAEL ≥ 20 (high)
Considerations Associated with Available Literature					
Number of species with LOAEL ≥ 20 or ED20	four (chicken, Japanese quail, mallard, turkey)	NA	one (chicken)	three (chicken, Japanese quail, mallard)	NA
Number of dose-response datasets evaluated	16 - Tier 1	1 - Tier 1	8 - Tier 1	7 - Tier 1	1 - Tier 1

Notes:

[a] Effect levels for growth and survival endpoints from mallard studies are receptor-specific and will be used to evaluate risk to mallard in the UCR.

[b] Pooled datasets included Lu and Combs 1988 and Lu et al. 1990

BW – body weight

ED20 – effect dose with 20% reduction in observed response relative to the control (modeled)

FIR – food ingestion rate

LOAEL ≥ 20 – lowest observed adverse effect level with a 20% or more reduction in response compared to the control

NA – not applicable

Table 4-15. Uncertainty Considerations for Mammalian Selected Effect Levels for Zinc

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	3.7	14	190
Reference	Khan et al. 2007	Khan et al. 2007	Brink et al. 1959 (pooled dataset)
Receptor used in study	rat	rat	pig
Considerations in Study Used to Derive Selected Effect Level			
Is species a UCR receptor?	no	no	no
Dose administration	gavage	gavage	diet
Growth study exposure	>10% of lifespan	NA	NA
Chemical form	zinc chloride	zinc chloride	zinc carbonate
Source of BW and FIR	NA (doses reported in the paper)	NA (doses reported in the paper)	BW and FIR – study
Type of effect level	ED20	LOAEL ≥ 20 (23% reduction in response relative to the control)	geomean
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias)	not a UCR receptor (unknown) dose administration (unknown)	not a UCR receptor (unknown) dose administration (unknown) effect level based on LOAEL ≥ 20 (high)	not a UCR receptor (unknown)dose administration (unknown)
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	three (mouse, pig, rat)	one (rat)	two (ferret, pig)
Number of dose-response datasets evaluated	14 - Tier 1	12 - Tier 1	4 - Tier 1

Notes:

BW – body weight

ED20 – effective dose with 20% reduction in observed response relative to the control (modeled)

FIR – food ingestion rate

LOAEL ≥ 20 – lowest observed adverse effect level with a 20% or more reduction in response compared to the control

NA – not applicable

Table 5-1. Summary of TRVs for Birds and Mammals

	Growth		Reproduction		Survival	
Metal	TRV (mg/kg bw/day)	TRV Type	TRV (mg/kg bw/day)	TRV Type	TRV (mg/kg bw/day)	TRV Type
Bird TRVs						
Cadmium	2.0	ED20	2.3	ED20	7.4	ED20
Copper	62	ED20	28	ED20	67	ED20
Lead	29	LOAEL ≥ 20	4.7	geometric mean	11	ED20
Manganese	none	NA	none	NA	none	NA
Zinc	66[a]	Eco-SSL	77	ED20	250	LOAEL ≥ 20
UCR Receptor-Specific Bird TRVs						
Cadmium - mallard	41	ED20	20	LOAEL ≥ 20	none	NA
Zinc - mallard	200	ED20	none	NA	330	LOAEL ≥ 20
Mammal TRVs						
Cadmium	4.2	ED20	2.7	ED20	1.5	ED20
Copper	12	ED20	27	LOAEL ≥ 20	8.7	geometric mean
Lead	20	LOAEL ≥ 20	4.7[a]	Eco-SSL	7.6	ED20
Manganese	71	LOAEL ≥ 20	310	ED20	91	ED20
Zinc	75[a]	Eco-SSL	75[a]	Eco-SSL	190	geometric mean
UCR Receptor-Specific Mammal TRVs						
Cadmium - shrew	104	LOAEL ≥ 20	none	NA	none	NA
Copper - mink	35	LOAEL ≥ 20	27	LOAEL ≥ 20	35	LOAEL ≥ 20

Notes:

Green shading indicates selected toxicity reference values (TRVs). TRVs were derived from the lowest value from the lowest tier from among the following values: 1) ED20 from individual dataset; 2) LOAEL ≥ 20 from individual dataset; or 3) ED20 or geometric mean of LOAELs ≥ 20 from pooled dataset. One exception is that the copper mammal reproduction TRV was based on the second lowest LOAEL ≥ 20 as discussed in Section 4.3.

[a] The selected TRV is the ecological soil screening level (Eco-SSL) because the lowest effect level is less than the Eco-SSL.

ED20 – effect dose with a 20% reduction in the response relative to the control (modeled)

LOAEL ≥ 20 – lowest observed adverse effect level with ≥20% reduction in the response relative to the control

NA - not applicable

APPENDIX A

STUDIES CONSIDERED IN THE TRV DERIVATION PROCESS

APPENDIX A-1

TABLES

Table A-1. Acronyms Used in the Eco-SSL Documents

Acronym	Definition
AD	adult
ALWT	albumin weight
B	both
BDWT	body weight changes
BO	bone
DEYO	death of young
DR	drinking water
DVP	development
EG	egg response site
EGG	egg effect type
EGPN	egg production
EGWT	egg weight
EM	embryo
ESQU	egg quality
ESTH	eggshell thickness
EY	eye
FD	food
F	female
FM	femur
FERT	fertility
GDPV	general development
GE	gestation
GGRO	general growth
GMPH	general morphology
GRO	growth
GREP	general reproduction
GV	gavage
IM	immature
JV	juvenile
LB	laying bird
LC	lactation
LFSP	lifespan
M	male
M	measured
MA	mature
MOR	mortality effect type
MORT	mortality effect measure
MPH	morphology
MT	multiple tissues/organs
MU	muscle
MUSC	muscle changes
NR	not reported
OD	oviduct
ODVP	offspring development
OR	oral
ORWT	organ weight changes
OV	ovary
PG	prostate gland
PRFM	pregnant females in a population
PROG	progeny numbers/counts
PRWT	progeny weight
RBEH	reproductive behavior
REP	reproduction
RHIS	reproductive organ histology
RPRD	reproductive capacity
RSEM	resorbed embryos
RSUC	reproductive success

Table A-1. Acronyms Used in the Eco-SSL Documents

Acronym	Definition
RT	Reproductive tissue
SL	spleen
SM	sexually mature
SM	sperm
SPCL	sperm cell counts
SPCV	sperm cell viability
SURV	survival
SV	seminal vesicle
TA	tail
TB	tibia
TE	testes
TEDG	testes degeneration
TEWT	testes weight
TPRD	total production
U	unmeasured
UX	unmeasured by verified
WI	wings
WO	whole organism
YO	young

Table A-2. Cadmium Data for Birds as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[a]
Reproduction																			
44	Leach et al. 1978[b]	398	chicken (*Gallus domesticus*)	2	U	FD	12	week	8	month	LB	F	REP	EGPN	WO	0.593	2.37	82	yes
45	Leach et al. 1978[b]	398	chicken (*Gallus domesticus*)	3	U	FD	12	month	6	month	LB	F	REP	PROG	WO	0.593	2.37	82	yes
46	Bokori et al. 1996	375	chicken (*Gallus domesticus*)	1	U	FD	39	week	14	day	IM	M	REP	TEWT	TE	0.799	2.40	85	no (ENR)
47	White and Finley 1978	396	mallard (*Anas platyrhychos*)	1	M	FD	90	day	1	year	AD	F	REP	Other	NR	1.53	21.1	83	yes
48	White et al. 1978	399	mallard (*Anas platyrhychos*)	1	M	FD	90	day	1	year	AD	B	REP	TEWT	TE	1.53	21.1	87	no (ENR)
49	Di Giulio and Scanlon 1985	389	mallard (*Anas platyrhychos*)	1	U	FD	42	day	32	week	JV	M	REP	TEWT	TE	4.20		73	no (ENR, UN)
50	Sell 1975	807	chicken (*Gallus domesticus*)	1	U	FD	23	day	16	month	LB	F	REP	PROG	WO		2.40	79	no (SDC)
51	Bokori et al. 1995	378	chicken (*Gallus domesticus*)	2	U	FD	5	week	21	day	JV	M	REP	TEDG	TE		3.71	79	no (ENR)
52	Bokori et al. 1995	379	Japanese quail (*Coturnix japonica*)	1	U	FD	37	day	NR	NR	LB	F	REP	PROG	WO		7.65	79	yes
53	Richardson et al. 1974	371	Japanese quail (*Coturnix japonica*)	1	U	FD	6	week	1	day	JV	M	REP	TEWT	TE		10.4	79	no (ENR)
Growth																			
54	Jacobs et al. 1978	400	Japanese quail (*Coturnix japonica*)	6	U	FD	7	day	7	day	JV	B	GRO	BDWT	WO	0.125		69	no (UN)
55	Stoewsand et al 1986	356	Japanese quail (*Coturnix japonica*)	2	M	FD	63	day	1	day	JV	B	GRO	BDWT	WO	0.260		75	no (UN)
56	Lefevre et al. 1982	392	chicken (*Gallus domesticus*)	3	U	FD	5	week	1	day	JV	NR	GRO	BDWT	WO	0.708	7.08	82	yes
57	Leach et al. 1978[b]	398	chicken (*Gallus domesticus*)	4	U	FD	6	week	1	day	JV	M	GRO	BDWT	WO	0.826	3.30	81	no (UN[c])
58	Cain et al. 1983	366	mallard (*Anas platyrhychos*)	4	M	FD	12	week	1	day	JV	B	GRO	BDWT	WO	0.858		82	no (UN)
59	Hill 1974	1369	chicken (*Gallus domesticus*)	2	U	FD	2	week	1	day	JV	B	GRO	BDWT	WO	1.25		76	no (UN)
60	Bokori et al. 1996	375	chicken (*Gallus domesticus*)	3	U	FD	4	week	14	day	JV	M	GRO	BDWT	WO	1.55	4.66	83	yes
61	Hill 1979	397	chicken (*Gallus domesticus*)	4	U	FD	2	week	1	day	JV	F	GRO	BDWT	WO	1.72	3.44	82	yes
62	Hill 1974	92	chicken (*Gallus domesticus*)	6	U	FD	2	week	1	day	JV	B	GRO	BDWT	WO	1.72	3.44	82	yes
63	Di Giulio and Scanlon 1985	389	mallard (*Anas platyrhychos*)	3	U	FD	42	day	32	week	JV	M	GRO	BDWT	WO	4.20		78	no (UN)
64	Blalock and Hill 1988	386	chicken (*Gallus domesticus*)	4	U	FD	2	week	1	day	JV	NR	GRO	BDWT	WO	4.24		68	no (UN)
65	Mayack et al. 1981	393	wood duck (*Aix sponsa*)	4	M	FD	12	week	1	week	JV	B	GRO	BDWT	WO	5.76		73	no (UN)
66	Hill 1979	397	chicken (*Gallus domesticus*)	2	U	FD	2	week	1	day	JV	F	GRO	BDWT	WO	6.44		74	no (UN)
67	Di Giulio and Scanlon 1984	183	mallard (*Anas platyrhychos*)	4	U	FD	42	day	11	month	JV	M	GRO	BDWT	WO	12.5	37.6	84	yes
68	Fadil and Magid 1996	5265	chicken (*Gallus domesticus*)	3	U	DR	30	day	1	day	JV	NR	GRO	BDWT	WO		1.05	71	yes
69	Hill 1990	8125	chicken (*Gallus domesticus*)	2	U	FD	18	day	1	day	JV	F	GRO	BDWT	WO		4.26	76	no (SNF[d])
70	Bafundo et al. 1984	8500	chicken (*Gallus domesticus*)	2	U	FD	14	day	8	day	JV	M	GRO	BDWT	WO		4.80	76	yes
71	Hill 1974	1369	chicken (*Gallus domesticus*)	2	U	FD	2	week	1	day	JV	B	GRO	BDWT	WO		4.90	76	yes
72	Bokori et al. 1995	378	chicken (*Gallus domesticus*)	4	U	FD	1	week	21	day	JV	M	GRO	BDWT	WO		5.63	77	yes
73	Pritzl et al. 1974	403	chicken (*Gallus domesticus*)	5	U	FD	20	day	2	week	JV	M	GRO	BDWT	WO		9.57	77	yes
74	Freeland and Cousins 1973	7011	chicken (*Gallus domesticus*)	2	U	FD	2	week	1	day	JV	M	GRO	BDWT	WO		9.75	77	yes
75	Richardson et al. 1974	371	Japanese quail (*Coturnix japonica*)	2	U	FD	4	week	1	day	JV	B	GRO	BDWT	WO		12.2	77	yes
76	Richardson and Fox 1974	402	Japanese quail (*Coturnix japonica*)	2	U	FD	4	week	1	day	JV	B	GRO	BDWT	WO		12.8	77	yes
77	Rama and Planas 1981	6468	chicken (*Gallus domesticus*)	2	U	FD	3	week	1	day	JV	NR	GRO	BDWT	WO		13.0	77	yes
78	Hill 1980	395	chicken (*Gallus domesticus*)	2	U	FD	1	week	1	day	JV	F	GRO	BDWT	WO		13.8	69	yes
79	Spivey et al. 1971	7101	Japanese quail (*Coturnix japonica*)	2	U	FD	2	week	1	day	JV	NR	GRO	BDWT	WO		14.7	77	yes
Survival																			
80	Bokori et al. 1996	375	chicken (*Gallus domesticus*)	3	U	FD	12	week	14	day	JV	M	MOR	MORT	WO	3.00		78	no (UN)
81	Blalock and Hill 1988	386	chicken (*Gallus domesticus*)	4	U	FD	3	week	1	day	JV	NR	MOR	MORT	WO	4.24		69	no (UN)
82	Mayack et al. 1981	393	wood duck (*Aix sponsa*)	4	M	FD	12	week	1	week	JV	B	MOR	MORT	WO	5.78		74	no (UN)
83	Hill 1974	92	chicken (*Gallus domesticus*)	6	U	FD	5	week	1	day	JV	B	MOR	MORT	WO	8.59		77	no (UN)
84	Pritzl et al. 1974	403	chicken (*Gallus domesticus*)	5	U	FD	20	day	2	week	JV	M	MOR	MORT	WO	9.57	14.3	84	yes
85	Richardson et al. 1974	371	Japanese quail (*Coturnix japonica*)	2	U	FD	4	week	1	day	JV	B	MOR	MORT	WO	10.5		69	no (UN)
86	Van Vleet et al. 1981	80	duck (*Anas* sp.)	3	U	FD	15	day	NR	NR	JV	M	MOR	MORT	WO	13.4		77	no (UN)
87	Spivey et al. 1971	7101	Japanese quail (*Coturnix japonica*)	2	U	FD	2	week	1	day	JV	NR	MOR	MORT	WO	14.2		69	no (UN)
88	Bokori et al. 1995	379	Japanese quail (*Coturnix japonica*)	4	U	FD	37	day	NR	NR	SM	F	MOR	MORT	WO	15.3	30.6	84	yes
89	White and Finley 1978	396	mallard (*Anas platyrhynchos*)	4	M	FD	90	day	1	year	AD	B	MOR	MORT	WO	16.9		80	no (UN)

Table A-2. Cadmium Data for Birds as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[a]
Survival (continued)																			
90	White et al 1978	399	mallard (*Anas platyrhynchos*)	4	M	FD	90	day	1	year	AD	B	MOR	MORT	WO	21.1		84	no (UN)
91	Bokori et al. 1995	378	chicken (*Gallus domesticus*)	4	U	FD	4	week	21	day	JV	M	MOR	MORT	WO	22.3	44.6	84	yes
92	Hill 1974	1369	chicken (*Gallus domesticus*)	2	U	FD	2	week	1	day	JV	B	MOR	MORT	WO		4.90	77	yes
93	Van Vleet et al. 1981	80	duck (*Anas* sp.)	2	U	FD	28	day	NR	NR	JV	M	MOR	MORT	WO		66.9	77	yes

Notes:

Not all studies presented in the cadmium ecological soil screening level (Eco-SSL) document for growth, reproduction, and survival were used to derive the Eco-SSL toxicity reference value (TRV).

See Eco-SSL document (USEPA 2005a) for the full reference list for studies cited in this table.

Abbreviations from the Eco-SSL document are defined in Table A-1.

Blank cells are shown as reported in the Eco-SSL document; no description was provided.

[a] Rationale for study unacceptability is in parentheses

[b] As reported in the Eco-SSL. The correct publication year for this paper is 1979.

[c] Dose/response dataset was reviewed and determined to be an unbounded no-observed-adverse-effect level (NOAEL) (differs from the Eco-SSL document).

[d] The citation for this paper was not presented in the Eco-SSL document and the paper was not found through an online search.

ENR - endpoint not relevant
LOAEL - lowest-observed-adverse-effect level
SDC - study design concern
SNF - data not found
UN - unbounded NOAEL

Table A-3. Cadmium Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?^{a}
Reproduction																			
163	Wills et al. 1981	646	rat (*Rattus norvegicus*)	3	U	FD	64	week	NR	NR	GE	B	REP	PROG	WO	0.0069		74	no (UN)
164	Webster 1988	525	mouse (*Mus musculus*)	4	U	DR	60	day	8	week	GE	F	REP	PRWT	WO	0.0939	15.6	76	yes
165	Sorell and Braziano 1990	822	rat (*Rattus norvegicus*)	4	U	DR	14	day	NR	NR	GE	F	REP	PRWT	WO	0.651	4.88	78	yes
166	Combs et al. 1983	643	rat (*Rattus norvegicus*)	5	U	FD	57	day	NR	NR	JV	M	REP	TEWT	TE	0.890		70	no (UN)
167	Sutou, et al. 1980	443	rat (*Rattus norvegicus*)	4	U	GV	6	week	5	week	GE	F	REP	Other	WO	1.00	10.0	85	no (DNU)
168	Sutou et al. 1980	647	rat (*Rattus norvegicus*)	4	U	GV	6	week	5	week	GE	F	REP	RSEM	WO	1.00	10.0	90	yes
169	Sawicka-Kapusta et al. 1994	694	mouse (*Mus musculus*)	4	U	FD	6	day	NR	NR	GE	F	REP	DEYO	WO	1.14	2.28	84	yes
170	Ahokas et al. 1980	669	rat (*Rattus norvegicus*)	4	U	DR	21	day	NR	NR	GE	F	REP	PRWT	WO	1.57	4.50	79	yes
171	Loeser and Lorke 1977	754	rat (*Rattus norvegicus*)	5	U	FD	3	month	NR	NR	JV	B	REP	SPCL	SM	2.53		70	no (ENR, UN)
172	Baranski and Sitarek 1987	809	rat (*Rattus norvegicus*)	5	U	GV	7	week	3	month	JV	F	REP	GREP	WO	4.00	40.0	85	no (ENR)
173	Baranski et al. 1983	641	rat (*Rattus norvegicus*)	4	U	GV	8	week	3	month	GE	F	REP	RSEM	WO	4.00		72	no (UN)
174	Zielinska-Psuja et al. 1979	569	rat (*Rattus norvegicus*)	3	U	FD	3	month	NR	NR	JV	M	REP	TEWT	TE	5.40	54.0	83	no (ENR)
175	Sasser et al. 1985	9321	rat (*Rattus norvegicus*)	4	U	DR	21	day	5	month	GE	F	REP	PRWT	WO	6.00	10.0	81	yes
176	Machemer and Lorke 1981	560	rat (*Rattus norvegicus*)	5	U	GV	9	day	4	month	GE	F	REP	FERT	WO	6.13	18.4	92	yes
177	Kotsonis and Klassen 1978	778	rat (*Rattus norvegicus*)	4	U	DR	24	week	70	day	JV	M	REP	PRFM	WO	6.44		66	no (UN)
178	Zenick et al. 1982	661	rat (*Rattus norvegicus*)	4	U	DR	11	week	100	day	JV	M	REP	SPCL	SM	7.41		67	no (ENR, UN)
179	Caflisch 1994	607	rat (*Rattus norvegicus*)	3	U	DR	40	day	NR	NR	AD	M	REP	TEWT	TE	11.4		74	no (ENR, UN)
180	Machemer and Lorke 1981	560	rat (*Rattus norvegicus*)	4	U	FD	9	day	4	month	GE	F	REP	FERT	WO	12.5		74	no (UN)
181	Desi et al. 1998	592	rat (*Rattus norvegicus*)	4	U	GV	16	day	12	week	GE	F	REP	PRWT	WO	13.9		77	no (UN)
182	Cornwall et al. 1984	651	rat (*Rattus norvegicus*)	2	U	GV	13	day	NR	NR	GE	F	REP	RSEM	WO	25.0		79	no (UN)
183	Seidenberg et al. 1986	113	mouse (*Mus musculus*)	2	U	GV	4	day	NR	NR	GE	F	REP	PRWT	WO	41.1		80	no (UN)
184	Wardell et al. 1982	748	rat (*Rattus norvegicus*)	5	U	GV	12	day	NR	NR	GE	F	REP	RSEM	WO	50.0	75	92	yes
185	Simmons et al. 1984	652	rat (*Rattus norvegicus*)	4	U	GV	13	day	NR	NR	GE	F	REP	RSEM	WO	50.0		77	no (UN)
186	Whelton et al. 1988	625	mouse (*Mus musculus*)	3	U	FD	252	day	68	day	GE	F	REP	PROG	WO		0.661	79	yes
187	Webster 1978	824	mouse (*Mus musculus*)	4	U	DR	19	day	NR	NR	GE	F	REP	PRWT	WO		1.42	80	yes
188	Schroeder and Mitchener 1971	66	mouse (*Mus musculus*)	2	U	DR	6	month	21	day	JV	F	REP	DEYO	WO		1.45	67	yes
189	Swiergosz et al. 1998	506	bank vole (*Clethrionomys glareolus*)	3	U	FD	6	month	5	month	JV	M	REP	SPCL	TE		1.87	79	no (ENR)
190	Hastings et al. 1978	571	rat (*Rattus norvegicus*)	2	U	DR	111	day	NR	NR	GE	F	REP	PRWT	WO		2.14	68	yes
191	Steibert et al. 1984	543	rat (*Rattus norvegicus*)	2	U	DR	170	day	NR	NR	GE	F	REP	PRWT	WO		3.93	75	yes
192	Mallol et al. 1984	550	rat (*Rattus norvegicus*)	2	U	DR	25	day	2	week	JV	B	REP	TEWT	TE		4.61	73	no (ENR)
193	Webster 1979	823	mouse (*Mus musculus*)	2	U	DR	19	day	NR	NR	GE	F	REP	PRWT	WO		5.59	74	yes
194	Steibert et al. 1984	544	rat (*Rattus norvegicus*)	2	U	DR	170	day	7	week	JV	F	REP	PRWT	WO		5.82	74	yes
195	Gupta et al. 1993	608	rat (*Rattus norvegicus*)	2	U	DR	28	day	NR	NR	GE	F	REP	PRWT	WO		6.30	73	yes
196	Saxena et.al. 1989	2857	rat (*Rattus norvegicus*)	2	U	DR	120	day	NR	NR	JV	M	REP	SPCL	TE		7.28	69	no (ENR)
197	Pond and Walker 1975	3731	rat (*Rattus norvegicus*)	2	U	FD	21	day	12	week	GE	F	REP	PRWT	WO		236	80	yes
Growth																			
198	Wills et al. 1981	646	rat (*Rattus norvegicus*)	3	U	FD	64	week	NR	NR	JV	B	GRO	BDWT	WO	0.00690		72	no (UN)
199	Vreman et al. 1988	471	cattle (*Bos taurus*)	2	M	FD	330	day	NR	NR	JV	M	GRO	BDWT	WO	0.00792		69	no (RU, UN)
200	Vreman et al. 1988	471	cattle (*Bos taurus*)	2	M	FD	328	day	NR	NR	JV	M	GRO	BDWT	WO	0.00884		69	no (RU, UN)
201	Vreman et al. 1988	471	cattle (*Bos taurus*)	2	M	FD	330	day	NR	NR	JV	M	GRO	BDWT	WO	0.0187		69	no (RU, UN)
202	Lind et al. 1997	685	mouse (*Mus musculus*)	2	M	FD	5	week	NR	NR	JV	F	GRO	BDWT	WO	0.0584		74	no (UN)
203	King et al. 1992	488	pig (*Sus scrofa*)	5	M	FD	128	day	NR	NR	JV	F	GRO	BDWT	WO	0.0793		74	no (UN)
204	Merali and Singhal 1980	639	rat (*Rattus norvegicus*)	3	U	GV	7	day	1	day	JV	M	GRO	BDWT	WO	0.100	1.0	88	yes
205	Rastogi et al. 1977	753	rat (*Rattus norvegicus*)	3	U	GV	30	day	1	day	JV	NR	GRO	BDWT	WO	0.100	1.0	83	yes
206	Williams et al. 1978	483	vole (*Microtus pennsylvanicus*)	2	U	FD	40	day	NR	NR	JV	NR	GRO	BDWT	WO	0.179		69	no (UN)
207	Ahokas et al. 1980	669	rat (*Rattus norvegicus*)	4	U	DR	21	day	NR	NR	GE	F	GRO	BDWT	WO	0.207	1.57	75	yes

Table A-3. Cadmium Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[a]
Growth (continued)																			
208	Cousins et al. 1977	670	rat (*Rattus norvegicus*)	3	U	FD	14	week	NR	NR	JV	M	GRO	BDWT	WO	0.268	1.34	82	yes
209	Koo and Winslow 1983	12092	rat (*Rattus norvegicus*)	3	U	FD	11	week	NR	NR	JV	M	GRO	BDWT	WO	0.323		72	no (UN)
210	Baranski and Sitarek 1987	809	rat (*Rattus norvegicus*)	5	U	GV	12	week	3	month	JV	F	GRO	BDWT	WO	0.400	4.0	83	yes
211	Doyle et al. 1974	3703	sheep (*Ovis aires*)	5	U	FD	163	day	4	month	JV	M	GRO	BDWT	WO	0.448	0.909	80	no (RU)
212	Williams et al. 1978	483	vole (*Microtus pennsylvanicus*)	3	U	FD	40	day	NR	NR	JV	NR	GRO	BDWT	WO	0.478		69	no (UN)
213	Williams et al. 1978	483	vole (*Microtus pennsylvanicus*)	2	U	FD	40	day	NR	NR	JV	NR	GRO	BDWT	WO	0.579		69	no (UN)
214	Ogoshi et al. 1989	720	rat (*Rattus norvegicus*)	3	U	DR	4	week	21	day	JV	F	GRO	BDWT	WO	0.581	1.16	77	yes
215	Schroeder et al. 1963	14446	rat (*Rattus norvegicus*)	2	U	DR	32	day	28	day	JV	B	GRO	BDWT	WO	0.593		66	no (UN)
216	Perry et al. 1977	3730	rat (*Rattus norvegicus*)	7	U	DR	24	month	21	day	JV	F	GRO	BDWT	WO	0.645	1.61	74	yes
217	Yuhas et al. 1979	776	rat (*Rattus norvegicus*)	4	U	DR	2	week	35	day	JV	M	GRO	BDWT	WO	0.770	7.70	72	yes
218	Combs et al. 1983	643	rat (*Rattus norvegicus*)	5	U	FD	57	day	NR	NR	JV	M	GRO	BDWT	WO	0.890		69	no (UN)
219	Combs et al. 1983	643	rat (*Rattus norvegicus*)	5	U	FD	57	day	NR	NR	JV	M	GRO	BDWT	WO	0.890		69	no (UN)
220	Sutou, et al. 1980	443	rat (*Rattus norvegicus*)	4	U	GV	6	week	5	week	GE	F	GRO	BDWT	WO	1.00	10.0	83	yes
221	Takashima et al. 1980	563	rat (*Rattus norvegicus*)	4	U	FD	19	month	NR	NR	JV	M	MPH	GMPH	BO	1.04	5.18	81	no (ENR)
222	Bhattacharyya et al. 1988	626	mouse (*Mus musculus*)	3	U	FD	252	day	68	day	GE	F	GRO	BDWT	WO	1.08	10.8	82	no (CNR)
223	Loeser and Lorke 1977	446	dog (*Canis familiaris*)	5	U	FD	3	month	4-6	month	JV	B	GRO	BDWT	WO	1.36		68	no (UN)
224	Sugawara and Sugawara 1983	21111	rat (*Rattus norvegicus*)	2	U	DR	36	day	27	day	JV	F	GRO	BDWT	WO	1.78		72	no (UN)
225	Machemer and Lorke 1981	560	rat (*Rattus norvegicus*)	5	U	GV	9	day	2	month	GE	F	GRO	BDWT	WO	1.84	6.13	88	yes
226	Mitra et al. 1995	783	rat (*Rattus norvegicus*)	2	M	FD	6	week	1	month	JV	NR	GRO	BDWT	WO	1.85		76	no (UN)
227	Mangler et al. 1988	521	rat (*Rattus norvegicus*)	2	U	DR	18	month	28	day	JV	F	GRO	BDWT	WO	2.22		73	no (UN)
228	Loeser and Lorke 1977	754	rat (*Rattus norvegicus*)	5	U	FD	3	month	NR	NR	JV	B	GRO	BDWT	WO	2.53		68	no (UN)
229	Yuyama 1982	710	rat (*Rattus norvegicus*)	4	U	FD	2	week	5	week	JV	M	GRO	BDWT	WO	2.65	10.6	82	yes
230	Washko and Cousins 1977	770	rat (*Rattus norvegicus*)	2	U	DR	8	week	NR	NR	JV	M	GRO	BDWT	WO	2.78		72	no (UN)
231	Lee et al. 1994	733	rat (*Rattus norvegicus*)	4	U	GV	8	week	60	day	JV	M	GRO	BDWT	WO	3.00	10.0	88	yes
232	Mitsumori et al. 1998	591	rat (*Rattus norvegicus*)	5	U	FD	4	day	5	week	JV	F	GRO	BDWT	WO	3.08	15.4	82	yes
233	Steibert et al. 1984	543	rat (*Rattus norvegicus*)	2	U	DR	170	day	NR	month	AD	F	GRO	BDWT	WO	3.73		73	no (UN)
234	Cousins et al. 1973	502	pig (*Sus scrofa*)	5	U	FD	6	week	55	day	JV	M	GRO	BDWT	WO	4.05	12.1	84	yes
235	Chetty et al. 1980	650	rat (*Rattus norvegicus*)	4	U	FD	4	week	NR	NR	JV	M	GRO	BDWT	WO	4.36	8.71	83	yes
236	Koller and Roan 1977	814	mouse (*Mus musculus*)	4	U	DR	70	day	28	day	JV	NR	GRO	BDWT	WO	4.44	44.4	76	yes
237	Watanabe et al. 1986	632	mouse (*Mus musculus*)	6	M	FD	2	year	7	week	AD	F	GRO	BDWT	WO	4.97		74	no (UN)
238	Swiergosz et al. 1998	506	bank vole (*Clethrionomys glareolus*)	3	U	FD	6	month	5	month	JV	M	GRO	BDWT	WO	4.99		68	no (UN)
239	Zielinska-Psuja et al. 1979	569	rat (*Rattus norvegicus*)	3	U	FD	3	month	NR	NR	JV	M	GRO	BDWT	WO	5.40	54.0	81	yes
240	Sugawara and Sugawara 1983	21111	rat (*Rattus norvegicus*)	2	U	DR	330	day	27	day	JV	F	GRO	BDWT	WO	5.54		72	no (UN)
241	Gustafson and Mercer 1984	551	rat (*Rattus norvegicus*)	7	U	FD	21	day	NR	NR	JV	M	GRO	BDWT	WO	6.06	15.2	83	yes
242	Blakely 1984	547	mouse (*Mus musculus*)	4	U	DR	3	week	6	week	JV	F	GRO	BDWT	WO	7.23		71	no (UN)
243	Zenick et al. 1982	661	rat (*Rattus norvegicus*)	4	U	DR	80	day	100	day	JV	M	GRO	BDWT	WO	7.38		72	no (UN)
244	Weber and Reid 1969	677	mouse (*Mus musculus*)	4	U	FD	3	week	NR	NR	JV	B	GRO	BDWT	WO	8.53		69	no (UN)
245	Ogoshi et al. 1989	720	rat (*Rattus norvegicus*)	6	U	DR	4	week	24	week	AD	NR	GRO	BDWT	WO	8.54	17.1	77	yes
246	Tanaka et al. 1995	690	rat (*Rattus norvegicus*)	3	M	FD	5	month	3	week	JV	M	GRO	BDWT	WO	8.61		73	no (UN)
247	Wlostowski et al. 2000	25891	bank vole (*Clethrionomys glareolus*)	3	UX	FD	6	week	1	month	JV	M	GRO	BDWT	WO	10.5		82	no (UN)
248	Watanabe et al. 1986	632	mouse (*Mus musculus*)	5	M	FD	2	year	10	week	GE	F	GRO	BDWT	WO	11.8		74	no (UN)
249	Machemer and Lorke 1981	560	rat (*Rattus norvegicus*)	4	U	FD	9	day	4	month	GE	F	GRO	BDWT	WO	12.5		72	no (UN)
250	Kodama et al. 1989	507	dog (*Canis familiaris*)	6	U	FD	250	week	8	month	JV	B	MPH	GMPH	BO	12.5		68	no (ENR, UN)
251	Wlostowski and Krasowska 1999	25890	bank vole (*Clethrionomys glareolus*)	3	UX	FD	6	week	1	month	JV	M	GRO	BDWT	WO	12.6		83	no (UN)
252	Ogoshi et al. 1989	720	rat (*Rattus norvegicus*)	3	U	DR	4	week	2	year	AD	NR	MPH	GMPH	FM	16.9		67	no (ENR, UN)
253	King et al. 1992	488	pig (*Sus scrofa*)	3	M	FD	132	day	NR	NR	JV	F	GRO	BDWT	WO	21.3		74	no (UN)

Table A-3. Cadmium Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[a]
Growth (continued)																			
254	Nation et al. 1990	617	rat (*Rattus norvegicus*)	2	U	FD	61	day	50	day	JV	M	GRO	BDWT	WO	31.3		68	no (UN)
255	Exon et al. 1979	3847	mouse (*Mus musculus*)	5	U	DR	6	week	NR	NR	JV	M	GRO	BDWT	WO	43.0	85.9	73	yes
256	Hamada et al. 1991	465	dog (*Canis familiaris*)	6	U	FD	9	year	6-8	month	JV	B	GRO	BDWT	WO	50.0	100	87	yes
257	Weigel et al. 1987	629	rat (*Rattus norvegicus*)	3	M	FD	6	week	NR	NR	JV	M	GRO	BDWT	WO		0.0744	76	yes
258	Bakry et al. 1992	772	rat (*Rattus norvegicus*)	2	U	GV	2	week	NR	NR	JV	B	MPH	GMPH	WO		0.143	84	no (ENR)
259	Smith et al. 1985	636	rat (*Rattus norvegicus*)	2	U	GV	14	day	5	day	JV	M	DVP	GDPV	EY		1.00	84	no (ENR)
260	Rajanna et al. 1984	637	rat (*Rattus norvegicus*)	4	U	FD	180	day	6	week	JV	M	GRO	BDWT	WO		1.97	77	yes
261	Groten et al. 1991	615	rat (*Rattus norvegicus*)	2	M	FD	7	day	5	week	JV	B	GRO	BDWT	WO		3.01	82	yes
262	Wilson et al. 1940[b]	825	rat (*Rattus norvegicus*)	6	U	FD	25	day	NR	NR	JV	M	GRO	BDWT	WO		3.21	77	yes
263	Osuna and Edds 1980[c]	494	pig (*Sus scrofa*)	2	M	FD	4	week	NR	NR	JV	M	GRO	BDWT	WO		3.43	83	no (UN[d])
264	Pond et al. 1973	583	pig (*Sus scrofa*)	2	U	FD	50	day	NR	NR	JV	NR	GRO	BDWT	WO		3.88	78	yes
265	Suzuki and Yoshida 1978	572	rat (*Rattus norvegicus*)	2	U	FD	14	day	NR	NR	JV	M	GRO	BDWT	WO		4.06	78	yes
266	Suzuki and Yoshida 1979	780	rat (*Rattus norvegicus*)	4	U	FD	28	day	NR	NR	JV	M	GRO	BDWT	WO		4.58	77	yes
267	Suzuki and Yoshida 1978	768	rat (*Rattus norvegicus*)	2	U	FD	9	day	NR	NR	JV	M	GRO	BDWT	WO		5.08	77	yes
268	Suzuki and Yoshida 1979	780	rat (*Rattus norvegicus*)	2	U	FD	14	day	NR	NR	JV	M	GRO	BDWT	WO		5.18	77	yes
269	Meyer et al. 1982	662	rat (*Rattus norvegicus*)	3	U	FD	30	day	NR	NR	JV	M	GRO	BDWT	WO		5.44	78	yes
270	Lynch et al. 1976	3711	cattle (*Bos taurus*)	2	U	OR	63	day	NR	NR	JV	M	GRO	BDWT	WO		5.74	79	no (RU)
271	Steibert et al. 1984	544	rat (*Rattus norvegicus*)	2	U	DR	170	day	7	week	JV	F	GRO	BDWT	WO		5.82	72	yes
272	Ando et al. 1978	801	rat (*Rattus norvegicus*)	2	U	GV	2	month	64	day	JV	F	MPH	GMPH	BO		6.13	84	no (ENR)
273	Freundt and Irbahim 1990	2640	rat (*Rattus norvegicus*)	2	U	DR	5	week	NR	NR	AD	F	GRO	BDWT	WO		6.89	72	yes
274	Nakamura et al. 1983	638	rat (*Rattus norvegicus*)	2	U	FD	11	week	NR	NR	NR	F	GRO	BDWT	WO		9.54	78	yes
275	Banis et al. 1969	3733	rat (*Rattus norvegicus*)	2	U	FD	30	day	NR	NR	JV	M	GRO	BDWT	WO		9.70	77	yes
276	Iguchi and Sano 1982	556	rat (*Rattus norvegicus*)	3	U	FD	8	week	NR	NR	YO	M	MPH	GMPH	TB		10.0	77	no (ENR)
277	Banis et al. 1969	3733	rat (*Rattus norvegicus*)	2	U	FD	3	week	5	week	JV	B	GRO	BDWT	WO		10.4	77	yes
278	Eakin et al. 1980	659	rat (*Rattus norvegicus*)	2	U	FD	16	week	NR	NR	JV	M	GRO	BDWT	WO		13.2	72	yes
279	Kajikawa et al. 1981	667	rat (*Rattus norvegicus*)	2	U	DR	91	week	NR	NR	JV	M	GRO	BDWT	WO		14.7	72	yes
280	Pond and Walker 1975	3731	rat (*Rattus norvegicus*)	2	U	FD	21	day	12	week	GE	F	GRO	BDWT	WO		16.8	78	yes
281	Suzuki and Yoshida 1977	574	rat (*Rattus norvegicus*)	2	U	FD	10	day	NR	NR	JV	M	GRO	BDWT	WO		20.7	77	yes
282	Van Vleet et al. 1981	149	pig (*Sus scrofa*)	2	U	FD	2	week	NR	NR	JV	M	GRO	BDWT	WO		75.8	77	yes
283	Dodds-Smith et al. 1992	440	shrew (*Sorex araneus*)	2	U	FD	12	week	NR	NR	JV	B	GRO	BDWT	WO		103	77	yes
284	Weber and Reid 1969	677	mouse (*Mus musculus*)	4	U	FD	3	week	NR	NR	JV	B	GRO	BDWT	WO		571	78	yes
Survival																			
285	Wills et al. 1981	646	rat (*Rattus norvegicus*)	3	U	FD	64	week	NR	NR	JV	B	MOR	MORT	WO	0.00690		73	no (UN)
286	Loeser and Lorke 1977	446	dog (*Canis familiaris*)	5	U	FD	3	month	4-6	month	JV	B	MOR	MORT	WO	1.36		78	no (UN)
287	Swiergosz et al. 1998	506	bank vole (*Clethrionomys glareolus*)	3	U	FD	6	month	5	month	JV	M	MOR	MORT	WO	1.87	4.99	84	yes
288	Mangler et al. 1988	521	rat (*Rattus norvegicus*)	2	U	DR	18	month	28	day	JV	F	MOR	MORT	WO	2.22		74	no (UN)
289	Loeser and Lorke 1977	754	rat (*Rattus norvegicus*)	5	U	FD	3	month	NR	NR	JV	B	MOR	MORT	WO	2.53		69	no (UN)
290	Groten et al. 1991	615	rat (*Rattus norvegicus*)	2	M	FD	56	day	5	week	JV	B	MOR	MORT	WO	2.61		83	no (UN)
291	Baranski and Sitarek 1987	809	rat (*Rattus norvegicus*)	5	U	GV	13	week	3	month	JV	F	MOR	MORT	WO	4.00	40.0	84	yes
292	Baranski et al. 1983	641	rat (*Rattus norvegicus*)	4	U	GV	8	week	3	month	GE	F	MOR	SURV	WO	4.00		76	no (UN)
293	Whelton et al. 1988	625	Mouse (*Mus musculus*)	3	U	FD	252	day	68	day	GE	F	MOR	MORT	WO	6.61		78	no (UN)
294	Sutou, et al. 1980	443	rat (*Rattus norvegicus*)	4	U	GV	6	week	5	week	JV	B	MOR	MORT	WO	10.0		85	no (UN)
295	Sasser et al. 1985	9321	rat (*Rattus norvegicus*)	4	U	DR	21	day	5	month	GE	F	MOR	MORT	WO	10.0		74	no (UN)
296	Machemer and Lorke 1981	560	rat (*Rattus norvegicus*)	4	U	FD	9	day	4	month	GE	F	MOR	MORT	WO	12.5		73	no (UN)
297	Van Vleet et al. 1981	149	pig (*Sus scrofa*)	2	U	FD	10	week	NR	NR	JV	M	MOR	MORT	WO	21.3		77	no (UN)
298	Seidenberg et al. 1986	113	mouse (*Mus musculus*)	2	U	GV	4	day	NR	NR	GE	F	MOR	MORT	WO	41.1		79	no (UN)

Table A-3. Cadmium Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[a]
Survival (continued)																			
299	Cousins et al. 1973	502	pig (*Sus scrofa*)	5	U	FD	6	week	55	day	JV	M	MOR	MORT	WO	67.3		70	no (UN)
300	Dodds-Smith et al. 1992	440	shrew (*Sorex araneus*)	2	U	FD	12	week	NR	NR	JV	B	MOR	MORT	WO	103		78	no (UN)
301	Weber and Reid 1969	677	mouse (*Mus musculus*)	4	U	FD	3	week	NR	NR	JV	B	MOR	MORT	WO	571	2160	83	yes
302	Schroeder et al. 1963	14446	rat (*Rattus norvegicus*)	2	U	DR	6	month	28	day	JV	M	MOR	SURV	WO		0.551	67	yes
303	Schroeder et al. 1964	14447	mouse (*Mus musculus*)	2	U	DR	18	month	21	day	JV	B	MOR	SURV	WO		0.620	73	yes
304	Lynch et al. 1976	3711	cattle (*Bos taurus*)	2	U	OR	63	day	NR	NR	JV	M	MOR	SURV	WO		5.74	80	no (RU)

Notes:

Not all studies presented in the cadmium ecological soil screening level (Eco-SSL) document for growth, reproduction, and survival were used to derive the Eco-SSL toxicity reference value (TRV).

See Eco-SSL document (USEPA 2005a) for the full reference list for studies cited in this table.

Abbreviations from the Eco-SSL document are defined in Table A-1.

Blank cells are shown as reported in the Eco-SSL document; no description was provided.

[a] Rationale for study unacceptability is in parentheses

[b] As reported in the Eco-SSL. The correct publication year for this paper is 1941.

[c] As reported in the Eco-SSL. The correct publication year for this paper is 1982.

[d] Dose/response dataset was reviewed and determined to be an unbounded no-observed-adverse-effect level (NOAEL) (differs from the Eco-SSL document).

CNR - control group not relevant
DNU - data not usable
ENR - endpoint not relevant
LOAEL - lowest-observed-adverse-effect level
RU - ruminant study
UN - unbounded NOAEL

Table A-4. Copper Data for Birds as Presented in Eco-SSL Document, Inculding Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose[a] (mg/kg bw/day)	LOAEL Dose[a] (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[b]
Reproduction																			
189	Ankari et al. 1998	2006	chicken (*Gallus domesticus*)	4	U	FD	84	day	25	week	LB	F	REP	EGPN	WO	4.05	12.1	80	yes
190	Harms and Buresh 1986	2117	chicken (*Gallus domesticus*)	3	U	FD	6	week	64	week	LB	F	REP	EGPN	WO	13.9	19.5	85	yes
191	Jackson and Stevenson 1981	2158	chicken (*Gallus domesticus*)	6	U	FD	280	day	18	week	LB	F	EGG	EGWT	EG	15.6	23.3	86	no (ENR)
192	Stevenson et al. 1983	6170	chicken (*Gallus domesticus*)	4	U	GV	5	day	27	week	LB	F	REP	PROG	WO	16.7	34.0	89	yes
193	Jackson and Stevenson 1981	2159	chicken (*Gallus domesticus*)	6	U	FD	336	day	26	week	LB	F	REP	EGPN	WO	17.0	25.5	86	yes
194	Stevenson et al. 1983	6170	chicken (*Gallus domesticus*)	4	U	FD	5	day	27	week	LB	F	REP	PROG	WO	18.0	28.0	86	yes
195	Jackson and Stevenson 1981	2158	chicken (*Gallus domesticus*)	6	U	FD	280	day	18	week	LB	F	EGG	EGWT	EG	19.4	29.0	86	no (ENR)
196	Jackson and Stevenson 1981	2159	chicken (*Gallus domesticus*)	6	U	FD	336	day	26	week	LB	F	REP	EGPN	WO	20.5	30.7	86	yes
197	Jackson et al. 1979	2160	chicken (*Gallus domesticus*)	5	U	FD	336	day	17	week	LB	F	REP	EGPN	WO	21.6		71	no (UN)
198	Griminger 1977	2112	chicken (*Gallus domesticus*)	5	U	FD	2	week	7	month	LB	F	EGG	ESTH	EG	22.4	44.8	85	no (ENR)
199	Pearce et al. 1983	2294	chicken (*Gallus domesticus*)	5	U	FD	12	day	26	week	LB	F	REP	EGPN	WO	22.5	45.0	85	yes
200	Jackson et al. 1979	2160	chicken (*Gallus domesticus*)	5	U	FD	232	day	17	week	LB	F	REP	EGPN	WO	23.2	29.9	86	yes
201	Stevenson and Jackson 1981	2291	chicken (*Gallus domesticus*)	2	M	FD	6	week	24	week	LB	F	REP	EGPN	WO	23.9		76	no (UN)
202	Stevenson and Jackson 1980	2292	chicken (*Gallus domesticus*)	5	U	FD	6	day	24	week	LB	F	REP	EGPN	WO	27.2	54.4	85	yes
203	Chiou et al. 1997	2050	chicken (*Gallus domesticus*)	5	M	FD	4	week	28	week	LB	F	REP	EGPN	WO	27.5	40.6	91	yes
204	Jackson 1977	2157	chicken (*Gallus domesticus*)	6	U	FD	35	day	NR	NR	LB	F	REP	PROG	WO	29.1	47.5	86	yes
205	Jackson and Stevenson 1981	2291	chicken (*Gallus domesticus*)	2	M	FD	6	week	24	week	LB	F	REP	EGPN	WO	30.4		76	no (SDC, UN)
206	Chiou et al. 1998	2049	chicken (*Gallus domesticus*)	4	U	FD	4	week	38	week	LB	F	REP	EGPN	WO	33.4	40.1	86	no (SDC)
207	Jackson and Stevenson 1981	2291	chicken (*Gallus domesticus*)	2	M	FD	6	week	24	week	LB	F	REP	EGPN	WO	35.2		76	no (SDC, UN)
208	Jackson and Stevenson 1981	2159	chicken (*Gallus domesticus*)	6	U	FD	336	day	26	week	LB	F	REP	ORWT	OV	40.0	50.0	86	no (ENR)
209	Jackson and Stevenson 1981	2159	chicken (*Gallus domesticus*)	6	U	FD	336	day	26	week	LB	F	REP	EGPN	WO	43.3		71	no (UN)
210	Shivanandappa et al. 1983	3727	chicken (*Gallus domesticus*)	6	U	OR	3	week	25	week	JV	M	REP	SPCV	TE	239	318	87	no (ENR)
211	Kadirvel and Kothandaraman 1978	11876	chicken (*Gallus domesticus*)	2	U	FD	28	week	12	week	LB	F	EGG	EGWT	WO		19.7	80	no (ENR)
212	Stevenson and Jackson 1980	2293	chicken (*Gallus domesticus*)	4	U	FD	8	week	24	week	LB	F	REP	EGPN	WO		22.6	79	yes
213	Shivanandappa et al. 1983	3727	chicken (*Gallus domesticus*)	5	U	OR	3	week	25	week	JV	M	REP	SPCV	TE		536	81	no (ENR)
Growth																			
214	Hoda and Maha 1995	2007	chicken (*Gallus domesticus*)	3	U	FD	6	week	1	day	JV	M	GRO	BDWT	WO	1.92		78	no (UN)
215	Kashani et al. 1986	2171	turkey (*Melagris gallopavo*)	4	U	FD	8	week	1	day	JV	M	GRO	BDWT	WO	2.34	4.68	83	yes
216	Pesti and Bakalli 1996	2244	chicken (*Gallus domesticus*)	2	U	FD	42	day	1	day	JV	M	GRO	BDWT	WO	2.70		76	no (UN)
217	Hill 1974	1369	chicken (*Gallus domesticus*)	2	U	FD	2	week	1	day	JV	B	GRO	BDWT	WO	2.75		76	no (UN)
218	Guenthner et al. 1978	2114	turkey (*Melagris gallopavo*)	2	U	FD	24	week	1	day	JV	M	GRO	BDWT	WO	2.97		68	no (UN)
219	McGhee et al. 1965	14453	chicken (*Gallus domesticus*)	5	U	FD	4	week	NR	NR	JV	NR	GRO	BDWT	WO	3.83	7.67	83	no (SDC)
220	King 1975	2177	duck (*Anas platyrhynchos*)	2	U	FD	56	day	8	day	JV	B	GRO	BDWT	WO	4.15		76	no (UN)
221	Pesti and Bakalli 1996	2244	chicken (*Gallus domesticus*)	4	U	FD	42	day	1	day	JV	M	GRO	BDWT	WO	4.43		76	no (UN)
222	King 1972	2178	chicken (*Gallus domesticus*)	2	U	FD	9	week	1	day	JV	B	GRO	BDWT	WO	4.65		67	no (UN)
223	Kayongo-Male and Palmer 1998	5149	turkey (*Melagris gallopavo*)	3	U	FD	4	week	NR	NR	JV	NR	GRO	BDWT	WO	4.75		68	no (UN)
224	Pesti and Bakalli 1996	2244	chicken (*Gallus domesticus*)	2	U	FD	42	day	1	day	JV	M	GRO	BDWT	WO	5.43		76	no (UN)
225	Pesti and Bakalli 1996	2244	chicken (*Gallus domesticus*)	3	U	FD	42	day	1	day	JV	M	GRO	BDWT	WO	5.56		76	no (UN)
226	Waibel et al. 1964	14405	turkey (*Melagris gallopavo*)	3	U	FD	3	week	7	day	JV	NR	GRO	BDWT	WO	5.82	46.6	75	yes
227	Hoda and Maha 1995	2007	chicken (*Gallus domesticus*)	3	U	FD	6	week	1	day	JV	NR	GRO	BDWT	WO	6.28		78	no (UN)
228	Hoda and Maha 1995	2007	chicken (*Gallus domesticus*)	3	U	FD	6	week	1	day	JV	NR	GRO	BDWT	WO	7.55		78	no (UN)
229	Hill 1974	92	chicken (*Gallus domesticus*)	2	U	FD	2	week	1	day	JV	B	GRO	BDWT	WI	7.63		76	no (UN)
230	Pesti and Bakalli 1996	2244	chicken (*Gallus domesticus*)	2	U	FD	42	day	1	day	JV	M	GRO	BDWT	WO	8.19		76	no (UN)
231	Ko et al. 1985	2181	chicken (*Gallus domesticus*)	4	U	FD	3	week	3	day	JV	M	GRO	BDWT	WO	8.40		69	no (UN)
232	Ekperigin and Vohra 1981	6474	chicken (*Gallus domesticus*)	4	U	FD	7	day	6	day	JV	NR	GRO	BDWT	WO	8.59	42.9	80	yes
233	Ekperigin and Vohra 1981	6474	chicken (*Gallus domesticus*)	3	U	FD	7	day	7	day	JV	NR	GRO	BDWT	WO	8.59	42.9	80	yes
234	Gill et al. 1995	2107	chicken (*Gallus domesticus*)	4	U	FD	3	week	4	week	JV	M	GRO	BDWT	WO	9.52	19.0	84	no (SNF)
235	Skrivan et al. 2000	25969	chicken (*Gallus domesticus*)	2	M	FD	38	day	1	day	JV	B	GRO	BDWT	WO	9.72		82	no (UN)
236	Foster 1999	18769	duck (*Anas platyrhynchos*)	5	M	DR	14	day	4	day	JV	NR	GRO	BDWT	WO	10.2	51.6	82	no (SNF)
237	Pesti and Bakalli 1996	2244	chicken (*Gallus domesticus*)	3	U	FD	42	day	1	day	JV	M	GRO	BDWT	WO	11.1		76	no (UN)
238	Pesti and Bakalli 1996	2244	chicken (*Gallus domesticus*)	2	U	FD	42	day	21	day	JV	M	GRO	BDWT	WO	11.5		67	no (UN)
239	Pesti and Bakalli 1996	2244	chicken (*Gallus domesticus*)	5	U	FD	35	day	1	day	JV	M	GRO	BDWT	WO	11.9		76	no (UN)
240	Nam et al. 1984	2226	chicken (*Gallus domesticus*)	3	U	FD	4	week	3	day	JV	NR	GRO	BDWT	WO	12.2	24.3	83	no (UN[c])

Table A-4. Copper Data for Birds as Presented in Eco-SSL Document, Inculding Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose[a] (mg/kg bw/day)	LOAEL Dose[a] (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[b]
Growth (continued)																			
241	Foster 1999	18769	duck (*Anas platyrhynchos*)	2	M	DR	14	day	4	day	JV	NR	GRO	BDWT	WO	12.6		78	no (SNF)
242	Chiou et al. 1999	2048	chicken (*Gallus domesticus*)	4	U	FD	3	week	3	week	JV	NR	GRO	BDWT	WO	13.3	26.6	84	yes
243	Jenkins et al. 1970	2162	chicken (*Gallus domesticus*)	2	M	FD	6	week	1	day	JV	B	GRO	BDWT	WO	13.4		73	no (UN)
244	Marron et al. 2001	25968	chicken (*Gallus domesticus*)	2	U	FD	21	day	7	day	JV	M	GRO	BDWT	WO	14.2		68	no (UN)
245	Hill 1990	5734	chicken (*Gallus domesticus*)	5	U	FD	19	day	1	day	JV	F	GRO	BDWT	WO	14.2		76	no (UN)
246	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	NR	GRO	BDWT	WO	14.3	28.7	82	yes
247	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	5	U	FD	4	week	1	day	JV	NR	GRO	BDWT	WO	14.3	28.7	82	yes
248	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	NR	GRO	BDWT	WO	14.3	28.7	82	yes
249	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	5	U	FD	4	week	1	day	JV	NR	GRO	BDWT	WO	14.3	28.7	82	yes
250	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	NR	GRO	BDWT	WO	14.3	28.7	82	yes
251	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	2	U	FD	4	week	1	day	JV	NR	GRO	BDWT	WO	14.3		67	no (UN)
252	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	2	U	FD	4	week	1	day	JV	NR	GRO	BDWT	WO	14.3		67	no (UN)
253	Bakalli et al. 1995	3717	chicken (*Gallus domesticus*)	2	U	FD	41	day	1	day	JV	M	GRO	BDWT	WO	14.3		76	no (UN)
254	Funk and Baker 1991	2099	chicken (*Gallus domesticus*)	3	U	FD	14	day	8	day	JV	M	GRO	BDWT	WO	15.7	25.8	84	yes
255	Miles et al. 1998	2221	chicken (*Gallus domesticus*)	4	U	FD	42	day	1	day	JV	B	GRO	BDWT	WO	16.5	24.7	84	yes
256	Stevenson and Jackson 1980	2292	chicken (*Gallus domesticus*)	5	U	FD	6	day	24	week	SM	F	GRO	BDWT	WO	16.7	33.4	83	yes
257	Miles et al. 1998	2221	chicken (*Gallus domesticus*)	4	U	FD	42	day	1	day	JV	B	GRO	BDWT	WO	17.2	25.8	84	yes
258	Pesti and Bakalli 1996	2244	chicken (*Gallus domesticus*)	4	U	FD	42	day	1	day	JV	M	GRO	BDWT	WO	17.5		76	no (UN)
259	Smith 1969	2284	chicken (*Gallus domesticus*)	4	U	FD	25	day	1	day	JV	M	GRO	BDWT	WO	17.8	31.1	83	yes
260	Wang et al. 1987	2319	chicken (*Gallus domesticus*)	4	U	FD	3	week	1	day	JV	M	GRO	BDWT	WO	17.8	35.5	82	yes
261	Stevenson et al. 1983	6170	chicken (*Gallus domesticus*)	4	U	FD	5	day	27	week	SM	F	GRO	BDWT	WO	18.0	28.0	80	yes
262	Jensen and Maurice 1978	2164	chicken (*Gallus domesticus*)	2	U	FD	3	week	1	day	JV	NR	GRO	BDWT	WO	18.2		68	no (UN)
263	Ward et al. 1995	6788	turkey (*Melagris gallopavo*)	2	M	FD	10	day	5	day	JV	M	GRO	BDWT	WO	18.3		74	no (UN)
264	Jensen and Maurice 1978	2164	chicken (*Gallus domesticus*)	2	U	FD	3	week	1	day	JV	NR	GRO	BDWT	WO	18.3		68	no (UN)
265	Jensen and Maurice 1978	2164	chicken (*Gallus domesticus*)	2	U	FD	3	week	1	day	JV	NR	GRO	BDWT	WO	18.4		68	no (UN)
266	Jensen and Maurice 1978[d]	2166	chicken (*Gallus domesticus*)	4	U	FD	4	week	1	day	JV	NR	GRO	BDWT	WO	18.5	37.1	83	yes
267	Jensen and Maurice 1978	2164	chicken (*Gallus domesticus*)	2	U	FD	3	week	1	day	JV	NR	GRO	BDWT	WO	18.6		68	no (UN)
268	Funk and Baker 1991	2099	chicken (*Gallus domesticus*)	5	U	FD	14	day	8	day	JV	M	GRO	BDWT	WO	19.6	30.5	84	yes
269	Kadirvel and Kothandaraman 1978	11876	chicken (*Gallus domesticus*)	2	U	FD	28	week	12	week	SM	F	GRO	BDWT	WO	19.7		69	no (UN)
270	Jackson and Stevenson 1981	2159	chicken (*Gallus domesticus*)	6	U	FD	336	day	26	week	SM	F	GRO	BDWT	WO	20.5	30.7	84	yes
271	Pimentel et al. 1992	5617	chicken (*Gallus domesticus*)	2	U	FD	3	week	1	day	JV	B	GRO	BDWT	WO	20.9		68	no (UN)
272	Robbins and Baker 1980	2267	chicken (*Gallus domesticus*)	3	U	FD	14	day	8	day	JV	NR	GRO	BDWT	WO	21.3	42.7	83	yes
273	Ekperigin and Vohra 1981	6474	chicken (*Gallus domesticus*)	5	U	FD	7	day	9	day	JV	NR	GRO	BDWT	WO	21.5	42.9	82	yes
274	Ekperigin and Vohra 1981	6474	chicken (*Gallus domesticus*)	2	U	FD	8	day	9	day	JV	NR	GRO	BDWT	WO	21.5		76	no (UN)
275	Jackson et al. 1979	2160	chicken (*Gallus domesticus*)	5	U	FD	336	day	17	week	SM	F	GRO	BDWT	WO	21.6		68	no (UN)
276	Wideman et al. 1996	2325	chicken (*Gallus domesticus*)	5	M	FD	2	week	1	day	JV	M	GRO	BDWT	WO	21.7		76	no (UN)
277	Miles et al. 1998	2221	chicken (*Gallus domesticus*)	4	M	FD	21	day	1	day	JV	B	GRO	BDWT	WO	21.9	34.0	89	yes
278	Griminger 1977	2112	chicken (*Gallus domesticus*)	5	U	FD	2	week	7	month	SM	F	GRO	BDWT	WO	22.4	44.8	83	yes
279	Kassim and Suwanpradit 1996	2172	chicken (*Gallus domesticus*)	4	U	FD	3	week	1	day	JV	M	GRO	BDWT	WO	22.7	34.1	83	yes
280	Jackson and Stevenson 1981	2158	chicken (*Gallus domesticus*)	6	U	FD	280	day	18	week	SM	F	GRO	BDWT	WO	23.0	30.7	84	yes
281	Jackson et al. 1979	2160	chicken (*Gallus domesticus*)	5	U	FD	232	day	17	week	SM	F	GRO	BDWT	WO	23.2	29.9	84	yes
282	Jackson and Stevenson 1981	2159	chicken (*Gallus domesticus*)	6	U	FD	336	day	26	week	SM	F	GRO	BDWT	WO	23.3	31.0	84	yes
283	Stevenson and Jackson 1981	2291	chicken (*Gallus domesticus*)	2	M	FD	6	week	24	week	SM	F	GRO	BDWT	WO	23.9		74	no (UN)
284	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	NR	GRO	BDWT	WO	24.7		67	no (UN)
285	Jackson and Stevenson 1981	2158	chicken (*Gallus domesticus*)	6	U	FD	280	day	18	week	SM	F	GRO	BDWT	WO	26.4	35.2	84	yes
286	Ward et al. 1995	6788	turkey (*Melagris gallopavo*)	2	M	DR	10	day	5	day	JV	M	GRO	BDWT	WO	26.6		69	no (UN)
287	Ledoux et al. 1989	5812	chicken (*Gallus domesticus*)	4	U	FD	3	week	1	day	JV	M	GRO	BDWT	WO	26.9	40.4	78	yes
288	Chiou et al. 1997	2050	chicken (*Gallus domesticus*)	5	M	FD	28	day	28	week	SM	F	GRO	BDWT	WO	27.9	35.3	89	yes
289	Hill 1989	7091	chicken (*Gallus domesticus*)	4	U	FD	19	day	NR	NR	JV	NR	GRO	BDWT	WO	28.4		70	no (UN)
290	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	4	U	FD	4	week	1	day	JV	NR	GRO	BDWT	WO	28.7	57.4	82	yes
291	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	NR	GRO	BDWT	WO	28.7		67	no (UN)
292	Miles et al. 1998	2221	chicken (*Gallus domesticus*)	4	M	FD	21	day	1	day	JV	B	GRO	BDWT	WO	29.5		83	no (UN)
293	Vohra and Kratzer 1968	14404	turkey (*Melagris gallopavo*)	3	U	FD	21	day	NR	NR	JV	B	GRO	BDWT	WO	29.7	59.3	82	yes

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Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose^a (mg/kg bw/day)	LOAEL Dose^a (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?^{b}
Growth (continued)																			
294	Hill 1990	5734	chicken (*Gallus domesticus*)	4	U	FD	19	day	1	day	JV	F	GRO	BDWT	WO	30.4		76	no (UN)
295	Stevenson and Jackson 1981	2291	chicken (*Gallus domesticus*)	2	M	FD	6	week	24	week	SM	F	GRO	BDWT	WO	30.7		74	no (UN)
296	Mehring et al. 1960	22	chicken (*Gallus domesticus*)	5	M	FD	10	week	1	day	JV	B	GRO	BDWT	WO	33.0	43.3	88	yes
297	Jensen et al. 1991	2163	chicken (*Gallus domesticus*)	4	U	FD	3	week	1	day	JV	M	GRO	BDWT	WO	34.1		68	no (UN)
298	Harms and Buresh 1986	2118	turkey (*Melagris gallopavo*)	3	U	FD	21	day	1	day	JV	B	GRO	BDWT	WO	34.6	51.9	84	yes
299	Funk and Baker 1991	2099	chicken (*Gallus domesticus*)	5	U	FD	14	day	8	day	JV	M	GRO	BDWT	WO	35.2	63.9	83	yes
300	Bafundo et al. 1984	2517	chicken (*Gallus domesticus*)	2	U	FD	14	day	8	day	JV	M	GRO	BDWT	WO	35.5		67	no (UN)
301	Hill 1990	5734	chicken (*Gallus domesticus*)	2	U	FD	19	day	1	day	JV	F	GRO	BDWT	WO	35.5		76	no (UN)
302	Funk and Baker 1991	2099	chicken (*Gallus domesticus*)	3	U	FD	14	day	8	day	JV	M	GRO	BDWT	WO	36.3		78	no (UN)
303	Jensen and Maurice 1979	2166	chicken (*Gallus domesticus*)	2	U	FD	4	week	1	day	JV	NR	GRO	BDWT	WO	36.6		77	no (UN)
304	Davis et al. 1996	1278	chicken (*Gallus domesticus*)	2	U	FD	21	day	14	day	JV	M	GRO	BDWT	WO	37.1		69	no (UN)
305	Chiou et al. 1998	2049	chicken (*Gallus domesticus*)	4	U	FD	4	week	38	week	SM	F	GRO	BDWT	WO	40.1		69	no (UN)
306	Southern and Baker 1983	6368	chicken (*Gallus domesticus*)	2	U	FD	14	day	8	day	JV	M	GRO	BDWT	WO	41.0		68	no (UN)
307	Jackson and Stevenson 1981	2159	chicken (*Gallus domesticus*)	6	U	FD	336	day	26	week	SM	F	GRO	BDWT	WO	43.3		69	no (UN)
308	Kassim and Suwanpradit 1996	2172	chicken (*Gallus domesticus*)	4	U	FD	3	week	3	week	JV	M	GRO	BDWT	WO	49.5	74.2	83	yes
309	Jackson and Stevenson 1981	2159	chicken (*Gallus domesticus*)	6	U	FD	336	day	26	week	SM	F	GRO	BDWT	WO	50.0		69	no (UN)
310	Vohra and Kratzer 1968	14404	turkey (*Melagris gallopavo*)	3	U	FD	21	day	NR	NR	JV	B	GRO	BDWT	WO	50.1		76	no (UN)
311	Jackson 1977	2157	chicken (*Gallus domesticus*)	6	U	FD	35	day	1	year	SM	F	GRO	BDWT	WO	50.9	55.9	84	yes
312	Foster 1999	18769	duck (*Anas platyrhynchos*)	4	M	FD	35	day	3	day	JV	NR	GRO	BDWT	WO	56.8	109	89	no (SNF)
313	Vohra and Kratzer 1968	14404	turkey (*Melagris gallopavo*)	5	U	FD	21	day	NR	NR	JV	B	GRO	BDWT	WO	60.0	120	82	yes
314	Stevenson et al. 1983	6170	chicken (*Gallus domesticus*)	4	U	GV	5	day	27	week	SM	F	GRO	BDWT	WO	65.4		68	no (UN)
315	Yannakopoulos et al. 1990	2333	Japanese quail (*Coturnix japonica*)	4	U	FD	34	day	7	day	JV	B	GRO	BDWT	WO	82.0		78	no (UN)
316	Leeson and Summers 1982	2196	chicken (*Gallus domesticus*)	4	U	FD	21	day	1	day	JV	M	GRO	BDWT	WO	103		68	no (UN)
317	Foster 1999	18769	duck (*Anas platyrhynchos*)	2	M	FD	35	day	3	day	JV	NR	GRO	BDWT	WO	143		78	no (SNF)
318	Ko et al. 1985	2181	chicken (*Gallus domesticus*)	4	U	FD	3	week	3	day	JV	M	GRO	BDWT	WO		2.69	78	no (SNF)
319	Kashani et al. 1986	2171	turkey (*Melagris gallopavo*)	2	U	FD	8	week	1	day	JV	M	GRO	BDWT	WO		4.88	77	yes
320	Harms and Eberst 1974	9234	turkey (*Melagris gallopavo*)	2	U	FD	3	week	1	day	JV	NR	GRO	GGRO	WO		10.3	77	no (UN^c)
321	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	NR	GRO	BDWT	WO		14.3	76	yes
322	Jensen and Maurice 1978	2165	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	NR	GRO	BDWT	WO		17.5	77	yes
323	Latymer and Coates 1981	2191	chicken (*Gallus domesticus*)	2	U	FD	24	day	1	day	JV	B	GRO	BDWT	WO		21.3	77	yes
324	Stevenson and Jackson 1980	2293	chicken (*Gallus domesticus*)	4	U	FD	8	week	24	week	SM	F	GRO	BDWT	WO		22.6	77	yes
325	Ledoux et al. 1987	2194	chicken (*Gallus domesticus*)	3	UX	FD	21	day	1	day	JV	F	GRO	BDWT	WO		22.7	82	no (DNU)
326	Robbins and Baker 1980	2266	chicken (*Gallus domesticus*)	3	U	FD	8	day	8	day	JV	M	GRO	BDWT	WO		26.4	77	yes
327	Robbins and Baker 1980	2266	chicken (*Gallus domesticus*)	3	U	FD	8	day	8	day	JV	M	GRO	BDWT	WO		26.4	77	yes
328	Hill 1974	1369	chicken (*Gallus domesticus*)	2	U	FD	5	week	1	day	JV	B	GRO	BDWT	WO		28.7	76	yes
329	Christmas and Harms 1979	2052	turkey (*Melagris gallopavo*)	3	U	FD	21	day	1	day	JV	B	GRO	BDWT	WO		31.4	78	yes
330	Jensen and Maurice 1978	2165	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	NR	GRO	BDWT	WO		34.9	77	yes
331	Stevenson and Jackson 1981	2291	chicken (*Gallus domesticus*)	2	M	FD	6	week	24	week	SM	F	GRO	BDWT	WO		35.2	83	yes
332	Ekperigin and Vohra 1981	2084	chicken (*Gallus domesticus*)	3	U	FD	1	week	12	day	JV	B	GRO	BDWT	WO		35.5	76	yes
333	Wang et al. 1987	2319	chicken (*Gallus domesticus*)	2	U	FD	3	week	1	day	JV	M	GRO	BDWT	WO		35.5	76	yes
334	Hill 1974	92	chicken (*Gallus domesticus*)	6	U	FD	2	week	1	day	JV	B	GRO	BDWT	WO		42.9	76	yes
335	Robbins and Baker 1980	2267	chicken (*Gallus domesticus*)	2	U	FD	12	day	8	day	JV	NR	GRO	BDWT	WO		50.1	77	yes
336	Robbins and Baker 1980	2266	chicken (*Gallus domesticus*)	2	U	FD	8	day	8	day	JV	M	GRO	BDWT	WO		55.2	77	yes
337	Robbins and Baker 1980	2267	chicken (*Gallus domesticus*)	2	U	FD	8	day	8	day	JV	NR	GRO	BDWT	WO		57.2	77	yes
338	Robbins and Baker 1980	2267	chicken (*Gallus domesticus*)	2	U	FD	12	day	8	day	JV	NR	GRO	BDWT	WO		59.0	77	yes
339	Vohra and Kratzer 1968	14404	turkey (*Melagris gallopavo*)	4	U	FD	21	day	NR	NR	JV	B	GRO	BDWT	WO		60.0	76	yes
340	Foster 1999	18769	duck (*Anas platyrhynchos*)	2	M	FD	35	day	3	day	JV	NR	GRO	BDWT	WO		75.5	83	no (SNF)
341	Hill 1979	1370	chicken (*Gallus domesticus*)	2	U	FD	2	week	1	day	JV	NR	GRO	BDWT	WO		85.9	76	yes
342	Jensen 1975	1403	chicken (*Gallus domesticus*)	2	U	FD	14	day	1	day	JV	NR	GRO	BDWT	WO		92.9	78	yes
343	Hill 1980	395	chicken (*Gallus domesticus*)	2	U	FD	1	week	1	day	JV	F	GRO	BDWT	WO		138	70	yes

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Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose^a (mg/kg bw/day)	LOAEL Dose^a (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?^{b}
Survival																			
344	Hill 1974	1369	chicken (*Gallus domesticus*)	2	U	FD	2	week	NR	NR	JV	B	MOR	MORT	WO	2.75		70	no (UN)
345	Wood and Worden 1973	36216	chicken (*Gallus domesticus*)	2	U	FD	49	day	2	day	JV	B	MOR	MORT	WO	3.55		77	no (UN)
346	Wood and Worden 1973	36216	duck (*Anas platyrhynchos*)	2	U	FD	49	day	2	day	JV	B	MOR	MORT	WO	6.69		77	no (UN)
347	Hill 1974	92	chicken (*Gallus domesticus*)	2	U	FD	5	week	1	day	JV	B	MOR	MORT	WO	7.63		68	no (UN)
348	McGhee et al. 1965	14453	chicken (*Gallus domesticus*)	5	U	FD	4	week	NR	NR	JV	NR	MOR	MORT	WO	8.14	16.3	84	no (SDC)
349	Ko et al. 1985	2181	chicken (*Gallus domesticus*)	4	U	FD	3	week	3	day	JV	M	MOR	MORT	WO	8.40		79	no (UN)
350	Skrivan et al. 2000	25969	chicken (*Gallus domesticus*)	2	M	FD	38	day	1	day	JV	B	MOR	MORT	WO	9.72		74	no (UN)
351	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	NR	MOR	MORT	WO	11.7		68	no (UN)
352	Jenkins et al. 1970	2162	chicken (*Gallus domesticus*)	2	M	FD	6	week	1	day	JV	B	MOR	MORT	WO	13.4		83	no (UN)
353	Marron et al. 2001	25968	chicken (*Gallus domesticus*)	2	U	FD	21	day	7	day	JV	M	MOR	MORT	WO	14.2		78	no (UN)
354	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	5	U	FD	4	week	1	day	JV	NR	MOR	MORT	WO	14.3	28.7	83	yes
355	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	NR	MOR	MORT	WO	14.3	28.7	83	yes
356	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	2	U	FD	4	week	1	day	JV	NR	MOR	MORT	WO	14.3		77	no (UN)
357	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	2	U	FD	4	week	1	day	JV	NR	MOR	MORT	WO	14.3		77	no (UN)
358	Wood and Worden 1973	36216	duck (*Anas platyrhynchos*)	2	U	FD	16	day	2	day	JV	B	MOR	MORT	WO	18.1		77	no (UN)
359	Ward et al. 1995	6788	turkey (*Melagris gallopavo*)	2	M	FD	10	day	5	day	JV	M	MOR	MORT	WO	18.3		84	no (UN)
360	Ankari et al. 1998	2006	chicken (*Gallus domesticus*)	4	U	FD	84	day	25	week	SM	F	MOR	MORT	WO	19.9		73	no (UN)
361	Latymer and Coates 1981	2191	chicken (*Gallus domesticus*)	2	U	FD	24	day	1	day	JV	B	MOR	MORT	WO	21.3		69	no (UN)
362	Jackson et al. 1979	2160	chicken (*Gallus domesticus*)	5	U	FD	336	day	17	week	SM	F	MOR	MORT	WO	21.6		79	no (UN)
363	Ward et al. 1995	6788	turkey (*Melagris gallopavo*)	2	M	DR	10	day	5	day	JV	M	MOR	MORT	WO	26.6		79	no (UN)
364	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	4	U	FD	4	week	1	day	JV	NR	MOR	MORT	WO	28.7	57.4	83	yes
365	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	5	U	FD	4	week	1	day	JV	NR	MOR	MORT	WO	28.7	57.4	83	yes
366	Hill 1974	1369	chicken (*Gallus domesticus*)	2	U	FD	5	week	1	day	JV	M	MOR	MORT	WO	28.7		70	no (UN)
367	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	NR	MOR	MORT	WO	28.7		77	no (UN)
368	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	NR	MOR	MORT	WO	28.7		77	no (UN)
369	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	NR	MOR	MORT	WO	28.7		77	no (UN)
370	Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	NR	MOR	MORT	WO	28.7		77	no (UN)
371	Jackson and Stevenson 1981	2159	chicken (*Gallus domesticus*)	6	U	FD	336	day	26	week	SM	F	MOR	MORT	WO	29.7		79	no (UN)
372	Miles et al. 1998	2221	chicken (*Gallus domesticus*)	4	U	FD	42	day	1	day	JV	B	MOR	MORT	WO	29.7		79	no (UN)
373	Miles et al. 1998	2221	chicken (*Gallus domesticus*)	4	U	FD	42	day	1	day	JV	B	MOR	MORT	WO	30.8		70	no (UN)
374	Jackson and Stevenson 1981	2158	chicken (*Gallus domesticus*)	6	U	FD	280	day	18	week	SM	F	MOR	MORT	WO	31.6		79	no (UN)
375	Mehring et al. 1960	22	chicken (*Gallus domesticus*)	5	M	FD	10	week	1	day	JV	B	MOR	MORT	WO	33.0	43.3	89	yes
376	Jackson and Stevenson 1981	2159	chicken (*Gallus domesticus*)	6	U	FD	336	day	26	week	SM	F	MOR	MORT	WO	35.2		79	no (UN)
377	Jackson and Stevenson 1981	2158	chicken (*Gallus domesticus*)	6	U	FD	280	day	18	week	SM	F	MOR	MORT	WO	35.4		79	no (UN)
378	Jackson et al. 1979	2160	chicken (*Gallus domesticus*)	5	U	FD	232	day	17	week	SM	F	MOR	MORT	WO	35.5		79	no (UN)
379	Jackson and Stevenson 1981	2159	chicken (*Gallus domesticus*)	6	U	FD	336	day	26	week	SM	F	MOR	MORT	WO	43.3		79	no (UN)
380	Waibel et al. 1964	14405	turkey (*Melagris gallopavo*)	3	U	FD	3	week	7	day	JV	NR	MOR	SURV	WO	46.6		72	no (UN)
381	Christmas and Harms 1979	2052	turkey (*Melagris gallopavo*)	3	U	FD	21	day	1	day	JV	B	MOR	MORT	WO	48.3		79	no (UN)
382	Jackson and Stevenson 1981	2159	chicken (*Gallus domesticus*)	6	U	FD	336	day	26	week	SM	F	MOR	MORT	WO	50.0		79	no (UN)
383	Vohra and Kratzer 1968	14404	turkey (*Melagris gallopavo*)	5	U	FD	21	day	NR	NR	JV	B	MOR	MORT	WO	60.0	120	83	yes
384	Jackson 1977	2157	chicken (*Gallus domesticus*)	6	U	FD	35	day	NR	NR	SM	F	MOR	MORT	WO	62.7		78	no (UN)
385	Hill 1974	92	chicken (*Gallus domesticus*)	6	U	FD	5	week	1	day	JV	F	MOR	MORT	WO	81.6	122	83	yes
386	Hill 1979	1370	chicken (*Gallus domesticus*)	2	U	FD	2	week	1	day	JV	B	MOR	MORT	WO	85.9		77	no (UN)
387	Jensen 1975	1403	chicken (*Gallus domesticus*)	2	U	FD	14	day	1	day	JV	NR	MOR	MORT	WO	92.9		79	no (UN)
388	Van Vleet et al. 1981	80	duck (*Anas platyrhynchos*)	2	U	FD	15	day	1	day	JV	M	MOR	MORT	WO	201		77	no (UN)
389	Ko et al. 1985	2181	chicken (*Gallus domesticus*)	4	U	FD	3	week	3	day	JV	M	MOR	MORT	WO		2.69	79	no (SNF)
390	Foster 1999	18769	duck (*Anas platyrhynchos*)	2	M	DR	4	day	4	day	JV	NR	MOR	MORT	WO		78.5	77	no (SNF)

Table A-4. Copper Data for Birds as Presented in Eco-SSL Document, Inculding Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose[a] (mg/kg bw/day)	LOAEL Dose[a] (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[b]
Survival (continued)																			
391	Shivanandappa et al. 1983	3727	chicken (*Gallus domesticus*)	6	U	OR	3	week	25	week	JV	M	MOR	MORT	WO		79.6	80	no (CNR)
392	Van Vleet et al. 1981	80	duck (*Anas platyrhynchos*)	2	U	FD	15	day	1	day	JV	M	MOR	MORT	WO		201	77	yes
393	Shivanandappa et al. 1983	3727	chicken (*Gallus domesticus*)	5	U	OR	4	day	25	week	JV	M	MOR	MORT	WO		536	80	no (CNR)

Notes:

Not all studies presented in the copper ecological soil screening level (Eco-SSL) document for growth, reproduction, and survival were used to derive the Eco-SSL toxicity reference value (TRV).

See Eco-SSL document (USEPA 2007a) for the full reference list for studies cited in this table.

Abbreviations from the Eco-SSL document are defined in Table A-1.

Blank cells are shown as reported in the Eco-SSL document; no description was provided.

[a] Lowest-observed-adverse-effect level (LOAEL) and no-observed-adverse-effect level (NOAEL) values that are equal and from the same reference represent different experimental designs.

[b] Rationale for study unacceptability is in parentheses

[c] Dose/response dataset was reviewed and determined to be an unbounded NOAEL (differs from the Eco-SSL document).

[d] As reported in the Eco-SSL. The correct publication year for this paper is 1979.

CNR - control group data not reported
DNU - data not usable (insufficient data)
ENR - endpoint not relevant
SDC - study design concern
SNF - study not found
UN - unbounded NOAEL

Table A-5. Copper Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose[a] (mg/kg bw/day)	LOAEL Dose[a] (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[b]
Reproduction																			
156	Aulerich et al. 1982	2013	mink (*Mustela vision*)	5	U	FD	357	day	NR	month	JV	F	REP	PROG	WO	3.40	6.79	85	yes
157	Thacker 1991	2304	pig (*Sus scrofa*)	2	U	FD	7	day	NR	NR	GE	F	REP	PROG	WO	6.51		79	no (UN)
158	Webster 1979	823	mouse (*Mus musculus*)	4	U	FD	19	day	4	month	GE	F	REP	PRWT	WO	50.7		79	no (UN)
159	Lecyk 1980	2193	mouse (*Mus musculus*)	7	U	FD	49	day	NR	NR	GE	B	REP	PROG	WO	90.9	136	84	yes
160	Lecyk 1980	2193	mouse (*Mus musculus*)	7	U	FD	49	day	NR	NR	GE	B	REP	PROG	WO	90.9	136	84	yes
161	NTP 1993a	2126	rat (*Rattus norvegicus*)	6	U	FD	13	week	6	week	JV	M	REP	SPCL	SM	107		80	no (ENR, UN)
162	NTP 1993a	2127	rat (*Rattus norvegicus*)	4	U	FD	92	day	6	week	JV	M	REP	SPCL	SM	304		70	no (ENR, UN)
163	NTP 1993a	2126	mouse (*Mus musculus*)	6	U	FD	13	week	6	week	JV	M	REP	SPCL	SM	358		76	no (ENR, UN)
164	NTP 1993a	2127	mouse (*Mus musculus*)	4	U	FD	92	day	6	week	JV	M	REP	SPCL	SM	48300		70	no (ENR, UN)
165	Cromwell et al. 1993	2062	pig (*Sus scrofa*)	2	U	FD	783	day	10	month	GE	F	REP	RSUC	WO		5.51	80	yes
166	Bataineh et al. 1998	1717	rat (*Rattus norvegicus*)	2	U	DR	12	week	NR	NR	AD	M	REP	TEWT	TE		41.2	67	no (ENR)
Growth																			
167	Engle and Spears 2001	25940	cattle (*Bos taurus*)	2	U	FD	239	day	NR	NR	JV	M	GRO	BDWT	WO	0.812		69	no (RU, UN)
168	Engle et al. 2000	25935	cattle (*Bos taurus*)	2	U	FD	154	day	NR	NR	JV	M	GRO	BDWT	WO	0.852		69	no (RU, UN)
169	Bailey et al. 2001	25941	cattle (*Bos taurus*)	3	M	FD	112	day	NR	NR	JV	NR	GRO	BDWT	WO	1.33		73	no (RU, UN)
170	Arthur 1965	2012	guinea pig (*Cavia porcellus*)	3	U	FD	8	week	NR	NR	JV	B	GRO	BDWT	WO	1.48		70	no (UN)
171	Uthus 2001	36349	rat (*Rattus norvegicus*)	2	U	FD	62	day	NR	NR	JV	M	GRO	BDWT	WO	2.07		77	no (UN)
172	Miranda et al. 1981	36240	rat (*Rattus norvegicus*)	2	M	FD	5	week	NR	NR	JV	M	GRO	BDWT	WO	3.60		81	no (UN)
173	Bassuny 1991	2020	rabbit (*Oryctolagus cuniculus*)	5	U	FD	7	week	35	day	JV	M	GRO	BDWT	WO	4.25		78	no (UN)
174	Ward et al. 1991	1888	pig (*Sus scrofa*)	2	M	FD	144	day	31	day	JV	B	GRO	BDWT	WO	4.37		74	no (UN)
175	King 1975	2179	rabbit (*Oryctolagus cuniculus*)	2	U	FD	8	week	5	week	JV	B	GRO	BDWT	WO	5.43		76	no (UN)
176	Cromwell et al. 1993	2062	pig (*Sus scrofa*)	2	U	FD	783	day	10.3	month	GE	F	GRO	BDWT	WO	5.51		69	no (UN)
177	Allcroft et al. 1961	14387	pig (*Sus scrofa*)	4	M	FD	4	week	8-10	week	JV	B	GRO	BDWT	WO	5.60	9.34	88	yes
178	Gershbein et al. 1983	136	rat (*Rattus norvegicus*)	2	U	FD	80	day	44	day	JV	M	GRO	BDWT	WO	5.89		68	no (UN)
179	Anugwa et al. 1984	2010	rabbit (*Oryctolagus cuniculus*)	3	M	FD	8	week	8	week	JV	B	GRO	BDWT	WO	6.67		74	no (UN)
180	Apgar et al. 1995	25922	pig (*Sus scrofa*)	4	M	FD	5	week	31	day	JV	B	GRO	BDWT	WO	6.90		74	no (UN)
181	Cromwell et al. 1998	25930	pig (*Sus scrofa*)	4	U	FD	28	day	26-32	day	JV	B	GRO	BDWT	WO	7.19		69	no (UN)
182	Omole 1977	12977	rabbit (*Oryctolagus cuniculus*)	4	U	FD	8	week	6	week	JV	B	GRO	BDWT	WO	7.34		69	no (UN)
183	Cromwell et al. 1998	25930	pig (*Sus scrofa*)	2	U	FD	28	day	26-32	day	JV	B	GRO	BDWT	WO	7.36		69	no (UN)
184	Cromwell et al. 1998	25930	pig (*Sus scrofa*)	2	M	FD	28	day	29	day	JV	B	GRO	BDWT	WO	7.37		74	no (UN)
185	Kline et al. 1971	20975	pig (*Sus scrofa*)	4	M	FD	88	day	69	day	JV	NR	GRO	BDWT	WO	7.63		73	no (UN)
186	Gipp et al. 1973	14396	pig (*Sus scrofa*)	2	U	FD	12	week	NR	NR	JV	F	GRO	BDWT	WO	7.66		68	no (UN)
187	Cromwell et al. 1989	2061	pig (*Sus scrofa*)	3	U	FD	28	day	28	day	JV	B	GRO	BDWT	WO	7.68		69	no (UN)
188	Luo and Dove 1996	25929	pig (*Sus scrofa*)	2	U	FD	15	day	26	day	JV	M	GRO	BDWT	WO	7.72		69	no (UN)
189	Myres and Bowland 1973	12809	pig (*Sus scrofa*)	2	U	FD	10	week	70	day	JV	B	GRO	BDWT	WO	7.84		69	no (UN)
190	Ritchie et al. 1963	14402	pig (*Sus scrofa*)	2	U	FD	15	week	7	week	JV	NR	GRO	BDWT	WO	8.08		68	no (UN)
191	Cromwell et al. 1998	25930	pig (*Sus scrofa*)	2	M	FD	28	day	30	day	JV	B	GRO	BDWT	WO	8.21		74	no (UN)
192	Braude and Ryder 1973	2034	pig (*Sus scrofa*)	4	M	FD	112	day	9	week	JV	NR	GRO	BDWT	WO	8.29		73	no (UN)
193	Allcroft et al. 1961	14387	pig (*Sus scrofa*)	4	M	FD	19	week	8-10	week	JV	B	GRO	BDWT	WO	8.43		73	no (UN)
194	Prince et al 1979	2253	pig (*Sus scrofa*)	2	U	FD	59	day	64	day	JV	NR	GRO	BDWT	WO	8.44		68	no (UN)
195	Cromwell et al. 1998	25930	pig (*Sus scrofa*)	3	M	FD	28	day	29	day	JV	B	GRO	BDWT	WO	8.50		74	no (UN)
196	Cromwell et al. 1998	25930	pig (*Sus scrofa*)	4	M	FD	28	day	30	day	JV	B	GRO	BDWT	WO	8.68		74	no (UN)
197	Cromwell et al 1989	2061	pig (*Sus scrofa*)	3	U	FD	28	day	28	day	JV	B	GRO	BDWT	WO	9.60		69	no (UN)
198	Gipp et al. 1974	14397	pig (*Sus scrofa*)	2	U	FD	35	day	3	week	JV	B	GRO	BDWT	WO	9.93		69	no (UN)
199	Brandt 1983	2033	mink (*Mustela vision*)	3	M	FD	4	month	90	day	JV	M	GRO	BDWT	WO	10.2	19.6	88	yes
200	Edmonds and Baker 1986	2075	pig (*Sus scrofa*)	3	U	FD	28	day	4	week	JV	NR	GRO	BDWT	WO	10.3	26.9	84	yes
201	Radecki et al. 1992	2255	pig (*Sus scrofa*)	2	U	FD	14	day	21	day	JV	B	GRO	BDWT	WO	12.0		68	no (UN)
202	Aulerich et al. 1982	2013	mink (*Mustela vision*)	5	U	FD	20	week	NR	month	JV	B	GRO	BDWT	WO	12.4		68	no (UN)
203	Felsman et al. 1973	3760	cattle (*Bos taurus*)	4	U	FD	98	day	6	week	JV	M	GRO	BDWT	WO	12.7		68	no (RU, UN)
204	Smith et al. 1975	3756	horse - Shetland pony (*Equus caballus*)	4	M	FD	84	day	NR	NR	JV	NR	GRO	BDWT	WO	13.8		74	no (UN)
205	Suttle and Mills 1966	3757	pig (*Sus scrofa*)	3	U	FD	14	day	NR	NR	JV	F	GRO	BDWT	WO	16.2	27.6	84	yes
206	Cromwell et al. 1989	2061	pig (*Sus scrofa*)	5	U	FD	33	day	28	day	JV	B	GRO	BDWT	WO	16.4		69	no (UN)
207	Apgar and Kornegay 1996	25928	pig (*Sus scrofa*)	2	M	FD	14	day	NR	NR	JV	M	GRO	BDWT	WO	16.5		77	no (UN)
208	Cromwell et al. 1989	2061	pig (*Sus scrofa*)	4	U	FD	28	day	28	day	JV	B	GRO	BDWT	WO	16.7		69	no (UN)

Table A-5. Copper Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose[a] (mg/kg bw/day)	LOAEL Dose[a] (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[b]
Growth (continued)																			
209	NTP 1993a	2126	rat (*Rattus norvegicus*)	6	U	DR	15	day	6	week	JV	B	GRO	BDWT	WO	17.2	51.6	79	yes
210	Lalich et al. 1965	2189	rat (*Rattus norvegicus*)	2	U	FD	42	day	NR	NR	JV	M	GRO	BDWT	WO	17.5		68	no (UN)
211	Cromwell et al. 1989	2061	pig (*Sus scrofa*)	4	U	FD	28	day	28	day	JV	B	GRO	BDWT	WO	17.8		69	no (UN)
212	Felsman et al. 1973	3760	cattle (*Bos taurus*)	4	U	FD	98	day	6	week	JV	M	GRO	BDWT	WO	22.9		68	no (RU, UN)
213	Grobner et al. 1986	2113	rabbit (*Oryctolagus cuniculus*)	6	M	FD	28	day	28	day	JV	NR	GRO	BDWT	WO	27.7	45.7	89	yes
214	Onifade and Abu 1998	2237	rabbit (*Oryctolagus cuniculus*)	4	U	FD	70	day	7	week	JV	NR	GRO	BDWT	WO	28.4		77	no (UN)
215	Bush et al. 1995	2043	mink (*Mustela vision*)	3	M	FD	132	day	10	week	JV	B	GRO	BDWT	WO	33.4		82	no (UN)
216	NTP 1993a	2126	mouse (*Mus musculus*)	6	U	DR	8	day	6	week	JV	B	GRO	BDWT	WO	33.8	101	78	yes
217	King 1975	2179	rabbit (*Oryctolagus cuniculus*)	2	U	FD	6	week	5	week	JV	B	GRO	BDWT	WO	37.1		67	no (UN)
218	White et al. 1985	2324	rat (*Rattus norvegicus*)	2	U	FD	50	day	21	day	JV	M	GRO	BDWT	WO	43.1		68	no (UN)
219	DeVries et al. 1986	10891	rat (*Rattus norvegicus*)	2	U	DR	11	month	3	week	JV	F	GRO	BDWT	WO	45.8		73	no (UN)
220	NTP 1993a	2126	rat (*Rattus norvegicus*)	6	U	FD	13	week	6	week	JV	B	GRO	BDWT	WO	49.8	99.6	84	no (DNU[c])
221	Komulainen 1983	12079	rat (*Rattus norvegicus*)	4	U	DR	1	week	4	week	JV	M	GRO	BDWT	WO	50.0	64.0	82	yes
222	Grobner et al. 1986	2113	rabbit (*Oryctolagus cuniculus*)	6	M	FD	28	day	28	day	JV	NR	GRO	BDWT	WO	59.0		74	no (UN)
223	Myers et al. 1993	2225	rat (*Rattus norvegicus*)	2	U	DR	6	week	NR	month	JV	M	GRO	BDWT	WO	73.4		67	no (UN)
224	Tatum et al. 2000	36389	rat (*Rattus norvegicus*)	2	U	FD	6	week	NR	NR	JV	F	GRO	BDWT	WO	75.7		68	no (UN)
225	NTP 1993a	2126	rat (*Rattus norvegicus*)	6	U	FD	15	day	6	week	JV	B	GRO	BDWT	WO	82.5	165	84	yes
226	Keen et al. 1982	11928	rat (*Rattus norvegicus*)	4	U	FD	7	week	NR	NR	JV	F	GRO	BDWT	WO	91.7	183	83	yes
227	NTP 1993a	2127	rat (*Rattus norvegicus*)	6	U	FD	92	day	6	week	JV	M	GRO	BDWT	WO	146	293	83	yes
228	NTP 1993a	2126	mouse (*Mus musculus*)	6	U	FD	13	week	6	week	JV	B	GRO	BDWT	WO	179	358	84	no (DNU)
229	Dodds-Smith et al. 1992	440	common shrew (*Sorex araneus*)	2	U	FD	12	week	NR	NR	JV	B	GRO	BDWT	WO	229		77	no (UN)
230	NTP 1993a	2127	rat (*Rattus norvegicus*)	5	U	DR	2	week	6	week	JV	M	GRO	BDWT	WO	259	400	78	yes
231	Pettersen et al. 2002	36374	mouse (*Mus musculus*)	3	U	FD	3	week	4	week	JV	B	GRO	BDWT	WO	494	988	83	yes
232	NTP 1993a	2126	mouse (*Mus musculus*)	6	U	FD	15	day	6	week	JV	B	GRO	BDWT	WO	690		69	no (UN)
233	NTP 1993a	2127	rat (*Rattus norvegicus*)	6	U	FD	15	day	6	week	JV	M	GRO	BDWT	WO	812	1738	83	yes
234	NTP 1993a	2127	mouse (*Mus musculus*)	5	U	DR	2	week	6	week	JV	M	GRO	BDWT	WO	1427	3395	78	yes
235	NTP 1993a	2127	mouse (*Mus musculus*)	6	U	FD	92	day	6	week	JV	M	GRO	BDWT	WO	2113	4670	83	yes
236	NTP 1993a	2127	mouse (*Mus musculus*)	6	U	FD	15	day	6	week	JV	F	GRO	BDWT	WO	19500	47500	83	yes
237	Solaiman et al. 2001	36748	goat (*Capra hircus*)	3	U	GV	9	week	7-8	month	JV	F	GRO	BDWT	WO		1.47	80	no (RU)
238	Ortolani et al. 2003	36759	sheep (*Ovis aries*)	2	U	DR	35	day	6	month	JV	M	GRO	BDWT	WO		3.00	76	no (RU)
239	Freundt and Ibrahim 1990	2640	rat (*Rattus norvegicus*)	2	U	DR	91	day	NR	NR	JV	F	GRO	BDWT	WO		5.78	72	yes
240	DeGoey et al. 1971	2064	pig (*Sus scrofa*)	2	U	FD	98	day	NR	NR	JV	B	GRO	BDWT	WO		7.46	78	no (UN[d])
241	DeGoey et al. 1971	2064	pig (*Sus scrofa*)	2	U	FD	23	day	NR	NR	JV	NR	MPH	MUSC	MU		15.5	77	no (ENR)
242	Boyden 1938	14653	rat (*Rattus norvegicus*)	5	U	FD	4	week	28	day	JV	B	GRO	BDWT	WO		23.5	77	yes
243	Rana and Kumar 1980	2256	rat (*Rattus norvegicus*)	2	U	GV	20	day	90	day	JV	M	GRO	BDWT	WO		39.8	84	yes
244	Kumar et al. 1987	2186	rat (*Rattus norvegicus*)	2	U	GV	45	day	90	day	JV	M	GRO	BDWT	WO		39.8	84	yes
245	Llewellyn et al. 1985	2203	rat (*Rattus norvegicus*)	2	U	FD	21	week	NR	NR	JV	M	GRO	BDWT	WO		106	71	yes
246	Fuentealba et al. 2000	36364	rat (*Rattus norvegicus*)	2	U	FD	12	week	21	day	JV	B	GRO	BDWT	WO		122	76	yes
247	Haywood 1985	2121	rat (*Rattus norvegicus*)	5	U	FD	15	week	NR	NR	JV	M	GRO	BDWT	WO		274	71	yes
248	Haywood and Loughran 1985	2124	rat (*Rattus norvegicus*)	5	U	FD	6	week	NR	month	JV	M	GRO	BDWT	WO		285	77	yes

Table A-5. Copper Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose[a] (mg/kg bw/day)	LOAEL Dose[a] (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[b]
Survival																			
249	Bassuny 1991	2020	rabbit (*Oryctolagus cuniculus*)	5	U	FD	7	week	35	day	JV	M	MOR	MORT	WO	4.25		79	no (UN)
250	Cromwell et al. 1993	2062	pig (*Sus scrofa*)	2	U	FD	783	day	10.3	month	GE	F	MOR	MORT	WO	5.51		70	no (UN)
251	Allcroft et al. 1961	14387	pig (*Sus scrofa*)	4	M	FD	4	week	8-10	week	JV	B	MOR	MORT	WO	5.60	9.34	89	yes
252	Brandt 1983	2033	mink (*Mustela vision*)	3	M	FD	4	month	90	day	JV	M	MOR	MORT	WO	10.2	19.6	89	yes
253	Jenkins 1989	48117	cattle (*Bos taurus*)	5	U	FD	6	week	3	day	JV	M	MOR	MORT	WO	16.3	32.5	77	no (RU)
254	Boyden 1938	14653	rat (*Rattus norvegicus*)	5	U	FD	1	week	28	day	JV	B	MOR	MORT	WO	23.3	35.0	84	yes
255	Edmonds and Baker 1986	2075	pig (*Sus scrofa*)	3	U	FD	28	day	4	week	JV	NR	MOR	MORT	WO	25.9		79	no (UN)
256	NTP 1993a	2126	rat (*Rattus norvegicus*)	6	U	DR	15	day	6	week	JV	B	MOR	MORT	WO	33.3	111	78	yes
257	Bush et al. 1995	2043	mink (*Mustela vision*)	3	M	FD	132	day	10	week	JV	B	MOR	MORT	WO	33.4		83	no (UN)
258	NTP 1993a	2126	mouse (*Mus musculus*)	6	U	DR	15	day	6	week	JV	F	MOR	MORT	WO	33.8	101	80	yes
259	Grobner et al. 1986	2113	rabbit (*Oryctolagus cuniculus*)	6	M	FD	28	day	28	day	JV	NR	MOR	MORT	WO	45.5		75	no (UN)
260	Grobner et al. 1986	2113	rabbit (*Oryctolagus cuniculus*)	6	M	FD	28	day	28	day	JV	NR	MOR	MORT	WO	59.0		75	no (UN)
261	Keen et al. 1982	11928	rat (*Rattus norvegicus*)	4	U	FD	7	week	NR	NR	JV	F	MOR	MORT	WO	91.7	183	84	yes
262	NTP 1993a	2126	rat (*Rattus norvegicus*)	6	U	FD	13	week	6	week	JV	B	MOR	MORT	WO	107		79	no (UN)
263	Dodds-Smith et al. 1992	440	common shrew (*Sorex araneus*)	2	U	FD	12	week	NR	NR	JV	B	MOR	MORT	WO	229		78	no (UN)
264	NTP 1993a	2127	rat (*Rattus norvegicus*)	5	U	DR	2	week	6	week	JV	M	MOR	MORT	WO	259	400	79	yes
265	NTP 1993a	2126	rat (*Rattus norvegicus*)	6	U	FD	15	day	6	week	JV	B	MOR	MORT	WO	307		79	no (UN)
266	Haywood 1985	2121	rat (*Rattus norvegicus*)	5	U	FD	2	week	NR	NR	JV	M	MOR	MORT	WO	457	548	78	no (DNR)
267	NTP 1993a	2126	mouse (*Mus musculus*)	6	U	FD	15	day	6	week	JV	B	MOR	MORT	WO	690		70	no (UN)
268	NTP 1993a	2126	mouse (*Mus musculus*)	6	U	FD	13	week	6	week	JV	B	MOR	MORT	WO	760		79	no (UN)
269	NTP 1993a	2127	rat (*Rattus norvegicus*)	6	U	FD	92	day	6	week	JV	B	MOR	MORT	WO	798		78	no (UN)
270	NTP 1993a	2127	mouse (*Mus musculus*)	5	U	DR	2	week	6	week	JV	B	MOR	MORT	WO	1427	3395	79	yes
271	NTP 1993a	2127	rat (*Rattus norvegicus*)	6	U	FD	15	day	6	week	JV	M	MOR	MORT	WO	4160		78	no (UN)
272	NTP 1993a	2127	mouse (*Mus musculus*)	6	U	FD	15	day	6	week	JV	B	MOR	MORT	WO	47519		78	no (UN)
273	NTP 1993a	2127	mouse (*Mus musculus*)	6	U	FD	92	day	6	week	JV	B	MOR	MORT	WO	48270		78	no (UN)
274	Gopinath et al. 1974	36202	sheep (*Ovis aries*)	2	U	DR	10	week	6	month	JV	F	MOR	MORT	WO		5.09	77	no (RU)
275	Ishmael et al. 1971	2155	sheep (*Ovis aries*)	2	U	OR	31	day	6	month	JV	F	MOR	MORT	WO		7.57	75	no (RU)
276	Ritchie et al. 1963	14402	pig (*Sus scrofa*)	2	U	FD	15	week	7	week	JV	NR	MOR	MORT	WO		8.08	78	yes
277	DeGoey et al. 1971	2064	pig (*Sus scrofa*)	2	U	FD	23	day	NR	NR	JV	NR	MOR	MORT	WO		15.5	78	no (UN[c])
278	McNatt et al. 1971	2216	rat (*Rattus norvegicus*)	2	U	DR	3	week	4-11	month	JV	M	MOR	MORT	WO		114	68	yes

Notes:

Not all studies presented in the copper ecological soil screening level (Eco-SSL) document for growth, reproduction, and survival were used to derive the Eco-SSL toxicity reference value (TRV).

See Eco-SSL document (USEPA 2007a) for the full reference list for studies cited in this table.

Abbreviations from the Eco-SSL document are defined in Table A-1.

Blank cells are shown as reported in the Eco-SSL document; no description was provided.

[a] Lowest-observed-adverse-effect level (LOAEL) and no-observed-adverse-effect level (NOAEL) values that are equal and from the same reference represent different experimental designs.

[b] Rationale for study unacceptability is in parentheses

[c] Dose/response dataset was reviewed and determined to be an unbounded NOAEL (differs from the Eco-SSL document).

DNR - data not relevant

DNU - data not used; data are the same as reported in NTP 1993a

ENR - endpoint not relevant

RU - ruminant study

UN - unbounded NOAEL

Table A-6. Lead Data for Birds as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[a]
Reproduction																			
50	Edens and Garlich 1983	2608	Japanese quail (*Coturnix japonica*)	4	U	FD	5	week	6	week	LB	F	REP	PROG	WO	0.194	1.94	77	yes
51	Edens and Garlich 1983	2608	chicken (*Gallus domesticus*)	3	U	FD	4	week	NR	NR	LB	F	REP	PROG	WO	1.63	3.26	79	yes
52	Meluzzi et al. 1996	2771	chicken (*Gallus domesticus*)	4	U	FD	30	day	22	week	LB	F	EGG	ALWT	EG	2.69	4.04	81	no (ENR)
53	Haegele et al. 1974	2668	chicken (*Gallus domesticus*)	2	U	FD	76	day	NR	NR	SM	F	EGG	ESTH	EG	5.63		71	no (ENR, UN)
54	Pattec 1984	2809	American kestrel (*Falco sparverius)*	3	M	FD	6	month	1-6	year	AD	F	REP	RSUC	WO	12.0		90	no (UN)
55	Morgan et al. 1975	2779	Japanese quail (*Coturnix japonica*)	5	U	FD	5	week	6	day	JV	M	REP	TEWT	TE	12.6	126	78	no (ENR)
56	Morgan et al. 1975	2779	Japanese quail (*Coturnix japonica*)	5	U	FD	5	week	1	day	JV	M	REP	TEWT	TE	67.4	135	80	no (ENR)
57	Stone and Soares 1976	2898	Japanese quail (*Coturnix japonica*)	3	U	FD	32	day	NR	NR	AD	F	REP	PROG	WO	125		67	no (UN)
58	Edens et al. 1976	2606	Japanese quail (*Coturnix japonica*)	5	U	FD	12	week	0	day	LB	B	REP	EGPN	EG		0.110	77	yes
59	Edens and Garlich 1983	2608	Japanese quail (*Coturnix japonica*)	4	U	FD	12	week	NR	NR	LB	F	REP	PROG	WO		0.194	75	yes
60	Edens and Garlich 1983	2608	chicken (*Gallus domesticus*)	5	U	FD	10	week	NR	NR	LB	F	REP	PROG	WO		3.26	75	yes
61	Kendall and Scanlon 1981	2734	ringed rurtle dove (*Streptopelia risoria*)	2	U	DR	11	week	NR	NR	AD	M	REP	TEWT	TE		11.8	68	no (ENR)
62	Edens and Melvin 1989	2609	Japanese quail (*Coturnix japonica*)	2	U	FD	1	week	14	week	JV	F	REP	TPRD	WO		93.1	75	yes
63	Stone and Soares 1976	2898	Japanese quail (*Coturnix japonica*)	2	U	FD	27	day	NR	NR	AD	F	REP	PROG	WO		377	74	yes
Growth																			
64	Edens and Garlich 1983	2608	Japanese quail (*Coturnix japonica*)	3	U	FD	5	week	1	day	JV	F	GRO	BDWT	WO	1.56	15.6	77	yes
65	Stone and Fox 1984	6291	Japanese quail (*Coturnix japonica*)	3	U	FD	2	week	1	day	JV	B	GRO	BDWT	WO	2.77		72	no (UN)
66	Stone et al. 1977	2897	Japanese quail (*Coturnix japonica*)	2	U	FD	2	week	1	day	JV	NR	GRO	BDWT	WO	4.64		70	no (UN)
67	Edens and Melvin 1989	2609	Japanese quail (*Coturnix japonica*)	3	U	FD	4	week	0	day	JV	F	GRO	BDWT	WO	5.93	59.3	76	yes
68	Damron et al. 1969	14768	chicken (*Gallus domesticus*)	4	U	FD	4	week	4	week	JV	NR	GRO	BDWT	WO	6.1	61.4	76	yes
69	Damron et al. 1969	14768	chicken (*Gallus domesticus*)	4	U	FD	4	week	4	week	JV	NR	GRO	BDWT	WO	7.10	71.0	76	yes
70	Edens et al. 1976	2606	Japanese quail (*Coturnix japonica*)	5	U	FD	12	week	0	day	JV	F	GRO	BDWT	WO	11.1	111	79	yes
71	Edens 1985	2605	Japanese quail (*Coturnix japonica*)	5	U	FD	12	week	1	week	JV	F	GRO	BDWT	WO	11.2	112	76	yes
72	Morgan et al. 1975	2779	Japanese quail (*Coturnix japonica*)	5	U	FD	2	week	6	day	JV	NR	GRO	BDWT	WO	12.6	126	76	yes
73	Morgan et al. 1975	2779	Japanese quail (*Coturnix japonica*)	5	U	FD	1	week	1	day	JV	NR	GRO	BDWT	WO	13.5	67.4	76	yes
74	Howell and Hill 1978	1387	chicken (*Gallus domesticus*)	2	U	FD	21	day	1	day	JV	B	GRO	BDWT	WO	14.2		67	no (UN)
75	Jeng et al. 1979	2718	duck (*Ana platyrhynchos*)	3	U	GV	3	month	24	week	MA	F	GRO	BDWT	WO	20.0		87	no (UN)
76	Hoffman et al. 1985	2696	American kestrel (*Falco sparverius*)	4	U	GV	10	day	1	day	JV	NR	GRO	BDWT	WO	25.0	125	88	no (ICF)
77	Howell and Hill 1978	1387	chicken (*Gallus domesticus*)	2	U	FD	20	day	1	day	JV	B	GRO	BDWT	WO	28.4		67	no (UN)
78	Stone et al. 1981	6463	Japanese quail (*Coturnix japonica*)	5	U	FD	14	day	1	day	JV	B	GRO	BDWT	WO	34.5		77	no (UN)
79	Custer et al. 1984	2581	American kestrel (*Falco sparverius*)	4	M	FD	60	day	1-2	year	AD	B	GRO	BDWT	WO	54.3		68	no (UN)
80	Berg et al. 1980	2534	chicken (*Gallus domesticus*)	5	U	FD	2	week	1	day	JV	M	GRO	BDWT	WO	61.3	123	83	yes
81	Frederick 1976	2638	mallard (*Anas platyrhynchos*)	4	U	FD	8	day	9	day	JV	NR	GRO	BDWT	WO	66.9		67	no (UN)
82	Donaldson and McGowan 1989	1285	chicken (*Gallus domesticus*)	5	U	FD	20	day	1	day	JV	M	GRO	BDWT	WO		38.2	72	yes
83	Latta and Donaldson 1986	2744	chicken (*Gallus domesticus*)	2	U	FD	3	week	1	day	JV	M	GRO	BDWT	WO		53.1	71	yes
84	Stone and Soares 1976	2898	Japanese quail (*Coturnix japonica*)	3	U	FD	32	day	NR	NR	AD	F	GRO	BDWT	WO		64.3	72	yes
85	Leeming and Donaldson 1984	2748	chicken (*Gallus domesticus*)	2	U	FD	19	day	1	day	JV	M	GRO	BDWT	WO		76.3	71	yes
86	Berg et al. 1980	2534	chicken (*Gallus domesticus*)	3	U	FD	2	week	1	day	JV	M	GRO	BDWT	WO		124	77	yes
87	Bafundo et al. 1984	2517	chicken (*Gallus domesticus*)	4	U	FD	14	day	8	day	JV	M	GRO	BDWT	WO		152	71	yes
88	Donaldson 1986	2600	chicken (*Gallus domesticus*)	2	U	FD	20	day	1	day	JV	M	GRO	BDWT	WO		163	72	yes
89	Khan et al. 1993	5507	chicken (*Gallus domesticus*)	2	U	OR	4	week	NR	NR	JV	B	GRO	BDWT	WO		200	74	yes
90	Cupo and Donaldson 1987	2579	chicken (*Gallus domesticus*)	2	U	FD	7	day	1	day	JV	M	GRO	BDWT	WO		262	72	yes
91	Berg et al. 1980	2534	chicken (*Gallus domesticus*)	2	U	FD	2	week	1	day	JV	M	GRO	BDWT	WO		270	77	yes
92	Franson and Custer 1982	2635	chicken (*Gallus domesticus*)	2	U	FD	7	day	1	day	IM	NR	GRO	BDWT	WO		273	72	yes
93	Bafundo et al. 1984	2517	chicken (*Gallus domesticus*)	2	U	FD	14	day	8	day	JV	M	GRO	BDWT	WO		282	71	yes

Table A-6. Lead Data for Birds as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[a]
Survival																			
94	Finley et al. 1976	2624	mallard (*Anas platyrhynchos)*	4	M	FD	12	week	1	year	AD	M	MOR	MORT	WO	2.47		80	no (UN)
95	Barthalmus et al. 1977	2526	pigeon (*Columba livia*)	4	U	GV	40	day	NR	NR	AD	M	MOR	MORT	WO	12.5	25.0	82	yes
96	Howell and Hill 1978	1387	chicken (*Gallus domesticus*)	2	U	FD	21	day	1	day	JV	B	MOR	MORT	WO	14.2		77	no (UN)
97	Howell and Hill 1978	1387	chicken (*Gallus domesticus*)	2	U	FD	20	day	1	day	JV	B	MOR	MORT	WO	28.4		77	no (UN)
98	Custer et al. 1984	2581	American kestrel (*Falco sparverius*)	4	M	FD	60	day	1-2	year	AD	B	MOR	MORT	WO	54.3		78	no (UN)
99	Frederick 1976	2638	mallard (*Anas platyrhynchos*)	4	U	FD	8	day	9	day	JV	NR	MOR	MORT	WO	66.9		77	no (UN)
100	Hoffman et al. 1985	2696	American kestrel (*Falco sparverius*)	4	U	GV	10	day	1	day	JV	NR	MOR	SURV	WO	125	625	89	no (ICF)
101	Vengris and Mare 1974	14384	chicken (*Gallus domesticus*)	7	U	GV	35	day	6	week	JV	B	MOR	MORT	WO	160	320	86	yes
102	Donaldson and McGowan 1989	1285	chicken (*Gallus domesticus*)	5	U	FD	20	day	1	day	JV	M	MOR	MORT	WO	163		66	no (UN)
103	Johnsen and Damron 1982	2724	goose (*Anser cygnides*)	5	U	FD	12	week	26	week	JV	NR	MOR	MORT	WO	196		73	no (UN)
104	Anders et al. 1982	2513	pigeon (*Columba livia*)	2	U	GV	4	week	NR	NR	AD	M	MOR	MORT	WO		6.3	73	yes
105	Cupo and Donaldson 1987	2579	chicken (*Gallus domesticus*)	2	U	FD	21	day	1	day	JV	M	MOR	MORT	WO		194	73	yes
106	Khan et al. 1993	1415	chicken (*Gallus domesticus*)	2	U	GV	7	day	43	day	JV	F	MOR	MORT	WO		400	80	yes

Notes:

Not all studies presented in the lead ecological soil screening level (Eco-SSL) document for growth, reproduction, and survival were used to derive the Eco-SSL toxicity reference value (TRV).

See Eco-SSL document (USEPA 2005b) for the full reference list for studies cited in this table.

Abbreviations from the Eco-SSL document are defined in Table A-1.

Blank cells are shown as reported in the Eco-SSL document; no description was provided.

[a] Rationale for study unacceptability is in parentheses

ENR - endpoint not relevant
LOAEL - lowest-observed-adverse-effect level
NOAEL - no-observed-adverse-effect level
ICF - irrelevant chemical form
UN - unbounded NOAEL

Table A-7. Lead Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[a]
Reproduction																			
121	Grant et al. 1980	2658	rat (*Rattus norvegicus*)	5	U	DR	62	day	21	day	GE	F	REP	PRWT	WO	0.710	7.00	77	yes
122	Dilts and Ahokas 1979	2593	rat (*Rattus norvegicus*)	6	U	DR	21	day	NR	NR	GE	F	REP	PRWT	WO	1.00	5.00	74	yes
123	Gandley et al. 1999	2642	rat (*Rattus norvegicus*)	3	U	DR	35	day	NR	NR	AD	M	REP	RSUC	WO	2.60	26.0	72	yes
124	Grant et al. 1980	2658	rat (*Rattus norvegicus*)	4	U	DR	62	day	21	day	GE	B	REP	PRWT	WO	3.00	6.0	79	yes
125	Carson et al. 1973	3830	sheep (*Ovis aries*)	3	U	FD	27	week	NR	NR	GE	F	REP	RSUC	WO	4.50		68	no (RU, UN)
126	Dilts and Ahokas 1980	2592	rat (*Rattus norvegicus*)	6	U	DR	21	day	NR	NR	GE	F	REP	PRWT	WO	5.00	10.0	76	yes
127	Sierra and Tiffany-Castiglioni 1992	2876	guinea pig (*Cavia porcellus*)	3	U	DR	40	day	NR	NR	GE	F	REP	PRWT	WO	5.50		73	no (UN)
128	Jessup and Shott 1969	11831	rat (*Rattus norvegicus*)	5	U	FD	92	week	21	day	JV	M	REP	TEWT	TE	7.50	74.9	78	no (ENR)
129	Kimmel et al. 1980	2737	rat (*Rattus norvegicus*)	4	U	DR	23.8	day	21	day	LC	F	REP	Other	WO	8.90		76	no (UN)
130	Kimmel et al. 1980	2737	rat (*Rattus norvegicus*)	5	U	DR	23.8	day	21	day	GE	F	REP	Other	WO	9.10	45.0	73	yes
131	McMurry et al. 1995	2770	cotton rat (*Sigmodon hispidus*)	3	U	DR	7	week	NR	NR	AD	M	REP	RHIS	RT	12.4	170	67	no (ENR)
132	Barratt et al. 1989	2524	rat (*Rattus norvegicus*)	4	U	GV	9	week	10	week	JV	M	REP	SPCV	TE	18.0	180	85	no (ENR)
133	Zenick et al. 1979	2943	rat (*Rattus norvegicus*)	3	U	DR	100	day	21	day	GE	F	REP	PRWT	WO	25.4		68	no (UN)
134	Cerklewski 1980	10607	rat (*Rattus norvegicus*)	2	U	FD	35	day	70	day	LC	F	REP	PRWT	WO	27.5		66	no (UN)
135	Chowdhury et al. 1984	3721	rat (*Rattus norvegicus*)	4	U	DR	60	day	NR	NR	SM	M	REP	TEWT	TE	31.6	63.2	71	no (ENR)
136	Bull et al. 1978	14812	rat (*Rattus norvegicus*)	4	U	DR	56	day	70	day	LC	F	REP	PROG	WO	32.5		69	no (UN)
137	Winder et al. 1984	2934	rat (*Rattus norvegicus*)	3	U	DR	31	day	NR	day	LC	F	REP	PRWT	WO	33.3	111	72	yes
138	Miller et al. 1982	2775	rat (*Rattus norvegicus*)	4	U	GV	41	day	NR	NR	GE	F	REP	PRWT	WO	41.0	54.6	87	yes
139	Wolfe et al. 1996	2502	rat (*Rattus norvegicus*)	5	U	DR	1	week	94	day	JV	M	REP	SPCL	SM	47.3	82.0	84	no (ENR)
140	Sourgens et al. 1987	2889	rat (*Rattus norvegicus*)	4	U	DR	30	day	NR	NR	SM	M	REP	Other	SV	56.0	285	73	no (ENR)
141	Carpenter 1982	2565	hamster (*Mesocricetus auratus*)	2	U	DR	51	day	15	week	GE	F	REP	PROG	WO	64.8		69	no (UN)
142	Carpenter 1982	2565	hamster (*Mesocricetus auratus*)	2	U	DR	14	day	11	week	GE	F	REP	PROG	WO	64.9		67	no (UN)
143	Ronis et al. 1998	2847	rat (*Rattus norvegicus*)	4	U	DR	37	day	NR	NR	GE	F	REP	PRWT	WO	90.1	270	74	yes
144	Wardell et al. 1982	748	rat (*Rattus norvegicus*)	5	U	GV	12	day	NR	NR	GE	F	REP	RSEM	EM	100	150	87	yes
145	Hamilton and O'Flaherty 1994	2670	rat (*Rattus norvegicus*)	3	U	DR	68	day	25	day	GE	F	REP	PRWT	WO	115		72	no (UN)
146	Hamilton et al. 1994	2671	rat (*Rattus norvegicus*)	4	U	DR	77	day	25	day	GE	F	REP	PRWT	WO	116		68	no (UN)
147	Fox et al. 1977	2633	rat (*Rattus norvegicus*)	2	U	DR	21	day	NR	NR	LC	F	REP	PRWT	WO	120		68	no (UN)
148	Eyden et al. 1978	2618	mouse (*Mus musculus*)	3	U	FD	8	week	2	month	GE	M	REP	SPCV	TE	144	1440	78	no (ENR)
149	Maker et al. 1973	2758	mouse (*Mus musculus*)	7	U	FD	30	day	NR	NR	LC	F	REP	PRWT	WO	202	506	79	yes
150	Maker et al. 1973	2758	mouse (*Mus musculus*)	7	U	FD	30	day	NR	NR	LC	F	REP	PRWT	WO	202	506	79	yes
151	Cramer et al. 1980	14816	rat (*Rattus norvegicus*)	4	U	DR	21	day	NR	NR	GE	F	REP	DEYO	WO	276	552	74	yes
152	Nathan et al. 1992	2785	rat (*Rattus norvegicus*)	5	U	DR	10	week	NR	NR	AD	M	REP	TEWT	MT	294	587	71	no (ENR)
153	Brady et al. 1975	14795	rat (*Rattus norvegicus*)	2	U	GV	102	day	30	day	GE	F	REP	PRWT	WO	441		69	no (UN)
154	Wenda-Rozewicka et al. 1996	2928	rat (*Rattus norvegicus*)	2	U	DR	9	month	NR	NR	SM	M	REP	RHIS	TE	600		66	no (ENR, UN)
155	Barrett and Livesey 1983	10239	rat (*Rattus norvegicus*)	4	U	FD	4	day	NR	NR	LC	F	REP	PRWT	WO	601	1500	86	no (ICF)
156	Piasekand Kostial 1987	2817	rat (*Rattus norvegicus*)	4	U	DR	13	week	NR	NR	JV	M	REP	FERT	WO	639		66	no (UN)
157	Junaid et al. 1997	2725	mouse (*Mus musculus*)	4	U	GV	60	day	NR	NR	AD	F	REP	RPRD	OV		2.00	77	no (ENR)
158	Morris et al. 1938	15125	rat (*Rattus norvegicus*)	3	U	FD	339	day	26-27	day	JV	B	REP	PRWT	WO		2.49	74	no (UN[b])
159	Schroeder and Mitchener 1971	66	rat (*Rattus norvegicus*)	2	U	DR	9	month	21	day	JV	F	REP	DEYO	WO		2.94	67	yes
160	Schroeder and Mitchener 1971	66	mouse (*Mus musculus*)	2	U	DR	6	month	21	day	JV	F	REP	DEYO	WO		3.62	67	yes
161	Gupta et al. 1995	2666	mouse (*Mus musculus*)	4	U	GV	52	day	2	month	GE	F	REP	PROG	EM		5.50	81	yes
162	Saxena et al. 1989	2857	rat (*Rattus norvegicus*)	2	U	DR	120	day	1	day	GE	M	REP	SPCL	TE		6.76	69	no (ENR)
163	Cernochova and Kamarad 1992	2568	mouse (*Mus musculus*)	2	U	DR	5	week	NR	NR	AD	M	REP	TEDG	TE		16.6	66	no (ENR)
164	Al-Omar et al. 2000	20974	mouse (*Mus musculus*)	2	M	GV	2	week	NR	NR	JV	M	REP	SPCL	SM		46.4	86	no (ENR)
165	Winneke et al. 1977	3935	rat (*Rattus norvegicus*)	2	U	FD	102	day	NR	NR	GE	F	REP	PROG	WO		49.6	78	yes
166	Batra et al. 1998	2528	rat (*Rattus norvegicus*)	2	U	GV	3	month	8	week	SM	M	REP	TEDG	TE		50.0	81	no (ENR)
167	Hayashi 1983	3864	rat (*Rattus norvegicus*)	2	U	DR	18	day	NR	NR	GE	F	REP	PRWT	WO		55.5	68	yes
168	Kempinas et al. 1988	2733	rat (*Rattus norvegicus*)	3	U	DR	90	day	NR	NR	AD	M	REP	SPCL	SM		61.2	69	no (ENR)
169	Donald et al. 1981	2598	mouse (*Mus musculus*)	2	U	DR	23	day	NR	NR	GE	F	REP	PRWT	WO		78.6	69	yes
170	Donald et al. 1986	2599	mouse (*Mus musculus*)	2	U	DR	62	day	NR	NR	GE	F	REP	PRWT	WO		99.8	69	yes
171	Talcott and Koller 1983	2906	mouse (*Mus musculus*)	2	U	DR	18	week	6-8	week	LC	F	REP	PRWT	WO		137	69	yes
172	Johansson and Wide 1986	2723	mouse (*Mus musculus*)	2	U	DR	12	week	9	week	SM	M	REP	PRFM	WO		139	74	no (ENR)

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Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[a]
Reproduction (continued)																			
173	Jacquet et al. 1997	2713	mouse (*Mus musculus*)	4	U	FD	18	day	NR	NR	GE	F	REP	PRWT	WO		154	72	yes
174	Wolfe et al. 1996	2502	rat (*Rattus norvegicus*)	2	M	DR	4	week	99	day	JV	M	REP	SPCL	SM		171	78	no (ENR)
175	Blanusa et al. 1989	14750	rat (*Rattus norvegicus*)	5	U	DR	6	week	4	month	GE	F	REP	RHIS	WO		175	69	no (ENR)
176	Cramer et al. 1980	14816	rat (*Rattus norvegicus*)	2	U	DR	22	day	NR	NR	GE	F	REP	PRWT	WO		178	69	yes
177	Sokol et al. 1985	2888	rat (*Rattus norvegicus*)	3	U	DR	30	day	52	day	JV	M	REP	GREP	PG		198	71	yes
178	Hallen et al. 1995	2669	rat (*Rattus norvegicus*)	2	U	DR	13	week	NR	NR	GE	F	REP	PRWT	WO		200	73	yes
179	Rabe et al. 1985	13216	rat (*Rattus norvegicus*)	2	U	DR	21	day	80	day	JV	F	REP	PRWT	WO		218	70	yes
180	Mykkanen et al. 1980	2783	rat (*Rattus norvegicus*)	4	U	FD	3	week	NR	NR	LC	F	REP	PRWT	WO		221	73	yes
181	Hsu 1980[c]	2704	rat (*Rattus norvegicus*)	2	U	FD	1	week	19	week	LC	F	REP	PRWT	WO		222	73	yes
182	Mykkanen et al. 1980	2783	rat (*Rattus norvegicus*)	4	U	FD	3	week	NR	NR	LC	F	REP	PRWT	WO		230	73	yes
183	Alfano and Petit 1982	2511	rat (*Rattus norvegicus*)	3	U	FD	25	day	NR	NR	LC	F	REP	PRWT	WO		258	78	yes
184	Yu et al. 1996	3939	rat (*Rattus norvegicus*)	2	U	DR	21	day	NR	NR	LC	F	REP	PRWT	WO		330	68	yes
185	Sokol 1989	2887	rat (*Rattus norvegicus*)	2	U	DR	30	day	52	day	JV	M	REP	SPCL	SM		354	69	no (ENR)
186	Ronis et al. 1998	2845	rat (*Rattus norvegicus*)	2	U	DR	17	day	NR	NR	GE	F	REP	PRWT	WO		360	68	yes
187	Ronis et al. 1998	2845	rat (*Rattus norvegicus*)	2	U	DR	24	day	NR	NR	LC	F	REP	PRWT	WO		360	68	yes
188	Ronis et al. 1996	2846	rat (*Rattus norvegicus*)	2	U	DR	12	day	NR	NR	GE	F	REP	PRWT	WO		362	69	yes
189	Sokol 1989	2887	rat (*Rattus norvegicus*)	2	U	DR	30	day	27	day	JV	M	REP	SPCL	SM		364	69	no (ENR)
190	Pinon-Lataillade et al. 1995	2821	mouse (*Mus musculus*)	2	U	DR	44	day	NR	NR	GE	F	REP	PRWT	WO		381	68	yes
191	Draski et al. 1989	3719	mouse (*Mus musculus*)	2	U	DR	14	day	NR	NR	LC	F	REP	PRWT	WO		381	68	yes
192	Ronis et al. 1996	2846	rat (*Rattus norvegicus*)	2	U	DR	50	day	24	day	JV	F	REP	RBEH	WO		381	69	no (ENR)
193	Rasile et al. 1995	2836	mouse (*Mus musculus*)	2	U	DR	45	day	50-100	day	GE	F	REP	ODVP	WO		404	69	no (ENR)
194	Thoreux-Manlay et al. 1995	2909	rat (*Rattus norvegicus*)	2	U	DR	22	day	NR	NR	GE	F	REP	PRWT	WO		420	68	yes
195	Donald et al. 1987	2597	mouse (*Mus musculus*)	2	U	DR	48	day	NR	NR	GE	F	REP	PRWT	WO		437	70	yes
196	Marchlewicz et al. 1993	2760	rat (*Rattus norvegicus*)	2	U	DR	9	month	3	month	SM	M	REP	SPCL	TE		579	69	no (ENR)
197	Piasecka et al. 1995	2816	rat (*Rattus norvegicus*)	2	U	DR	9	month	NR	NR	SM	M	REP	TEDG	TE		600	69	no (ENR)
198	Piasek et al. 1988	14751	rat (*Rattus norvegicus*)	2	U	DR	3	week	14	week	LC	F	REP	PRWT	WO		635	69	yes
199	Jacquet 1977	2711	mouse (*Mus musculus*)	2	U	FD	7	day	NR	NR	GE	F	REP	RSUC	EM		646	73	yes
200	Selvin-Testa et al. 1997	2869	rat (*Rattus norvegicus*)	2	U	DR	126	day	1	day	GE	F	REP	PROG	WO		651	66	yes
201	Piasek and Kostial 1991	2818	rat (*Rattus norvegicus*)	2	U	DR	20	week	10	week	GE	F	REP	PRWT	WO		750	73	yes
202	Epstein et al. 1991	2614	mouse (*Mus musculus*)	2	U	DR	4	day	NR	NR	LC	F	REP	PRWT	WO		762	68	yes
203	Holtzman et al. 1981	2698	rat (*Rattus norvegicus*)	2	U	FD	2	week	NR	NR	LC	F	REP	PRWT	WO		828	78	yes
204	Holtzman et al. 1978	2699	rat (*Rattus norvegicus*)	2	U	FD	7	day	NR	NR	LC	F	REP	PRWT	WO		833	78	yes
205	Barlow et al. 1977	2523	rat (*Rattus norvegicus*)	2	U	FD	21	day	NR	NR	LC	F	REP	PRWT	WO		991	74	yes
206	Gulati et al. 1985	2837	mouse (*Mus musculus*)	4	M	DR	18	week	11	week	JV	F	REP	TEWT	WO		1370	75	no (ENR)
207	McConnell and Berry 1979	2767	rat (*Rattus norvegicus*)	2	U	FD	30	day	NR	NR	LC	F	REP	PRWT	WO		1770	73	yes
208	Sharma and Kanwar 1985	2871	mouse (*Mus musculus*)	2	U	DR	14	week	NR	NR	GE	B	REP	PROG	WO		1990	70	yes
209	Goldstein et al. 1974	14824	rat (*Rattus norvegicus*)	2	U	FD	16	day	NR	NR	LC	F	REP	PROG	WO		2570	78	no (DNU)
210	Holtzman et al. 1980	14827	rat (*Rattus norvegicus*)	2	U	FD	7	day	NR	NR	LC	F	REP	PRWT	WO		2570	78	yes
211	Krigman et al. 1974	2741	rat (*Rattus norvegicus*)	2	U	FD	25	day	NR	NR	LC	F	REP	PRWT	WO		2570	78	yes
212	Pentschew and Garro 1966	2811	rat (*Rattus norvegicus*)	M[d]	FD[d]	27[d]	d[d]	NR[d]	NR[d]	LC[d]	F[d]	C[d]	REP	PROG	WO		2840	78	yes
213	Sharma and Kanwar 1985	2871	mouse (*Mus musculus*)	2	U	DR	14	week	21	day	JV	B	REP	PROG	WO		3630	70	yes
214	Michaelson and Sauerhoff 1974	2774	rat (*Rattus norvegicus*)	2	U	FD	17	day	NR	NR	LC	F	REP	PRWT	WO		6170	74	yes
Growth																			
215	Willoughby et al. 1972	14386	horse (*Equus caballus*)	2	U	FD	15	week	20 to	week	JV	M	GRO	BDWT	WO	0.150		68	no (UN)
216	Fox et al. 1982	2634	rat (*Rattus norvegicus*)	2	U	FD	21	day	0	day	JV	F	GRO	BDWT	WO	0.500		67	no (UN)
217	Dilts and Ahokas 1979	2593	rat (*Rattus norvegicus*)	6	U	DR	21	day	NR	NR	GE	F	GRO	BDWT	WO	1.00	5.00	72	yes
218	Kimmel et al. 1980	2737	rat (*Rattus norvegicus*)	5	U	DR	7	day	50	day	AD	F	GRO	BDWT	WO	1.27	13.0	73	yes
219	Lynch et al. 1975	14380	cattle (*Bos taurus*)	4	U	OR	7	week	1	week	JV	M	GRO	BDWT	WO	1.99		75	no (RU, UN)
220	Wiebe and Barr 1988	2930	rat (*Rattus norvegicus*)	3	U	DR	14	day	21	day	JV	F	GRO	BDWT	WO	2.40		72	no (UN)
221	Schroeder et al. 1963	14446	rat (*Rattus norvegicus*)	2	U	DR	332	day	28	day	JV	B	GRO	BDWT	WO	2.98		66	no (UN)
222	Kimmel et al. 1980	2737	rat (*Rattus norvegicus*)	4	U	DR	7	week	21	day	GE	F	GRO	BDWT	WO	4.70	8.90	80	yes
223	Horwitt and Cowgill 1937	3873	dog (*Canis familiaris*)	3	M	FD	7	month	NR	NR	JV	NR	GRO	BDWT	WO	4.71		68	no (UN)

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Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[a]
Growth (continued)																			
224	Zheng et al. 1996	2944	rat (*Rattus norvegicus*)	3	U	DR	30	day	22-24	day	JV	M	GRO	BDWT	WO	5.64	28.2	71	yes
225	Hammond et al. 1989	2675	rat (*Rattus norvegicus*)	4	U	DR	23	day	22	day	JV	F	GRO	BDWT	WO	5.80	29.0	73	yes
226	Lynch et al. 1976	3711	cattle (*Bos taurus*)	3	U	OR	84	day	NR	NR	JV	M	GRO	BDWT	WO	7.79		80	no (RU, UN)
227	Rader et al. 1981	2830	rat (*Rattus norvegicus*)	2	U	OR	6	week	NR	NR	AD	M	GRO	BDWT	WO	9.10		67	no (UN)
228	Nehru et al. 1997	2788	rat (*Rattus norvegicus*)	2	U	GV	8	week	NR	NR	JV	F	GRO	BDWT	WO	10.0		78	no (UN)
229	Gruber et al. 1997	2660	rat (*Rattus norvegicus*)	3	U	DR	6	month	NR	NR	AD	M	GRO	BDWT	WO	10.6	532	69	yes
230	Lorenzo et al. 1978	2751	rabbit (*Oryctolagus cuniculus*)	3	U	GV	10	day	1	day	JV	F	GRO	BDWT	WO	10.7	50.4	78	yes
231	El-Gazzar et al. 1978	21143	rat (*Rattus norvegicus*)	2	U	DR	140	day	21	day	JV	M	GRO	BDWT	WO	10.7		67	no (UN)
232	Rader et al. 1981	2830	rat (*Rattus norvegicus*)	2	U	DR	6	week	NR	NR	JV	M	GRO	BDWT	WO	15.1		71	no (UN)
233	Mahaffey et al. 1977	14580	rat (*Rattus norvegicus*)	2	UX	FD	10	week	NR	NR	JV	M	GRO	BDWT	WO	15.4		79	no (UN)
234	Rader et al. 1981	2830	rat (*Rattus norvegicus*)	2	U	OR	6	week	NR	NR	AD	M	GRO	BDWT	WO	15.5		74	no (UN)
235	Rader et al. 1981	2829	rat (*Rattus norvegicus*)	2	U	DR	7	week	NR	NR	JV	M	GRO	BDWT	WO	16.1		71	no (UN)
236	Gerber et al. 1978	14822	mouse (*Mus musculus*)	3	U	DR	14	day	0	day	JV	NR	GRO	BDWT	WO	16.3	163	71	yes
237	Barratt et al. 1989	2524	rat (*Rattus norvegicus*)	4	U	GV	9	week	10	week	JV	M	GRO	BDWT	WO	18.0	180	83	yes
238	Morris et al. 1938	15125	rat (*Rattus norvegicus*)	3	U	FD	339	day	26-27	day	JV	B	GRO	BDWT	WO	18.3		72	no (UN)
239	Tafelski and Lamperti 1975	2905	rat (*Rattus norvegicus*)	4	U	GV	29	day	NR	NR	SM	F	GRO	BDWT	WO	18.9		71	no (UN)
240	Mahaffey et al. 1973	2756	rat (*Rattus norvegicus*)	7	U	DR	10	week	NR	NR	JV	M	GRO	BDWT	WO	24.3		71	no (UN)
241	Bull et al. 1978	14812	rat (*Rattus norvegicus*)	4	U	DR	56	day	70	day	LC	F	GRO	BDWT	WO	32.5		67	no (UN)
242	Fick et al. 1976	3704	sheep (*Ovis aries*)	5	U	FD	84	day	NR	NR	JV	M	GRO	BDWT	WO	32.7		66	no (RU, UN)
243	Bankowska and Hine 1985	14852	rat (*Rattus norvegicus*)	2	U	DR	10	week	NR	NR	JV	M	GRO	BDWT	WO	38.5		67	no (UN)
244	Logner et al. 1984	3889	cattle (*Bos taurus*)	4	U	FD	7	week	16	week	JV	M	GRO	BDWT	WO	43.0		72	no (RU, UN)
245	Agodi et al. 1990	2507	rat (*Rattus norvegicus*)	2	U	GV	28	day	2	day	JV	B	GRO	BDWT	WO	50.0		79	no (UN)
246	Wolfe et al. 1996	2502	rat (*Rattus norvegicus*)	5	M	DR	4	week	94	day	JV	M	GRO	BDWT	WO	71.5	178	82	yes
247	Gelman and Michaelson 1979	14821	rat (*Rattus norvegicus*)	4	U	GV	12	day	2	day	JV	B	GRO	BDWT	WO	75.0	225	85	yes
248	Rudra Pal et al. 1975	2806	rat (*Rattus norvegicus*)	2	U	FD	4	week	NR	NR	JV	M	GRO	BDWT	WO	100		67	no (UN)
249	Goyer et al. 1970	14799	rat (*Rattus norvegicus*)	6	U	DR	10	week	NR	NR	JV	M	GRO	BDWT	WO	120	383	71	yes
250	Eyden et al. 1978	2618	mouse (*Mus musculus*)	3	U	FD	4	week	3	month	JV	B	GRO	BDWT	WO	136	1360	76	yes
251	Talcott and Koller 1983	2906	mouse (*Mus musculus*)	2	U	DR	18	week	6-8	week	LC	F	GRO	BDWT	WO	137		67	no (UN)
252	Johansson and Wide 1986	2723	mouse (*Mus musculus*)	2	U	DR	12	week	NR	NR	GE	M	GRO	BDWT	WO	139		72	no (UN)
253	Sokol et al. 1985	2888	rat (*Rattus norvegicus*)	3	U	DR	30	day	52	day	JV	M	GRO	BDWT	WO	169	508	74	yes
254	Wolfe et al. 1996	2502	rat (*Rattus norvegicus*)	2	M	DR	4	week	99	day	JV	B	GRO	BDWT	WO	171		76	no (UN)
255	Kishi et al. 1983	12025	rat (*Rattus norvegicus*)	4	U	GV	18	day	3	day	JV	M	GRO	BDWT	WO	180		79	no (UN)
256	Wadi and Ahmad 1999	2924	mouse (*Mus musculus*)	3	U	DR	6	week	7	week	SM	M	GRO	BDWT	WO	187	373	69	yes
257	Petrusz et al. 1979	2815	rat (*Rattus norvegicus*)	4	U	GV	18	day	2	day	JV	B	GRO	BDWT	WO	200		70	no (UN)
258	Yagminas et al. 1990	3937	rat (*Rattus norvegicus*)	2	U	GV	91	day	NR	NR	JV	M	GRO	BDWT	WO	200		79	no (UN)
259	Rabe et al. 1985	13216	rat (*Rattus norvegicus*)	2	U	DR	21	day	80	day	JV	F	GRO	BDWT	WO	218		68	no (UN)
260	Mykkanen et al. 1980	2783	rat (*Rattus norvegicus*)	4	U	FD	1	week	NR	NR	LC	F	GRO	BDWT	WO	230	460	77	yes
261	Sourgens et al. 1987	2889	rat (*Rattus norvegicus*)	4	U	DR	30	day	NR	NR	JV	M	GRO	BDWT	WO	285		67	no (UN)
262	Exon et al. 1979	3847	mouse (*Mus musculus*)	5	U	DR	10	week	NR	NR	JV	M	GRO	BDWT	WO	362		67	no (UN)
263	Sokol 1989	2887	rat (*Rattus norvegicus*)	2	U	DR	30	day	52	day	JV	M	GRO	BDWT	WO	364		67	no (UN)
264	Holtzman et al. 1982	2697	rat (*Rattus norvegicus*)	4	U	GV	14	day	14	day	JV	NR	GRO	BDWT	WO	400	800	85	no (ID)
265	Holtzman et al. 1982	2697	rat (*Rattus norvegicus*)	5	U	GV	14	day	20	day	JV	NR	GRO	BDWT	WO	400	800	85	no (ID)
266	Gerber et al. 1978	14822	rat (*Rattus norvegicus*)	2	U	FD	14	month	0	day	JV	NR	GRO	BDWT	WO	431		70	no (UN)
267	Brady et al. 1975	14795	rat (*Rattus norvegicus*)	2	U	GV	102	day	30	day	LC	F	GRO	BDWT	WO	441		67	no (UN)
268	Stewart et al. 1998	2896	mouse (*Mus musculus*)	4	U	GV	12	day	6	day	JV	M	GRO	BDWT	WO	534		79	no (UN)
269	Maker et al. 1973	2758	mouse (*Mus musculus*)	7	U	FD	30	day	NR	NR	LC	F	GRO	BDWT	WO	632	1260	77	yes
270	Selvin-Testa et al. 1997	2869	rat (*Rattus norvegicus*)	2	U	DR	126	day	1	day	GE	F	GRO	BDWT	WO	651		66	no (UN)
271	Piasek and Kostial 1991	2818	rat (*Rattus norvegicus*)	2	U	DR	20	week	10	week	GE	F	GRO	BDWT	WO	750		71	no (UN)
272	Maker et al. 1973	2758	mouse (*Mus musculus*)	7	U	FD	28	day	NR	NR	LC	F	GRO	BDWT	WO	1260	2530	77	no (DNF)
273	Barrett and Livesey 1983	10239	rat (*Rattus norvegicus*)	4	U	FD	18	day	NR	NR	LC	F	GRO	BDWT	WO	1500		71	no (UN)
274	Schroeder et al. 1970	252	rat (*Rattus norvegicus*)	2	U	DR	9	day	21	day	JV	M	GRO	BDWT	WO		3.30	72	yes
275	Kelliher et al. 1973	14377	cattle (*Bos taurus*)	2	U	FD	283	day	7	month	JV	M	GRO	BDWT	WO		15.0	76	no (RU)

Table A-7. Lead Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[a]
Growth (continued)																			
276	Hamilton and O'Flaherty 1994	2670	rat (*Rattus norvegicus*)	3	U	DR	92	day	25	day	GE	F	MPH	GMPH	TB		28.7	70	no (ENR)
277	Hamilton et al. 1994	2671	rat (*Rattus norvegicus*)	4	U	DR	7	day	25	day	GE	F	GRO	BDWT	WO		29.0	66	yes
278	Hammond and Succop 1995	2678	rat (*Rattus norvegicus*)	2	U	DR	5	day	26	day	JV	F	GRO	BDWT	WO		29.0	66	yes
279	Hammond et al. 1993	2677	rat (*Rattus norvegicus*)	2	U	DR	26	day	22	day	JV	F	GRO	BDWT	WO		29.5	70	yes
280	Hammond et al. 1993	2677	rat (*Rattus norvegicus*)	2	U	DR	14	day	26	day	JV	F	MPH	Other	TA		29.9	69	no (ENR)
281	Minnema and Hammond 1994	2776	rat (*Rattus norvegicus*)	2	U	DR	10	day	26	day	JV	F	GRO	BDWT	WO		30.4	67	yes
282	Al-Omar et al. 2000	20974	mouse (*Mus musculus*)	2	M	GV	3	week	NR	NR	JV	M	GRO	BDWT	WO		46.4	84	yes
283	White 1977	2929	dog (*Canis familiaris*)	2	U	OR	5	week	<1	year	JV	NR	GRO	BDWT	WO		50.0	84	no (DNU)
284	Pankakoski et al. 1994	2807	shrew (*Sorex araneus*)	4	M	FD	31	day	NR	NR	JV	B	GRO	BDWT	WO		61.5	76	no (SDC)
285	Shailesh Kumar and Desiraju 1990	2870	rat (*Rattus norvegicus*)	3	U	GV	58	day	2	day	JV	B	GRO	BDWT	WO		100	79	yes
286	Hsu et al. 1975	14376	pig (*Sus scrofa*)	2	U	FD	13	week	4	week	JV	NR	GRO	BDWT	WO		173	73	yes
287	Harry et al. 1985	2680	rat (*Rattus norvegicus*)	2	U	GV	29	day	2	day	JV	F	GRO	BDWT	WO		200	79	yes
288	Lessler and Wright 1976	2750	rat (*Rattus norvegicus*)	2	U	FD	5	week	NR	NR	MA	NR	GRO	BDWT	WO		272	72	yes
289	Press 1975[e]	2827	rat (*Rattus norvegicus*)	2	U	GV	6	day	1	day	JV	B	GRO	BDWT	WO		328	79	no (ID)
290	Sokol 1989	2887	rat (*Rattus norvegicus*)	2	U	DR	30	day	27	day	JV	M	GRO	BDWT	WO		354	67	yes
291	Ronis et al. 1996	2846	rat (*Rattus norvegicus*)	2	U	DR	50	day	24	day	JV	M	GRO	BDWT	WO		371	67	yes
292	Toews et al. 1983	2911	rat (*Rattus norvegicus*)	2	U	GV	28	day	2	day	JV	M	GRO	BDWT	WO		400	79	yes
293	Holtzman et al. 1982	2697	rat (*Rattus norvegicus*)	4	U	GV	14	day	18	day	JV	NR	GRO	BDWT	WO		400	79	no (ID)
294	Rasile et al. 1995	2836	mouse (*Mus musculus*)	2	U	DR	45	day	50-100	day	GE	F	GRO	BDWT	WO		404	67	yes
295	Mykkanen et al. 1980	2783	rat (*Rattus norvegicus*)	4	U	FD	1	week	NR	NR	LC	F	GRO	BDWT	WO		442	71	yes
296	Piasek et al. 1988	14751	rat (*Rattus norvegicus*)	2	U	DR	6	week	14	week	LC	F	GRO	BDWT	WO		638	67	yes
297	Gulati et al. 1985	2837	mouse (*Mus musculus*)	4	M	DR	10	week	11	week	JV	F	GRO	BDWT	WO		748	73	yes
298	Barlow et al. 1977	2523	rat (*Rattus norvegicus*)	2	U	FD	21	day	NR	NR	LC	F	GRO	BDWT	WO		991	72	yes
299	Brashear et al. 1978	2546	rat (*Rattus norvegicus*)	2	U	GV	18	day	2	day	JV	B	GRO	BDWT	WO		1000	79	no (ID)
300	Gerber et al. 1978	14822	rat (*Rattus norvegicus*)	2	U	FD	2	week	0	day	JV	NR	GRO	BDWT	WO		1430	72	yes
301	Holtzman et al. 1982	2697	rat (*Rattus norvegicus*)	4	U	GV	14	day	24	day	JV	NR	GRO	BDWT	WO		1600	79	no (ID)
302	Holtzman et al. 1981	2698	rat (*Rattus norvegicus*)	2	U	FD	2	week	60-80	day	JV	M	GRO	BDWT	WO		2390	69	yes
303	Holtzman et al. 1982	2697	rat (*Rattus norvegicus*)	3	U	GV	14	day	16	day	JV	NR	GRO	BDWT	WO		2400	79	no (ID)
304	Holtzman et al. 1980	14827	rat (*Rattus norvegicus*)	2	U	FD	14	day	60	day	JV	M	GRO	BDWT	WO		2650	77	yes
305	Schroeder and Mitchener 1975	1858	mouse (*Mus musculus*)	2	U	DR	669	day	19-20	day	JV	B	MOR	LFSP	WO	3.50		68	no (UN)
306	Junaid et al. 1997	2725	mouse (*Mus musculus*)	4	U	GV	60	day	NR	NR	AD	F	MOR	MORT	WO	4.00	8.00	82	yes
307	Lynch et al. 1976	3711	cattle (*Bos taurus*)	3	U	OR	84	day	NR	NR	JV	M	MOR	SURV	WO	7.79		85	no (RU, UN)
308	Lorenzo et al. 1978	2751	rabbit (*Oryctolagus cuniculus*)	5	U	GV	30	day	1	day	JV	F	MOR	MORT	WO	10.7	50.4	84	yes
309	Azar et al. 1973	3747	rat (*Rattus norvegicus*)	5	M	FD	2	year	NR	NR	NR	M	MOR	MORT	WO	10.9	42.4	81	no (SDC)
310	Logner et al. 1984	3889	cattle (*Bos taurus*)	4	U	FD	10	day	74	day	JV	M	MOR	MORT	WO	16.0	43.0	88	no (RU)
311	Azar et al. 1973	3747	dog (*Canis familiaris*)	5	M	FD	2	year	NR	NR	NR	B	MOR	MORT	WO	24.7		68	no (UN)
312	Jessup 1967	2720	rabbit (*Oryctolagus cuniculus*)	3	U	FD	10	day	NR	NR	GE	F	MOR	MORT	WO	29.2		72	no (UN)
313	Lassen and Buck 1979	3709	pig (*Sus scrofa*)	5	U	DR	13	week	6	week	JV	NR	MOR	MORT	WO	30.2		68	no (UN)
314	Bankowska and Hine 1985	14852	rat (*Rattus norvegicus*)	2	U	DR	4	week	NR	NR	JV	M	MOR	MORT	WO	40.3		68	no (UN)
315	Al-Omar et al. 2000	20974	mouse (*Mus musculus*)	2	M	GV	5	week	NR	NR	JV	M	MOR	MORT	WO	46.4		85	no (UN)
316	Carpenter 1982	2565	hamster (*Mesocricetus auratus*)	2	U	DR	51	day	15	week	GE	F	MOR	MORT	WO	64.8		68	no (UN)
317	Carpenter 1982	2565	hamster (*Mesocricetus auratus*)	2	U	DR	14	day	11	week	GE	F	MOR	MORT	WO	64.9		68	no (UN)
318	Jessup and Shott 1969	11831	rat (*Rattus norvegicus*)	5	U	FD	92	week	21	day	JV	M	MOR	SURV	WO	74.9		73	no (UN)
319	Jessup 1969	2721	rat (*Rattus norvegicus*)	4	U	FD	8	week	NR	NR	GE	B	MOR	SURV	WO	78.9		73	no (UN)
320	Azar et al. 1973	3747	rat (*Rattus norvegicus*)	3	M	FD	2	year	NR	NR	NR	M	MOR	MORT	WO	87.5	163	83	no (SDC)
321	Wolfe et al. 1996	2502	rat (*Rattus norvegicus*)	5	U	DR	24	week	94	day	JV	B	MOR	MORT	WO	104		77	no (UN)
322	Lessler and Wright 1976	2750	rat (*Rattus norvegicus*)	2	U	FD	24	week	NR	NR	YO	M	MOR	MORT	WO	170		73	no (UN)
323	Lessler and Wright 1976	2750	rat (*Rattus norvegicus*)	2	U	FD	8	week	NR	NR	MA	M	MOR	MORT	WO	170		66	no (UN)

Table A-7. Lead Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[a]
Survival																			
324	Petrusz et al. 1979	2815	rat (*Rattus norvegicus*)	4	U	GV	18	day	2	day	JV	B	MOR	MORT	WO	200		80	no (UN)
325	Ogilvie and Martin 1981	2799	mouse (*Mus musculus*)	2	U	DR	10	month	NR	NR	AD	M	MOR	MORT	WO	379		68	no (UN)
326	Holtzman et al. 1982	2697	rat (*Rattus norvegicus*)	5	U	GV	14	day	20	day	JV	NR	MOR	MORT	WO	400	800	86	yes
327	Holtzman et al. 1982	2697	rat (*Rattus norvegicus*)	4	U	GV	14	day	24	day	JV	NR	MOR	MORT	WO	400	800	86	yes
328	Rasile et al. 1995	2836	mouse (*Mus musculus*)	2	U	DR	98	day	50-100	day	GE	F	MOR	MORT	WO	404		68	no (UN)
329	Piasekand Kostial 1987	2817	rat (*Rattus norvegicus*)	4	U	DR	18	week	NR	NR	JV	M	MOR	MORT	WO	639		72	no (UN)
330	Holtzman et al. 1982	2697	rat (*Rattus norvegicus*)	4	U	GV	14	day	24	day	JV	NR	MOR	MORT	WO	2000	2400	86	yes
331	Holtzman et al. 1982	2697	rat (*Rattus norvegicus*)	3	U	GV	14	day	14	day	JV	NR	MOR	MORT	WO	3200		80	no (UN)
332	Kanisawa and Schroeder 1969	3701	rat (*Rattus norvegicus*)	2	U	DR	727	day	30	day	JV	F	MOR	LFSP	WO		0.569	67	yes
333	Zmudski et al. 1983	3940	cattle (*Bos taurus*)	4	U	DR	21	day	10	week	JV	M	MOR	MORT	WO		2.70	72	no (RU)
334	Schroeder et al. 1963	14446	rat (*Rattus norvegicus*)	2	U	DR	6	month	28	day	JV	B	MOR	SURV	WO		2.87	67	yes
335	Schroeder et al. 1964	14447	mouse (*Mus musculus*)	2	U	DR	21	month	21	day	JV	M	MOR	SURV	WO		3.10	73	yes
336	Wells et al. 1986	14803	cattle (*Bos taurus*)	2	U	DR	8	day	3	month	JV	M	MOR	MORT	WO		20.0	72	no (RU)
337	Pankakoski et al. 1994	2807	shrew (*Sorex araneus*)	4	M	FD	31	day	NR	NR	JV	B	MOR	MORT	WO		61.5	77	yes
338	Press 1975[e]	2827	rat (*Rattus norvegicus*)	2	U	GV	14	day	1	day	JV	B	MOR	MORT	WO		328	80	yes
339	Shailesh Kumar and Desiraju 1990	2870	rat (*Rattus norvegicus*)	2	U	GV	58	day	2	day	JV	B	MOR	MORT	WO		400	84	yes
340	Holtzman et al. 1982	2697	rat (*Rattus norvegicus*)	4	U	GV	14	day	16	day	JV	NR	MOR	MORT	WO		400	80	yes
341	Eyden et al. 1978	2618	mouse (*Mus musculus*)	6	U	FD	115	day	NR	NR	AD	B	MOR	SURV	WO		635	72	yes
342	Gulati et al. 1985	2837	mouse (*Mus musculus*)	4	M	DR	18	week	11	week	JV	B	MOR	MORT	WO		670	74	yes
343	Lamb et al. 1997	2505	mouse (*Mus musculus*)	4	U	DR	105	day	6	week	JV	B	MOR	MORT	WO		670	72	yes

Notes:

Not all studies presented in the lead ecological soil screening level (Eco-SSL) document for growth, reproduction, and survival were used to derive the Eco-SSL toxicity reference value (TRV).

See Eco-SSL document (USEPA 2005b) for the full reference list for studies cited in this table.

Abbreviations from the Eco-SSL document are defined in Table A-1.

Blank cells are shown as reported in the Eco-SSL document; no description was provided.

[a] Rationale for study unacceptability is in parentheses

[b] Dose/response dataset was reviewed and determined to be an unbounded no-observed-adverse-effect level (NOAEL) (differs from the Eco-SSL document).

[c] As reported in the Eco-SSL. The correct publication year for this study is 1981.

[d] As reported in the Eco-SSL. These entries appear to be off by one column.

[e] As reported in the Eco-SSL. The correct publication year for this study is 1977.

DNF - data not found
DNU - data not used because insufficient information was reported.
ENR - endpoint not relevant
ICF - irrelevant chemical form
ID - insufficient data
LOAEL - lowest-observed-adverse-effect level
RU - ruminant study
SDC - study design concern
UN - unbounded NOAEL

Table A-8. Manganese Data for Birds as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose[a] (mg/kg bw/day)	LOAEL Dose[a] (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[b]
Reproduction																			
15	Sazzad et al. 11994	5474	chicken (*Gallus domesticus*)	2	U	FD	12	week	23	week	LB	F	REP	PROG	WO	191		70	no (UN)
16	Sazzad et al. 11994	5474	chicken (*Gallus domesticus*)	2	U	FD	12	week	23	week	LB	F	REP	PROG	WO	202		70	no (UN)
17	Laskey and Edens 1985	8426	Japanese quail (*Coturnix japonica*)	2	U	FD	75	day	1	day	JV	M	REP	TEWT	TE	575		81	no (ENR, UN)
Growth																			
18	Spulkamy et al. 11976	6772	chicken (*Gallus domesticus*)	5	U	FD	7	week	1	week	JV	M	GRO	BDWT	WO	23.1		69	no (UN)
19	Settle et al. 11969	7191	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	B	GRO	BDWT	WO	24.3		68	no (UN)
20	Wedekind and Baker 1990	5728	chicken (*Gallus domesticus*)	3	U	FD	14	day	8	day	JV	M	GRO	BDWT	WO	50.2		67	no (UN)
21	Halpin et al. 11986	6054	chicken (*Gallus domesticus*)	3	U	GV	14	day	8	day	JV	M	GRO	BDWT	WO	67.0		71	no (UN)
22	Henry et al. 1986	6087	chicken (*Gallus domesticus*)	2	U	FD	21	day	1	day	JV	M	GRO	BDWT	WO	71.8		68	no (UN)
23	Baker and Halpin 1991	5700	chicken (*Gallus domesticus*)	2	U	FD	14	day	8	day	JV	M	GRO	BDWT	WO	87.7		68	no (UN)
24	De Rosa et al. 11980	44196	chicken (*Gallus domesticus*)	2	U	FD	1	week	2	week	JV	B	GRO	BDWT	WO	97.6		71	no (UN)
25	Brown and Southern 1985	6215	chicken (*Gallus domesticus*)	2	U	FD	14	day	4	day	JV	M	GRO	BDWT	WO	110		77	no (UN)
26	Black et al. 1985	6195	chicken (*Gallus domesticus*)	4	U	FD	3	week	1	day	JV	M	GRO	BDWT	WO	197		69	no (UN)
27	Black et al. 11984	6305	chicken (*Gallus domesticus*)	4	U	FD	21	day	1	day	JV	M	GRO	BDWT	WO	202		74	no (UN)
28	Wong-Valle et al. 11989	5788	chicken (*Gallus domesticus*)	4	U	FD	21	day	1	day	JV	M	GRO	BDWT	WO	213		67	no (UN)
29	Wong-Valle et al. 11989	5788	chicken (*Gallus domesticus*)	4	U	FD	21	day	1	day	JV	M	GRO	BDWT	WO	213		67	no (UN)
30	Martinez and Diaz 1996	5345	chicken (*Gallus domesticus*)	4	U	FD	14	day	1	day	JV	M	GRO	BDWT	WO	215	431	84	yes
31	Southern and Baker 1983	6382	chicken (*Gallus domesticus*)	3	U	FD	14	day	8	day	JV	M	GRO	BDWT	WO	252		68	no (UN)
32	Southern and Baker 1983	6363	chicken (*Gallus domesticus*)	4	U	FD	14	day	7	day	JV	M	GRO	BDWT	WO	261	348	83	yes
33	Vohra and Kratzer 1968	14404	turkey (*Meleagris gallopavo*)	9	U	FD	21	day	NR	NR	JV	B	GRO	BDWT	WO	302	356	82	yes
34	Southern and Baker 1983	6363	chicken (*Gallus domesticus*)	4	U	FD	14	day	7	day	JV	M	GRO	BDWT	WO	435		68	no (UN)
35	Southern and Baker 1983	6363	chicken (*Gallus domesticus*)	4	U	FD	14	day	7	day	JV	M	GRO	BDWT	WO	437		68	no (UN)
36	Southern and Baker 1983	6363	chicken (*Gallus domesticus*)	4	U	FD	14	day	7	day	JV	M	GRO	BDWT	WO	439		68	no (UN)
37	Laskey and Edens 1985	8426	Japanese quail (*Coturnix japonica*)	2	U	FD	75	day	1	day	JV	M	GRO	BDWT	WO	575		81	no (UN)
38	Leeson and Summers 1982	2196	chicken (*Gallus domesticus*)	5	U	FD	21	day	1	day	JV	M	GRO	BDWT	WO	1120		68	no (UN)
Survival																			
39	Black et al. 1984	6252	chicken (*Gallus domesticus*)	4	U	FD	26	day	4	day	JV	B	MOR	MORT	WO	216		72	no (UN)
40	Vohra and Kratzer 1968	14404	turkey (*Meleagris gallopavo*)	9	U	FD	21	day	NR	NR	JV	B	MOR	MORT	WO	356		68	no (UN)

Notes:

Not all studies presented in the manganese ecological soil screening level (Eco-SSL) document for growth, reproduction, and survival were used to derive the Eco-SSL toxicity reference value (TRV).

See Eco-SSL document (USEPA 2007b) for the full reference list for studies cited in this table.

Abbreviations from the Eco-SSL document are defined in Table A-1.

Blank cells are shown as reported in the Eco-SSL document; no description was provided.

[a] Lowest-observed-adverse-effect level (LOAEL) and no-observed-adverse-effect level (NOAEL) values that are equal and from the same reference represent different experimental designs.

[b] Rationale for study unacceptability is in parentheses

ENR - endpoint not relevant

UN - unbounded NOAEL

Table A-9. Manganese Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose[a] (mg/kg bw/day)	LOAEL Dose[a] (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[b]
Reproduction																			
61	Grummer et al. 1950	14464	pig (*Sus scrofa*)	2	U	FD	124	day	9	week	GE	F	REP	PROG	WO	2.83		71	no (UN)
62	Rehnberg et al. 1980	57	rat (*Rattus norvegicus*)	4	U	GV	20	day	1	day	JV	B	REP	RHIS	TE	21.0	71.0	90	no (ENR)
63	USDA 1973	35143	rat (*Rattus norvegicus*)	5	U	GV	9	day	NR	NR	GE	F	REP	PROG	WO	78.3		77	no (UN)
64	USDA 1973	35143	rabbit (*Oryctolagus cuniculus*)	5	U	GV	12	day	NR	NR	GE	F	REP	PROG	WO	112		77	no (UN)
65	USDA 1973	35143	mouse (*Mus musculus*)	5	U	GV	9	day	NR	NR	GE	F	REP	PROG	WO	125		77	no (UN)
66	USDA 1973	35143	hamster (*Mesocricetus auratus*)	5	U	GV	4	day	NR	NR	GE	F	REP	PROG	WO	136		77	no (UN)
67	Pappas et al. 1997	33496	rat (*Rattus norvegicus*)	3	U	DR	30	day	NR	NR	GE	F	REP	PRWT	WO	153	620	82	yes
68	Kontur and Fechter 1985	34752	rat (*Rattus norvegicus*)	4	U	DR	21	day	NR	NR	GE	F	REP	PRWT	WO	276	415	81	yes
69	Laskey et al. 1982	56	rat (*Rattus norvegicus*)	4	U	FD	43	day	NR	NR	GE	F	REP	PRWT	WO	291		78	yes
70	Leung et al. 1982	34895	rat (*Rattus norvegicus*)	3	U	DR	26	day	NR	NR	GE	F	REP	PRWT	WO	1069	2139	79	yes
71	Becker and McCollum 1938	14459	rat (*Rattus norvegicus*)	5	U	FD	730	day	NR	NR	JV	M	REP	TEDG	TE	1996		77	no (ENR, UN)
72	Bataineh et al. 1998	1717	rat (*Rattus norvegicus*)	2	U	DR	12	week	NR	NR	AD	M	REP	TEWT	TE		26.4	67	no (ENR)
73	Laskey et al 1985	34755	rat (*Rattus norvegicus*)	2	U	GV	21	day	0	day	JV	M	REP	TEWT	TE		71.0	86	no (ENR)
Growth																			
74	Ivan and Grieve 1975	34990	cattle (*Bos taurus*)	2	U	FD	10	week	22-28	week	JV	M	GRO	BDWT	WO	1.30		68	no (RU, UN)
75	Mohamed et al. 1986	36002	water buffalo (*Bubalus carabanensis*)	3	M	FD	90	day	13-19	month	JV	M	GRO	BDWT	WO	1.86		73	no (UN)
76	Svajgr et al. 1969	34656	pig (*Sus scrofa*)	2	U	FD	84	day	NR	NR	JV	B	GRO	BDWT	WO	2.74		69	no (UN)
77	Grummer et al. 1950	14464	pig (*Sus scrofa*)	2	U	FD	124	day	NR	NR	JV	B	GRO	BDWT	WO	2.83		69	no (UN)
78	Gershbein et al. 1983	136	rat (*Rattus norvegicus*)	2	U	FD	80	day	44	day	JV	M	GRO	BDWT	WO	5.89		68	no (UN)
79	Bhoot et al. 1981	35470	cattle (*Bos taurus*)	3	U	FD	66	day	1	year	JV	F	GRO	BDWT	WO	7.05		71	no (RU, UN)
80	Lee and Johnson 1988	34504	rat (*Rattus norvegicus*)	3	U	FD	2	week	NR	NR	JV	B	GRO	BDWT	WO	7.37		68	no (UN)
81	Kontur and Fechter 1985	36045	rat (*Rattus norvegicus*)	3	U	GV	21	day	1	day	JV	B	GRO	BDWT	WO	13.8		75	no (UN)
82	Leibholz et al. 1962	14468	pig (*Sus scrofa*)	4	U	FD	10	week	2	week	JV	B	GRO	BDWT	WO	14.4	144	81	no (UN[c])
83	Lipe et al. 1999	33403	rat (*Rattus norvegicus*)	3	U	GV	30	day	30	day	JV	M	GRO	BDWT	WO	20.0		75	no (UN)
84	Deskin et al. 1981	34921	rat (*Rattus norvegicus*)	4	U	GV	24	day	1	day	JV	M	GRO	BDWT	WO	20.0		75	no (UN)
85	Rehnberg et al. 1980	57	rat (*Rattus norvegicus*)	4	U	GV	5	day	1	day	JV	B	GRO	BDWT	WO	21.0	71.0	88	yes
86	Cunningham et al. 1966	14461	cattle (*Bos taurus*)	4	U	FD	84	day	10	week	JV	M	GRO	BDWT	WO	21.7	65.0	84	no (RU)
87	Black et al. 1985	35824	sheep (*Ovis aries*)	5	U	FD	84	day	NR	NR	JV	M	GRO	BDWT	WO	59.4	119	84	no (RU)
88	Laskey et al. 1985	34755	rat (*Rattus norvegicus*)	2	U	GV	21	day	0	day	JV	M	GRO	BDWT	WO	71.0		84	no (UN)
89	Cunningham et al. 1966	14461	cattle (*Bos taurus*)	4	U	FD	100	day	10	week	JV	M	GRO	BDWT	WO	73.8		69	no (RU, UN)
90	USDA 1973	35143	rat (*Rattus norvegicus*)	5	U	GV	9	day	NR	month	GE	F	GRO	BDWT	WO	78.3		75	no (UN)
91	Leibholz et al. 1962	14468	pig (*Sus scrofa*)	6	U	FD	6	week	2	week	JV	B	GRO	BDWT	WO	86.3		68	no (UN)
92	Nachtman et al. 1986	34669	rat (*Rattus norvegicus*)	2	U	DR	65	week	6	week	JV	M	GRO	BDWT	WO	102		72	no (UN)
93	Black et al. 1985	35824	sheep (*Ovis aries*)	4	U	FD	84	day	NR	NR	JV	M	GRO	BDWT	WO	112	223	84	no (RU)
94	USDA 1973	35143	rabbit (*Oryctolagus cuniculus*)	5	U	GV	12	day	NR	NR	GE	F	GRO	BDWT	WO	112		75	no (UN)
95	USDA 1973	35143	mouse (*Mus musculus*)	5	U	GV	9	day	NR	NR	GE	F	GRO	BDWT	WO	125		75	no (UN)
96	USDA 1973	35143	hamster (*Mesocricetus auratus*)	5	U	GV	4	day	NR	NR	GE	F	GRO	BDWT	WO	136		75	no (UN)
97	Kontur and Fechter 1985	34752	rat (*Rattus norvegicus*)	4	U	DR	21	day	NR	NR	GE	F	GRO	BDWT	WO	162	271	79	yes
98	Komura and Sakamoto 1991	33786	mouse (*Mus musculus*)	2	U	FD	100	day	6	week	JV	M	GRO	BDWT	WO	262		69	no (UN)
99	Komura and Sakamoto 1991	33786	mouse (*Mus musculus*)	2	U	FD	100	day	6	week	JV	M	GRO	BDWT	WO	270		69	no (UN)
100	Johnson and Kies 1987	34574	rat (*Rattus norvegicus*)	3	U	FD	56	day	NR	NR	JV	M	GRO	BDWT	WO	394		68	no (UN)
101	Gaillard et al. 1996	33511	rat (*Rattus norvegicus*)	2	U	DR	11	week	3	week	JV	M	GRO	BDWT	WO	554		73	no (UN)
102	Lipe et al. 1999	33403	rat (*Rattus norvegicus*)	3	U	GV	24	day	90	day	AD	M	GRO	BDWT	WO		10.0	80	yes
103	Komura and Sakamoto 1991	33786	mouse (*Mus musculus*)	2	U	FD	30	day	6	week	JV	M	GRO	BDWT	WO		284	73	yes
104	Komura and Sakamoto 1991	33786	mouse (*Mus musculus*)	2	U	FD	30	day	6	week	JV	M	GRO	BDWT	WO		284	78	yes

Table A-9. Manganese Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose[a] (mg/kg bw/day)	LOAEL Dose[a] (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[b]
Survival																			
105	Rehnberg et al. 1980	57	rat (*Rattus norvegicus*)	4	U	GV	17	day	1	day	JV	B	MOR	SURV	WO	21.0	71.0	89	yes
106	USDA 1973	35143	rat (*Rattus norvegicus*)	5	U	GV	9	day	NR	NR	GE	F	MOR	SURV	WO	78.3		76	no (UN)
107	USDA 1973	35143	rabbit (*Oryctolagus cuniculus*)	5	U	GV	12	day	NR	NR	GE	F	MOR	SURV	WO	112		85	no (UN)
108	USDA 1973	35143	mouse (*Mus musculus*)	5	U	GV	9	day	NR	NR	GE	F	MOR	SURV	WO	125		85	no (UN)
109	USDA 1973	35143	hamster (*Mesocricetus auratus*)	5	U	GV	4	day	NR	NR	GE	F	MOR	SURV	WO	136		80	no (UN)

Notes:

Not all studies presented in the manganese ecological soil screening level (Eco-SSL) document for growth, reproduction, and survival were used to derive the Eco-SSL toxicity reference value (TRV).

See Eco-SSL document (USEPA 2007b) for the full reference list for studies cited in this table.

Abbreviations from the Eco-SSL document are defined in Table A-1.

Blank cells are shown as reported in the Eco-SSL document; no description was provided.

[a] Lowest-observed-adverse-effect level (LOAEL) and no-observed-adverse-effect level (NOAEL) values that are equal and from the same reference represent different experimental designs.

[b] Rationale for study unacceptability is in parentheses

[c] Dose/response dataset was reviewed and determined to be an unbounded NOAEL (differs from the Eco-SSL document).

ENR - endpoint not relevant
RU - ruminant study
UN - unbounded NOAEL

Table A-10. Zinc Data for Birds as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose^a (mg/kg bw/day)	LOAEL Dose^a (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?^{b}
Reproduction																			
75	Kaya et al. 2001	48543	chicken (*Gallus domesticus*)	5	U	FD	12	week	NR	NR	LB	F	REP	PROG	WO	13.8		75	no (UN)
76	Schisler and Kienholz 1967	8798	chicken (*Gallus domesticus*)	2	U	FD	14	week	48	week	LB	F	REP	PROG	WO	14.4		70	no (UN)
77	Jensen and Maurice 1980	9749	chicken (*Gallus domesticus*)	3	U	FD	6	week	NR	NR	LB	F	REP	PROG	WO	24.7	98.8	82	yes
78	Jackson et al. 1986	6133	chicken (*Gallus domesticus*)	6	U	FD	140	day	40	week	LB	F	REP	PROG	WO	55	105	81	yes
79	Gibson et al. 1986	6048	chicken (*Gallus domesticus*)	6	U	FD	10	week	30	week	JV	F	REP	PROG	WO	57.3	66.5	81	yes
80	Stevenson et al. 1987	8184	chicken (*Gallus domesticus*)	9	U	FD	140	day	28	week	JV	F	REP	PROG	WO	63.9	76.7	81	yes
81	Gibson et al. 1986	6048	chicken (*Gallus domesticus*)	6	U	FD	10	week	30	week	LB	F	REP	PROG	WO	64.1	123	81	yes
82	Stevenson et al. 1987	8184	chicken (*Gallus domesticus*)	9	U	FD	140	day	28	week	LB	F	REP	PROG	WO	67.8	84.8	81	yes
83	Stahl et al. 1990	5764	chicken (*Gallus domesticus*)	4	U	FD	12	week	56	week	LB	F	REP	PROG	WO	106		71	no (UN)
84	Gasaway and Buss 1972	9261	mallard duck (*Anas platyrhynchos*)	4	U	FD	60	day	7	week	JV	M	REP	TEWT	TE		31.2	79	no (ENR)
85	Jackson et al. 1986	6133	chicken (*Gallus domesticus*)	5	U	FD	1	week	40	week	SM	F	REP	PROG	WO		88	75	yes
86	Jensen and Maurice 1980	9749	chicken (*Gallus domesticus*)	2	U	FD	6	week	NR	NR	LB	F	REP	PROG	WO		101	79	yes
87	Stepinska et al. 1987	5770	chicken (*Gallus domesticus*)	2	U	FD	5	day	71	week	LB	F	REP	PROG	WO		205	75	yes
88	Jackson et al. 1986	6133	chicken (*Gallus domesticus*)	5	U	FD	1	week	40	week	LB	F	REP	PROG	WO		367	75	no (DNF)
89	Berry and Brake 1985	6144	chicken (*Gallus domesticus*)	2	U	FD	4	day	60	week	LB	F	REP	RHIS	OD		988	73	no (ENR)
90	Berry and Brake 1990	7089	chicken (*Gallus domesticus*)	2	U	FD	49	day	66	week	LB	F	REP	RHIS	OD		988	73	no (ENR)
Growth																			
91	Schisler and Kienholz 1967	8798	chicken (*Gallus domesticus*)	2	U	FD	14	week	48	week	JV	F	GRO	BDWT	WO	14.4		68	no (UN)
92	Baker and Halpin 1988	5917	chicken (*Gallus domesticus*)	2	M	FD	14	day	8	day	JV	M	GRO	BDWT	WO	15.0		73	no (UN)
93	Mohanna and Nys 1999	5090	chicken (*Gallus domesticus*)	2	U	FD	16	day	5	day	JV	NR	GRO	BDWT	WO	16.1		68	no (UN)
94	Hamilton et al. 1979	6655	Japanese quail (*Coturnix japonica*)	2	U	FD	14	day	0	day	JV	B	GRO	BDWT	WO	21.5		80	no (UN)
95	Hill 1974	1369	chicken (*Gallus domesticus*)	2	U	FD	3	week	1	day	JV	B	GRO	BDWT	WO	28.7		76	no (UN)
96	Stahl et al. 1989	5820	chicken (*Gallus domesticus*)	2	U	FD	20	day	1	day	JV	B	GRO	BDWT	WO	35.4		68	no (UN)
97	Hill 1990	5734	chicken (*Gallus domesticus*)	2	U	FD	19	day	1	day	JV	F	GRO	BDWT	WO	36.6		76	no (UN)
98	Hamilton et al. 1981	6403	Japanese quail (*Coturnix japonica*)	3	U	FD	14	day	1	day	JV	B	GRO	BDWT	WO	43.3	86.6	83	yes
99	Jackson et al. 1986	6133	chicken (*Gallus domesticus*)	6	U	FD	140	day	40	week	SM	F	GRO	BDWT	WO	55.0	105	79	yes
100	Harland et al. 1975	6887	Japanese quail (*Coturnix japonica*)	2	U	FD	1	week	1	day	JV	B	GRO	BDWT	WO	55.1		77	no (UN)
101	Berg and Martinson 1972	93	chicken (*Gallus domesticus*)	7	U	FD	2	week	1	day	JV	NR	GRO	BDWT	WO	55.3	111	78	yes
102	Lefevre et al. 1982	392	chicken (*Gallus domesticus*)	2	U	FD	5	week	1	day	JV	NR	GRO	BDWT	WO	63.2		76	no (UN)
103	Sandoval et al. 1998	7245	chicken (*Gallus domesticus*)	4	U	FD	3	week	1	day	JV	M	GRO	BDWT	WO	70.6	106	84	yes
104	Roberson and Schaible 1960	14538	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	M	GRO	BDWT	WO	74.3	111	83	yes
105	Roberson and Schaible 1960	14538	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	M	GRO	BDWT	WO	74.7	112	83	yes
106	Roberson and Schaible 1960	14538	chicken (*Gallus domesticus*)	4	U	FD	4	week	1	day	JV	M	GRO	BDWT	WO	75.0	150	79	yes
107	Roberson and Schaible 1960	14538	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	M	GRO	BDWT	WO	75.7	114	83	yes
108	Hill 1974	92	chicken (*Gallus domesticus*)	5	U	FD	2	week	1	day	JV	B	GRO	BDWT	WO	85.9	172	82	yes
109	Hamilton et al. 1979	6655	Japanese quail (*Coturnix japonica*)	6	U	FD	14	day	8	day	JV	B	GRO	BDWT	WO	86.8	174	86	yes
110	Henry et al. 1987	6039	chicken (*Gallus domesticus*)	4	U	FD	1	week	1	day	JV	M	GRO	BDWT	WO	92.3	185	83	yes
111	Gibson et al. 1986	6048	chicken (*Gallus domesticus*)	6	U	FD	10	week	30	week	JV	F	GRO	BDWT	WO	96.9	145	79	yes
112	Stevenson et al. 1987	8184	chicken (*Gallus domesticus*)	9	U	FD	140	day	28	week	JV	F	GRO	BDWT	WO	99.1	149	79	yes
113	Sandoval et al. 1999	5067	chicken (*Gallus domesticus*)	2	U	FD	7	day	14	day	JV	M	GRO	BDWT	WO	103		68	no (UN)
114	Sandoval et al. 1999	5067	chicken (*Gallus domesticus*)	2	U	FD	7	day	14	day	JV	M	GRO	BDWT	WO	103		68	no (UN)
115	Stahl et al. 1990	5764	chicken (*Gallus domesticus*)	3	U	FD	44	week	24	week	LB	F	GRO	BDWT	WO	129		69	no (UN)
116	Stevenson et al. 1987	8184	chicken (*Gallus domesticus*)	9	U	FD	140	day	28	week	LB	F	GRO	BDWT	WO	129	194	79	yes
117	Bafundo et al. 1984	2517	chicken (*Gallus domesticus*)	2	U	FD	14	day	8	day	JV	F	GRO	BDWT	WO	142		67	no (UN)
118	Dewar et al. 1983	37018	chicken (*Gallus domesticus*)	4	U	FD	4	week	1	day	JV	B	GRO	BDWT	WO	143	286	79	yes
119	Vohra and Kratzer 1968	14404	turkey (*Meleagris gallopavo*)	7	U	FD	21	day	NR	NR	JV	B	GRO	BDWT	WO	148	297	77	yes
120	Roberson and Schaible 1960	14538	chicken (*Gallus domesticus*)	4	U	FD	4	week	1	day	JV	M	GRO	BDWT	WO	155	232	83	yes
121	Roberson and Schaible 1960	14538	chicken (*Gallus domesticus*)	4	U	FD	4	week	1	day	JV	M	GRO	BDWT	WO	158	237	83	yes
122	Southern and Baker 1983	6368	chicken (*Gallus domesticus*)	3	U	FD	14	day	8	day	JV	M	GRO	BDWT	WO	177	354	83	yes
123	Oh et al. 1979	6627	chicken (*Gallus domesticus*)	6	U	FD	4	week	1	day	JV	NR	GRO	BDWT	WO	252	503	79	yes
124	Jackson et al. 1986	6133	chicken (*Gallus domesticus*)	5	U	FD	1	week	40	week	SM	F	GRO	BDWT	WO	367	480	79	yes
125	Lu and Combs 1988	5903	chicken (*Gallus domesticus*)	2	U	FD	15	day	1	day	JV	NR	GRO	BDWT	WO		21.6	72	no (SDC)

Table A-10. Zinc Data for Birds as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose[a] (mg/kg bw/day)	LOAEL Dose[a] (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[b]
Growth (continued)																			
126	Stahl et al. 1989	5820	chicken (*Gallus domesticus*)	2	U	FD	20	day	1	day	JV	B	GRO	BDWT	WO		31.0	77	yes
127	Lu and Combs 1988	5866	chicken (*Gallus domesticus*)	2	U	FD	6	day	20	day	JV	NR	GRO	BDWT	WO		39.0	73	yes
128	Lu et al. 1990	8008	chicken (*Gallus domesticus*)	2	U	FD	7	day	14	day	JV	B	GRO	BDWT	WO		65.7	72	yes
129	Jackson et al. 1986	6133	chicken (*Gallus domesticus*)	5	U	FD	21	day	40	week	SM	F	GRO	BDWT	WO		88	73	yes
130	Jensen and Maurice 1980	9749	chicken (*Gallus domesticus*)	2	U	FD	6	week	NR	NR	SM	F	GRO	BDWT	WO		101	77	yes
131	Gasaway and Buss 1972	9261	mallard duck (*Anas platyrhynchos*)	4	U	FD	10	day	7	week	JV	B	GRO	BDWT	WO		126	77	yes
132	Pimentel et al. 1992	5617	chicken (*Gallus domesticus*)	2	M	FD	3	week	1	day	JV	B	GRO	BDWT	WO		132	77	yes
133	Dewar et al. 1983	37018	chicken (*Gallus domesticus*)	4	U	FD	4	week	2	week	JV	B	GRO	BDWT	WO		143	72	yes
134	Berg and Martinson 1972	93	chicken (*Gallus domesticus*)	2	U	FD	2	week	1	day	JV	NR	GRO	BDWT	WO		252	72	yes
135	Bafundo et al. 1984	6273	chicken (*Gallus domesticus*)	2	U	FD	14	day	8	day	JV	M	GRO	BDWT	WO		190	76	yes
136	Bafundo et al. 1984	2517	chicken (*Gallus domesticus*)	2	U	FD	14	day	8	day	JV	M	GRO	BDWT	WO		284	76	yes
137	Bartov 1996	5373	chicken (*Gallus domesticus*)	4	U	FD	2	week	1	week	JV	F	GRO	BDWT	WO		315	73	yes
138	Rama and Planas 1981	6435	chicken (*Gallus domesticus*)	2	U	FD	9	week	1	day	JV	NR	GRO	BDWT	WO		433	70	yes
139	Dean et al. 1991	5681	chicken (*Gallus domesticus*)	2	M	FD	1	week	1	day	JV	M	GRO	BDWT	WO		757	78	yes
140	Bartov et al. 1994	7956	chicken (*Gallus domesticus*)	3	U	FD	2	week	1	week	JV	F	GRO	BDWT	WO		914	73	yes
141	Palafox and Ho-A 1980	6545	chicken (*Gallus domesticus*)	2	U	FD	5	day	38	week	JV	F	GRO	BDWT	WO		988	71	yes
142	Bartov 1996	5373	chicken (*Gallus domesticus*)	4	U	FD	2	week	1	week	JV	F	GRO	BDWT	WO		1370	73	yes
Survival																			
143	Hamilton et al. 1979	6655	Japanese quail (*Coturnix japonica*)	2	U	FD	14	day	0	day	JV	B	MOR	MORT	WO	21.5		81	no (UN)
144	Stahl et al. 1989	5820	chicken (*Gallus domesticus*)	2	U	FD	20	day	1	day	JV	B	MOR	MORT	WO	31.0		78	no (UN)
145	Stahl et al. 1989	5820	chicken (*Gallus domesticus*)	2	U	FD	20	day	1	day	JV	B	MOR	MORT	WO	35.4		78	no (UN)
146	Harland et al. 1975	6887	Japanese quail (*Coturnix japonica*)	2	U	FD	1	week	1	day	JV	B	MOR	MORT	WO	55.1		78	no (UN)
147	Lefevre et al. 1982	392	chicken (*Gallus domesticus*)	2	U	FD	5	week	1	day	JV	NR	MOR	MORT	WO	63.2		79	no (UN)
148	Gibson et al. 1986	6048	chicken (*Gallus domesticus*)	6	U	FD	10	week	30	week	JV	F	MOR	MORT	WO	68.8	87.1	80	yes
149	Roberson and Schaible 1960	14538	chicken (*Gallus domesticus*)	10	U	FD	4	week	1	week	JV	M	MOR	SURV	WO	75.6		73	no (UN)
150	Hamilton et al. 1981	6403	Japanese quail (*Coturnix japonica*)	3	U	FD	14	day	1	day	JV	B	MOR	MORT	WO	89.5		78	no (UN)
151	Blalock and Hill 1988	5868	chicken (*Gallus domesticus*)	3	U	FD	12	day	1	day	JV	F	MOR	MORT	WO	109	219	79	yes
152	Roberson and Schaible 1960	14538	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	M	MOR	SURV	WO	115		78	no (UN)
153	Roberson and Schaible 1960	14538	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	M	MOR	SURV	WO	120		77	no (UN)
154	Roberson and Schaible 1960	14538	chicken (*Gallus domesticus*)	3	U	FD	4	week	1	day	JV	M	MOR	SURV	WO	121		78	no (UN)
155	Dewar et al. 1983	37018	chicken (*Gallus domesticus*)	4	U	FD	4	week	1	day	JV	B	MOR	MORT	WO	143	286	80	yes
156	Roberson and Schaible 1960	14538	chicken (*Gallus domesticus*)	4	U	FD	4	week	1	day	JV	M	MOR	SURV	WO	159	239	84	yes
157	Hill 1974	92	chicken (*Gallus domesticus*)	5	U	FD	5	week	1	day	JV	B	MOR	MORT	WO	172		68	no (UN)
158	Hamilton et al. 1979	6655	Japanese quail (*Coturnix japonica*)	6	U	FD	14	day	0	day	JV	B	MOR	MORT	WO	183	366	87	yes
159	Oh et al. 1979	6627	chicken (*Gallus domesticus*)	6	U	FD	4	week	1	day	JV	NR	MOR	MORT	WO	252	503	80	yes
160	Roberson and Schaible 1960	14538	chicken (*Gallus domesticus*)	4	U	FD	4	week	1	day	JV	M	MOR	SURV	WO	255		78	no (UN)
161	Roberson and Schaible 1960	14538	chicken (*Gallus domesticus*)	4	U	FD	4	week	1	day	JV	M	MOR	SURV	WO	272		78	no (UN)
162	Dewar et al. 1983	37018	chicken (*Gallus domesticus*)	3	U	FD	4	day	18	month	AD	F	MOR	MORT	WO	319		69	no (UN)
163	Hill 1974	1369	chicken (*Gallus domesticus*)	2	U	FD	3	week	1	day	JV	B	MOR	MORT	WO	320		77	no (UN)
164	Dewar et al. 1983	37018	chicken (*Gallus domesticus*)	4	U	FD	4	week	2	week	JV	B	MOR	MORT	WO	327	491	79	yes
165	Vohra and Kratzer 1968	14404	turkey (*Meleagris gallopavo*)	7	U	FD	21	day	NR	NR	JV	B	MOR	MORT	WO	741		72	no (UN)
166	Gasaway and Buss 1972	9261	mallard duck (*Anas platyrhynchos*)	4	U	FD	30	day	7	week	JV	B	MOR	MORT	WO		126	78	yes
167	Van Vleet et al. 1981	80	duck (*Anas platyrhynchos*)	2	U	FD	15	day	1	day	JV	M	MOR	MORT	WO		401	77	yes
168	Van Vleet et al. 1981	80	duck (*Anas platyrhynchos*)	2	U	FD	15	day	1	day	JV	M	MOR	MORT	WO		803	77	yes

Notes:

Not all studies presented in the zinc ecological soil screening level (Eco-SSL) document for growth, reproduction, and survival were used to derive the Eco-SSL toxicity reference value (TRV).

See Eco-SSL document (USEPA 2007c) for the full reference list for studies cited in this table.

Abbreviations from the Eco-SSL document are defined in Table A-1.

Blank cells are shown as reported in the Eco-SSL document; no description was provided.

[a] Lowest-observed-adverse-effect level (LOAEL) and no-observed-adverse-effect level (NOAEL) values that are equal and from the same reference represent different experimental designs.

[b] Rationale for study unacceptability is in parentheses

DNF - data not found

ENR - endpoint not relevant

UN - unbounded NOAEL

Table A-11. Zinc Data for Mammals as Presented in Eco-SSL document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose[a] (mg/kg bw/day)	LOAEL Dose[a] (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[b]
Reproduction																			
87	Hill et. al. 1983	45143	pig (*Sus scrofa*)	3	U	FD	12	month	7-8	month	GE	F	REP	ODVP	WO	8.23	82.3	79	no (ENR)
88	Seidenberg et al. 1986	113	mouse (*Mus musculus*)	2	U	GV	4	day	NR	NR	GE	F	REP	PRWT	NR	8.89		82	no (UN)
89	Alaoui et al. 1985	36854	rat (*Rattus norvegicus*)	2	U	FD	5	week	NR	NR	JV	M	REP	ORWT	TE	9.64		71	no (ENR, UN)
90	Cerklewski 1979	37008	rat (*Rattus norvegicus*)	2	U	FD	37	day	105	day	LC	F	REP	PRWT	WO	14.4		80	no (UN)
91	Food and Drug Res. Lab 1973	42289	mouse (*Mus musculus*)	3	U	GV	10	day	NR	NR	GE	F	REP	PRFM	WO	30.0		77	no (ENR, UN)
92	Khera and Shah 1979	21134	rat (*Rattus norvegicus*)	2	U	FD	4	day	NR	NR	GE	F	REP	PRWT	WO	34.0		69	no (UN)
93	Miller et al. 1989	14685	cattle (*Bos taurus*)	3	U	FD	14	week	NR	NR	LC	F	REP	PRWT	WO	37.9	75.9	86	no (RU)
94	Amemiya et al. 1986	21069	rat (*Rattus norvegicus*)	2	U	FD	21	day	NR	NR	GE	F	REP	PRWT	WO	41.2		74	no (UN)
95	Evenson et al. 1993	14660	rat (*Rattus norvegicus*)	2	U	FD	8	week	3	week	JV	M	REP	TEWT	TE	42.1		70	no (ENR, UN)
96	Food and Drug Res. Lab 1973	42289	rat (*Rattus norvegicus*)	4	U	GV	10	day	NR	NR	GE	F	REP	PRFM	WO	42.5		77	no (ENR, UN)
97	Food and Drug Res. Lab 1974	42292	rabbit (*Oryctolagus cuniculus*)	5	U	GV	13	day	NR	NR	GE	F	REP	PRFM	WO	60.0		77	no (ENR, UN)
98	Food and Drug Res. Lab 1973	42289	hamster (*Mesocricetus auratus*)	3	U	GV	5	day	NR	NR	GE	F	REP	PRFM	WO	88.0		77	no (ENR, UN)
99	Shrader et al. 1978	21138	rat (*Rattus norvegicus*)	2	U	FD	21	day	NR	NR	GE	F	REP	PRWT	WO	89.6		73	no (UN)
100	Hirsch and Hurley 1978	21139	rat (*Rattus norvegicus*)	2	U	FD	12	day	NR	NR	GE	F	REP	PRWT	WO	89.6		75	no (UN)
101	Hill et al. 1983	35659	pig (*Sus scrofa*)	3	U	FD	20	week	NR	NR	LC	F	REP	RHIS	WO	97.8		70	no (ENR, UN)
102	Webster 1979	823	mouse (*Mus musculus*)	4	U	FD	19	day	4	month	GE	F	REP	PRWT	WO	101		79	no (UN)
103	Anderson et al. 1993	139	mouse (*Mus musculus*)	2	U	FD	13	week	12	week	JV	M	REP	PRWT	WO	110		74	no (UN)
104	Schlicker and Cox 1968	25	rat (*Rattus norvegicus*)	2	U	FD	36	day	NR	NR	GE	F	REP	PRWT	WO	167		73	no (UN)
105	Ketcheson et al. 1969	37837	rat (*Rattus norvegicus*)	3	U	FD	14	day	NR	NR	LC	F	REP	PRWT	WO	181	452	81	yes
106	Maita et al. 1981	43680	rat (*Rattus norvegicus*)	4	U	FD	13	week	5	week	JV	M	REP	ORWT	TE	234	2514	82	no (ENR)
107	Chu and Cox 1970	42767	rat (*Rattus norvegicus*)	2	U	FD	21	day	NR	NR	LC	F	REP	GREP	WO	347		74	no (UN)
108	Maita et al. 1981	43680	mouse (*Mus musculus*)	4	U	FD	13	week	5	week	JV	M	REP	ORWT	TE	458	4927	82	no (ENR)
109	Maita et al. 1981	43680	mouse (*Mus musculus*)	4	U	FD	13	week	5	week	JV	F	REP	ORWT	OV	479	4878	82	no (ENR)
110	Bui et al. 1998	21045	rat (*Rattus norvegicus*)	2	M	GV	7	day	NR	NR	GE	F	REP	PRWT	WO	975		80	no (UN)
111	Maita et al. 1981	43680	rat (*Rattus norvegicus*)	4	U	FD	13	week	5	week	JV	F	REP	ORWT	OV	2486		71	no (ENR, UN)
112	Kumar 1976	43587	rat (*Rattus norvegicus*)	2	U	FD	17	day	100	day	GE	F	REP	RSEM	WO		12.2	78	yes
113	Barone et al. 1998	21042	rat (*Rattus norvegicus*)	2	U	FD	10	day	NR	NR	GE	F	REP	PROG	WO		81.1	73	yes
114	Newman et al. 2002	48540	rat (*Rattus norvegicus*)	2	U	FD	16	day	NR	NR	GE	F	REP	PROG	WO		232	81	yes
115	Pal and Pal 1987	14664	rat (*Rattus norvegicus*)	2	U	FD	18	day	120-130	day	GE	F	REP	GREP	WO		326	78	yes
116	Chu and Cox 1972	42670	rat (*Rattus norvegicus*)	2	U	FD	14	day	NR	NR	LC	F	REP	PRWT	WO		326	72	yes
117	Cox et al. 1969	42838	rat (*Rattus norvegicus*)	2	U	FD	22	day	NR	NR	GE	F	REP	PRWT	WO		353	74	yes
118	Schlicker and Cox 1968	25	rat (*Rattus norvegicus*)	2	U	FD	18	day	NR	NR	GE	F	REP	PRWT	WO		424	74	yes
Growth																			
119	Attia et al. 1987	36003	water buffalo (*Bubalus bubalis*)	5	U	FD	90	day	7-9	month	JV	M	GRO	BDWT	WO	4.33		69	no (UN)
120	Huerta et al. 2002	25973	cattle (*Bos taurus*)	2	U	FD	50	day	18	month	JV	F	GRO	BDWT	WO	4.78		68	no (RU, UN)
121	Huerta et al. 2002	25973	cattle (*Bos taurus*)	2	U	FD	50	day	18	month	JV	F	GRO	BDWT	WO	4.78		68	no (RU, UN)
122	Alaoui et al. 1985	36854	rat (*Rattus norvegicus*)	2	U	FD	5	week	NR	NR	JV	M	GRO	BDWT	WO	9.64		69	no (UN)
123	Hill et al. 1983	45143	pig (*Sus scrofa*)	3	U	FD	8	month	7-8	month	GE	F	GRO	GGRO	WO	10.3	103	77	yes
124	Weigarnd and Kirchgessner 1978	41855	rat (*Rattus norvegicus*)	4	U	FD	12	day	NR	NR	JV	M	GRO	BDWT	WO	11.7		68	no (UN)
125	Eisemann et al. 1979	43242	pig (*Sus scrofa*)	2	M	FD	16	week	6-8	week	JV	B	GRO	BDWT	WO	13.5		69	no (UN)
126	Cerklewski 1979	37008	rat (*Rattus norvegicus*)	2	U	FD	37	day	105	day	LC	F	GRO	BDWT	WO	14.4		78	no (UN)
127	Elliot and Walker 1968	38623	pig (*Sus scrofa*)	2	U	FD	4	week	NR	NR	JV	B	GRO	BDWT	WO	14.9		68	no (UN)
128	Cerklewski and Forbes 1976	2627	rat (*Rattus norvegicus*)	2	U	FD	7	week	NR	NR	JV	M	GRO	BDWT	WO	15.7		69	no (UN)
129	Wapnir and Lee 1993	39821	rat (*Rattus norvegicus*)	2	U	FD	3	week	NR	NR	JV	M	GRO	BDWT	WO	15.7		68	no (UN)
130	Agarwal et al. 1986	21084	rat (*Rattus norvegicus*)	2	U	FD	14	day	9-10	week	SM	M	GRO	BDWT	WO	18.0		72	no (UN)
131	Brandt 1983	2033	mink (*Mustela vison*)	3	M	FD	4	month	90	day	JV	M	GRO	BDWT	WO	20.2		82	no (UN)
132	Shankar et al. 1986	46830	rat (*Rattus norvegicus*)	2	U	FD	120	day	40	day	JV	F	GRO	BDWT	WO	28.9		73	no (UN)

Table A-11. Zinc Data for Mammals as Presented in Eco-SSL document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose[a] (mg/kg bw/day)	LOAEL Dose[a] (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[b]
Growth (continued)																			
133	Food and Drug Res. Lab 1973	42289	mouse (*Mus musculus*)	3	U	GV	10	day	NR	NR	GE	F	GRO	BDWT	WO	30.0		75	no (UN)
134	Reeves and Newman 1997	21067	rat (*Rattus norvegicus*)	2	U	FD	7	week	3	week	JV	M	GRO	BDWT	WO	30.4		79	no (UN)
135	Gaynor et al. 1988	47892	cattle (*Bos taurus*)	2	M	FD	4	week	NR	NR	LC	F	GRO	BDWT	WO	30.6		74	no (RU, UN)
136	Gaynor et al. 1988	47892	cattle (*Bos taurus*)	2	M	FD	5	week	NR	NR	LC	F	GRO	BDWT	WO	33.2		74	no (RU, UN)
137	Khera and Shah 1979	21134	rat (*Rattus norvegicus*)	2	U	FD	4	day	NR	NR	GE	F	GRO	BDWT	WO	34		67	no (UN)
138	Evenson et al. 1993	14660	rat (*Rattus norvegicus*)	2	U	FD	8	week	3	week	JV	F	GRO	BDWT	WO	42.1		68	no (UN)
139	Food and Drug Res. Lab 1973	42289	rat (*Rattus norvegicus*)	4	U	GV	10	day	NR	NR	GE	F	GRO	BDWT	WO	42.5		75	no (UN)
140	Brink et al. 1959	14525	pig (*Sus scrofa*)	6	U	FD	42	day	NR	NR	JV	NR	GRO	BDWT	WO	43.5	87.1	84	yes
141	Miller et al. 1989	14685	cattle (*Bos taurus*)	3	U	FD	14	week	NR	NR	LC	F	GRO	BDWT	WO	63.7		69	no (RU, UN)
142	Reeves et al. 1994	37015	rat (*Rattus norvegicus*)	2	U	FD	2	week	NR	NR	JV	M	GRO	BDWT	WO	56		75	no (UN)
143	Food and Drug Res. Lab 1974	42292	rabbit (*Oryctolagus cuniculus*)	5	U	GV	12	day	NR	NR	GE	F	GRO	BDWT	WO	60.0		75	no (UN)
144	Food and Drug Res. Lab 1973	42289	hamster (*Mesocricetus auratus*)	3	U	GV	5	day	NR	NR	GE	F	GRO	BDWT	WO	88.0		75	no (UN)
145	Bui et al. 1998	21045	rat (*Rattus norvegicus*)	2	M	GV	7	day	NR	NR	GE	F	GRO	BDWT	WO	97.5		69	no (UN)
146	Van Vleet et al. 1981	149	pig (*Sus scrofa*)	2	U	FD	10	week	NR	NR	JV	M	GRO	BDWT	WO	99.1		73	no (UN)
147	Schell and Kornegay 1996	42234	pig (*Sus scrofa*)	4	M	FD	2	week	23	day	JV	B	GRO	BDWT	WO	103		69	no (UN)
148	Schell and Kornegay 1996	42234	pig (*Sus scrofa*)	4	M	FD	23	day	23	day	JV	B	GRO	BDWT	WO	106		74	no (UN)
149	Anderson et al. 1993	139	mouse (*Mus musculus*)	2	U	FD	13	week	12	week	JV	M	GRO	BDWT	WO	110		81	no (UN)
150	Maita et al. 1981	43680	rat (*Rattus norvegicus*)	4	U	FD	13	week	5	week	JV	M	GRO	BDWT	WO	234	2514	80	yes
151	Bentley and Grubb 1991	40436	rabbit (*Oryctolagus cuniculus*)	3	U	FD	22	week	NR	NR	JV	B	GRO	BDWT	WO	282		68	no (UN)
152	Llewellyn et al. 1985	2203	golden hamster (*Mesocricetus auratus*)	2	U	FD	18	week	NR	NR	JV	M	GRO	BDWT	WO	295		67	no (UN)
153	Maita et al. 1981	43680	mouse (*Mus musculus*)	4	U	FD	13	week	5	week	JV	M	GRO	BDWT	WO	458	4927	80	yes
154	Ketcheson et al. 1969	37837	rat (*Rattus norvegicus*)	3	U	FD	14	day	NR	NR	LC	F	GRO	BDWT	WO	470		73	no (UN)
155	Maita et al. 1981	43680	mouse (*Mus musculus*)	4	U	FD	13	week	5	week	JV	F	GRO	BDWT	WO	479	4878	80	yes
156	O'Neil-Cutting et al. 1981	14656	rat (*Rattus norvegicus*)	2	U	FD	18	week	NR	NR	JV	M	GRO	BDWT	WO	597		77	no (UN)
157	Zhang et al. 1995	39356	mouse (*Mus musculus*)	2	M	FD	10	day	8	week	JV	F	GRO	BDWT	WO	825		68	no (UN)
158	Zhang et al. 1995	39356	mouse (*Mus musculus*)	2	M	FD	10	day	8	week	JV	F	GRO	BDWT	WO	845		73	no (UN)
159	Zhang et al. 1995	39356	mouse (*Mus musculus*)	2	M	FD	10	day	8	week	JV	F	GRO	BDWT	WO	846		68	no (UN)
160	Pettersen et al. 2002	36374	mouse (*Mus musculus*)	3	U	FD	3	week	4	week	JV	B	GRO	BDWT	WO	1419	2838	83	yes
161	Urabe and Hayakawa 1990	40997	rat (*Rattus norvegicus*)	2	U	FD	42	day	NR	NR	JV	M	GRO	BDWT	WO	1684		78	no (UN)
162	Maita et al. 1981	43680	rat (*Rattus norvegicus*)	4	U	FD	13	week	5	week	JV	F	GRO	BDWT	WO	2486		69	no (UN)
163	Nakamura et al. 1983	638	rat (*Rattus norvegicus*)	2	U	FD	11	week	NR	NR	JV	F	GRO	BDWT	WO		8.71	73	yes
164	Rosa et al. 1986	47007	sheep (*Ovis aries*)	2	U	FD	56	day	NR	NR	SM	M	GRO	BDWT	WO		16.1	71	no (RU)
165	Subramanian et al. 2000	21011	rat (*Rattus norvegicus*)	2	U	FD	6	week	NR	NR	JV	M	GRO	BDWT	WO		28.2	73	yes
166	Davies et al. 1977	14527	sheep (*Ovis aries*)	2	M	FD	26	day	1	week	JV	M	GRO	BDWT	WO		75.7	81	no (RU)
167	Barone et al. 1998	21042	rat (*Rattus norvegicus*)	2	U	FD	10	day	NR	NR	GE	F	GRO	BDWT	WO		81.1	71	yes
168	Hsu et al. 1975	14376	pig (*Sus scrofa*)	2	U	FD	13	week	4	week	JV	NR	GRO	BDWT	WO		89.1	73	yes
169	Schlicker and Cox 1968	25	rat (*Rattus norvegicus*)	2	U	FD	18	day	NR	NR	GE	F	GRO	BDWT	WO		424	68	yes
170	Settlemire and Matrone 1967	38015	rat (*Rattus norvegicus*)	2	U	FD	5	week	4-6	week	JV	M	GRO	BDWT	WO		667	76	yes
171	Ogiso et al. 1974	42961	rat (*Rattus norvegicus*)	2	U	FD	15	day	NR	NR	JV	M	GRO	BDWT	WO		956	77	yes
172	Scott and Magee 1979	43264	rat (*Rattus norvegicus*)	2	U	FD	1	week	NR	NR	JV	M	GRO	BDWT	WO		968	77	yes

Table A-11. Zinc Data for Mammals as Presented in Eco-SSL document, Including Study Acceptability Determination

Result #	Reference	Ref No.	Test Organism	No. of Conc. or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose[a] (mg/kg bw/day)	LOAEL Dose[a] (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation?[b]
Survival																			
173	Seidenberg et al. 1986	113	mouse (*Mus musculus*)	2	U	GV	4	day	NR	NR	GE	F	MOR	MORT	WO	8.89		85	no (UN)
174	Van der Schee et al. 1980	21171	sheep (*Ovis aries*)	3	M	FD	98	day	NR	NR	JV	M	MOR	MORT	WO	12.0		83	no (RU, UN)
175	Food and Drug Res. Lab 1973	42289	mouse (*Mus musculus*)	3	U	GV	10	day	NR	NR	GE	F	MOR	SURV	WO	30.0		76	no (UN)
176	Food and Drug Res. Lab 1973	42289	rat (*Rattus norvegicus*)	4	U	GV	10	day	NR	NR	GE	F	MOR	SURV	WO	42.5		76	no (UN)
177	Brink et al. 1959	14525	pig (*Sus scrofa*)	6	U	FD	42	day	NR	NR	JV	NR	MOR	MORT	WO	43.5	87.1	85	yes
178	Food and Drug Res. Lab 1974	42292	rabbit (*Oryctolagus cuniculus*)	5	U	GV	13	day	NR	NR	GE	F	MOR	MORT	WO	60.0		76	no (UN)
179	Ott et al. 1966	14535	sheep (*Ovis aries*)	8	U	FD	6	week	NR	NR	JV	NR	MOR	MORT	WO	82.9	99.5	80	no (RU)
180	Willoughby et al. 1972	14385	horse (*Equus caballus*)	2	M	FD	9	week	3-4	week	JV	F	MOR	MORT	WO	83.7		78	no (UN)
181	Food and Drug Res. Lab 1973	42289	hamster (*Mesocricetus auratus*)	3	U	GV	5	day	NR	NR	GE	F	MOR	SURV	WO	88.0		76	no (UN)
182	Aulerich et al. 1991	46274	mink (*Mustela vison*)	4	M	FD	144	day	>1	year	AD	M	MOR	MORT	WO	165		80	no (UN)
183	Aulerich et al. 1991	46274	mink (*Mustela vison*)	4	M	FD	144	day	10-12	week	JV	M	MOR	MORT	WO	297		84	no (UN)
184	Aulerich et al. 1991	46274	mink (*Mustela vison*)	4	M	FD	144	day	10-12	week	JV	F	MOR	MORT	WO	324		84	no (UN)
185	Aulerich et al. 1991	46274	mink (*Mustela vison*)	4	M	FD	114	day	>1	year	AD	F	MOR	MORT	WO	327		80	no (UN)
186	Maita et al. 1981	43680	mouse (*Mus musculus*)	4	U	FD	13	week	5	week	JV	M	MOR	MORT	WO	458	4927	81	no (UN[c])
187	Maita et al. 1981	43680	rat (*Rattus norvegicus*)	4	U	FD	13	week	5	week	JV	F	MOR	MORT	WO	2486		70	no (UN)
188	Maita et al. 1981	43680	rat (*Rattus norvegicus*)	4	U	FD	13	week	5	week	JV	M	MOR	MORT	WO	2514		79	no (UN)
189	Maita et al. 1981	43680	mouse (*Mus musculus*)	4	U	FD	13	week	5	week	JV	F	MOR	MORT	WO	4878		79	no (UN)
190	Van Vleet et al. 1981	149	pig (*Sus scrofa*)	2	U	FD	10	week	NR	NR	JV	M	MOR	MORT	WO		99.1	78	no (UN[c])

Notes:

Not all studies presented in the zinc ecological soil screening level (Eco-SSL) document for growth, reproduction, and survival were used to derive the Eco-SSL toxicity reference value (TRV).

See Eco-SSL document (USEPA 2007c) for the full reference list for studies cited in this table.

Abbreviations from the Eco-SSL document are defined in Table A-1.

Blank cells are shown as reported in the Eco-SSL document; no description was provided.

[a] Lowest-observed-adverse-effect level (LOAEL) and no-observed-adverse-effect level (NOAEL) values that are equal and from the same reference represent different experimental designs.

[b] Rationale for study unacceptability is in parentheses

[c] Dose/response dataset was reviewed and determined to be an unbounded NOAEL (differs from the Eco-SSL document).

ENR - endpoint not relevant
RU - ruminant study
UN - unbounded NOAEL

Table A-12. Wildlife TRV References Not Included in Eco-SSL Documents

Receptor	Test Organism	Reference	Information Used to Determine Tier	Tier
Cadmium				
Growth				
Bird	chicken (*Gallus domesticus*)	Abduljaleel and Shuhaimi-Othman 2013	UN	NT
Bird	duck (*Anas platyrhynchos*)	Lucia et al. 2010	FD	2
Bird	Japanese quail (*Coturnix japonica*)	Olgun 2015	FD	1
Mammal	bank vole (*Clethrionomys glareolus*)	Bonda et al. 2004	UN	NT
Mammal	mouse (*Mus musculus*)	Seidenberg et al. 1986[a]	UN	NT
Mammal	horse (*Equus caballus*)	Willoughby et al. 1972	UN	NT
Reproduction				
Bird	Japanese quail (*Coturnix japonica*)	Olgun 2015	FD	1
Mammal	rat (*Rattus norvegicus*)	Aprioku et al. 2014	DR	2
Mammal	rat (*Rattus norvegicus*)	Nagymajtenyi et al. 1997	UN	NT
Survival				
Bird	Japanese quail (*Coturnix japonica*)	Olgun 2015	FD	1
Mammal	rat (*Rattus norvegicus*)	Borzelleca et al. 1989	UN	NT
Copper				
Growth				
Bird	duck (*Anas platyrhynchos*)	Attia et al. 2012	SDC	NT
Bird	chicken (*Gallus domesticus*)	Cinar et al. 2014	UN	NT
Bird	chicken (*Gallus domesticus*)	Dozier et al. 2003	UN	NT
Bird	chicken (*Gallus domesticus*)	Norvell et al. 1975	UN	NT
Bird	chicken (*Gallus domesticus*)	Payvastegan et al. 2013	UN	NT
Bird	chicken (*Gallus domesticus*)	Persia et al. 2004	FD	1
Bird	chicken (*Gallus domesticus*)	Yenice et al. 2015	SDC	NT
Mammal	sheep (*Ovis aries*)	Haywood et al. 2004	RU	NT
Mammal	vole (*Microtus pennsylvanicus*)	Miska-Schramm et al. 2014	DR	2
Mammal	rat, mouse (*Rattus norvegicus, Mus musculus*)	NTP 1993b	DR	2
Mammal	pig (*Sus scrofa)*	Shelton et al. 2011	SDC	NT
Mammal	mink (*Mustela vision*)	Wu et al. 2014	UN	NT
Reproduction				
Bird	chicken (*Gallus domesticus*)	Balevi and Coskun 2004	UN	NT
Bird	chicken (*Gallus domesticus*)	Lien et al. 2004	UN	NT
Bird	chicken (*Gallus domesticus*)	Stefanello et al. 2014	SDC	NT
Mammal	rat (*Rattus norvegicus*)	Chung et al. 2009	UN, ENR	NT
Survival				
Mammal	mouse (*Mus musculus*)	Pocino et al. 1991	ENR	NT

Table A-12. Wildlife TRV References Not Included in Eco-SSL Documents

Receptor	Test Organism	Reference	Information Used to Determine Tier	Tier
Lead				
Growth				
Bird	chicken (*Gallus domesticus*)	Abduljaleel and Shuhaimi-Othman 2013	FD	1
Bird	herring gull (*Larus argentatus*)	Burger 1990	ENR	NT
Bird	common tern (*Sterna hirundo*)	Burger and Gochfeld 1985	INJ	NT
Bird	herring gull (*Larus argentatus*)	Burger and Gochfeld 1993	INJ	NT
Bird	herring gull (*Larus argentatus*)	Burger and Gochfeld 1994	INJ	NT
Bird	herring gull (*Larus argentatus*)	Burger and Gochfeld 1995	ENR	NT
Bird	common tern (*Sterna hirundo*)	Gochfeld and Berger 1988	ENR	NT
Bird	ringed turtle dove (*Streptopelia risoria*)	Kendall and Scanlon 1982[a]	UN	NT
Bird	American kestrel (*Falco sparverius*)	Pattee 1984[a]	UN	NT
Bird	Great tit (*Parus major*)	Ruuskanen et al. 2014	SDC	NT
Mammal	rat (*Rattus norvegicus*)	Angell and Weiss 1982	DR	2
Mammal	rat (*Rattus norvegicus*)	Fowler et al. 1980	UN	NT
Mammal	rat (*Rattus norvegicus*)	Hackett et al. 1982	INJ	NT
Mammal	rat (*Rattus norvegicus*)	Hammond et al. 1990	DR	2
Mammal	shrew, vole (*Sorex araneus, Microtus pennsylvanicus*)	Ma 1989	SDC	NT
Mammal	rat (*Rattus norvegicus*)	Overmann 1977	UN	NT
Mammal	rat (*Rattus norvegicus*)	Reiter et al. 1975	UN	NT
Mammal	horse (*Equus caballus*)	Willoughby et al. 1972	SDC	NT
Mammal	mouse (*Mus musculus*)	Wise 1981	FD	2
Mammal	rat (*Rattus norvegicus*)	Zenick et al. 1979[a]	UN	NT
Reproduction				
Mammal	mink (*Mustela vision*)	Bursian et al 2013	SDC	NT
Mammal	mouse (*Mus musculus*)	Iavicoli et al. 2006	UN	NT
Mammal	mouse (*Mus musculus*)	Odenbro and Kihlstrom 1977	ENR	NT
Survival				
Bird	common tern (*Sterna hirundo*)	Burger and Gochfeld 1988	INJ	NT
Manganese				
Growth				
Mammal	rat (*Rattus norvegicus*)	Dorman et al. 2000	UN	NT
Mammal	rat (*Rattus norvegicus*)	Foster et al. 2015	UN	NT
Mammal	rat, mouse (*Rattus norvegicus, Mus musculus*)	NTP 1993	FD	1
Mammal	mink (*Mustela vision*)	Zhang et al. 2014	UN	NT
Reproduction				
Mammal	dog (*Canis lupus familiaris*)	Bao et al. 2014	UN	NT
Mammal	mouse (*Mus musculus*)	Gray and Laskey 1980	UN	NT
Survival				
Mammal	rat (*Rattus norvegicus*)	NTP 1993	FD	1

Table A-12. Wildlife TRV References Not Included in Eco-SSL Documents

Receptor	Test Organism	Reference	Information Used to Determine Tier	Tier
Zinc				
Growth				
Bird	chicken (*Gallus domesticus*)	Persia et al. 2004	UN	NT
Mammal	mouse (*Mus musculus*)	Aughey et al. 1977	UN	2
Mammal	pig (*Sus scrofa)*	Davin et al. 2013	UN, SDC	NT
Mammal	rat (*Rattus norvegicus*)	Khan et al. 2007	FD	1
Mammal	rat (*Rattus norvegicus*)	Llobet et al. 1988	DR	2
Mammal	ferret (*Mustela putorius furo)*	Straube et al. 1980	NDR	NT
Mammal	horse *(Equus caballus*)	Willoughby et al. 1972	SDC	NT
Reproduction				
Bird	duck (*Anas platyrhynchos*)	Chen et al. 2017	UN	NT
Bird	chicken (*Gallus domesticus*)	Stefanello et al. 2014	ENR	NT
Mammal	rat (*Rattus norvegicus*)	Khan et al. 2007	FD	1
Mammal	rat (*Rattus norvegicus*)	Sutton and Nelson 1937	SDC	NT
Survival				
Bird	chicken (*Gallus domesticus*)	Dozier et al. 2003	UN	NT
Mammal	ferret (*Mustela putorius furo)*	Straube et al. 1980	FD	1

Notes:

[a] Listed in ecological soil screening level (Eco-SSL) for different endpoint.

DR - drinking water exposure
ENR - endpoint not relevant
INJ - injection study
FD - dietary/food exposure
NT - no tier applied because study was not acceptable for toxicity reference value (TRV) derivation
NDR - no data reported in study
RU - ruminant study
SDC - study design concern
UN - unbounded no-observed-adverse-effect level (NOAEL)

Table A-13. Tier Determination and Results of Study Selection Process for Acceptable Cadmium Studies for Birds from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Ref No.	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection[a]	No. of Usable Datasets
Reproduction										
Leach et al. 1978[b]	398	chicken (*Gallus domesticus*)	2.37	NA	NA	no	1	1	T	2
Bokori et al. 1995	379	Japanese quail (*Coturnix japonica*)	7.65	NA	NA	no	1	2	T	1
White and Finley 1978	396	mallard (*Anas platyrhychos*)	21.1	NA	NA	no	1	3	T	1
Growth										
Hill 1979	397	chicken (*Gallus domesticus*)	3.44	yes	no	no	1	1	T	1
Hill 1974	92	chicken (*Gallus domesticus*)	3.44	yes	no	no	1	2	T	1
Hill 1990	8125	chicken (*Gallus domesticus*)	4.26	yes	no	no	1	na[c]	na	na
Bokori et al. 1996	375	chicken (*Gallus domesticus*)	4.66	yes	no	no	1	3	T	0
Bafundo et al. 1984	8500	chicken (*Gallus domesticus*)	4.80	yes	no	no	1	4	T	1
Hill 1974	1369	chicken (*Gallus domesticus*)	4.90	yes	no	no	1	5	T	1
Bokori et al. 1995	378	chicken (*Gallus domesticus*)	5.63	yes	no	no	1	6	A	1
Lefevre et al. 1982	392	chicken (*Gallus domesticus*)	7.08	yes	no	no	1	7	NR	NA
Pritzl et al. 1974	403	chicken (*Gallus domesticus*)	9.57	yes	no	no	1	8	NR	NA
Freeland and Cousins 1973	7011	chicken (*Gallus domesticus*)	9.75	yes	no	no	1	9	NR	NA
Richardson et al. 1974	371	Japanese quail (*Coturnix japonica*)	12.2	yes	no	no	1	10	S	1
Richardson and Fox 1974	402	Japanese quail (*Coturnix japonica*)	12.8	yes	no	no	1	11	P	1
Rama and Planas 1981	6468	chicken (*Gallus domesticus*)	13.0	yes	no	no	1	12	P	1
Hill 1980	395	chicken (*Gallus domesticus*)	13.8	yes	no	no	1	13	P	1
Spivey et al. 1971	7101	Japanese quail (*Coturnix japonica*)	14.7	yes	no	no	1	14	NR	NA
Fadil and Magid 1996	5265	chicken (*Gallus domesticus*)	1.05	yes	no	yes	2	15	NR	NA
Di Giulio and Scanlon 1984[d]	183	mallard (*Anas platyrhychos*)	37.6	no	no	no	2	16	S	1
Survival										
Hill 1974	1369	chicken (*Gallus domesticus*)	4.90	NA	NA	no	1	1	T	0
Pritzl et al. 1974	403	chicken (*Gallus domesticus*)	14.3	NA	NA	no	1	2	T	1
Bokori et al. 1995	379	Japanese quail (*Coturnix japonica*)	30.6	NA	NA	no	1	3	T	1
Bokori et al. 1995	378	chicken (*Gallus domesticus*)	44.6	NA	NA	no	1	4	T	1
Van Vleet et al. 1981	80	duck (*Anas* sp.)	66.9	NA	NA	no	1	5	T	1

Notes:

See ecological soil screening level (Eco-SSL) document (USEPA 2005a) for the full reference list for studies cited in this table.

[a] Study selection abbreviations are defined as follows: T = top five study based on tier and lowest-observed-adverse-effect level (LOAEL), A = additional studies reviewed if five datasets were not available from the top five studies, P = studies included for pooling with a comparable study, S = studies included for receptors not represented in the other studies reviewed, and NR = not reviewed because five usable datasets were available in higher

[b] As reported in the Eco-SSL. The correct publication year for this paper is 1979.

[c] The full citation for this paper was not presented in the Eco-SSL and the paper could not be found through an online search.

na - not available

NA - not applicable

NR - not reviewed

Table A-14. Tier Determination and Results of Study Selection Process for Acceptable Cadmium Studies for Mammals from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Ref No.	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifepan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection[a]	No. of Usable Datasets
Reproduction										
Whelton et al. 1988	625	mouse (*Mus musculus*)	0.661	NA	NA	no	1	1	T	1
Sawicka-Kapusta et al. 1994	694	mouse (*Mus musculus*)	2.28	NA	NA	no	1	2	T	2
Sutou et al. 1980	647	rat (*Rattus norvegicus*)	10.0	NA	NA	no	1	3	T	4
Machemer and Lorke 1981	560	rat (*Rattus norvegicus*)	18.4	NA	NA	no	1	4	T	1
Wardell et al. 1982	748	rat (*Rattus norvegicus*)	75	NA	NA	no	1	5	T	0
Pond and Walker 1975	3731	rat (*Rattus norvegicus*)	236	NA	NA	no	1	7	NR	NR
Webster 1978	824	mouse (*Mus musculus*)	1.42	NA	NA	yes	2	8	NR	NR
Schroeder and Mitchener 1971	66	mouse (*Mus musculus*)	1.45	NA	NA	yes	2	9	NR	NR
Hastings et al. 1978	571	rat (*Rattus norvegicus*)	2.14	NA	NA	yes	2	10	NR	NR
Steibert et al. 1984	543	rat (*Rattus norvegicus*)	3.93	NA	NA	yes	2	11	NR	NR
Ahokas et al. 1980	669	rat (*Rattus norvegicus*)	4.50	NA	NA	yes	2	12	NR	NR
Sorell and Braziano 1990	822	rat (*Rattus norvegicus*)	4.88	NA	NA	yes	2	13	NR	NR
Webster 1979	823	mouse (*Mus musculus*)	5.59	NA	NA	yes	2	14	NR	NR
Steibert et al. 1984	544	rat (*Rattus norvegicus*)	5.82	NA	NA	yes	2	15	NR	NR
Gupta et al. 1993	608	rat (*Rattus norvegicus*)	6.30	NA	NA	yes	2	16	NR	NR
Sasser et al. 1985	9321	rat (*Rattus norvegicus*)	10.0	NA	NA	yes	2	17	NR	NR
Webster 1988	525	mouse (*Mus musculus*)	15.6	NA	NA	yes	2	18	NR	NR
Growth										
Weigel et al. 1987	629	rat (*Rattus norvegicus*)	0.0744	yes	no	no	1	1	T	0
Merali and Singhal 1980	639	rat (*Rattus norvegicus*)	1.0	yes	no	no	1	2	T	0
Rastogi et al. 1977	753	rat (*Rattus norvegicus*)	1.0	yes	no	no	1	3	T	0
Cousins et al. 1977	670	rat (*Rattus norvegicus*)	1.34	yes	yes	no	1	4	T	0
Rajanna et al. 1984	637	rat (*Rattus norvegicus*)	1.97	yes	yes	no	1	5	T	0
Groten et al. 1991	615	rat (*Rattus norvegicus*)	3.01	yes	no	no	1	6	A	0
Wilson et al. 1940[b]	825	rat (*Rattus norvegicus*)	3.21	yes	no	no	1	7	A	1
Pond et al. 1973	583	pig (*Sus scrofa*)	3.88	yes	no	no	1	8	A	1
Baranski and Sitarek 1987	809	rat (*Rattus norvegicus*)	4.0	no	yes	no	1	9	A	1
Suzuki and Yoshida 1978	572	rat (*Rattus norvegicus*)	4.06	yes	no	no	1	10	A	0
Suzuki and Yoshida 1979	780	rat (*Rattus norvegicus*)	4.58	yes	no	no	1	11	A	2
Suzuki and Yoshida 1978	768	rat (*Rattus norvegicus*)	5.08	yes	no	no	1	12	A	0
Meyer et al. 1982	662	rat (*Rattus norvegicus*)	5.44	yes	no	no	1	13	NR	NR
Machemer and Lorke 1981	560	rat (*Rattus norvegicus*)	6.13	yes	no	no	1	14	NR	NR
Chetty et al. 1980	650	rat (*Rattus norvegicus*)	8.71	yes	no	no	1	15	NR	NR
Nakamura et al. 1983	638	rat (*Rattus norvegicus*)	9.54	yes	yes	no	1	16	NR	NR
Banis et al. 1969	3733	rat (*Rattus norvegicus*)	9.70	yes	no	no	1	17	NR	NR
Sutou, et al. 1980	443	rat (*Rattus norvegicus*)	10.0	yes	no	no	1	18	NR	NR
Banis et al. 1969	3733	rat (*Rattus norvegicus*)	10.4	yes	no	no	1	19	NR	NR
Yuyama 1982	710	rat (*Rattus norvegicus*)	10.6	yes	no	no	1	20	NR	NR
Cousins et al. 1973	502	pig (*Sus scrofa*)	12.1	yes	no	no	1	21	NR	NR
Eakin et al. 1980	659	rat (*Rattus norvegicus*)	13.2	yes	yes	no	1	22	NR	NR
Gustafson and Mercer 1984	551	rat (*Rattus norvegicus*)	15.2	yes	no	no	1	23	NR	NR
Mitsumori et al. 1998	591	rat (*Rattus norvegicus*)	15.4	yes	no	no	1	24	NR	NR
Suzuki and Yoshida 1977	574	rat (*Rattus norvegicus*)	20.7	yes	no	no	1	25	P	1
Zielinska-Psuja et al. 1979	569	rat (*Rattus norvegicus*)	54.0	yes	yes	no	1	26	NR	NR
Van Vleet et al. 1981	149	pig (*Sus scrofa*)	75.8	yes	no	no	1	27	NR	NR
Hamada et al. 1991	465	dog (*Canis familiaris*)	100	yes	no	no	1	28	S	1
Dodds-Smith et al. 1992	440	shrew (*Sorex araneus*)	103	yes	no	no	1	29	S	1
Weber and Reid 1969	677	mouse (*Mus musculus*)	571	yes	no	no	1	30	S	1
Ogoshi et al. 1989	720	rat (*Rattus norvegicus*)	1.16	yes	na	yes	2	31	NR	NR
Ahokas et al. 1980	669	rat (*Rattus norvegicus*)	1.57	yes	na	yes	2	32	NR	NR
Perry et al. 1977	3730	rat (*Rattus norvegicus*)	1.61	yes	na	yes	2	33	NR	NR
Steibert et al. 1984	544	rat (*Rattus norvegicus*)	5.82	yes	na	yes	2	34	NR	NR
Freundt and Irbahim 1990	2640	rat (*Rattus norvegicus*)	6.89	yes	na	yes	2	35	NR	NR
Yuhas et al. 1979	776	rat (*Rattus norvegicus*)	7.70	yes	na	yes	2	36	NR	NR
Lee et al. 1994	733	rat (*Rattus norvegicus*)	10.0	no	no	no	2	37	NR	NR
Kajikawa et al. 1981	667	rat (*Rattus norvegicus*)	14.7	yes	no	yes	2	38	NR	NR
Pond and Walker 1975	3731	rat (*Rattus norvegicus*)	16.8	no	no	no	2	39	NR	NR
Ogoshi et al. 1989	720	rat (*Rattus norvegicus*)	17.1	no	na	yes	2	40	NR	NR
Koller and Roan 1977	814	mouse (*Mus musculus*)	44.4	yes	na	yes	2	41	NR	NR
Exon et al. 1979	3847	mouse (*Mus musculus*)	85.9	yes	na	yes	2	42	NR	NR
Survival										
Swiergosz et al. 1998	506	bank vole (*Clethrionomys glareolus*)	4.99	NA	NA	no	1	1	T	1
Baranski and Sitarek 1987	809	rat (*Rattus norvegicus*)	40.0	NA	NA	no	1	2	T	1
Weber and Reid 1969	677	mouse (*Mus musculus*)	2160	NA	NA	no	1	3	T	1
Schroeder et al. 1963	14446	rat (*Rattus norvegicus*)	0.551	NA	NA	yes	2	4	T	2
Schroeder et al. 1964	14447	mouse (*Mus musculus*)	0.620	NA	NA	yes	2	5	T	1

Notes:

See ecological soil screening level (Eco-SSL) document (USEPA 2005a) for the full reference list for studies cited in this table.

[a] Study selection abbreviations are defined as follows: T = top five study based on tier and lowest-observed-adverse-effect level (LOAEL), A = additional studies reviewed if five datasets were not available from the top five studies, P = studies included for pooling with a comparable study, S = studies included for receptors not represented in the other studies reviewed, and NR = not reviewed because five usable datasets were available in higher ranked studies.

[b] As reported in the Eco-SSL. The correct publication year for this paper is 1941.

NA - not applicable

na - not available

NR - not reviewed

Table A-15. Tier Determination and Results of Study Selection Process for Acceptable Copper Studies for Birds from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Ref No.	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifepan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection[a]	No. of Usable Datasets
Reproduction										
Ankari et al. 1998	2006	chicken (*Gallus domesticus*)	12.1	NA	NA	no	1	1	T	0
Harms and Buresh 1986	2117	chicken (*Gallus domesticus*)	19.5	NA	NA	no	1	2	T	1
Stevenson and Jackson 1980	2293	chicken (*Gallus domesticus*)	22.6	NA	NA	no	1	3	T	1
Jackson and Stevenson 1981	2159	chicken (*Gallus domesticus*)	25.5	NA	NA	no	1	4	T	2
Stevenson et al. 1983	6170	chicken (*Gallus domesticus*)	28.0	NA	NA	no	1	5	T	2
Jackson et al. 1979	2160	chicken (*Gallus domesticus*)	29.9	NA	NA	no	1	6	P	3
Chiou et al. 1997	2050	chicken (*Gallus domesticus*)	40.6	NA	NA	no	1	7	P	1
Pearce et al. 1983	2294	chicken (*Gallus domesticus*)	45.0	NA	NA	no	1	8	P	1
Jackson 1977	2157	chicken (*Gallus domesticus*)	47.5	NA	NA	no	1	9	NR	NR
Stevenson and Jackson 1980	2292	chicken (*Gallus domesticus*)	54.4	NA	NA	no	1	10	P	1
Growth										
Kashani et al. 1986	2171	turkey (*Melagris gallopavo*)	4.68	yes	no	no	1	1	T	0
Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	14.3	yes	no	no	1	2	T	3
Jensen and Maurice 1978	2165	chicken (*Gallus domesticus*)	17.5	yes	no	no	1	3	T	1
Latymer and Coates 1981	2191	chicken (*Gallus domesticus*)	21.3	yes	no	no	1	4	T	1
Miles et al. 1998	2221	chicken (*Gallus domesticus*)	24.7	yes	no	no	1	5	T	2
Funk and Baker 1991	2099	chicken (*Gallus domesticus*)	25.8	yes	no	no	1	6	NR	NR
Robbins and Baker 1980	2266	chicken (*Gallus domesticus*)	26.4	yes	no	no	1	7	NR	NR
Chiou et al. 1999	2048	chicken (*Gallus domesticus*)	26.6	yes	no	no	1	8	NR	NR
Hill 1974	1369	chicken (*Gallus domesticus*)	28.7	yes	no	no	1	9	P	1
Smith 1969	2284	chicken (*Gallus domesticus*)	31.1	yes	no	no	1	10	P	0[b]
Christmas and Harms 1979	2052	turkey (*Melagris gallopavo*)	31.4	yes	no	no	1	11	NR	NR
Kassim and Suwanpradit 1996	2172	chicken (*Gallus domesticus*)	34.1	yes	no	no	1	12	NR	NR
Wang et al. 1987	2319	chicken (*Gallus domesticus*)	35.5	yes	no	no	1	13	P	1
Ekperigin and Vohra 1981	2084	chicken (*Gallus domesticus*)	35.5	yes	no	no	1	14	NR	NR
Jensen and Maurice 1978[c]	2166	chicken (*Gallus domesticus*)	37.1	yes	no	no	1	15	P	1
Ledoux et al. 1989	5812	chicken (*Gallus domesticus*)	40.4	yes	no	no	1	16	NR	NR
Robbins and Baker 1980	2267	chicken (*Gallus domesticus*)	42.7	yes	no	no	1	17	NR	NR
Ekperigin and Vohra 1981	6474	chicken (*Gallus domesticus*)	42.9	yes	no	no	1	18	NR	NR
Hill 1974	92	chicken (*Gallus domesticus*)	42.9	yes	no	no	1	19	NR	NR
Mehring et al. 1960	22	chicken (*Gallus domesticus*)	43.3	yes	no	no	1	20	NR	NR
Waibel et al. 1964	14405	turkey (*Melagris gallopavo*)	46.6	yes	no	no	1	21	NR	NR
Robbins and Baker 1980	2267	chicken (*Gallus domesticus*)	50.1	yes	no	no	1	22	NR	NR
Harms and Buresh 1986	2118	turkey (*Melagris gallopavo*)	51.9	yes	no	no	1	23	NR	NR
Robbins and Baker 1980	2266	chicken (*Gallus domesticus*)	55.2	yes	no	no	1	24	NR	NR
Vohra and Kratzer 1968	14404	turkey (*Melagris gallopavo*)	59.3	yes	no	no	1	25	NR	NR
Hill 1979	1370	chicken (*Gallus domesticus*)	85.9	yes	no	no	1	26	NR	NR
Jensen 1975	1403	chicken (*Gallus domesticus*)	92.9	yes	no	no	1	27	NR	NR
Hill 1980	395	chicken (*Gallus domesticus*)	138	yes	no	no	1	28	NR	NR
Stevenson and Jackson 1980	2293	chicken (*Gallus domesticus*)	22.6	no	no	no	2	29	NR	NR
Stevenson et al. 1983	6170	chicken (*Gallus domesticus*)	28.0	no	no	no	2	30	NR	NR
Jackson et al. 1979	2160	chicken (*Gallus domesticus*)	29.9	no	no	no	2	31	NR	NR
Jackson and Stevenson 1981	2159	chicken (*Gallus domesticus*)	30.7	no	yes	no	2	32	NR	NR
Jackson and Stevenson 1981	2158	chicken (*Gallus domesticus*)	30.7	no	yes	no	2	33	NR	NR
Jackson and Stevenson 1981	2159	chicken (*Gallus domesticus*)	31.0	no	no	no	2	34	NR	NR
Stevenson and Jackson 1980	2292	chicken (*Gallus domesticus*)	33.4	no	no	no	2	35	NR	NR
Stevenson and Jackson 1981	2291	chicken (*Gallus domesticus*)	35.2	no	no	no	2	36	NR	NR
Chiou et al. 1997	2050	chicken (*Gallus domesticus*)	35.3	no	no	no	2	37	NR	NR
Griminger 1977	2112	chicken (*Gallus domesticus*)	44.8	no	no	no	2	38	NR	NR
Jackson 1977	2157	chicken (*Gallus domesticus*)	55.9	no	no	no	2	39	NR	NR
Survival										
Poupoulis and Jensen 1976	2250	chicken (*Gallus domesticus*)	28.7	NA	NA	no	1	1	T	2
Mehring et al. 1960	22	chicken (*Gallus domesticus*)	43.3	NA	NA	no	1	2	T	1
Vohra and Kratzer 1968	14404	turkey (*Melagris gallopavo*)	120	NA	NA	no	1	3	T	1
Hill 1974	92	chicken (*Gallus domesticus*)	122	NA	NA	no	1	4	T	1
Van Vleet et al. 1981	80	duck (*Anas platyrhynchos*)	201	NA	NA	no	1	5	S	2

Notes:

See ecological soil screening level (Eco-SSL) document (USEPA 2007a) for the full reference list for studies cited in this table.

[a] Study selection abbreviations are defined as follows: T = top five study based on tier and lowest-observed-adverse-effect level (LOAEL), P = studies included for pooling with a comparable study, S = studies included for receptors not represented in the other studies reviewed, and NR = not reviewed because five usable datasets were available in higher ranked studies.

[b] Zero is based on using data as an individual study because there is no LOAEL ≥ 20, but data could still be used for pooling.

[c] As reported in the Eco-SSL. The correct publication year for this paper is 1979.

NA - not applicable

NR - not reviewed

Table A-16. Tier Determination and Results of Study Selection Process for Acceptable Copper Studies for Mammals from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Ref No.	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifepan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection[a]	No. of Usable Datasets
Reproduction										
Cromwell et al. 1993	2062	pig (*Sus scrofa*)	5.51	NA	NA	no	1	1	T	1
Aulerich et al. 1982	2013	mink (*Mustela vision*)	6.79	NA	NA	no	1	2	T	1
Lecyk 1980	2193	mouse (*Mus musculus*)	136	NA	NA	no	1	3	T	2
Growth										
Allcroft et al. 1961	14387	pig (*Sus scrofa*)	9.34	yes	no	no	1	1	T	1
Brandt 1983	2033	mink (*Mustela vision*)	19.6	yes	no	no	1	2	T	1
Boyden 1938	14653	rat (*Rattus norvegicus*)	23.5	yes	no	no	1	3	T	1
Edmonds and Baker 1986	2075	pig (*Sus scrofa*)	26.9	yes	no	no	1	4	T	0
Suttle and Mills 1966	3757	pig (*Sus scrofa*)	27.6	yes	no	no	1	5	T	1
Grobner et al. 1986	2113	rabbit (*Oryctolagus cuniculus*)	45.7	yes	no	no	1	6	A	0
Llewellyn et al. 1985	2203	rat (*Rattus norvegicus*)	106	yes	yes	no	1	7	A	1
Fuentealba et al. 2000	36364	rat (*Rattus norvegicus*)	122	yes	yes	no	1	8	NR	NR
NTP 1993a	2126	rat (*Rattus norvegicus*)	165	yes	no	no	1	9	NR	NR
Keen et al. 1982	11928	rat (*Rattus norvegicus*)	183	yes	no	no	1	10	NR	NR
Haywood 1985	2121	rat (*Rattus norvegicus*)	274	yes	yes	no	1	11	NR	NR
Haywood and Loughran 1985	2124	rat (*Rattus norvegicus*)	285	yes	no	no	1	12	NR	NR
NTP 1993a	2127	rat (*Rattus norvegicus*)	293	yes	yes	no	1	13	NR	NR
Pettersen et al. 2002	36374	mouse (*Mus musculus*)	988	yes	no	no	1	14	S	0
NTP 1993a	2127	rat (*Rattus norvegicus*)	1738	yes	no	no	1	15	NR	NR
NTP 1993a	2127	mouse (*Mus musculus*)	4670	yes	no	no	1	16	NR	NR
NTP 1993a	2127	mouse (*Mus musculus*)	47500	yes	no	no	1	17	NR	NR
Rana and Kumar 1980	2256	rat (*Rattus norvegicus*)	39.8	no	no	no	2	18	NR	NR
Kumar et al. 1987	2186	rat (*Rattus norvegicus*)	39.8	no	no	no	2	19	NR	NR
NTP 1993a	2126	rat (*Rattus norvegicus*)	51.6	yes	no	yes	2	20	NR	NR
Komulainen 1983	12079	rat (*Rattus norvegicus*)	64.0	yes	no	yes	2	21	NR	NR
NTP 1993a	2126	mouse (*Mus musculus*)	101	yes	no	yes	2	22	NR	NR
NTP 1993a	2127	rat (*Rattus norvegicus*)	400	yes	no	yes	2	23	NR	NR
NTP 1993a	2127	mouse (*Mus musculus*)	3395	yes	no	yes	2	24	NR	NR
Freundt and Ibrahim 1990	2640	rat (*Rattus norvegicus*)	5.78	no	yes	yes	2	25	NR	NR
Survival										
Ritchie et al. 1963	14402	pig (*Sus scrofa*)	8.08	NA	NA	no	1	1	T	1
Allcroft et al. 1961	14387	pig (*Sus scrofa*)	9.34	NA	NA	no	1	2	T	1
Brandt 1983	2033	mink (*Mustela vision*)	19.6	NA	NA	no	1	3	T	1
Boyden 1938	14653	rat (*Rattus norvegicus*)	35.0	NA	NA	no	1	4	T	1
Keen et al. 1982	11928	rat (*Rattus norvegicus*)	183	NA	NA	no	1	5	T	1
NTP 1993a	2127	rat (*Rattus norvegicus*)	400	NA	NA	yes	2	6	NR	NR
NTP 1993a	2126	mouse (*Mus musculus*)	101	NA	NA	yes	2	7	S	2
NTP 1993a	2126	rat (*Rattus norvegicus*)	111	NA	NA	yes	2	8	NR	NR
McNatt et al. 1971	2216	rat (*Rattus norvegicus*)	114	NA	NA	yes	2	9	NR	NR
NTP 1993a	2127	mouse (*Mus musculus*)	3395	NA	NA	yes	2	10	NR	NR

Notes:

See ecological soil screening level (Eco-SSL) document (USEPA 2007a) for the full reference list for studies cited in this table.

[a] Study selection abbreviations are defined as follows: T = top five study based on tier and lowest-observed-adverse-effect level (LOAEL), A = additional studies reviewed if five datasets were not available from the top five studies, S = studies included for receptors not represented in the other studies reviewed, and NR = not reviewed because five usable datasets were available in higher ranked studies.

NA - not applicable

NR - not reviewed

Table A-17. Tier Determination and Results of Study Selection Process for Acceptable Lead Studies for Birds from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Ref No.	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifepan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection[a]	No. of Usable Datasets
Reproduction										
Edens et al. 1976	2606	Japanese quail (*Coturnix japonica*)	0.110	NA	NA	no	1	1	T	3
Edens and Garlich 1983	2608	Japanese quail (*Coturnix japonica*)	0.194	NA	NA	no	1	2	T	3
Edens and Melvin 1989	2609	Japanese quail (*Coturnix japonica*)	93.1	NA	NA	no	1	3	T	1
Stone and Soares 1976	2898	Japanese quail (*Coturnix japonica*)	377	NA	NA	no	1	4	T	1
Growth										
Edens and Garlich 1983	2608	Japanese quail (*Coturnix japonica*)	15.6	yes	no	no	1	1	T	0
Donaldson and McGowan 1989	1285	chicken (*Gallus domesticus*)	38.2	yes	no	no	1	2	T	1
Latta and Donaldson 1986	2744	chicken (*Gallus domesticus*)	53.1	yes	no	no	1	3	T	1
Edens and Melvin 1989	2609	Japanese quail (*Coturnix japonica*)	59.3	yes	no	no	1	4	T	0
Damron et al. 1969	14768	chicken (*Gallus domesticus*)	61.4	yes	no	no	1	5	T	1
Morgan et al. 1975	2779	Japanese quail (*Coturnix japonica*)	67.4	yes	no	no	1	6	A	0
Leeming and Donaldson 1984	2748	chicken (*Gallus domesticus*)	76.3	yes	no	no	1	7	A	0
Edens et al. 1976	2606	Japanese quail (*Coturnix japonica*)	111	yes	no	no	1	8	A	1
Edens 1985	2605	Japanese quail (*Coturnix japonica*)	112	yes	no	no	1	9	A	0
Berg et al. 1980	2534	chicken (*Gallus domesticus*)	123	yes	no	no	1	10	A	3
Bafundo et al. 1984	2517	chicken (*Gallus domesticus*)	152	yes	no	no	1	11	NR	NR
Donaldson 1986	2600	chicken (*Gallus domesticus*)	163	yes	no	no	1	12	P	2
Khan et al. 1993	5507	chicken (*Gallus domesticus*)	200	yes	no	no	1	13	NR	NR
Cupo and Donaldson 1987	2579	chicken (*Gallus domesticus*)	262	yes	no	no	1	14	P	1
Berg et al. 1980	2534	chicken (*Gallus domesticus*)	270	yes	no	no	1	15	NR	NR
Franson and Custer 1982	2635	chicken (*Gallus domesticus*)	273	yes	no	no	1	16	P	1
Stone and Soares 1976	2898	Japanese quail (*Coturnix japonica*)	64.3	no	no	no	2	17	NR	NR
Survival										
Anders et al. 1982	2513	pigeon (*Columba livia*)	6.3	NA	NA	no	1	1	T	0
Barthalmus et al. 1977	2526	pigeon (*Columba livia*)	25.0	NA	NA	no	1	2	T	1
Cupo and Donaldson 1987	2579	chicken (*Gallus domesticus*)	194	NA	NA	no	1	3	T	0
Vengris and Mare 1974	14384	chicken (*Gallus domesticus*)	320	NA	NA	no	1	4	T	1
Khan et al. 1993	1415	chicken (*Gallus domesticus*)	400	NA	NA	no	1	5	T	0

Notes:

See ecological soil screening level (Eco-SSL) document (USEPA 2005b) for the full reference list for studies cited in this table.

[a] Study selection abbreviations are defined as follows: T = top five study based on tier and lowest-observed-adverse-effect level (LOAEL), A = additional studies reviewed if five datasets were not available from the top five studies, P = studies included for pooling with a comparable study, and NR = not reviewed because five usable datasets were available in higher ranked studies.

NA - not applicable

NR - not reviewed

Table A-18. Tier Determination and Results of Study Selection Process for Acceptable Lead Studies for Mammals from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Ref No.	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifespan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection[a]	No. of Usable Datasets
Reproduction										
Schroeder and Mitchener 1971	66	rat (*Rattus norvegicus*), mouse (Mus muscul	2.94	NA	NA	no[b]	1	1	T	0
Gupta et al. 1995	2666	mouse (*Mus musculus*)	5.50	NA	NA	no	1	2	T	1
Winneke et al. 1977	3935	rat (*Rattus norvegicus*)	49.6	NA	NA	no	1	3	T	2
Miller et al. 1982	2775	rat (*Rattus norvegicus*)	54.6	NA	NA	no	1	4	T	0
Wardell et al. 1982	748	rat (*Rattus norvegicus*)	150	NA	NA	no	1	5	T	0
Jacquet et al. 1997	2713	mouse (*Mus musculus*)	154	NA	NA	no	1	6	A	0
Mykkanen et al. 1980	2783	rat (*Rattus norvegicus*)	221	NA	NA	no	1	7	A	2
Hsu 1980	2704	rat (*Rattus norvegicus*)	222	NA	NA	no	1	8	NR	NR
Alfano and Petit 1982	2511	rat (*Rattus norvegicus*)	258	NA	NA	no	1	9	NR	NR
Maker et al. 1973	2758	mouse (*Mus musculus*)	506	NA	NA	no	1	10	NR	NR
Maker et al. 1973	2758	mouse (*Mus musculus*)	506	NA	NA	no	1	11	NR	NR
Jacquet 1977	2711	mouse (*Mus musculus*)	646	NA	NA	no	1	11	NR	NR
Holtzman et al. 1981	2698	rat (*Rattus norvegicus*)	828	NA	NA	no	1	12	NR	NR
Holtzman et al. 1978	2699	rat (*Rattus norvegicus*)	833	NA	NA	no	1	13	NR	NR
Barlow et al. 1977	2523	rat (*Rattus norvegicus*)	991	NA	NA	no	1	14	NR	NR
Barrett and Livesey 1983	10239	rat (*Rattus norvegicus*)	1500	NA	NA	no	1	15	NR	NR
McConnell and Berry 1979	2767	rat (*Rattus norvegicus*)	1770	NA	NA	no	1	15	NR	NR
Krigman et al. 1974	2741	rat (*Rattus norvegicus*)	2570	NA	NA	no	1	16	NR	NR
Goldstein et al. 1974	14824	rat (*Rattus norvegicus*)	2570	NA	NA	no	1	17	NR	NR
Holtzman et al. 1980	14827	rat (*Rattus norvegicus*)	2570	NA	NA	no	1	17	NR	NR
Pentschew and Garro 1966	2811	rat (*Rattus norvegicus*)	2840	NA	NA	no	1	18	NR	NR
Michaelson and Sauerhoff 1974	2774	rat (*Rattus norvegicus*)	6170	NA	NA	no	1	19	NR	NR
Dilts and Ahokas 1979	2593	rat (*Rattus norvegicus*)	5.00	NA	NA	yes	2	20	NR	NR
Grant et al. 1980	2658	rat (*Rattus norvegicus*)	6.0	NA	NA	yes	2	21	NR	NR
Dilts and Ahokas 1980	2592	rat (*Rattus norvegicus*)	10.0	NA	NA	yes	2	22	NR	NR
Gandley et al. 1999	2642	rat (*Rattus norvegicus*)	26.0	NA	NA	yes	2	23	NR	NR
Kimmel et al. 1980	2737	rat (*Rattus norvegicus*)	45.0	NA	NA	yes	2	24	NR	NR
Hayashi 1983	3864	rat (*Rattus norvegicus*)	55.5	NA	NA	yes	2	25	NR	NR
Donald et al. 1981	2598	mouse (*Mus musculus*)	78.6	NA	NA	yes	2	26	NR	NR
Donald et al. 1986	2599	mouse (*Mus musculus*)	99.8	NA	NA	yes	2	27	NR	NR
Winder et al. 1984	2934	rat (*Rattus norvegicus*)	111	NA	NA	yes	2	28	NR	NR
Talcott and Koller 1983	2906	mouse (*Mus musculus*)	137	NA	NA	yes	2	29	NR	NR
Cramer et al. 1980	14816	rat (*Rattus norvegicus*)	178	NA	NA	yes	2	30	NR	NR
Sokol et al. 1985	2888	rat (*Rattus norvegicus*)	198	NA	NA	yes	2	31	NR	NR
Hallen et al. 1995	2669	rat (*Rattus norvegicus*)	200	NA	NA	yes	2	32	NR	NR
Rabe et al. 1985	13216	rat (*Rattus norvegicus*)	218	NA	NA	yes	2	33	NR	NR
Ronis et al. 1998	2847	rat (*Rattus norvegicus*)	270	NA	NA	yes	2	34	NR	NR
Yu et al. 1996	3939	rat (*Rattus norvegicus*)	330	NA	NA	yes	2	35	NR	NR
Ronis et al. 1998	2845	rat (*Rattus norvegicus*)	360	NA	NA	yes	2	36	NR	NR
Ronis et al. 1998	2845	rat (*Rattus norvegicus*)	360	NA	NA	yes	2	40	NR	NR
Ronis et al. 1996	2846	rat (*Rattus norvegicus*)	362	NA	NA	yes	2	37	NR	NR
Pinon-Lataillade et al. 1995	2821	mouse (*Mus musculus*)	381	NA	NA	yes	2	38	NR	NR
Draski et al. 1989	3719	mouse (*Mus musculus*)	381	NA	NA	yes	2	39	NR	NR
Thoreux-Manlay et al. 1995	2909	rat (*Rattus norvegicus*)	420	NA	NA	yes	2	40	NR	NR
Donald et al. 1987	2597	mouse (*Mus musculus*)	437	NA	NA	yes	2	41	NR	NR

Table A-18. Tier Determination and Results of Study Selection Process for Acceptable Lead Studies for Mammals from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Ref No.	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifespan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection[a]	No. of Usable Datasets
Reproduction (continued)										
Cramer et al. 1980	14816	rat (*Rattus norvegicus*)	552	NA	NA	yes	2	42	NR	NR
Piasek et al. 1988	14751	rat (*Rattus norvegicus*)	635	NA	NA	yes	2	43	NR	NR
Selvin-Testa et al. 1997	2869	rat (*Rattus norvegicus*)	651	NA	NA	yes	2	44	NR	NR
Piasek and Kostial 1991	2818	rat (*Rattus norvegicus*)	750	NA	NA	yes	2	45	NR	NR
Epstein et al. 1991	2614	mouse (*Mus musculus*)	762	NA	NA	yes	2	46	NR	NR
Sharma and Kanwar 1985	2871	mouse (*Mus musculus*)	1990	NA	NA	yes	2	47	NR	NR
Sharma and Kanwar 1985	2871	mouse (*Mus musculus*)	3630	NA	NA	yes	2	52	NR	NR
Growth[c]										
Al-Omar et al. 2000	20974	mouse (*Mus musculus*)	46.4	yes	no	no	1	1	T	0
Lorenzo et al. 1978	2751	rabbit (*Oryctolagus cuniculus*)	50.4	yes	no	no	1	2	T	1
Kumar and Desiraju 1990	2870	rat (*Rattus norvegicus*)	100	yes	no	no	1	3	T	1
Hsu et al. 1975	14376	pig (*Sus scrofa*)	173	yes	yes	no	1	4	T	0
Harry et al. 1985	2680	rat (*Rattus norvegicus*)	200	yes	no	no	1	5	T	0
Toews et al. 1983	2911	rat (*Rattus norvegicus*)	400	yes	no	no	1	6	A	1
Mykkanen et al. 1980	2783	rat (*Rattus norvegicus*)	442	yes	no	no	1	7	A	0
Barlow et al. 1977	2523	rat (*Rattus norvegicus*)	991	yes	no	no	1	8	A	0
Maker et al. 1973	2758	mouse (*Mus musculus*)	1260	yes	no	no	1	9	A	0
Gerber et al. 1978	14822	rat (*Rattus norvegicus*)	1430	yes	no	no	1	10	A	1
Eyden et al. 1978	2618	mouse (*Mus musculus*)	1360	no	no	no	2	11	NR	NR
Holtzman et al. 1981	2698	rat (*Rattus norvegicus*)	2390	no	no	no	2	12	NR	NR
Holtzman et al. 1980	14827	rat (*Rattus norvegicus*)	2650	no	no	no	2	13	NR	NR
Barratt et al. 1989	2524	rat (*Rattus norvegicus*)	180	no	no	no	2	14	NR	NR
Lessler and Wright 1976	2750	rat (*Rattus norvegicus*)	272	no	no	no	2	15	NR	NR
Schroeder et al. 1970	252	rat (*Rattus norvegicus*)	3.30	yes	no	yes	2	16	NR	NR
Dilts and Ahokas 1979	2593	rat (*Rattus norvegicus*)	5.00	yes	no	yes	2	17	NR	NR
Kimmel et al. 1980	2737	rat (*Rattus norvegicus*)	8.90	yes	no	yes	2	18	NR	NR
Zheng et al. 1996	2944	rat (*Rattus norvegicus*)	28.2	yes	no	yes	2	19	NR	NR
Hammond et al. 1989	2675	rat (*Rattus norvegicus*)	29.0	yes	no	yes	2	20	NR	NR
Hamilton et al. 1994	2671	rat (*Rattus norvegicus*)	29.0	yes	no	yes	2	21	NR	NR
Hammond and Succop 1995	2678	rat (*Rattus norvegicus*)	29.0	yes	no	yes	2	22	NR	NR
Hammond et al. 1993	2677	rat (*Rattus norvegicus*)	29.5	yes	no	yes	2	23	NR	NR
Minnema and Hammond 1994	2776	rat (*Rattus norvegicus*)	30.4	yes	no	yes	2	24	NR	NR
Gerber et al. 1978	14822	mouse (*Mus musculus*)	163	yes	no	yes	2	25	NR	NR
Wolfe et al. 1996	2502	rat (*Rattus norvegicus*)	178	no	no	yes	2	26	NR	NR
Goyer et al. 1970	14799	rat (*Rattus norvegicus*)	383	yes	no	yes	2	27	NR	NR
Sokol 1989	2887	rat (*Rattus norvegicus*)	354	yes	no	yes	2	28	NR	NR
Ronis et al. 1996	2846	rat (*Rattus norvegicus*)	371	yes	no	yes	2	29	NR	NR
Wadi and Ahmad 1999	2924	mouse (*Mus musculus*)	373	yes	no	yes	2	30	NR	NR
Rasile et al. 1995	2836	mouse (*Mus musculus*)	404	yes	no	yes	2	31	NR	NR
Sokol et al. 1985	2888	rat (*Rattus norvegicus*)	508	yes	no	yes	2	32	NR	NR
Gruber et al. 1997	2660	rat (*Rattus norvegicus*)	532	yes	yes	yes	2	33	NR	NR
Piasek et al. 1988	14751	rat (*Rattus norvegicus*)	638	no	no	yes	2	34	NR	NR
Gulati et al. 1985	2837	mouse (*Mus musculus*)	748	no	no	yes	2	35	NR	NR

Table A-18. Tier Determination and Results of Study Selection Process for Acceptable Lead Studies for Mammals from the Eco-SSL Document

Reference	Ref No.	Test Organism	LOAEL Dose (mg/kg bw/day)	Results of Study Selection Process: Critical Lifestage?	Length of Study > 10% of Species Lifespan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection[a]	No. of Usable Datasets
Survival										
Junaid et al. 1997	2725	mouse (*Mus musculus*)	8.00	NA	NA	no	1	1	T	1
Lorenzo et al. 1978	2751	rabbit (*Oryctolagus cuniculus*)	50.4	NA	NA	no	1	2	T	1
Pankakoski et al. 1994	2807	shrew (*Sorex araneus*)	61.5	NA	NA	no	1	3	T	1
Press 1975[d]	2827	rat (*Rattus norvegicus*)	328	NA	NA	no	1	4	T	1
Kumar and Desiraju 1990	2870	rat (*Rattus norvegicus*)	400	NA	NA	no	1	5	T	1
Holtzman et al. 1982	2697	rat (*Rattus norvegicus*)	400	NA	NA	no	1	6	NR	NR
Eyden et al. 1978	2618	mouse (*Mus musculus*)	635	NA	NA	no	1	7	NR	NR
Holtzman et al. 1982	2697	rat (*Rattus norvegicus*)	800	NA	NA	no	1	8	NR	NR
Holtzman et al. 1982	2697	rat (*Rattus norvegicus*)	800	NA	NA	no	1	9	NR	NR
Holtzman et al. 1982	2697	rat (*Rattus norvegicus*)	2400	NA	NA	no	1	10	NR	NR
Kanisawa and Schroeder 1969	3701	rat (*Rattus norvegicus*)	0.569	NA	NA	yes	2	11	NR	NR
Schroeder et al. 1963	14446	rat (*Rattus norvegicus*)	2.87	NA	NA	yes	2	12	NR	NR
Schroeder et al. 1964	14447	mouse (*Mus musculus*)	3.10	NA	NA	yes	2	13	NR	NR
Gulati et al. 1985	2837	mouse (*Mus musculus*)	670	NA	NA	yes	2	14	NR	NR
Lamb et al. 1997	2505	mouse (*Mus musculus*)	670	NA	NA	yes	2	15	NR	NR

Notes:

See ecological soil screening level (Eco-SSL) document (USEPA 2005b) for the full reference list for studies cited in this table.

[a] Study selection abbreviations are defined as follows: T = top five study based on tier and lowest-observed-adverse-effect level (LOAEL), A = additional studies reviewed if five datasets were not available from the top five studies, and NR = not reviewed because five usable datasets were available in higher ranked studies.

[b] The Eco-SSL reported drinking water exposure for this study. The actual exposure method was diet and drinking water so the study was classified as Tier 1.

[c] Four usable growth datasets were available from the ten Tier 1 studies reviewed. Because of the large number of Tier 1 studies reviewed for growth, Tier 2 studies were not included.

[d] As reported in the Eco-SSL. The correct publication year for this paper is 1977.

NA - not applicable

NR - not reviewed

Table A-19. Tier Determination and Results of Study Selection Process for Acceptable Manganese Studies for Birds from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Ref No.	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifepan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection[a]	No. of Usable Datasets
Growth										
Southern and Baker 1983	6363	chicken (*Gallus domesticus*)	348	yes	no	no	1	1	T	0
Vohra and Kratzer 1968	14404	turkey (*Meleagris gallopavo*)	356	yes	no	no	1	2	T	0
Martinez and Diaz 1996	5345	chicken (*Gallus domesticus*)	431	yes	no	no	1	3	T	0

Notes:

See ecological soil screening level (Eco-SSL) document (USEPA 2007b) for the full reference list for studies cited in this table.

[a] T = top five study based on tier and lowest-observed-adverse-effect level (LOAEL)

Table A-20. Tier Determination and Results of Study Selection Process for Acceptable Manganese Studies for Mammals from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Ref No.	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifepan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection[a]	No. of Usable Datasets
Reproduction										
Laskey et al. 1982[b]	56	Rat (*Rattus norvegicus*)		NA	NA	no	1	1	T	1
Kontur and Fechter 1985	34752	rat (*Rattus norvegicus*)	415	NA	NA	yes	2	2	T	0
Pappas et al. 1997	33496	rat (*Rattus norvegicus*)	620	NA	NA	yes	2	3	T	1
Leung et al. 1982	34895	rat (*Rattus norvegicus*)	2139	NA	NA	yes	2	4	T	1
Growth										
Rehnberg et al. 1980	57	rat (*Rattus norvegicus*)	71.0	yes	no	no	1	1	T	1
Komura and Sakamoto 1991	33786	mouse (*Mus musculus*)	284	yes	no	no	1	2	T	0
Lipe et al. 1999	33403	rat (*Rattus norvegicus*)	10.0	no	no	no	2	3	T	0
Kontur and Fechter 1985	34752	rat (*Rattus norvegicus*)	271	no	no	yes	2	4	T	0
Survival										
Rehnberg et al. 1980	57	rat (*Rattus norvegicus*)	71.0	NA	NA	no	1	1	T	1

Notes:

Blank cells are shown as reported in the ecological soil screening level (Eco-SSL) document; no description was provided.

See Eco-SSL document (USEPA 2007b) for the full reference list for studies cited in this table.

[a] T = top five study based on tier and lowest-observed-adverse-effect level (LOAEL)

[b] No LOAEL was reported in the Eco-SSL for this study. Paper was reviewed and found to have an effect.

NA - not applicable

Table A-21. Tier Determination and Results of Study Selection Process for Acceptable Zinc Studies for Birds from the Eco-SSL Document

Reference	Ref No.	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	> 10% of Species Lifepan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection[a]	No. of Usable Datasets
Reproduction										
Gibson et al. 1986	6048	chicken (*Gallus domesticus*)	66.5	NA	NA	no	1	1	T	2
Stevenson et al. 1987	8184	chicken (*Gallus domesticus*)	76.7	NA	NA	no	1	2	T	1
Jackson et al. 1986	6133	chicken (*Gallus domesticus*)	88	NA	NA	no	1	3	T	2
Jensen and Maurice 1980	9749	chicken (*Gallus domesticus*)	98.8	NA	NA	no	1	4	T	2
Stepinska et al. 1987	5770	chicken (*Gallus domesticus*)	205	NA	NA	no	1	5	T	1
Growth										
Stahl et al. 1989	5820	chicken (*Gallus domesticus*)	31.0	yes	no	no	1	1	T	1
Lu and Combs 1988	5866	chicken (*Gallus domesticus*)	39.0	yes	no	no	1	2	T	1
Lu et al. 1990	8008	chicken (*Gallus domesticus*)	65.7	yes	no	no	1	3	T	1
Hamilton et al. 1981	6403	Japanese quail (*Coturnix japonica*)	86.6	yes	no	no	1	4	T	0
Sandoval et al. 1998	7245	chicken (*Gallus domesticus*)	106	yes	no	no	1	5	T	2
Berg and Martinson 1972	93	chicken (*Gallus domesticus*)	111	yes	no	no	1	6	NR	NR
Roberson and Schaible 1960	14538	chicken (*Gallus domesticus*)	111	yes	no	no	1	7	P	4
Gasaway and Buss 1972	9261	mallard duck (*Anas platyrhynchos*)	126	yes	no	no	1	8	S	1
Pimentel et al. 1992	5617	chicken (*Gallus domesticus*)	132	yes	no	no	1	9	NR	NR
Dewar et al. 1983	37018	chicken (*Gallus domesticus*)	143	yes	no	no	1	10	NR	NR
Hill 1974	92	chicken (*Gallus domesticus*)	172	yes	no	no	1	11	P	1
Hamilton et al. 1979	6655	Japanese quail (*Coturnix japonica*)	174	yes	no	no	1	12	NR	NR
Henry et al. 1987	6039	chicken (*Gallus domesticus*)	185	yes	no	no	1	13	NR	NR
Bafundo et al. 1984	6273	chicken (*Gallus domesticus*)	190	yes	no	no	1	14	NR	NR
Vohra and Kratzer 1968	14404	turkey (*Meleagris gallopavo*)	297	yes	no	no	1	15	S	1
Bartov 1996	5373	chicken (*Gallus domesticus*)	315	yes	no	no	1	16	NR	NR
Southern and Baker 1983	6368	chicken (*Gallus domesticus*)	354	yes	no	no	1	17	NR	NR
Rama and Planas 1981	6435	chicken (*Gallus domesticus*)	433	yes	no	no	1	18	NR	NR
Oh et al. 1979	6627	chicken (*Gallus domesticus*)	503	yes	no	no	1	19	NR	NR
Dean et al. 1991	5681	chicken (*Gallus domesticus*)	757	yes	no	no	1	20	NR	NR
Bartov et al. 1994	7956	chicken (*Gallus domesticus*)	914	yes	no	no	1	21	NR	NR
Jackson et al. 1986	6133	chicken (*Gallus domesticus*)	88	no	no	no	2	22	NR	NR
Jensen and Maurice 1980	9749	chicken (*Gallus domesticus*)	101	no	no	no	2	23	NR	NR
Gibson et al. 1986	6048	chicken (*Gallus domesticus*)	145	no	no	no	2	24	NR	NR
Stevenson et al. 1987	8184	chicken (*Gallus domesticus*)	149	no	no	no	2	25	NR	NR
Bafundo et al. 1984	2517	chicken (*Gallus domesticus*)	284	no	no	no	2	26	NR	NR
Palafox and Ho-A 1980	6545	chicken (*Gallus domesticus*)	988	no	no	no	2	27	NR	NR
Survival										
Gibson et al. 1986	6048	chicken (*Gallus domesticus*)	87.1	NA	NA	no	1	1	T	1
Gasaway and Buss 1972	9261	mallard duck (*Anas platyrhynchos*)	126	NA	NA	no	1	2	T	1
Blalock and Hill 1988	5868	chicken (*Gallus domesticus*)	219	NA	NA	no	1	3	T	1
Roberson and Schaible 1960	14538	chicken (*Gallus domesticus*)	239	NA	NA	no	1	4	T	1
Dewar et al. 1983	37018	chicken (*Gallus domesticus*)	286	NA	NA	no	1	5	T	2
Hamilton et al. 1979	6655	Japanese quail (*Coturnix japonica*)	366	NA	NA	no	1	6	S	1
Van Vleet et al. 1981	80	duck (*Anas platyrhynchos*)	401	NA	NA	no	1	7	NR	NR
Oh et al. 1979	6627	chicken (*Gallus domesticus*)	503	NA	NA	no	1	8	NR	NR

Notes:

See ecological soil screening level (Eco-SSL) document (USEPA 2007c) for the full reference list for studies cited in this table.

[a] Study selection abbreviations are defined as follows: T = top five study based on tier and lowest-observed-adverse-effect level (LOAEL), P = studies included for pooling with a comparable study, S = studies included for receptors not represented in the other studies reviewed, and NR = not reviewed because five usable datasets were available in higher ranked studies.

NA - not applicable

NR - not reviewed

Table A-22. Tier Determination and Results of Study Selection Process for Acceptable Zinc Studies for Mammals from the Eco-SSL Document

Reference	Ref No.	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifepan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection[a]	No. of Usable Datasets
Reproduction										
Kumar 1976	43587	rat (*Rattus norvegicus*)	12.2	NA	NA	no	1	1	T	0
Barone et al. 1998	21042	rat (*Rattus norvegicus*)	81.1	NA	NA	no	1	2	T	0
Newman et al. 2002	48540	rat (*Rattus norvegicus*)	232	NA	NA	no	1	3	T	1
Pal and Pal 1987	14664	rat (*Rattus norvegicus*)	326	NA	NA	no	1	4	T	1
Chu and Cox 1972	42670	rat (*Rattus norvegicus*)	326	NA	NA	no	1	5	T	1
Cox et al. 1969	42838	rat (*Rattus norvegicus*)	353	NA	NA	no	1	6	A	0
Schlicker and Cox 1968	25	rat (*Rattus norvegicus*)	424	NA	NA	no	1	7	A	4
Ketcheson et al. 1969	37837	rat (*Rattus norvegicus*)	452	NA	NA	no	1	8	NR	NR
Growth										
Nakamura et al. 1983	638	rat (*Rattus norvegicus*)	8.71	yes	yes	no	1	1	T	0
Subramanian et al. 2000	21011	rat (*Rattus norvegicus*)	28.2	yes	no	no	1	2	T	0
Barone et al. 1998	21042	rat (*Rattus norvegicus*)	81.1	yes	no	no	1	3	T	0
Brink et al. 1959	14525	pig (*Sus scrofa*)	87.1	yes	no	no	1	4	T	3
Hsu et al. 1975	14376	pig (*Sus scrofa*)	89.1	yes	yes	no	1	5	T	0
Hill et al. 1983	45143	pig (*Sus scrofa*)	103	yes	yes	no	1	6	A	1
Schlicker and Cox 1968	25	rat (*Rattus norvegicus*)	424	yes	no	no	1	7	A	0
Settlemire and Matrone 1967	38015	rat (*Rattus norvegicus*)	667	yes	no	no	1	8	A	1
Ogiso et al. 1974	42961	rat (*Rattus norvegicus*)	956	yes	no	no	1	9	NR	NR
Scott and Magee 1979	43264	rat (*Rattus norvegicus*)	968	yes	no	no	1	10	NR	NR
Maita et al. 1981	43680	rat (*Rattus norvegicus*)	2514	yes	yes	no	1	11	NR	NR
Pettersen et al. 2002	36374	mouse (*Mus musculus*)	2838	yes	no	no	1	12	S	0
Maita et al. 1981	43680	mouse (*Mus musculus*)	4878	yes	yes	no	1	13	S	1
Survival										
Brink et al. 1959	14525	pig (*Sus scrofa*)	87.1	NA	NA	no	1	1	T	3

Notes:

See ecological soil screening level (Eco-SSL) document (USEPA 2007c) for the full reference list for studies cited in this table.

[a] Study selection abbreviations are defined as follows: T = top five study based on tier and lowest-observed-adverse-effect level (LOAEL), A = additional studies reviewed if five datasets were not available from the top five studies, S = studies included for receptors not represented in the other studies reviewed, and NR = not reviewed because five usable datasets were available in higher ranked studies.

NA - not applicable

NR - not reviewed

Table A-23. Number of LOAELs in Eco-SSL Documents Less than the Selected UCR TRVs

							Number of Eco-SSL LOAELs < Selected TRV[a]														
							Acceptable Datasets Reviewed Based on Tiered Process							Acceptable Datasets Not Reviewed Based on Tiered Process[b]		Unacceptable Datasets					
Chemical	Receptor	Endpoint	Selected TRV	Total No. of LOAELs	Total No. LOAELs < Selected TRV	% LOAELs < Selected TRV	Tier 2 Study	Different Body Weight and Food Ingestion Rate Used	Effect Not <80% Relative to the Control	ED20 Calculated	Part of Pooled Dataset	No LOAEL Based on Study Review	Dose Converted from Weight of Salt to Weight of Metal	Tier 2 Study	Based on LOAEL Ranking	Endpoint not Relevant	Ruminant Study	NOAEL	Concerns with Study Design	Insufficient Data	Study Could Not Be Obtained
Cadmium	Birds	Growth	2.0	18	1	6%	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium	Birds	Reproduction	2.3	9	0	0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium	Birds	Survival	7.4	5	1	20%	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Copper	Birds	Growth	62	70	62	89%	0	5	16	0	0	0	0	8	26	0	0	2	1	1	3
Copper	Birds	Reproduction	28	20	6	30%	0	2	1	0	1	0	0	0	0	2	0	0	0	0	0
Copper	Birds	Survival	67	13	7	54%	0	2	2	1	0	0	0	0	0	0	0	0	1	0	1
Lead	Birds	Growth	29	22	1	5%	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Lead	Birds	Reproduction	4.7	11	6	55%	0	0	4	0	1	0	0	0	0	1	0	0	0	0	0
Lead	Birds	Survival	11	6	1	17%	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Manganese	Birds	Growth	no TRV	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	Birds	Reproduction	no TRV	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	Birds	Survival	no TRV	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	Birds	Growth	66	39	4	10%	0	1	0	0	2	0	0	0	0	0	0	0	1	0	0
Zinc	Birds	Reproduction	77	13	3	23%	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0
Zinc	Birds	Survival	250	10	4	40%	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0
Cadmium	Mammals	Growth	4.2	52	17	33%	0	1	8	1	0	0	0	3	0	2	1	1	0	0	0
Cadmium	Mammals	Reproduction	2.7	23	6	26%	0	0	2	0	0	0	0	3	0	1	0	0	0	0	0
Cadmium	Mammals	Survival	1.5	6	2	33%	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copper	Mammals	Growth	12	31	5	16%	0	0	0	1	0	0	0	1	0	0	2	1	0	0	0
Copper	Mammals	Reproduction	27	5	2	40%	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Copper	Mammals	Survival	8.7	15	3	20%	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0
Lead	Mammals	Growth	20	51	5	10%	0	0	0	0	0	0	0	4	0	0	1	0	0	0	0
Lead	Mammals	Reproduction	4.7	80	4	5%	0	0	2	0	0	0	0	0	0	1	0	1	0	0	0
Lead	Mammals	Survival	7.6	20	4	20%	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0
Manganese	Mammals	Growth	71	9	2	22%	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Manganese	Mammals	Reproduction	310	6	3	50%	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Manganese	Mammals	Survival	91	1	1	100%	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Zinc	Mammals	Growth	75	16	3	19%	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0
Zinc	Mammals	Reproduction	75	13	1	8%	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Zinc	Mammals	Survival	190	4	3	75%	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0

Notes:

[a] There may be more than one reason why a lowest observed adverse effect level (LOAEL) is less than the selected toxicity reference value (TRV). In such cases the primary reason is shown (e.g., the body weight and food ingestion rate may be different, but the primary reason is that the effect at the LOAEL selected in the Eco-SSL document is not <80% relative to the control).

[b] See Section 3.3 of the main document for a desciption of the process by which studies were selected for review.

Eco-SSL - ecological soil screening level
ED20 - dose that causes a 20 percent effect
NA - not applicable
NOAEL - no observed apparent effect level

APPENDIX A-2

REFERENCES

NOTE:

See Eco-SSL document (USEPA 2007c) for the full reference list for studies in all tables in this appendix except Table A-12.

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APPENDIX B

DATA EXTRACTED FROM TOXICOLOGICAL STUDY REVIEWS

This appendix presents data extracted from acceptable papers reviewed for use in the derivation of wildlife toxicity reference values (TRVs) for cadmium, copper, lead, manganese, and zinc for use in the Upper Columbia River baseline ecological risk assessment. Tables B-2, B-4, B-6, B-8, and B-10 present bird data for each of the five metals, respectively, and Tables B-3, B-5, B-7, B-9, and B-11 present mammal data for each of the five metals respectively.

The following information and data in the tables were extracted directly from each of the papers:

- Chemical form
- Receptor
- Lifestage
- Endpoint
- Exposure mode (i.e., food, gavage, or drinking water)
- Exposure duration
- Dose in mg/kg bw/day, if provided in the paper
- Concentration in food in mg/kg, if provided in the paper[1]
- Effect (e.g., final body weight, percent of animals surviving)

If body-weight-normalized daily doses were not provided in the paper, then the doses were calculated using the following equation, as indicated in column labeled “Dose Notes”:

Dose = (C x IR) / BW Equation 1

Where:

Dose = daily dose of chemical expressed in mg/kg bw/day

C = concentration of chemical in food in mg/kg (dry weight or wet weight)[2] or drinking water in mg/L

BW = body weight in kg

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[1] Concentrations of the target chemical in the basal diet were included, when reported. For example, if the concentration of the target chemical in the basal diet was 10 mg/kg, and the amount added to the feed was 100 mg/kg, the amount of chemical in the food was considered to be 110 mg/kg. In cases where the chemical concentration was reported based on the weight of the compound (e.g., cadmium chloride), the weight was converted to that of the element alone (e.g., cadmium) using the molecular weights of the components.

[2] The majority of studies used formulated feed as the diet for the laboratory organism; therefore, reported food concentrations were assumed to be based on dry weight unless otherwise noted in the study report.

IR = food ingestion rate in kg/day (dry weight or wet weight)[3] or drinking water ingestion rate in L/day

If a receptor's body weight and/or food or drinking water ingestion rate were not provided in the paper, the source is indicated in column labeled "BW Source" and/or column labeled "IR Source." The effect relative to the control was calculated using the data in the "Effect" columns as the effect at each dose relative to the effect at the control level. The reported lowest-observed-adverse-effect level (LOAEL) in column B is the dose for the lowest effect that was statistically significant as reported in the study. The LOAEL ≥ 20 is the lowest effect with a response that was at least 20% different from the control, as calculated in the "Effect Relative to Control (%)" columns.

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[3] The wet or dry weight basis of the IR used in Equation 1 needed to match the basis of the concentration in ingested media (C).

APPENDIX B-1

TABLES

Table B-1. Acronyms, Abbreviations, and Units of Measure

Acronym/Abbreviation	Definition
BW	body weight
DW	drinking water
ED20	modeled concentration resulting in a 20% effect relative to the control
Exp.	experiment
FD	food (diet)
FIR	food ingestion rate
GV	gavage
LOAEL	lowest-observed-adverse-effect level
LOAEL ≥ 20	LOAEL representing a ≥ 20 percent reduction in the response compared to the control
NA	not applicable
no stats	statistical analyses not reported
NR	not reported
-	no data
Unit of Measure	**Definition**
dw	dry weight
g	gram(s)
kg	kilogram(s)
kg/day	kilogram(s) per day
L/day	liter(s) per day
lbs	pounds
mg/kg	milligram(s) per kilogram
mg/kg bw/day	milligram per kilogram of body weight per day
ww	wet weight

Table B-2. Cadmium TRV Data for Birds

Source	Reported LOAEL[a]	LOAEL ≥ 20	Chemical form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Dose (mg/kg bw/day) Control	1	2	3	4	5	Notes
Growth															
Bafundo et al. 1984	no stats	5	cadmium chloride	chicken	1 week	body weight gain	FD	2.0	0	5.03	-	-	-	-	calculated from BW and FIR
Bokori et al. 1995b	no stats	19	cadmium sulfate	chicken	21 days	body weight	FD	4.0	0	4.74	18.9	37.9	-	-	calculated from BW and FIR
Bokori et al. 1996	no stats	NA	cadmium sulfate	chicken	chick to adult	body weight	FD	39.0	0	1.57	4.7	-	-	-	calculated from BW and FIR
Di Giulio and Scanlon 1984	54	54	cadmium chloride	mallard	11 months	body weight	FD	6.0	0	5.99	18	53.9	-	-	calculated from BW and FIR
Hill 1974a	5.1	7.7	cadmium sulfate	chicken	1 day	body weight gain	FD	2.0	0	2.57	5.14	7.7	10.3	12.8	calculated from BW and FIR
Hill 1974b	7.3	7.3	cadmium sulfate	chicken	1 day	body weight gain	FD	2.0	0	7.32	-	-	-	-	calculated from BW and FIR
Hill 1979	no stats	5.1	cadmium sulfate	chicken	1 day	body weight gain	FD	2.0	0	2.57	5.14	7.7	-	-	calculated from BW and FIR
Hill 1980	13	13	cadmium sulfate	chicken	1 day	body weight gain	FD	2.0	0	12.8	-	-	-	-	calculated from BW and FIR
Olgun 2015	no stats	5.3	cadmium sulfate	Japanese quail	21 weeks	body weight	FD	10.0	0.0421	0.7	1.36	2.67	5.31	10.6	calculated from BW and FIR
Richardson and Fox 1974	12	12	cadmium chloride	Japanese quail	1 day	body weight	FD	4.0	0	12.5	-	-	-	-	calculated from BW and FIR
Rama and Planas 1981	no stats	10	cadmium sulfate	chicken	1 day	body weight gain	FD	9.0	0.0963	9.72	-	-	-	-	calculated from BW and FIR
Richardson et al. 1974	12	12	cadmium chloride	Japanese quail	1 day	body weight	FD	4.0	0	12.3	-	-	-	-	calculated from BW and FIR
Richardson et al. 1974	11	NA	cadmium chloride	Japanese quail	1 day	body weight	FD	6.0	0	10.6	-	-	-	-	calculated from BW and FIR
Reproduction															
Bokori et al. 1995b	no stats	9.4	cadmium sulfate	Japanese quail	adult	egg production	FD	5.3	0	9.36	18.7	37.4	-	-	calculated from BW and FIR
Leach et al. 1979	3.8	3.8	cadmium sulfate	chicken	adult	egg production	FD	48.0	0.0171	0.251	0.953	3.76	-	-	calculated from BW and FIR
Leach et al. 1979	0.24	3.7	cadmium sulfate	chicken	adult	egg production	FD	12.0	0.0055	0.239	0.941	3.75	-	-	calculated from BW and FIR
Olgun 2015	no stats	5.3	cadmium sulfate	Japanese quail	22 weeks	egg production	FD	10.0	0.0421	0.7	1.36	2.67	5.31	10.6	calculated from BW and FIR
White and Finley 1978	20	20	cadmium chloride	mallard	adult	egg production	FD	4.3 - 12.8	0.0076	0.153	1.45	20	-	-	calculated from BW and FIR
Survival															
Bokori et al. 1995b	no stats	9.4	cadmium sulfate	Japanese quail	adult	survival	FD	5.3	0	9.36	18.7	37.4	0	0	calculated from BW and FIR
Bokori et al. 1995a	no stats	38	cadmium sulfate	chicken	21 days	survival	FD	8.0	0	4.74	18.9	37.9	0	0	calculated from BW and FIR
Hill 1974b	7.3	NA	cadmium sulfate	chicken	1 day	survival	FD	2.0	0	7.32	0	0	0	0	calculated from BW and FIR
Olgun 2015	no stats	11	cadmium sulfate	Japanese quail	23 weeks	survival	FD	10.0	0.0421	0.7	1.36	2.67	5.31	10.6	calculated from BW and FIR
Pritzl et al. 1974	no stats	60	cadmium carbonate	chicken	2 weeks	survival	FD	2.9	0	40.3	60.4	80.5	101	0	calculated from BW and FIR
Van Vleet et al. 1981	no stats	39	cadmium sulfate	Pekin duck	1 day	survival	FD	4.0	0	39.2	0	0	0	0	calculated from BW and FIR

Table B-2. Cadmium TRV Data for Birds

	Body Weight (kg)							**Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)**							
Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source	Wet or Dry Weight Basis
Growth															
Bafundo et al. 1984	0.36	0.36	-	-	-	-	NRC 1994	0.0402	0.0402	-	-	-	-	NRC 1994	dw
Bokori et al. 1995b	1.52	1.52	1.52	1.52	-	-	present study	0.0961	0.0961	0.0961	0.0961	0.0961	-	NRC 1994	dw
Bokori et al. 1996	3.2	3.2	3.2	-	-	-	present study	0.2	0.2	0.2	-	-	-	USEPA 1988	dw
Di Giulio and Scanlon 1984	1.12	1.12	1.12	1.12	-	-	present study	0.134	0.134	0.134	0.134	-	-	present study	NA
Hill 1974a	0.148	0.148	0.148	0.148	0.148	0.148	NRC 1994	0.019	0.019	0.019	0.019	0.019	0.019	NRC 1994	dw
Hill 1974b	0.148	0.148	-	-	-	-	NRC 1994	0.019	0.019	-	-	-	-	NRC 1994	dw
Hill 1979	0.148	0.148	0.148	0.148	-	-	NRC 1994	0.019	0.019	0.019	0.019	-	-	NRC 1994	dw
Hill 1980	0.148	0.148	-	-	-	-	NRC 1994	0.019	0.019	-	-	-	-	NRC 1994	dw
Olgun 2015	0.15	0.15	0.15	0.15	0.15	0.15	Vos et al. 1971	0.0197	0.0197	0.0197	0.0197	0.0197	0.0197	Nagy 2001	dw
Richardson and Fox 1974	0.075	0.075	-	-	-	-	Narinc et al. 2010	0.0125	0.0125	-	-	-	-	Nagy 2001	dw
Rama and Planas 1981	0.2	0.2	-	-	-	-	USEPA 1988	0.0193	0.0193	-	-	-	-	USEPA 1988	dw
Richardson et al. 1974	0.075	0.075	-	-	-	-	Narinc et al. 2010	0.0123	0.0123	-	-	-	-	Nagy 2001	dw
Richardson et al. 1974	0.12	0.12	-	-	-	-	Narinc et al. 2010	0.0169	0.0169	-	-	-	-	Nagy 2001	dw
Reproduction															
Bokori et al. 1995b	0.178	0.178	0.178	0.178	-	-	present study	0.0222	0.0222	0.0222	0.0222	-	-	Nagy 2001	dw
Leach et al. 1979	0.78	0.78	0.78	0.78	-	-	USEPA 1988	0.0608	0.0608	0.0608	0.0608	-	-	USEPA 1988	dw
Leach et al. 1979	0.78	0.78	0.78	0.78	-	-	USEPA 1988	0.0608	0.0608	0.0608	0.0608	-	-	USEPA 1988	dw
Olgun 2015	0.15	0.15	0.15	0.15	0.15	0.15	Vos et al. 1971	0.0197	0.0197	0.0197	0.0197	0.0197	0.0197	Nagy 2001	dw
White and Finley 1978	1.15	1.15	1.15	1.15	-	-	present study	0.11	0.11	0.11	0.11	-	-	present study	NA
Survival															
Bokori et al. 1995b	0.178	0.178	0.178	0.178	-	-	present study	0.0222	0.0222	0.0222	0.0222	-	-	Nagy 2001	dw
Bokori et al. 1995a	1.52	1.52	1.52	1.52	-	-	present study	0.0961	0.0961	0.0961	0.0961	-	-	NRC 1994	dw
Hill 1974b	0.148	0.148	-	-	-	-	NRC 1994	0.019	0.019	-	-	-	-	NRC 1994	dw
Olgun 2015	0.15	0.15	0.15	0.15	0.15	0.15	Vos et al. 1971	0.0197	0.0197	0.0197	0.0197	0.0197	0.0197	Nagy 2001	dw
Pritzl et al. 1974	0.15	0.15	0.15	0.15	0.15	-	USEPA 1988	0.0151	0.0151	0.0151	0.0151	0.0151	-	USEPA 1988	dw
Van Vleet et al. 1981	0.78	0.78	-	-	-	-	NRC 1994	0.0611	0.0611	-	-	-	-	Nagy 2001	dw

Table B-2. Cadmium TRV Data for Birds

	Concentration in Food (mg/kg)							**Effect**					
Source	Control[b]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Wet or Dry Weight Basis	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth													
Bafundo et al. 1984	0	45	-	-	-	-	dw	265	204	-	-	-	-
Bokori et al. 1995b	0	75	300	600	-	-	dw	1.47	1.03	0.476	0.353	-	-
Bokori et al. 1996	0	25	75	-	-	-	dw	6.1	5.58	5.4	-	-	-
Di Giulio and Scanlon 1984	0	50	150	450	-	-	NA	1.2	1.22	1.11	0.911	-	-
Hill 1974a	0	20	40	60	80	100	dw	0.202	0.19	0.17	0.108	0.094	0.071
Hill 1974b	0	57	-	-	-	-	dw	0.224	0.123	-	-	-	-
Hill 1979	0	20	40	60	-	-	dw	100	94.4	73.7	52	-	-
Hill 1980	0	100	-	-	-	-	dw	0.217	0.06	-	-	-	-
Olgun 2015	0.32	5.32	10.3	20.3	40.3	80.3	dw	0.153	0.15	0.152	0.127	0.0958	0.0918
Richardson and Fox 1974	0	75	-	-	-	-	dw	0.0891	0.0461	-	-	-	-
Rama and Planas 1981	1	101	-	-	-	-	dw	0.65	0.375	-	-	-	-
Richardson et al. 1974	0	75	-	-	-	-	dw	0.0825	0.0575	-	-	-	-
Richardson et al. 1974	0	75	-	-	-	-	dw	0.097	0.082	-	-	-	-
Reproduction													
Bokori et al. 1995b	0	75	150	300	-	-	dw	206	95	68	30	-	-
Leach et al. 1979	0.22	3.22	12.2	48.2	-	-	dw	60.4	68.9	65.1	36.7	-	-
Leach et al. 1979	0.07	3.07	12.1	48.1	-	-	dw	64.3	69.5	59.9	48.3	-	-
Olgun 2015	0.32	5.32	10.3	20.3	40.3	80.3	dw	94.7	94.7	93.8	88.8	66.8	37.8
White and Finley 1978	0.08	1.6	15.2	210	-	-	NA	3.5	3.29	3.67	1	-	-
Survival													
Bokori et al. 1995b	0	75	150	300	-	-	dw	90	70	50	40	-	-
Bokori et al. 1995a	0	75	300	600	-	-	dw	90	100	95	10	-	-
Hill 1974b	0	57	-	-	-	-	dw	97.5	85	-	-	-	-
Olgun 2015	0.32	5.32	10.3	20.3	40.3	80.3	dw	93.8	93.8	93.8	100	100	43.8
Pritzl et al. 1974	0	400	600	800	1000	-	dw	100	90	45	0	0	-
Van Vleet et al. 1981	0	500	-	-	-	-	dw	100	10	-	-	-	-

Table B-2. Cadmium TRV Data for Birds

	Effect (continued)	**Effect Relative to Control (%)**					
Source	Description	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth							
Bafundo et al. 1984	weight gain (g)	100	77	-	-	-	-
Bokori et al. 1995b	body weight after 4 weeks (week 6) (kg)	100	70	32	24	-	-
Bokori et al. 1996	average final body weight at week 41 (kg)	100	91	89	-	-	-
Di Giulio and Scanlon 1984	average final body weight (kg)	100	102	92	76	-	-
Hill 1974a	2 wk weight gain (kg)	100	94	84	53	47	35
Hill 1974b	weight gain (kg)	100	55	-	-	-	-
Hill 1979	average 2 week gain as percent of control (g)	100	94	74	52	-	-
Hill 1980	average 2 week gain (kg)	100	28	-	-	-	-
Olgun 2015	body weight (kg) (using body weight change and estimated initial body weight of 0.15 kg from Vos et al. 1971)	100	99	99	83	63	60
Richardson and Fox 1974	average final body weight (kg)	100	52	-	-	-	-
Rama and Planas 1981	average weight gain (kg)	100	58	-	-	-	-
Richardson et al. 1974	average male/female final weight (kg)	100	70	-	-	-	-
Richardson et al. 1974	average male final weight (kg)	100	85	-	-	-	-
Reproduction							
Bokori et al. 1995b	total eggs laid per group	100	46	33	15	-	-
Leach et al. 1979	egg production after 48 weeks	100	114	108	61	-	-
Leach et al. 1979	egg production after 12 weeks	100	108	93	75	-	-
Olgun 2015	egg production (eggs/100 birds per day)	100	100	99	94	70	40
White and Finley 1978	average number of eggs laid per hen	100	94	105	29	-	-
Survival							
Bokori et al. 1995b	% survival	100	78	56	44	-	-
Bokori et al. 1995a	% survival at week 8	100	111	106	11	-	-
Hill 1974b	% survival	100	87	-	-	-	-
Olgun 2015	% survival	100	100	100	107	107	47
Pritzl et al. 1974	% survival	100	90	45	0	0	-
Van Vleet et al. 1981	% survival after day 11	100	10	-	-	-	-

Notes:

Concentrations in food were assumed to be reported on a dry weight basis unless clearly stated otherwise in the study. The wet or dry weight basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

Lowest-observed-adverse-effect levels (LOAELs) are reported in mg/kg bw/day.

[a] LOAEL determined by study based on statistical analyses

[b] If reported, the basal diet concentration is included in the control diet concentration

Table B-3. Cadmium TRV Data for Mammals

									Dose (mg/kg bw/day)						
Source	Reported LOAEL[a]	LOAEL ≥ 20	Chemical form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	4	5	Notes
Growth															
Baranski and Sitarek 1987	0.29	29	cadmium chloride	rat	3 months	body weight	GV	14.0	0	0.029	0.29	2.9	29	-	doses presented in paper
Cousins et al. 1977	2.1	NA	cadmium chloride	rat	juvenile	body weight	FD	14.0	0	0.419	2.09	-	-	-	calculated from BW and FIR
Dodds-Smith et al. 1992	104	104	cadmium chloride	shrew	weanling	body weight	FD	12.0	0	104	-	-	-	-	calculated from BW and FIR
Groten et al. 1991	3.0	NA	cadmium chloride	rat	5 weeks	body weight	FD	8.0	0.0167	3	-	-	-	-	calculated from BW and FIR
Hamada et al. 1991	no stats	100	cadmium chloride	dog	6-8 months	body weight	FD	8-9 years	0	1	3	10	50	100	doses presented in paper
Merali and Singhal 1980	1.0	NA	cadmium chloride	rat	1 day	body weight	GV	6.1	0	0.1	1	-	-	-	doses presented in paper
Pond et al. 1973	6.3	6.3	cadmium chloride	pig	weanling	body weight	FD	7.1	0	6.31	-	-	-	-	calculated from BW and FIR
Rajanna et al. 1984	no stats	NA	cadmium chloride	rat	6 weeks	body weight	FD	25.7	0	2.25	4.49	6.74	-	-	calculated from BW and FIR
Rastogi et al 1977	1.0	NA	cadmium chloride	rat	1 day	body weight	GV	4.3	0	0.1	1	-	-	-	doses presented in paper
Weigel et al. 1987	0.07	NA	cadmium oxide	rat	weanling	body weight	FD	7.9	0.0195	0.069	0.183	-	-	-	calculated from BW and FIR
Suzuki and Yoshida 1977	no stats	5.0	cadmium chloride	rat	juvenile assumed (growing rats)	body weight (Exp. 2)	FD	6.4	0	5.03	-	-	-	-	calculated from BW and FIR
Suzuki and Yoshida 1978a	no stats	NA	cadmium chloride	rat	juvenile assumed (growing rats)	body weight (Exp. 1)	FD	25.7	0	5.67	-	-	-	-	calculated from BW and FIR
Suzuki and Yoshida 1978a	no stats	NA	cadmium chloride	rat	juvenile assumed (growing rats)	body weight (Exp. 2)	FD	25.7	0	3.82	-	-	-	-	calculated from BW and FIR
Suzuki and Yoshida 1978b	no stats	NA	cadmium chloride	rat	juvenile assumed (growing rats)	body weight (Exp. 1)	FD	2.0	0	5.58	-	-	-	-	calculated from BW and FIR
Suzuki and Yoshida 1979	6.0	6.0	cadmium chloride	rat	juvenile assumed (growing rats)	body weight	FD	2.0	0	6.02	-	-	-	-	calculated from BW and FIR
Suzuki and Yoshida 1979	5.9	5.9	cadmium chloride	rat	juvenile assumed (growing rats)	body weight	FD	4.0	0	5.89	11.8	23.6	-	-	calculated from BW and FIR
Weber and Reid 1969	162	162	cadmium acetate	mouse	weanling	body weight (Exp. 1)	FD	3.0	0	162	810	1620	-	-	calculated from BW and FIR
Wilson et al. 1941	no stats	3.5	cadmium chloride	rat	juvenile assumed (50 g)	body weight	FD	7.1	0	3.51	7.02	14.2	28.3	56.7	calculated from BW and FIR
Reproduction															
Machemer and Lorke 1981	61	61	cadmium chloride	rat	adult	pregnancy success	GV	1.4	0	1.84	6.13	18.4	61.3	-	doses presented in paper
Sawicka-Kapusta et al. 1994	6.9	6.9	cadmium chloride	mouse	15 days pregnant	offspring growth	FD	5.0	0.138	3.46	6.92	20.8	-	-	calculated from BW and FIR
Sawicka-Kapusta et al. 1994	no stats	21	cadmium chloride	mouse	15 days pregnant	offspring survival	FD	5.0	0.138	3.46	6.92	20.8	-	-	calculated from BW and FIR
Sutou et al. 1980	10	10	cadmium chloride	rat	4 weeks	fetal body weight (male)	GV	9.0	0	0.1	1	10	-	-	doses presented in paper
Sutou et al. 1980	10	10	cadmium chloride	rat	4 weeks	fetal body weight (female)	GV	9.0	0	0.1	1	10	-	-	doses presented in paper
Sutou et al. 1980	10	10	cadmium chloride	rat	4 weeks	fetal implants	GV	>9	0	0.1	1	10	-	-	doses presented in paper
Sutou et al. 1980	10	10	cadmium chloride	rat	4 weeks	live fetuses	GV	>9	0	0.1	1	10	-	-	doses presented in paper
Wardell et al. 1982	50	NA	NR	rat	adult	litter weight	GV	1.9	0	4	10	25	50	-	doses presented in paper
Whelton et al. 1988	no stats	9.2	cadmium chloride	mouse	adult	offspring growth	FD	36.0	0.0459	0.919	9.19	-	-	-	calculated from BW and FIR
Survival															
Baranski and Sitarek 1987	29	29	cadmium chloride	rat	adult	survival	GV	14.0	0	0.029	0.29	2.9	29	-	doses presented in paper
Schroeder et al. 1963	0.56	0.56	NR	rat	weanling	survival (female)	DW	92.0	0	0.558	-	-	-	-	calculated from BW and FIR
Schroeder et al. 1964	0.70	0.70	NR	mouse	weanling	survival (male)	DW	78.0	0	0.703	-	-	-	-	calculated from BW and FIR
Schroeder et al. 1963	0.55	0.55	NR	rat	weanling	survival (male)	DW	92.0	0	0.55	-	-	-	-	calculated from BW and FIR
Swiergosz et al. 1998	no stats	3.4	cadmium chloride	vole	adult	survival	FD	24.0	0.0618	3.43	9.16	-	-	-	calculated from BW and FIR
Weber and Reid 1969	no stats	810	cadmium acetate	mouse	adult	survival	FD	3.0	0	162	810	1620	-	-	calculated from BW and FIR

Table B-3. Cadmium TRV Data for Mammals

	Body Weight (kg)							**Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)**							
Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source	Wet or Dry Weight Basis
Growth															
Baranski and Sitarek 1987	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Cousins et al. 1977	0.256	0.256	0.256	-	-	-	present study	0.0214	0.0214	0.0214	-	-	-	present study	dw
Dodds-Smith et al. 1992	0.0086	0.00704	-	-	-	-	present study	-	-	-	-	-	-	NA (dose presented)	NA
Groten et al. 1991	0.19	0.19	-	-	-	-	present study	0.0187	0.0187	-	-	-	-	USEPA 1988	dw
Hamada et al. 1991	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Merali and Singhal 1980	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Pond et al. 1973	24.7	24.7	-	-	-	-	present study	1.01	1.01	-	-	-	-	present study	dw
Rajanna et al. 1984	0.248	0.248	0.248	0.248	-	-	present study	0.0223	0.0223	0.0223	0.0223	-	-	USEPA 1988	dw
Rastogi et al 1977	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Weigel et al. 1987	0.184	0.184	0.184	-	-	-	present study	0.015	0.015	0.015	-	-	-	present study	dw
Suzuki and Yoshida 1977	0.178	0.178	-	-	-	-	present study	0.0179	0.0179	-	-	-	-	USEPA 1988	dw
Suzuki and Yoshida 1978a	0.399	0.399	-	-	-	-	present study	0.0142	0.0142	-	-	-	-	USEPA 1988	dw
Suzuki and Yoshida 1978a	0.348	0.348	-	-	-	-	present study	0.0305	0.0305	-	-	-	-	USEPA 1988	dw
Suzuki and Yoshida 1978b	0.131	0.131	-	-	-	-	present study	0.0146	0.0146	-	-	-	-	USEPA 1988	dw
Suzuki and Yoshida 1979	0.142	0.142	-	-	-	-	present study	0.0171	0.0171	-	-	-	-	USEPA 1988	dw
Suzuki and Yoshida 1979	0.175	0.175	0.175	0.175	-	-	present study	0.0207	0.0207	0.0207	0.0207	-	-	USEPA 1988	dw
Weber and Reid 1969	0.0153	0.0153	0.0153	0.0153	-	-	present study	0.006	0.006	0.006	0.006	-	-	present study	dw
Wilson et al. 1941	0.125	0.125	0.125	0.125	0.125	0.125	present study	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	USEPA 1988	dw
Reproduction															
Machemer and Lorke 1981	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Sawicka-Kapusta et al. 1994	0.00464	0.00464	0.00464	0.00464	-	-	present study	0.00161	0.00161	0.00161	0.00161	-	-	USEPA 1988	dw
Sawicka-Kapusta et al. 1994	0.00464	0.00464	0.00464	0.00464	-	-	present study	0.00161	0.00161	0.00161	0.00161	-	-	USEPA 1988	dw
Sutou et al. 1980	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Sutou et al. 1980	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Sutou et al. 1980	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Sutou et al. 1980	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Wardell et al. 1982	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Whelton et al. 1988	0.03	0.03	0.03	-	-	-	USEPA 1988	0.00551	0.00551	0.00551	-	-	-	USEPA 1988	dw
Survival															
Baranski and Sitarek 1987	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Schroeder et al. 1963	0.3	0.3	-	-	-	-	USEPA 1988	0.0335	0.0335	-	-	-	-	Calder and Braun 1983	NA
Schroeder et al. 1964	0.03	0.03	-	-	-	-	USEPA 1988	0.00422	0.00422	-	-	-	-	Calder and Braun 1983	NA
Schroeder et al. 1963	0.35	0.35	-	-	-	-	USEPA 1988	0.0385	0.0385	-	-	-	-	Calder and Braun 1983	NA
Swiergosz et al. 1998	0.035	0.035	0.035	-	-	-	present study	0.00801	0.00801	0.00801	-	-	-	Nagy 2001	dw
Weber and Reid 1969	0.0153	0.0153	0.0153	0.0153	-	-	present study	0.006	0.006	0.006	0.006	-	-	present study	dw

Table B-3. Cadmium TRV Data for Mammals

	Concentration in Food (mg/kg)							Effect					
Source	Control[b]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Wet or Dry Weight Basis	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth													
Baranski and Sitarek 1987	-	-	-	-	-	-	NA	239	238	237	222	171	-
Cousins et al. 1977	0	5	25	-	-	-	dw	0.401	0.385	0.357	-	-	-
Dodds-Smith et al. 1992	-	-	-	-	-	-	NA	0.0091	0.0071	-	-	-	-
Groten et al. 1991	0.17	30.5	0	-	-	-	dw	0.315	0.285	-	-	-	-
Hamada et al. 1991	-	-	-	-	-	-	NA	11.1	9.95	11.8	11.1	11.7	7.8
Merali and Singhal 1980	-	-	-	-	-	-	NA	0.173	0.168	0.148	-	-	-
Pond et al. 1973	0	154	-	-	-	-	dw	36.4	28.6	-	-	-	-
Rajanna et al. 1984	0	25	50	75	-	-	dw	0.496	0.459	0.453	0.445	-	-
Rastogi et al 1977	-	-	-	-	-	-	NA	0.112	0.104	0.091	-	-	-
Weigel et al. 1987	0.24	0.85	2.25	-	-	-	dw	0.303	0.287	0.285	-	-	-
Suzuki and Yoshida 1977	0	50	-	-	-	-	dw	0.355	0.275	-	-	-	-
Suzuki and Yoshida 1978a	0	50	-	-	-	-	dw	0.698	0.579	-	-	-	-
Suzuki and Yoshida 1978a	0	50	-	-	-	-	dw	0.595	0.537	-	-	-	-
Suzuki and Yoshida 1978b	0	50	-	-	-	-	dw	0.161	0.139	-	-	-	-
Suzuki and Yoshida 1979	0	50	-	-	-	-	dw	0.185	0.134	-	-	-	-
Suzuki and Yoshida 1979	0	50	100	200	-	-	dw	0.251	0.199	0.159	0.108	-	-
Weber and Reid 1969	0	412	2060	4120	-	-	dw	0.0225	0.01	0.0093	0.0089	-	-
Wilson et al. 1941	0	31	62	125	250	500	dw	0.2	0.16	0.14	0.12	0.07	0.05
Reproduction													
Machemer and Lorke 1981	-	-	-	-	-	-	NA	20	19	20	18	0	-
Sawicka-Kapusta et al. 1994	0.4	10	20	60	-	-	dw	0.00771	0.00756	0.00599	0.00474	-	-
Sawicka-Kapusta et al. 1994	0.4	10	20	60	-	-	dw	73	63.9	60.8	42.3	-	-
Sutou et al. 1980	-	-	-	-	-	-	NA	0.00363	0.00358	0.00352	0.00241	-	-
Sutou et al. 1980	-	-	-	-	-	-	NA	0.00348	0.0034	0.00337	0.00232	-	-
Sutou et al. 1980	-	-	-	-	-	-	NA	14.7	13.9	13.6	10.6	-	-
Sutou et al. 1980	-	-	-	-	-	-	NA	14.2	13.9	13.1	7.2	-	-
Wardell et al. 1982	-	-	-	-	-	-	NA	0.00236	0.00243	0.00225	0.00232	0.002	-
Whelton et al. 1988	0.25	5	50	-	-	-	dw	13	13.4	9.8	-	-	-
Survival													
Baranski and Sitarek 1987	-	-	-	-	-	-	NA	100	100	100	100	46	-
Schroeder et al. 1963	0	5	-	-	-	-	NA	86.5	54.7	-	-	-	-
Schroeder et al. 1964	0	5	-	-	-	-	NA	50	32	-	-	-	-
Schroeder et al. 1963	0	5	-	-	-	-	NA	90.4	21.1	-	-	-	-
Swiergosz et al. 1998	0.27	15	40	-	-	0	NA	86	60	46	-	-	-
Weber and Reid 1969	0	412	2060	4120	-	-	dw	100	92	42	25	-	-

Table B-3. Cadmium TRV Data for Mammals

	Effect (continued)	**Effect Relative to Control (%)**					
Source	Description	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth							
Baranski and Sitarek 1987	body weight at 14 weeks (g)	100	100	99	93	72	-
Cousins et al. 1977	average final body weight (kg)	100	96	89	-	-	-
Dodds-Smith et al. 1992	final male weight (kg)	100	78	-	-	-	-
Groten et al. 1991	body weight (kg)	100	90	-	-	-	-
Hamada et al. 1991	final weight (kg)	100	89	106	100	105	70
Merali and Singhal 1980	estimated body weight at day 43 (kg)	100	97	86	-	-	-
Pond et al. 1973	body weight (kg) calculated from weight gain	100	78	-	-	-	-
Rajanna et al. 1984	body weight using initial weight and average weight gain (kg) at 180 days	100	93	91	90	-	-
Rastogi et al 1977	body weight (kg)	100	93	81	-	-	-
Weigel et al. 1987	body weight (kg) at 8 weeks of exposure	100	95	94	-	-	-
Suzuki and Yoshida 1977	final body weight (kg) (estimated from figure 2 + initial body weight)	100	77	-	-	-	-
Suzuki and Yoshida 1978a	body weight (kg) calculated from weight gain	100	83	-	-	-	-
Suzuki and Yoshida 1978a	body weight (kg) calculated from weight gain	100	90	-	-	-	-
Suzuki and Yoshida 1978b	body weight (kg) calculated from weight gain	100	86	-	-	-	-
Suzuki and Yoshida 1979	body weight (kg) calculated from weight gain	100	73	-	-	-	-
Suzuki and Yoshida 1979	body weight (kg) calculated from weight gain	100	79	64	43	-	-
Weber and Reid 1969	body weight (kg) at week 3	100	44	41	40	-	-
Wilson et al. 1941	body weight (kg)	100	80	70	60	35	25
Reproduction							
Machemer and Lorke 1981	number pregnant	100	95	100	90	0	-
Sawicka-Kapusta et al. 1994	final weight (kg)	100	98	78	61	-	-
Sawicka-Kapusta et al. 1994	% survival	100	88	83	58	-	-
Sutou et al. 1980	male fetal body weight (kg)	100	99	97	66	-	-
Sutou et al. 1980	female fetal body weight (kg)	100	98	97	67	-	-
Sutou et al. 1980	number fetal implants	100	95	93	72	-	-
Sutou et al. 1980	number live fetuses	100	98	92	51	-	-
Wardell et al. 1982	average litter weight (kg)	100	103	95	98	85	-
Whelton et al. 1988	pup growth (g per pup)	100	103	75	-	-	-
Survival							
Baranski and Sitarek 1987	% survival	100	100	100	100	46	-
Schroeder et al. 1963	% survival	100	63	-	-	-	-
Schroeder et al. 1964	% survival at 18 months	100	64	-	-	-	-
Schroeder et al. 1963	% survival	100	23	-	-	-	-
Swiergosz et al. 1998	survival (reported as absolute percent values)	100	70	53	-	-	-
Weber and Reid 1969	% survival	100	92	42	25	-	-

Notes:

Concentrations in food were assumed to be reported on a dry weight basis unless clearly stated otherwise in the study. The wet or dry weight basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

Lowest-observed-adverse-effect levels (LOAELs) are reported in mg/kg bw/day.

[a] LOAEL determined by study based on statistical analyses.

[b] If reported, the basal diet concentration is included in the control diet concentration.

Table B-4. Copper TRV Data for Birds

									Dose (mg/kg bw/day)						
Source	Reported LOAEL[a]	LOAEL ≥ 20	Chemical form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	4	5	Notes
Growth															
Hill 1974a	64	128	copper sulfate	chicken	1 day	body weight	FD	2.0	0	64.2	128	193	257	321	calculated from BW and FIR
Jensen and Maurice 1978	28	NA	copper sulfate	chicken	chick	body weight (Exp. 1)	FD	4.0	0	27.9	55.8	-	-	-	calculated from BW and FIR
Jensen and Maurice 1978	56	84	copper sulfate	chicken	chick	body weight (Exp. 2)	FD	4.0	0	55.8	83.8	-	-	-	calculated from BW and FIR
Jensen and Maurice 1979	56	56	copper sulfate	chicken	1 day	body weight (Exp. 2)	FD	4.0	0.558	56.4	-	-	-	-	calculated from BW and FIR
Kashani et al. 1986	2.2	NA	cupric sulfate	turkey	1 day	body weight (Exp. 1)	FD	24.0	0.191	2.2	-	-	-	-	calculated from BW and FIR
Kashani et al. 1986	2.2	NA	cupric sulfate	turkey	1 day	body weight (Exp. 2)	FD	24.0	0.191	1.19	2.2	4.21	-	-	calculated from BW and FIR
Latymer and Cotes 1981	28	28	copper sulfate	chicken	1 day	body weight	FD	3.4	0.454	28.4	-	-	-	-	calculated from BW and FIR
Miles et al. 1998	68	NA	copper sulfate	chicken	1 day	body weight (Exp. 1)	FD	3.0	3.34	22.5	43.8	67.9	-	-	calculated from BW and FIR
Miles et al. 1998	no stats	69	dicopper chloride	chicken	1 day	body weight (Exp. 2)	FD	6.0	1.75	24.1	46.4	68.8	-	-	calculated from BW and FIR
Miles et al. 1998	no stats	69	copper sulfate	chicken	1 day	body weight (Exp. 2)	FD	6.0	1.75	24.1	46.4	68.8	-	-	calculated from BW and FIR
Persia et al. 2004	89	118	copper chloride	chicken	8 days	body weight (Exp. 2)	FD	2.1	0.591	17.7	29.6	59.1	88.7	118	calculated from BW and FIR
Persia et al. 2004	67	107	copper chloride	chicken	8 days	body weight (Exp. 3)	FD	2.0	0.671	67.1	87.3	107	-	-	calculated from BW and FIR
Poupoulis and Jensen 1976	56	112	copper sulfate	chicken	1 day	body weight gain (Exp. 1)	FD	4.0	0.223	14.2	28.1	56.1	112	-	calculated from BW and FIR
Poupoulis and Jensen 1976	56	84	copper sulfate	chicken	1 day	body weight gain (Exp. 2)	FD	4.0	0.223	28.1	56.1	84	112	-	calculated from BW and FIR
Poupoulis and Jensen 1976	112	112	copper sulfate	chicken	1 day	body weight gain (Exp. 5)	FD	4.0	0.223	28.1	56.1	112	-	-	calculated from BW and FIR
Smith 1969	no stats	NA	copper sulfate	chicken	1 day	body weight	FD	3.6	0.941	10.7	20.5	35.2	-	-	calculated from BW and FIR
Wang et al. 1987	65	NA	copper sulfate	chicken	1 day	body weight gain (Exp. 2)	FD	2.9	0.642	64.8	-	-	-	-	calculated from BW and FIR
Wang et al. 1987	not clear	65	copper sulfate	chicken	1 day	body weight gain (Exp. 1)	FD	2.9	0.642	64.8	-	-	-	-	calculated from BW and FIR
Reproduction															
Al Ankari et al. 1998	13	NA	copper sulfate/acetate	chicken	25 weeks	egg production	FD	12.0	0.414	4.55	12.8	21.1	-	-	calculated from BW and FIR
Chiou et al. 1997	41	41	copper sulfate	chicken	28 weeks	egg production	FD	4.0	1.85	13.4	27.8	41	52	-	calculated from BW and FIR
Harms and Buresh 1986	32	32	copper sulfate	chicken	68 weeks	egg production (Exp. 3)	FD	6.0	0.378	31.9	-	-	-	-	calculated from BW and FIR
Jackson and Stevenson 1981a	not clear	37	copper sulfate	chicken	27 weeks	egg production (breed 1)	FD	40.0	0.613	9.81	19	28.2	37.4	46.6	calculated from BW and FIR
Jackson and Stevenson 1981a	not clear	33	copper sulfate	chicken	27 weeks	egg production (breed 2)	FD	40.0	0.727	11.6	22.5	33.4	44.3	55.2	calculated from BW and FIR
Jackson and Stevenson 1981b	not clear	35	copper sulfate	chicken	26 weeks	egg production (breed 1)	FD	48.0	1.06	12.4	23.7	35	46.3	57.6	calculated from BW and FIR
Jackson and Stevenson 1981b	not clear	35	copper sulfate	chicken	26 weeks	egg production (breed 2)	FD	48.0	0.808	9.46	18.1	26.8	35.4	44.1	calculated from BW and FIR
Jackson et al. 1979	not clear	51	copper sulfate	chicken	24 weeks	egg production (breed 1)	FD	32.0	0.314	12.9	25.5	38	50.6	-	calculated from BW and FIR
Jackson et al. 1979	not clear	38	copper sulfate	chicken	24 weeks	egg production (breed 2)	FD	32.0	0.314	12.9	25.5	38	50.6	-	calculated from BW and FIR
Jackson et al. 1979	not clear	56	copper sulfate	chicken	24 weeks	egg production	FD	48.0	0.345	14.1	27.9	41.7	55.5	-	calculated from BW and FIR
Pearce et al. 1983	not clear	63	copper sulfate	chicken	26 weeks	egg production	FD	6.9	0.315	15.8	31.5	63.1	126	-	calculated from BW and FIR
Stevenson and Jackson 1980a	not clear	32	copper sulfate	chicken	24 weeks	egg production	FD	8.0	0.473	32	63.6	127	-	-	calculated from BW and FIR
Stevenson et al. 1983	not clear	74	copper sulfate	chicken	27 weeks	egg production	FD	0.7	0.736	18.4	36.8	73.6	-	-	calculated from BW and FIR
Stevenson and Jackson 1980b	not clear	32	copper sulfate	chicken	24 weeks	egg production	FD	6.9	0.479	16.3	32	63.6	127	-	calculated from BW and FIR
Survival															
Hill 1974	193	193	copper sulfate	chicken	1 day	survival	FD	2.0	0	64.2	128	193	257	321	calculated from BW and FIR
Mehring et al. 1960	no stats	87	copper oxide	chicken	1 day	survival	FD	10.0	1.93	29.9	42.2	55.5	87.4	-	calculated from BW and FIR
Poupoulis and Jensen 1976	no stats	84	copper sulfate	chicken	chick	survival (Exp. 2)	FD	4.0	0.223	28.1	56.1	84	112	-	calculated from BW and FIR
Poupoulis and Jensen 1976	no stats	112	copper sulfate	chicken	1 day	survival (Exp. 5)	FD	4.0	0.223	28.1	56.1	112	-	-	calculated from BW and FIR
Van Vleet et al. 1981	no stats	114	copper sulfate	Pekin duck	duckling	survival	FD	4.0	0	114	-	-	-	-	calculated from BW and FIR
Van Vleet et al. 1981	no stats	149	copper sulfate	Pekin duck	duckling	survival	FD	2.1	0	149	-	-	-	-	calculated from BW and FIR
Vohra and Kratzer 1968	176	264	copper sulfate	turkey	juvenile	survival	FD	3.0	0	87.9	176	264	352	-	calculated from BW and FIR

Table B-4. Copper TRV Data for Birds

	Body Weight (kg)							**Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)**							
Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source	Wet or Dry Weight Basis
Growth															
Hill 1974a	0.148	0.148	0.148	0.148	0.148	0.148	NRC 1994	0.019	0.019	0.019	0.019	0.019	0.019	NRC 1994	dw
Jensen and Maurice 1978	0.36	0.36	0.36	-	-	-	NRC 1994	0.0402	0.0402	0.0402	-	-	-	NRC 1994	dw
Jensen and Maurice 1978	0.36	0.36	0.36	-	-	-	NRC 1994	0.0402	0.0402	0.0402	-	-	-	NRC 1994	dw
Jensen and Maurice 1979	0.36	0.36	-	-	-	-	NRC 1994	0.0402	0.0402	-	-	-	-	NRC 1994	dw
Kashani et al. 1986	2.13	2.13	-	-	-	-	NRC 1994	0.14	0.14	-	-	-	-	NRC 1994	dw
Kashani et al. 1986	2.13	2.13	2.13	2.13	-	-	NRC 1994	0.14	0.14	0.14	0.14	-	-	NRC 1994	dw
Latymer and Cotes 1981	0.36	0.36	-	-	-	-	NRC 1994	0.0402	0.0402	-	-	-	-	NRC 1994	dw
Miles et al. 1998	0.148	0.148	0.148	0.148	-	-	NRC 1994	0.019	0.019	0.019	0.019	-	-	NRC 1994	dw
Miles et al. 1998	0.36	0.36	0.36	0.36	-	-	NRC 1994	0.0402	0.0402	0.0402	0.0402	-	-	NRC 1994	dw
Miles et al. 1998	0.36	0.36	0.36	0.36	-	-	NRC 1994	0.0402	0.0402	0.0402	0.0402	-	-	NRC 1994	dw
Persia et al. 2004	0.292	0.292	0.292	0.292	0.292	0.292	present study	0.0345	0.0345	0.0345	0.0345	0.0345	0.0345	present study	dw
Persia et al. 2004	0.408	0.408	0.408	0.408	-	-	present study	0.0548	0.0548	0.0548	0.0548	-	-	present study	dw
Poupoulis and Jensen 1976	0.36	0.36	0.36	0.36	0.36	-	NRC 1994	0.0402	0.0402	0.0402	0.0402	0.0402	-	NRC 1994	dw
Poupoulis and Jensen 1976	0.36	0.36	0.36	0.36	0.36	-	NRC 1994	0.0402	0.0402	0.0402	0.0402	0.0402	-	NRC 1994	dw
Poupoulis and Jensen 1976	0.36	0.36	0.36	0.36	-	-	NRC 1994	0.0402	0.0402	0.0402	0.0402	-	-	NRC 1994	dw
Smith 1969	0.178	0.178	0.178	0.178	-	-	present study	0.0175	0.0175	0.0175	0.0175	-	-	USEPA 1988	dw
Wang et al. 1987	0.148	0.148	-	-	-	-	NRC 1994	0.019	0.019	-	-	-	-	NRC 1994	dw
Wang et al. 1987	0.148	0.148	-	-	-	-	NRC 1994	0.019	0.019	-	-	-	-	NRC 1994	dw
Reproduction															
Al Ankari et al. 1998	1.51	1.51	1.51	1.51	-	-	present study	0.125	0.125	0.125	0.125	-	-	present study	NA
Chiou et al. 1997	1.46	1.46	1.46	1.46	1.46	-	present study	0.1	0.1	0.1	0.1	0.1	-	present study	NA
Harms and Buresh 1986	3.2	3.2	-	-	-	-	NRC 1994	0.202	0.202	-	-	-	-	NRC 1994	dw
Jackson and Stevenson 1981a	2	2	2	2	2	2	present study	0.123	0.123	0.123	0.123	0.123	0.123	present study	NA
Jackson and Stevenson 1981a	1.63	1.63	1.63	1.63	1.63	1.63	present study	0.118	0.118	0.118	0.118	0.118	0.118	present study	NA
Jackson and Stevenson 1981b	1.62	1.62	1.62	1.62	1.62	1.62	present study	0.122	0.122	0.122	0.122	0.122	0.122	present study	NA
Jackson and Stevenson 1981b	2.13	2.13	2.13	2.13	2.13	2.13	present study	0.123	0.123	0.123	0.123	0.123	0.123	present study	NA
Jackson et al. 1979	1.85	1.85	1.85	1.85	1.85	-	present study	0.117	0.117	0.117	0.117	0.117	-	present study	NA
Jackson et al. 1979	1.85	1.85	1.85	1.85	1.85	-	present study	0.117	0.117	0.117	0.117	0.117	-	present study	NA
Jackson et al. 1979	1.71	1.71	1.71	1.71	1.71	-	present study	0.118	0.118	0.118	0.118	0.118	-	USEPA 1988	dw
Pearce et al. 1983	3.2	3.2	3.2	3.2	3.2	-	NRC 1994	0.202	0.202	0.202	0.202	0.202	-	NRC 1994	dw
Stevenson and Jackson 1980a	3.2	3.2	3.2	3.2	-	-	NRC 1994	0.202	0.202	0.202	0.202	-	-	NRC 1994	dw
Stevenson et al. 1983	1.44	1.44	1.44	1.44	-	-	present study	0.106	0.106	0.106	0.106	-	-	present study	NA
Stevenson and Jackson 1980b	3.2	3.2	3.2	3.2	3.2	-	NRC 1994	0.202	0.202	0.202	0.202	0.202	-	NRC 1994	dw
Survival															
Hill 1974	0.148	0.148	0.148	0.148	0.148	0.148	NRC 1994	0.019	0.019	0.019	0.019	0.019	0.019	NRC 1994	dw
Mehring et al. 1960	1.08	1.08	1.08	1.08	1.08	-	present study	0.0801	0.0801	0.0801	0.0801	0.0801	-	USEPA 1988	dw
Poupoulis and Jensen 1976	0.36	0.36	0.36	0.36	0.36	-	NRC 1994	0.0402	0.0402	0.0402	0.0402	0.0402	-	NRC 1994	dw
Poupoulis and Jensen 1976	0.36	0.36	0.36	0.36	-	-	NRC 1994	0.0402	0.0402	0.0402	0.0402	-	-	NRC 1994	dw
Van Vleet et al. 1981	0.862	0.862	-	-	-	-	NRC 1994	0.0654	0.0654	-	-	-	-	Nagy 2001	dw
Van Vleet et al. 1981	0.363	0.363	-	-	-	-	NRC 1994	0.0362	0.0362	-	-	-	-	Nagy 2001	dw
Vohra and Kratzer 1968	0.25	0.25	0.25	0.25	0.25	-	NRC 1994	0.0271	0.0271	0.0271	0.0271	0.0271	-	NRC 1994	dw

Table B-4. Copper TRV Data for Birds

	Concentration in Food (mg/kg)							**Effect**					
Source	Control[b]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Wet or Dry Weight Basis	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth													
Hill 1974a	0	500	1000	1500	2000	2500	dw	0.2	0.177	0.135	0.064	0.025	0.005
Jensen and Maurice 1978	0	250	500	-	-	-	dw	0.654	0.591	0.564	-	-	-
Jensen and Maurice 1978	0	500	750	-	-	-	dw	0.695	0.592	0.547	-	-	-
Jensen and Maurice 1979	5	505	-	-	-	-	dw	0.678	0.519	-	-	-	-
Kashani et al. 1986	2.9	33.4	-	-	-	-	dw	2.92	2.8	-	-	-	-
Kashani et al. 1986	2.9	18.2	33.4	64	-	-	dw	3.06	3.14	2.96	2.96	-	-
Latymer and Cotes 1981	4.06	254	-	-	-	-	dw	0.372	0.248	-	-	-	-
Miles et al. 1998	26	175	341	529	-	-	dw	0.605	0.595	0.568	0.485	-	-
Miles et al. 1998	15.7	216	416	616	-	-	dw	1.96	1.92	1.85	1.26	-	-
Miles et al. 1998	15.7	216	416	616	-	-	dw	1.96	1.92	1.84	1.47	-	-
Persia et al. 2004	5	150	250	500	750	1000	dw	0.416	0.422	0.427	0.423	0.388	0.309
Persia et al. 2004	5	500	650	800	-	-	dw	0.709	0.662	0.626	0.551	-	-
Poupoulis and Jensen 1976	2	127	252	502	1000	-	dw	0.498	0.485	0.511	0.418	0.242	-
Poupoulis and Jensen 1976	2	252	502	752	1000	-	dw	0.44	0.43	0.364	0.199	0.203	-
Poupoulis and Jensen 1976	2	252	502	1000	-	-	dw	0.523	0.518	0.489	0.263	-	-
Smith 1969	9.6	110	210	360	-	-	dw	0.32	0.324	0.329	0.3	-	-
Wang et al. 1987	5	505	-	-	-	-	dw	0.475	0.394	-	-	-	-
Wang et al. 1987	5	505	-	-	-	-	dw	0.541	0.413	-	-	-	-
Reproduction													
Al Ankari et al. 1998	5	55	155	255	-	-	dw	24.1	23.8	23	22.6	-	-
Chiou et al. 1997	27	195	405	598	758	-	dw	84.7	87.3	83.5	43.3	28.5	-
Harms and Buresh 1986	6	506	-	-	-	-	dw	78.3	25.2	-	-	-	-
Jackson and Stevenson 1981a	10	160	310	460	610	760	dw	224	240	230	210	167	109
Jackson and Stevenson 1981a	10	160	310	460	610	760	dw	239	230	242	163	114	88
Jackson and Stevenson 1981b	14	164	314	464	614	764	dw	269	257	263	202	163	93
Jackson and Stevenson 1981b	14	164	314	464	614	764	dw	276	247	264	233	190	131
Jackson et al. 1979	5	205	405	605	805	-	dw	185	198	191	164	110	-
Jackson et al. 1979	5	205	405	605	805	-	dw	186	193	178	132	54.7	-
Jackson et al. 1979	5	205	405	605	805	-	dw	262	280	266	221	133	-
Pearce et al. 1983	5	250	500	1000	2000	-	dw	0.9	1	0.8	0.2	0.1	-
Stevenson and Jackson 1980a	7.5	508	1010	2010	-	-	dw	5.4	4.2	1.2	0.5	-	-
Stevenson et al. 1983	10	250	500	1000	-	-	dw	1	0.95	0.85	0.7	-	-
Stevenson and Jackson 1980b	7.6	258	508	1010	2010	-	dw	0.9	0.9	0.7	0.2	0.1	-
Survival													
Hill 1974	0	500	1000	1500	2000	2500	dw	100	100	100	54.3	47.7	11
Mehring et al. 1960	26	403	570	749	1180	-	dw	97.5	90	95	85	60	-
Poupoulis and Jensen 1976	2	252	502	752	1000	-	dw	100	100	90	80	67	-
Poupoulis and Jensen 1976	2	252	502	1000	0	-	dw	97	97	100	75	-	-
Van Vleet et al. 1981	0	1500	-	-	-	-	dw	100	25	-	-	-	-
Van Vleet et al. 1981	0	1500	-	-	-	-	dw	100	60	-	-	-	-
Vohra and Kratzer 1968	0	810	1620	2430	3240	-	dw	100	100	100	50	0	-

Table B-4. Copper TRV Data for Birds

	Effect (continued)	**Effect Relative to Control (%)**					
Source	Description	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth							
Hill 1974a	weight gain (kg)	100	89	68	32	13	3
Jensen and Maurice 1978	final weight (kg)	100	90	86	-	-	-
Jensen and Maurice 1978	final weight (kg)	100	85	79	-	-	-
Jensen and Maurice 1979	final weight (kg)	100	77	-	-	-	-
Kashani et al. 1986	weight at 8 weeks (kg)	100	96	-	-	-	-
Kashani et al. 1986	weight at 8 weeks (kg)	100	103	97	97	-	-
Latymer and Cotes 1981	mean body weight (kg)	100	67	-	-	-	-
Miles et al. 1998	body weight (kg)	100	98	94	80	-	-
Miles et al. 1998	average M/F body weight (kg)	100	98	94	64	-	-
Miles et al. 1998	average M/F body weight (kg)	100	98	94	75	-	-
Persia et al. 2004	final bw calculated from initial bw and weight gain (kg)	100	101	103	102	93	74
Persia et al. 2004	final bw calculated from initial bw and weight gain (kg)	100	93	88	78	-	-
Poupoulis and Jensen 1976	weight gain during 4 weeks (kg)	100	97	103	84	49	-
Poupoulis and Jensen 1976	weight gain during 4 weeks (kg)	100	98	83	45	46	-
Poupoulis and Jensen 1976	weight gain during 4 weeks (kg)	100	99	93	50	-	-
Smith 1969	average of initial weight plus weight gained for two experimental groups (kg)	100	101	103	94	-	-
Wang et al. 1987	average weight gain (kg)	100	83	-	-	-	-
Wang et al. 1987	average weight gain (kg)	100	76	-	-	-	-
Reproduction							
Al Ankari et al. 1998	number of eggs per 28 days	100	99	95	94	-	-
Chiou et al. 1997	egg production (%)	100	103	99	51	34	-
Harms and Buresh 1986	% hen producing eggs/day	100	32	-	-	-	-
Jackson and Stevenson 1981a	number of eggs	100	107	103	94	75	49
Jackson and Stevenson 1981a	number of eggs	100	96	101	68	48	37
Jackson and Stevenson 1981b	number of eggs	100	96	98	75	61	35
Jackson and Stevenson 1981b	number of eggs	100	89	96	84	69	47
Jackson et al. 1979	eggs produced	100	107	104	89	60	-
Jackson et al. 1979	eggs produced	100	103	95	71	29	-
Jackson et al. 1979	egss produced	100	107	102	84	51	-
Pearce et al. 1983	average daily number of eggs laid/ bird (48 days)	100	111	89	22	11	-
Stevenson and Jackson 1980a	number of eggs	100	78	22	9	-	-
Stevenson et al. 1983	number of eggs/bird	100	95	85	70	-	-
Stevenson and Jackson 1980b	daily egg number at day 48	100	100	78	22	11	-
Survival							
Hill 1974	% survival (birds not inoculated)	100	100	100	54	48	11
Mehring et al. 1960	% survival; control is based on the average of the two control groups	100	92	97	87	62	-
Poupoulis and Jensen 1976	% survival	100	100	90	80	67	-
Poupoulis and Jensen 1976	% survival	100	100	103	77	-	-
Van Vleet et al. 1981	% survival	100	25	-	-	-	-
Van Vleet et al. 1981	% survival	100	60	-	-	-	-
Vohra and Kratzer 1968	% survival	100	100	100	50	0	-

Notes:

Concentrations in food were assumed to be reported on a dry weight basis unless clearly stated otherwise in the study. The wet or dry weight basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

Lowest-observed-adverse-effect levels (LOAELs) are reported in mg/kg bw/day.

[a] LOAEL determined by study based on statistical analyses.

[b] If reported, the basal diet concentration is included in the control diet concentration.

Table B-5. Copper TRV Data for Mammals

									Dose (mg/kg bw/day)									
Source	Reported LOAEL[a]	LOAEL ≥ 20	Chemical form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	4	5	6	Notes	Control	Dose 1
Growth																		
Allcroft et al. 1961	17	17	copper sulfate	pig	8-10 weeks	body weight gain	FD	21.0	0.247	9.3	17.3	36.7	-	-	-	calculated from BW and FIR	45	45
Boyden et al. 1938	no stats	122	copper sulfate	rat	4 weeks	body weight gain	FD	4.0	0	61.1	122	-	-	-	-	calculated from BW and FIR	0.1	0.1
Brandt 1983	35	35	copper sulfate	mink	90 days	body weight	FD	~12	0.878	18.2	35.1	-	-	-	-	calculated from BW and FIR	1.98	1.98
Edmonds and Baker 1986	no stats	NA	copper sulfate	pig	4 weeks	body weight (Exp. 3)	FD	4.0	0	19	49.5	-	-	-	-	calculated from BW and FIR	9.05	9.05
Grobner et al. 1986	no stats	NA	copper sulfate	rabbit	weanling	body weight (Exp. 2)	FD	4.0	1.22	4.21	8.2	14.6	41.7	74.6	-	calculated from BW and FIR	1.25	1.25
Grobner et al. 1986	no stats	NA	copper sulfate	rabbit	weanling	body weight (Exp. 2)	FD	4.0	0.731	3.97	8.62	14.1	35.4	58.3	-	calculated from BW and FIR	1.26	1.26
Llewellyn et al. 1985	112	112	copper acetate	rat	weanling	body weight	FD	21.0	0.77	112	-	-	-	-	-	calculated from BW and FIR	0.1	0.1
Petterson et al. 2002	no stats	NA	copper chloride	mouse	4.5 weeks	body weight	FD	3.0	2.66	367	734	-	-	-	-	calculated from BW and FIR	0.0173	0.0173
Suttle and Mills 1966	no stats	25	copper sulfate	pig	weanling	body weight (Exp. 2)	FD	5.7	0.294	15	25.3	-	-	-	-	calculated from BW and FIR	23.5	23.5
Reproduction																		
Aulerich et al. 1982	no stats	27	copper sulfate	mink	kit	offspring survival	FD	20.0	10.1	14.3	18.5	26.9	43.7	-	-	calculated from BW and FIR	1.05	1.05
Aulerich et al. 1982	27	NA	copper sulfate	mink	kit	offspring growth	FD	20.0	10.1	14.3	18.5	26.9	43.7	-	-	calculated from BW and FIR	1.05	1.05
Cromwell et al. 1993	2	2	copper sulfate	pig	multigenerational	farrowing success	FD	2.1 years	0.0815	2.4	-	-	-	-	-	calculated from BW and FIR	152	152
Lecyk 1980	no stats	293	copper sulfate	mouse	sexually mature	litter size (breed 1)	FD	7.0	0	36.6	73.1	110	146	219	293	calculated from BW and FIR	0.03	0.03
Lecyk 1980	no stats	219	copper sulfate	mouse	sexually mature	litter size (breed 2)	FD	7.0	0	36.6	73.1	110	146	219	293	calculated from BW and FIR	0.03	0.03
Survival																		
Ritchie et al. 1963	no stats	4	copper sulfate	pig	7 weeks	survival	FD	15.0	0.217	2.28	4.35	-	-	-	-	calculated from BW and FIR	25.2	25.2
Keen et al. 1982	no stats	204	copper sulfate	rat	juvenile	survival	FD	6.7	1.02	11.2	103	204	-	-	-	calculated from BW and FIR	0.172	0.172
Allcroft et al. 1961	no stats	17	copper sulfate	pig	8-10 weeks	survival	FD	21.0	0.247	9.3	17.3	36.7	-	-	-	calculated from BW and FIR	45	45
Brandt 1983	no stats	35	copper sulfate	mink	90 days	survival	FD	~12	0.878	18.2	35.1	-	-	-	-	calculated from BW and FIR	1.98	1.98
Boyden et al. 1938	no stats	489	copper sulfate	rat	4 weeks	survival	FD	4.0	0	61.1	122	244	489	-	-	calculated from BW and FIR	0.1	0.1
NTP 1993a	no stats	140	copper sulfate	mouse	6 weeks	survival (male)	DW	2.0	0	14	46.7	140	467	1400	-	calculated from BW and FIR	0.0262	0.0262
NTP 1993a	no stats	203	copper sulfate	mouse	6 weeks	survival (female)	DW	2.0	0	20.3	67.5	203	675	2030	-	calculated from BW and FIR	0.0211	0.0211

Table B-5. Copper TRV Data for Mammals

	Body Weight (kg)						**Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)**								
Source	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Source	Wet or Dry Weight Basis
Growth															
Allcroft et al. 1961	45	45	-	-	-	Cai et al. 2009	1.5	1.5	1.5	1.5	-	-	-	Cai et al. 2009	dw
Boyden et al. 1938	0.1	0.1	-	-	-	USEPA 1988	0.0122	0.0122	0.0122	0.0122	-	-	-	USEPA 1988	dw
Brandt 1983	1.98	-	-	-	-	present study	0.217	0.217	0.217	-	-	-	-	Bleavins and Aulerich 1981	dw
Edmonds and Baker 1986	9.05	-	-	-	-	present study	0.689	0.689	0.689	-	-	-	-	present study	dw
Grobner et al. 1986	1.25	1.25	1.25	1.25	-	present study	0.104	0.104	0.104	0.104	0.104	0.104	-	present study, daily intake for control (Table 6)	dw
Grobner et al. 1986	1.26	1.26	1.26	1.26	-	present study	0.0891	0.0891	0.0891	0.0891	0.0891	0.0891	-	present study, daily intake for control (Table 6)	dw
Llewellyn et al. 1985	-	-	-	-	-	USEPA 1988	0.0122	0.0122	-	-	-	-	-	USEPA 1988	dw
Petterson et al. 2002	0.0173	-	-	-	-	present study	0.00382	0.00382	0.00382	-	-	-	-	USEPA 1988	dw
Suttle and Mills 1966	23.5	-	-	-	-	present study	1.38	1.38	1.38	-	-	-	-	present study	dw
Reproduction															
Aulerich et al. 1982	1.05	1.05	1.05	-	-	present study	0.176	0.176	0.176	0.176	0.176	-	-	Bleavins and Aulerich 1981	ww
Aulerich et al. 1982	1.05	1.05	1.05	-	-	present study	0.176	0.176	0.176	0.176	0.176	-	-	Bleavins and Aulerich 1981	ww
Cromwell et al. 1993	-	-	-	-	-	present study	1.41	1.41	-	-	-	-	-	Nagy 2001	dw
Lecyk 1980	0.03	0.03	0.03	0.03	0.03	USEPA 1988	0.00551	0.00551	0.00551	0.00551	0.00551	0.00551	0.00551	USEPA 1988	dw
Lecyk 1980	0.03	0.03	0.03	0.03	0.03	USEPA 1988	0.00551	0.00551	0.00551	0.00551	0.00551	0.00551	0.00551	USEPA 1988	dw
Survival															
Ritchie et al. 1963	25.2	-	-	-	-	present study	0.416	0.416	0.416	-	-	-	-	Nagy 2001	dw
Keen et al. 1982	0.172	0.172	-	-	-	present study	0.0175	0.0175	0.0175	0.0175	-	-	-	USEPA 1988	dw
Allcroft et al. 1961	45	45	-	-	-	Cai et al. 2009	1.5	1.5	1.5	1.5	-	-	-	Cai et al. 2009	dw
Brandt 1983	1.98	-	-	-	-	present study	0.217	0.217	0.217	-	-	-	-	Bleavins and Aulerich 1981	dw
Boyden et al. 1938	0.1	0.1	0.1	-	-	USEPA 1988	0.0122	0.0122	0.0122	0.0122	0.0122	-	-	USEPA 1988	dw
NTP 1993a	0.0262	0.0262	0.0262	0.0262	-	present study	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	-	present study	NA
NTP 1993a	0.0211	0.0211	0.0211	0.0211	-	present study	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056	-	present study	NA

Table B-5. Copper TRV Data for Mammals

	Concentration in Food (mg/kg)								**Effect**						
Source	Control[b]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Wet or Dry Weight Basis	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6
Growth															
Allcroft et al. 1961	7.4	279	518	1100	-	-	-	dw	1.24	1.18	0.36	0.09	-	-	-
Boyden et al. 1938	0	500	1000	2000	-	-	-	dw	86	78	51	5	-	-	-
Brandt 1983	8	166	320	-	-	-	-	dw	1.98	1.92	1.58	-	-	-	-
Edmonds and Baker 1986	0	250	650	-	-	-	-	dw	18.1	17.5	15.7	-	-	-	-
Grobner et al. 1986	14.8	50.9	99.1	177	505	902	-	dw	2.51	2.67	2.69	2.57	2.67	2.44	-
Grobner et al. 1986	10.3	55.9	122	199	498	822	-	dw	2.51	2.54	2.59	2.56	2.41	2.04	-
Llewellyn et al. 1985	6.3	916	-	-	-	-	-	dw	100	77.1	-	-	-	-	-
Petterson et al. 2002	12	1660	3310	-	-	-	-	dw	20	-	17.5	-	-	-	-
Suttle and Mills 1966	5	255	430	-	-	-	-	dw	30	31	23	-	-	-	-
Reproduction															
Aulerich et al. 1982	60.5	85.5	111	161	261	-	-	ww	88	91	81	62	68	-	-
Aulerich et al. 1982	60.5	85.5	111	161	261	-	-	ww	0.137	0.143	0.133	0.116	0.143	-	-
Cromwell et al. 1993	8.8	259	-	-	-	-	-	dw	88.9	64.3	-	-	-	-	-
Lecyk 1980	0	199	398	597	796	1190	1590	dw	3.09	4.6	4.5	4.42	4.2	2.5	1.94
Lecyk 1980	0	199	398	597	796	1190	1590	dw	4.47	5.4	5.1	4.14	4.1	3.11	2.7
Survival															
Ritchie et al. 1963	13.1	138	263	-	-	-	-	dw	100	100	75	-	-	-	-
Keen et al. 1982	10	110	1010	2010	-	-	-	dw	100	100	100	71.4	-	-	-
Allcroft et al. 1961	7.4	279	518	1100	-	-	-	dw	100	100	0	0	-	-	-
Brandt 1983	8	166	320	-	-	-	-	ww	100	100	50	-	-	-	-
Boyden et al. 1938	0	500	1000	2000	4000	-	-	dw	100	100	100	100	0	-	-
NTP 1993a	0	76.4	255	764	2550	7640	-	NA	100	100	100	80	0	0	-
NTP 1993a	0	76.4	255	764	2550	7640	-	NA	100	100	100	40	0	0	-

Table B-5. Copper TRV Data for Mammals

	Effect (continued)	Effect Relative to Control (%)						
Source	Description	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6
Growth								
Allcroft et al. 1961	daily weight gain (lbs)	100	95	29	7	-	-	-
Boyden et al. 1938	avgerage growth in four weeks (g)	100	91	59	6	0	-	-
Brandt 1983	average final body weight (kg)	100	97	80	-	-	-	-
Edmonds and Baker 1986	final body weight using initial body weight and daily weight gain (kg)	100	97	87	-	-	-	-
Grobner et al. 1986	final body weight (based on initial body weight and average daily gain) (kg)	100	106	107	103	106	97	-
Grobner et al. 1986	final body weight (based on initial body weight and average daily gain) (kg)	100	101	103	102	96	81	-
Llewellyn et al. 1985	final body weight relative to control (g)	100	77	-	-	-	-	-
Petterson et al. 2002	body weight (g)	100	-	88	-	-	-	-
Suttle and Mills 1966	final body weight (kg)	100	103	77	-	-	-	-
Reproduction								
Aulerich et al. 1982	% kit survival	100	103	92	70	77	-	-
Aulerich et al. 1982	average kit weight at 4 weeks	100	104	97	85	105	-	-
Cromwell et al. 1993	% gilts to farrow	100	72	-	-	-	-	-
Lecyk 1980	litter size	100	149	146	143	136	81	63
Lecyk 1980	litter size	100	121	114	93	92	70	60
Survival								
Ritchie et al. 1963	% survival	100	100	75	-	-	-	-
Keen et al. 1982	% survival	100	100	100	71	-	-	-
Allcroft et al. 1961	% survival	100	100	0	0	-	-	-
Brandt 1983	% survival	100	100	50	-	-	-	-
Boyden et al. 1938	% survival	100	100	100	100	0	-	-
NTP 1993a	% survival	100	100	100	80	0	0	-
NTP 1993a	% survival	100	100	100	40	0	0	-

Notes:

Concentrations in food were assumed to be reported on a dry weight basis unless clearly stated otherwise in the study. The wet or dry weight basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

Lowest-observed-adverse-effect levels (LOAELs) are reported in mg/kg bw/day.

[a] LOAEL determined by study based on statistical analyses.

[b] If reported, the basal diet concentration is included in the control diet concentration.

Table B-6. Lead TRV Data for Birds

									Dose (mg/kg bw/day)						
Source	Reported LOAEL[a]	LOAEL ≥ 20	Chemical form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	4	5	Notes
Growth															
Abduljaleel & Shuhaimi-Othman 2013	29	29	lead nitrate	chicken	1 day old chicks	body weight	FD	4.0	0	29.4	49.1	98.1	-	-	calculated from BW and FIR
Berg et al. 1980	206	206	lead carbonate	chicken	1 day	body weight (Exp. 1)	FD	2.0	0	206	-	-	-	-	calculated from BW and FIR
Berg et al. 1980	no stats	NA	lead carbonate	chicken	1 day	body weight (Exp. 1)	FD	2.0	0	212	-	-	-	-	calculated from BW and FIR
Berg et al. 1980	102	154	lead carbonate	chicken	1 day	body weight (Exp. 2)	FD	2.0	0	51.2	102	154	205	-	calculated from BW and FIR
Berg et al. 1980	103	205	lead carbonate	chicken	1 day	body weight (Exp. 3)	FD	2.0	0	103	205	-	-	12.8	calculated from BW and FIR
Cupo and Donaldson 1988	1102	184	lead acetate	chicken	1 day	body weight	FD	3.0	0	184	-	-	-	-	calculated from BW and FIR
Damron et al. 1969	80	80	lead acetate	chicken	4 weeks	body weight	FD	4.0	0	0.799	7.99	79.9	-	-	calculated from BW and FIR
Donaldson 1986	165	165	lead acetate trihydrate	chicken	1 day	body weight (Exp. 1)	FD	2.9	0	165	-	-	-	-	calculated from BW and FIR
Donaldson 1986	166	166	lead acetate trihydrate	chicken	1 day	body weight (Exp. 2)	FD	2.9	0	166	-	-	-	10.6	calculated from BW and FIR
Donaldson and McGowan 1989	64	128	lead acetate trihydrate	chicken	1 day	body weight	FD	2.9	0	64.2	128	193	257	-	calculated from BW and FIR
Edens 1985	129	NA	lead acetate	Japanese quail	1 day	body weight	FD	12.0	0	0.129	1.29	12.9	129	-	calculated from BW and FIR
Edens and Garlich 1983	26	NA	lead acetate	chicken	producing eggs for ~15 weeks	body weight	FD	10.0	0	3.29	6.58	13.2	26.3	-	calculated from BW and FIR
Edens and Melvin 1989	66	NA	lead acetate	Japanese quail	1 day	body weight (breed 2)	FD	21.0	0	66.2	-	-	-	-	calculated from BW and FIR
Edens and Melvin 1989	60	NA	lead acetate	Japanese quail	1 day	body weight (breed 1)	FD	21.0	0	60.3	-	-	-	-	calculated from BW and FIR
Edens and Melvin 1989	131	NA	lead acetate	Japanese quail	1 day	body weight (female)	FD	15.0	0	0.131	1.31	13.1	131	-	calculated from BW and FIR
Edens et al. 1976	151	151	lead acetate	Japanese quail	1 day	body weight	FD	12.0	0	0.151	1.51	15.1	151	-	calculated from BW and FIR
Franson and Custer 1982	210	210	lead acetate	chicken	1 day	body weight	FD	4.0	0.142	210	-	-	-	-	calculated from BW and FIR
Latta and Donaldson 1986	128	128	lead acetate	chicken	1 day	body weight gain	FD	2.7	0	128	-	-	-	-	calculated from BW and FIR
Leeming and Donaldson 1984	128	NA	lead acetate trihydrate	chicken	1 day	body weight gain	FD	2.7	0	128	-	-	-	-	calculated from BW and FIR
Morgan et al. 1975	152	NA	lead acetate	Japanese quail	6 days	body weight (Trial 1)	FD	5.0	0	0.152	1.52	15.2	152	-	calculated from BW and FIR
Morgan et al. 1975	79	NA	lead acetate	Japanese quail	hatchling	body weight (Trial 2)	FD	5.0	0	1.57	15.7	78.7	157	-	calculated from BW and FIR
Reproduction															
Edens and Garlich 1983	4	NA	lead acetate	chicken	78% egg production	egg production (Exp. 1)	FD	4.0	0	1.95	3.9	-	-	-	calculated from BW and FIR
Edens and Garlich 1983	1.2	1.2	lead acetate	Japanese quail	6 weeks	egg production (Exp. 2)	FD	5.0	0	0.12	1.2	12	-	-	calculated from BW and FIR
Edens and Garlich 1983	3.3	13	lead acetate	chicken	producing eggs for ~15 weeks	egg production (Exp. 3)	FD	10.0	0	3.29	6.58	13.2	26.3	-	calculated from BW and FIR
Edens and Garlich 1983	0.21	0.21	lead acetate	Japanese quail	1 day	egg production (Exp. 4)	FD	5.0	0	0.207	2.07	20.7	-	-	calculated from BW and FIR
Edens and Melvin 1989	no stats	199	lead acetate	Japanese quail	1 day	egg production	FD	21.0	0	60.3	-	-	-	-	calculated from BW and FIR
Edens et al. 1976	not clear	499	lead acetate	Japanese quail	1 day	egg production	FD	12.0	0	0.151	1.51	15.1	151	-	calculated from BW and FIR
Edens et al. 1976	15.1	15.1	lead acetate	Japanese quail	1 day	egg hatchability	FD	12.0	0	0.151	1.51	15.1	151	-	calculated from BW and FIR
Edens et al. 1976	15.1	15.1	lead acetate	Japanese quail	1 day	egg production	FD	12.0	0	0.151	1.51	15.1	151	-	calculated from BW and FIR
Stone and Soares 1976	421.4	421	lead acetate	Japanese quail	adult	egg production	FD	3.9	0	421	-	-	-	-	calculated from BW and FIR
Survival															
Anders et al. 1982	no stats	NA	lead acetate	pigeon	adult	survival	GV	5.0	0	6.25	-	-	-	-	doses presented in paper
Barthalmus et al. 1977	no stats	13	lead acetate	pigeon	adult	survival	GV	varied	0	6.25	12.5	25	-	-	doses presented in paper
Cupo and Donaldson 1988	no stats	NA	lead acetate	chicken	1 day	survival	FD	3.0	0	184	-	-	-	-	calculated from BW and FIR
Khan et al. 1993	no stats	NA	lead acetate	chicken	1 day	survival	GV	1.0	0	643	-	-	-	-	doses presented in paper
Vengris and Mare 1974	no stats	320	lead acetate	chicken	6 weeks	survival	GV	5.0	0	160	320	640	-	-	doses presented in paper

Table B-6. Lead TRV Data for Birds

	Body Weight (kg)							Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)							
Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source	Wet or Dry Weight Basis
Growth															
Abduljaleel & Shuhaimi-Othman 2013	0.587	0.587	0.587	0.587	0	-	NRC 1994	0.0576	0.0576	0.0576	0.0576	-	-	NRC 1994	dw
Berg et al. 1980	0.128	0.128	-	-	-	-	present study	0.0132	0.0132	-	-	-	-	USEPA 1988	dw
Berg et al. 1980	0.108	0.108	-	-	-	-	present study	0.0114	0.0114	-	-	-	-	USEPA 1988	dw
Berg et al. 1980	0.134	0.134	0.134	0.134	0.134	-	present study	0.0137	0.0137	0.0137	0.0137	0.0137	-	USEPA 1988	dw
Berg et al. 1980	0.132	0.132	0.132	-	-	-	present study	0.0136	0.0136	0.0136	-	-	-	USEPA 1988	dw
Cupo and Donaldson 1988	0.269	0.269	-	-	-	-	present study	0.0247	0.0247	-	-	-	-	USEPA 1988	dw
Damron et al. 1969	1.91	1.91	1.91	1.91	-	-	NRC 1994	0.153	0.153	0.153	0.153	0	-	NRC 1994	dw
Donaldson 1986	0.536	0.536	-	-	-	-	present study	0.0443	0.0443	-	-	-	-	USEPA 1988	dw
Donaldson 1986	0.515	0.515	-	-	-	-	present study	0.0428	0.0428	-	-	-	-	USEPA 1988	dw
Donaldson and McGowan 1989	0.148	0.148	0.148	0.148	0.148	-	NRC 1994	0.019	0.019	0.019	0.019	0.019	-	NRC 1994	dw
Edens 1985	0.159	0.159	0.159	0.159	0.159	-	present study	0.0205	0.0205	0.0205	0.0205	0.0205	-	Nagy 2001	dw
Edens and Garlich 1983	1.84	1.84	1.84	1.84	1.84	-	present study	0.121	0.121	0.121	0.121	0.121	-	present study	dw
Edens and Melvin 1989	0.147	0.147	-	-	-	-	present study	0.0195	0.0195	-	-	-	-	Nagy 2001	dw
Edens and Melvin 1989	0.198	0.198	-	-	-	-	present study	0.0239	0.0239	-	-	-	-	Nagy 2001	dw
Edens and Melvin 1989	0.152	0.152	0.152	0.152	0.152	-	present study	0.0199	0.0199	0.0199	0.0199	0.0199	-	Nagy 2001	dw
Edens et al. 1976	0.0965	0.0965	0.0965	0.0965	0.0965	-	present study	0.0146	0.0146	0.0146	0.0146	0.0146	-	Nagy 2001	dw
Franson and Custer 1982	0.07	0.07	-	-	-	-	USEPA 1988	0.00793	0.00793	-	-	-	-	USEPA 1988	dw
Latta and Donaldson 1986	0.148	0.148	-	-	-	-	NRC 1994	0.019	0.019	-	-	-	-	NRC 1994	dw
Leeming and Donaldson 1984	0.148	0.148	-	-	-	-	NRC 1994	0.019	0.019	-	-	-	-	NRC 1994	dw
Morgan et al. 1975	0.0947	0.0947	0.0947	0.0947	0.0947	-	present study	0.0144	0.0144	0.0144	0.0144	0.0144	-	Nagy 2001	dw
Morgan et al. 1975	0.085	0.085	0.085	0.085	0.085	-	present study	0.0134	0.0134	0.0134	0.0134	0.0134	-	Nagy 2001	dw
Reproduction															
Edens and Garlich 1983	0.78	0.78	0.78	-	-	-	USEPA 1988	0.0608	0.0608	0.0608	-	-	-	USEPA 1988	dw
Edens and Garlich 1983	0.2	0.2	0.2	0.2	-	-	Narinc et al. 2010	0.0241	0.0241	0.0241	0.0241	-	-	Nagy 2001	dw
Edens and Garlich 1983	1.84	1.84	1.84	1.84	1.84	-	present study	0.121	0.121	0.121	0.121	0.121	-	present study	dw
Edens and Garlich 1983	0.15	0.15	0.15	0.15	-	-	present study	0.031	0.031	0.031	0.031	-	-	present study	dw
Edens and Melvin 1989	0.198	0.198	-	-	-	-	present study	0.0239	0.0239	-	-	-	-	Nagy 2001	dw
Edens et al. 1976	0.0965	0.0965	0.0965	0.0965	0.0965	-	present study	0.0146	0.0146	0.0146	0.0146	0.0146	-	Nagy 2001	dw
Edens et al. 1976	0.0965	0.0965	0.0965	0.0965	0.0965	-	present study	0.0146	0.0146	0.0146	0.0146	0.0146	-	Nagy 2001	dw
Edens et al. 1976	0.0965	0.0965	0.0965	0.0965	0.0965	-	present study	0.0146	0.0146	0.0146	0.0146	0.0146	-	Nagy 2001	dw
Stone and Soares 1976	0.122	0.122	-	-	-	-	present study	0.0171	0.0171	-	-	-	-	Nagy 2001	dw
Survival															
Anders et al. 1982	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	-
Barthalmus et al. 1977	0.445	0.445	0.445	0.445	-	-	present study	-	-	-	-	-	-	NA (dose presented)	-
Cupo and Donaldson 1988	0.269	0.269	-	-	-	-	present study	0.0247	0.0247	-	-	-	-	USEPA 1988	dw
Khan et al. 1993	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	-
Vengris and Mare 1974	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	-

Table B-6. Lead TRV Data for Birds

	Concentration in Food (mg/kg)							Effect					
Source	Control[b]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Wet or Dry Weight Basis	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth													
Abduljaleel & Shuhaimi-Othman 2013	0	300	500	1000	-	-	dw	0.628	0.502	0.493	0.491	-	-
Berg et al. 1980	0	2000	-	-	-	-	dw	0.128	0.09	-	-	-	-
Berg et al. 1980	0	2000	-	-	-	-	dw	0.108	0.108	-	-	-	-
Berg et al. 1980	0	500	1000	1500	2000	-	dw	0.134	0.126	0.116	0.105	0.094	-
Berg et al. 1980	0	1000	2000	-	-	-	dw	0.132	0.114	0.097	-	-	-
Cupo and Donaldson 1988	0	2000	-	-	-	-	dw	0.496	0.233	-	-	-	-
Damron et al. 1969	0	10	100	1000	0	-	dw	0.838	0.834	0.861	0.513	-	-
Donaldson 1986	0	2000	-	-	-	-	dw	0.536	0.384	-	-	-	-
Donaldson 1986	0	2000	-	-	-	-	dw	0.515	0.344	-	-	-	-
Donaldson and McGowan 1989	0	500	1000	1500	2000	-	dw	0.564	0.46	0.391	0.425	0.378	-
Edens 1985	0	1	10	100	1000	-	dw	0.159	0.157	0.156	0.154	0.131	-
Edens and Garlich 1983	0	50	100	200	400	-	dw	1.84	1.81	1.78	1.72	1.55	-
Edens and Melvin 1989	0	500	-	-	-	-	dw	0.198	0.178	-	-	-	-
Edens and Melvin 1989	0	500	-	-	-	-	dw	0.147	0.129	-	-	-	-
Edens and Melvin 1989	0	1	10	100	1000	-	dw	0.152	0.145	0.145	0.143	0.128	-
Edens et al. 1976	0	1	10	100	1000	-	dw	0.163	0.159	0.161	0.157	0.129	-
Franson and Custer 1982	1.25	1850	-	-	-	-	dw	0.34	0.161	-	-	-	-
Latta and Donaldson 1986	0	1000	-	-	-	-	dw	0.343	0.23	-	-	-	-
Leeming and Donaldson 1984	0	1000	-	-	-	-	dw	0.463	0.383	-	-	-	-
Morgan et al. 1975	0	1	10	100	1000	-	dw	0.132	0.135	0.137	0.131	0.11	-
Morgan et al. 1975	0	10	100	500	1000	-	dw	0.107	0.107	0.107	0.096	0.089	-
Reproduction													
Edens and Garlich 1983	0	25	50	-	-	-	dw	84	80	74	-	-	-
Edens and Garlich 1983	0	1	10	100	0	-	dw	72	69	52	49	-	-
Edens and Garlich 1983	0	50	100	200	400	-	dw	84	71	74	62	42	-
Edens and Garlich 1983	0	1	10	100	-	-	dw	82	65	58	30	-	-
Edens and Melvin 1989	0	500	-	-	-	-	dw	82	60	-	-	-	-
Edens et al. 1976	0	1	10	100	1000	-	dw	87	77	87	79	15	-
Edens et al. 1976	0	1	10	100	1000	-	dw	81.6	75.2	82.4	59.1	4	-
Edens et al. 1976	0	1	10	100	1000	-	dw	6	5.4	5.2	4.2	0.3	-
Stone and Soares 1976	0	3000	-	-	-	-	dw	0.56	0.23	-	-	-	-
Survival													
Anders et al. 1982	-	-	-	-	-	-	NA (dose presented)	100	83.3	-	-	-	-
Barthalmus et al. 1977	-	-	-	-	-	-	NA (dose presented)	100	100	80	50	-	-
Cupo and Donaldson 1988	0	2000	-	-	-	-	dw	96.2	81.7	-	-	-	-
Khan et al. 1993	-	-	-	-	-	-	NA (dose presented)	100	90	-	-	-	-
Vengris and Mare 1974	-	-	-	-	-	-	NA (dose presented)	100	100	50	0	-	-

Table B-6. Lead TRV Data for Birds

	Effect (continued)	Effect Relative to Control (%)					
Source	Description	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth							
Abduljaleel & Shuhaimi-Othman 2013	mean body weight gain (kg)	100	80	79	78	-	-
Berg et al. 1980	mean body weight gain (kg)	100	70	-	-	-	-
Berg et al. 1980	mean body weight gain (kg)	100	100	-	-	-	-
Berg et al. 1980	mean body weight gain (kg)	100	94	87	78	70	-
Berg et al. 1980	mean body weight gain (kg)	100	86	73	-	-	-
Cupo and Donaldson 1988	average final body weight (kg)	100	47	-	-	-	-
Damron et al. 1969	final body weight (kg)	100	100	103	61	-	-
Donaldson 1986	chick weight (kg) after 20 days of control, adequate dietary riboflavin	100	72	-	-	-	-
Donaldson 1986	chick weight (kg) after 20 days of control, adequate dietary riboflavin	100	67	-	-	-	-
Donaldson and McGowan 1989	final body weight (kg)	100	82	69	75	67	-
Edens 1985	average final body weight (kg) female	100	99	98	97	82	-
Edens and Garlich 1983	average final body weight (kg) Exp. 3	100	98	97	93	84	-
Edens and Melvin 1989	average final body weight (kg)	100	90	-	-	-	-
Edens and Melvin 1989	average final body weight (kg)	100	88	-	-	-	-
Edens and Melvin 1989	average final body weight Fatty (kg)	100	95	95	94	84	-
Edens et al. 1976	final body weight of females (kg)	100	98	99	96	79	-
Franson and Custer 1982	final weight (kg)	100	47	-	-	-	-
Latta and Donaldson 1986	body weight gain of 100% dietary Met (kg), males	100	67	-	-	-	-
Leeming and Donaldson 1984	body weight gain of 100% dietary Met (kg), males	100	83	-	-	-	-
Morgan et al. 1975	final body weight (kg) at 6 weeks	100	102	104	99	83	-
Morgan et al. 1975	final body weight (kg) at 5 weeks	100	100	100	90	83	-
Reproduction							
Edens and Garlich 1983	hen-day egg production	100	95	88	-	-	-
Edens and Garlich 1983	hen-day egg production	100	96	72	68	-	-
Edens and Garlich 1983	hen-day egg production	100	85	88	74	50	-
Edens and Garlich 1983	hen-day egg production	100	79	71	37	-	-
Edens and Melvin 1989	% hen-day egg production	100	73	-	-	-	-
Edens et al. 1976	% hens producing eggs	100	89	100	91	17	-
Edens et al. 1976	% hatch of setable eggs	100	92	101	72	5	-
Edens et al. 1976	setable eggs/hen/week	100	90	87	70	5	-
Stone and Soares 1976	eggs/hen/day	100	41	-	-	-	-
Survival							
Anders et al. 1982	% survival	100	83	-	-	-	-
Barthalmus et al. 1977	% survival	100	100	80	50	-	-
Cupo and Donaldson 1988	% survival	100	85	-	-	-	-
Khan et al. 1993	% survival	100	90	-	-	-	-
Vengris and Mare 1974	% survival	100	100	50	0	-	-

Notes:

Concentrations in food were assumed to be reported on a dry weight basis unless clearly stated otherwise in the study. The wet or dry weight basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

Lowest-observed-adverse-effect levels (LOAELs) are reported in mg/kg bw/day.

[a] LOAEL determined by study based on statistical analyses.

[b] If reported, the basal diet concentration is included in the control diet concentration.

Table B-7. Lead TRV Data for Mammals

									Dose (mg/kg bw/day)						
Source	Reported LOAEL[a]	LOAEL ≥ 20	Chemical form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	4	5	Notes
Growth															
Al-Omar et al. 2000	46	NA	lead oxide	mouse	adult	body weight gain	GV	5.0	0	46.4	-	-	-	-	doses presented in paper
Barlow et al. 1977	1141	NA	lead acetate	rat	adult	maternal body weight	FD	3.0	0	1140	-	-	-	-	calculated from BW and FIR
Gerber et al. 1978	1064	1064	lead acetate	rat	infant	body weight	FD	52.0	0	1060	-	-	-	-	calculated from BW and FIR
Harry et al. 1985	200	NA	lead acetate	rat	2 days	body weight	GV	3.7	0	200	-	-	-	-	doses presented in paper
Hsu et al. 1975	37	NA	lead acetate	pig	4 weeks	body weight	FD	13.0	0	36.7	-	-	-	-	calculated from BW and FIR
Lorenzo et al. 1978	no stats	20	lead nitrate	rabbit	1 day	% weight gain	GV	4.3	0	2.21	9.97	19.9	39.9	0	converted Pb(NO3)2 to Pb, divided by BW
Maker et al. 1973	no stats	NA	lead carbonate	mouse	adult	body weight	FD	4.3	0	1840	-	-	-	-	calculated from BW and FIR
Mykkanen et al. 1980	no stats	NA	lead acetate	rat	adult	weight gain	FD	3.0	0	509	1020	-	-	-	calculated from BW and FIR
Mykkanen et al. 1980	no stats	NA	lead acetate	rat	adult	weight gain	FD	3.0	0	236	471	942	-	-	calculated from BW and FIR
Kumar and Desiraju 1990	100	400	lead acetate	rat	2 days	body weight	GV	8.4	0	100	400	-	-	-	doses presented in paper
Toews et al. 1983	400	400	lead acetate	rat	pup	body weight	GV	4.0	0	400	-	-	-	-	doses presented in paper
Reproduction															
Gupta et al. 1995	3	3.2	lead acetate	mouse	adult	living embryos per mother	GV	4.0	0	3.19	7.96	15.9	-	-	doses presented in paper
Jacquet et al. 1977	919	NA	not specified	mouse	sexually mature	embryo weight	FD	2.6	0	230	459	919	-	-	calculated from BW and FIR
Miller et al. 1982	no stats	NA	lead acetate	rat	adult	embryo weight	GV	5.9	0	50	75	100	-	-	doses presented in paper
Mykkanen et al. 1980	no effect	1018	lead acetate	rat	adult	pup weight (breed 1)	FD	3.0	0	255	1020	-	-	-	calculated from BW and FIR
Mykkanen et al. 1980	236	942	lead acetate	rat	adult	pup weight (breed 2)	FD	3.0	0	236	942	-	-	-	calculated from BW and FIR
Schroeder and Mitchener 1971	2.7	NA	soluble lead	rat	multigenerational	offspring survival	FD, DW	3 generations	0	2.67	-	-	-	-	dose in food + dose in water (based on Calder and Braun 1983)
Schroeder and Mitchener 1971	3.5	NA	soluble lead	mouse	multigenerational	offspring survival	FD, DW	3 generations	0	3.54	-	-	-	-	dose in food + dose in water (based on Calder and Braun 1983)
Wardell et al. 1982	150	NA	lead acetate	rat	adult	fetal mortality (resorptions)	GV	1.9	0	10	50	100	150	-	doses presented in paper
Winneke et al. 1977	138	138	lead acetate	rat	adult	litter size	FD	18.6	0	138	-	-	-	-	calculated from BW and FIR
Winneke et al. 1977	138	138	lead acetate	rat	adult	pregnancy success	FD	18.6	0	138	-	-	-	-	calculated from BW and FIR
Survival															
Junaid et al. 1997	no stats	8.0	lead acetate	mouse	adult	survival	GV	8.6	0	2	4	8	-	-	doses presented in paper
Lorenzo et al. 1978	no stats	10	lead nitrate	rabbit	1 day	survival	GV	4.3	0	2.21	9.97	19.9	39.9	-	dose in Pb(NO3)2 to Pb divided by BW
Pankakoski et al. 1994	191	191	lead in earthworm prey	shrew	juvenile (< 5 months)	survival	FD	0.6	0.206	3.4	2.11	191	218	542	calculated from BW and FIR
Press 1977	no stats	328	lead acetate	rat	1 day	survival	GV	2.1	0	328	-	-	-	-	doses presented in paper
Kumar and Desiraju 1990	no stats	400	lead acetate	rat	2 days	survival	GV	8.4	0	400	-	-	-	-	doses presented in paper

Table B-7. Lead TRV Data for Mammals

	Body Weight (kg)							**Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)**							
Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source	Wet or Dry Weight
Growth															
Al-Omar et al. 2000	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Barlow et al. 1977	0.25	0.25	-	-	-	-	present study	0.0224	0.0224	-	-	-	-	USEPA 1988	dw
Gerber et al. 1978	0.151	0.151	-	-	-	-	present study	0.016	0.016	-	-	-	-	USEPA 1988	dw
Harry et al. 1985	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Hsu et al. 1975	35.4	35.4	-	-	-	-	present study	1.3	1.3	-	-	-	-	present Study	NA
Lorenzo et al. 1978	0.282	0.282	0.282	0.282	0.282	-	USEPA 1988	-	-	-	-	-	-	NA (dose presented)	NA
Maker et al. 1973	0.03	0.03	-	-	-	-	USEPA 1988	0.00551	0.00551	-	-	-	-	USEPA 1988	dw
Mykkanen et al. 1980	0.35	0.35	0.35	-	-	-	USEPA 1988	0.028	0.028	0.028	-	-	-	USEPA 1988	dw
Mykkanen et al. 1980	0.44	0.44	0.44	0.44	-	-	USEPA 1988	0.0325	0.0325	0.0325	0.0325	-	-	USEPA 1988	dw
Kumar and Desiraju 1990	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Toews et al. 1983	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Reproduction															
Gupta et al. 1995	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Jacquet et al. 1977	0.03	0.03	0.03	0.03	-	-	USEPA 1988	0.00551	0.00551	0.00551	0.00551	-	-	USEPA 1988	dw
Miller et al. 1982	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Mykkanen et al. 1980	0.35	0.35	0.35	-	-	-	USEPA 1988	0.028	0.028	0.028	-	-	-	USEPA 1988	dw
Mykkanen et al. 1980	0.44	0.44	0.44	-	-	-	USEPA 1988	0.0325	0.0325	0.0325	-	-	-	USEPA 1988	dw
Schroeder and Mitchener 1971	0.48	0.48	-	-	-	-	USEPA 1988	0.0345	-	-	-	-	-	USEPA 1988	dw
Schroeder and Mitchener 1971	0.03	0.03	-	-	-	-	USEPA 1988	0.00551	-	-	-	-	-	USEPA 1988	dw
Wardell et al. 1982	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Winneke et al. 1977	0.18	0.18	-	-	-	-	present study	0.018	0.018	-	-	-	0	USEPA 1988	dw
Winneke et al. 1977	0.18	0.18	-	-	-	-	present study	0.018	0.018	-	-	-	-	USEPA 1988	dw
Survival															
Junaid et al. 1997	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Lorenzo et al. 1978	0.282	0.282	0.282	0.282	0.282	-	USEPA 1988	-	-	-	-	-	-	NA (dose presented)	NA
Pankakoski et al. 1994	0.008	0.008	0.008	0.008	0.008	0.008	present study	0.00412	0.00412	0.00412	0.00412	0.00412	0.00412	Nagy 2001	ww
Press 1977	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Kumar and Desiraju 1990	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA

Table B-7. Lead TRV Data for Mammals

	Concentration in Food (mg/kg)							Effect					
Source	Control[b]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Wet or Dry Weight Basis	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth													
Al-Omar et al. 2000	-	-	-	-	-	-	NA (dose presented)	0.0484	0.0456	-	-	-	-
Barlow et al. 1977	0	12700	-	-	-	-	dw	0.25	0.21	-	-	-	-
Gerber et al. 1978	0	10000	-	-	-	-	dw	0.264	0.17	-	-	-	-
Harry et al. 1985	-	-	-	-	-	-	NA (dose presented)	0.079	0.07	-	-	-	-
Hsu et al. 1975	0	1000	-	-	-	-	dw	59.5	49.4	-	-	-	-
Lorenzo et al. 1978	-	-	-	-	-	-	NA (dose presented)	850	880	-	500	-	-
Maker et al. 1973	0	10000	-	-	-	-	dw	100	85	-	-	-	-
Mykkanen et al. 1980	0	6370	12700	-	-	-	dw	107	105	101	-	-	-
Mykkanen et al. 1980	0	3190	6370	12700	-	-	dw	107	116	102	95	-	-
Kumar and Desiraju 1990	-	-	-	-	-	-	NA (dose presented)	0.148	0.126	0.07	-	-	-
Toews et al. 1983	-	-	-	-	-	-	NA (dose presented)	0.08	0.0616	-	-	-	-
Reproduction													
Gupta et al. 1995	-	-	-	-	-	-	NA (dose presented)	7.5	5.75	5.8	5.5	-	-
Jacquet et al. 1977	0	1250	2500	5000	0	0	dw	0.000978	0.000922	0.00085	0.000793	-	-
Miller et al. 1982	-	-	-	-	-	-	NA (dose presented)	3.35	3.13	3.52	2.73	-	-
Mykkanen et al. 1980	0	3190	12700	-	-	-	dw	0.043	0.036	0.032	-	-	-
Mykkanen et al. 1980	0	3190	12700	-	-	-	dw	0.055	0.045	0.033	-	-	-
Schroeder and Mitchener 1971	-	-	-	-	-	-	dw	100	93	-	-	-	-
Schroeder and Mitchener 1971	-	-	-	-	-	-	NA	100	87.5	-	-	-	-
Wardell et al. 1982	-	-	-	-	-	-	NA (dose presented)	92	93	96	98	81	-
Winneke et al. 1977	0	1380	-	-	-	-	dw	8	5.7	-	-	-	-
Winneke et al. 1977	0	1380	-	-	-	-	dw	20	14	-	-	-	-
Survival													
Junaid et al. 1997	-	-	-	-	-	-	NA	100	100	100	80	-	-
Lorenzo et al. 1978	-	-	-	-	-	-	NA	84	83	50	15	0	-
Pankakoski et al. 1994	0.4	6.6	4.1	371	423	1050	ww	100	100	100	0	0	0
Press 1977	-	-	-	-	-	-	NA	100	0	-	-	-	-
Kumar and Desiraju 1990	-	-	-	-	-	-	NA	100	40	-	-	-	-

Table B-7. Lead TRV Data for Mammals

	Effect (continued)	**Effect Relative to Control (%)**					
Source	Description	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth							
Al-Omar et al. 2000	final body weight using initial body weight (25 g) and weight gain	100	94	-	-	-	-
Barlow et al. 1977	average final mother weight (kg)	100	84	-	-	-	-
Gerber et al. 1978	body weight (kg)	330	213	-	-	-	-
Harry et al. 1985	average male/female weight at day 29 (kg)	100	89	-	-	-	-
Hsu et al. 1975	final body weight (kg) (calculated from initial bw and daily weight gain)	100	83	-	-	-	-
Lorenzo et al. 1978	avgerage % weight gain	100	104	-	59	-	-
Maker et al. 1973	average weight as % of control	100	85	-	-	-	-
Mykkanen et al. 1980	weight gain (as a % of delivery weight)	100	98	94	-	-	-
Mykkanen et al. 1980	weight gain (as a % of delivery weight)	100	108	95	89	-	-
Kumar and Desiraju 1990	body weight at 60 days old (kg)	100	85	47	-	-	-
Toews et al. 1983	body weight on day 30 (kg)	100	77	-	-	-	-
Reproduction							
Gupta et al. 1995	living embryos per mother	100	77	77	73	-	-
Jacquet et al. 1977	average final weight of embryo (kg)	100	94	87	81	-	-
Miller et al. 1982	embryo weight (g)	100	93	105	81	-	-
Mykkanen et al. 1980	average final pup weight (kg)	100	84	74	-	-	-
Mykkanen et al. 1980	average final pup weight (kg)	100	82	60	-	-	-
Schroeder and Mitchener 1971	percent survival: F1 generation	100	93	-	-	-	-
Schroeder and Mitchener 1971	percent survival: F1 generation	100	88	-	-	-	-
Wardell et al. 1982	% survival (no resportions)	100	101	104	107	88	-
Winneke et al. 1977	litter size	100	71	-	-	-	-
Winneke et al. 1977	number of pregnant rats	100	70	-	-	-	-
Survival							
Junaid et al. 1997	% survival	100	100	100	80	-	-
Lorenzo et al. 1978	mortality determined at 30 days of age	100	99	60	18	0	-
Pankakoski et al. 1994	% survival	100	100	100	0	0	0
Press 1977	% survival	100	0	-	-	-	-
Kumar and Desiraju 1990	% survival	100	40	-	-	-	-

Notes:

selected to match the basis of the food concentration.

Lowest-observed-adverse-effect levels (LOAELs) are reported in mg/kg bw/day.

[a] LOAEL determined by study based on statistical analyses

[b] If reported, the basal diet concentration is included in the control diet concentration.

Table B-8. Manganese TRV Data for Birds

									Dose (mg/kg bw/day)						
Source	Reported LOAEL[a]	LOAEL ≥ 20	Chemical form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	4	5	Notes
Growth															
Martinez and Diaz 1996	161	NA	manganese oxide	chicken	1 day	body weight	FD	6.0	11.5	49	86.4	161	-	-	calculated from BW and FIR
Southern and Baker 1983	403	NA	manganese chloride	chicken	8 days	body weight	FD	2.0	16.2	306	403	499	-	-	calculated from BW and FIR
Vohra and Kratzer 1968	515	NA	manganese sulfate	turkey	juvenile	body weight gain	FD	3.0	7.76	325	390	515	-	-	calculated from BW and FIR

Table B-8. Manganese TRV Data for Birds

	Body Weight (kg)							**Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)**							
Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source	Wet or Dry Weight Basis
Growth															
Martinez and Diaz 1996	0.795	0.795	0.795	0.795	-	-	present study	0.0799	0.0799	0.0799	0.0799	-	-	present Study	NA
Southern and Baker 1983	0.196	0.196	0.196	0.196	-	-	present study	0.0189	0.0189	0.0189	0.0189	-	-	USEPA 1988	dw
Vohra and Kratzer 1968	0.5	0.5	0.5	0.5	-	-	NRC 1994	0.0529	0.0529	0.0529	0.0529	-	-	NRC 1994	dw

Table B-8. Manganese TRV Data for Birds

	Concentration in Food (mg/kg)							Effect					
Source	Control[b]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Wet or Dry Weight Basis	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth													
Martinez and Diaz 1996	115	487	859	1600	-	-	dw	2.02	1.92	1.85	1.75	-	-
Southern and Baker 1983	168	3170	4170	5170	-	-	dw	0.312	0.316	0.281	0.29	-	-
Vohra and Kratzer 1968	73.4	3070	3690	4870	-	-	dw	0.322	0.332	0.32	0.284	-	-

Table B-8. Manganese TRV Data for Birds

	Effect (continued)	Effect Relative to Control (%)					
Source	Description	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth							
Martinez and Diaz 1996	final body weight on day 42 (kg)	100	95	92	87	-	-
Southern and Baker 1983	final body weight (kg)	100	101	90	93	-	-
Vohra and Kratzer 1968	average weight gain (kg)	100	103	99	88	-	-

Notes:

Concentrations in food were assumed to be reported on a dry weight basis unless clearly stated otherwise in the study. The wet or dry weight basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

Lowest-observed-adverse-effect levels (LOAELs) are reported in mg/kg bw/day.

[a] LOAEL determined by study based on statistical analyses.

[b] If reported, the basal diet concentration is included in the control diet concentration.

Table B-9. Manganese TRV Data for Mammals

									Dose (mg/kg bw/day)						
Source	Reported LOAEL[a]	LOAEL ≥ 20	Chemical form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	4	5	Notes
Growth															
Komura and Sakomoto 1991	no stats	NA	manganese acetate	mouse	6 weeks	body weight	FD	12.9	16.6	272	-	-	-	-	calculated from BW and FIR
Komura and Sakomoto 1991	no stats	NA	manganese chloride	mouse	6 weeks	body weight	FD	12.9	16.6	272	-	-	-	-	calculated from BW and FIR
Kontur and Fechter 1985	no stats	NA	manganese chloride	rat	adult (gestation day 1)	body weight	DW	3.0	0	230	461	922	-	-	calculated from BW and FIR
Lipe et a. 1999	10	NA	manganese chloride	rat	90 days	body weight	GV	4.3	0	10	20	-	-	-	doses presented in paper
NTP 1993b	1321	NA	manganese sulfate	rat	50 days	body weight (male)	FD	2.0	2.43	85	167	332	662	1320	calculated from BW and FIR
NTP 1993b	74	NA	manganese sulfate	rat	50 days	body weight (female)	FD	13.0	2.1	38.7	73.6	145	288	573	calculated from BW and FIR
NTP 1993b	1847	NA	manganese sulfate	mouse	63 days	body weight (male)	FD	13.0	3.39	119	234	464	925	1850	calculated from BW and FIR
NTP 1993b	1731	NA	manganese sulfate	mouse	63 days	body weight (female)	FD	13.0	3.18	111	219	435	867	1730	calculated from BW and FIR
Rehnberg et al. 1980	71	71	manganese oxide	rat	1 day	body weight	GV	2.9	0	21	71	214	-	-	doses presented in paper
Reproduction															
Kontur and Fechter 1985	922	NA	manganese chloride	rat	adult (gestation day 1)	litter size	DW	3.0	0	230	461	922	-	-	calculated from BW and FIR
Laskey et al. 1982	404	404	manganese oxide	rat	pregnant	pregnancy success	FD	gestation to 32 weeks	5.53	44.5	118	404	-	-	calculated from BW and FIR
Leung et al. 1982	no stats	634	manganese chloride	rat	adult	offspring body weight	DW	3.7	0	31.7	317	634	-	-	calculated from BW and FIR
Pappas et al. 1997	1420	1420	manganese chloride	rat	pregnant	offspring body weight	DW	gestation to post-natal day 30	0	350	1420	-	-	-	doses presented in paper
Survival															
NTP 1993b	431	45.5	manganese sulfate	rat	41 days	suvival (male)	FD	2 years	2.63	45.5	146	431	-	-	calculated from BW and FIR
Rehnberg et al. 1980	71	214	manganese oxide	rat	1 day	survival	GV	2.9	0	21	71	214	-	-	doses presented in paper

Table B-9. Manganese TRV Data for Mammals

	Body Weight (kg)							**Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)**							
Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source	Wet or Dry Weight Basis
Growth															
Komura and Sakomoto 1991	0.0282	0.0282	0.0282	0.0282	0.0282	-	present study	0.0036	0.0036	-	-	-	-	present study	NA
Komura and Sakomoto 1991	0.0282	0.0282	0.0282	0.0282	0.0282	-	present study	0.0036	0.0036	-	-	-	-	present study	NA
Kontur and Fechter 1985	0.371	0.371	0.371	0.371	-	-	present study	0.0392	0.0392	0.0392	0.0392	-	-	present study	NA
Lipe et a. 1999	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
NTP 1993b	0.212	0.212	0.212	0.212	0.212	0.212	present study	0.0172	0.0172	0.0172	0.0172	0.0172	0.0172	present study	NA
NTP 1993b	0.142	0.142	0.142	0.142	0.142	0.142	present study	0.00995	0.00995	0.00995	0.00995	0.00995	0.00995	present study	NA
NTP 1993b	0.0282	0.0282	0.0282	0.0282	0.0282	0.0282	present study	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	present study	NA
NTP 1993b	0.0221	0.0221	0.0221	0.0221	0.0221	0.0221	present study	0.00235	0.00235	0.00235	0.00235	0.00235	0.00235	present study	NA
Rehnberg et al. 1980	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Reproduction															
Kontur and Fechter 1985	0.371	0.371	0.371	0.371	-	-	present study	0.0392	0.0392	0.0392	0.0392	-	-	present study	NA
Laskey et al. 1982	0.134	0.132	0.146	0.123	-	-	present study	0.0148	0.0147	0.0157	0.014	-	-	USEPA 1988	dw
Leung et al. 1982	0.24	0.24	0.24	0.24	-	-	USEPA 1988	0.0274	0.0274	0.0274	0.0274	-	-	Calder and Braun 1983	NA
Pappas et al. 1997	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA
Survival															
NTP 1993b	0.264	0.264	0.264	0.264	-	-	present study	0.0232	0.0232	0.0232	0.0232	-	-	USEPA 1988	dw
Rehnberg et al. 1980	-	-	-	-	-	-	NA (dose presented)	-	-	-	-	-	-	NA (dose presented)	NA

Table B-9. Manganese TRV Data for Mammals

	Concentration in Food (mg/kg)							**Effect**					
Source	Control[b]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Wet or Dry Weight Basis	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth													
Komura and Sakomoto 1991	130	2130	-	-	-	-	dw	0.0395	0.0358	-	-	-	-
Komura and Sakomoto 1991	130	2130	-	-	-	-	dw	0.0395	0.0344	-	-	-	-
Kontur and Fechter 1985	0	2180	4370	8730	-	-	NA	0.442	0.434	0.424	0.388	-	-
Lipe et a. 1999	-	-	-	-	-	-	NA	0.462	0.43	0.42	-	-	-
NTP 1993b	29.9	1050	2060	4090	8150	16300	dw	0.241	0.235	0.242	0.235	0.243	0.21
NTP 1993b	29.9	550	1050	2060	4090	8150	dw	0.184	0.181	0.175	0.176	0.178	0.174
NTP 1993b	29.9	1050	2060	4090	8150	16300	dw	0.0314	0.0305	0.031	0.0309	0.0306	0.0274
NTP 1993b	29.9	1050	2060	4090	8150	16300	dw	0.0242	0.0242	0.0243	0.0245	0.0242	0.0228
Rehnberg et al. 1980	-	-	-	-	-	-	NA	0.0584	0.0566	0.045	0.044	-	-
Reproduction													
Kontur and Fechter 1985	0	2180	4370	8730	-	-	NA (dose presented)	0.00613	0.00624	0.00609	0.00539	-	-
Laskey et al. 1982	50	400	1100	3550	-	-	dw	84	84	79	63	-	-
Leung et al. 1982	0	278	2780	5550	-	-	NA	0.22	0.215	0.2	0.145	-	-
Pappas et al. 1997	0	2000	10000	-	-	-	NA (dose presented)	0.113	0.109	0.0793	-	-	-
Survival													
NTP 1993b	29.9	517	1650	4900	-	-	dw	0.357	0.243	0.314	0.1	-	-
Rehnberg et al. 1980	-	-	-	-	-	-	NA	98	94	85	54	-	-

Table B-9. Manganese TRV Data for Mammals

	Effect (continued)	**Effect Relative to Control (%)**					
Source	Description	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth							
Komura and Sakomoto 1991	body weight on day 60 (kg)	100	91	-	-	-	-
Komura and Sakomoto 1991	body weight on day 60 (kg)	100	87	-	-	-	-
Kontur and Fechter 1985	final maternal body weight (kg)	100	98	96	88	-	-
Lipe et a. 1999	average final weight (kg)	100	93	91	-	-	-
NTP 1993b	male final body weight (kg)	100	98	100	98	101	87
NTP 1993b	female final body weight (kg)	100	98	95	96	97	95
NTP 1993b	male final body weight (kg)	100	97	99	98	97	87
NTP 1993b	female final body weight	100	100	100	101	100	94
Rehnberg et al. 1980	average final weight (kg)	100	97	77	75	-	-
Reproduction							
Kontur and Fechter 1985	average littler weight (kg)	100	102	99	88	-	-
Laskey et al. 1982	percent pregnant	100	100	94	75	-	-
Leung et al. 1982	average final pup weight (kg)	100	98	91	66	-	-
Pappas et al. 1997	pup body weight at PND 32 (kg)	100	96	70	-	-	-
Survival							
NTP 1993b	proportion of males surviving to study termination	100	68	88	28	-	-
Rehnberg et al. 1980	% survival	100	96	87	55	-	-

Notes:

Concentrations in food were assumed to be reported on a dry weight basis unless clearly stated otherwise in the study. The wet or dry weight basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

Lowest-observed-adverse-effect levels (LOAELs) are reported in mg/kg bw/day.

[a] LOAEL determined by study based on statistical analyses.

[b] If reported, the basal diet concentration is included in the control diet concentration.

Table B-10. Zn TRV Data for Birds

									Dose (mg/kg bw/day)									
Source	Reported LOAEL[a]	LOAEL ≥ 20	Chemical form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	4	5	6	7	8	Notes
Growth																		
Gasaway and Buss 1972	no stats	325	zinc carbonate	mallard	7 weeks	body weight gain	FD	5.7	25	325	625	925	1230	-	-	-	-	calculated from BW and FIR
Hamilton et al. 1981	110	NA	zinc carbonate	Japanese quail	hatchling	body weight (Exp. 2)	FD	2.0	4.22	57	110	-	-	-	-	-	-	calculated from BW and FIR
Hamilton et al. 1981	101	NA	zinc carbonate	Japanese quail	hatchling	body weight (Exp. 5)	FD	2.0	3.87	101	-	-	-	-	-	-	-	calculated from BW and FIR
Hill 1974a	257	257	zinc sulfate	chicken	1 day	body weight gain	FD	2.0	0	6.42	25.7	64.2	128	257	-	-	-	calculated from BW and FIR
Lu and Combs 1988	107	107	zinc oxide	chicken	20 days	body weight gain (Exp. 3)	FD	3.0	7.47	107	-	-	-	-	-	-	-	calculated from BW and FIR
Lu et al. 1990	65	65	zinc oxide	chicken	2 weeks	body weight gain (Exp. 1)	FD	1.0	7.93	64.6	-	-	-	-	-	-	-	calculated from BW and FIR
Roberson and Schaible 1960	252	252	zinc oxide	chicken	1 day	body weight (Exp. 2)	FD	4.0	0	84.2	168	252	-	-	-	-	-	calculated from BW and FIR
Roberson and Schaible 1960	168	252	zinc sulfate	chicken	1 day	body weight (Exp. 2)	FD	4.0	0	84.2	168	252	-	-	-	-	-	calculated from BW and FIR
Roberson and Schaible 1960	168	252	zinc carbonate	chicken	1 day	body weight (Exp. 2)	FD	4.0	0	84.2	168	252	-	-	-	-	-	calculated from BW and FIR
Roberson and Schaible 1960	126	NA	zinc sulfate	chicken	1 day	body weight (Exp. 3)	FD	4.0	0	4.19	83.7	126	-	-	-	-	-	calculated from BW and FIR
Roberson and Schaible 1960	126	126	zinc carbonate	chicken	1 day	body weight (Exp. 3)	FD	4.0	0	83.7	126	-	-	-	-	-	-	calculated from BW and FIR
Roberson and Schaible 1960	126	NA	zinc oxide	chicken	1 day	body weight (Exp. 3)	FD	4.0	0	83.7	126	-	-	-	-	-	-	calculated from BW and FIR
Sandoval et al. 1988	136	136	zinc sulfate	chicken	1 day	body weight gain (Exp. 2)	FD	3.0	7.96	136	-	-	-	-	-	-	-	calculated from BW and FIR
Sandoval et al. 1988	136	136	zinc gluconate	chicken	1 day	body weight gain (Exp. 2)	FD	3.0	7.96	136	-	-	-	-	-	-	-	calculated from BW and FIR
Stahl et al. 1989	253	253	zinc carbonate	chicken	hatchling	body weight gain	FD	3.0	4.29	12	253	-	-	-	-	-	-	calculated from BW and FIR
Vohra and Kratzer 1968	423	423	zinc oxide	turkey	chick	body weight gain	FD	3.0	0	423	629	845	1060	-	-	-	-	calculated from BW and FIR
Reproduction																		
Gibson et al. 1986	no stats	125	zinc acetate dihydrate	chicken	30 weeks	egg production	FD	10.0	2.1	63.8	125	187	249	311	-	-	-	calculated from BW and FIR
Gibson et al. 1986	no stats	125	zinc oxide	chicken	30 weeks	egg production	FD	10.0	2.1	63.8	125	187	249	311	-	-	-	calculated from BW and FIR
Jackson et al. 1986	232	232	zinc oxide	chicken	40 weeks	egg production	FD	3.0	3.21	232	462	691	920	0	-	-	-	calculated from BW and FIR
Jackson et al. 1986	no stats	137	zinc oxide	chicken	40 weeks	egg production	FD	20.0	3.74	70.5	137	204	271	337	-	-	-	calculated from BW and FIR
Jensen and Maurice 1980	160	160	zinc sulfate	chicken	adult	egg production (Exp. 4)	FD	6.0	3.9	11.7	42.9	160	-	-	-	-	-	calculated from BW and FIR
Jensen and Maurice 1980	160	160	zinc sulfate	chicken	adult	egg production (Exp. 3)	FD	6.0	3.9	160	-	-	-	-	-	-	-	calculated from BW and FIR
Stepinska et al. 1987	no stats	1182	zinc oxide	chicken	71 weeks	egg production	FD	0.7	2.65	1180	-	-	-	-	-	-	-	calculated from BW and FIR
Stevenson et al. 1987	no stats	127	zinc oxide	chicken	28 weeks	egg production	FD	20.0	5.24	35.7	51	66.2	81.4	96.7	127	188	249	calculated from BW and FIR
Survival																		
Blalock and Hill 1988	no stats	263	zinc oxide	chicken	1 day	survival	FD	2.0	6.42	135	263	648	-	-	-	-	-	calculated from BW and FIR
Dewar et al. 1983	no stats	780	zinc oxide	chicken	15 days	survival (Exp. 1)	FD	4.0	9.5	266	523	780	-	-	-	-	-	calculated from BW and FIR
Dewar et al. 1983	no stats	523	zinc oxide	chicken	1 day	survival (Exp. 2)	FD	4.0	9.5	138	266	523	-	-	-	-	-	calculated from BW and FIR
Gasaway and Buss 1972	no stats	325	zinc carbonate	mallard	7 weeks	survival	FD	8.6	25	325	625	925	1230	-	-	-	-	calculated from BW and FIR
Gibson et al. 1986	no stats	311	zinc acetate	chicken	30 weeks	survival	FD	10.0	2.1	63.8	125	187	249	311	-	-	-	calculated from BW and FIR
Hamilton et al. 1979	no stats	430	zinc carbonate	Japanese quail	1 day	survival	FD	2.0	5.31	18.6	31.8	58.4	111	218	430	-	-	calculated from BW and FIR
Roberson and Schaible 1960	no stats	252	zinc carbonate	chicken	1 day	survival (Exp. 2)	FD	4.0	0	84.2	168	252	-	-	-	-	-	calculated from BW and FIR

Table B-10. Zn TRV Data for Birds

	Body Weight (kg)										**Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)**										
Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Dose 8	Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Dose 8	Source	Wet or Dry Weight Basis
Growth																					
Gasaway and Buss 1972	1.08	1.08	1.08	1.08	1.08	-	-	-	-	Dunning 1983	0.108	0.108	0.108	0.108	0.108	-	-	-	-	Heinz et al. 1987	dw
Hamilton et al. 1981	0.0335	0.0335	0.0335	-	-	-	-	-	-	present study	0.00707	0.00707	0.00707	-	-	-	-	-	-	Nagy 2001	dw
Hamilton et al. 1981	0.044	0.044	0.044	-	-	-	-	-	-	present study	0.00852	0.00852	-	-	-	-	-	-	-	Nagy 2001	dw
Hill 1974a	0.148	0.148	0.148	0.148	0.148	0.148	-	-	-	NRC 1994	0.019	0.019	0.019	0.019	0.019	0.019	-	-	-	NRC 1994	dw
Lu and Combs 1988	0.16	0.16	-	-	-	-	-	-	-	USEPA 1988	0.0159	0.0159	-	-	-	-	-	-	-	USEPA 1988	dw
Lu et al. 1990	0.07	0.07	-	-	-	-	-	-	-	USEPA 1988	0.00793	0.00793	-	-	-	-	-	-	-	USEPA 1988	dw
Roberson and Schaible 1960	0.476	0.476	0.476	0.476	-	-	-	-	-	present study	0.0401	0.0401	0.0401	0.0401	-	-	-	-	-	USEPA 1988	dw
Roberson and Schaible 1960	0.476	0.476	0.476	0.476	-	-	-	-	-	present study	0.0401	0.0401	0.0401	0.0401	-	-	-	-	-	USEPA 1988	dw
Roberson and Schaible 1960	0.476	0.476	0.476	0.476	-	-	-	-	-	present study	0.0401	0.0401	0.0401	0.0401	-	-	-	-	-	USEPA 1988	dw
Roberson and Schaible 1960	0.491	0.491	0.491	0.491	-	-	-	-	-	present study	0.0411	0.0411	0.0411	0.0411	-	-	-	-	-	USEPA 1988	dw
Roberson and Schaible 1960	0.491	0.491	0.491	-	-	-	-	-	-	present study	0.0411	0.0411	0.0411	-	-	-	-	-	-	USEPA 1988	dw
Roberson and Schaible 1960	0.491	0.491	0.491	-	-	-	-	-	-	present study	0.0411	0.0411	0.0411	-	-	-	-	-	-	USEPA 1988	dw
Sandoval et al. 1988	0.148	0.148	-	-	-	-	-	-	-	NRC 1994	0.019	0.019	-	-	-	-	-	-	-	NRC 1994	dw
Sandoval et al. 1988	0.148	0.148	-	-	-	-	-	-	-	NRC 1994	0.019	0.019	-	-	-	-	-	-	-	NRC 1994	dw
Stahl et al. 1989	0.06	0.06	0.06	-	-	-	-	-	-	USEPA 1988	0.00696	0.00696	0.00696	-	-	-	-	-	-	USEPA 1988	dw
Vohra and Kratzer 1968	0.48	0.48	0.48	0.48	0.48	-	-	-	-	NRC 1994	0.0507	0.0507	0.0507	0.0507	0.0507	-	-	-	-	NRC 1994	dw
Reproduction																					
Gibson et al. 1986	1.95	1.95	1.95	1.95	1.95	1.95	-	-	-	present study	0.12	0.12	0.12	0.12	0.12	0.12	-	-	-	present study	NA
Gibson et al. 1986	1.95	1.95	1.95	1.95	1.95	1.95	-	-	-	present study	0.12	0.12	0.12	0.12	0.12	0.12	-	-	-	present study	NA
Jackson et al. 1986	1.88	1.88	1.88	1.88	1.88	-	-	-	-	present study	0.108	0.108	0.108	0.108	0.108	-	-	-	-	present study	NA
Jackson et al. 1986	1.85	1.85	1.85	1.85	1.85	1.85	-	-	-	present study	0.123	0.123	0.123	0.123	0.123	0.123	-	-	-	present study	NA
Jensen and Maurice 1980	0.78	0.78	0.78	0.78	-	-	-	-	-	USEPA 1988	0.0608	0.0608	0.0608	0.0608	-	-	-	-	-	USEPA 1988	dw
Jensen and Maurice 1980	0.78	0.78	-	-	-	-	-	-	-	USEPA 1988	0.0608	0.0608	-	-	-	-	-	-	-	USEPA 1988	dw
Stepinska et al. 1987	2.17	2.17	-	-	-	-	-	-	-	present study	0.128	0.128	-	-	-	-	-	-	-	present study	NA
Stevenson et al. 1987	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	1.69	present study	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103	present study	NA
Survival																					
Blalock and Hill 1988	0.148	0.148	0.148	0.148	-	-	-	-	-	NRC 1994	0.019	0.019	0.019	0.019	-	-	-	-	-	NRC 1994	dw
Dewar et al. 1983	0.148	0.148	0.148	0.148	-	-	-	-	-	NRC 1994	0.019	0.019	0.019	0.019	-	-	-	-	-	NRC 1994	dw
Dewar et al. 1983	0.148	0.148	0.148	0.148	-	-	-	-	-	NRC 1994	0.019	0.019	0.019	0.019	-	-	-	-	-	NRC 1994	dw
Gasaway and Buss 1972	1.08	1.08	1.08	1.08	1.08	-	-	-	-	Dunning 1983	0.108	0.108	0.108	0.108	0.108	-	-	-	-	Heinz et al. 1987	dw
Gibson et al. 1986	1.95	1.95	1.95	1.95	1.95	1.95	-	-	-	present study	0.12	0.12	0.12	0.12	0.12	0.12	-	-	-	present study	NA
Hamilton et al. 1979	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	-	-	Narinc et al. 2010	0.00698	0.00698	0.00698	0.00698	0.00698	0.00698	0.00698	-	-	Nagy 2001	dw
Roberson and Schaible 1960	0.476	0.476	0.476	0.476	-	-	-	-	-	present study	0.0401	0.0401	0.0401	0.0401	-	-	-	-	-	USEPA 1988	dw

Table B-10. Zn TRV Data for Birds

	Concentration in Food (mg/kg)										Effect								
Source	Control[b]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Dose 8	Wet or Dry Weight Basis	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Dose 8
Growth																			
Gasaway and Buss 1972	250	3250	6250	9250	12300	-	-	-	-	dw	102	76	66	52	58	-	-	-	-
Hamilton et al. 1981	20	270	520	-	-	-	-	-	-	dw	0.045	0.044	0.04	-	-	-	-	-	-
Hamilton et al. 1981	20	520	-	-	-	-	-	-	-	dw	0.044	0.036	-	-	-	-	-	-	-
Hill 1974a	0	50	200	500	1000	2000	-	-	-	dw	0.205	0.198	0.194	0.2	0.188	0.155	-	-	-
Lu and Combs 1988	75	1080	-	-	-	-	-	-	-	dw	96	52	-	-	-	-	-	-	-
Lu et al. 1990	70	570	-	-	-	-	-	-	-	dw	65.9	45.9	-	-	-	-	-	-	-
Roberson and Schaible 1960	0	1000	2000	3000	-	-	-	-	-	dw	0.476	0.488	0.441	0.337	-	-	-	-	-
Roberson and Schaible 1960	0	1000	2000	3000	-	-	-	-	-	dw	0.476	0.464	0.419	0.282	-	-	-	-	-
Roberson and Schaible 1960	0	1000	2000	3000	-	-	-	-	-	dw	0.476	0.483	0.407	0.214	-	-	-	-	-
Roberson and Schaible 1960	0	50	1000	1500	-	-	-	-	-	dw	0.491	0.5	0.47	0.402	-	-	-	-	-
Roberson and Schaible 1960	0	1000	1500	-	-	-	-	-	-	dw	0.491	0.49	0.39	-	-	-	-	-	-
Roberson and Schaible 1960	0	1000	1500	-	-	-	-	-	-	dw	0.491	0.497	0.455	-	-	-	-	-	-
Sandoval et al. 1988	62	1060	-	-	-	-	-	-	-	dw	0.0391	0.0261	-	-	-	-	-	-	-
Sandoval et al. 1988	62	1060	-	-	-	-	-	-	-	dw	0.0391	0.0195	-	-	-	-	-	-	-
Stahl et al. 1989	37	103	2180	-	-	-	-	-	-	dw	0.123	0.131	0.06	-	-	-	-	-	-
Vohra and Kratzer 1968	0	4000	5950	8000	10000	-	-	-	-	dw	0.407	0.325	0.258	0.167	0.15	-	-	-	-
Reproduction																			
Gibson et al. 1986	34	1030	2030	3030	4030	5030	-	-	-	dw	6.4	5.8	2.6	0.6	0.5	0.3	-	-	-
Gibson et al. 1986	34	1030	2030	3030	4030	5030	-	-	-	dw	6.4	6.2	4.6	1.9	0.5	0.4	-	-	-
Jackson et al. 1986	56	4060	8060	12100	16100	20100	-	-	-	dw	6	0.6	0	0	0	-	-	-	-
Jackson et al. 1986	56	1060	2060	3060	4060	5060	6060	-	-	dw	21.7	21.6	15.9	6.1	2.3	1.7	-	-	-
Jensen and Maurice 1980	50	150	550	2050	-	-	-	-	-	dw	82	72	79	53	-	-	-	-	-
Jensen and Maurice 1980	50	2050	-	-	-	-	-	-	-	dw	61	35	-	-	-	-	-	-	-
Stepinska et al. 1987	45	20000	-	-	-	-	-	-	-	dw	59	3.7	-	-	-	-	-	-	-
Stevenson et al. 1987	86	586	836	1090	1340	1590	2090	3090	4090	dw	111	114	115	103	101	92.5	75.5	24	10
Survival																			
Blalock and Hill 1988	50	1050	2050	5050	-	-	-	-	-	dw	100	100	80	60	-	-	-	-	-
Dewar et al. 1983	74	2070	4070	6070	-	-	-	-	-	dw	95.5	100	90.9	59.1	-	-	-	-	-
Dewar et al. 1983	74	1070	2070	4070	-	-	-	-	-	dw	0.975	0.925	1	0.775	-	-	-	-	-
Gasaway and Buss 1972	250	3250	6250	9250	12300	-	-	-	-	dw	100	33	0	0	0	-	-	-	-
Gibson et al. 1986	34	1030	2030	3030	4030	5030	-	-	-	dw	100	100	100	100	100	42.9	-	-	-
Hamilton et al. 1979	25	87.5	150	275	525	1030	2030	-	-	dw	90	90	100	90	78	80	40	-	-
Roberson and Schaible 1960	0	1000	2000	3000	-	-	-	-	-	dw	96.7	100	96.7	76.7	-	-	-	-	-

Table B-10. Zn TRV Data for Birds

	Effect (continued)	**Effect Relative to Control (%)**								
Source	Description	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Dose 8
Growth										
Gasaway and Buss 1972	average percent of original weight at day 40	100	75	65	51	57	-	-	-	-
Hamilton et al. 1981	body weight at 14 days (kg)	100	98	89	-	-	-	-	-	-
Hamilton et al. 1981	body weight at 14 days (kg)	100	82	-	-	-	-	-	-	-
Hill 1974a	average body weight gain (kg)	100	97	95	98	92	76	-	-	-
Lu and Combs 1988	average weight gain/chick (g)	100	54	-	-	-	-	-	-	-
Lu et al. 1990	% body weight gain	100	70	-	-	-	-	-	-	-
Roberson and Schaible 1960	average final body weight (kg)	100	103	93	71	-	-	-	-	-
Roberson and Schaible 1960	average final body weight (kg)	100	97	88	59	-	-	-	-	-
Roberson and Schaible 1960	average final body weight (kg)	100	101	86	45	-	-	-	-	-
Roberson and Schaible 1960	average final body weight (kg)	100	102	96	82	-	-	-	-	-
Roberson and Schaible 1960	average final body weight (kg)	100	100	79	-	-	-	-	-	-
Roberson and Schaible 1960	average final body weight (kg)	100	101	93	-	-	-	-	-	-
Sandoval et al. 1988	average daily body weight gain (kg)	100	67	-	-	-	-	-	-	-
Sandoval et al. 1988	average daily body weight gain (kg)	100	50	-	-	-	-	-	-	-
Stahl et al. 1989	weight gain (kg)	100	107	49	-	-	-	-	-	-
Vohra and Kratzer 1968	average weight gain (kg), Experiment 2 (no EDTA supplement)	100	80	63	41	37	-	-	-	-
Reproduction										
Gibson et al. 1986	egg production (#)	100	91	41	9	8	5	-	-	-
Gibson et al. 1986	egg production (#)	100	97	72	30	8	6	-	-	-
Jackson et al. 1986	egg production (#) at 3 weeks	100	10	0	0	0	-	-	-	-
Jackson et al. 1986	egg production (#) at 20 weeks	100	100	73	28	11	8	-	-	-
Jensen and Maurice 1980	egg production % (Exp. 4)	100	88	96	65	-	-	-	-	-
Jensen and Maurice 1980	egg production % (Exp. 3)	100	57	-	-	-	-	-	-	-
Stepinska et al. 1987	egg production (%)	100	6	-	-	-	-	-	-	-
Stevenson et al. 1987	egg number (140 days)	100	103	104	93	91	84	68	22	9
Survival										
Blalock and Hill 1988	Cumulative survival (%)	100	100	80	60	-	-	-	-	-
Dewar et al. 1983	% survival at 6 weeks	100	105	95	62	-	-	-	-	-
Dewar et al. 1983	% survival at 4 weeks	100	95	103	79	-	-	-	-	-
Gasaway and Buss 1972	% survival at 60 days	100	33	0	0	0	-	-	-	-
Gibson et al. 1986	% survival	100	100	100	100	100	43	-	-	-
Hamilton et al. 1979	% survival at 2 weeks	100	100	111	100	87	89	44	-	-
Roberson and Schaible 1960	% survival	100	103	100	79	-	-	-	-	-

Notes:

Concentrations in food were assumed to be reported on a dry weight basis unless clearly stated otherwise in the study. The wet or dry weight basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

Lowest-observed-adverse-effect levels (LOAELs) are reported in mg/kg bw/day.

[a] LOAEL determined by study based on statistical analyses.

[b] If reported, the basal diet concentration is included in the control diet concentration.

Table B-11. Zinc TRV Data for Mammals

									Dose (mg/kg bw/day)						
Source	Reported LOAEL^a	LOAEL ≥ 20	Chemical form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	4	5	Notes
Growth															
Barone et al. 1998	93	NA	not specified	rat	adult (200-250 g)	body weight	FD	Day 11 of gestation to day before expected delivery	3.01	92.8	-	-	-	-	calculated from BW and FIR
Brink et al. 1959	no stats	242	not specified	pig	weanling	body weight (Exp. 1)	FD	6.0	0	35	60.5	121	242	484	calculated from BW and FIR
Brink et al. 1959	no stats	312	not specified	pig	weanling	body weight (Exp. 2)	FD	5.0	3.62	42.2	80.8	158	312	0	calculated from BW and FIR
Brink et al. 1959	no stats	195	not specified	pig	weanling	body weight (Exp. 3)	FD	6.0	2.25	195	-	-	-	-	calculated from BW and FIR
Hill et al. 1983	47	47	zinc oxide	pig	30 kg BW	body weight	FD	from 30 kg body weight to 18 months old	0	0.475	4.75	47.5	-	-	calculated from BW and FIR
Hsu et al. 1975	no stats	NA	zinc oxide	pig	4 weeks	body weight	FD	9-13	3.43	175	-	-	-	-	calculated from BW and FIR
Khan et al. 2007	7.2	7.2	zinc chloride	rat	adult	male body weight	GV	14.0	0	3.6	7.2	14.4	-	-	doses presented in paper
Maita et al. 1981	19400	19400	zinc sulfate	mouse	5 weeks	body weight (female)	FD	13.0	0	194	1940	19400	-	-	doses presented in paper
Maita et al. 1981	18549	NA	zinc sulfate	mouse	5 weeks	body weight (male)	FD	13.0	0	185	1850	18500	-	-	doses presented in paper
Maita et al. 1981	9477	NA	zinc sulfate	rat	5 weeks	body weight (male)	FD	13.0	0	94.8	948	9480	-	-	doses presented in paper
Nakamura et al. 1983	9.7	NA	zinc acetate	rat	not reported (148 g)	body weight	FD	11.0	0	9.72	-	-	-	-	calculated from BW and FIR
Petterson et al. 2002	no stats	NA	zinc chloride	mouse	4.5 weeks	body weight	FD	3.0	0	1060	2130	-	-	-	calculated from BW and FIR
Settlemire and Matrone 1967	917	917	zinc carbonate	rat	4-6 weeks	body weight gain	FD	5.0	0	917	-	-	-	-	calculated from BW and FIR
Subramanian et al. 2000	33	NA	zinc oxide	rat	adult	body weight	FD	6.0	0.000739	4.16	33.3	-	-	-	calculated from BW and FIR
Reproduction															
Barone et al. 1998	75	NA	not specified	rat	adult	litter size	FD	gestation	2.42	74.7	-	-	-	-	calculated from BW and FIR
Chu and Cox 1972	380	380	not specified	rat	adult	offspring growth	FD	3.0	0	380	-	-	-	-	calculated from BW and FIR
Cox et al. 1969	375	NA	zinc oxide	rat	adult	fetal growth	FD	3.1	0.842	375	-	-	-	-	calculated from BW and FIR
Ketcheson et al. 1969	355	355	zinc oxide	rat	adult	offspring growth	FD	gestation to 14 days lactation	0.638	143	355	-	-	-	calculated from BW and FIR
Khan et al. 2007	14.4	14	zinc chloride	rat	adult (female)	offspring survival	GV	20.0	0	3.6	7.2	14.4	-	-	doses presented in paper
Kumar 1976	14	NA	zinc sulfate	rat	100 days	fetal survival	FD	2.6	2.4	14.4	-	-	-	-	calculated from BW and FIR
Newman et al. 2002	no stats	232	zinc acetate dihydrate	rat	adult	offspring survival	FD	gestational day 5 to post-natal day 40	0	232	-	-	-	-	calculated from BW and FIR
Pal and Pal 1987	no stats	417	zinc sulfate	rat	120-130 days	normal fetuses	FD	2.6	1.25	417	-	-	-	-	calculated from BW and FIR
Schlicker and Cox 1968	no stats	404	zinc oxide	rat	adult	fetal survival	FD	2.1	0	404	-	-	-	-	calculated from BW and FIR
Schlicker and Cox 1968	404	404	zinc oxide	rat	adult	fetal growth	FD	2.1	0	404	-	-	-	-	calculated from BW and FIR
Schlicker and Cox 1968	404	404	zinc oxide	rat	adult	fetal growth	FD	2.6	0	404	-	-	-	-	calculated from BW and FIR
Schlicker and Cox 1968	no stats	404	zinc oxide	rat	adult	fetal survival	FD	5.1	0	404	-	-	-	-	doses presented in paper
Survival															
Brink et al. 1959	no stats	121	zinc carbonate	pig	6	survival (Exp. 1)	FD	2 years	0	30.3	60.6	121	242	485	calculated from BW and FIR
Brink et al. 1959	no stats	313	zinc carbonate	pig	5	survival (Exp. 2)	FD	2 years	3.62	42.2	80.9	158	313	-	calculated from BW and FIR
Brink et al. 1959	no stats	195	zinc carbonate	pig	6	survival (Exp. 3)	FD	2 years	2.26	195	-	-	-	-	calculated from BW and FIR
Straube et al. 1980	no stats	858	zinc oxide	ferret	2-24	survival	FD	2 years	7.65	149	433	858	-	-	calculated from BW and FIR

Table B-11. Zinc TRV Data for Mammals

	Body Weight (kg)							Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)							
Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source	Wet or Dry Weight
Growth															
Barone et al. 1998	0.225	0.225	-	-	-	-	present study	0.0209	0.0209	-	-	-	-	USEPA 1988	dw
Brink et al. 1959	28.1	28.1	32.6	32.6	32.6	32.6	present study	1.97	1.97	1.97	1.97	1.97	1.97	present study	NA
Brink et al. 1959	23.7	23.7	23.7	23.7	23.7	-	present study	1.83	1.83	1.83	1.83	1.83	0	present study	NA
Brink et al. 1959	30.5	30.5	-	-	-	-	present study	1.46	1.47	-	-	-	-	present study	NA
Hill et al. 1983	141	141	141	141	-	-	present study	1.34	1.34	1.34	1.34	-	-	Nagy 2001	dw
Hsu et al. 1975	29.7	29.7	-	-	-	-	present study	1.28	1.28	-	-	-	-	present study	NA
Khan et al. 2007	-	-	-	-	-	-	NA (dose provided in paper)	-	-	-	-	-	-	NA (dose provided in paper)	NA
Maita et al. 1981	0.033	0.033	0.033	0.033	-	-	present study	0.00587	0.00587	0.00587	0.00587	-	-	USEPA 1988	dw
Maita et al. 1981	0.0375	0.0375	0.0375	0.0375	-	-	present study	0.00639	0.00639	0.00639	0.00639	-	-	USEPA 1988	dw
Maita et al. 1981	0.29	0.29	0.29	0.29	-	-	present study	0.0247	0.0247	0.0247	0.0247	-	-	USEPA 1988	dw
Nakamura et al. 1983	0.165	0.165	-	-	-	-	present study	0.008	0.008	-	-	-	-	present study	dw
Petterson et al. 2002	0.0173	0.0173	0.0173	-	-	-	present study	0.00382	0.00382	0.00382	-	-	-	USEPA 1988	dw
Settlemire and Matrone 1967	0.1	0.1	-	-	-	-	USEPA 1988	0.0122	0.0122	-	-	-	-	USEPA 1988	dw
Subramanian et al. 2000	0.18	0.18	0.18	-	-	-	present study	0.015	0.015	0.015	-	-	-	present study	dw
Reproduction															
Barone et al. 1998	0.427	0.427	-	-	-	-	present study	0.0319	0.0319	-	-	-	-	USEPA 1988	dw
Chu and Cox 1972	0.21	0.21	-	-	-	-	USEPA 1988	0.02	0.02	-	-	-	-	USEPA 1988	dw
Cox et al. 1969	0.22	0.22	-	-	-	-	present study	0.0206	0.0206	-	-	-	-	USEPA 1988	dw
Ketcheson et al. 1969	0.277	0.277	0.277	-	-	-	present study	0.0197	0.0197	0.0197	0	-	-	present study	NA
Khan et al. 2007	-	-	-	-	-	-	NA (dose provided in paper)	-	-	-	-	-	-	NA (dose provided in paper)	NA
Kumar 1976	0.35	0.35	-	-	-	-	USEPA 1988	0.028	0.028	-	-	-	-	EPA 1988	dw
Newman et al. 2002	0.2	0.2	-	-	-	-	present study	0.012	0.012	-	-	-	-	present study	NA
Pal and Pal 1987	0.16	0.16	-	-	-	-	USEPA 1988	0.0167	0.0167	-	-	-	-	USEPA 1988	dw
Schlicker and Cox 1968	0.175	0.175	-	-	0	0	present study	0.0177	0.0177	-	-	-	-	USEPA 1988	dw
Schlicker and Cox 1968	0.175	0.175	-	-	-	-	present study	0.0177	0.0177	-	-	-	-	USEPA 1988	dw
Schlicker and Cox 1968	0.175	0.175	-	-	-	-	present study	0.0177	0.0177	-	-	-	-	USEPA 1988	dw
Schlicker and Cox 1968	0.175	0.175	-	-	-	-	present study	0.0177	0.0177	-	-	-	-	USEPA 1988	dw
Survival															
Brink et al. 1959	32.6	32.6	32.6	32.6	32.6	32.6	present study	1.97	1.97	1.97	1.97	1.97	1.97	present study	NA
Brink et al. 1959	23.7	23.7	23.7	23.7	23.7	-	present study	1.83	1.83	1.83	1.83	1.83	-	present study	NA
Brink et al. 1959	30.5	30.5	-	-	-	-	present study	1.47	1.47	-	-	-	-	present study	NA
Straube et al. 1980	0.6	0.6	0.6	0.6	-	-	present study	0.17	0.17	0.17	0.17	-	-	present study	NA

Table B-11. Zinc TRV Data for Mammals

	Concentration in Food (mg/kg)							Effect					
Source	Control[b]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Wet or Dry Weight Basis	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth													
Barone et al. 1998	32.4	1000	-	-	-	-	dw	0.427	0.395	-	-	-	-
Brink et al. 1959	0	500	1000	2000	4000	8000	dw	85	86.3	86.3	74.6	61.9	43.9
Brink et al. 1959	46.9	547	1050	2050	4050	0	dw	74.6	75.8	77	74.8	49.6	-
Brink et al. 1959	46.9	4050	-	-	-	-	dw	93.6	71.3	-	-	-	-
Hill et al. 1983	0	50	500	5000	-	-	dw	193	181	190	144	-	-
Hsu et al. 1975	80	4080	-	-	-	-	dw	59.5	50.2	-	-	-	-
Khan et al. 2007	-	-	-	-	-	-	NA	223	179	165	161	-	-
Maita et al. 1981	0	122	1220	12200	-	-	dw	0.042	0.045	0.043	0.031	-	-
Maita et al. 1981	0	122	1220	12200	-	-	dw	0.047	0.047	0.044	0.038	-	-
Maita et al. 1981	0	122	1220	12200	-	-	dw	0.45	0.46	0.43	0.37	-	-
Nakamura et al. 1983	0	200	-	-	-	-	dw	0.196	0.184	-	-	-	-
Petterson et al. 2002	0	4800	9600	-	-	-	dw	20	-	17	-	-	-
Settlemire and Matrone 1967	0	7500	-	-	-	-	dw	0.172	0.074	-	-	-	-
Subramanian et al. 2000	0.00888	50	400	-	-	-	dw	0.22	0.218	0.198	-	-	-
Reproduction													
Barone et al. 1998	32.4	1000	-	-	-	-	dw	14.7	12.6	-	-	-	-
Chu and Cox 1972	0	4000	-	-	-	-	dw	0.0194	0.0102	-	-	-	-
Cox et al. 1969	9	4010	-	-	-	-	dw	0.546	0.439	-	-	-	-
Ketcheson et al. 1969	9	2010	5010	-	-	-	dw	8.89	9.47	7.09	-	-	-
Khan et al. 2007	-	-	-	-	-	-	NA	96.1	94.5	88.1	74.4	-	-
Kumar 1976	30	180	-	-	-	-	dw	2	9.5	-	-	-	-
Newman et al. 2002	0	3870	-	-	-	-	dw	100	0	-	-	-	-
Pal and Pal 1987	12	4000	-	-	-	-	dw	82	24	-	-	-	-
Schlicker and Cox 1968	0	4000	-	-	-	-	dw	0	29	-	-	-	-
Schlicker and Cox 1968	0	4000	-	-	-	-	dw	0.0212	0.0162	-	-	-	-
Schlicker and Cox 1968	0	4000	-	-	-	-	dw	0.132	0.0987	-	-	-	-
Schlicker and Cox 1968	0	4000	-	-	-	-	dw	0	100	-	-	-	-
Survival													
Brink et al. 1959	0	500	1000	2000	4000	8000	dw	100	100	100	67	50	83
Brink et al. 1959	46.9	547	1050	2050	4050	-	dw	100	100	100	100	75	-
Brink et al. 1959	46.9	4050	-	-	-	-	dw	100	62.5	-	-	-	-
Straube et al. 1980	27	527	1530	3030	-	-	ww	100	100	100	0	-	-

Table B-11. Zinc TRV Data for Mammals

	Effect (continued)	**Effect Relative to Control (%)**					
Source	Description	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth							
Barone et al. 1998	body weight of dams	100	92	-	-	-	-
Brink et al. 1959	final body weight (lbs) using initial and average daily gain	100	101	102	88	73	52
Brink et al. 1959	final body weight (lbs) using initial and average daily gain	100	102	103	100	67	-
Brink et al. 1959	average daily gain (kg)	100	76	-	-	-	-
Hill et al. 1983	average final (18 months) weight (kg)	100	94	98	75	-	-
Hsu et al. 1975	final body weight based on intial plus average weight gain/day (low Ca)	100	84	-	-	-	-
Khan et al. 2007	male body weight gain (g)	100	80	74	72	-	-
Maita et al. 1981	final weight (kg)	100	107	102	74	-	-
Maita et al. 1981	final weight (kg)	100	100	94	81	-	-
Maita et al. 1981	final weight (kg)	100	102	96	82	-	-
Nakamura et al. 1983	body weight at 11 weeks (kg)	100	94	-	-	-	-
Petterson et al. 2002	final body weight (g)	100	-	85	-	-	-
Settlemire and Matrone 1967	body weight gain (kg)	100	43	-	-	-	-
Subramanian et al. 2000	body weight (kg)	100	99	90	-	-	-
Reproduction							
Barone et al. 1998	litter size	100	86	-	-	-	-
Chu and Cox 1972	offspring body weight gain at 21 days (kg)	100	53	-	-	-	-
Cox et al. 1969	fetal bw at 22 days (g)	100	80	-	-	-	-
Ketcheson et al. 1969	14-day old body weight (dry weight) (g)	100	107	80	-	-	-
Khan et al. 2007	4-day survival index	100	98	92	77	-	-
Kumar 1976	% resorptions	100	92	-	-	-	-
Newman et al. 2002	% of pups surviving	100	0	-	-	-	-
Pal and Pal 1987	no. normal fetuses	100	29	-	-	-	-
Schlicker and Cox 1968	% resorption at 15 days	100	71	-	-	-	-
Schlicker and Cox 1968	fetal body weight at 15 days (g)	100	76	-	-	-	-
Schlicker and Cox 1968	fetal body weight at 18 days (g)	100	75	-	-	-	-
Schlicker and Cox 1968	% resorption at 15 + 16 days	100	0	-	-	-	-
Survival							
Brink et al. 1959	% survival	100	100	100	67	50	83
Brink et al. 1959	% survival	100	100	100	100	75	-
Brink et al. 1959	% survival	100	63	-	-	-	-
Straube et al. 1980	% survival	100	100	100	0	-	-

Notes:

selected to match the basis of the food concentration.

Lowest-observed-adverse-effect levels (LOAELs) are reported in mg/kg bw/day.

[a] LOAEL determined by study based on statistical analyses

[b] If reported, the basal diet concentration is included in the control diet concentration

APPENDIX B-2

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REFERENCES

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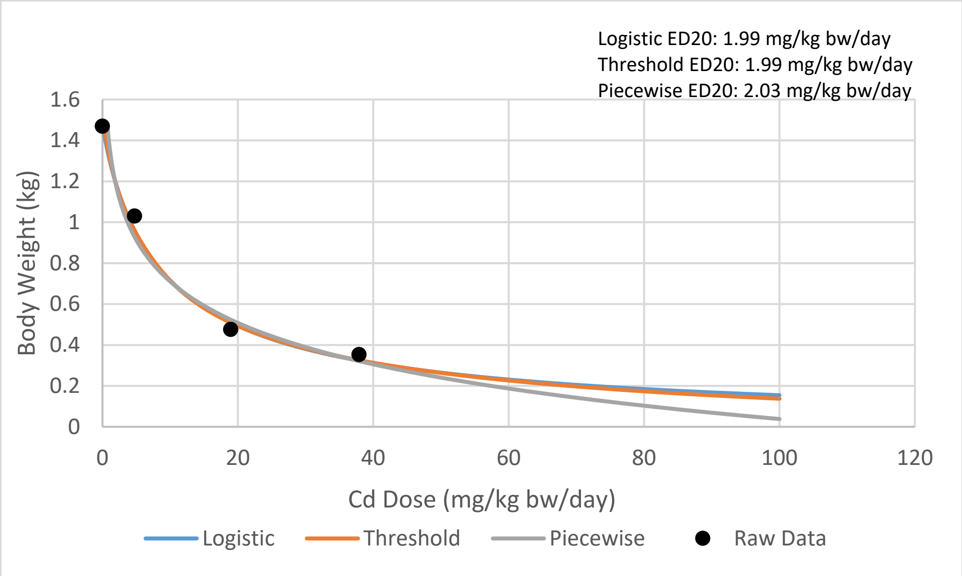
APPENDIX C

MODELED DOSE-RESPONSE CURVES

APPENDIX C-1

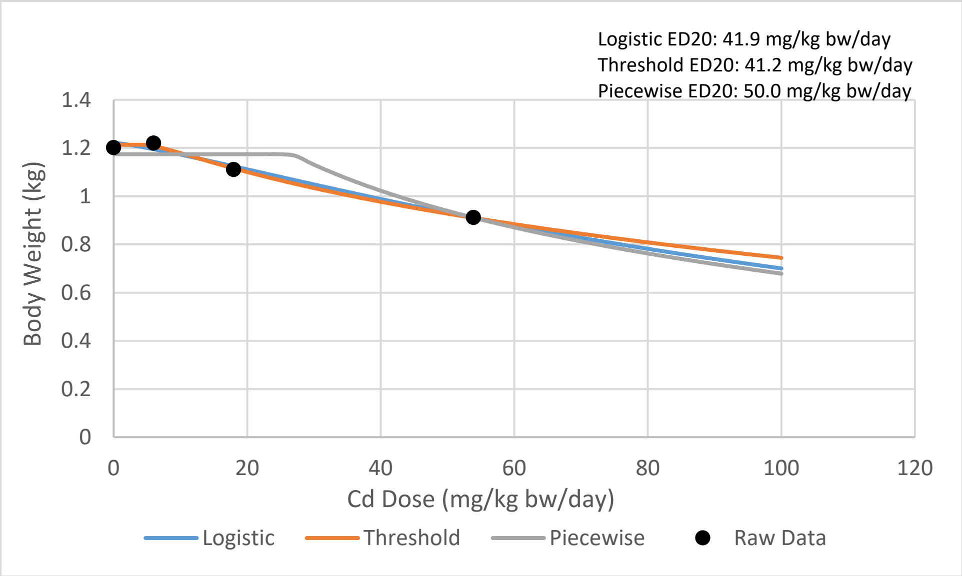
MODELED DOSE-RESPONSE CURVES FOR BIRD TRV DERIVATION



Logistic ED20: 1.99 mg/kg bw/day
Threshold ED20: 1.99 mg/kg bw/day
Piecewise ED20: 2.03 mg/kg bw/day

Log-transformed data from Bokori et al. (1995a)

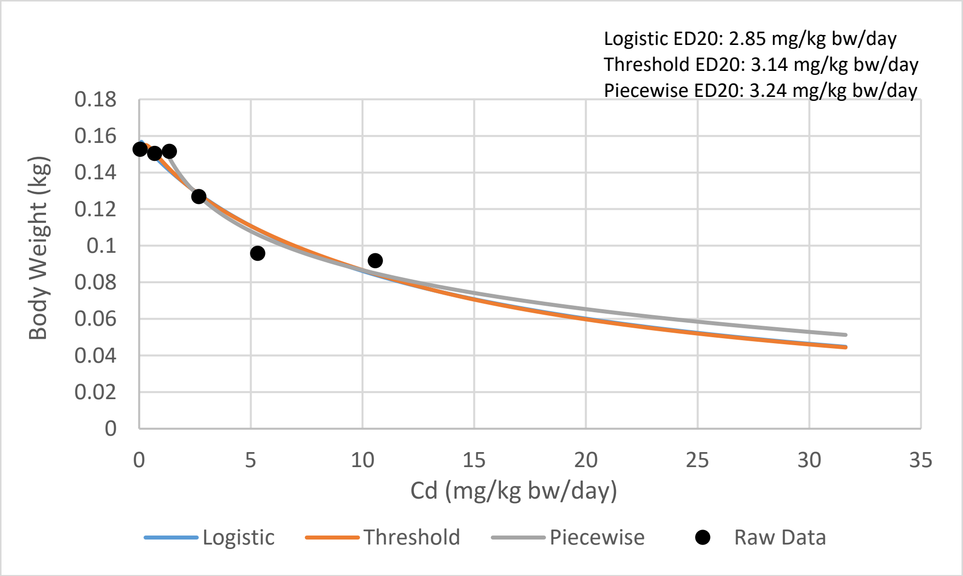
Figure C-1. Dose-Response Curves for Avian Growth Endpoint for Cadmium



Logistic ED20: 41.9 mg/kg bw/day
Threshold ED20: 41.2 mg/kg bw/day
Piecewise ED20: 50.0 mg/kg bw/day

Log-transformed data from DiGiulio and Scanlon (1984)

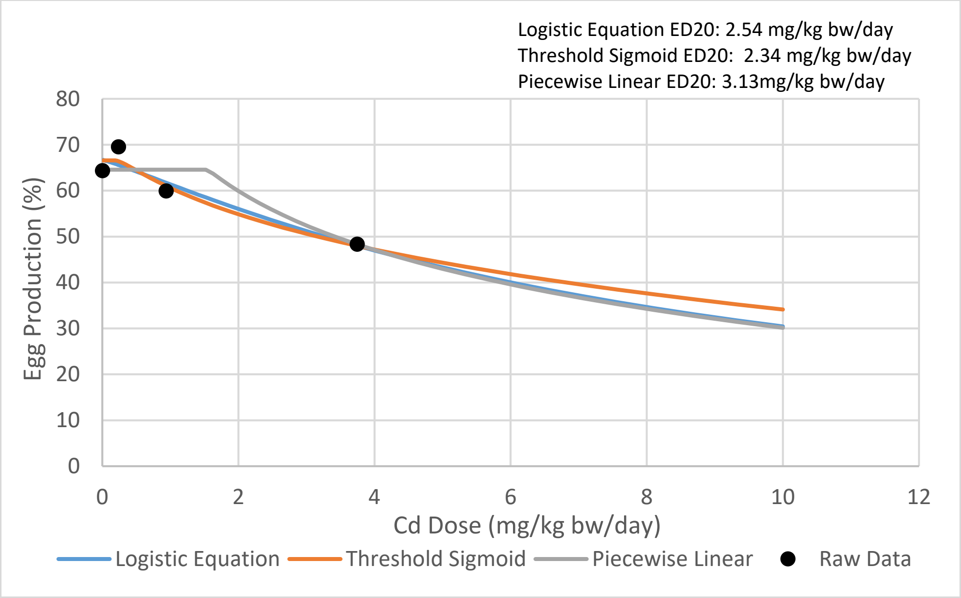
Figure C-2. Dose-Response Curves for Avian Growth Endpoint for Cadmium



Logistic ED20: 2.85 mg/kg bw/day
Threshold ED20: 3.14 mg/kg bw/day
Piecewise ED20: 3.24 mg/kg bw/day

Log-transformed data from Olgun (2015)

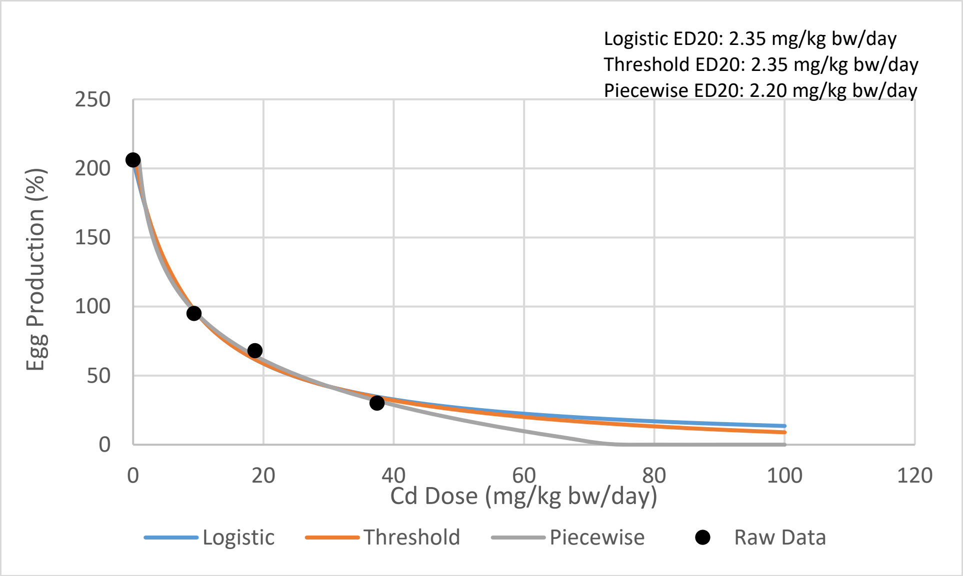
Figure C-3. Dose-Response Curves for Avian Growth Endpoint for Cadmium



Logistic Equation ED20: 2.54 mg/kg bw/day
Threshold Sigmoid ED20: 2.34 mg/kg bw/day
Piecewise Linear ED20: 3.13mg/kg bw/day

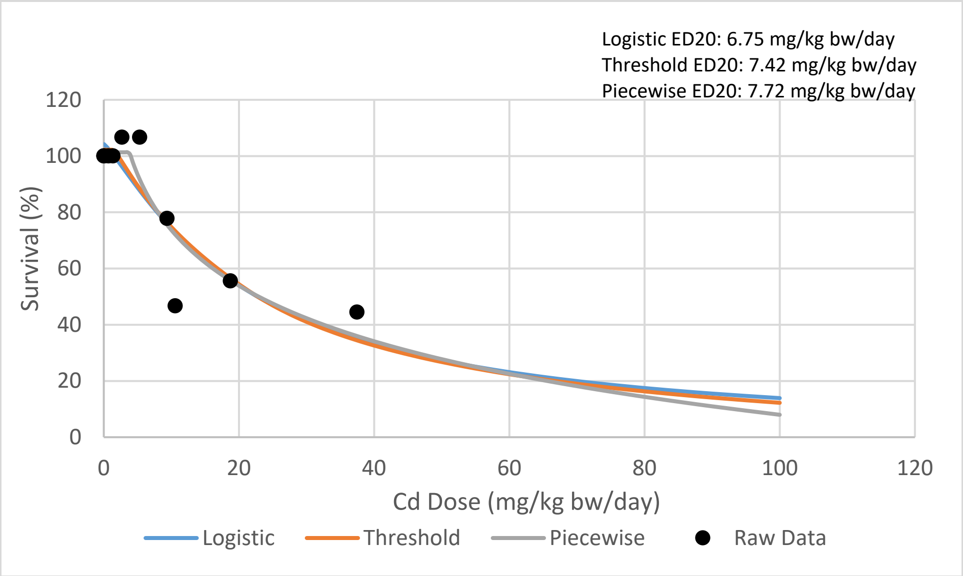
Log-transformed data from Leach et al. (1979)

Figure C-4. Dose-Response Curves for Avian Reproduction Endpoint for Cadmium



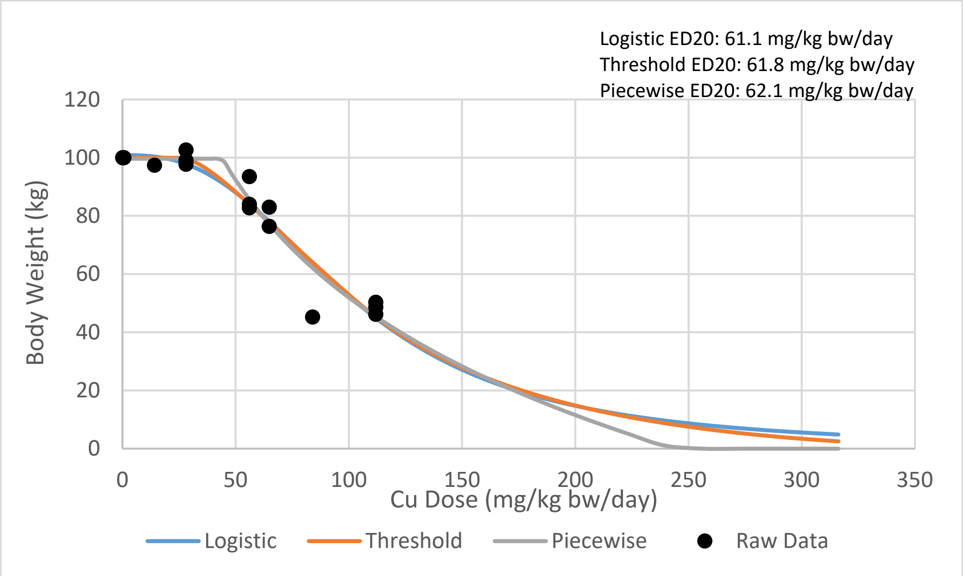
Log-transformed data from Bokori et al. (1995a)

Figure C-5. Dose-Response Curves for Avian Reproduction Endpoint for Cadmium



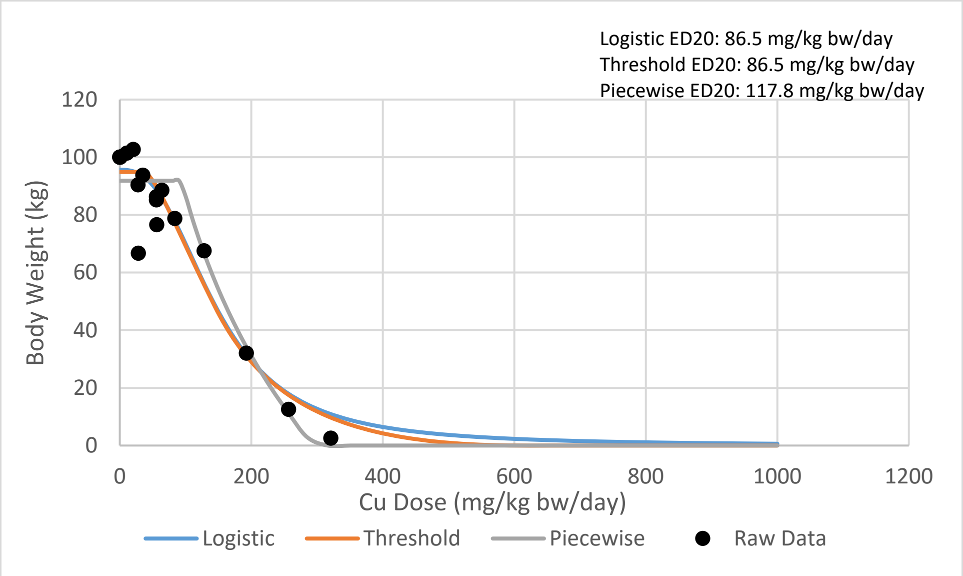
Log-transformed data from pooled group C: Bokori et al. (1995b) and Olgun (2015)

Figure C-6. Dose-Response Curves for Avian Survival Endpoint for Cadmium



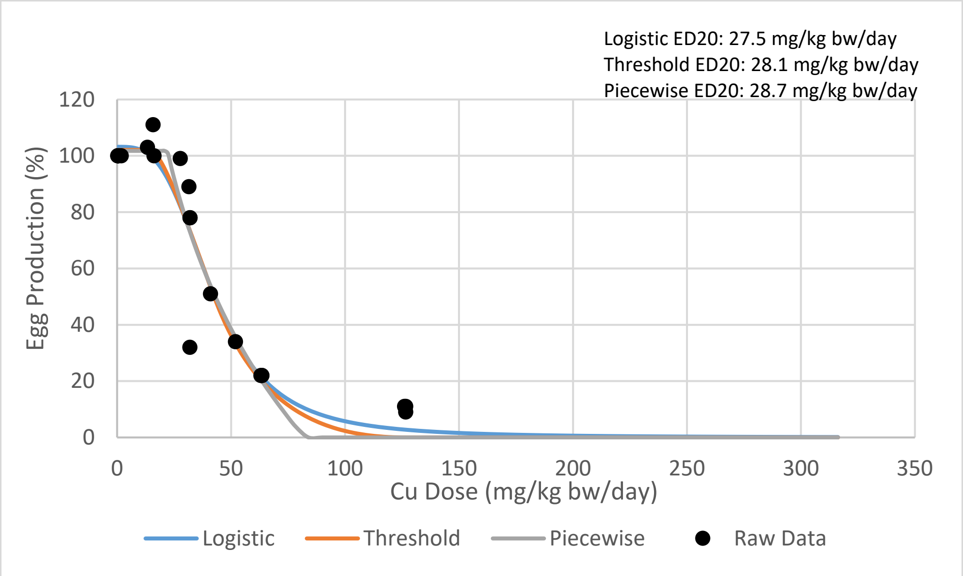
Log-transformed data from pooled group D: Poupoulis and Jensen (1976) and Wang et al. (1987)

Figure C-7. Dose-Response Curves for Avian Growth Endpoint for Copper



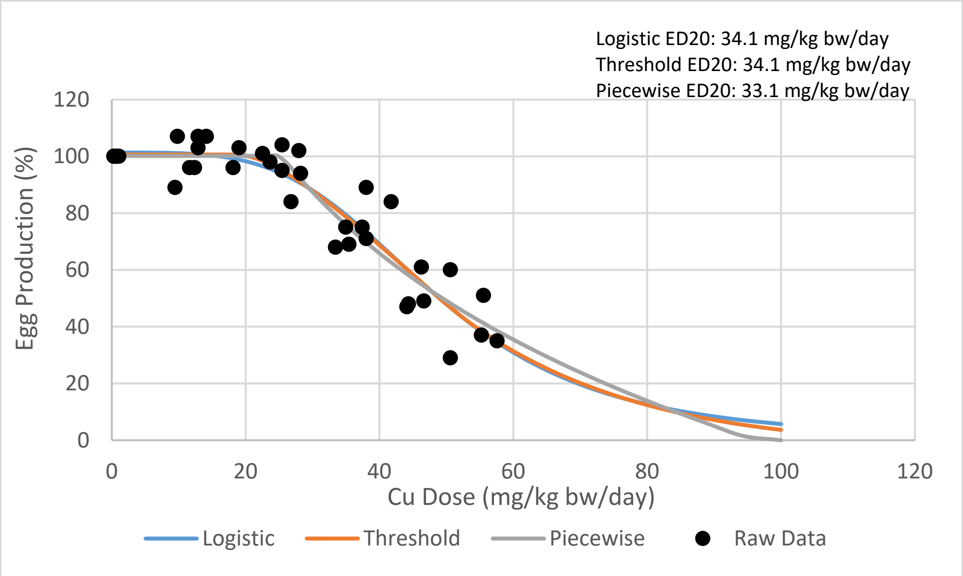
Log-transformed data from Hill (1974), Jensen and Maurice (1978), Smith (1969), and Latymer and Cotes (1981)

Figure C-8. Dose-Response Curves for Avian Growth Endpoint for Copper



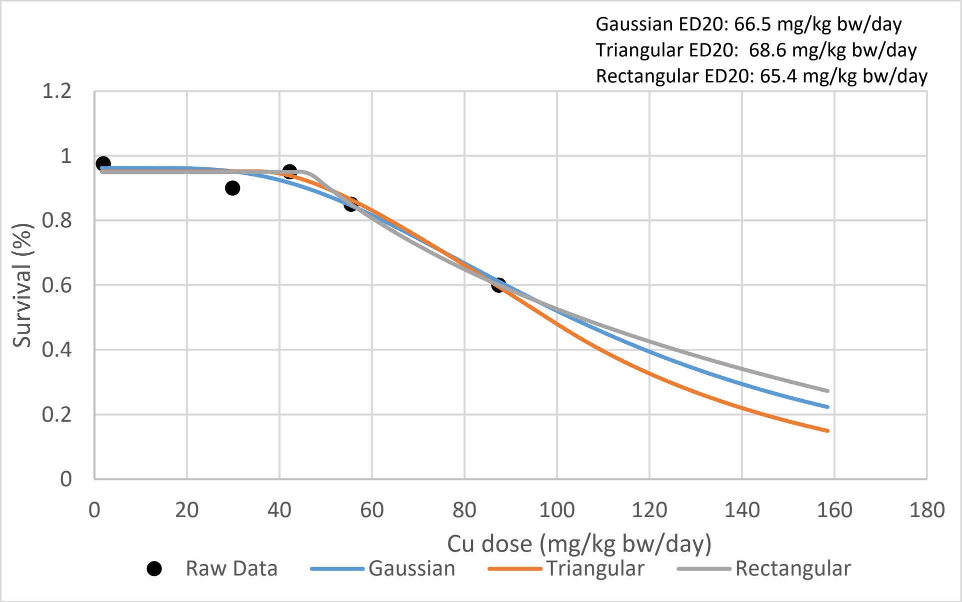
Log-transformed data from pooled group A: Chiou et al. (1997), Harms and Buresh (1986), Pearce et al. (1983), and Stevenson and Jackson (1980a, b)

Figure C-9. Dose-Response Curves for Avian Reproduction Endpoint for Copper



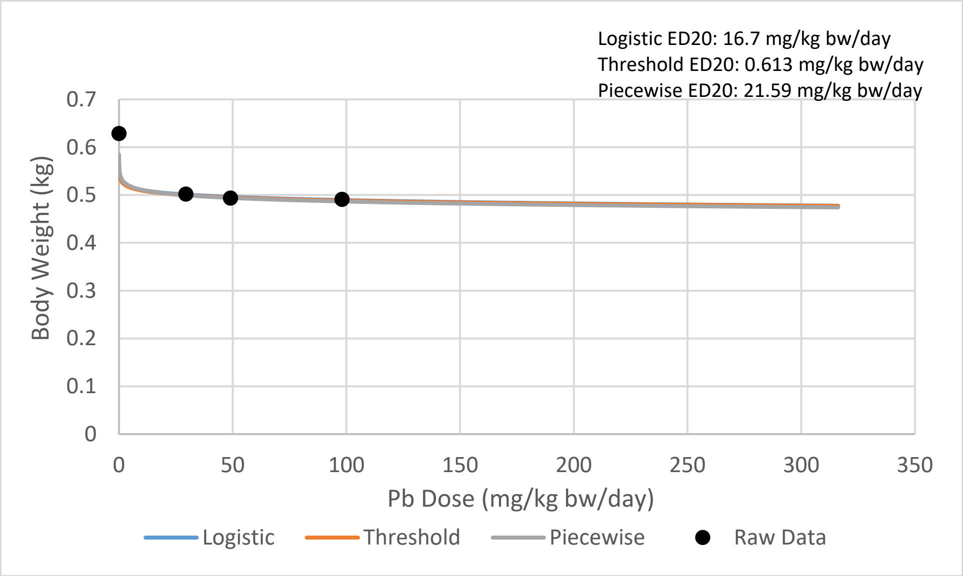
Log-transformed data from pooled group B: Jackson and Stevenson (1981a,b), and Jackson et al. (1979)

Figure C-10. Dose-Response Curves for Avian Reproduction Endpoint for Copper



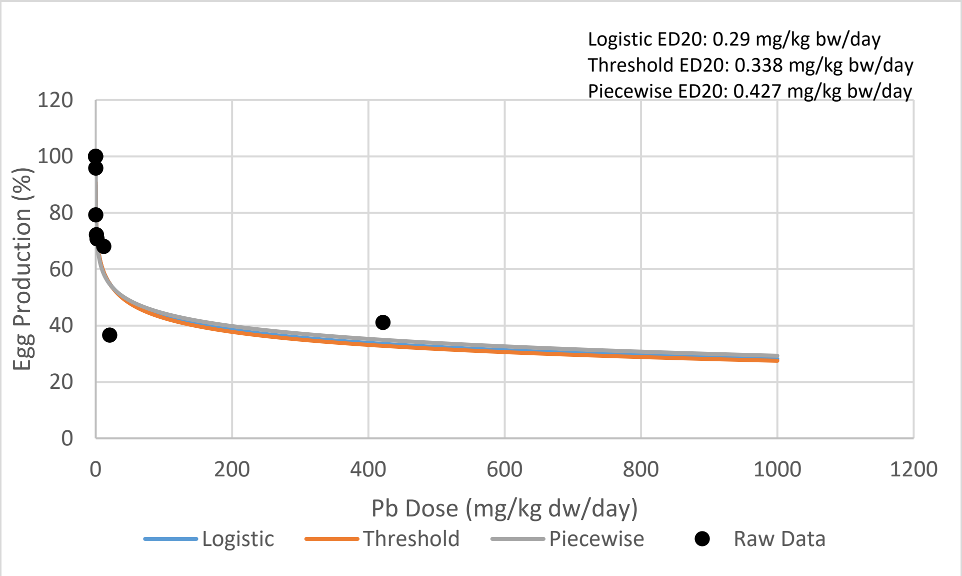
Log-transformed data from Mehring et al. (1960)

Figure C-11. Dose-Response Curves for Avian Survival Endpoint for Copper



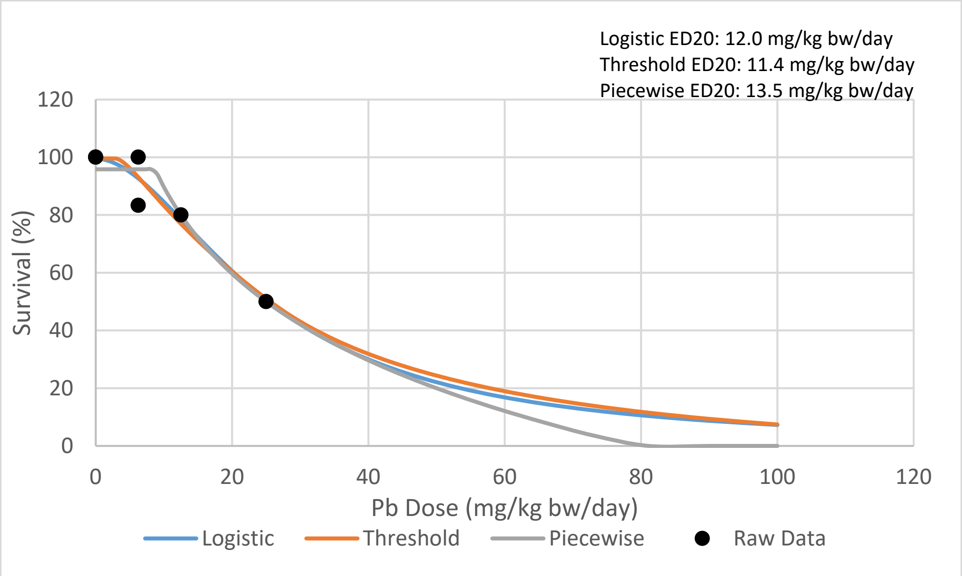
Log-transformed data from Abduljaleel and Shuhaimi-Othman (2013)
Note: Fit was poor for all three models, so an ED20 was not used for TRV derivation.

Figure C-12. Dose-Response Curves for Avian Growth Endpoint for Lead



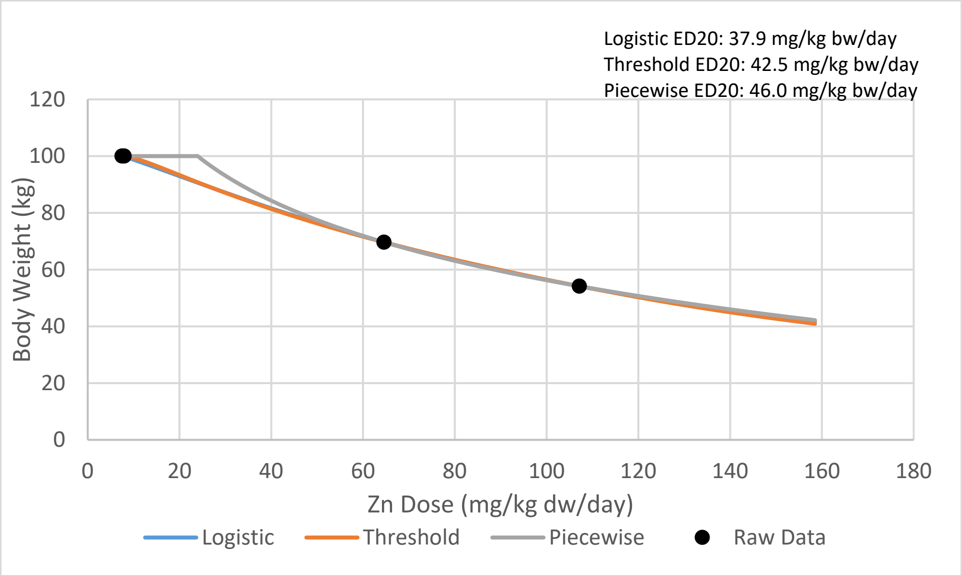
Log-transformed data from pooled group D: Edens and Garlich (1983), Stone and Soares (1976)
Note: Fit was poor for all three models, so an ED20 was not used for TRV derivation.

Figure C-13. Dose-Response Curves for Avian Reproduction Endpoint for Lead



Log-transformed data from pooled group F: Barthalmus et al. (1977) and Anders et al. (1982)

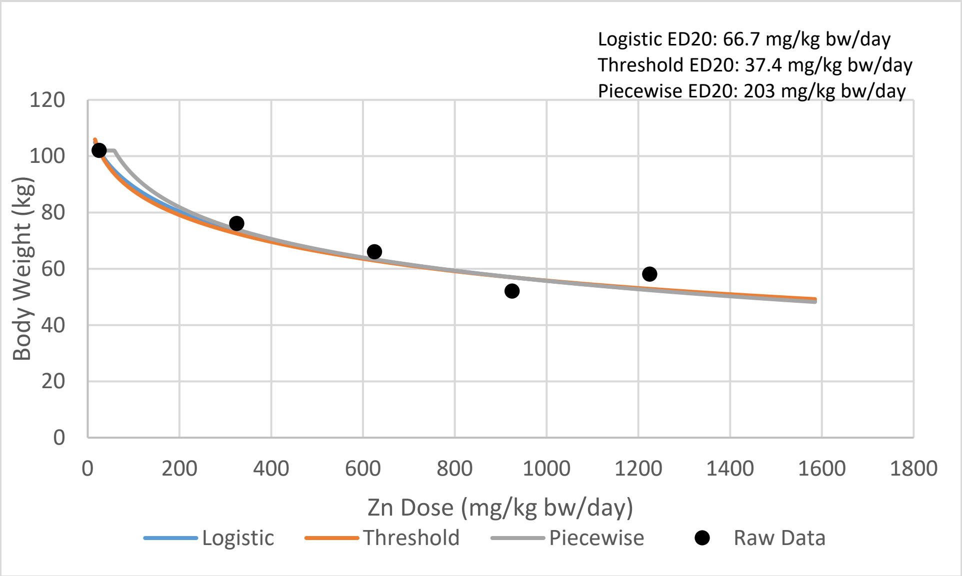
Figure C-14. Dose-Response Curves for Avian Survival Endpoint for Lead



Logistic ED20: 37.9 mg/kg bw/day
Threshold ED20: 42.5 mg/kg bw/day
Piecewise ED20: 46.0 mg/kg bw/day

Log-transformed data from pooled group A: Lu and Combs (1988), Lu et al. (1990)

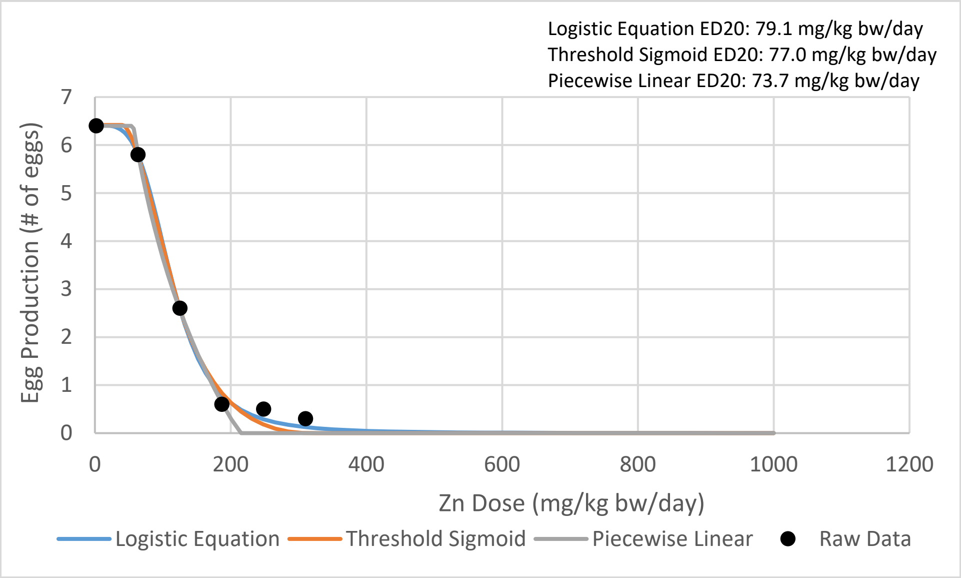
Figure C-15. Dose-Response Curves for Avian Growth Endpoint for Zinc



Logistic ED20: 66.7 mg/kg bw/day
Threshold ED20: 37.4 mg/kg bw/day
Piecewise ED20: 203 mg/kg bw/day

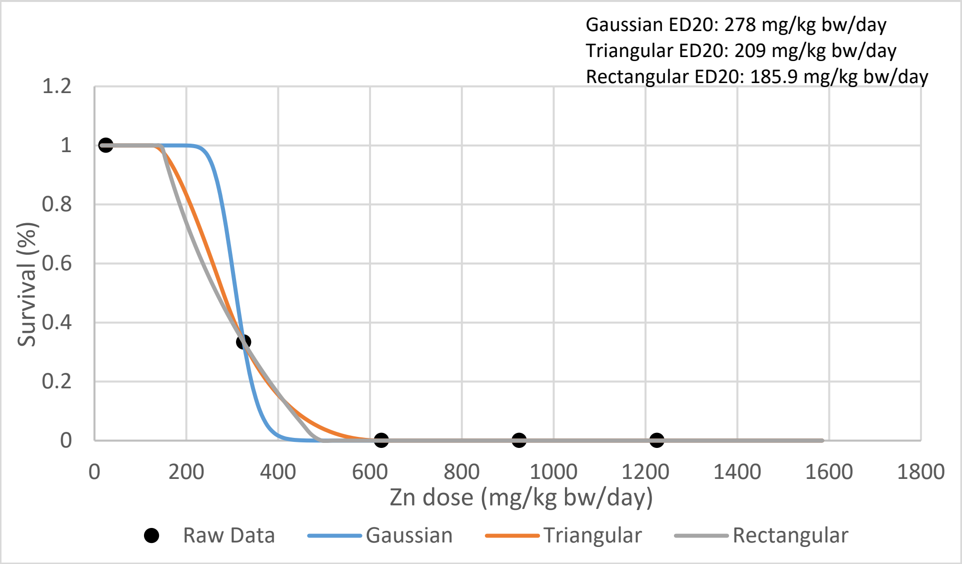
Log-transformed data from Gasaway and Buss (1972)

Figure C-16. Dose-Response Curves For Avian Growth Endpoint For Zinc



Log-transformed data from Gibson et al. (1986)

Figure C-17. Dose-Response Curves for Avian Reproduction Endpoint for Zinc

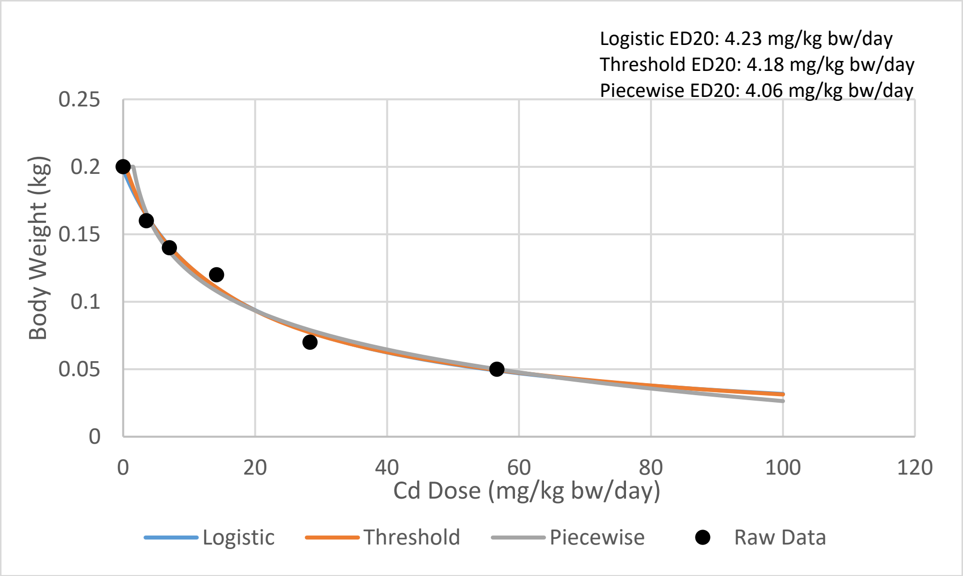


Log-transformed data from Gasaway and Buss (1972)
Note: Fit was poor for all three models, so an ED20 was not used for TRV derivation.

Figure C-18. Dose-Response Curves For Avian Survival Endpoint For Zinc

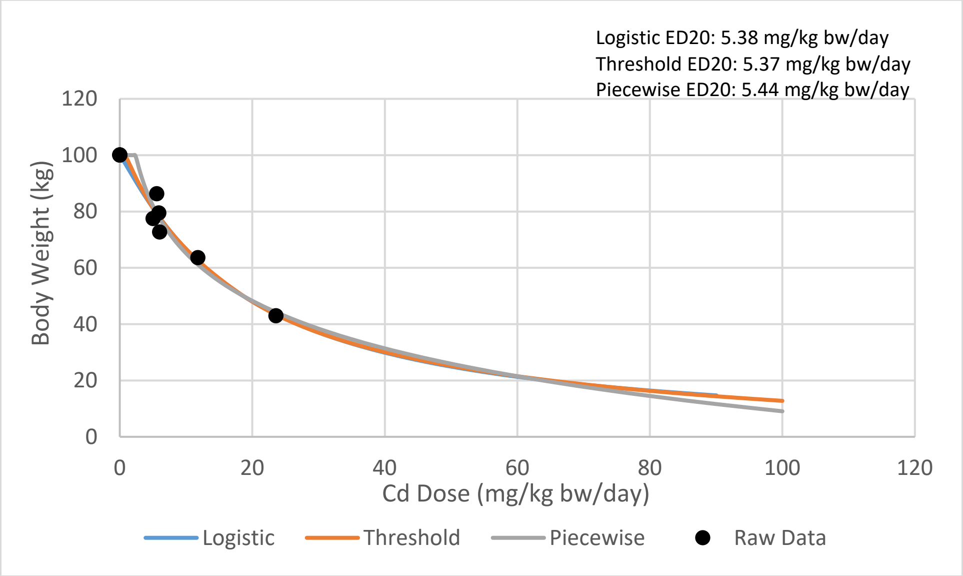
APPENDIX C -2

MODELED DOSE-RESPONSE CURVES FOR MAMMALIAN TRV DERIVATION



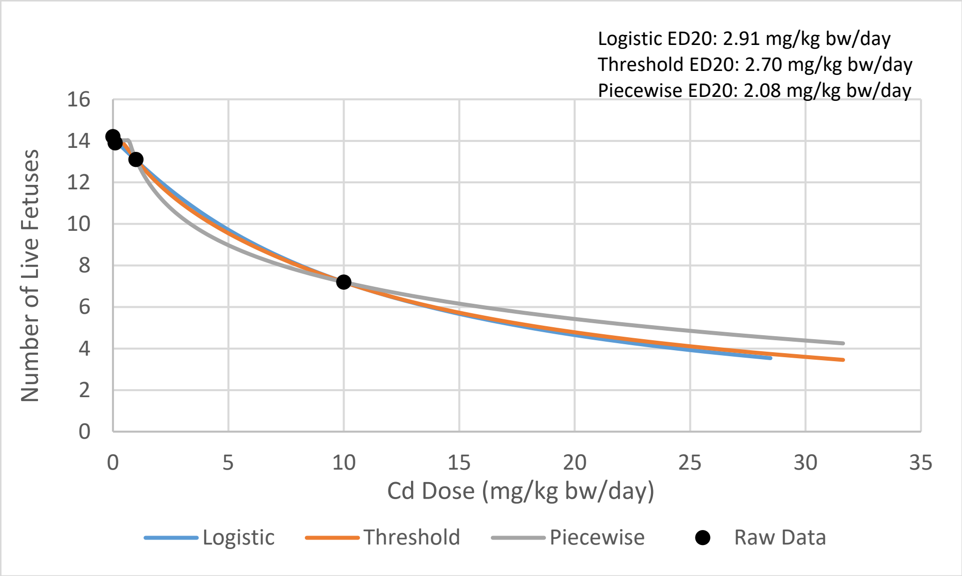
Log-transformed data from Wilson et al. (1941)

Figure C-19. Dose-Response Curves for Mammalian Growth Endpoint for Cadmium



Log-transformed data from pooling group A: Suzuki and Yoshida (1977, 1978, and 1979)

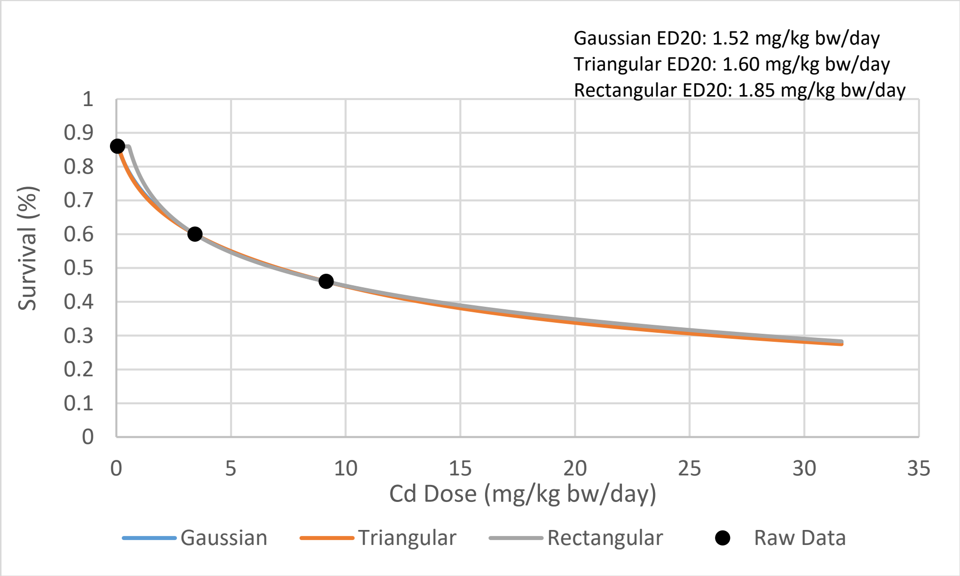
Figure C-20. Dose-Response Curves for Mammalian Growth Endpoint for Cadmium



Logistic ED20: 2.91 mg/kg bw/day
Threshold ED20: 2.70 mg/kg bw/day
Piecewise ED20: 2.08 mg/kg bw/day

Log-transformed data from Sutou et al. (1980)

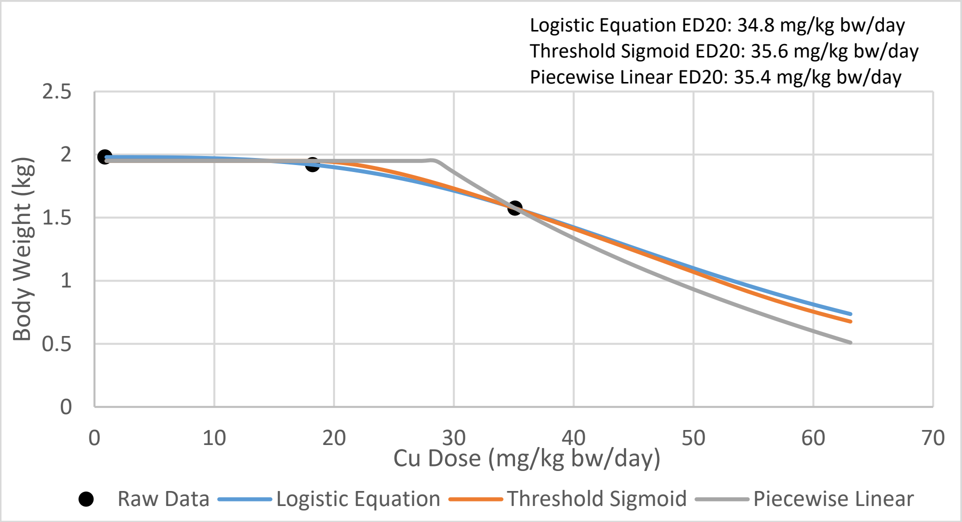
Figure C-21. Dose-Response Curves for Mammalian Reproduction Endpoint for Cadmium



Gaussian ED20: 1.52 mg/kg bw/day
Triangular ED20: 1.60 mg/kg bw/day
Rectangular ED20: 1.85 mg/kg bw/day

Log-transformed data from Swiergosz et al. (1998)

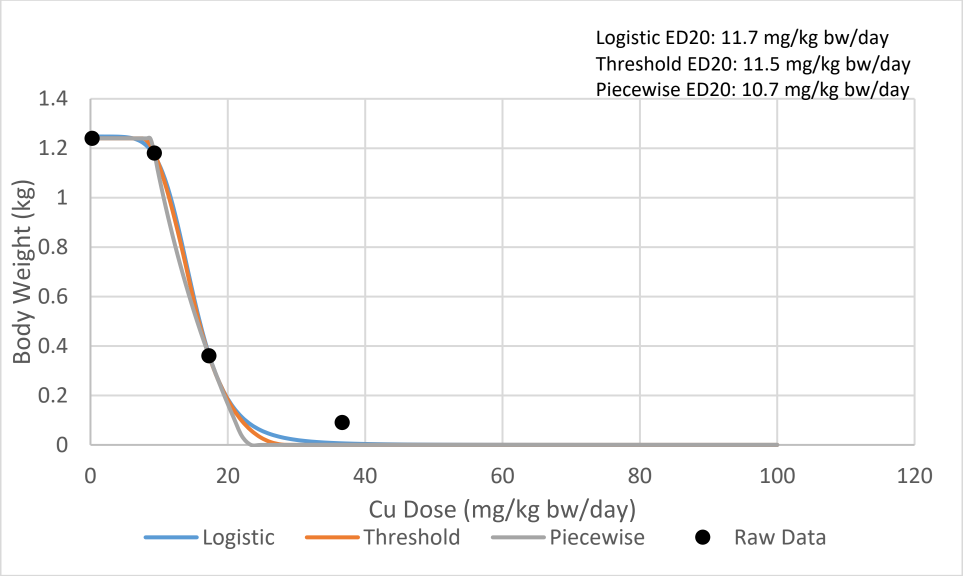
Figure C-22. Dose-Response Curves for Mammalian Survival Endpoint for Cadmium



Log-transformed data from Brandt (1983)

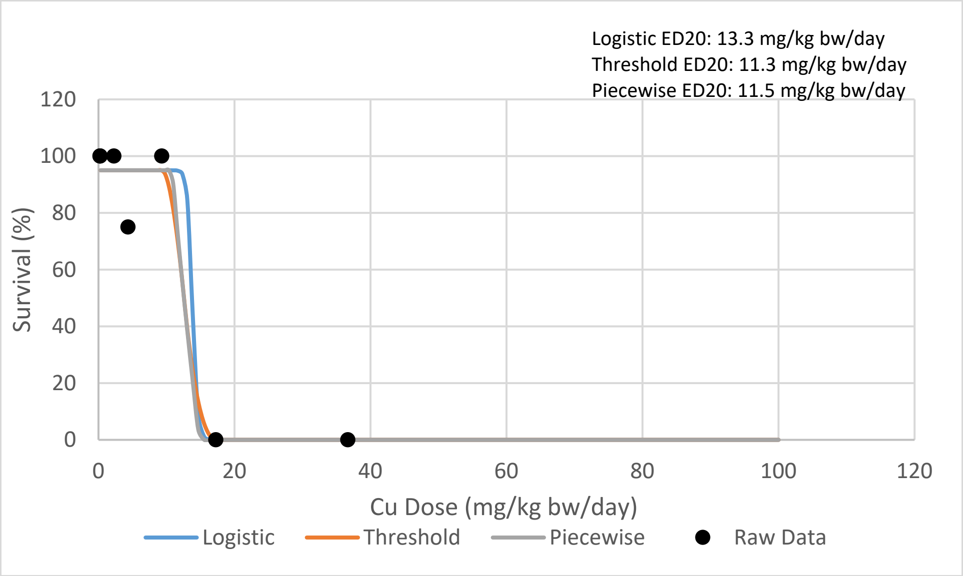
Note: Fit was poor for all three models, so an ED20 was not used for TRV derivation.

Figure C-23. Dose-Response Curves for Mammalian Endpoint for Copper



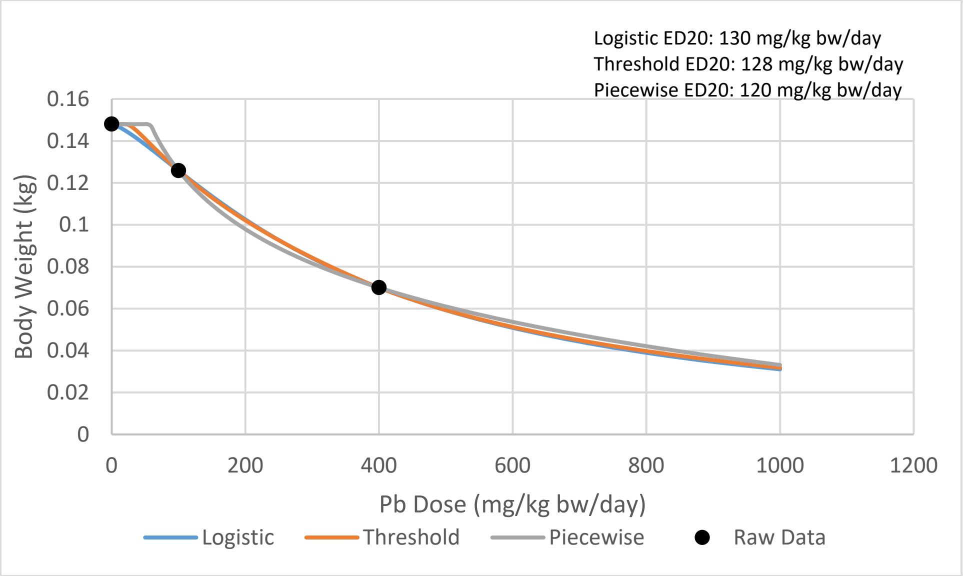
Log-transformed data from Allcroft et al. (1961)

Figure C-24. Dose-Response Curves for Mammalian Growth Endpoint for Copper



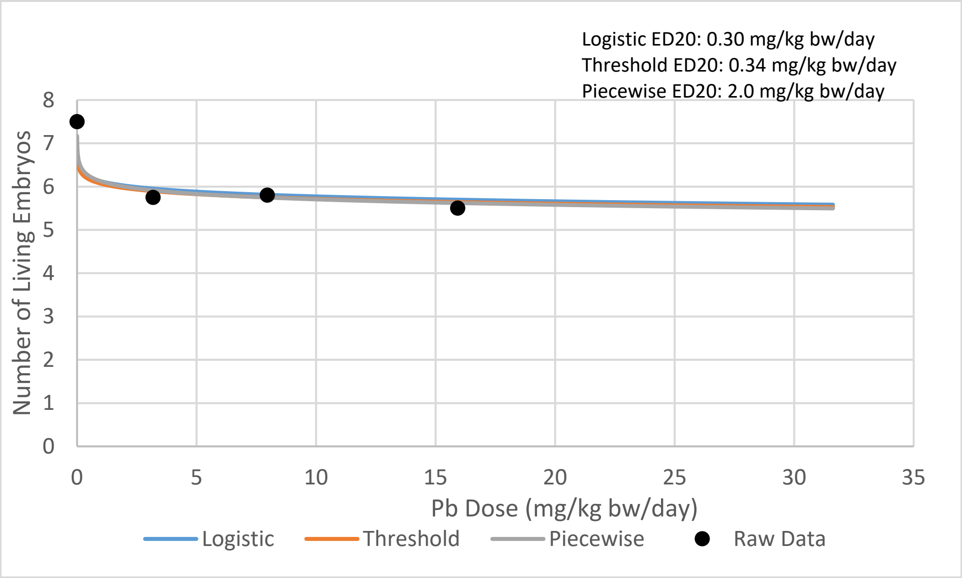
Log-transformed data from pooling group B: Allcroft et al. (1961) and Rtichie et al. (1963)
Note: Fit was poor for all three models, so an ED20 was not used for TRV derivation.

Figure C-25. Dose-Response Curves for Mammalian Survival Endpoint for Copper



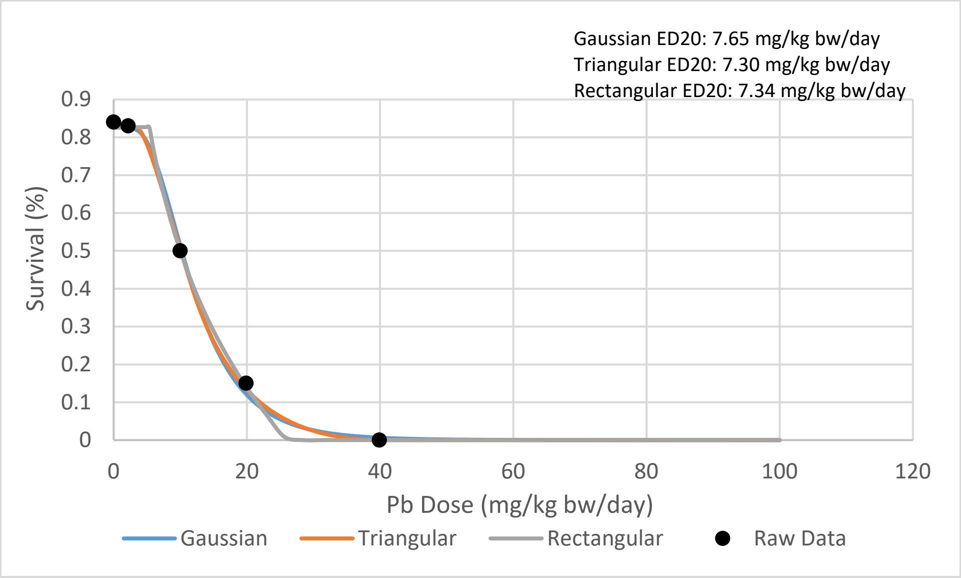
Log-transformed data from Kumar and Desiraju (1990)

Figure C-26. Dose-Response Curves for Mammalian Growth Endpoint for Lead



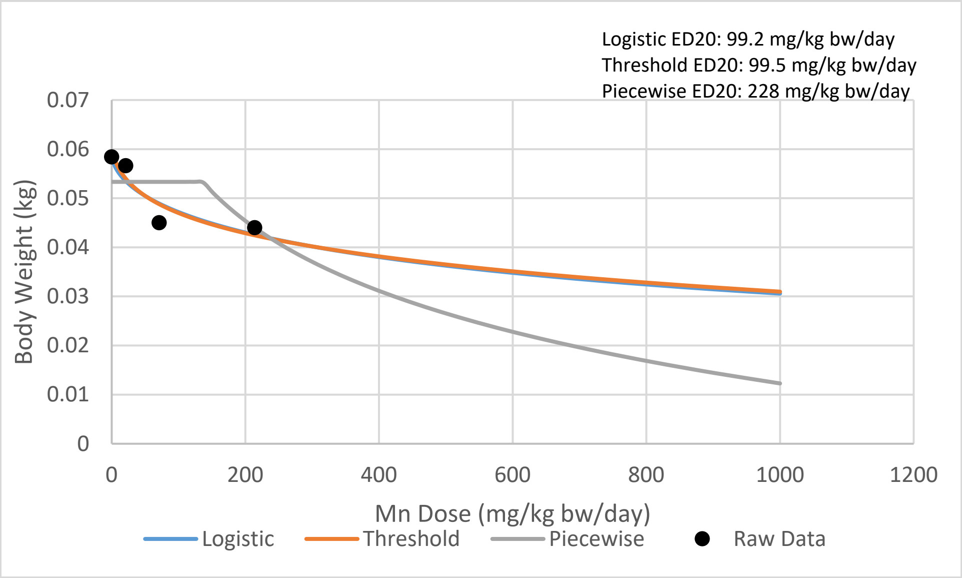
Log-transformed data from Gupta et al. (1995)
Note: Fit was poor for all three models, so an ED20 was not used for TRV derivation.

Figure C-27. Dose-Response Curves for Mammalian Reproduction Endpoint for Lead



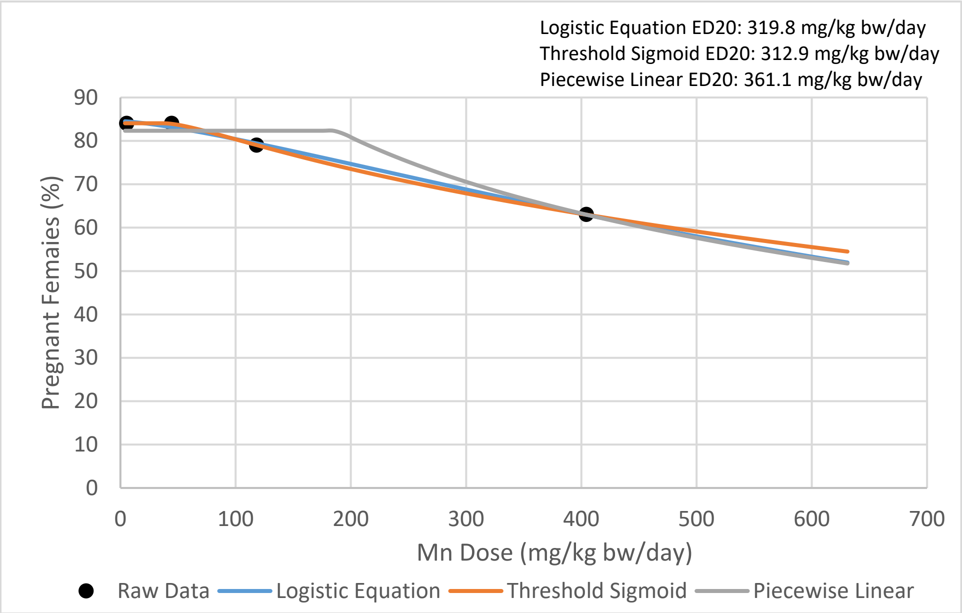
Log-transformed data from Lorenzo et al. (1978)

Figure C-28. Dose-Response Curves for Mammalian Survival Endpoint for Lead


Logistic ED20: 99.2 mg/kg bw/day
Threshold ED20: 99.5 mg/kg bw/day
Piecewise ED20: 228 mg/kg bw/day

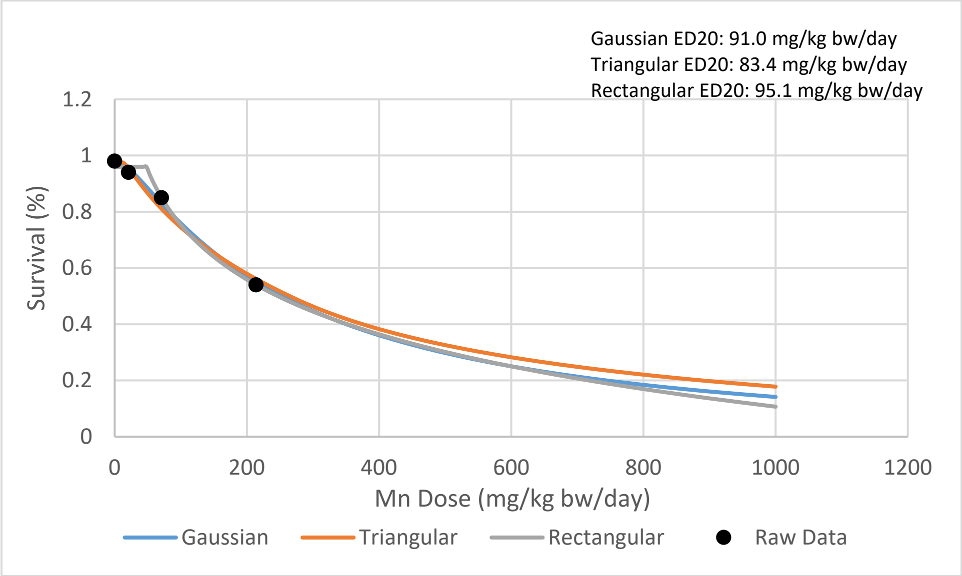
Log-transformed data from Rehnberg et al. (1980)
Note: Fit was poor for all three models, so an ED20 was not used for TRV derivation.

Figure C-29. Dose-Response Curves for Mammalian Growth Endpoint for Manganese


Logistic Equation ED20: 319.8 mg/kg bw/day
Threshold Sigmoid ED20: 312.9 mg/kg bw/day
Piecewise Linear ED20: 361.1 mg/kg bw/day

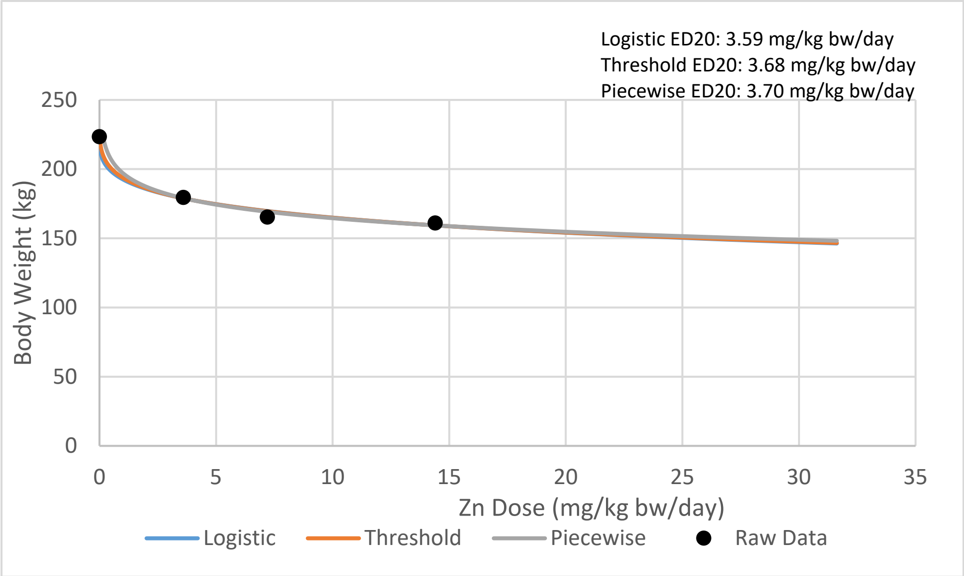
Log-transformed data from Laskey et al. (1982)

Figure C-30. Dose-Response Curves for Mammalian Reproduction Endpoint for Manganese



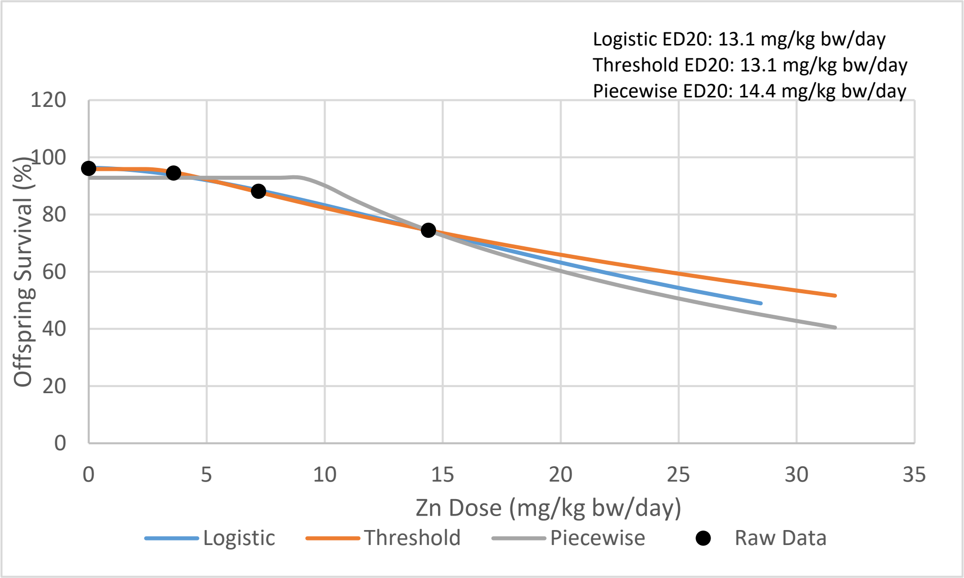
Log-transformed data from Rehnberg et al. (1980)

Figure C-31. Dose-Response Curves for Mammalian Survival Endpoint for Manganese



Log-transformed data from Khan et al. (2007)

Figure C-32. Dose-Response Curves for Mammalian Growth Endpoint for Zinc



Log-transformed data from Khan et al. (2007)

Note: Fit was poor for all three models, so an ED20 was not used for TRV derivation.

Figure C-33. Dose-response Curves for Mammalian Reproduction Endpoint for Zinc

APPENDIX C-3

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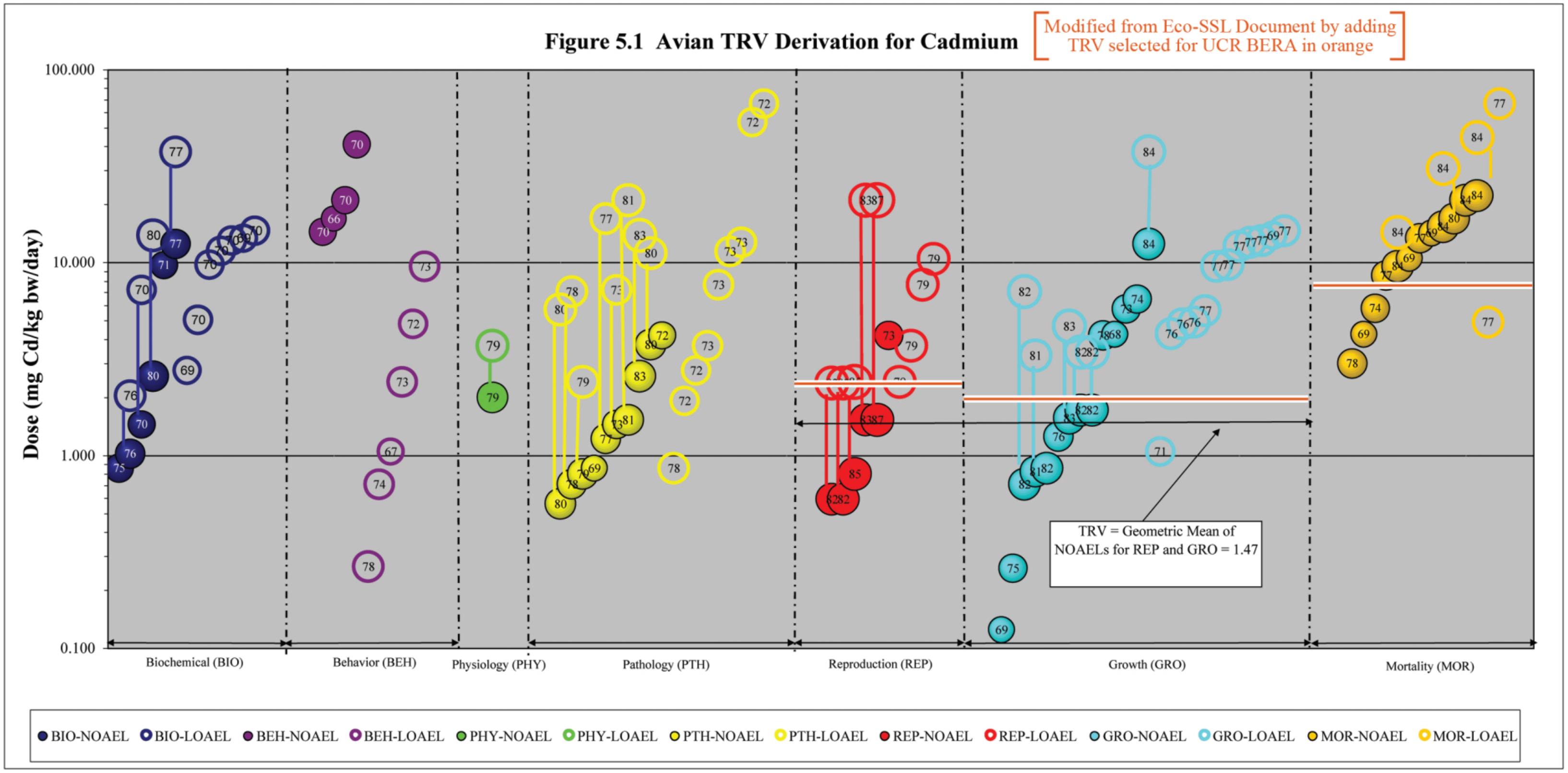
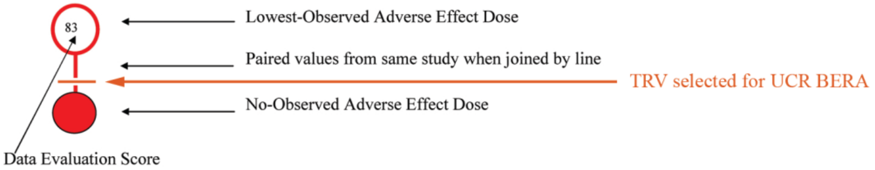
APPENDIX D

ECO-SSL TRV DERIVATION PLOTS COMPARED TO SELECTED TRVS





Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean.

4) The geometric mean is equal to 1.47 mg cadmium/kg bw/d and is lower than the lowest bounded LOAEL within the reproduction, growth and survival effect groups.

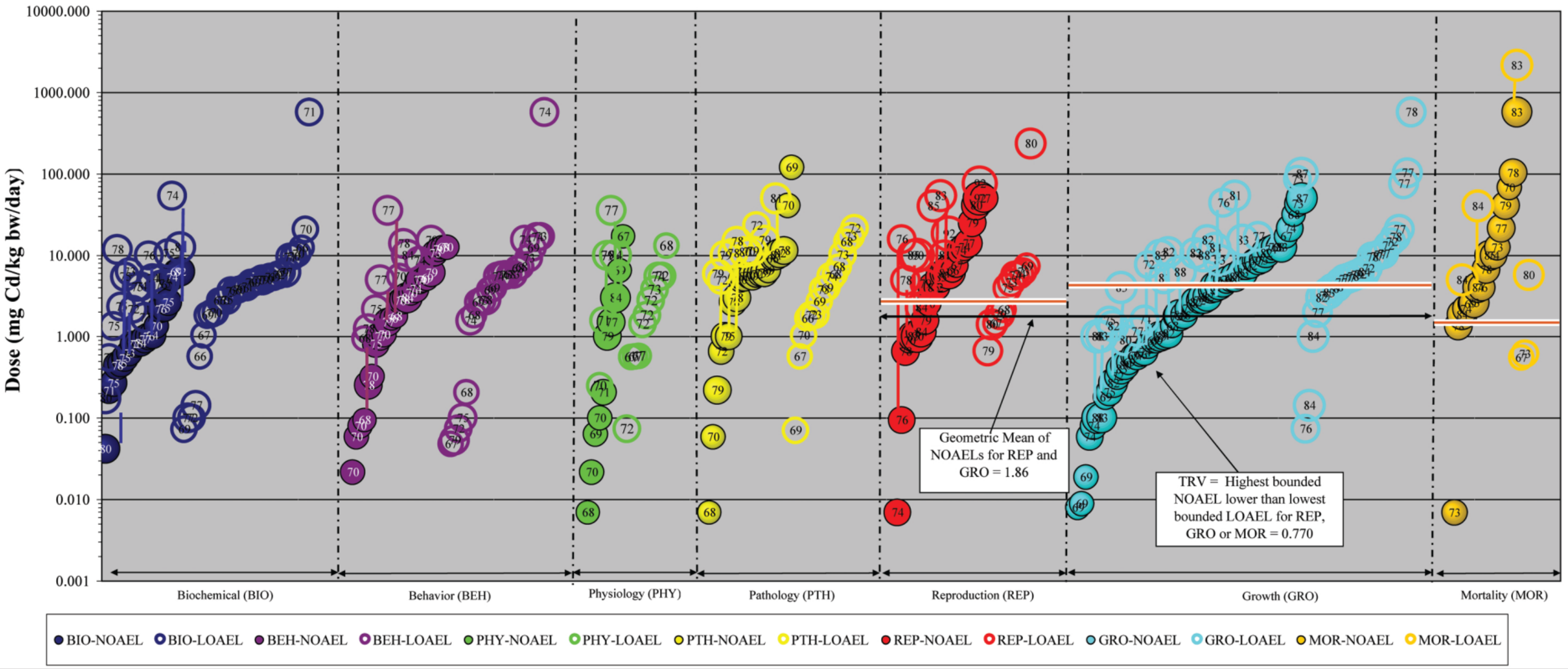
5) The avian wildlife TRV for cadmium is equal to 1.47 mg cadmium/kg bw/day which is the geometric mean of the NOAEL values for growth and reproduction.

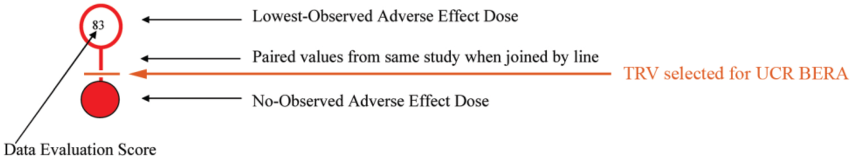
Selected BERA wildlife TRVs for comparative purposes (in mg Cd/kg bw/day): Growth = 2.0, Reproduction = 2.3; Survival = 7.4

Figure D-1. Avian TRV Derivation for Cadmium as Presented in Figure 5.1 of USEPA's 2005 Eco-SSL Document

Figure 6.1 Mammalian TRV Derivation for Cadmium

Modified from Eco-SSL Document by adding TRV selected for UCR BERA in orange





Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

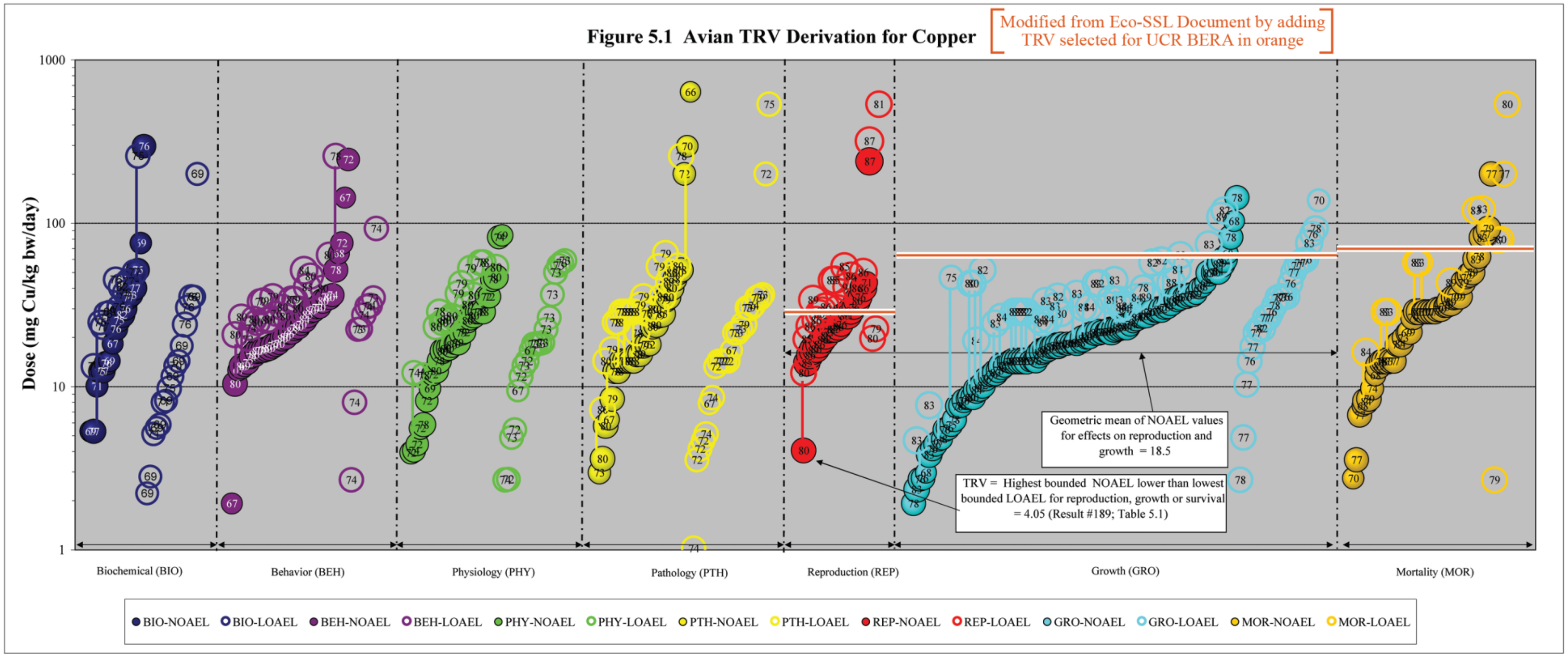
2) There are three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean.

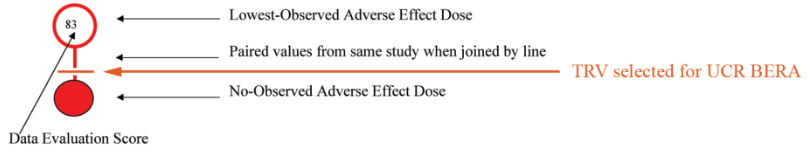
4) The geometric mean is equal to 1.86 mg cadmium /kg bw/d but is higher than the lowest bounded LOAEL for results within the reproduction, growth, and survival (MOR) effect groups.

5) The mammalian wildlife TRV for cadmium is equal to 0.770 mg cadmium/kg bw/day which is the highest bounded NOAEL lower than the lowest bounded LOAEL for reproduction, growth, or survival.

Selected BERA wildlife TRVs for comparative purposes (in mg Cd/kg bw/day): Growth = 4.2; Reproduction = 2.7; Survival = 1.5

Figure D-2. Mammal TRV Derivation for Cadmium as Presented in Figure 6.1 of USEPA's 2005 Eco-SSL Document





Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are at least three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean.

3) The geometric mean is equal to 18.5 mg copper/kg bw/d and is higher than the lowest bounded LOAEL for results within the reproduction, growth, and survival (MOR) effect groups.

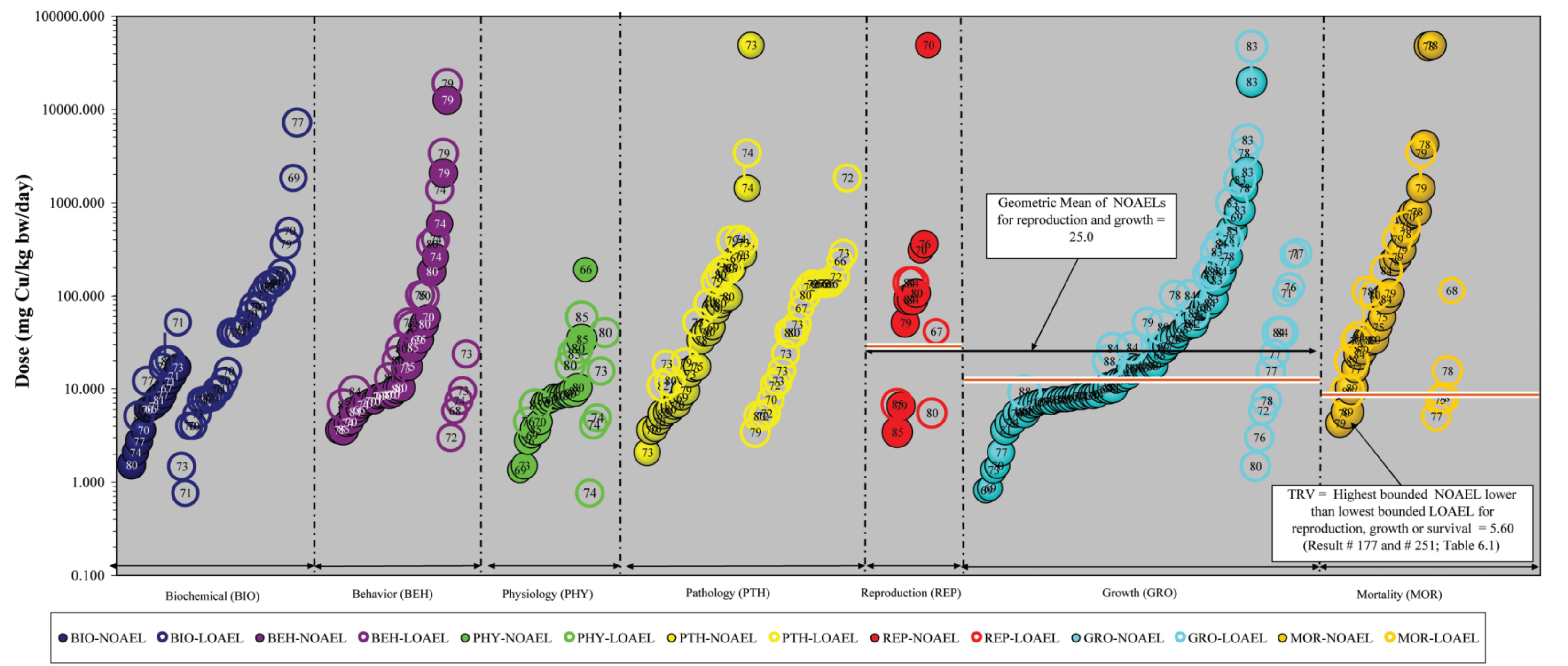
3) The avian wildlife TRV for copper is equal to 4.05 mg copper/kg bw/day which is the highest NOAEL value lower than the lowest bound LOAEL value for effects on reproduction, growth or survival.

Selected BERA wildlife TRVs for comparative purposes (in mg Cu/kg bw/day): Growth = 62; Reproduction = 28; Survival = 67

Figure D-3. Avian TRV Derivation for Copper as Presented in Figure 5.1 of USEPA's 2007 Eco-SSL Document

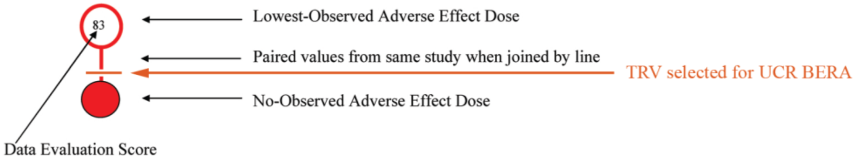
Figure 6.1 Mammalian TRV Derivation for Copper

Modified from Eco-SSL Document by adding TRV selected for UCR BERA in orange



Geometric Mean of NOAELs for reproduction and growth = 25.0

TRV = Highest bounded NOAEL lower than lowest bounded LOAEL for reproduction, growth or survival = 5.60 (Result # 177 and # 251; Table 6.1)



Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

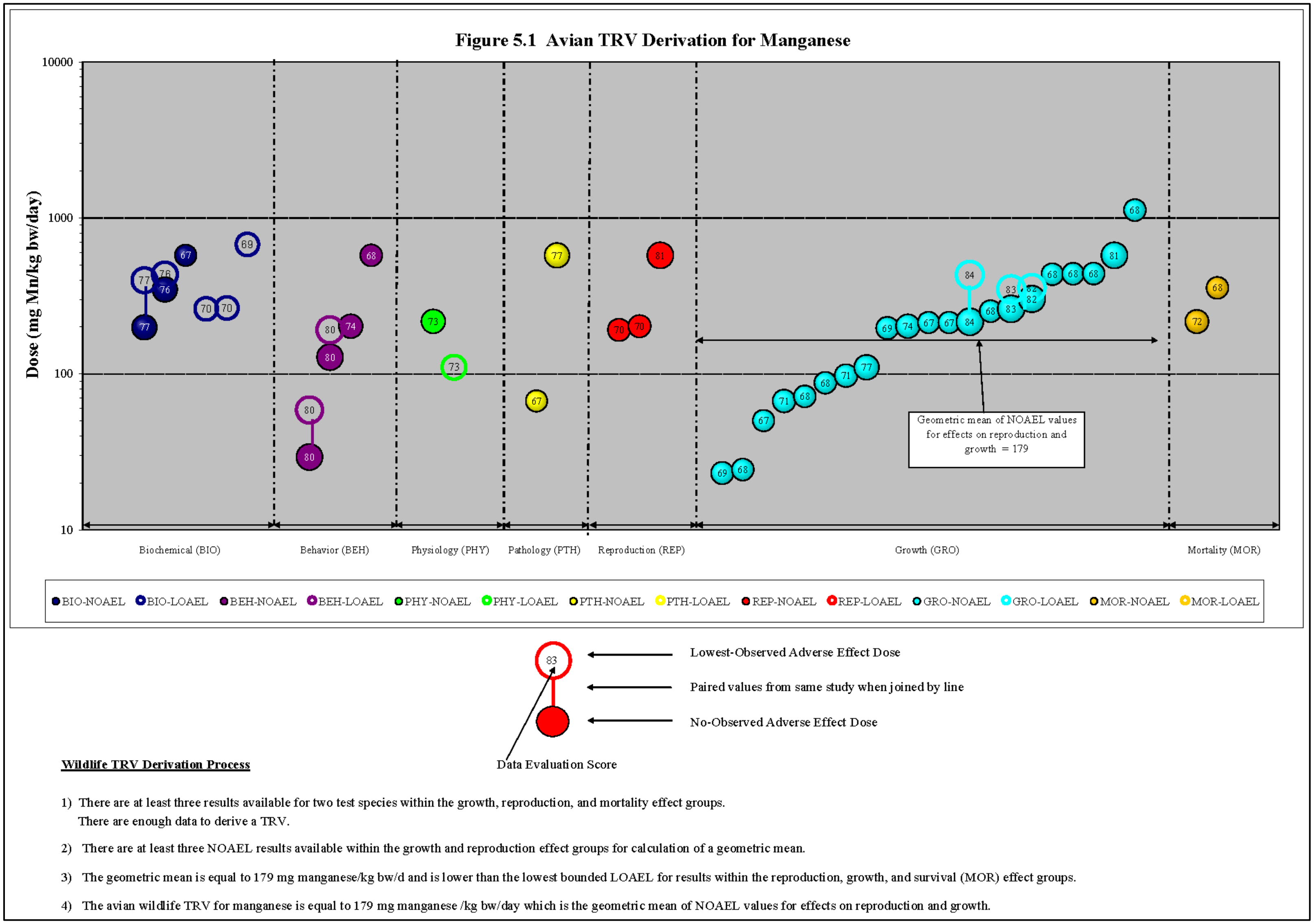
2) There are three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean.

3) The geometric mean is equal to 25.0 mg copper/kg bw/d and is higher than the lowest bounded LOAEL for results within the reproduction, growth, and survival (MOR) effect groups.

4) The mammalian wildlife TRV for copper is equal to 5.60 mg copper/kg bw/day which is the highest NOAEL value lower than the lowest LOAEL value for reproduction and growth.

Selected BERA wildlife TRVs for comparative purposes (in mg Cu/kg bw/day): Growth = 12; Reproduction = 27; Survival = 8.7

Figure D-4. Mammal TRV Derivation for Copper as Presented in Figure 6.1 of USEPA's 2007 Eco-SSL Document



Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are at least three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean.

3) The geometric mean is equal to 179 mg manganese/kg bw/d and is lower than the lowest bounded LOAEL for results within the reproduction, growth, and survival (MOR) effect groups.

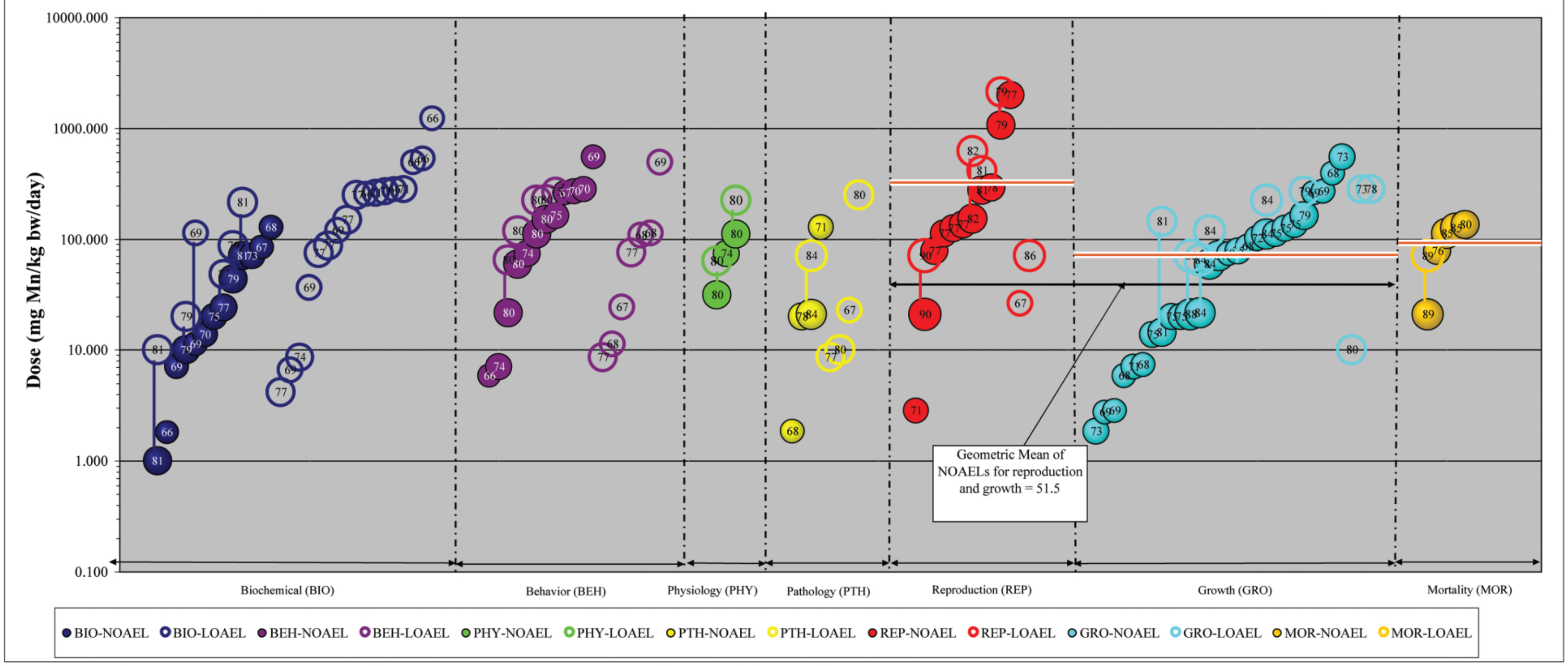
4) The avian wildlife TRV for manganese is equal to 179 mg manganese /kg bw/day which is the geometric mean of NOAEL values for effects on reproduction and growth.

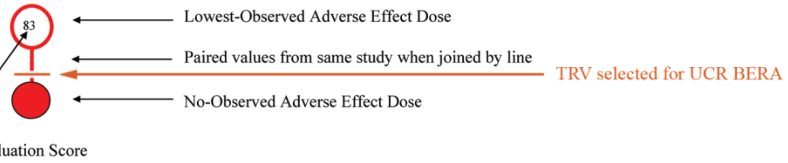
No avian TRVs were identified for manganese.

Figure D-5. Avian TRV Derivation for Manganese as Presented in Figure 5.1 of USEPA's 2007 Eco-SSL Document

Figure 6.1 Mammalian TRV Derivation for Manganese

[Modified from Eco-SSL Document by adding TRV selected for UCR BERA in orange]





Wildlife TRV Derivation Process

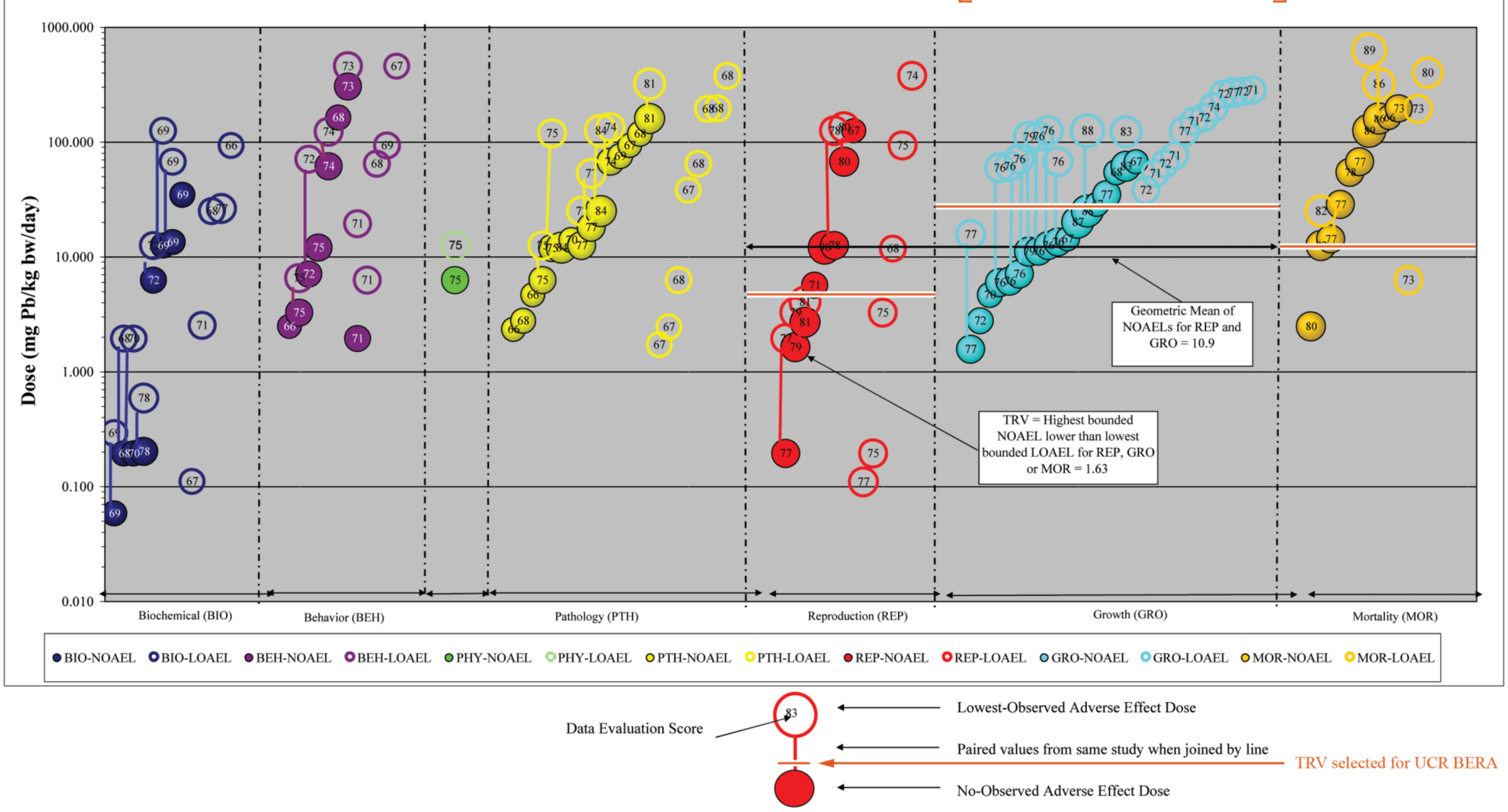
1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups.
   There are enough data to derive a TRV.
2) There are three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean.
3) The geometric mean is equal to 51.5 mg manganese/kg bw/d and is lower than the lowest bounded LOAEL for results within the reproduction, growth, and survival (MOR) effect groups.
4) The mammalian wildlife TRV for manganese is equal to 51.5 mg Mn/kg bw/day which is the geometric mean of NOAEL values within the reproduction and growth effect groups.

Selected BERA wildlife TRVs for comparative purposes (in mg Mn/kg bw/day): Growth = 71; Reproduction = 310; Survival = 91

Figure D-6. Mammal TRV Derivation for Manganese as Presented in Figure 6.1 of USEPA's 2007 Eco-SSL Document

Figure 5.1 Avian TRV Derivation for Lead

Modified from Eco-SSL Document by adding TRV selected for UCR BERA in orange



Geometric Mean of NOAELs for REP and GRO = 10.9

TRV = Highest bounded NOAEL lower than lowest bounded LOAEL for REP, GRO or MOR = 1.63

Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are three NOAEL results available for calculation of a geometric mean.

4) The geometric mean is equal to 10.9 mg/kg bw/d but is higher than the lowest bounded LOAEL within the reproduction, growth, and survival R effect groups.

5) The avian wildlife TRV for lead is equal to 1.63 mg lead/kg bw/day which is the highest bounded NOAEL below the lowest bounded LOAEL for effects on growth, reproduction, and survival.

Selected BERA wildlife TRVs for comparative purposes (in mg Pb/kg bw/day): Growth = 29; Reproduction = 4.7; Survival = 11

Figure D-7. Avian TRV Derivation for Lead as Presented in Figure 5.1 of USEPA's 2005 Eco-SSL Document

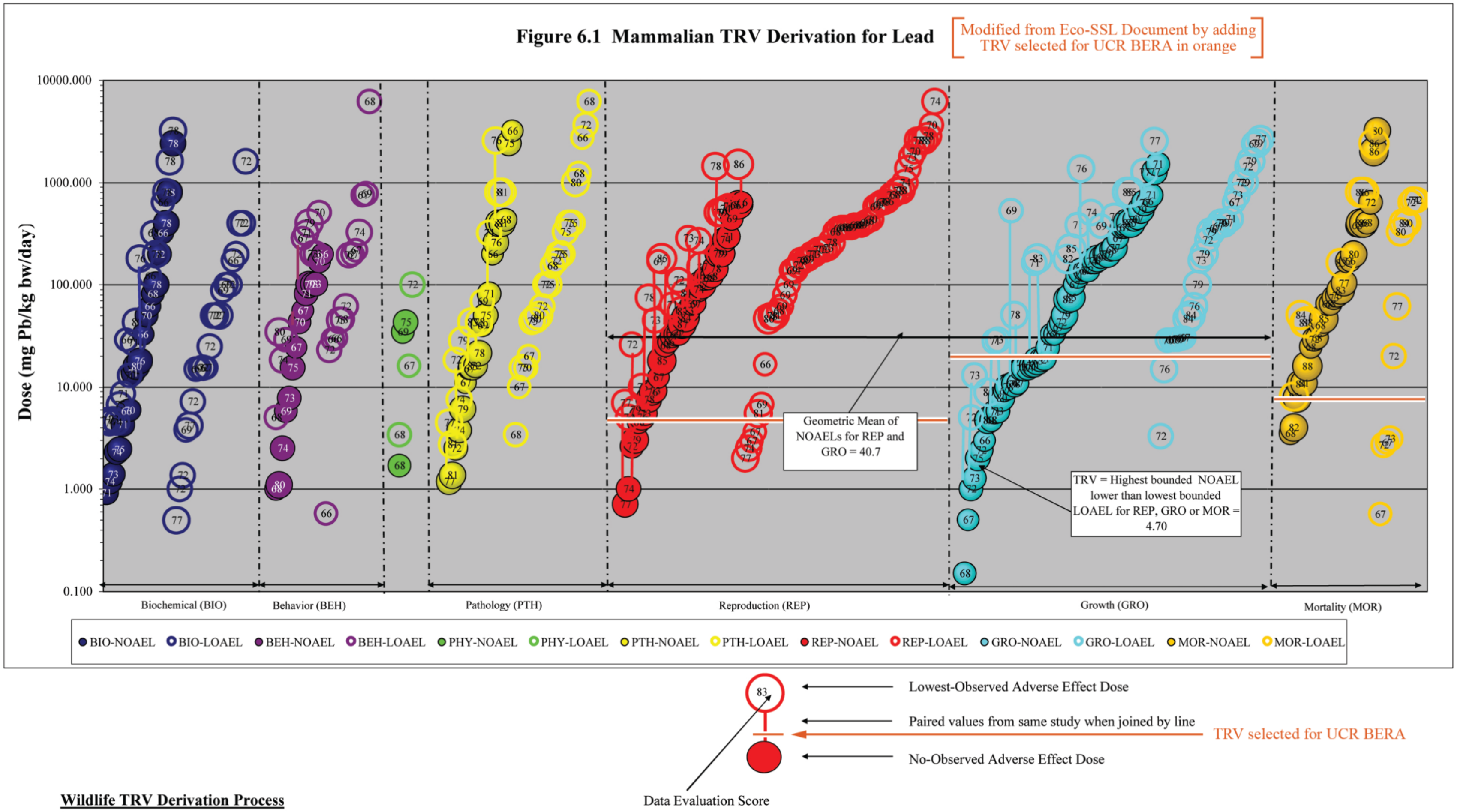


Figure 6.1 Mammalian TRV Derivation for Lead

Modified from Eco-SSL Document by adding TRV selected for UCR BERA in orange

Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are three NOAEL results available for calculation of a geometric mean.

4) The geometric mean is equal to 40.7 mg/kg bw/d but is higher than the lowest bounded LOAEL for results within the reproduction, growth, and survival effect groups.

5) The mammalian wildlife TRV for lead is equal to 4.70 mg lead/kg bw/day which is the highest bounded NOAEL below the lowest bounded LOAEL for results in the growth, reproduction, and survival effect groups.

Selected BERA wildlife TRVs for comparative purposes (in mg Pb/kg bw/day): Growth = 20; Reproduction = 4.7; Survival = 7.6

Figure D-8. Mammal TRV Derivation for Lead as Presented in Figure 6.1 of USEPA's 2005 Eco-SSL Document

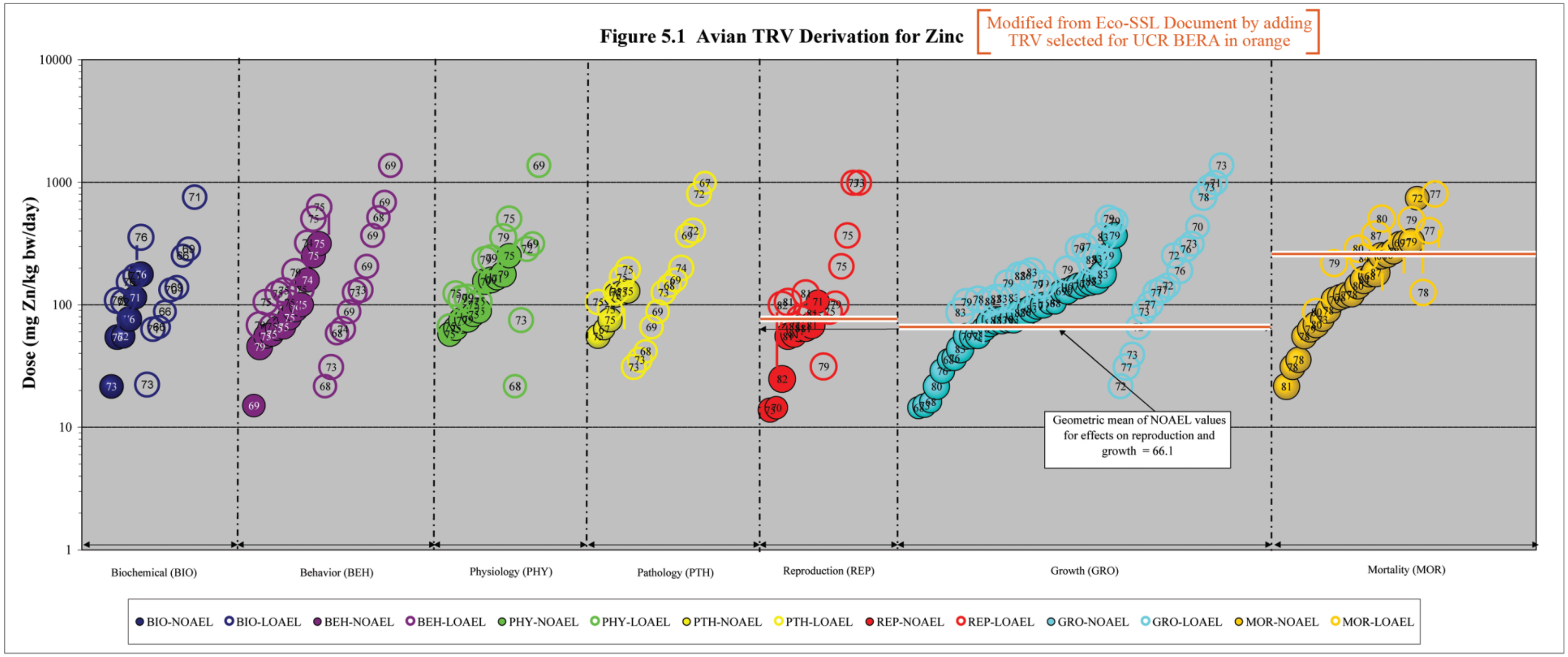
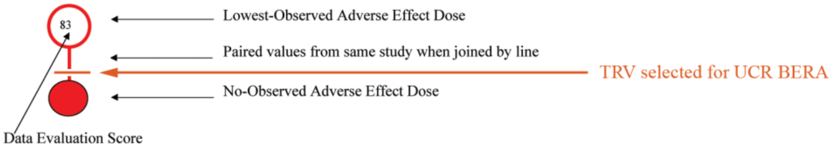


Figure 5.1 Avian TRV Derivation for Zinc

Modified from Eco-SSL Document by adding TRV selected for UCR BERA in orange



Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

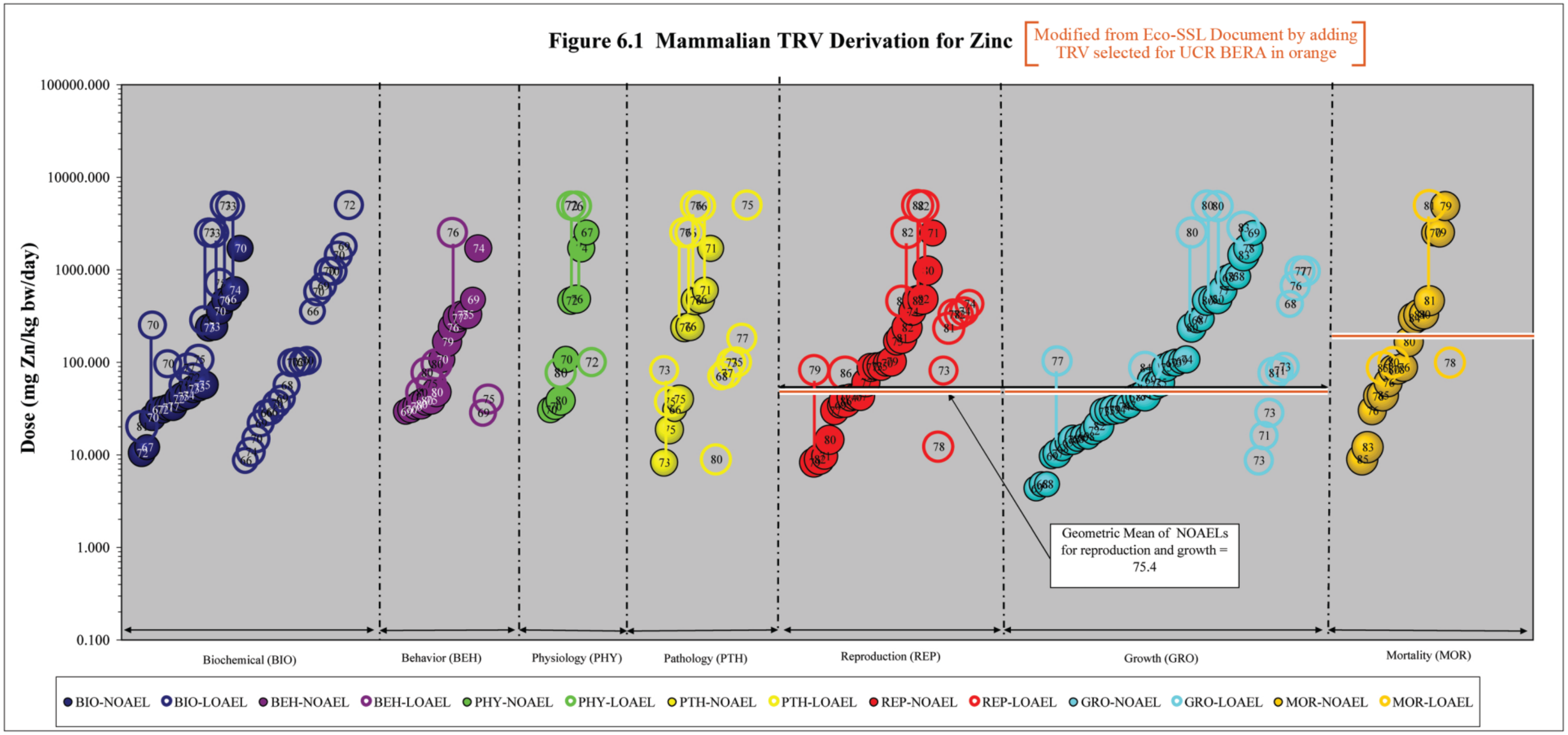
2) There are at least three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean.

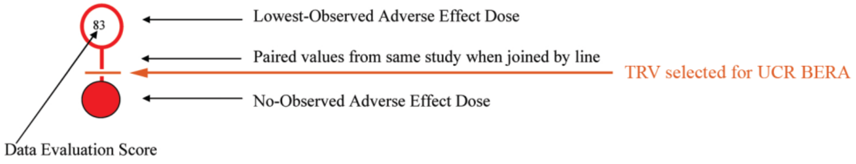
3) The geometric mean is equal to 66.1 mg zinc/kg bw/d. This value is lower than the lowest bounded LOAEL for results within the reproduction, growth, and survival (MOR) effect groups.

3) The avian wildlife TRV for zinc is equal to 66.1 mg zinc/kg bw/day which is the geometric mean of NOAEL values for effects on reproduction and growth.

Selected BERA wildlife TRVs for comparative purposes (in mg Zn/kg bw/day): Growth = 66; Reproduction = 77; Survival = 250

Figure D-9. Avian TRV Derivation for Zinc as Presented in Figure 5.1 of USEPA's 2007 Eco-SSL Document





Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean.

3) The geometric mean is equal to 75.4 mg zinc/kg bw/d and is lower than the lowest bounded LOAEL for results within the reproduction, growth, and survival (MOR) effect groups.

4) The mammalian wildlife TRV for zinc is equal to 75.4 mg zinc/kg bw/day which is the geometric mean of NOAEL results within the reproduction and growth effect groups.

Selected BERA wildlife TRVs for comparative purposes (in mg Zn/kg bw/day): Growth = 75; Reproduction = 75; Survival = 190

Figure D-10. Mammal TRV Derivation for Zinc as Presented in Figure 6.1 of USEPA's 2007 Eco-SSL Document

ATTACHMENT E2

SUPPLEMENTAL WILDLIFE TRV DEVELOPMENT MEMO

Windward environmental LLC

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MEMORANDUM

To: Teck American Incorporated

From: Windward Environmental LLC

Subject: Additional Wildlife Toxicity Reference Values for the Upper Columbia River Upland BERA

Date: January 5, 2023

INTRODUCTION

An initial set of wildlife toxicity reference values (TRVs) for five metals for use in the Upper Columbia River (UCR) baseline ecological risk assessment (BERA) for the upland habitat, along with derivation methods, was presented in the *Final Wildlife Toxicity Reference Values for the Baseline Ecological Risk Assessment: Methods and Results for Five Metals* (TAI 2019b). This document presents additional wildlife TRVs derived for the remaining chemicals of potential concern (COPCs) identified for terrestrial birds and mammals in the *Final Chemicals of Potential Concern Refinement for Aquatic and Terrestrial Receptors* (TAI 2019a, 2020). Methods used to derive the additional TRVs were consistent with the methods presented in the initial TRV document (TAI 2019b).

The initial set of TRVs was derived for the following COPCs for both birds and mammals:

- Cadmium
- Copper
- Lead
- Manganese
- Zinc

This memorandum addresses TRV derivation for the remaining COPCs identified for terrestrial wildlife (TAI 2019a):

- Antimony (mammals only)
- Chromium (birds and mammals)

- Selenium (birds and mammals)
- Vanadium (birds only)

In addition, this memorandum addresses TRV derivation for metals identified as chemicals of interest (COIs) for terrestrial wildlife based on the lack of screening-level benchmarks:

- Aluminum (birds and mammals)
- Antimony (birds only)
- Barium (birds only)
- Beryllium (birds only)
- Iron (birds and mammals)
- Mercury (birds and mammals
- Molybdenum (birds and mammals)
- Thallium (birds and mammals)

This memorandum also includes a refinement to the selection of representative receptor-specific TRVs presented in the initial wildlife TRV document. Instead of identifying a TRV as receptor-specific based on a similar common name per the initial document, this refinement identifies TRVs as receptor-specific only when the genus and species of the test animal matches that of the representative receptor used for dietary modeling in the Upland BERA. This refinement results in fewer instances of the identification and use of receptor-specific TRVs, which is a more conservative approach because the receptor-specific TRV for a particular metal and endpoint is always equal to or higher than its respective generic TRV.

METHODS

The seven-step process presented in the initial wildlife TRV document (TAI 2019b) was used to derive the wildlife TRVs presented in this document (Figure E2-1). Detailed descriptions of each step are presented in Sections 3.1 through 3.7 of the initial wildlife TRV document. A summary of the process is provided herein.

After toxicity literature were compiled for dietary toxicity studies measuring growth, reproduction, and survival (Step 1), acceptability criteria were applied to eliminate studies that were not considered appropriate for use in TRV derivation (Step 2). A tiered process was applied to identify preferred studies for TRV selection (i.e., Tier 1 studies), as well as secondary studies for inclusion if preferred studies were not available (i.e., Tier 2 studies) (Step 3). Based on the tiered process, a subset of acceptable studies was reviewed in detail to compile dose-response datasets (Step 4). For each of these datasets, either an ED20 (dose that causes a 20% effect) was modeled using the U.S. Environmental Protection Agency's (EPA's) Toxicity Relationship Analysis Program (TRAP), or an effect level was derived from the dose with at least a 20%

reduction in the observed response relative to the control (abbreviated as the lowest-observed-adverse-effect level [LOAEL] ≥ 20) (Step 5).

To select a TRV for each chemical, receptor group (birds and mammals), and endpoint (growth, reproduction, and survival) (Step 6), a lowest effect level was identified from the lowest tier of studies: 1) LOAEL ≥ 20 from an individual dataset, 2) ED20 from an individual dataset, or 3) ED20 or geometric mean from a pooled dataset (Figure E2-2). If, based on best professional judgement, it was determined that there was substantial uncertainty in the effect level, then the study was excluded from selection as an effect level (Figure E2-2).

Two additional steps were conducted prior to selecting the lowest effect level as a TRV (Figure E2-2):

- The ecological soil screening level (Eco-SSL) documents were reviewed to determine if there were any studies with unbounded no-observed-adverse-effect levels (NOAELs) for comparable dose-response datasets that were higher than the selected effect level.
- If the selected effect level was lower than the TRV used to derive the Eco-SSL, then the Eco-SSL TRV was selected for use as the Upland BERA TRV, on the grounds that the Upland BERA TRV shouldn't be lower than the TRV used to derive the Eco-SSL issued by EPA's Superfund program.

If a dose-response dataset was available for a specific representative terrestrial receptor species used in the Upland BERA, then a receptor-specific TRV was also derived from those data. Receptor-specific TRVs were used only if the genus and species of the test animal matched that of the representative receptor.

The final step (Step 7) involved the evaluation of uncertainties in the selected TRVs to determine TRV reliability and potential bias. Based on the results of Step 6, which involved selecting the lowest LOAEL, ED20, or geomean of all datasets evaluated for a particular receptor/chemical/endpoint, the derivation process resulted in an overall conservative bias for the selected TRVs. Potential bias related to other uncertainties is discussed in the uncertainty evaluation below.

RESULTS

Literature Search and Study Review

Results from the literature compilation and study acceptability processes are presented in Annex A. Tables E2.A-2 through E2.A-7 in Annex A present the study acceptability results for chemicals and receptors included in the Eco-SSL documents. As a result of the literature search for chemicals with Eco-SSLs, additional references were identified as listed in Table E2.A-8. As a result of the literature search for chemicals without Eco-SSLs, a number of references were not used for TRV derivation because they reported unbounded NOAELs; these references are listed in Table E2.A-9. Unbounded NOAELs from the Eco-SSL documents are reported in Tables E2.A-2 through E2.A-7.

Table E2-1 summarizes the results from the application of the tiered process, including the number of papers reviewed, number of usable datasets, and assignment of tiers. Detailed information on the tier determination results for each metal and receptor included in the Eco-SSL documents is presented in Tables E2.A-10 through E2.A-15. Tables E2-2 through E2-11 present toxicity data summaries for each metal. Annex B presents the details of data extracted from the studies.

The following points should be noted for a subset of the metals:

- **Antimony**: One of the studies included in the derivation of the Eco-SSL TRV (Schroeder et al. 1970) was not used to derive a TRV because of uncertainties in the study. Lynch et al. (1999) found that the Schroeder et al. (1970) study contained numerous shortcomings, irregularities, and inconsistencies, and that it therefore should not be used as an indication of antimony toxicity.
- **Chromium**: The hexavalent form of chromium is considered the most toxic. It is generally produced by industrial processes such as electroplating, stainless steel production, leather tanning, textile manufacturing, and wood preservation (NIH 2018). Because UCR sources are not expected to contain hexavalent chromium, only studies using trivalent chromium were used for TRV derivation. Likewise, studies using the yeast chromium form (i.e., a form found in Brewer's yeast, which is a nutritional supplement) were not included in the TRV derivation.
- **Mercury**: Methylmercury is the form of mercury most toxic to wildlife (Evers 2018). Only studies with methylmercury were included in the review of toxicity studies for TRV derivation.

TRAP Modeling Results

All dose-response datasets identified through the study selection and review process, as summarized in Table E2-1, were plotted to show the dose vs. effect relative to the control, with separate plots for each chemical, receptor group (bird or mammal), and endpoint (growth, reproduction, and survival). Figures E2-3 through E2-41 show the dose-response datasets for each metal evaluated in this memorandum, including the resultant ED20 values for those datasets that could be modeled successfully. Figures E2-42 through E2-81 show the same data as Figures E2-3 through E2-41, but on a log-transformed basis.[1]

For each dataset, the modeling status fell into one the following five categories:

1. Data were modeled as an individual dataset in TRAP to derive the ED20.

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[1] Plots are also shown on a concentration-response basis in Figures E2-82 through E2-116, representing concentrations in food rather than dietary doses. These figures are presented for informational purposes only, to be consistent with the same types of plots presented in the initial wildlife TRV document (Windward and Parametrix 2019).

2. Data were selected for modeling as an individual or pooled dataset, but an ED20 could not be generated, or the ED20 was not used due to poor model fit.
3. Data did not meet the criteria for modeling (i.e., dataset did not have an effect that was at least 20% less than the control; did not have two consecutively lower and different effects less than the control; or had consecutively lower effects followed by an increased effect, and a lower tier dataset was available).
4. Data were not selected for modeling because the effect concentration was substantially higher than other ED20s and/or LOAELs based on visual inspection of the plotted data.
5. Data were modeled as a pooled dataset in TRAP to derive the ED20.

Information about the modeling status of each dataset is presented in Tables E2-2 through E2-8 for each of the metals and includes ED20 values, if derived. For those studies that could be modeled in TRAP, dose-response curves and modeled ED20s are presented in Annex C. A summary of dose-response model parameters and dose-response effect values is also presented in Annex D.

TRV Selection and Uncertainty Evaluation

The effect level selected was the lowest value among the LOAEL ≥ 20, ED20, or geometric mean from the lowest tier for the growth, reproduction, and survival endpoints. A summary of selected effect levels is presented in Table E2-12.

Following the selection of effect levels, Eco-SSL data (presented in Annex A) were reviewed to determine if there were any unbounded NOAELs from comparable datasets higher than the selected effect levels (see TRV selection process shown in Figure E2-2). No such NOAELs were identified.

As a final step (Figure E2-2), selected effect levels were compared to Eco-SSL TRVs. One effect level (for selenium/birds/growth) was lower than its respective Eco-SSL TRV, and therefore, the value from the Eco-SSL document was identified as the TRV. This resulted in the selection of the Eco-SSL TRV of 0.29 mg/kg bw/day as the TRV for selenium/birds/growth rather than the effect level of 0.28 mg/kg bw/day.

All other TRVs were equivalent to the effect levels shown in Table E2-12. Table E2-13 presents the final additional TRVs identified based on all the steps shown in Figure E2-2. TRVs were derived for at least one endpoint for all metals, with the exception of antimony/mammals, for which a TRV could not be derived because no toxicity studies were found or none of the studies showed at least a 20% reduction in the observed response relative to the control. The selected TRVs are compared to TRV derivation plots from the Eco-SSL documents in Annex E.

As noted in the introduction to this memorandum, the criteria for identifying a TRV as receptor-specific was refined from the initial wildlife TRV document (TAI 2019b) so that a TRV was identified as receptor-specific only when the genus and species of the test animal (rather than the common name) matches that of the representative receptor used in the Upland BERA. Based on this refinement for the chemicals addressed in this document, receptor-specific TRVs were derived only for methylmercury and American kestrel (Table E2-13). In addition, updates were made to receptor-specific TRVs reported in the initial wildlife TRV document as follows:

- Gray wolf was added as a representative receptor after finalization of the initial wildlife TRV document. The cadmium/growth TRV for dog was added as a receptor-specific TRV for wolf because the two species have the same taxonomic identification (*Canas lupus)* (Table E2-14).
- The shrew-specific TRV for cadmium/growth was removed because the test species (*Sorex araneus*) is not the same as the representative receptor species (*Sorex cinereus* and *Sorex palustris*).

The LOAELs presented in Eco-SSL documents that are lower than each selected TRV, along with the rationale for not using these LOAELs, are presented in Annex A (Table E2.A-15). Based on the rationale presented therein, inclusion of these studies would not be expected to result in more reliable TRVs.

For the uncertainty evaluation, each selected effect level was evaluated to determine which considerations could result in decreased confidence in the value, and whether these considerations could result in potential biases in the TRV based on the effect level (Tables E2-15 through E2-29; in addition, Table E2-30 presents uncertainty considerations for updated receptor-specific TRVs). Some of the most common factors affecting confidence in the TRVs were:

- The use of laboratory species that are representative receptors used in the Upland BERA[2]
- The form of dose administration which could affect uptake by the test organism
- The use of a highly soluble form of a metal which may be more bioaccessible than the forms found in UCR sediments and tissue
- The use of secondary sources to estimate the body weight and/or food ingestion rate for dose calculations
- The selection of a LOAEL ≥ 20 rather than an ED20, particularly if the reduction in response relative to the control was substantially greater than 20%
- Data available for only a small number of species and/or datasets.

An additional factor affecting the level of confidence in a smaller number of TRVs is the use of Tier 2 datasets for TRV derivation (i.e., those datasets from growth studies conducted during a non-critical life stage for less than 10% of a species' lifespan or from

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[2] Potential interspecies differences in toxicity may be due to factors such as metabolism or toxicokinetics.

drinking water studies), which results in a higher level of uncertainty relative to the use of TRVs derived from Tier 1 datasets.

Confidence levels associated with the modeled ED20s as reported by TRAP are presented in Annex D for datasets with five or more data points. TRAP error estimates were assumed to be unreliable for datasets with fewer than five data points or if there was a warning message indicating a large standard error for one or more of the model parameters (see Table E2.D-1 in Annex D).

The effects of these factors on the level of confidence and bias in the risk estimates calculated using these TRVs is discussed in greater detail in the Upland BERA.

SUMMARY

Additional TRVs were derived for terrestrial bird and mammal COPCs that were not included in the initial wildlife TRV document (TAI 2019b). Additional TRVs were also derived for terrestrial bird or mammal COIs that are discussed in the uncertainty section of the Upland BERA if they are also COPCs for aquatic birds or mammals. Methods for deriving the additional TRVs were consistent with those presented in the initial wildlife TRV document. The following points summarize the results of the TRV derivation process for the additional COPCs or COIs:

- TRVs were derived for at least one endpoint for the following metals for both birds and mammals (except where noted): aluminum, barium (birds only) chromium (trivalent), iron, methylmercury, molybdenum, selenium, thallium (mammals only), and vanadium (birds only).
- TRVs were not derived for antimony (mammals) because none of the studies showed at least a 20% reduction in the observed response relative to the control. TRVs were not derived for antimony (birds), beryllium (birds), or thallium (birds or mammals), because no acceptable studies were found during the literature search.
- Common uncertainties among many of the TRVs were identified:
    - The use of laboratory species that are not representative receptors used in the Upland BERA
    - The form of dose administration which could affect uptake by the test organism
    - The use of a highly soluble form of the metal that is probably more bioaccessible than the forms found in UCR sediments and tissue
    - The use of secondary sources to estimate the body weight and/or FIR for dose calculations

- The selection of a LOAEL ≥ 20 rather than an ED20, particularly if the reduction in response relative to the control was substantially greater than 20%
- Data available for only a small number of species and/or datasets.

An additional uncertainty is associated with TRVs derived from Tier 2 datasets.

This memorandum also includes an update to some of the terrestrial receptor-specific TRVs presented in the initial wildlife TRV document (TAI 2019b). A summary of all TRVs for terrestrial birds and mammals is presented in Table E2-31.

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FIGURES

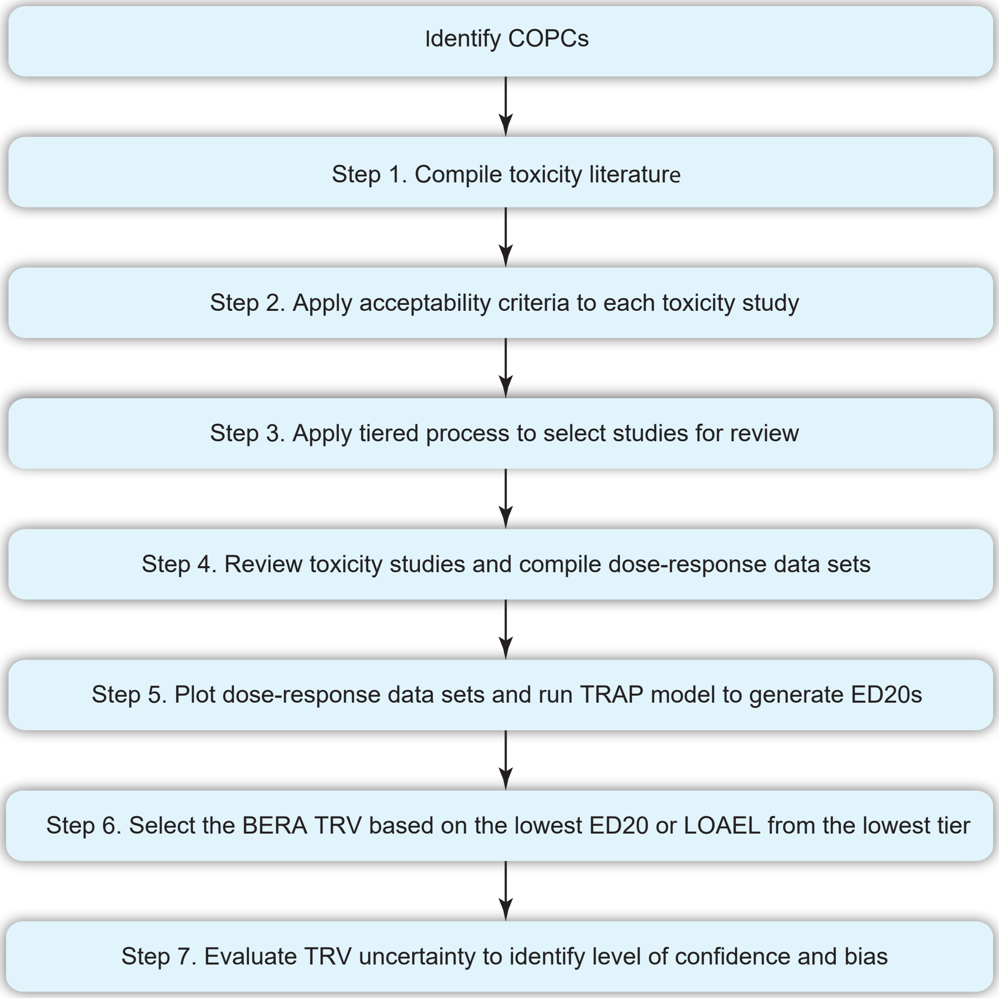
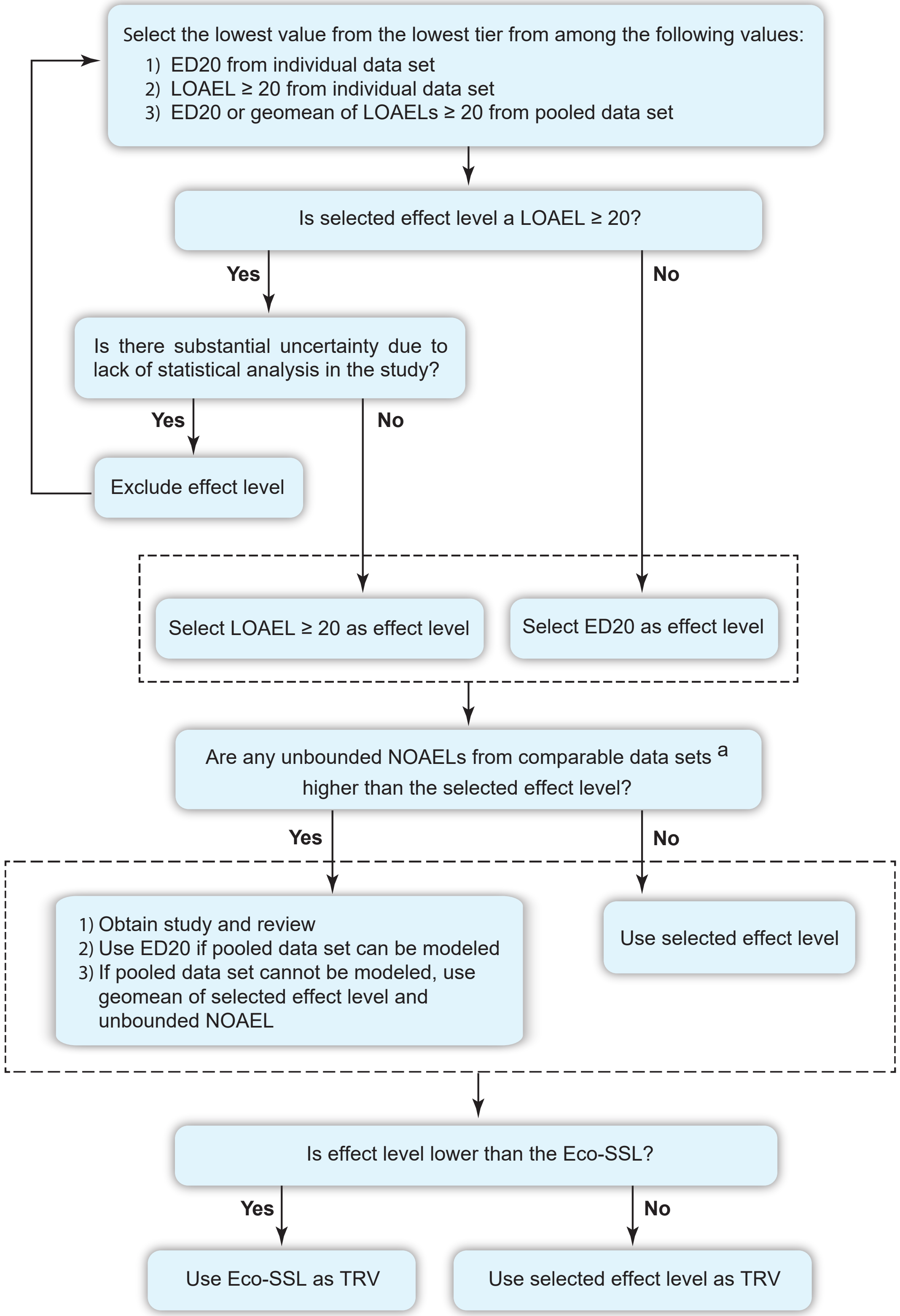


Figure E2-1. Seven-Step Process for Deriving TRVs

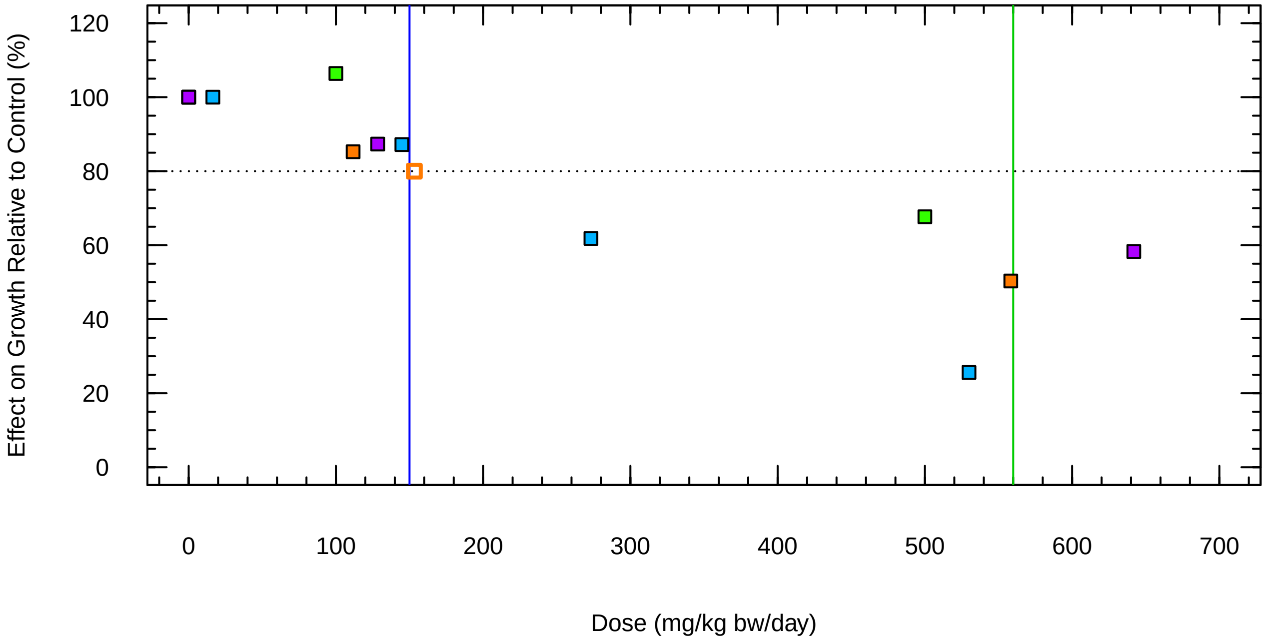


Notes:

Dashed lines indicate where the next step in the process applies to both previous steps.

[a] A comparable data set is one with the same effect measure, species, chemical form, method of dose administration, and similar exposure duration for growth studies.

Figure E2-2. Flow Chart for Upland BERA TRV Selection Process



Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
🟧 Capdevielle and Scanes 1995a	chicken	body weight	diet	2	aluminum sulfate		
🟩 Capdevielle and Scanes 1995b	mallard	body weight	diet	2.1	aluminum sulfate		
🟪 Capdevielle et al. 1996	chicken	body weight	diet	1.5	aluminum sulfate	A	
🟦 Elliot and Edwards 1991	chicken	body weight	diet	2.3	aluminum sulfate	A	
☐ ED20 for Capdevielle and Scanes 1995a	chicken	body weight	diet	2	aluminum sulfate		150

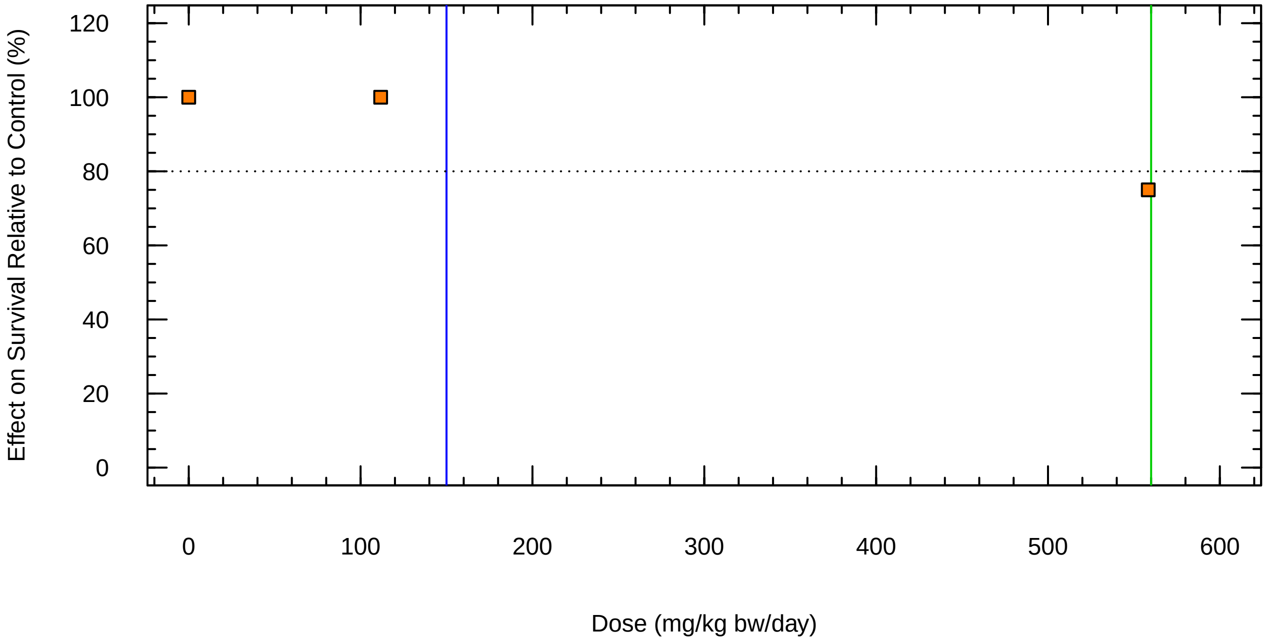
☐ Tier 1

— Selected TRV (Growth) = 150 mg/kg bw/day
— Selected TRV (Survival) = 560 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−3. Dose−Response Data for the Avian Growth Endpoint for Aluminum



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Capdevielle and Scanes 1995a	chicken	survival	diet	2	aluminum sulfate

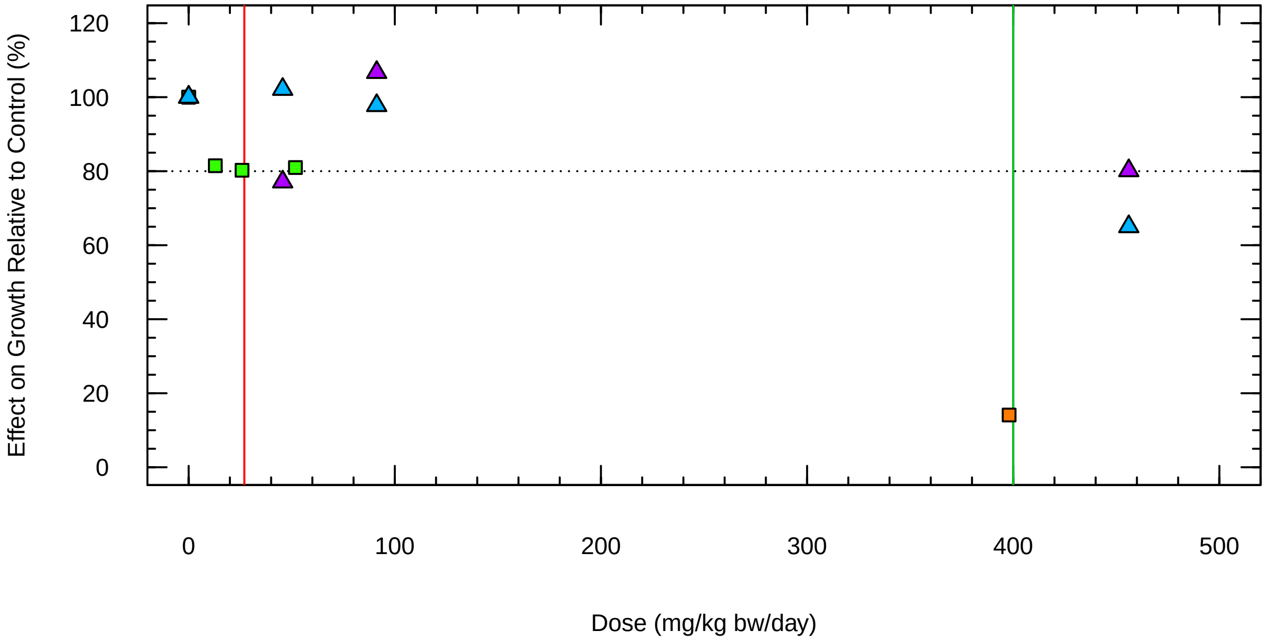
☐ Tier 1

— Selected TRV (Growth) = 150 mg/kg bw/day
— Selected TRV (Survival) = 560 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−4. Dose−Response Data for the Avian Survival Endpoint for Aluminum



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Belles et al. 1999	mouse	body weight gain	gavage	1.5	aluminum nitrate nonahydrate
🟩	Paternain et al. 1988	rat	body weight gain	gavage	1.3	aluminum nitrate nonahydrate
▲	Domingo et al. 1987a	rat	body weight	drinking water	14	aluminum nitrate nonahydrate
▲	Domingo et al. 1987a	rat	body weight	drinking water	14	aluminum nitrate nonahydrate

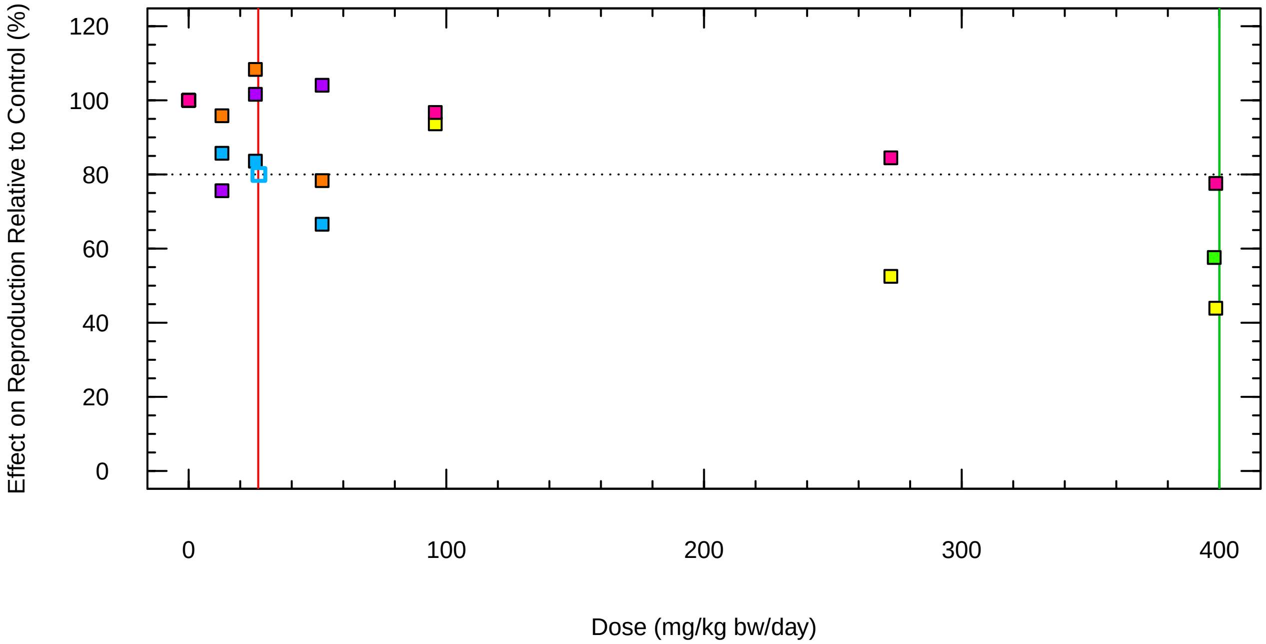
☐ Tier 1 △ Tier 2

— Selected TRV (Growth) = 400 mg/kg bw/day
— Selected TRV (Reproduction) = 27 mg/kg bw/day
— Selected TRV (Survival) = 400 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−5. Dose−Response Data for the Mammalian Growth Endpoint for Aluminum



Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	ED20 or Geomean (mg/kg bw/day)
🟧 Domingo et al. 1987b	rat	pup survival	oral	unclear	aluminum nitrate nonahydrate	
🟩 Belles et al. 1999	mouse	fetal body weight	gavage	1.5	aluminum nitrate nonahydrate	
🟪 Paternain et al. 1988	rat	fetal survival	gavage	1.3	aluminum nitrate nonahydrate	
🟦 Paternain et al. 1988	rat	fetal body weight	gavage	1.3	aluminum nitrate nonahydrate	
🟨 Bernuzzi et al. 1989	rat	postnatal survival	diet	2.6	aluminum chloride	
🟥 Bernuzzi et al. 1989	rat	pup body weight	diet	2.6	aluminum chloride	
☐ ED20 for Paternain et al. 1988	rat	fetal body weight	gavage	1.3	aluminum nitrate nonahydrate	27

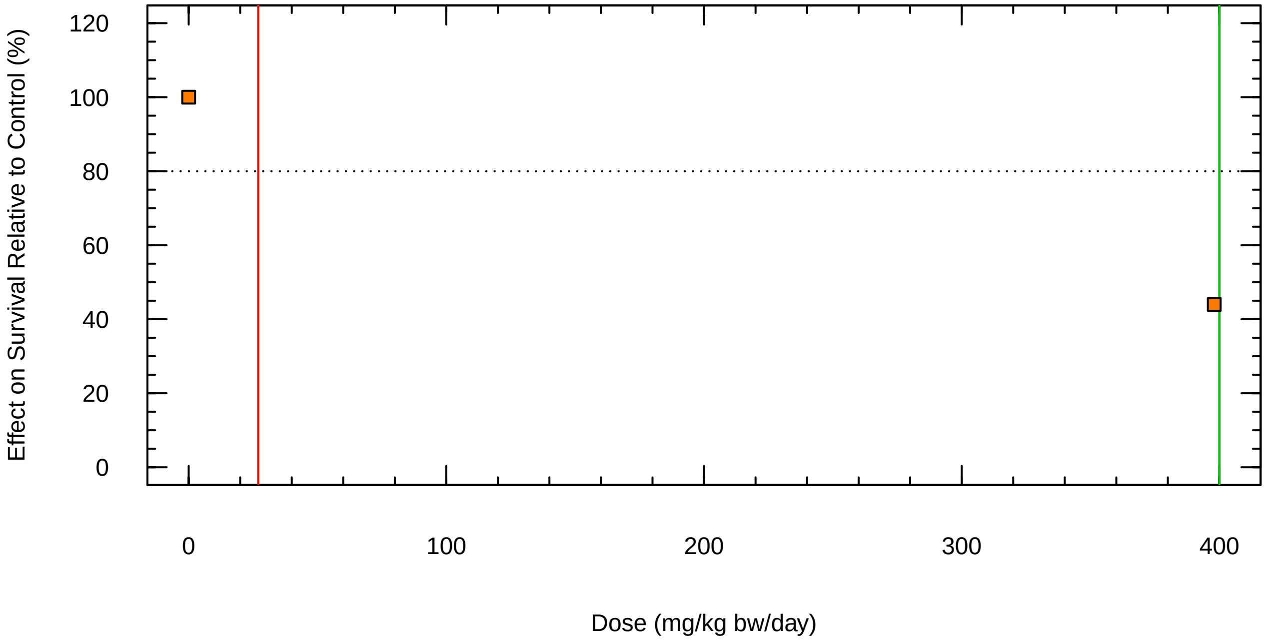
☐ Tier 1

— Selected TRV (Growth) = 400 mg/kg bw/day
— Selected TRV (Reproduction) = 27 mg/kg bw/day
— Selected TRV (Survival) = 400 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−6. Dose−Response Data for the Mammalian Reproduction Endpoint for Aluminum



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Belles et al. 1999	mouse	survival	gavage	1.5	aluminum nitrate nonahydrate

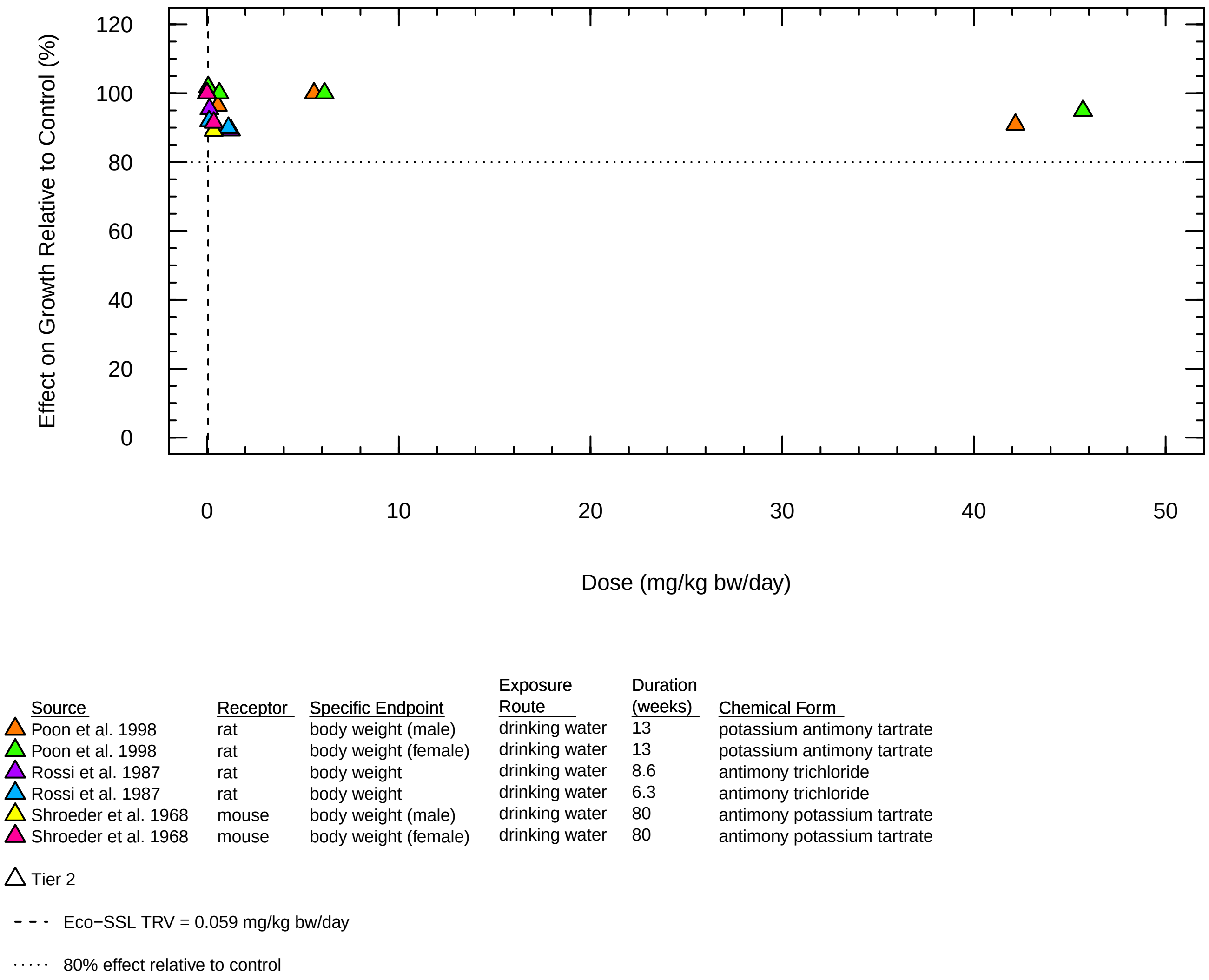
☐ Tier 1

— Selected TRV (Growth) = 400 mg/kg bw/day
— Selected TRV (Reproduction) = 27 mg/kg bw/day
— Selected TRV (Survival) = 400 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−7. Dose−Response Data for the Mammalian Survival Endpoint for Aluminum



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
▲	Poon et al. 1998	rat	body weight (male)	drinking water	13	potassium antimony tartrate
▲	Poon et al. 1998	rat	body weight (female)	drinking water	13	potassium antimony tartrate
▲	Rossi et al. 1987	rat	body weight	drinking water	8.6	antimony trichloride
▲	Rossi et al. 1987	rat	body weight	drinking water	6.3	antimony trichloride
▲	Shroeder et al. 1968	mouse	body weight (male)	drinking water	80	antimony potassium tartrate
▲	Shroeder et al. 1968	mouse	body weight (female)	drinking water	80	antimony potassium tartrate

△ Tier 2

- - - Eco−SSL TRV = 0.059 mg/kg bw/day

····· 80% effect relative to control

Figure E2−8. Dose−Response Data for the Mammalian Growth Endpoint for Antimony

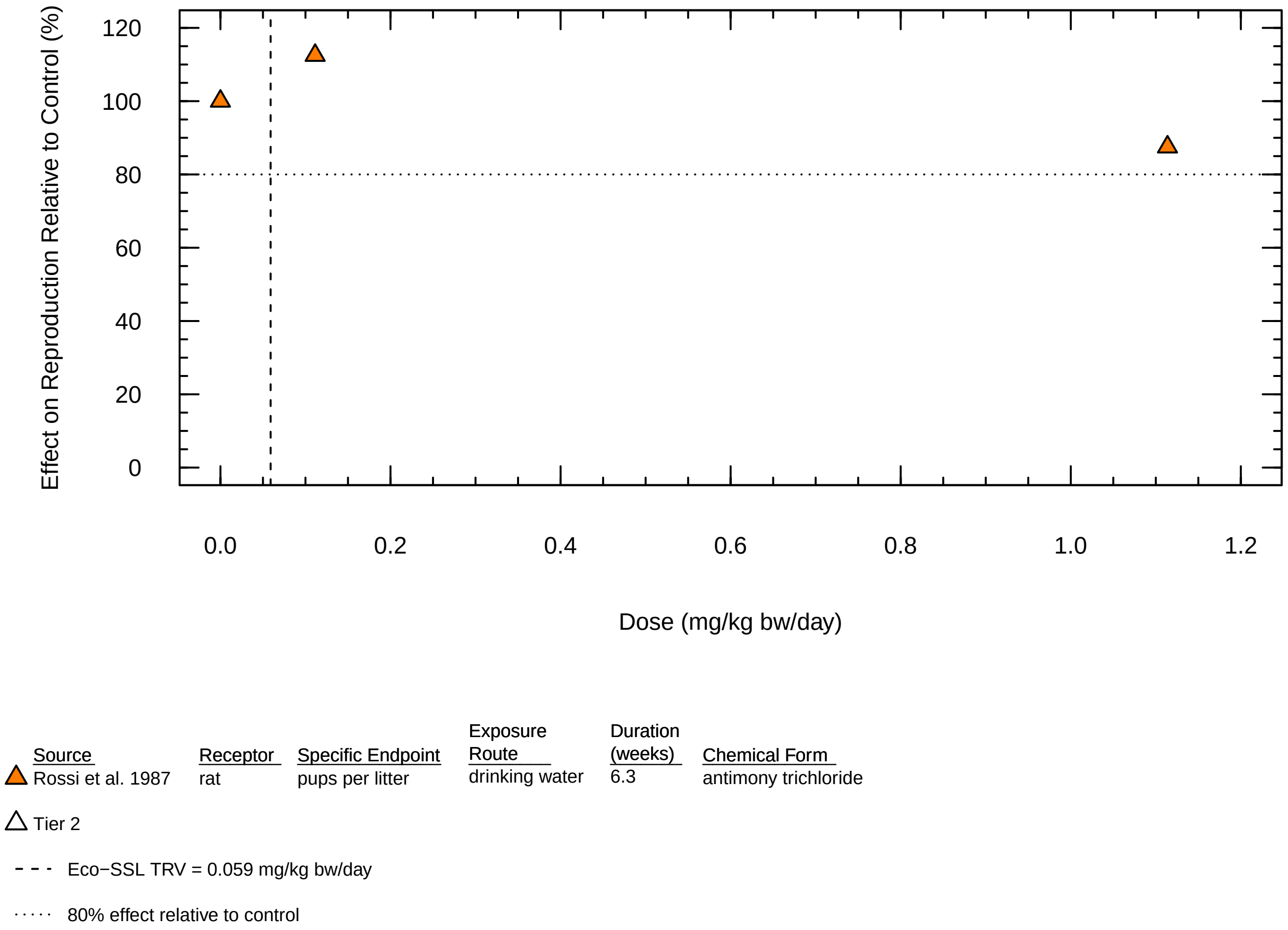


Figure E2−9. Dose−Response Data for the Mammalian Reproduction Endpoint for Antimony

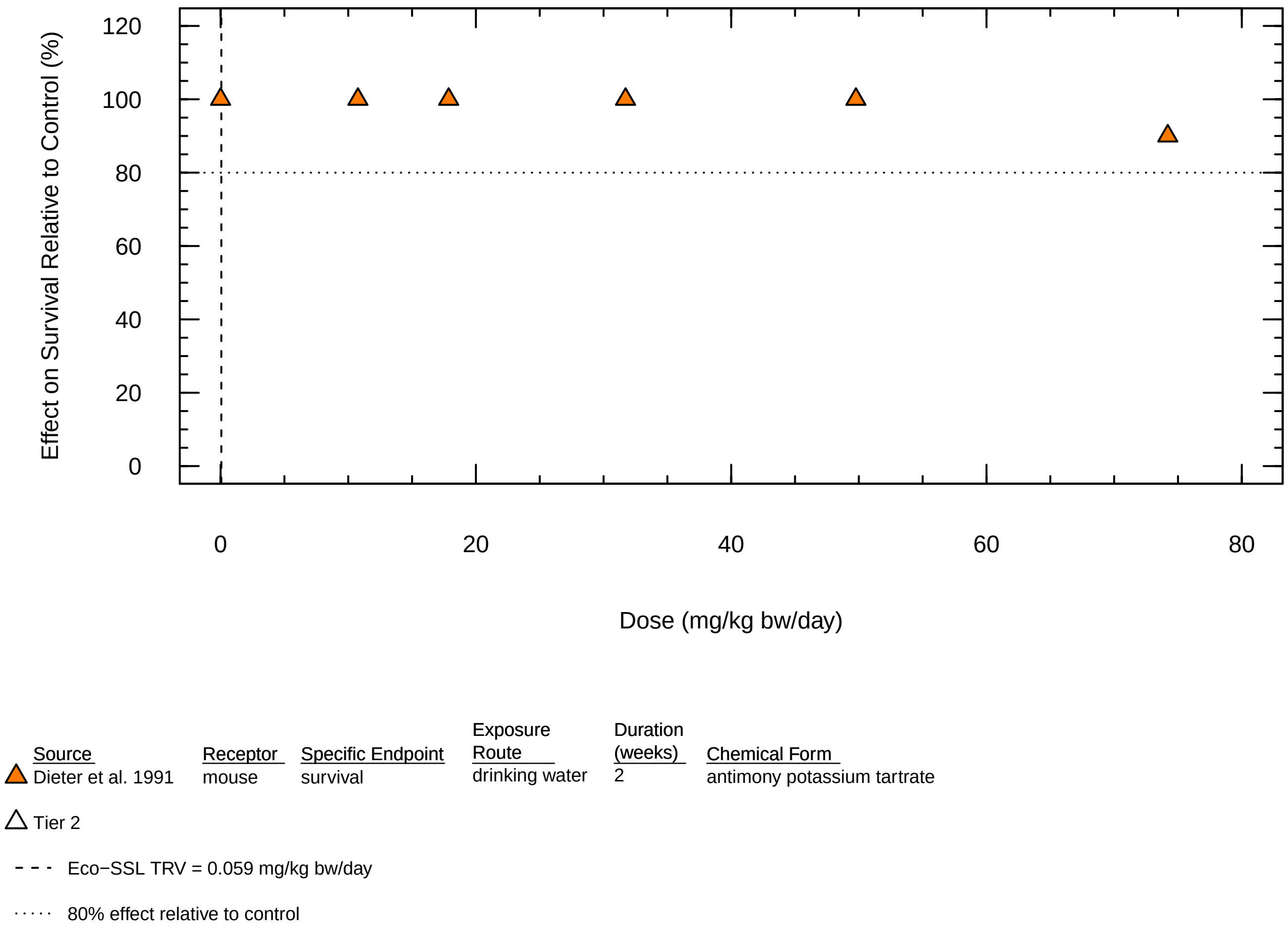
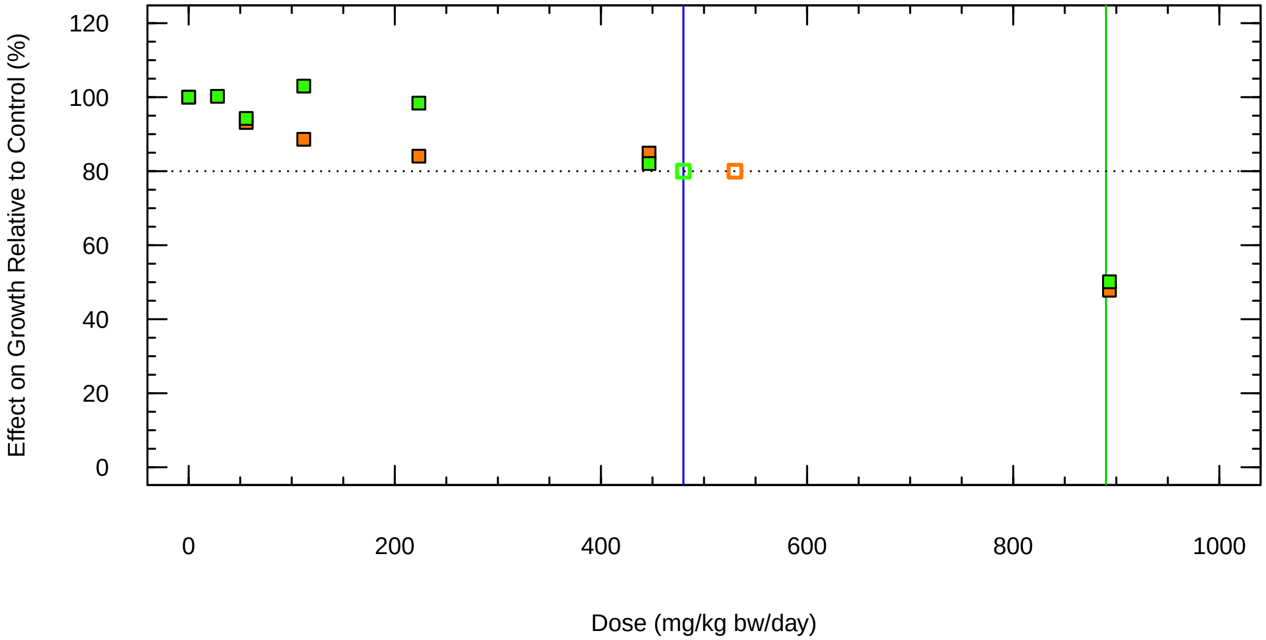


Figure E2−10. Dose−Response Data for the Mammalian Survival Endpoint for Antimony



Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	ED20 or Geomean (mg/kg bw/day)
🟧 Johnson et al. 1960	chicken	body weight gain	diet	4	barium hydroxide	
🟩 Johnson et al. 1960	chicken	body weight gain	diet	4	barium acetate	
☐ ED20 for Johnson et al. 1960	chicken	body weight gain	diet	4	barium hydroxide	530
☐ ED20 for Johnson et al. 1960	chicken	body weight gain	diet	4	barium acetate	480

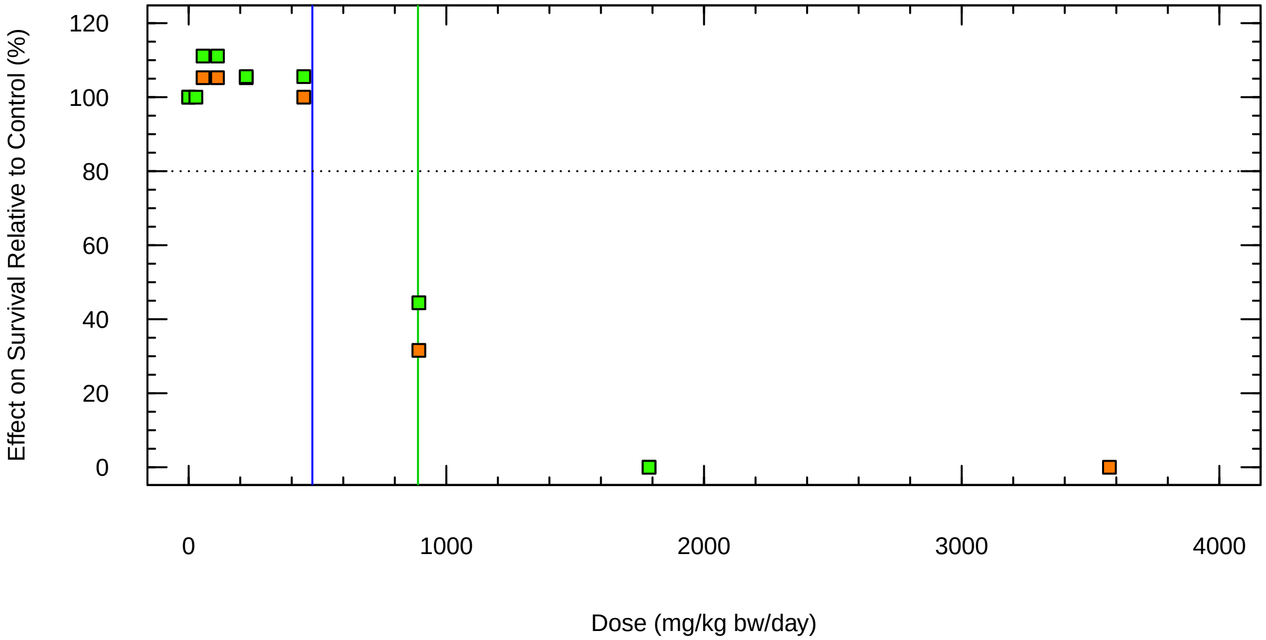
☐ Tier 1

— Selected TRV (Growth) = 480 mg/kg bw/day
— Selected TRV (Survival) = 890 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−11. Dose−Response Data for the Avian Growth Endpoint for Barium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Johnson et al. 1960	chicken	survival	diet	4	barium hydroxide
🟩	Johnson et al. 1960	chicken	survival	diet	4	barium acetate

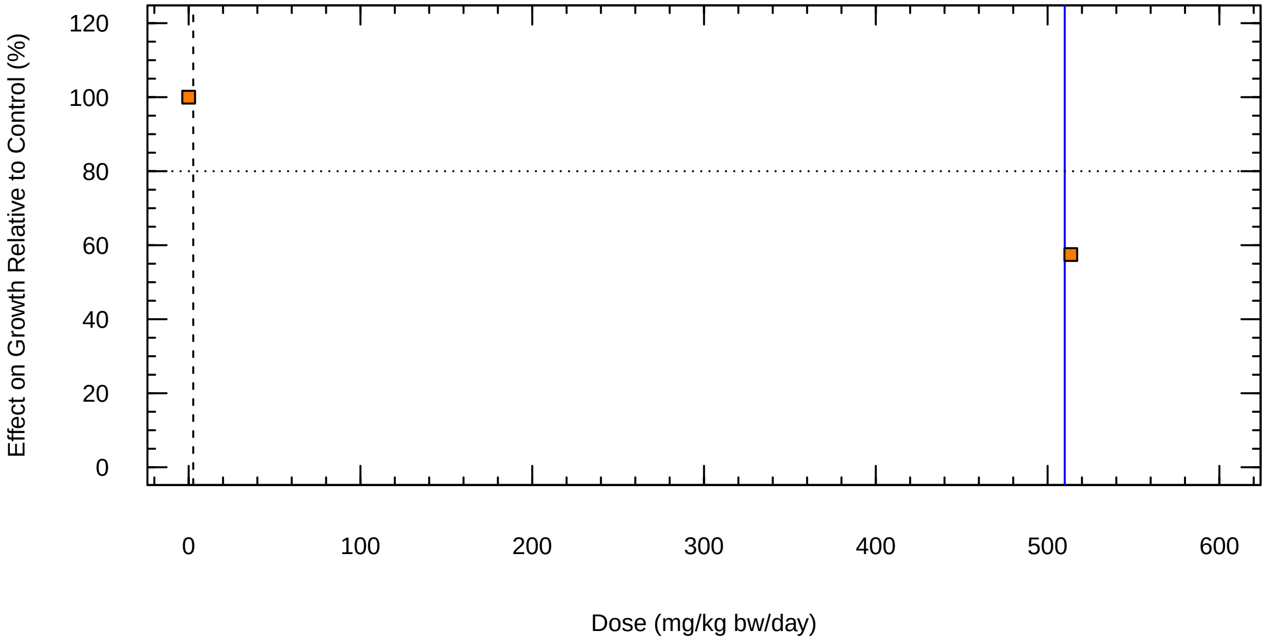
☐ Tier 1

Selected TRV (Growth) = 480 mg/kg bw/day
Selected TRV (Survival) = 890 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−12. Dose−Response Data for the Avian Survival Endpoint for Barium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Chung et al. 1985	chicken	body weight	diet	2	chromium sulfate (chromium [III])

☐ Tier 1

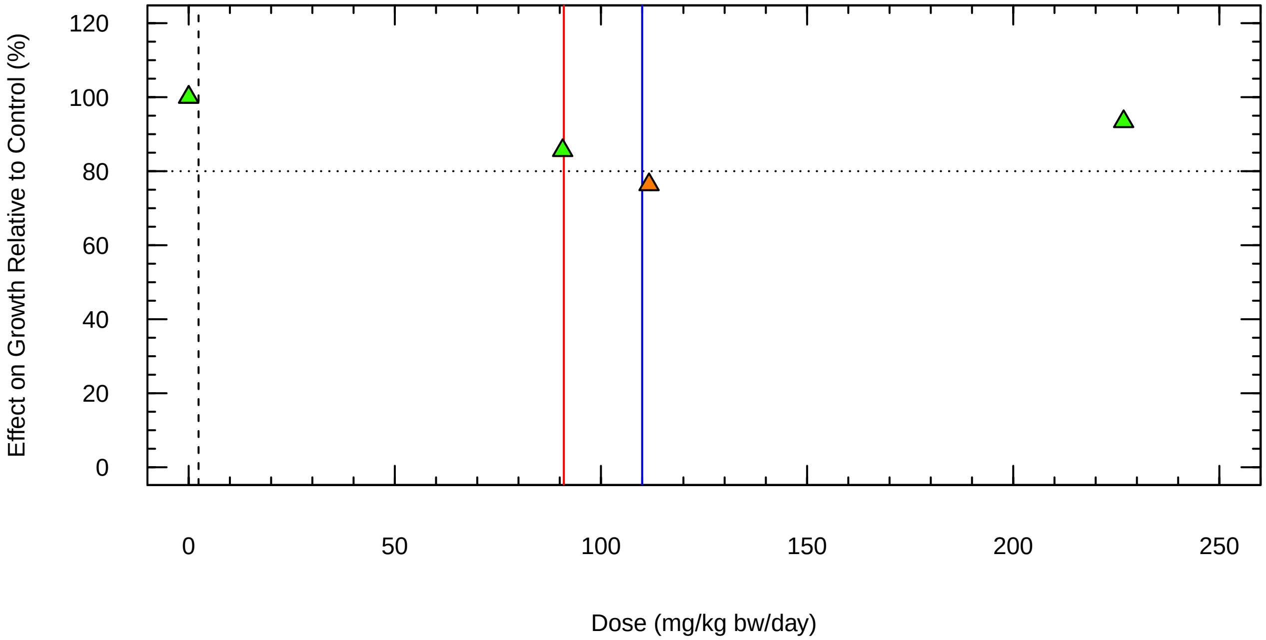
- - - Eco−SSL TRV = 2.66 mg/kg bw/day

— Selected TRV (Growth) = 510 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−13. Dose−Response Data for the Avian Growth Endpoint for Chromium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
▲	Bataineh et al. 1997	rat	body weight (male)	drinking water	12	chromium chloride (chromium [III])
▲	Elbetieha and Al−Hamood 1997	mouse	body weight	drinking water	12	chromium chloride (chromium [III])

△ Tier 2

- - - Eco−SSL TRV = 2.4 mg/kg bw/day

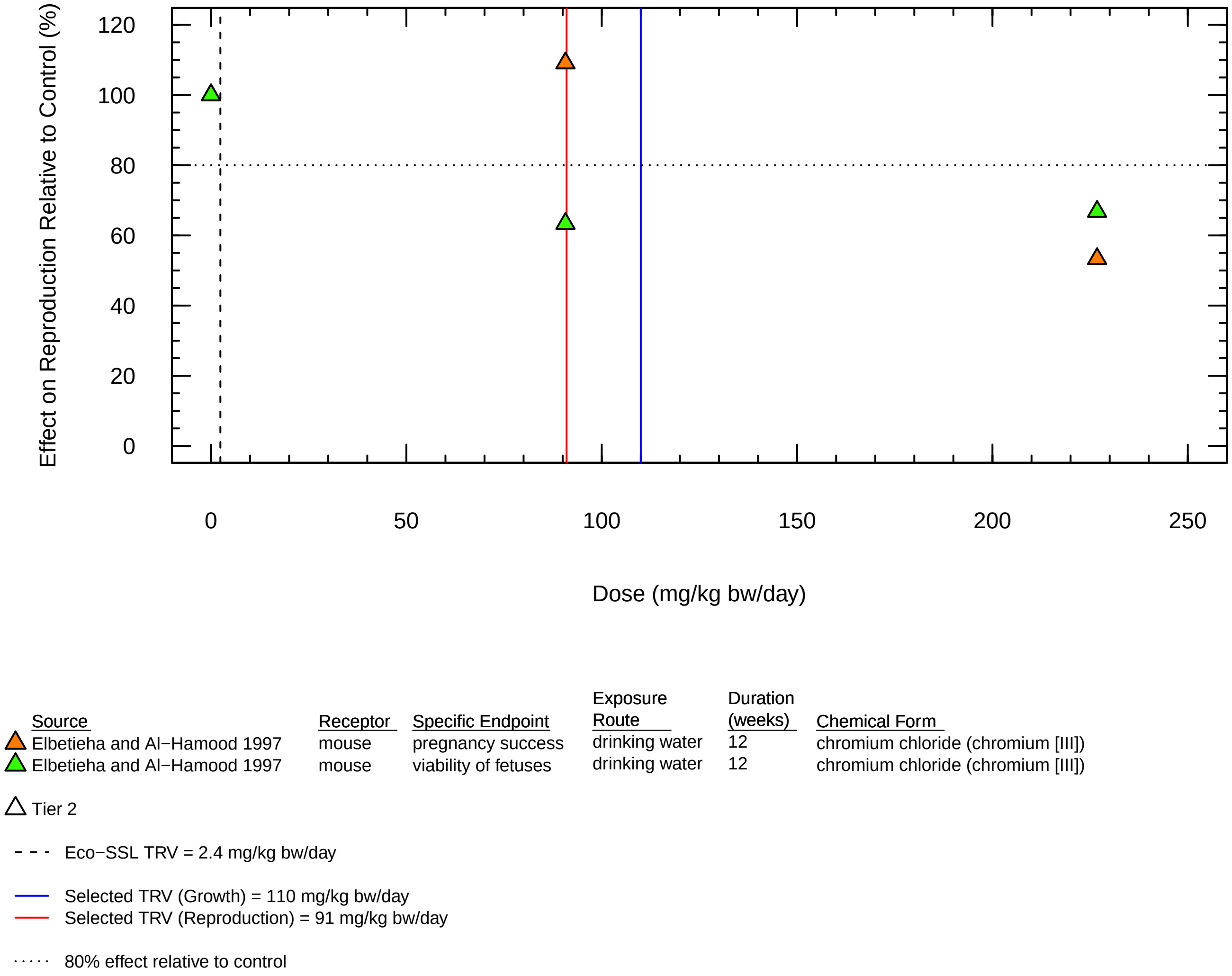
— Selected TRV (Growth) = 110 mg/kg bw/day

— Selected TRV (Reproduction) = 91 mg/kg bw/day

····· 80% effect relative to control

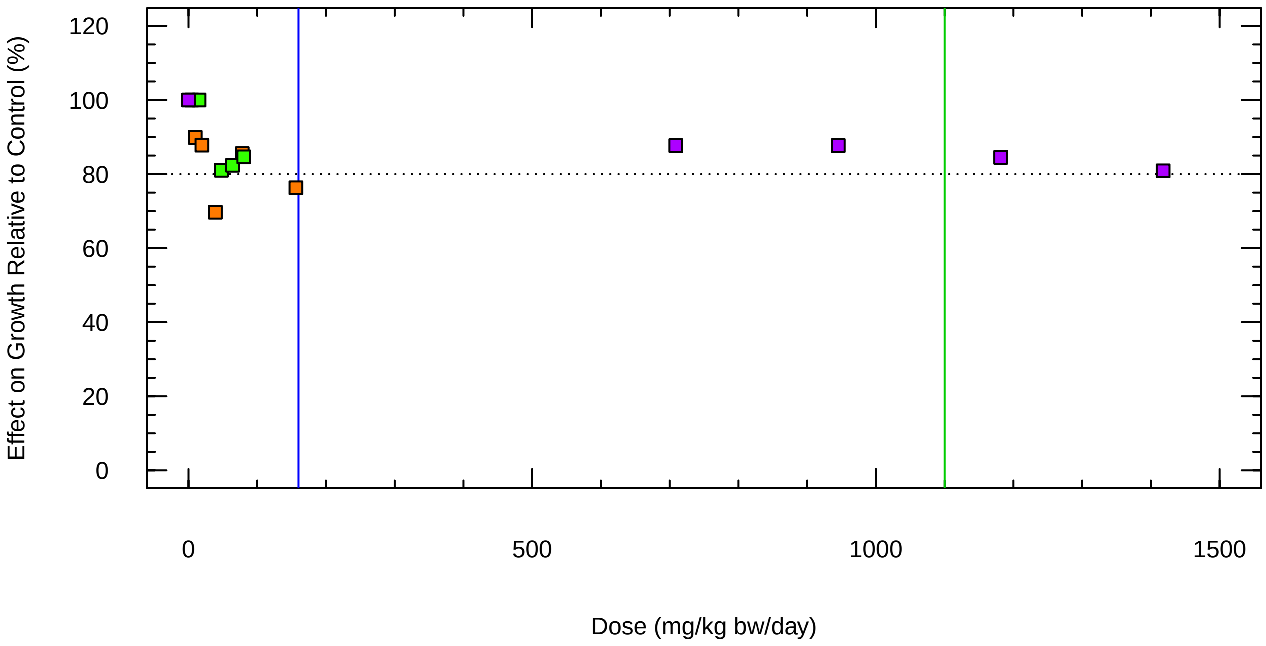
Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−14. Dose−Response Data for the Mammalian Growth Endpoint for Chromium



Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−15. Dose−Response Data for the Mammalian Reproduction Endpoint for Chromium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	McGhee et al. 1965	chicken	body weight	diet	4	iron sulfate
🟩	Cao et al. 1996	chicken	body weight	diet	3	iron sulfate
🟪	Pescatore and Harter−Dennis 1989	chicken	body weight	gavage	single dose	iron sulfate

☐ Tier 1

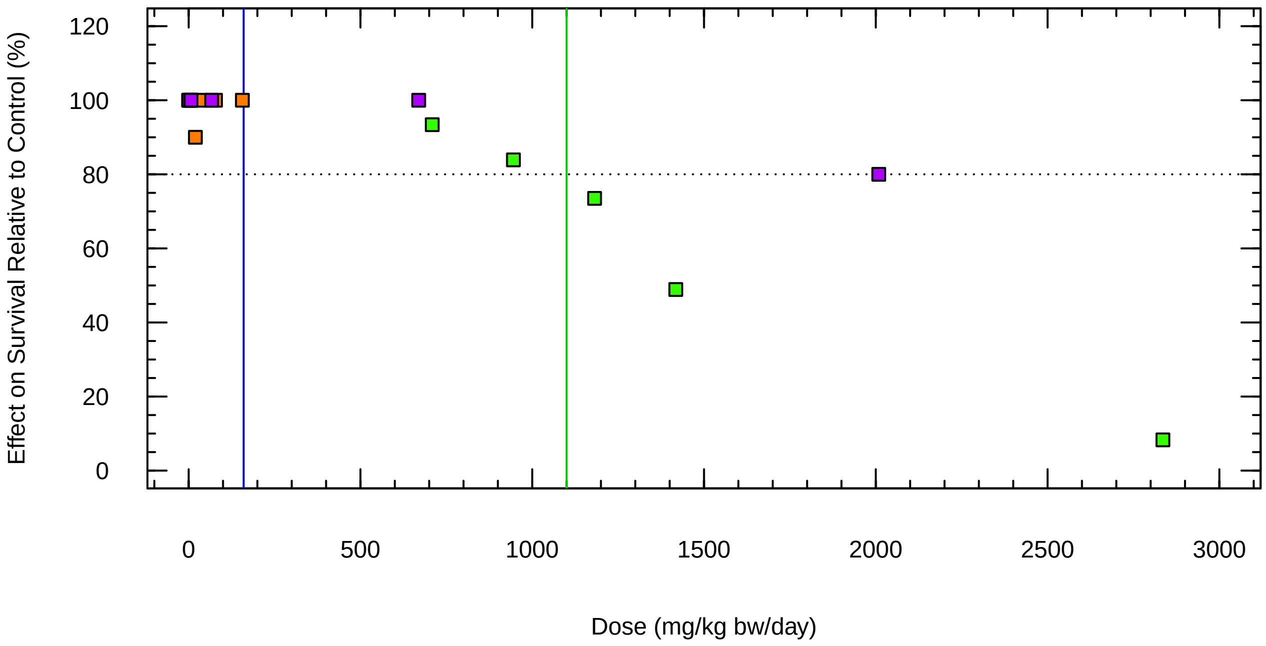
— Selected TRV (Growth) = 160 mg/kg bw/day

— Selected TRV (Survival) = 1100 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−16. Dose−Response Data for the Avian Growth Endpoint for Iron



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	McGhee et al. 1965	chicken	survival	diet	4	iron sulfate	
🟩	Pescatore and Harter−Dennis 1989	chicken	survival	gavage	single dose	iron sulfate	A
🟪	Wallner−Pendleton et al. 1986	chicken	survival	gavage	single dose	iron sulfate	A

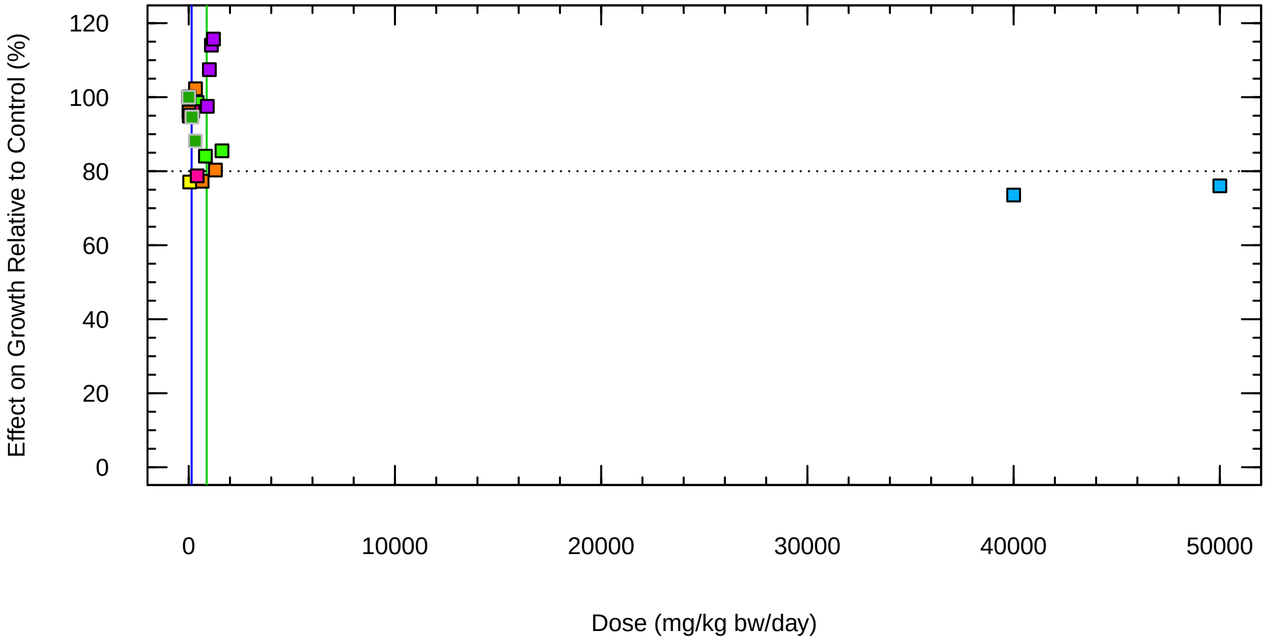
☐ Tier 1

— Selected TRV (Growth) = 160 mg/kg bw/day
— Selected TRV (Survival) = 1100 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−17. Dose−Response Data for the Avian Survival Endpoint for Iron



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Plummer et al. 1997	rat (male)	body weight	diet	32	carbonyl iron	
🟩	Plummer et al. 1997	rat (female)	body weight	diet	32	carbonyl iron	
🟪	Whittaker et al. 2002	rat	body weight	gavage	single dose	iron sulfate	
🟦	Whittaker et al. 2002	rat	body weight	gavage	single dose	carbonyl iron	
🟨	Banis et al. 1969	rat	body weight	diet	4	iron sulfate	A
🟥	Storey and Greger 1987	rat	body weight	diet	3	iron sulfate	A
🟫	Prince et al. 1979	pig	body weight	diet	16	ferrous sulfide	
🟩	Zhu et al. 2016	rat	body weight	diet	13	carbonyl iron	

☐ Tier 1

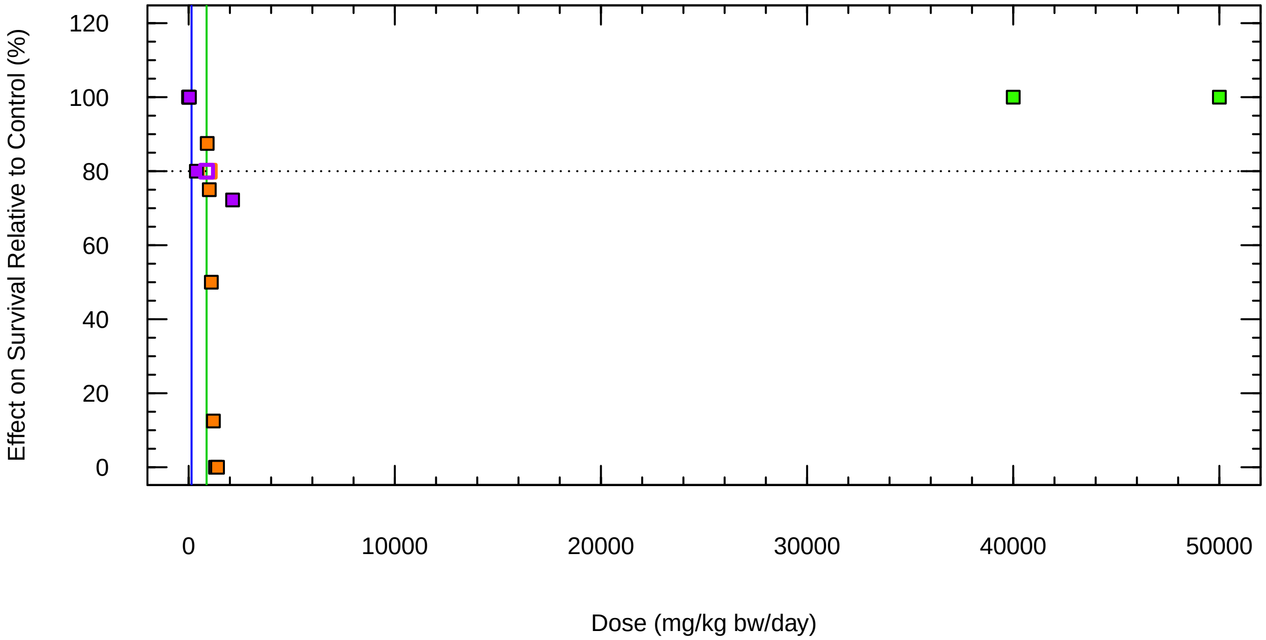
— Selected TRV (Growth) = 140 mg/kg bw/day

— Selected TRV (Survival) = 870 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−18. Dose−Response Data for the Mammalian Growth Endpoint for Iron



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	ED20 or Geomean (mg/kg bw/day)
🟧	Whittaker et al. 2002	rat	survival	gavage	single dose	iron sulfate	
🟩	Whittaker et al. 2002	rat	survival	gavage	single dose	carbonyl iron	
🟪	Whittaker et al. 1996	rat	survival	diet	12	carbonyl iron	
□	ED20 for Whittaker et al. 2002	rat	survival	gavage	single dose	iron sulfate	1000
□	ED20 for Whittaker et al. 1996	rat	survival	diet	12	carbonyl iron	870

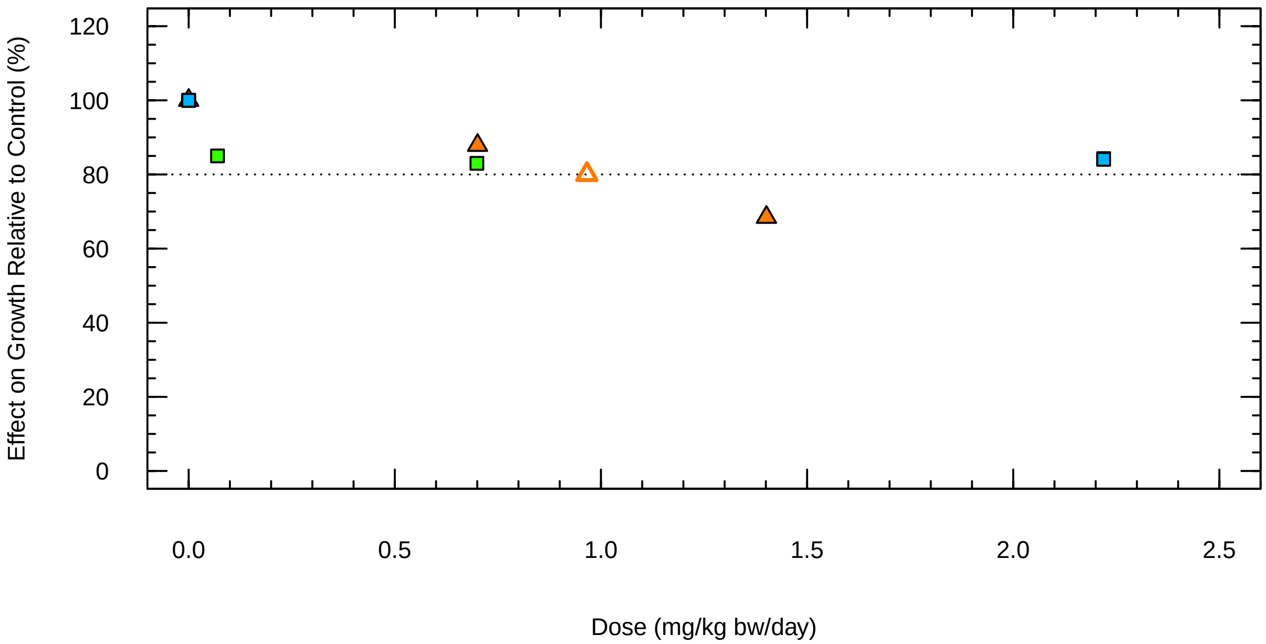
☐ Tier 1

— Selected TRV (Growth) = 140 mg/kg bw/day
— Selected TRV (Survival) = 870 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−19. Dose−Response Data for the Mammalian Survival Endpoint for Iron

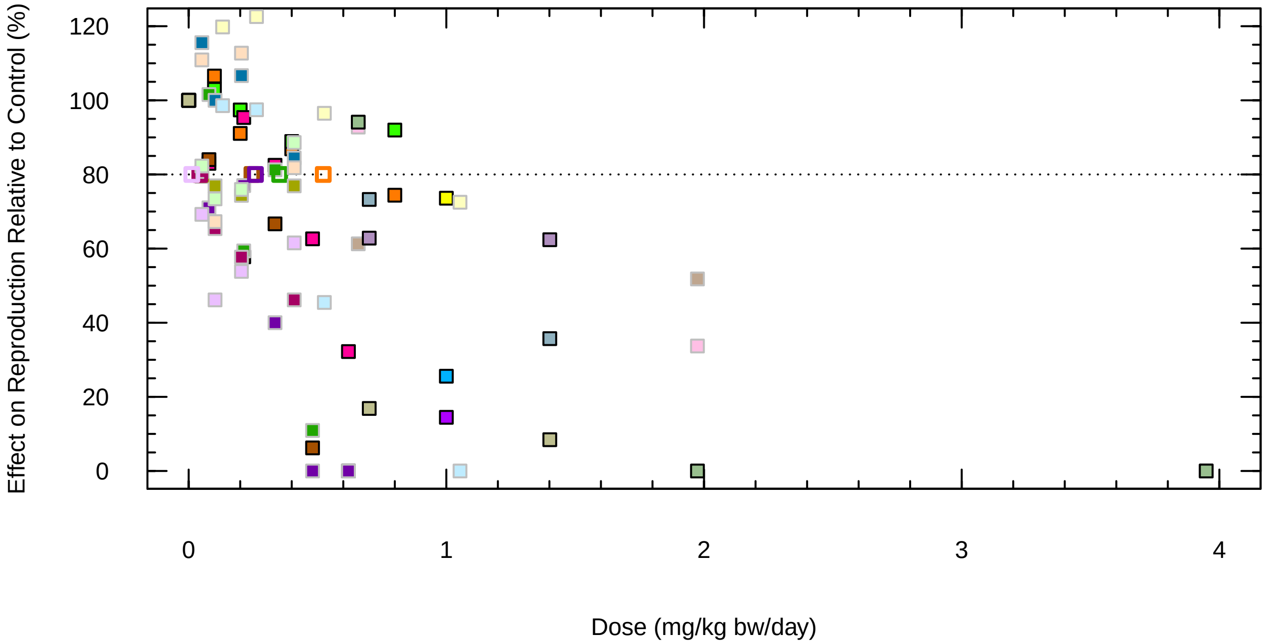


Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
▲ Scott et al. 1977	chicken	body weight	diet	8	methylmercury chloride		
🟩 Spalding et al. 2000	egret	weight index	diet	14	methylmercury chloride		
🟪 Sell and Horani 1976	chicken	body weight gain (Exp 1)	diet	4	methylmercury chloride	A	
🟦 Sell and Horani 1976	chicken	body weight gain (Exp 2)	diet	3.6	methylmercury chloride	A	
△ ED20 for Scott et al. 1977	chicken	body weight	diet	8	methylmercury chloride		0.97

□ Tier 1 △ Tier 2

····· 80% effect relative to control

Figure E2−20. Dose−Response Data for the Avian Growth Endpoint for Methylmercury

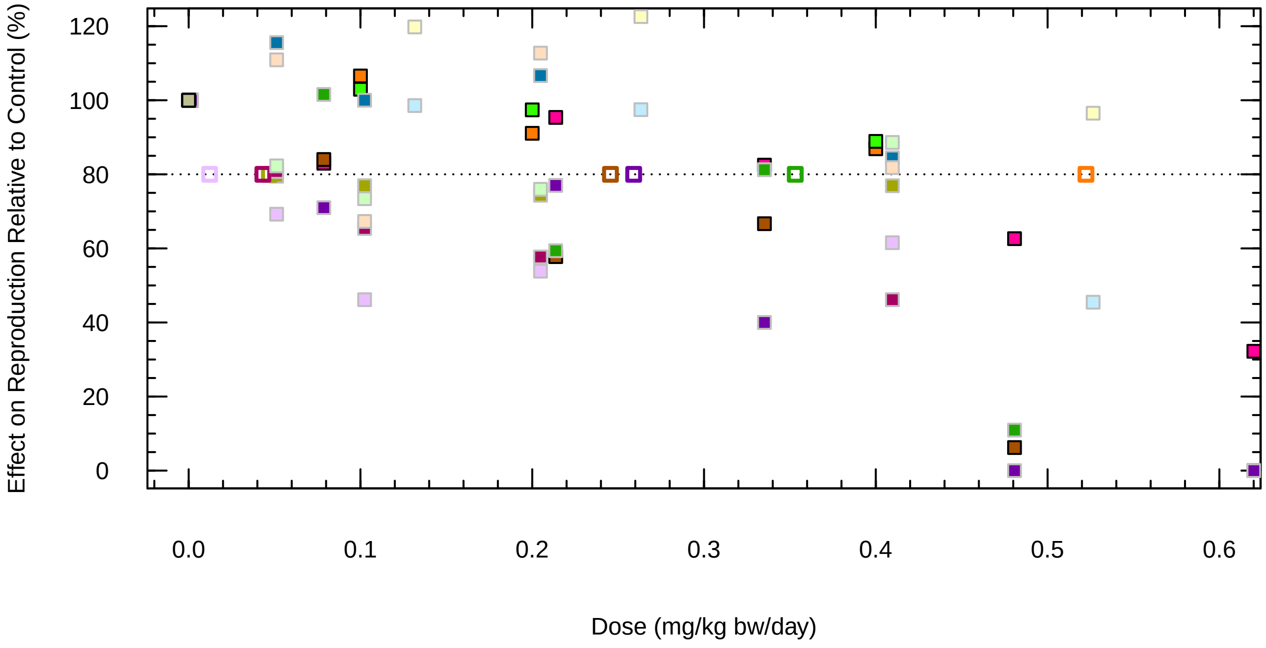


	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
■	Heinz et al. 2010	mallard	# of ducklings per hen	diet	3.7	methylmercury chloride	B	
■	Heinz et al. 2010	mallard	duckling body weight	diet	3.7	methylmercury chloride		
■	Heinz and Hoffman 1998	mallard	# of ducklings per hen	diet	up to 11	methylmercury chloride	B	
■	Heinz and Hoffman 1998	mallard	% hatchability	diet	up to 11	methylmercury chloride		
■	Heinz and Hoffman 1998	mallard	duckling survival	diet	up to 11	methylmercury chloride		
■	Albers et al. 2007	kestrel	egg production	diet	at least 11	methylmercury chloride		
■	Albers et al. 2007	kestrel	# of eggs hatched	diet	at least 11	methylmercury chloride		
■	Albers et al. 2007	kestrel	% eggs hatched	diet	at least 11	methylmercury chloride		
■	Albers et al. 2007	kestrel	% fledged	diet	at least 11	methylmercury chloride		
■	Varian−Ramos et al. 2014	finch	% hatchability	diet	52	methylmercury cysteine		
■	Varian−Ramos et al. 2014	finch	% chicks fledged	diet	52	methylmercury cysteine		
■	Varian−Ramos et al. 2014	finch	# of offspring	diet	52	methylmercury cysteine		
■	Varian−Ramos et al. 2014	finch	F1 % hatchability	diet	unclear	methylmercury cysteine		
■	Varian−Ramos et al. 2014	finch	F1 % chicks fledged	diet	unclear	methylmercury cysteine		
■	Varian−Ramos et al. 2014	finch	F1 # of offspring	diet	unclear	methylmercury cysteine		
■	Eskeland and Nafstad 1978	quail	chick survival	diet	6	methylmercury chloride		
■	Eskeland and Nafstad 1978	quail	hatch success	diet	6	methylmercury chloride		
■	El−Begearmi et al. 1977	quail	% egg fertility	diet	16	methylmercury hydroxide		
■	El−Begearmi et al. 1977	quail	egg production	diet	16	methylmercury hydroxide		
■	El−Begearmi et al. 1977	quail	% hatchability	diet	16	methylmercury hydroxide		
■	Scott et al. 1977	chicken	egg fertility	diet	8	methylmercury chloride		
■	Scott et al. 1977	chicken	egg production	diet	8	methylmercury chloride		
■	Scott et al. 1977	chicken	egg hatchability	diet	8	methylmercury chloride		
□	ED20 for Heinz et al. 2010	mallard	# of ducklings per hen	diet	3.7	methylmercury chloride	B	0.52
□	ED20 for Albers et al. 2007	kestrel	# of eggs hatched	diet	at least 11	methylmercury chloride		0.25
□	ED20 for Albers et al. 2007	kestrel	% eggs hatched	diet	at least 11	methylmercury chloride		0.35
□	ED20 for Albers et al. 2007	kestrel	% fledged	diet	at least 11	methylmercury chloride		0.26
□	ED20 for Varian−Ramos et al. 2014	finch	% chicks fledged	diet	52	methylmercury cysteine		0.047
□	ED20 for Varian−Ramos et al. 2014	finch	# of offspring	diet	52	methylmercury cysteine		0.043
□	ED20 for Varian−Ramos et al. 2014	finch	F1 # of offspring	diet	unclear	methylmercury cysteine		0.012

□ Tier 1

····· 80% effect relative to control

Figure E2−21a. Dose−Response Data for the Avian Reproduction Endpoint for Methylmercury

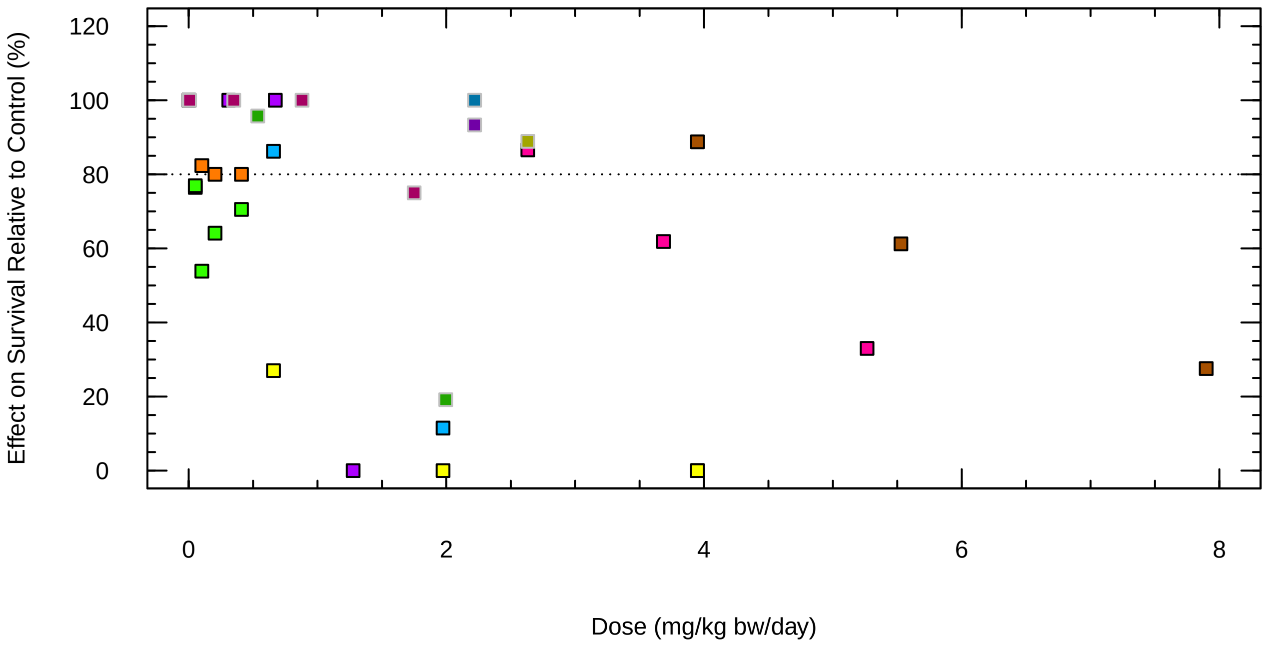


Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
■ Heinz et al. 2010	mallard	# of ducklings per hen	diet	3.7	methylmercury chloride	B	
■ Heinz et al. 2010	mallard	duckling body weight	diet	3.7	methylmercury chloride		
■ Heinz and Hoffman 1998	mallard	# of ducklings per hen	diet	up to 11	methylmercury chloride	B	
■ Heinz and Hoffman 1998	mallard	% hatchability	diet	up to 11	methylmercury chloride		
■ Heinz and Hoffman 1998	mallard	duckling survival	diet	up to 11	methylmercury chloride		
■ Albers et al. 2007	kestrel	egg production	diet	at least 11	methylmercury chloride		
■ Albers et al. 2007	kestrel	# of eggs hatched	diet	at least 11	methylmercury chloride		
■ Albers et al. 2007	kestrel	% eggs hatched	diet	at least 11	methylmercury chloride		
■ Albers et al. 2007	kestrel	% fledged	diet	at least 11	methylmercury chloride		
■ Varian−Ramos et al. 2014	finch	% hatchability	diet	52	methylmercury cysteine		
■ Varian−Ramos et al. 2014	finch	% chicks fledged	diet	52	methylmercury cysteine		
■ Varian−Ramos et al. 2014	finch	# of offspring	diet	52	methylmercury cysteine		
■ Varian−Ramos et al. 2014	finch	F1 % hatchability	diet	unclear	methylmercury cysteine		
■ Varian−Ramos et al. 2014	finch	F1 % chicks fledged	diet	unclear	methylmercury cysteine		
■ Varian−Ramos et al. 2014	finch	F1 # of offspring	diet	unclear	methylmercury cysteine		
■ Eskeland and Nafstad 1978	quail	chick survival	diet	6	methylmercury chloride		
■ Eskeland and Nafstad 1978	quail	hatch success	diet	6	methylmercury chloride		
■ El−Begearmi et al. 1977	quail	% egg fertility	diet	16	methylmercury hydroxide		
■ El−Begearmi et al. 1977	quail	egg production	diet	16	methylmercury hydroxide		
■ El−Begearmi et al. 1977	quail	% hatchability	diet	16	methylmercury hydroxide		
■ Scott et al. 1977	chicken	egg fertility	diet	8	methylmercury chloride		
■ Scott et al. 1977	chicken	egg production	diet	8	methylmercury chloride		
■ Scott et al. 1977	chicken	egg hatchability	diet	8	methylmercury chloride		
□ ED20 for Heinz et al. 2010	mallard	# of ducklings per hen	diet	3.7	methylmercury chloride	B	0.52
□ ED20 for Albers et al. 2007	kestrel	# of eggs hatched	diet	at least 11	methylmercury chloride		0.25
□ ED20 for Albers et al. 2007	kestrel	% eggs hatched	diet	at least 11	methylmercury chloride		0.35
□ ED20 for Albers et al. 2007	kestrel	% fledged	diet	at least 11	methylmercury chloride		0.26
□ ED20 for Varian−Ramos et al. 2014	finch	% chicks fledged	diet	52	methylmercury cysteine		0.047
□ ED20 for Varian−Ramos et al. 2014	finch	# of offspring	diet	52	methylmercury cysteine		0.043
□ ED20 for Varian−Ramos et al. 2014	finch	F1 # of offspring	diet	unclear	methylmercury cysteine		0.012

□ Tier 1

····· 80% effect relative to control

Figure E2−21b. Dose−Response Data for the Avian Reproduction Endpoint for Methylmercury (Truncated X−Axis)

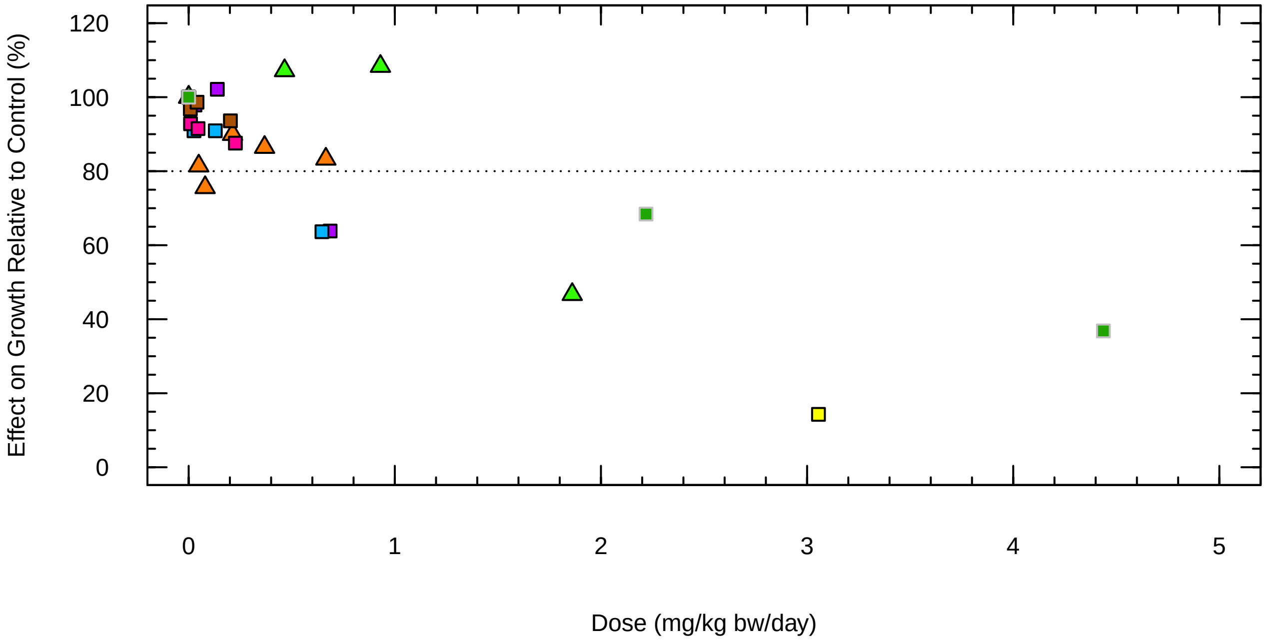


	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Varian−Ramos et al. 2014	finch	survival	diet	52	methylmercury cysteine	
🟩	Varian−Ramos et al. 2014	finch	F1 survival	diet	unclear	methylmercury cysteine	
🟪	Bennet et al. 2009	kestrel	survival	diet	5−7	methylmercury chloride	
🟦	El−Begearmi et al. 1977	quail	survival (female)	diet	16	methylmercury hydroxide	C
🟨	El−Begearmi et al. 1977	quail	survival (male)	diet	16	methylmercury hydroxide	C
🟥	Hill and Soares 1987	quail	survival	diet	0.71	methylmercury chloride	
🟫	Hill and Soares 1987	quail	survival	diet	0.71	methylmercury chloride	
🟩	Spann et al. 1986	quail	survival	diet	6	methylmercury chloride	
🟪	Sell and Horani 1976	chicken	survival (Exp 1)	diet	4	methylmercury chloride	
🟦	Sell and Horani 1976	chicken	survival (Exp 2)	diet	3.6	methylmercury chloride	
🟨	Sell and Horani 1976	quail	survival (Exp 2)	diet	3.3	methylmercury chloride	
🟥	Scheuhammer 1988	finch	survival	diet	11	methylmercury chloride	

☐ Tier 1

····· 80% effect relative to control

Figure E2−22. Dose−Response Data for the Avian Survival Endpoint for Methylmercury

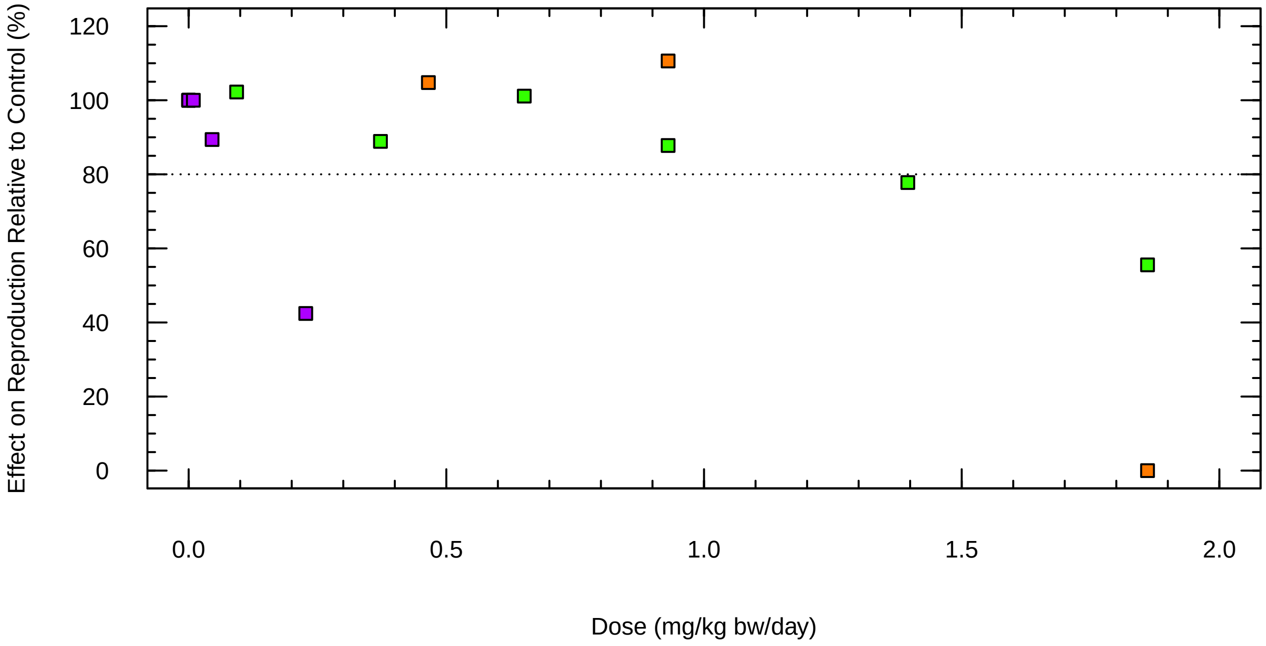


	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
▲	Wobeser et al. 1976	mink	body weight	diet	13	methylmercury chloride	
▲	Gandhi et al. 2013	rat	body weight gain	gavage	3	methylmercury chloride	
🟪	Mitsumori et al. 1990	mouse	body weight	diet	104	methylmercury chloride	
🟦	Mitsumori et al. 1983	rat	body weight	diet	130	methylmercury chloride	D
🟨	Stillings et al. 1974	rat	body weight gain	diet	4	methylmercury chloride	
🟥	Verschuuren et al. 1976a	rat	F2 body weight gain	diet	12	methylmercury chloride	
🟫	Verschuuren et al. 1976b	rat	body weight	diet	104	methylmercury chloride	D
🟩	Friedman et al. 1978	rat	body weight	diet	10	methlymercury chloride	

☐ Tier 1 △ Tier 2

····· 80% effect relative to control

Figure E2−23. Dose−Response Data for the Mammalian Growth Endpoint for Methylmercury

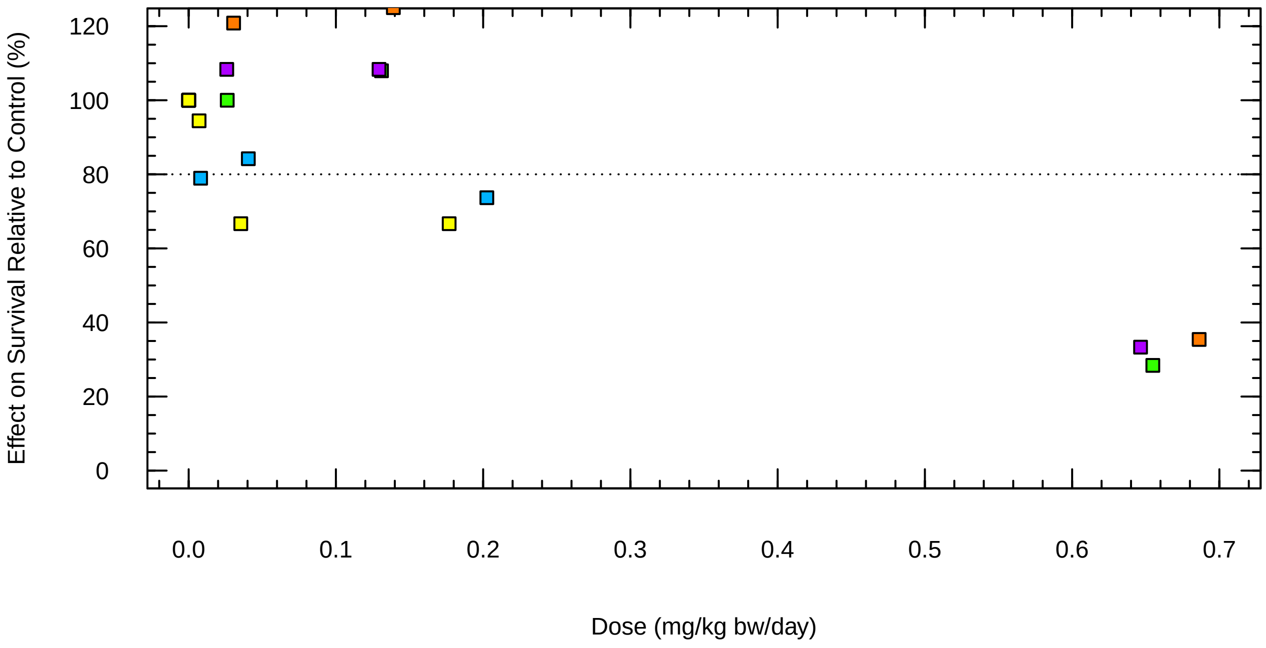


	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Gandhi et al. 2013	rat	fetal survival	gavage	3	methylmercury chloride
🟩	Tonk et al. 2010	rat	litter survival	gavage	variable	methylmercury chloride
🟪	Verschuuren et al. 1976a	rat	F1 viability index	diet	12	methylmercury chloride

☐ Tier 1

····· 80% effect relative to control

Figure E2−24. Dose−Response Data for the Mammalian Reproduction Endpoint for Methylmercury

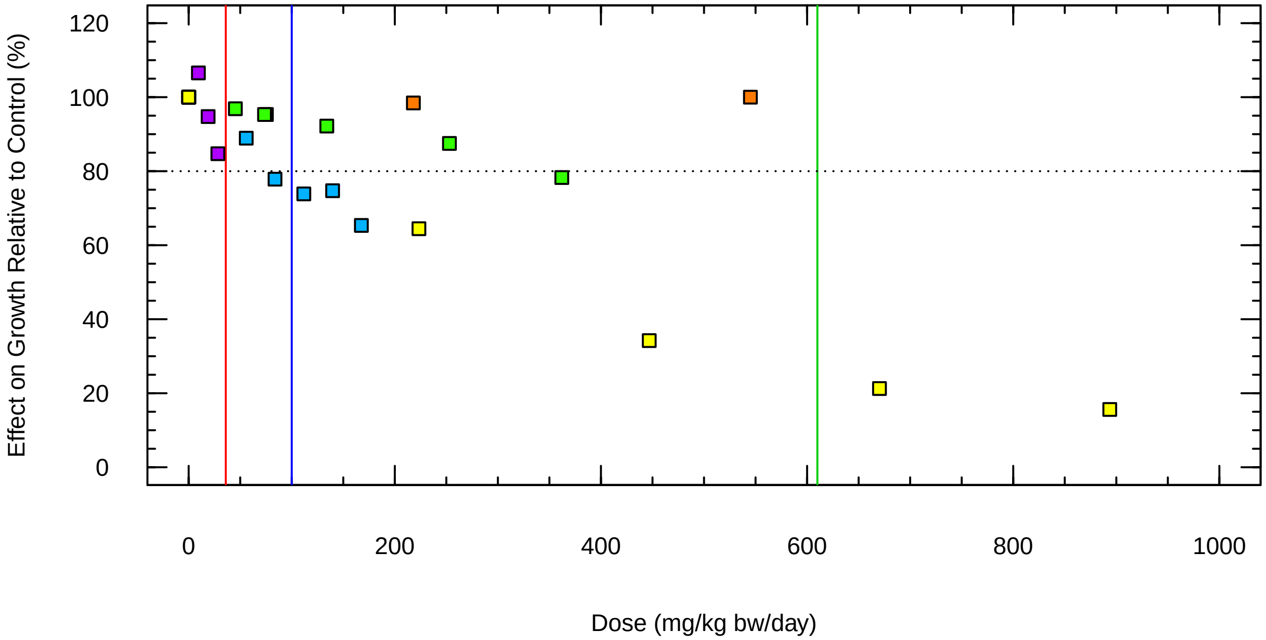


	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Mitsumori et al. 1990	mouse	survival	diet	104	methylmercury chloride	
🟩	Mitsumori et al. 1983	rat	survival	diet	130	methylmercury chloride	E
🟪	Mitsumori et al. 1983	rat	survival	diet	130	methylmercury chloride	E
🟦	Verschuuren et al. 1976b	rat	survival (female)	diet	104	methylmercury chloride	E
🟨	Verschuuren et al. 1976b	rat	survival (male)	diet	104	methylmercury chloride	E

☐ Tier 1

····· 80% effect relative to control

Figure E2−25. Dose−Response Data for the Mammalian Survival Endpoint for Methylmercury



Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧 Stafford et al. 2015	bobwhite quail	body weight gain	diet	4.3	molydenum disulfide	
🟩 Stafford et al. 2015	bobwhite quail	body weight gain	diet	4.3	sodium molybdate	
🟪 Kratzer 1952	chicken	weight gain	diet	3.3	sodium molybdate	
🟦 Davies et al. 1960	chicken	body weight (Exp 1b)	diet	4	sodium molybdate	A
🟨 Davies et al. 1960	chicken	body weight (Exp 1c)	diet	4	sodium molybdate	A

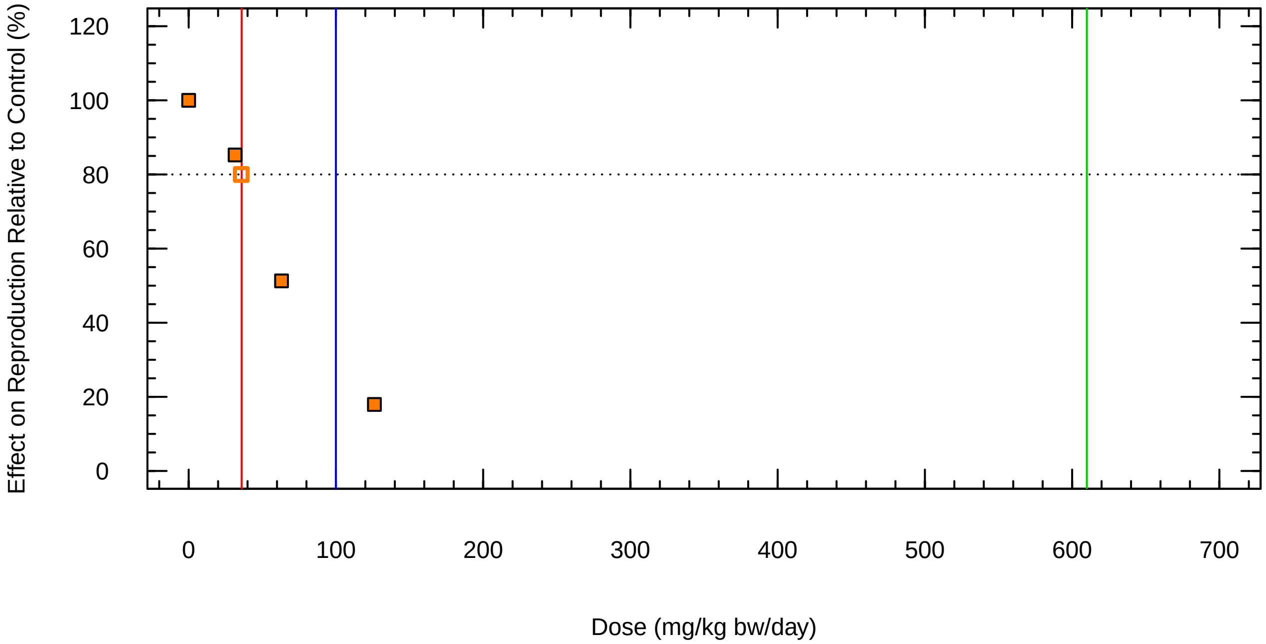
☐ Tier 1

— Selected TRV (Growth) = 100 mg/kg bw/day
— Selected TRV (Reproduction) = 36 mg/kg bw/day
— Selected TRV (Survival) = 610 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−26. Dose−Response Data for the Avian Growth Endpoint for Molybdenum



Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	ED20 or Geomean (mg/kg bw/day)
■ Lepore and Miller 1965	chicken	egg production	diet	3	sodium molybdate	
□ ED20 for Lepore and Miller 1965	chicken	egg production	diet	3	sodium molybdate	36

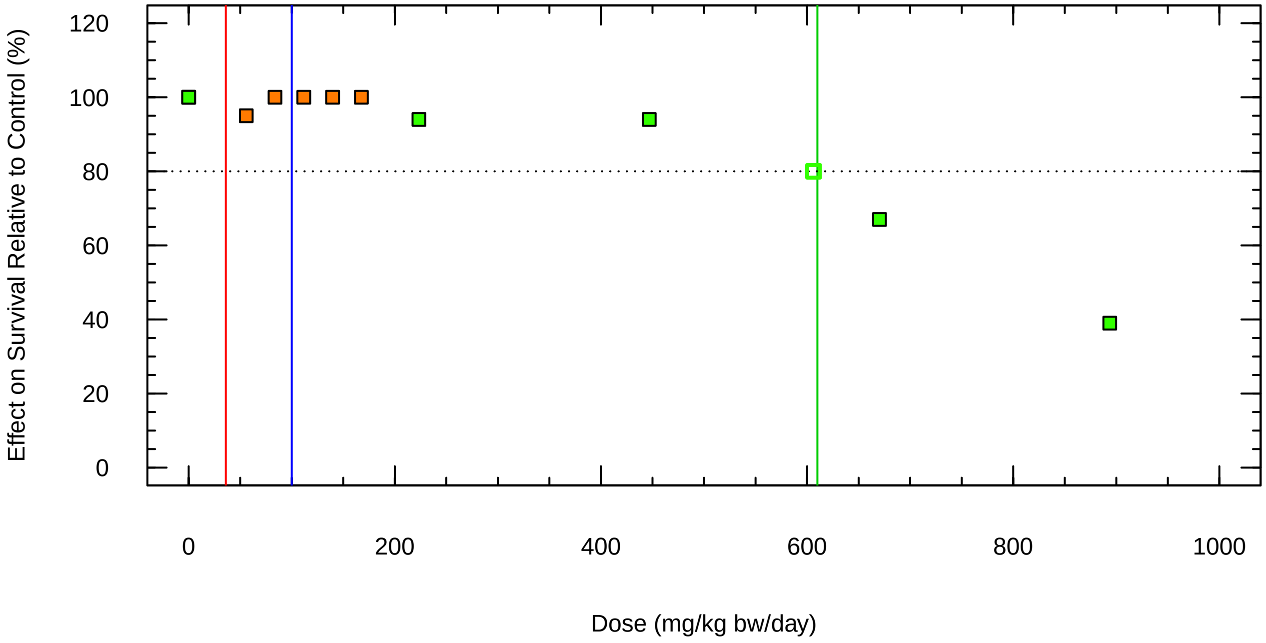
□ Tier 1

— Selected TRV (Growth) = 100 mg/kg bw/day
— Selected TRV (Reproduction) = 36 mg/kg bw/day
— Selected TRV (Survival) = 610 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−27. Dose−Response Data for the Avian Reproduction Endpoint for Molybdenum



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	ED20 or Geomean (mg/kg bw/day)
🟧	Davies et al. 1960	chicken	survival (Exp 1b)	diet	4	sodium molybdate	
🟩	Davies et al. 1960	chicken	survival (Exp 1c)	diet	4	sodium molybdate	
□	ED20 for Davies et al. 1960	chicken	survival (Exp 1c)	diet	4	sodium molybdate	610

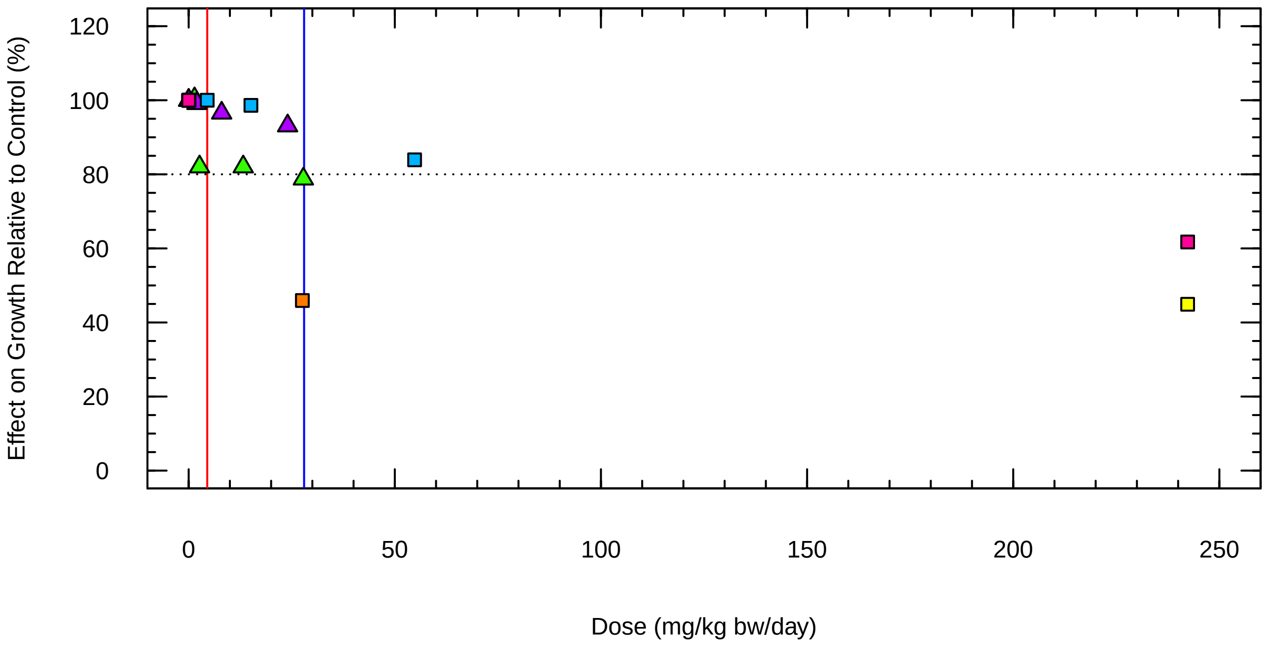
☐ Tier 1

— Selected TRV (Growth) = 100 mg/kg bw/day
— Selected TRV (Reproduction) = 36 mg/kg bw/day
— Selected TRV (Survival) = 610 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−28. Dose−Response Data for the Avian Survival Endpoint for Molybdenum



Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧 Brinkman and Miller 1961	rat	body weight gain	diet	6	sodium molybdate	
▲ Fungwe et al. 1990	rat	body weight gain	drinking water	9	sodium molybdate	
▲ Lyubimov et al. 2004	rat	body weight	gavage	8	ammonium tetrathiomolybdate	
🟦 Murray et al. 2013	rat	body weight	diet	12	sodium molybdate dihydrate	
🟨 Bandyopadhyay et al. 1981	rat	body weight gain	oral	4	ammonium molybdate	A
🟥 Bandyopadhyay et al.1981	rat	body weight gain	oral	4	ammonium molybdate	A

☐ Tier 1 △ Tier 2

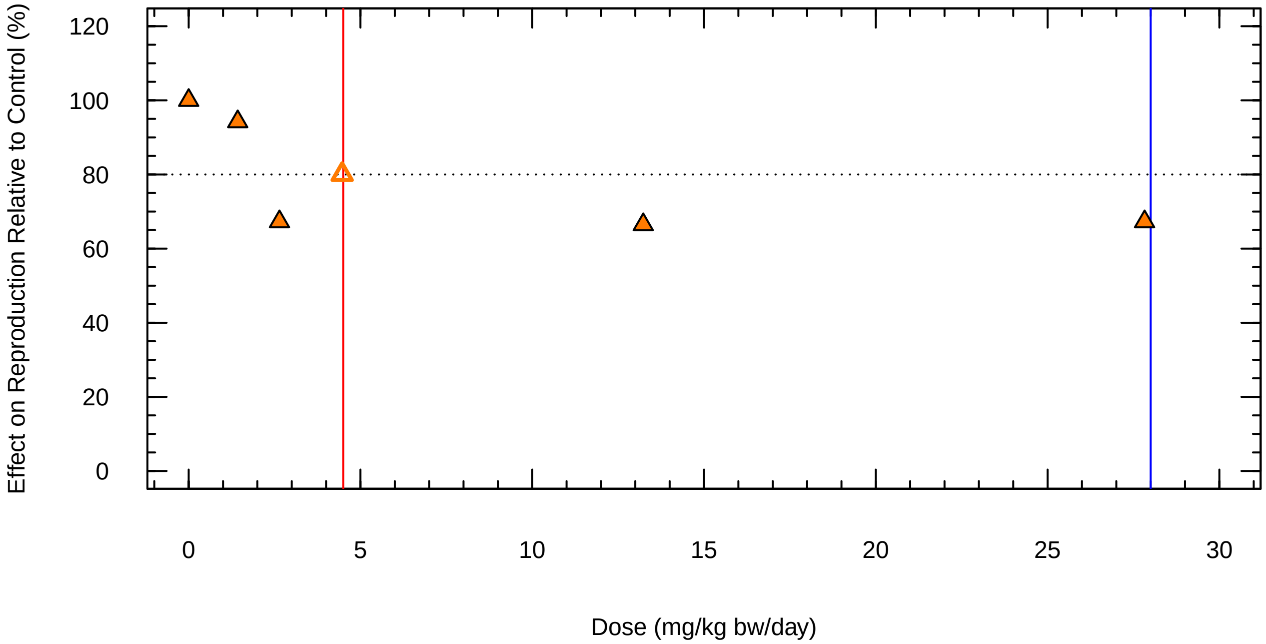
— Selected TRV (Growth) = 28 mg/kg bw/day

— Selected TRV (Reproduction) = 4.5 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−29. Dose−Response Data for the Mammalian Growth Endpoint for Molybdenum



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	ED20 or Geomean (mg/kg bw/day)
▲	Fungwe et al. 1990	rat	litter weight	drinking water	9	sodium molybdate	
△	ED20 for Fungwe et al. 1990	rat	litter weight	drinking water	9	sodium molybdate	4.5

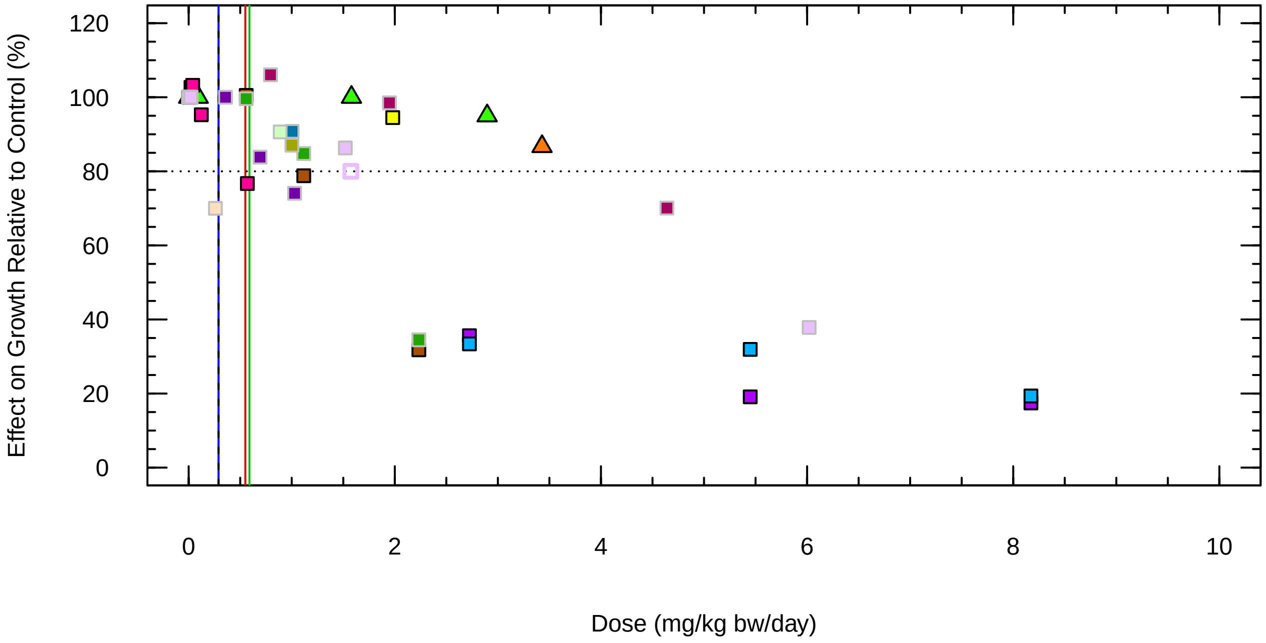
△ Tier 2

— Selected TRV (Growth) = 28 mg/kg bw/day
— Selected TRV (Reproduction) = 4.5 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−30. Dose−Response Data for the Mammalian Reproduction Endpoint for Molybdenum



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
▲	Gad and El−Twab 2009	quail	body weight	gavage	4	sodium selenite		
▲	Santolo et al. 2010	quail	body weight gain	diet	4	seleno−L−methionine		
■	El−Begearmi and Combs 1982	chicken	body weight (brewer's yeast diet)	diet	4	sodium selenite	A	
■	El−Begearmi and Combs 1982	chicken	body weight (corn−soy diet)	diet	4	sodium selenite	A	
■	Heinz and Fitzgerald 1993a	mallard	body weight	diet	21	seleno−DL−methionine	D	
■	Jensen 1986	chicken	body weight	diet	3	sodium selenite	A	
■	Hill 1979a	chicken	body weight gain (Exp 1)	diet	4−5	selenium dioxide	B	
■	Hill 1979a	chicken	body weight gain (Exp 2)	diet	4−5	selenium dioxide	B	
■	Echevarria et al. 1988	chicken	body weight gain	diet	3	sodium selenite	C	
■	Stowesand et al. 1977	quail	body weight	diet	10	sodium selenite		
■	Stowesand et al. 1977	quail	body weight	diet	10	seleniferous wheat		
■	O'Toole and Raisbeck 1997	mallard	body weight	diet	21	seleno−L−methionine	D	
■	Dafalla and Adam 1986	chicken	body weight	diet	4	sodium selenite	A	
■	Sell and Horani 1976	chicken	body weight gain	diet	4	sodium selenite	C	
■	Hoffman et al. 1992	mallard	body weight	diet	4	seleno−DL−methionine		
□	ED20 for Hoffman et al. 1992	mallard	body weight	diet	4	seleno−DL−methionine		1.6

□ Tier 1 △ Tier 2

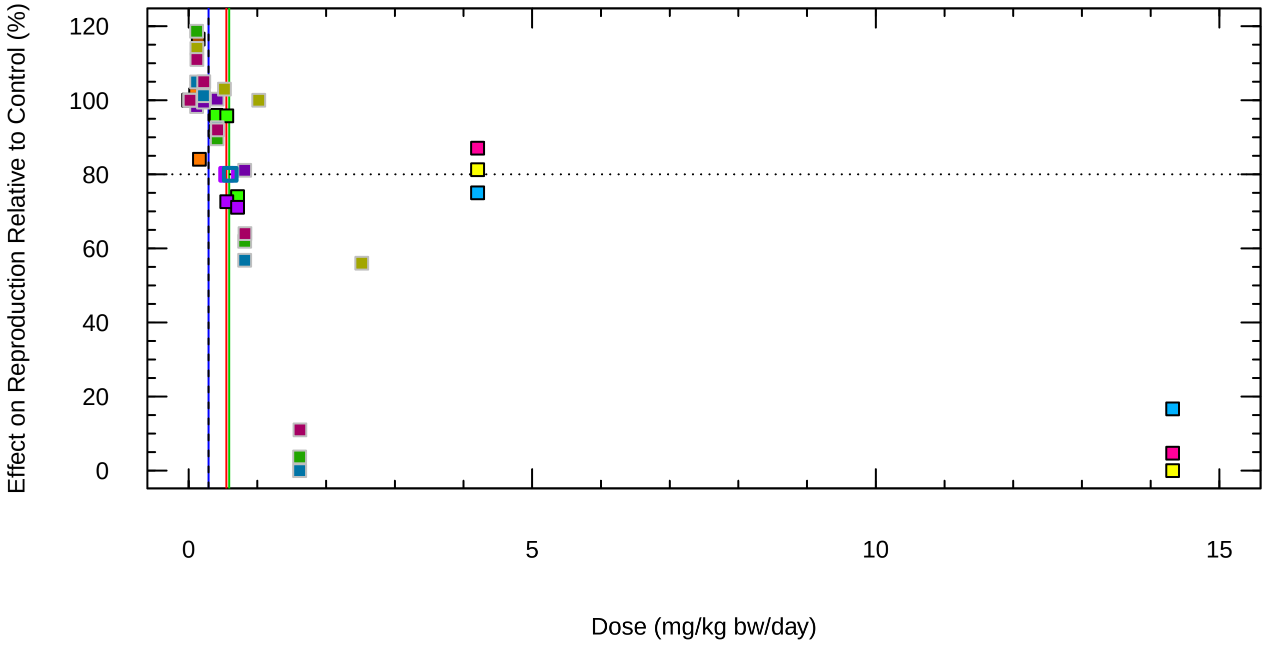
- - - Eco−SSL TRV = 0.29 mg/kg bw/day

— Selected TRV (Growth) = 0.29 mg/kg bw/day
— Selected TRV (Reproduction) = 0.55 mg/kg bw/day
— Selected TRV (Survival) = 0.59 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−31. Dose−Response Data for the Avian Growth Endpoint for Selenium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
🟧	Kääntee and Kurbela 1980	chicken	egg production	diet	4	sodium selenite		
🟩	Ort and Latshaw 1978	chicken	egg production (Exp 2)	diet	16	sodium selenite		
🟪	Ort and Latshaw 1978	chicken	hatchability (Exp 2)	diet	16	sodium selenite		
🟦	Wiemeyer and Hoffman 1996	owl	% pairs with hatchlings	diet	12	seleno−DL−methionine		
🟨	Wiemeyer and Hoffman 1996	owl	# of pairs with 5−day−old young	diet	12	seleno−DL−methionine		
🟥	Wiemeyer and Hoffman 1996	owl	% hatch of eggs incubated	diet	12	seleno−DL−methionine		
🟫	Stone and Soares 1976	quail	egg production (Exp 1 and 3)	diet	3.9−4.6	sodium selenite		
🟩	Heinz et al. 1989	mallard	% hatch of fertile eggs	diet	>14	selenomethionine	E	
🟪	Heinz et al. 1989	mallard	duckling survival	diet	>14	selenomethionine		
🟦	Heinz et al. 1989	mallard	# of ducklings	diet	>14	selenomethionine		
🟨	Hoffman and Heinz 1988	mallard	hatching success	diet	NR	sodium selenite		
🟥	Hoffman and Heinz 1988	mallard	hatching success	diet	NR	seleno−methionine	E	
□	ED20 for Ort and Latshaw 1978	chicken	hatchability (Exp 2)	diet	16	sodium selenite		0.55
□	ED20 for Heinz et al. 1989	mallard	# of ducklings	diet	>14	selenomethionine		0.60

☐ Tier 1

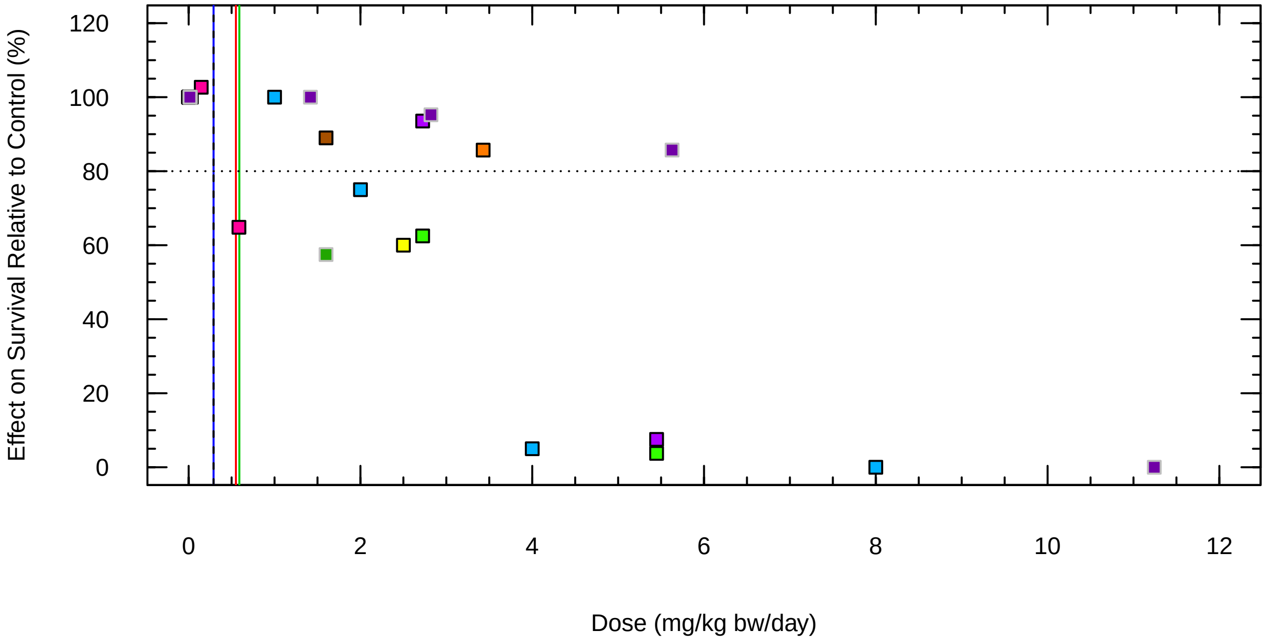
- - - Eco−SSL TRV = 0.29 mg/kg bw/day

── Selected TRV (Growth) = 0.29 mg/kg bw/day
── Selected TRV (Reproduction) = 0.55 mg/kg bw/day
── Selected TRV (Survival) = 0.59 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−32. Dose−Response Data for the Avian Reproduction Endpoint for Selenium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Gad and El−Twab 2009	quail	survival	gavage	4	sodium selenite	
🟩	El−Begearmi and Combs 1982	chicken	survival (brewer's yeast diet)	diet	4	sodium selenite	G
🟪	El−Begearmi and Combs 1982	chicken	survival (corn−soy diet)	diet	4	sodium selenite	G
🟦	Heinz and Fitzgerald 1993b	mallard	survival	diet	16	seleno−DL−methionine	I
🟨	Khan et al. 1993	chicken	survival	gavage	0.86	sodium selenite	
🟥	Arnold et al. 1973	chicken	survival	diet	64	sodium selenite	
🟫	El−Begearmi et al. 1977	quail	survival (males)	diet	16	sodium selenite	H
🟩	El−Begearmi et al. 1977	quail	survival (females)	diet	16	sodium selenite	H
🟪	Albers et al. 1996	mallard	survival	diet	16	seleno−DL−methionine	I

☐ Tier 1

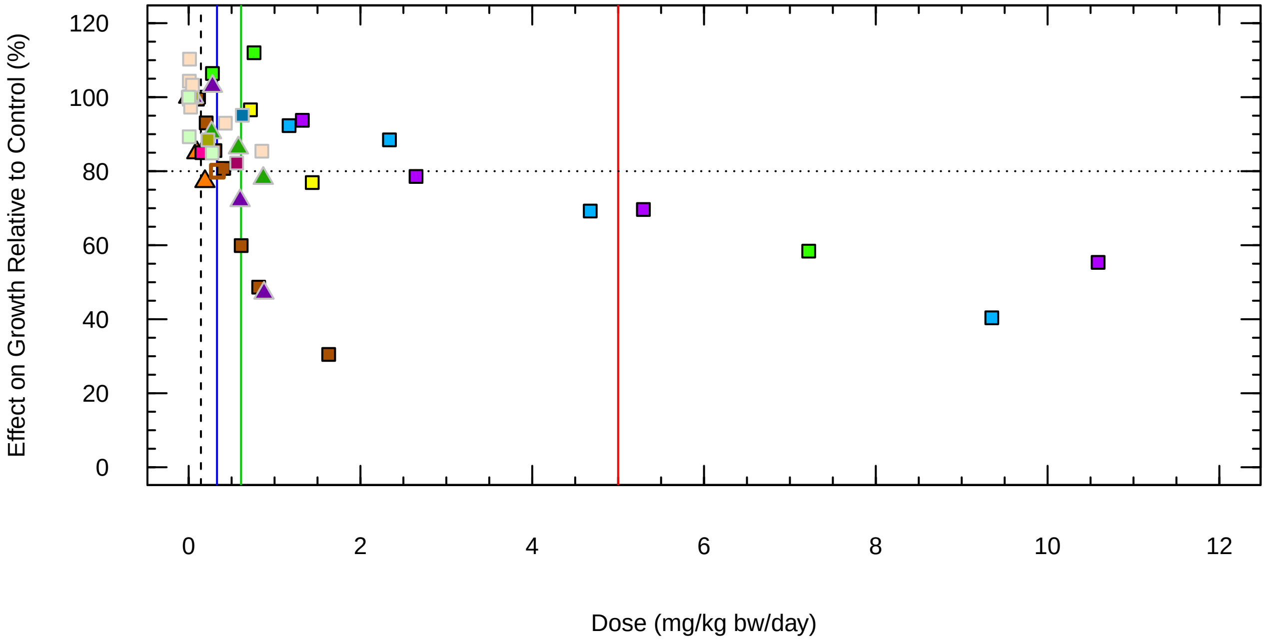
- - - Eco−SSL TRV = 0.29 mg/kg bw/day

— Selected TRV (Growth) = 0.29 mg/kg bw/day
— Selected TRV (Reproduction) = 0.55 mg/kg bw/day
— Selected TRV (Survival) = 0.59 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−33. Dose−Response Data for the Avian Survival Endpoint for Selenium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
▲	Kaur and Parshad 1994	rat	body weight	diet	5.1	sodium selenite		
■	Spallholz et al. 1973	mouse	body weight gain	diet	5	sodium selenite		
■	Julius et al. 1983	hamster	body weight (male, Exp 1)	diet	3	sodium selenite	A	
■	Julius et al. 1983	hamster	body weight (female, Exp 1)	diet	3	sodium selenite	A	
■	Julius et al. 1983	hamster	body weight (male, Exp 2)	diet	3	sodium selenite	A	
■	Behne et al. 1992	rat	body weight	diet	14.3	L−selenomethionine		
■	Mahan and Moxon 1984	pig	body weight	diet	5.3	sodium selenite		
▲	Goehring et al. 1984	rat	body weight gain	diet	4	seleniferous grain		
▲	Goehring et al. 1984	rat	body weight gain	diet	4	sodium selenite		
■	Baker et al. 1989	pig	body weight	diet	3.7	sodium selenate		
■	Boylan et al. 1990	mouse	body weight	diet	26	sodium selenite		
■	Wahlstrom et al. 1956	pig	body weight	diet	14	sodium selenite		
■	Birt et al. 1983	hamster	body weight	diet	25	sodium selenite		
■	Birt et al. 1986	hamster	body weight	diet	64	sodium selenite		
□	ED20 for Mahan and Moxon 1984	pig	body weight	diet	5.3	sodium selenite		0.33

□ Tier 1 △ Tier 2

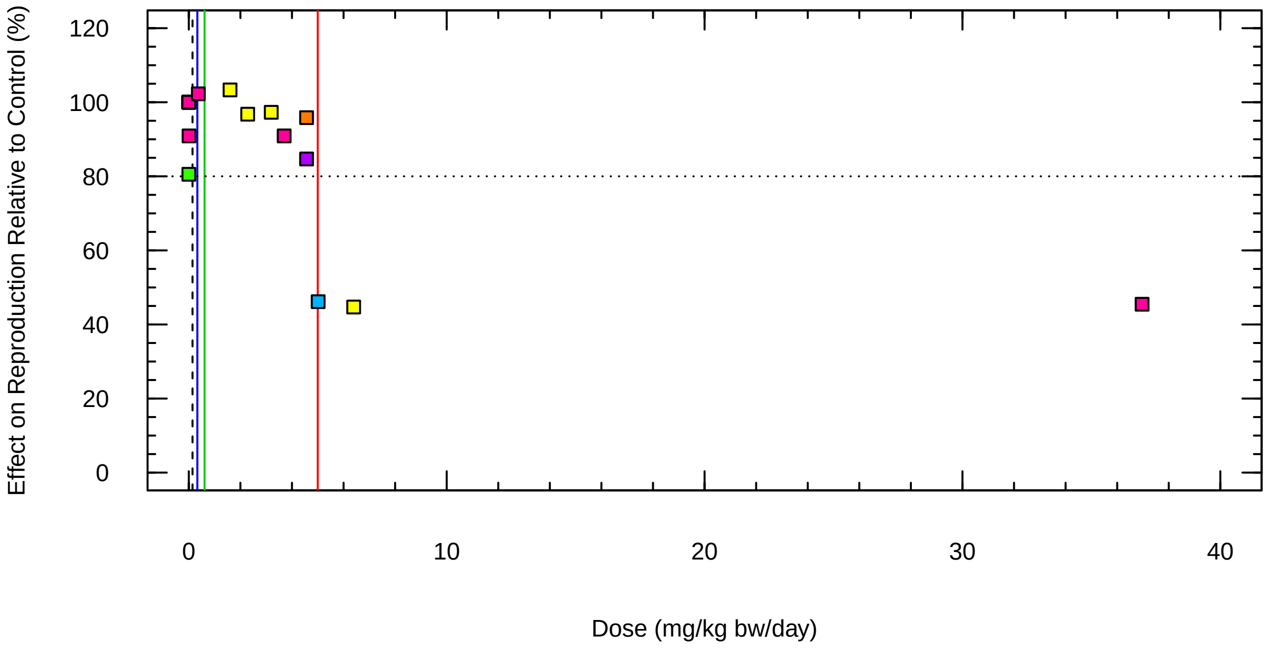
- - - Eco−SSL TRV = 0.143 mg/kg bw/day

— Selected TRV (Growth) = 0.33 mg/kg bw/day
— Selected TRV (Reproduction) = 5 mg/kg bw/day
— Selected TRV (Survival) = 0.61 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−34. Dose−Response Data for the Mammalian Growth Endpoint for Selenium



Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧 Chernoff and Kavlock 1982	mouse	% pregnant	gavage	0.71	sodium selenite
🟩 Wahlstrom and Olson 1959	pig	# of live piglets	diet	34	sodium selenite
🟪 Gray and Kavlock 1984	mouse	# of live offspring	gavage	0.71	sodium selenite
🟦 Seidenberg et al. 1986	mouse	# of litters born	gavage	0.71	sodium selenate
🟨 Hardin et al. 1987	mouse	% viable litters	gavage	1.1	sodium selenite
🟥 Webster 1979	mouse	% with litters	diet	2.7	sodium selenite

☐ Tier 1

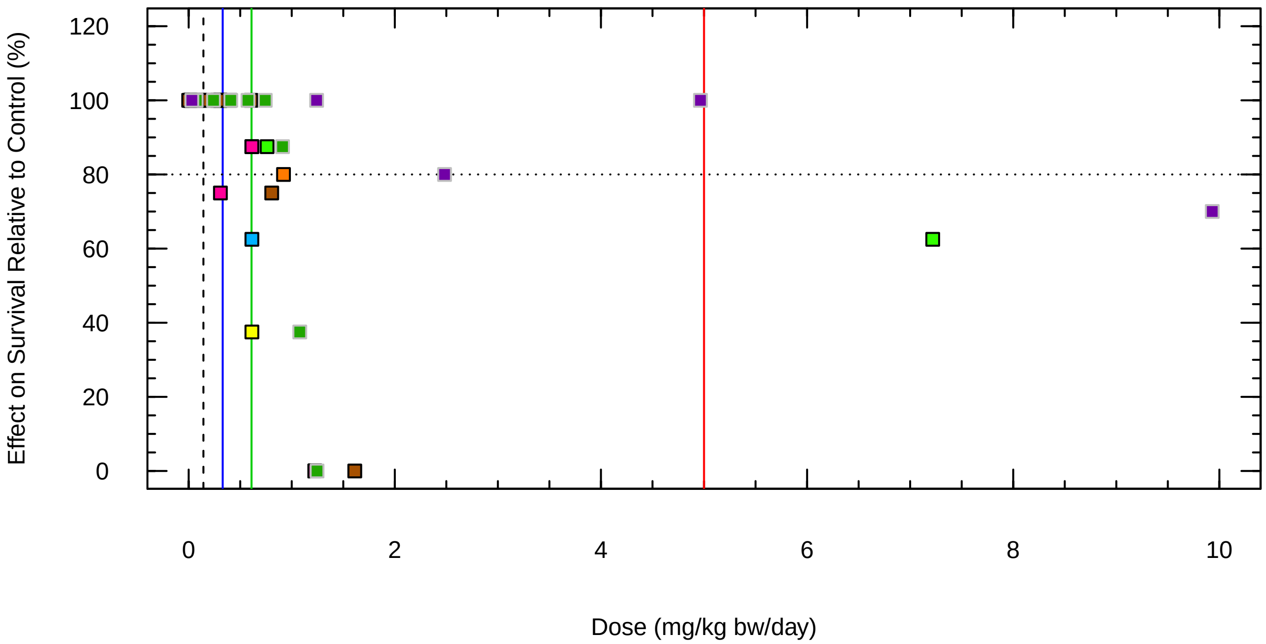
- - - Eco−SSL TRV = 0.143 mg/kg bw/day

— Selected TRV (Growth) = 0.33 mg/kg bw/day
— Selected TRV (Reproduction) = 5 mg/kg bw/day
— Selected TRV (Survival) = 0.61 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−35. Dose−Response Data for the Mammalian Reproduction Endpoint for Selenium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Palmer et al. 1982	rat	survival	diet	4	seleniferous corn	B
🟩	Spallholz et al. 1973	mouse	survival	diet	5	sodium selenite	
🟪	McAdam and Levander 1987	rat	survival	diet	6	D−selenomethionine	B
🟦	McAdam and Levander 1987	rat	survival	diet	6	L−selenomethionine	B
🟨	McAdam and Levander 1987	rat	survival	diet	6	sodium selenite	
🟥	McAdam and Levander 1987	rat	survival	diet	6	sodium selenate	
🟫	Moxon and Mahan 1981	pig	survival	diet	5.3	sodium selenite	
🟩	Halverson et al. 1966	rat	survival	diet	6	seleniferous wheat	B
🟪	Julius et al. 1983	hamster	survival	diet	3	sodium selenite	

☐ Tier 1

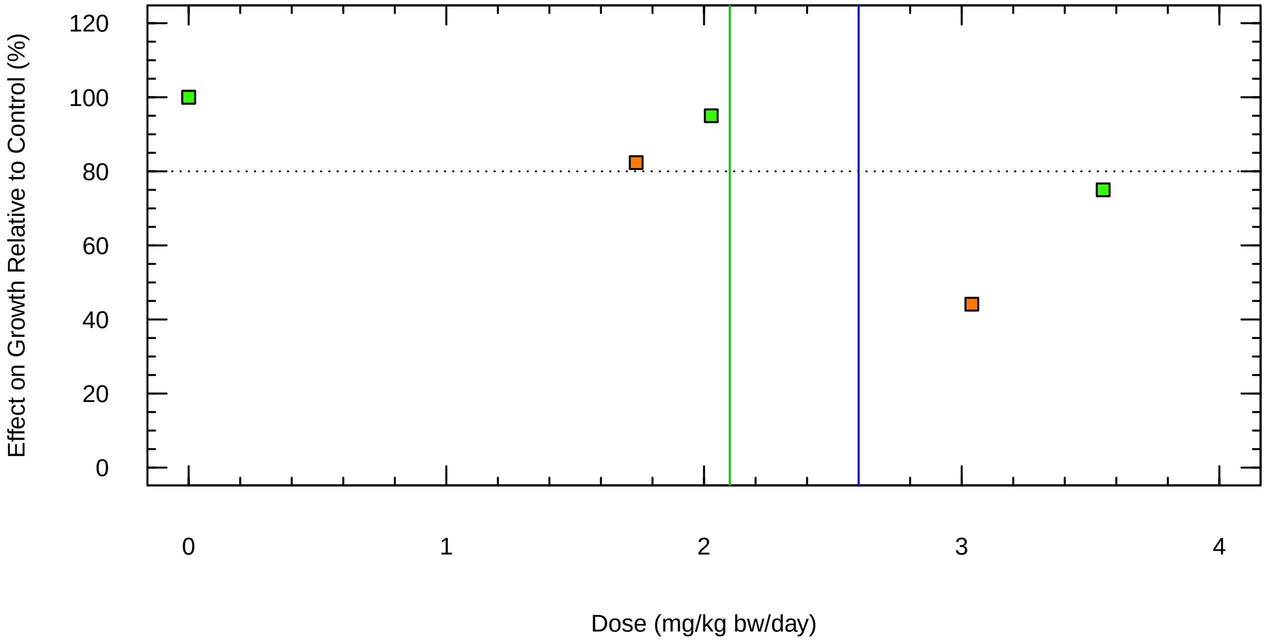
- - - Eco−SSL TRV = 0.143 mg/kg bw/day

— Selected TRV (Growth) = 0.33 mg/kg bw/day
— Selected TRV (Reproduction) = 5 mg/kg bw/day
— Selected TRV (Survival) = 0.61 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−36. Dose−Response Data for the Mammalian Survival Endpoint for Selenium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Downs et al. 1960	rat (male)	body weight	diet	15	thallic oxide	A
🟩	Downs et al. 1960	rat (female)	body weight	diet	15	thallic oxide	A

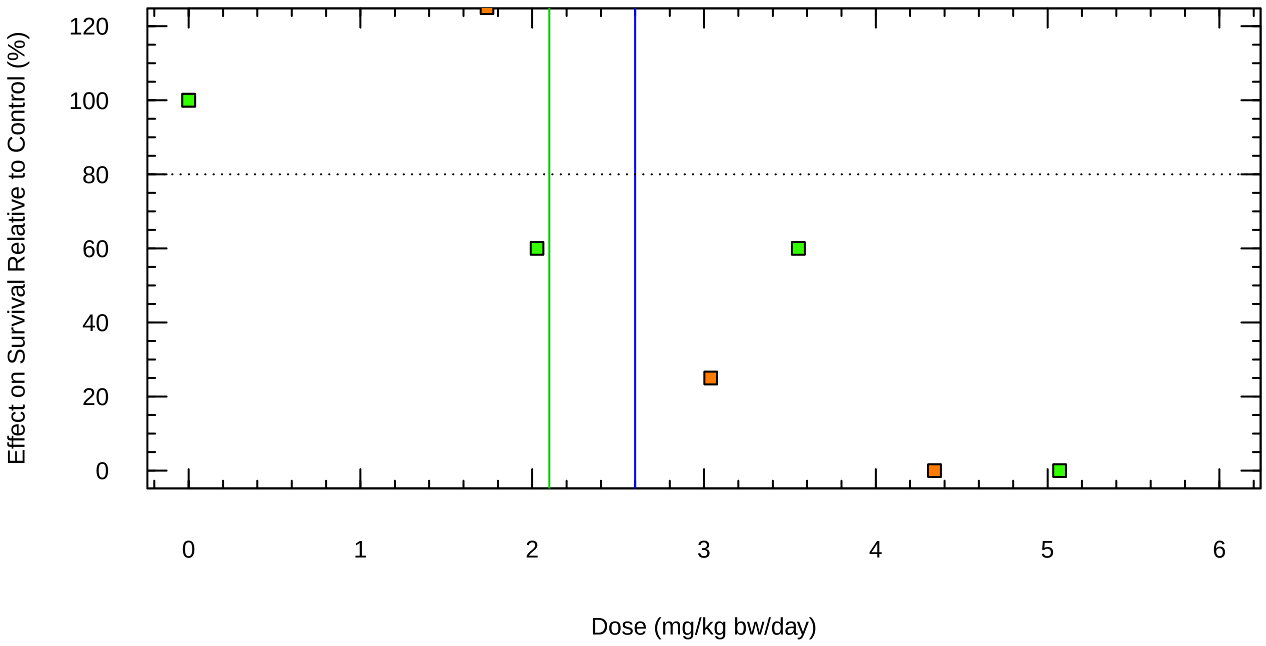
☐ Tier 1

— Selected TRV (Growth) = 2.6 mg/kg bw/day
— Selected TRV (Survival) = 2.1 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−37. Dose−Response Data for the Mammalian Growth Endpoint for Thallium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Downs et al. 1960	rat (male)	survival	diet	15	thallic oxide	B
🟩	Downs et al. 1960	rat (female)	survival	diet	15	thallic oxide	B

☐ Tier 1

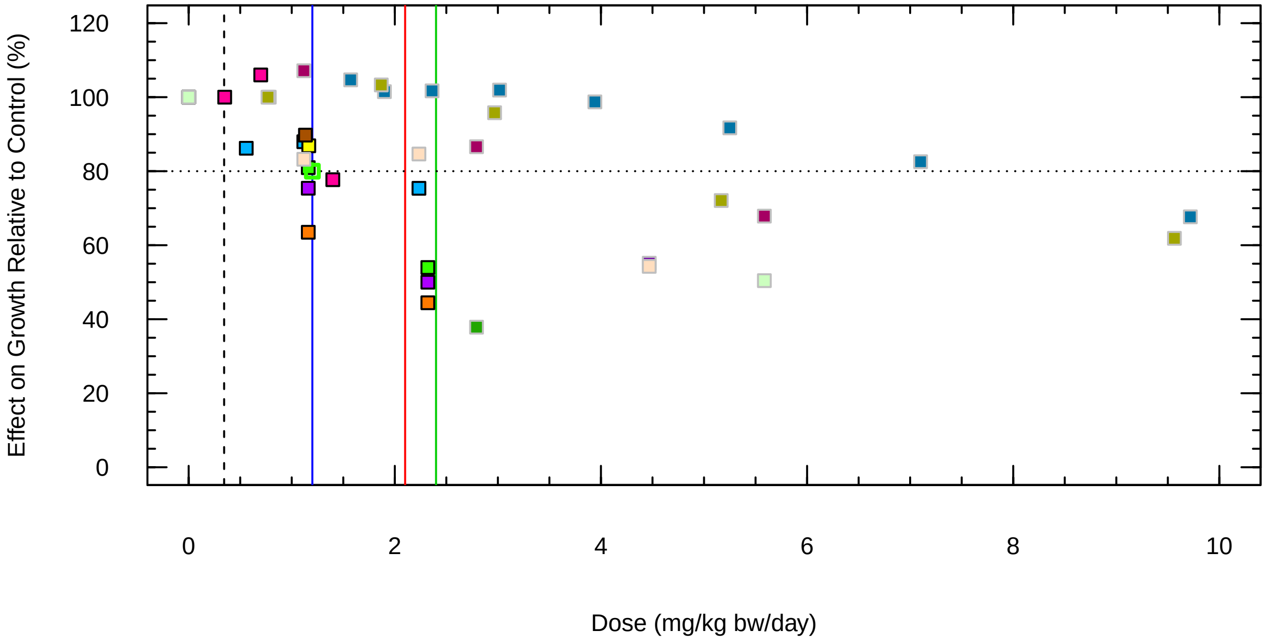
— Selected TRV (Growth) = 2.6 mg/kg bw/day

— Selected TRV (Survival) = 2.1 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−38. Dose−Response Data for the Mammalian Survival Endpoint for Thallium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
🟧	Berg and Lawrence 1971	chicken	body weight	diet	2	ammonium metavanadate	A	
🟩	Berg and Lawrence 1971	chicken	body weight	diet	2	vanadyl sulfate		
🟪	Berg and Lawrence 1971	chicken	body weight	diet	2	vanadyl dichloride	E	
🟦	Cervantes and Jensen 1986	chicken	body weight	diet	4	ammonium metavanadate	A	
🟨	Hill 1974	chicken	body weight gain	diet	2	sodium metavanadate	B	
🟥	Hill 1979a	chicken	body weight gain	diet	2	sodium metavanadate	B	
🟫	Summers and Moran 1972	chicken	body weight gain	diet	3	NR		
🟩	Hill 1990b	chicken	body weight gain	diet	2.7	sodium metavanadate	B	
🟪	Hill 1990a	chicken	body weight gain	diet	2.7	sodium metavanadate	B	
🟦	Nelson et al. 1962	chicken	body weight	diet	4	ammonium metavanadate	A	
🟨	Nelson et al. 1962	chicken	body weight	diet	4	ammonium metavanadate	A	
🟥	Qureshi et al. 1999	chicken	body weight	diet	3	ammonium metavanadate	A	
🟧	Blalock and Hill 1987	chicken	body weight	diet	3	vanadyl chloride	E	
🟩	Hill 1994	chicken	body weight	diet	2.9	ammonium metavanadate	A	
□	ED20 for Berg and Lawrence 1971	chicken	body weight	diet	2	vanadyl sulfate		1.2

☐ Tier 1

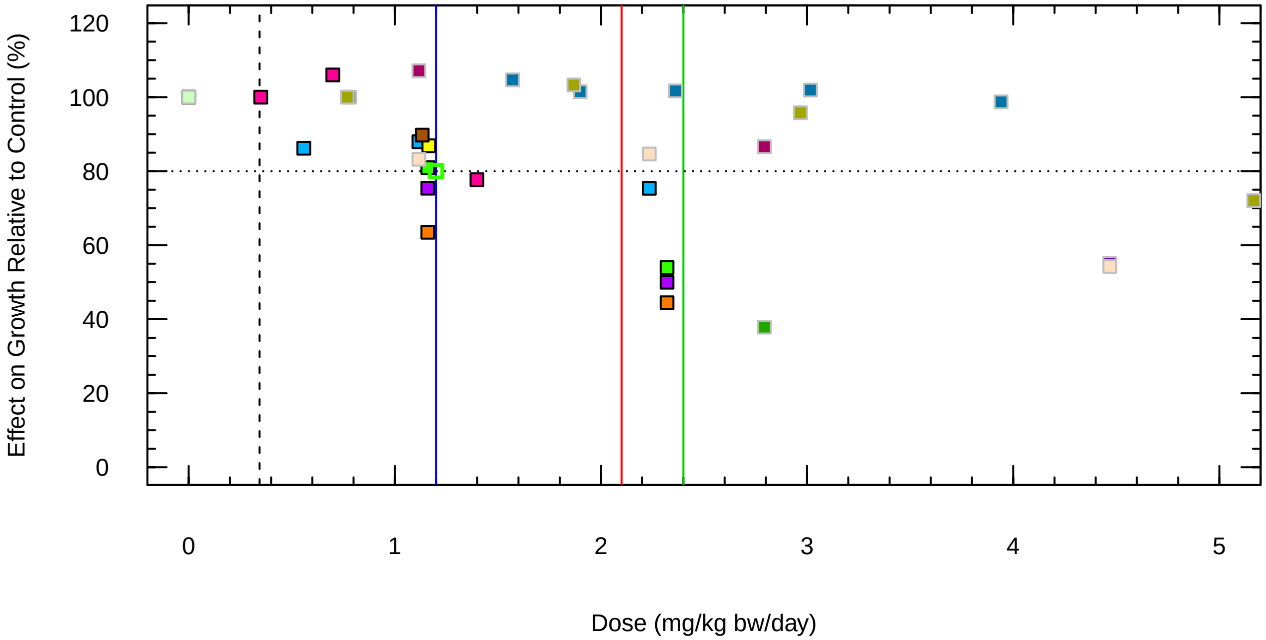
- - - Eco−SSL TRV = 0.344 mg/kg bw/day

— Selected TRV (Growth) = 1.2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.1 mg/kg bw/day
— Selected TRV (Survival) = 2.4 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−39a. Dose−Response Data for the Avian Growth Endpoint for Vanadium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
🟧	Berg and Lawrence 1971	chicken	body weight	diet	2	ammonium metavanadate	A	
🟩	Berg and Lawrence 1971	chicken	body weight	diet	2	vanadyl sulfate		
🟪	Berg and Lawrence 1971	chicken	body weight	diet	2	vanadyl dichloride	E	
🟦	Cervantes and Jensen 1986	chicken	body weight	diet	4	ammonium metavanadate	A	
🟨	Hill 1974	chicken	body weight gain	diet	2	sodium metavanadate	B	
🟥	Hill 1979a	chicken	body weight gain	diet	2	sodium metavanadate	B	
🟫	Summers and Moran 1972	chicken	body weight gain	diet	3	NR		
🟩	Hill 1990b	chicken	body weight gain	diet	2.7	sodium metavanadate	B	
🟪	Hill 1990a	chicken	body weight gain	diet	2.7	sodium metavanadate	B	
🟦	Nelson et al. 1962	chicken	body weight	diet	4	ammonium metavanadate	A	
🟨	Nelson et al. 1962	chicken	body weight	diet	4	ammonium metavanadate	A	
🟥	Qureshi et al. 1999	chicken	body weight	diet	3	ammonium metavanadate	A	
■	Blalock and Hill 1987	chicken	body weight	diet	3	vanadyl chloride	E	
■	Hill 1994	chicken	body weight	diet	2.9	ammonium metavanadate	A	
□	ED20 for Berg and Lawrence 1971	chicken	body weight	diet	2	vanadyl sulfate		1.2

□ Tier 1

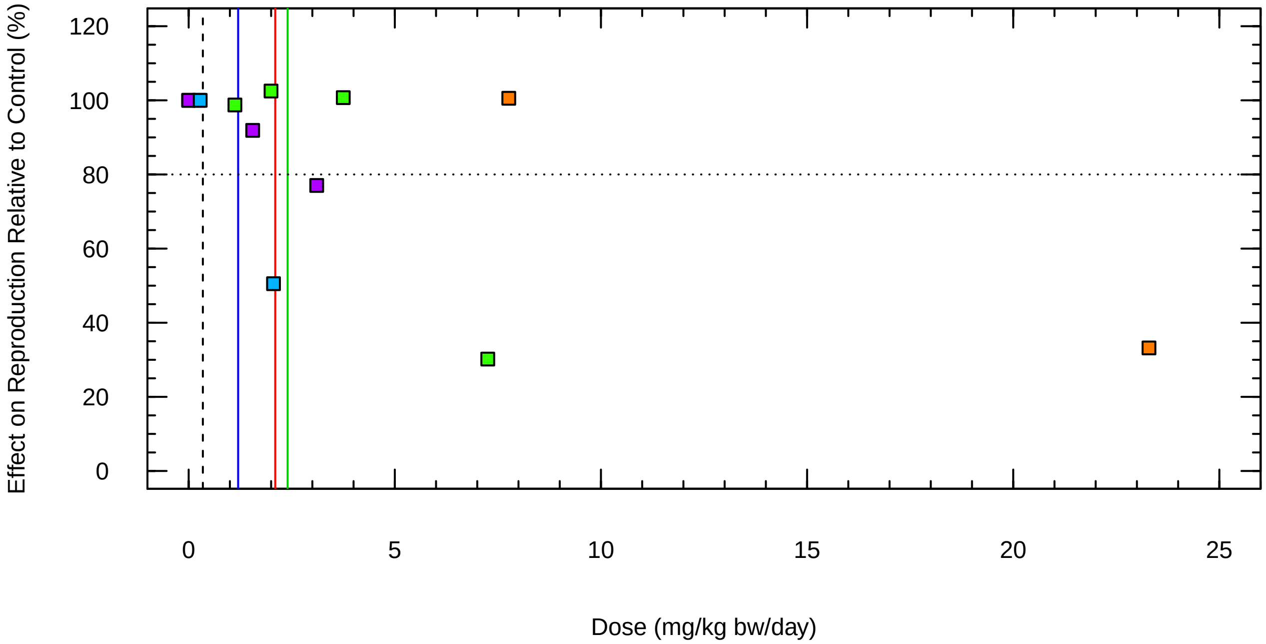
- - - Eco−SSL TRV = 0.344 mg/kg bw/day

— Selected TRV (Growth) = 1.2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.1 mg/kg bw/day
— Selected TRV (Survival) = 2.4 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−39b. Dose−Response Data for the Avian Growth Endpoint for Vanadium (Truncated X−Axis)



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Hafez and Kratzer 1976b	chicken	egg production	diet	NR	ammonium metavanadate	C
🟩	Kubena and Phillips 1982	chicken	egg production	diet	20	calcium orthovanadate	
🟪	Ousterhout and Berg 1980	chicken	egg production	diet	4	ammonium metavanadate	C
🟦	Toussant and Latshaw 1994	chicken	egg production	diet	4	ammonium metavanadate	C

☐ Tier 1

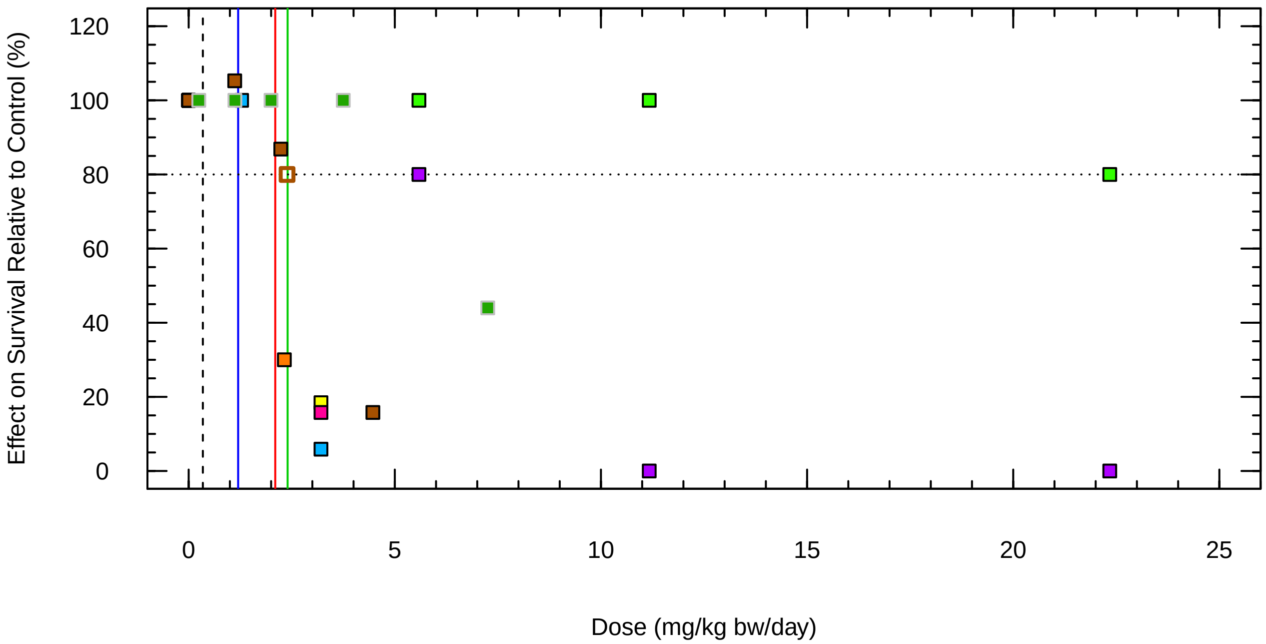
- - - Eco−SSL TRV = 0.344 mg/kg bw/day

― Selected TRV (Growth) = 1.2 mg/kg bw/day
― Selected TRV (Reproduction) = 2.1 mg/kg bw/day
― Selected TRV (Survival) = 2.4 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−40. Dose−Response Data for the Avian Reproduction Endpoint for Vanadium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
🟧	Berg and Lawrence 1971	chicken	survival	diet	2	ammonium metavanadate	D	
🟩	Hafez and Kratzer 1976a	chicken	survival (Exp 1)	diet	4	ammonium metavanadate	D	
🟪	Hafez and Kratzer 1976a	chicken	survival (Exp 2)	diet	4	ammonium metavanadate	D	
🟦	Hathcock et al. 1964	chicken	survival (Exp 1)	diet	2	ammonium metavanadate	D	
🟨	Hathcock et al. 1964	chicken	survival (Exp 2)	diet	2	ammonium metavanadate	D	
🟥	Hathcock et al. 1964	chicken	survival	diet	2	vanadyl sulfate		
🟫	Blalock and Hill 1987	chicken	survival	diet	3	vanadyl chloride		
🟩	Kubena and Phillips 1982	chicken	survival	diet	20	calcium orthovanadate		
☐	ED20 for Blalock and Hill 1987	chicken	survival	diet	3	vanadyl chloride		2.4

☐ Tier 1

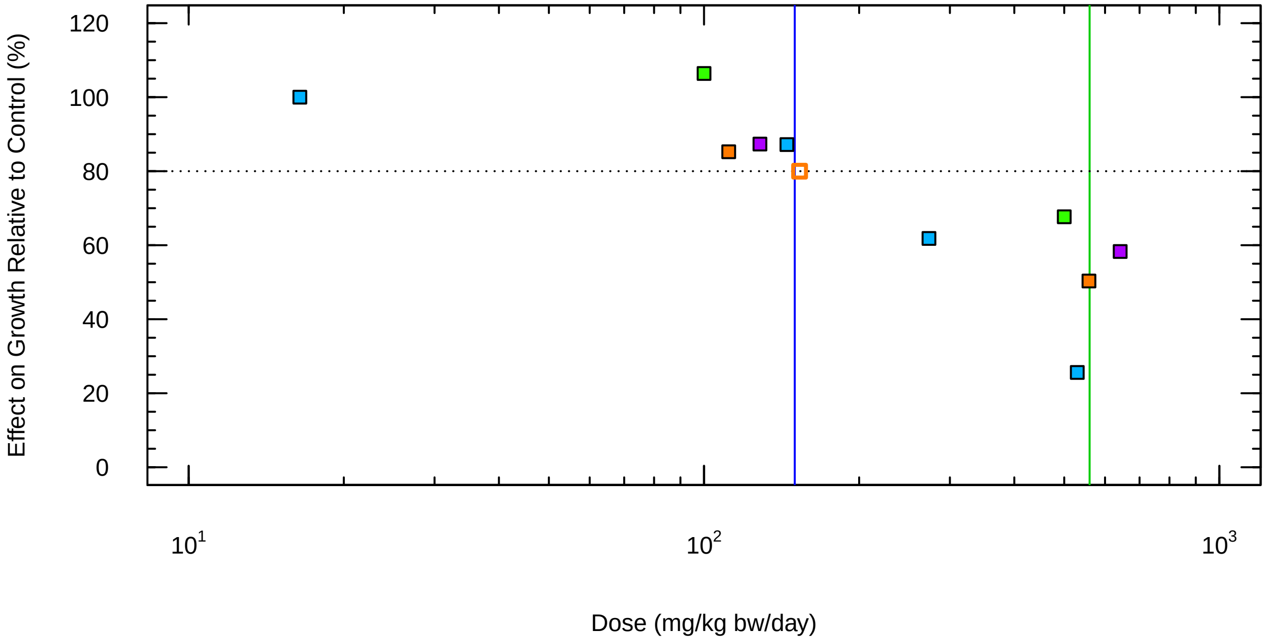
- - - Eco−SSL TRV = 0.344 mg/kg bw/day

— Selected TRV (Growth) = 1.2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.1 mg/kg bw/day
— Selected TRV (Survival) = 2.4 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−41. Dose−Response Data for the Avian Survival Endpoint for Vanadium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
🟧	Capdevielle and Scanes 1995a	chicken	body weight	diet	2	aluminum sulfate		
🟩	Capdevielle and Scanes 1995b	mallard	body weight	diet	2.1	aluminum sulfate		
🟪	Capdevielle et al. 1996	chicken	body weight	diet	1.5	aluminum sulfate	A	
🟦	Elliot and Edwards 1991	chicken	body weight	diet	2.3	aluminum sulfate	A	
☐	ED20 for Capdevielle and Scanes 1995a	chicken	body weight	diet	2	aluminum sulfate		150

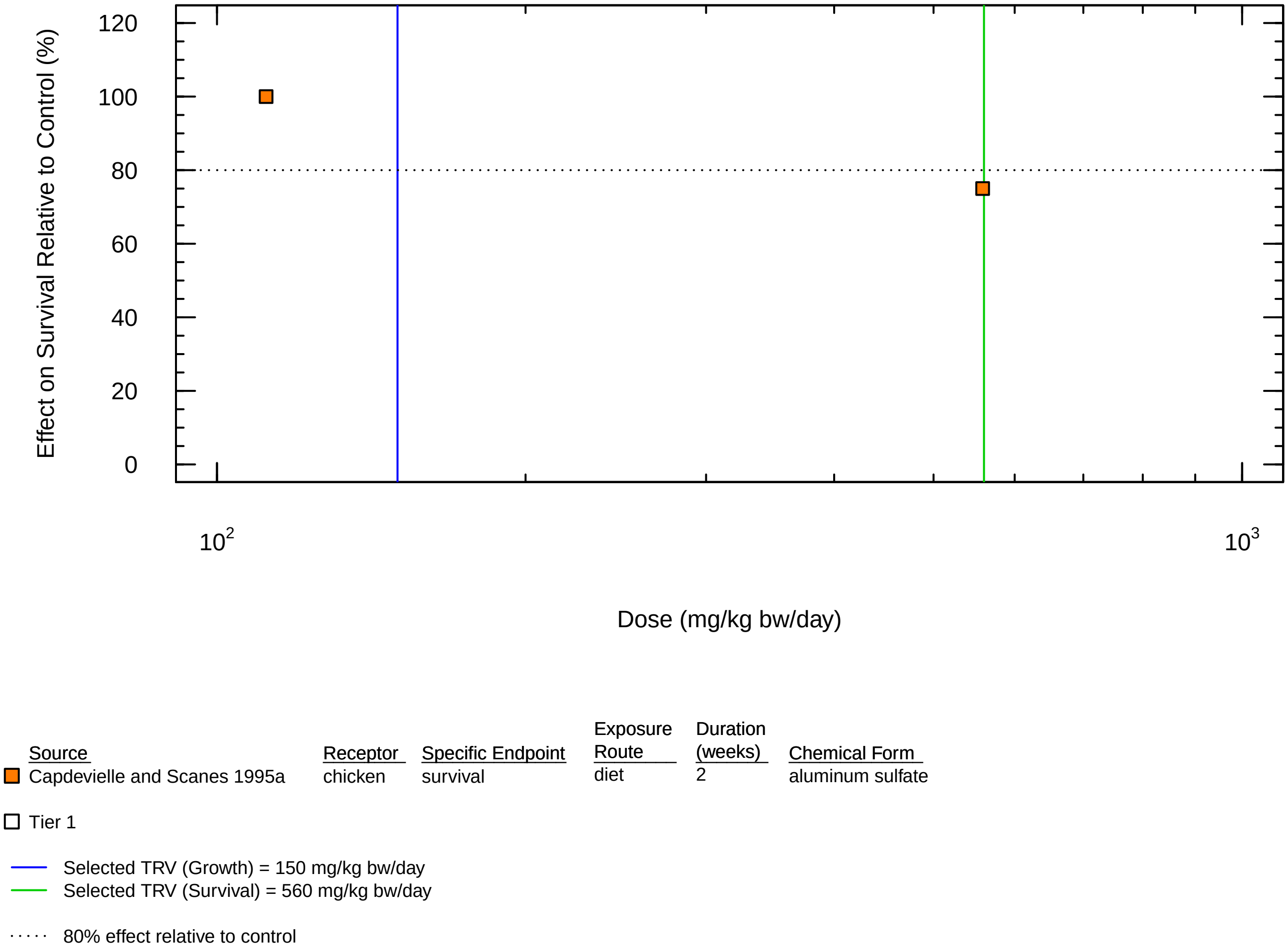
☐ Tier 1

— Selected TRV (Growth) = 150 mg/kg bw/day
— Selected TRV (Survival) = 560 mg/kg bw/day

····· 80% effect relative to control

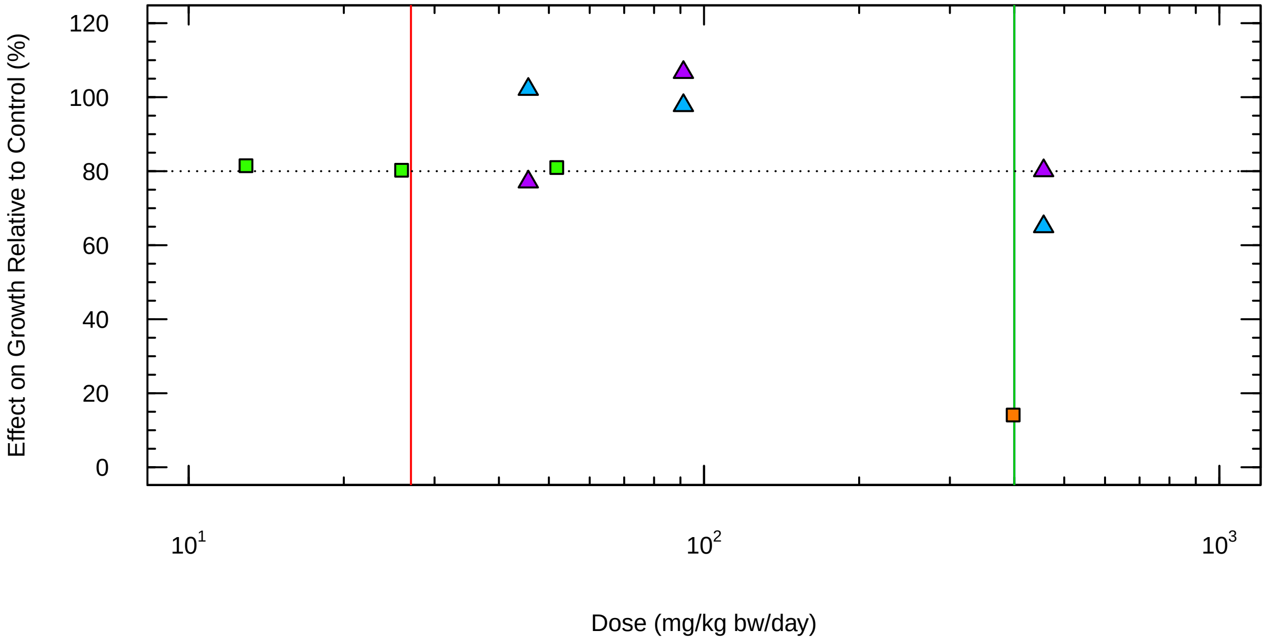
Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−42. Dose−Response Data for the Avian Growth Endpoint for Aluminum, Log−Transformed



Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−43. Dose−Response Data for the Avian Survival Endpoint for Aluminum, Log−Transformed



Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧 Belles et al. 1999	mouse	body weight gain	gavage	1.5	aluminum nitrate nonahydrate
🟩 Paternain et al. 1988	rat	body weight gain	gavage	1.3	aluminum nitrate nonahydrate
▲ Domingo et al. 1987a	rat	body weight	drinking water	14	aluminum nitrate nonahydrate
▲ Domingo et al. 1987a	rat	body weight	drinking water	14	aluminum nitrate nonahydrate

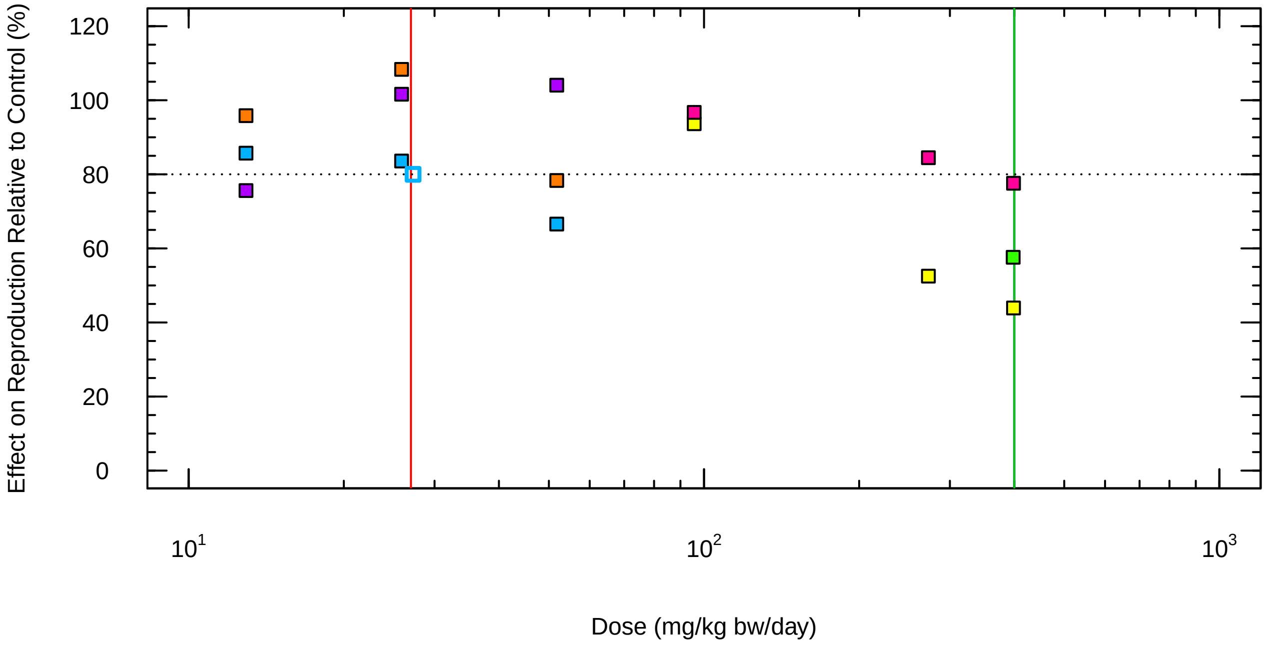
☐ Tier 1 △ Tier 2

— Selected TRV (Growth) = 400 mg/kg bw/day
— Selected TRV (Reproduction) = 27 mg/kg bw/day
— Selected TRV (Survival) = 400 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−44. Dose−Response Data for the Mammalian Growth Endpoint for Aluminum, Log−Transformed



Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	ED20 or Geomean (mg/kg bw/day)
🟧 Domingo et al. 1987b	rat	pup survival	oral	unclear	aluminum nitrate nonahydrate	
🟩 Belles et al. 1999	mouse	fetal body weight	gavage	1.5	aluminum nitrate nonahydrate	
🟪 Paternain et al. 1988	rat	fetal survival	gavage	1.3	aluminum nitrate nonahydrate	
🟦 Paternain et al. 1988	rat	fetal body weight	gavage	1.3	aluminum nitrate nonahydrate	
🟨 Bernuzzi et al. 1989	rat	postnatal survival	diet	2.6	aluminum chloride	
🟥 Bernuzzi et al. 1989	rat	pup body weight	diet	2.6	aluminum chloride	
☐ ED20 for Paternain et al. 1988	rat	fetal body weight	gavage	1.3	aluminum nitrate nonahydrate	27

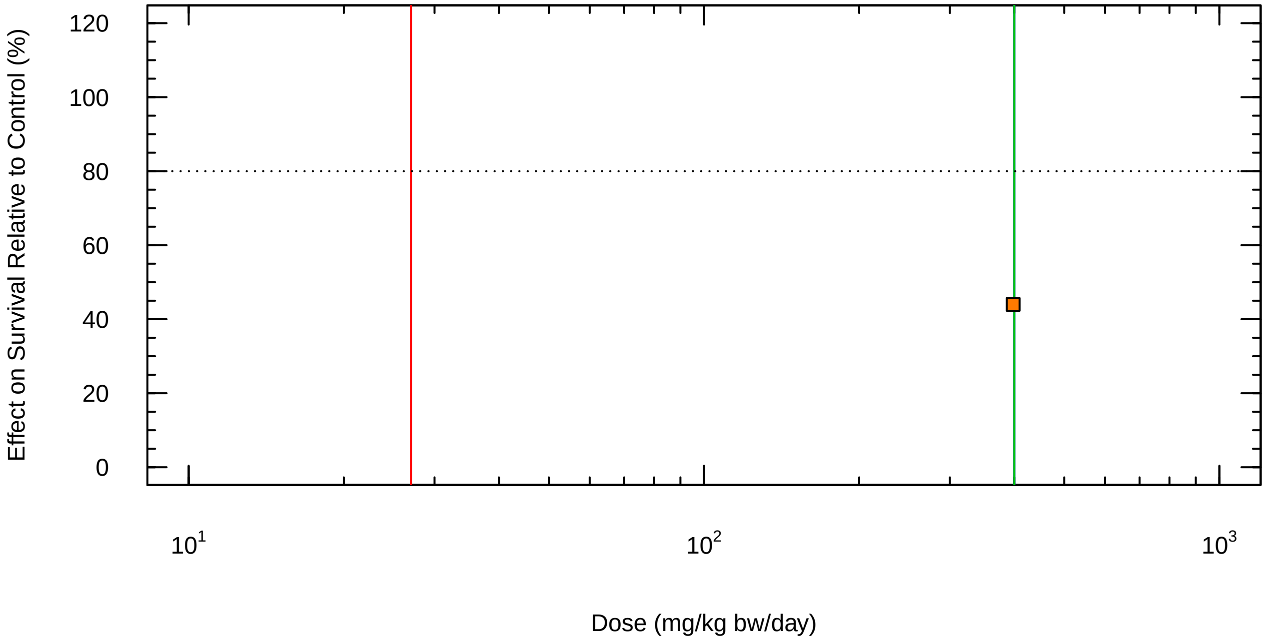
☐ Tier 1

— Selected TRV (Growth) = 400 mg/kg bw/day
— Selected TRV (Reproduction) = 27 mg/kg bw/day
— Selected TRV (Survival) = 400 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−45. Dose−Response Data for the Mammalian Reproduction Endpoint for Aluminum, Log−Transformed



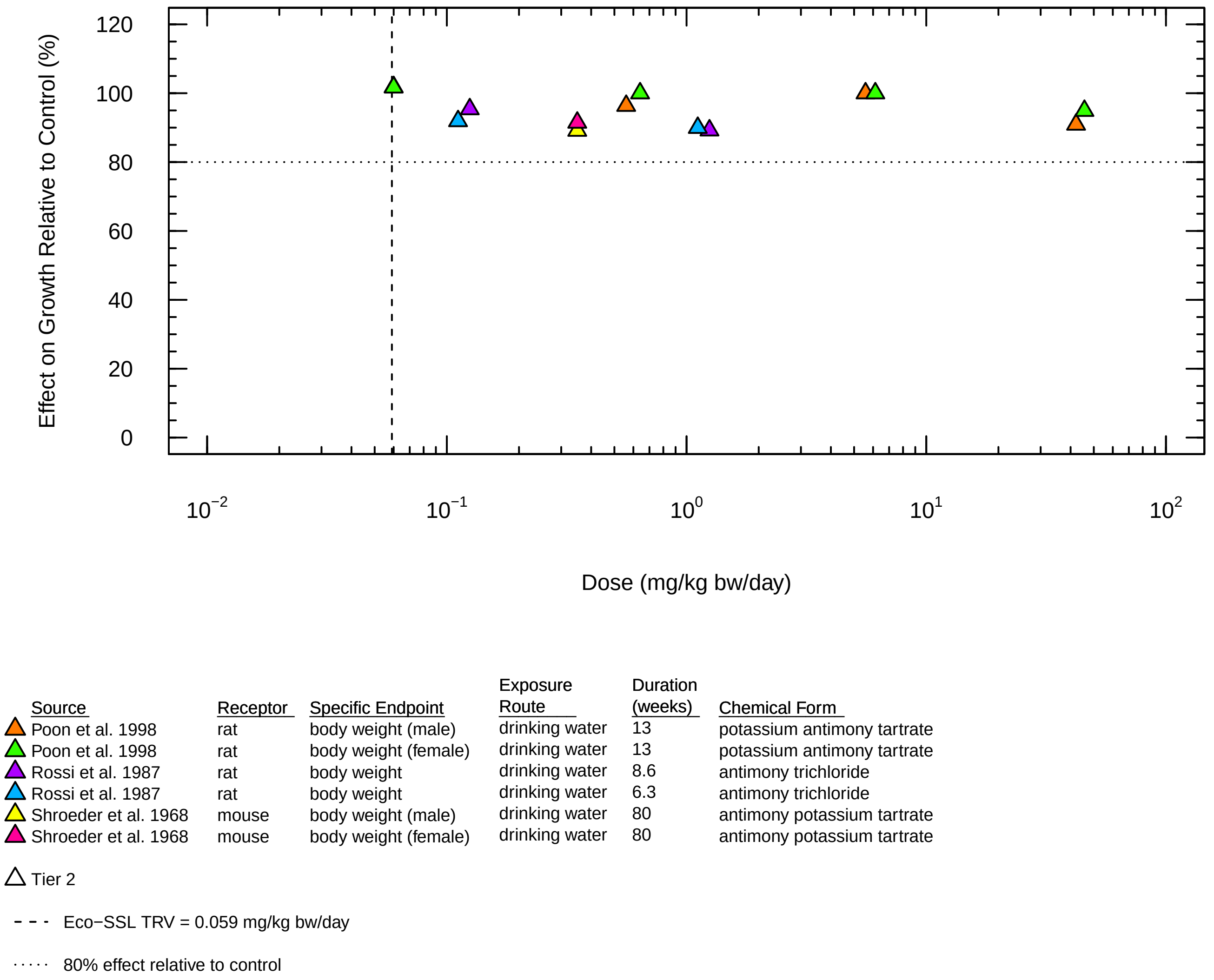
	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Belles et al. 1999	mouse	survival	gavage	1.5	aluminum nitrate nonahydrate

☐ Tier 1

—	Selected TRV (Growth) = 400 mg/kg bw/day
—	Selected TRV (Reproduction) = 27 mg/kg bw/day
—	Selected TRV (Survival) = 400 mg/kg bw/day
·····	80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−46. Dose−Response Data for the Mammalian Survival Endpoint for Aluminum, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
▲	Poon et al. 1998	rat	body weight (male)	drinking water	13	potassium antimony tartrate
▲	Poon et al. 1998	rat	body weight (female)	drinking water	13	potassium antimony tartrate
▲	Rossi et al. 1987	rat	body weight	drinking water	8.6	antimony trichloride
▲	Rossi et al. 1987	rat	body weight	drinking water	6.3	antimony trichloride
▲	Shroeder et al. 1968	mouse	body weight (male)	drinking water	80	antimony potassium tartrate
▲	Shroeder et al. 1968	mouse	body weight (female)	drinking water	80	antimony potassium tartrate

△ Tier 2

- - - Eco−SSL TRV = 0.059 mg/kg bw/day

· · · · · 80% effect relative to control

Figure E2−47. Dose−Response Data for the Mammalian Growth Endpoint for Antimony, Log−Transformed

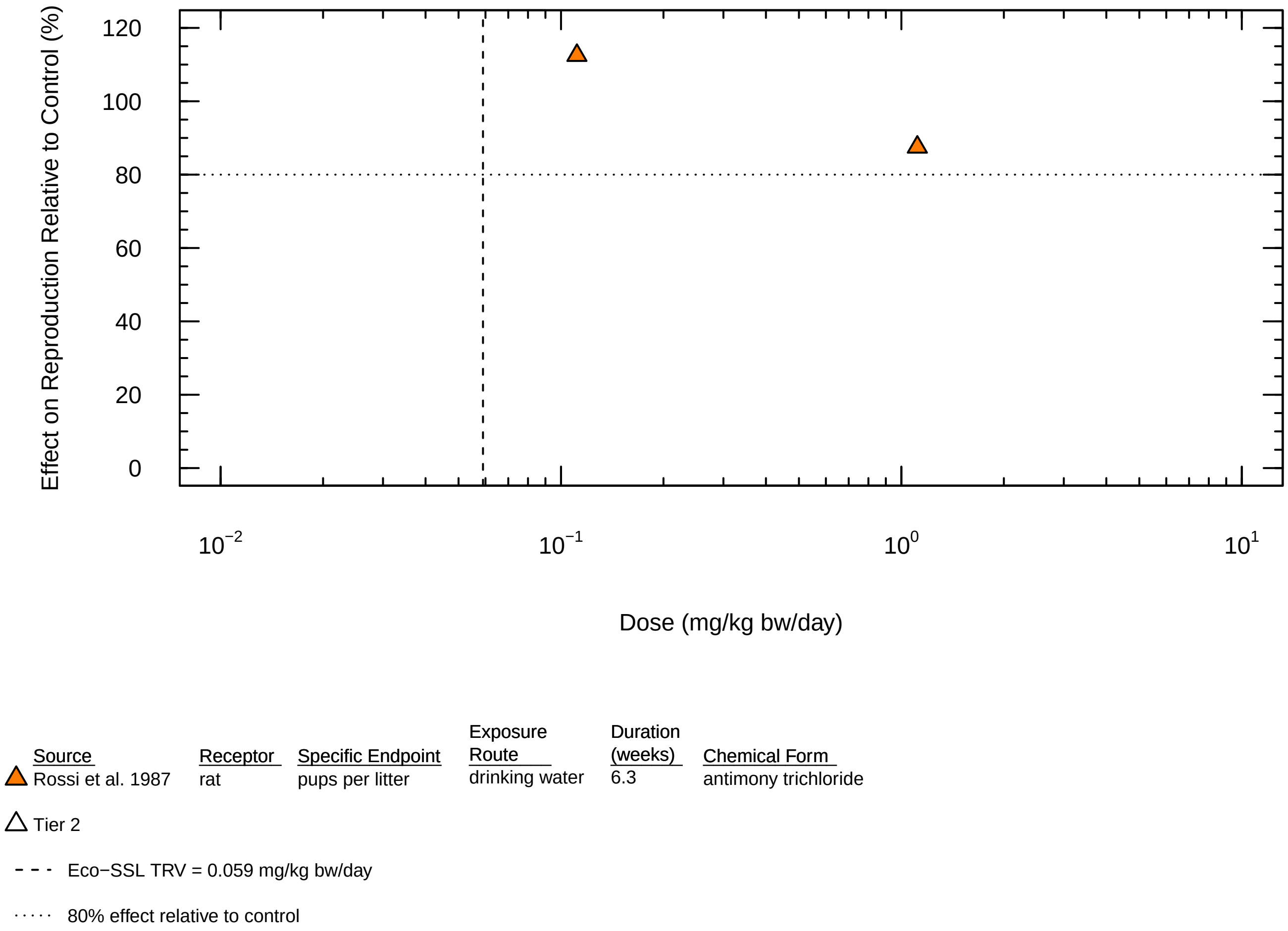


Figure E2−48. Dose−Response Data for the Mammalian Reproduction Endpoint for Antimony, Log−Transformed

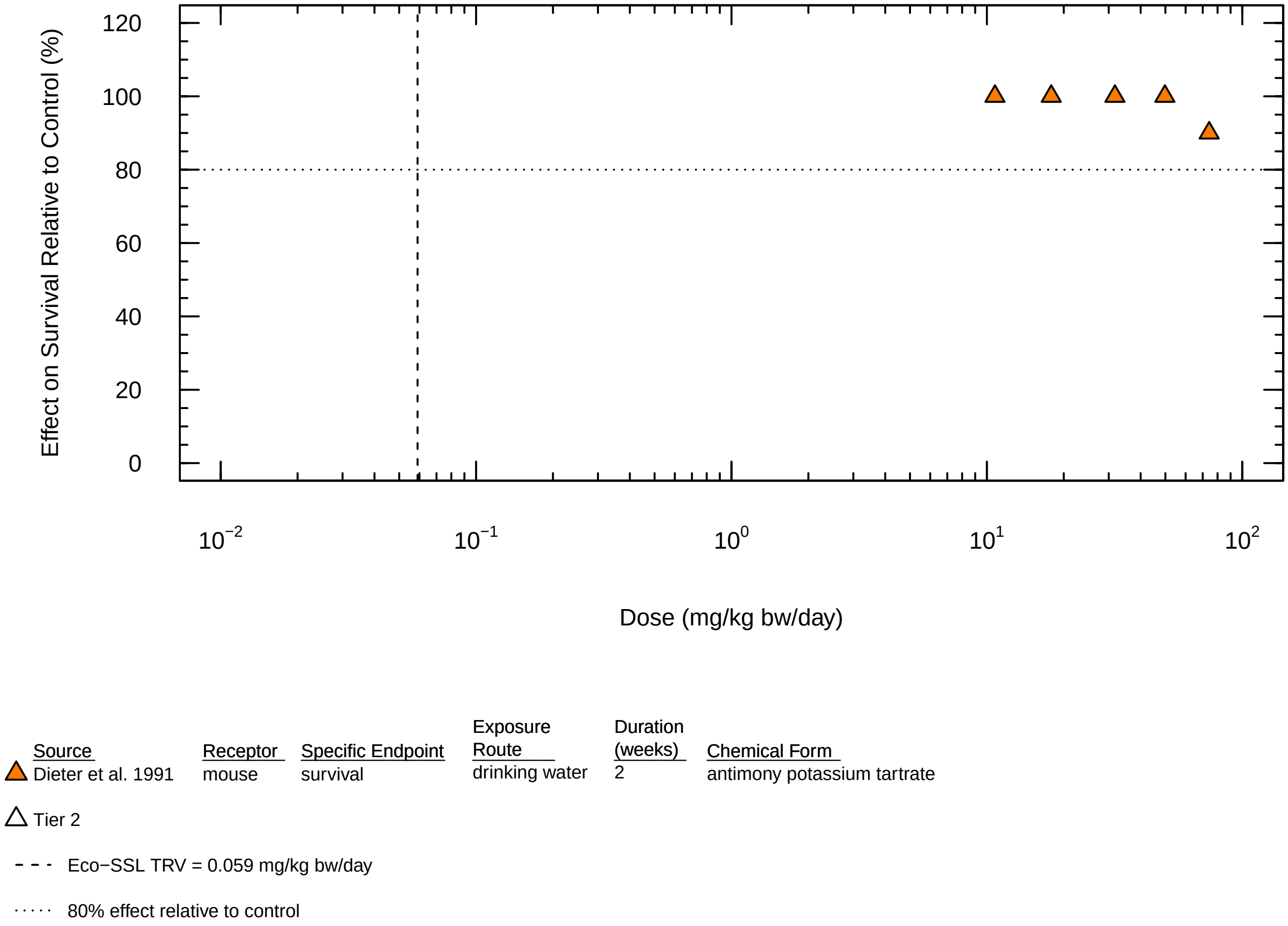
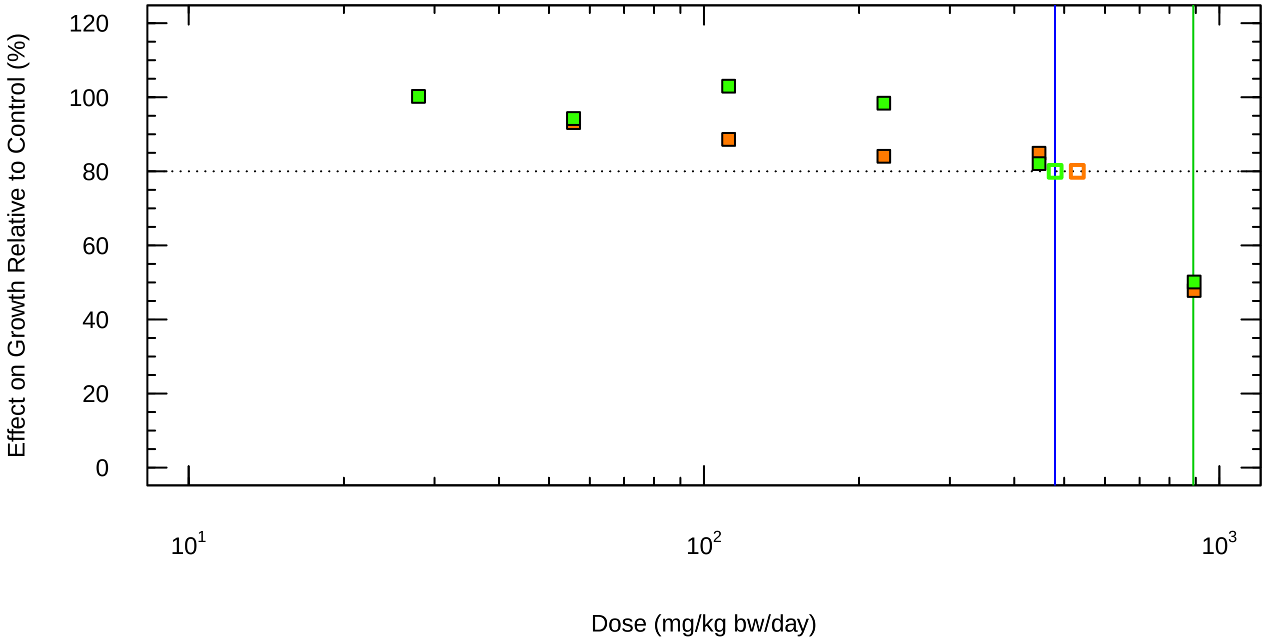


Figure E2−49. Dose−Response Data for the Mammalian Survival Endpoint for Antimony, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	ED20 or Geomean (mg/kg bw/day)
🟧	Johnson et al. 1960	chicken	body weight gain	diet	4	barium hydroxide	
🟩	Johnson et al. 1960	chicken	body weight gain	diet	4	barium acetate	
□	ED20 for Johnson et al. 1960	chicken	body weight gain	diet	4	barium hydroxide	530
□	ED20 for Johnson et al. 1960	chicken	body weight gain	diet	4	barium acetate	480

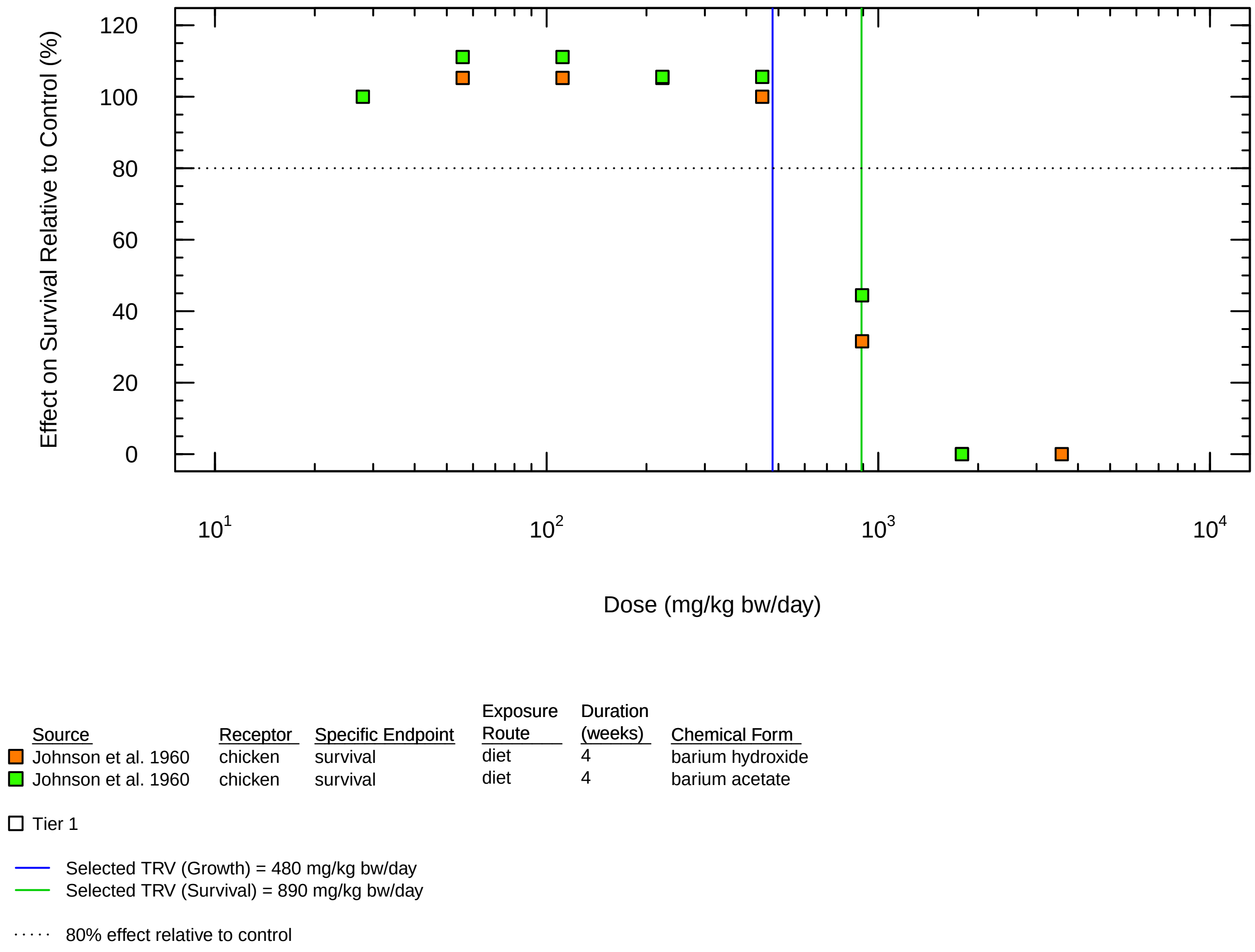
□ Tier 1

— Selected TRV (Growth) = 480 mg/kg bw/day
— Selected TRV (Survival) = 890 mg/kg bw/day

····· 80% effect relative to control

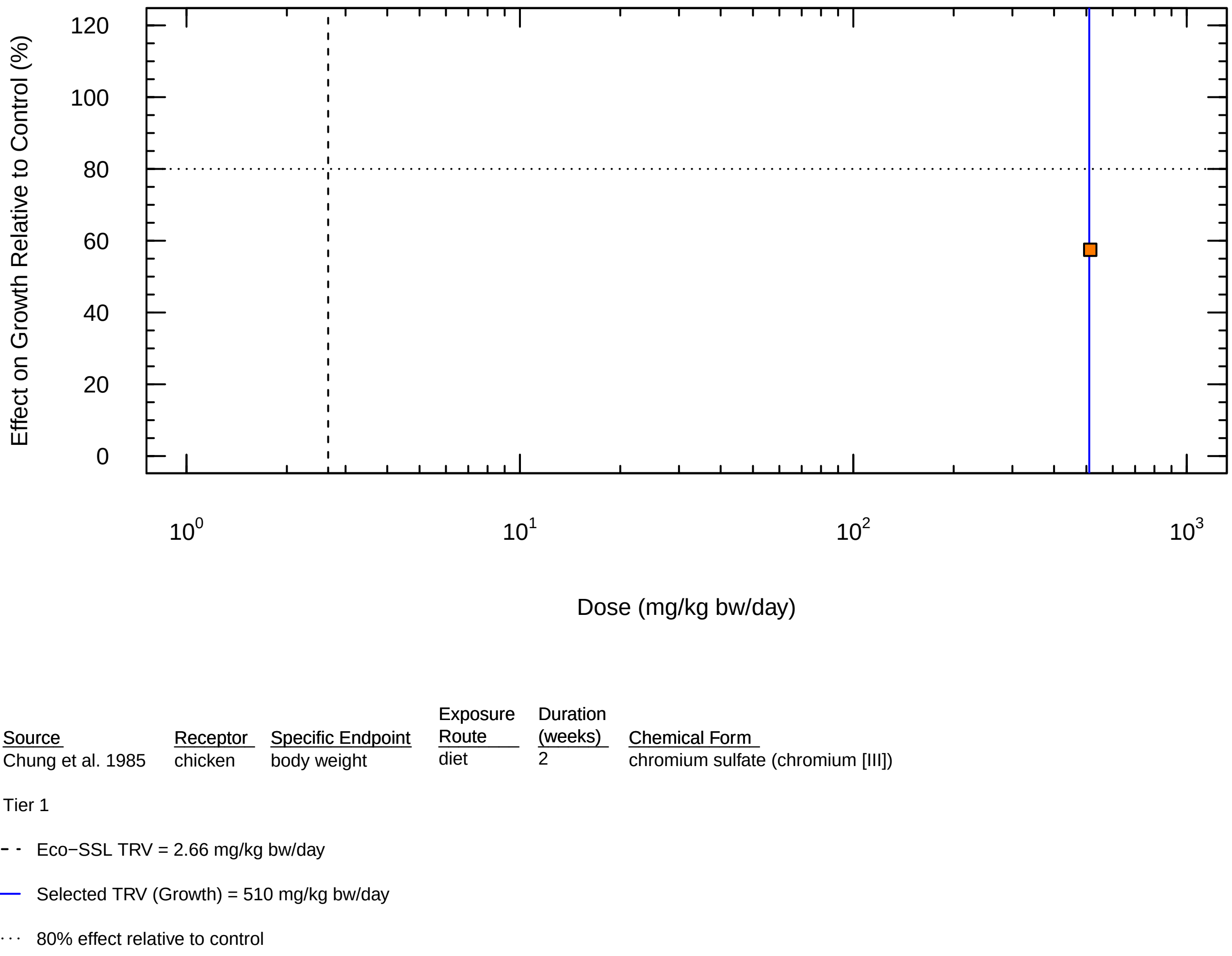
Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−50. Dose−Response Data for the Avian Growth Endpoint for Barium, Log−Transformed



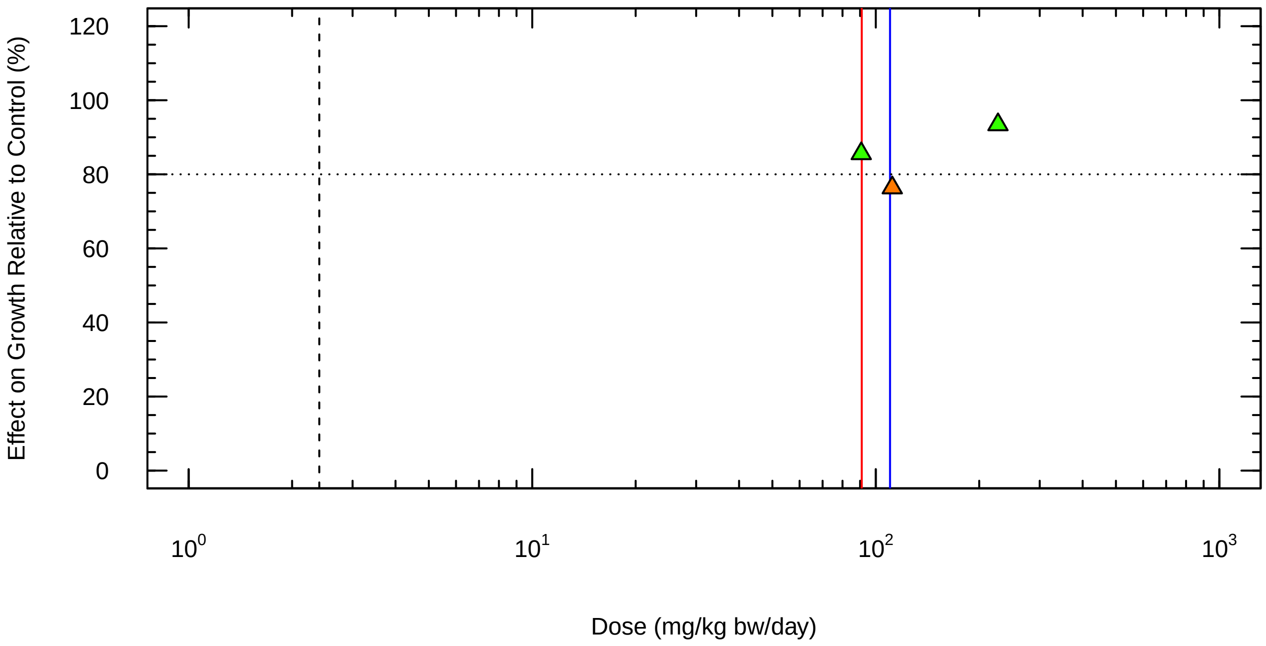
Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−51. Dose−Response Data for the Avian Survival Endpoint for Barium, Log−Transformed



Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−52. Dose−Response Data for the Avian Growth Endpoint for Chromium, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
▲	Bataineh et al. 1997	rat	body weight (male)	drinking water	12	chromium chloride (chromium [III])
▲	Elbetieha and Al−Hamood 1997	mouse	body weight	drinking water	12	chromium chloride (chromium [III])

△ Tier 2

- - - Eco−SSL TRV = 2.4 mg/kg bw/day

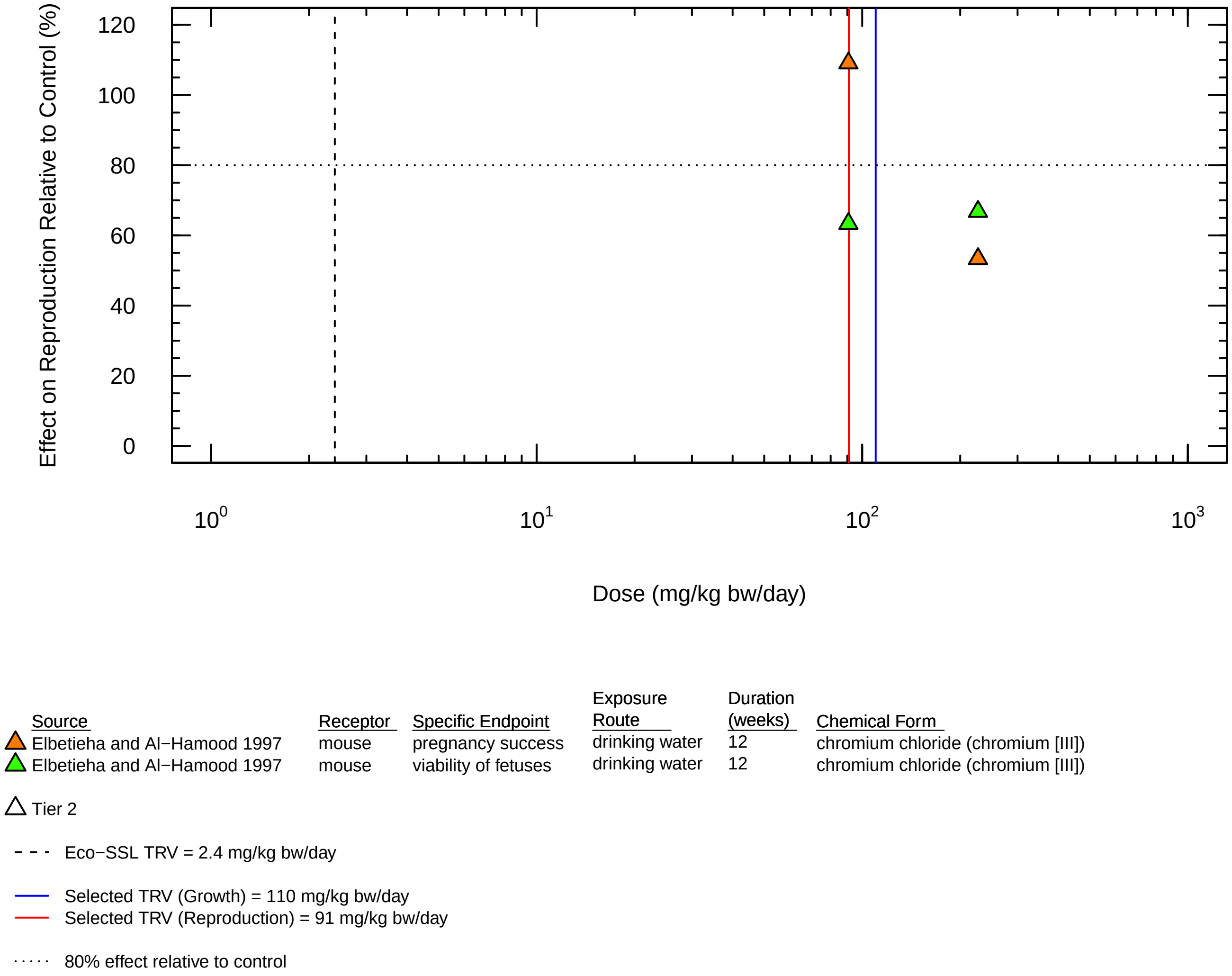
— Selected TRV (Growth) = 110 mg/kg bw/day

— Selected TRV (Reproduction) = 91 mg/kg bw/day

····· 80% effect relative to control

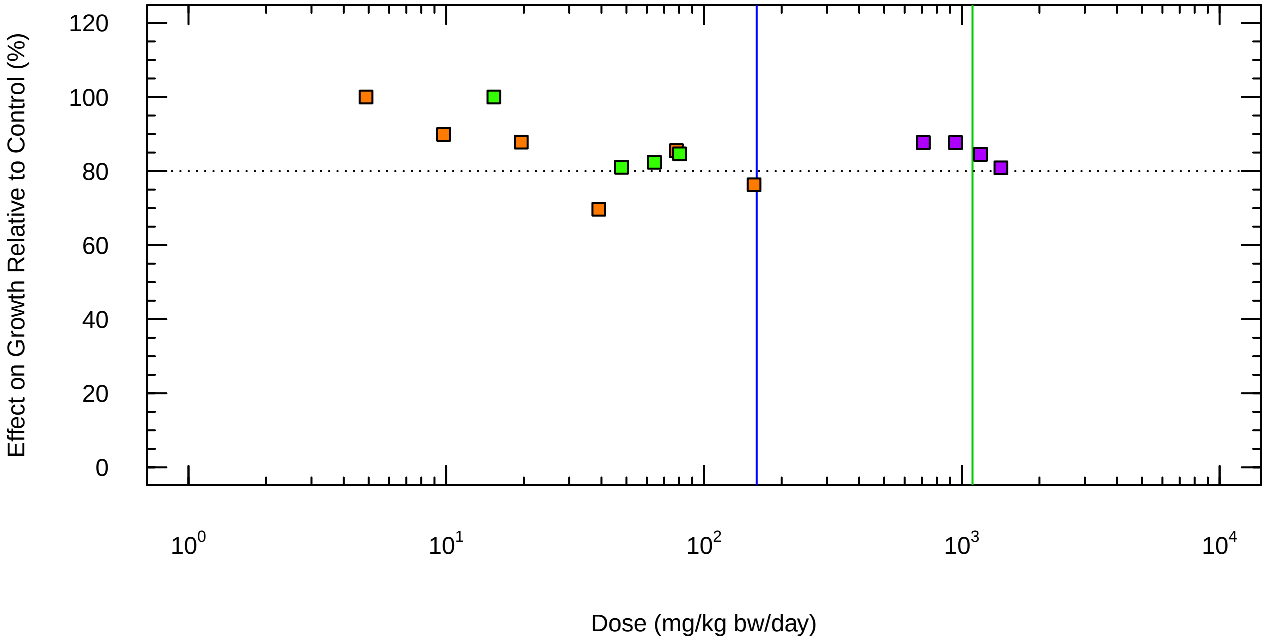
Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−53. Dose−Response Data for the Mammalian Growth Endpoint for Chromium, Log−Transformed



Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−54. Dose−Response Data for the Mammalian Reproduction Endpoint for Chromium, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	McGhee et al. 1965	chicken	body weight	diet	4	iron sulfate
🟩	Cao et al. 1996	chicken	body weight	diet	3	iron sulfate
🟪	Pescatore and Harter−Dennis 1989	chicken	body weight	gavage	single dose	iron sulfate

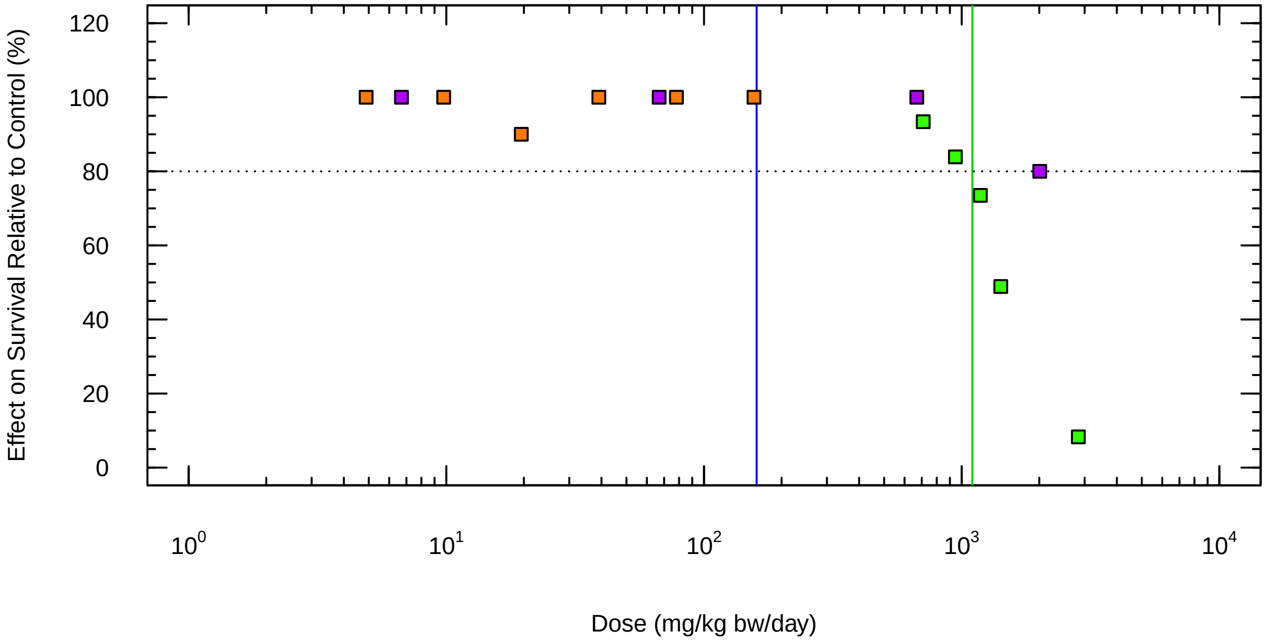
☐ Tier 1

— Selected TRV (Growth) = 160 mg/kg bw/day
— Selected TRV (Survival) = 1100 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−55. Dose−Response Data for the Avian Growth Endpoint for Iron, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	McGhee et al. 1965	chicken	survival	diet	4	iron sulfate	
🟩	Pescatore and Harter−Dennis 1989	chicken	survival	gavage	single dose	iron sulfate	A
🟪	Wallner−Pendleton et al. 1986	chicken	survival	gavage	single dose	iron sulfate	A

☐ Tier 1

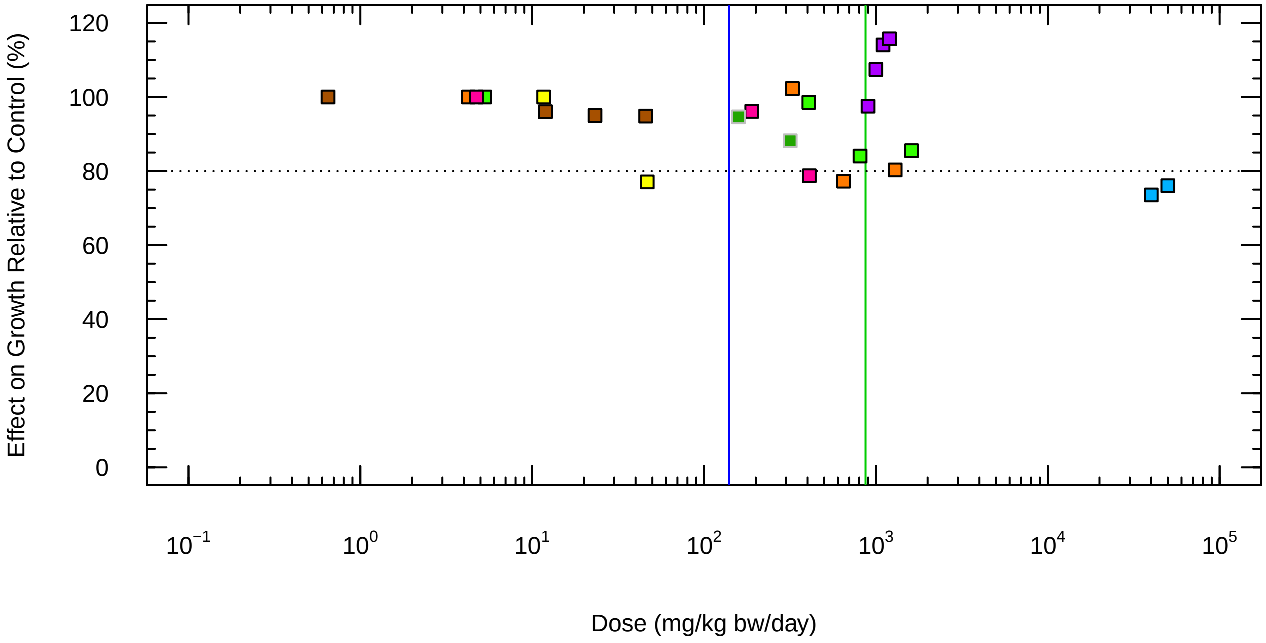
— Selected TRV (Growth) = 160 mg/kg bw/day

— Selected TRV (Survival) = 1100 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−56. Dose−Response Data for the Avian Survival Endpoint for Iron, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Plummer et al. 1997	rat (male)	body weight	diet	32	carbonyl iron	
🟩	Plummer et al. 1997	rat (female)	body weight	diet	32	carbonyl iron	
🟪	Whittaker et al. 2002	rat	body weight	gavage	single dose	iron sulfate	
🟦	Whittaker et al. 2002	rat	body weight	gavage	single dose	carbonyl iron	
🟨	Banis et al. 1969	rat	body weight	diet	4	iron sulfate	A
🟥	Storey and Greger 1987	rat	body weight	diet	3	iron sulfate	A
🟫	Prince et al. 1979	pig	body weight	diet	16	ferrous sulfide	
🟩	Zhu et al. 2016	rat	body weight	diet	13	carbonyl iron	

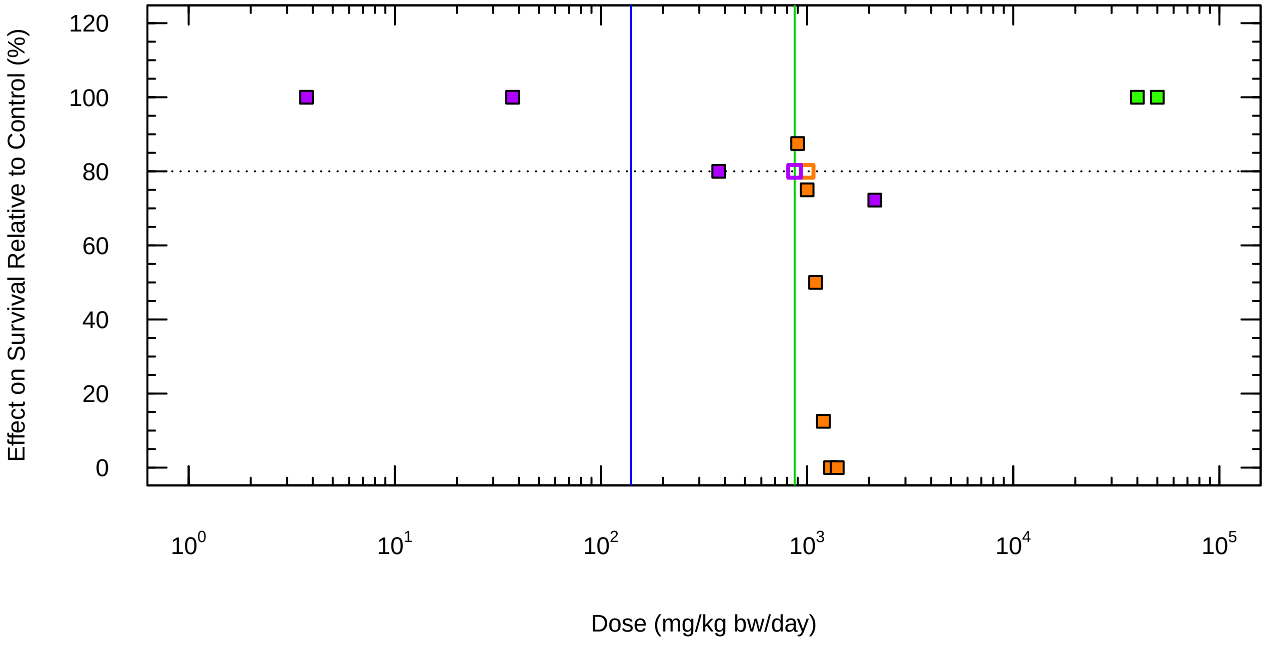
☐ Tier 1

— Selected TRV (Growth) = 140 mg/kg bw/day
— Selected TRV (Survival) = 870 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−57. Dose−Response Data for the Mammalian Growth Endpoint for Iron, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	ED20 or Geomean (mg/kg bw/day)
🟧	Whittaker et al. 2002	rat	survival	gavage	single dose	iron sulfate	
🟩	Whittaker et al. 2002	rat	survival	gavage	single dose	carbonyl iron	
🟪	Whittaker et al. 1996	rat	survival	diet	12	carbonyl iron	
□	ED20 for Whittaker et al. 2002	rat	survival	gavage	single dose	iron sulfate	1000
□	ED20 for Whittaker et al. 1996	rat	survival	diet	12	carbonyl iron	870

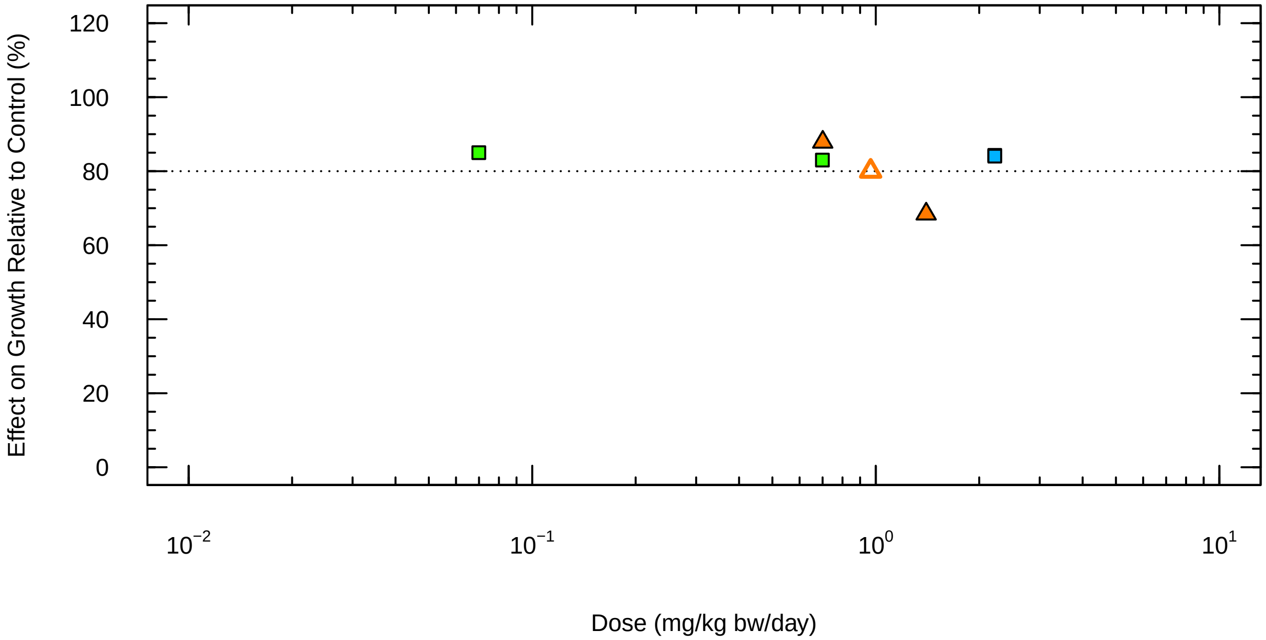
☐ Tier 1

— Selected TRV (Growth) = 140 mg/kg bw/day
— Selected TRV (Survival) = 870 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−58. Dose−Response Data for the Mammalian Survival Endpoint for Iron, Log−Transformed

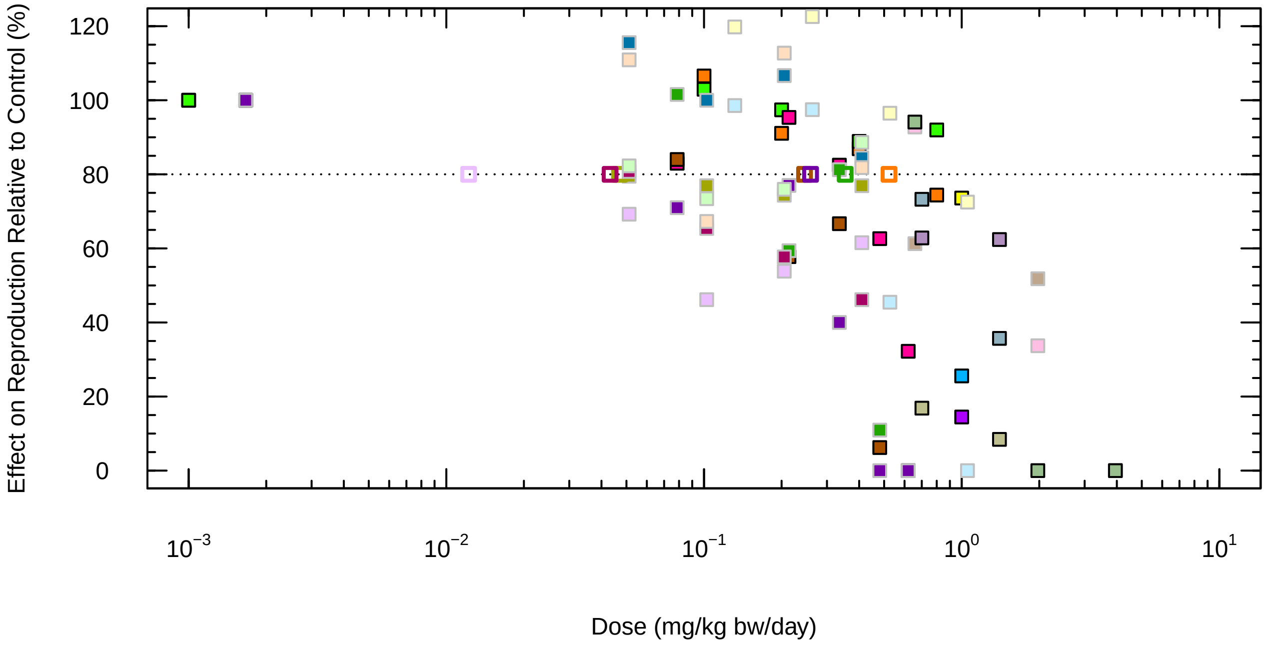


Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
▲ Scott et al. 1977	chicken	body weight	diet	8	methylmercury chloride		
■ Spalding et al. 2000	egret	weight index	diet	14	methylmercury chloride		
■ Sell and Horani 1976	chicken	body weight gain (Exp 1)	diet	4	methylmercury chloride	A	
■ Sell and Horani 1976	chicken	body weight gain (Exp 2)	diet	3.6	methylmercury chloride	A	
△ ED20 for Scott et al. 1977	chicken	body weight	diet	8	methylmercury chloride		0.97

☐ Tier 1 △ Tier 2

····· 80% effect relative to control

Figure E2−59. Dose−Response Data for the Avian Growth Endpoint for Methylmercury, Log−Transformed

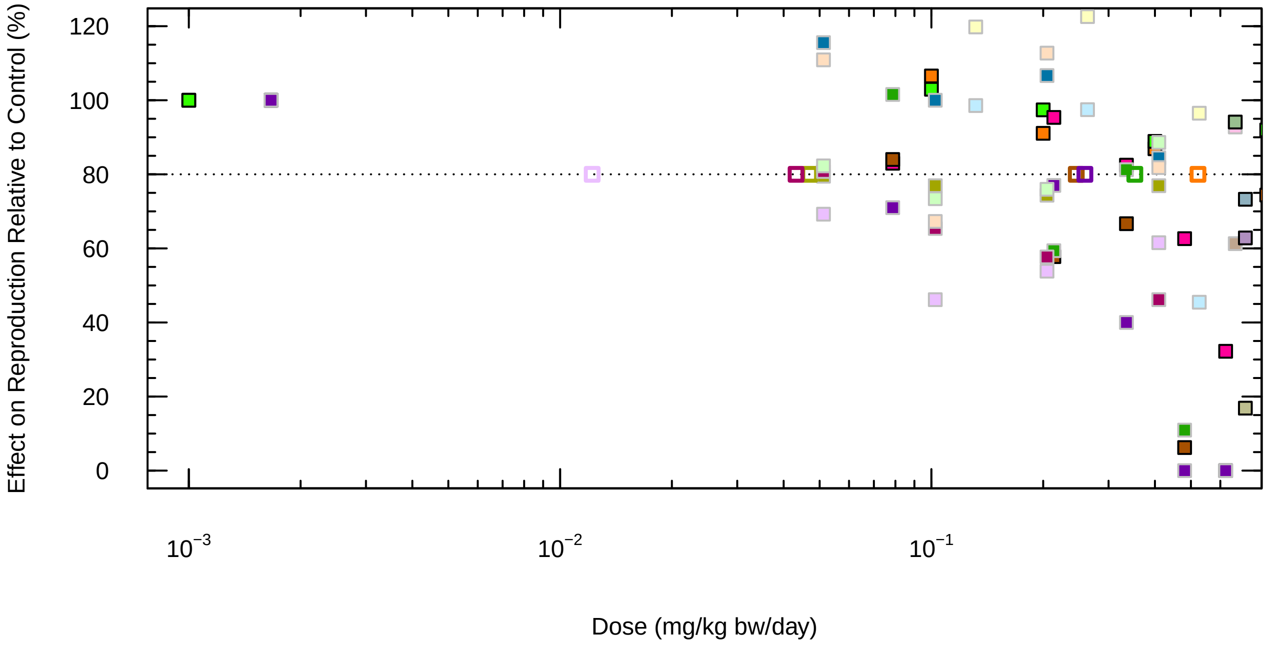


	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
■	Heinz et al. 2010	mallard	# of ducklings per hen	diet	3.7	methylmercury chloride	B	
■	Heinz et al. 2010	mallard	duckling body weight	diet	3.7	methylmercury chloride		
■	Heinz and Hoffman 1998	mallard	# of ducklings per hen	diet	up to 11	methylmercury chloride	B	
■	Heinz and Hoffman 1998	mallard	% hatchability	diet	up to 11	methylmercury chloride		
■	Heinz and Hoffman 1998	mallard	duckling survival	diet	up to 11	methylmercury chloride		
■	Albers et al. 2007	kestrel	egg production	diet	at least 11	methylmercury chloride		
■	Albers et al. 2007	kestrel	# of eggs hatched	diet	at least 11	methylmercury chloride		
■	Albers et al. 2007	kestrel	% eggs hatched	diet	at least 11	methylmercury chloride		
■	Albers et al. 2007	kestrel	% fledged	diet	at least 11	methylmercury chloride		
■	Varian−Ramos et al. 2014	finch	% hatchability	diet	52	methylmercury cysteine		
■	Varian−Ramos et al. 2014	finch	% chicks fledged	diet	52	methylmercury cysteine		
■	Varian−Ramos et al. 2014	finch	# of offspring	diet	52	methylmercury cysteine		
■	Varian−Ramos et al. 2014	finch	F1 % hatchability	diet	unclear	methylmercury cysteine		
■	Varian−Ramos et al. 2014	finch	F1 % chicks fledged	diet	unclear	methylmercury cysteine		
■	Varian−Ramos et al. 2014	finch	F1 # of offspring	diet	unclear	methylmercury cysteine		
■	Eskeland and Nafstad 1978	quail	chick survival	diet	6	methylmercury chloride		
■	Eskeland and Nafstad 1978	quail	hatch success	diet	6	methylmercury chloride		
■	El−Begearmi et al. 1977	quail	% egg fertility	diet	16	methylmercury hydroxide		
■	El−Begearmi et al. 1977	quail	egg production	diet	16	methylmercury hydroxide		
■	El−Begearmi et al. 1977	quail	% hatchability	diet	16	methylmercury hydroxide		
■	Scott et al. 1977	chicken	egg fertility	diet	8	methylmercury chloride		
■	Scott et al. 1977	chicken	egg production	diet	8	methylmercury chloride		
■	Scott et al. 1977	chicken	egg hatchability	diet	8	methylmercury chloride		
□	ED20 for Heinz et al. 2010	mallard	# of ducklings per hen	diet	3.7	methylmercury chloride	B	0.52
□	ED20 for Albers et al. 2007	kestrel	# of eggs hatched	diet	at least 11	methylmercury chloride		0.25
□	ED20 for Albers et al. 2007	kestrel	% eggs hatched	diet	at least 11	methylmercury chloride		0.35
□	ED20 for Albers et al. 2007	kestrel	% fledged	diet	at least 11	methylmercury chloride		0.26
□	ED20 for Varian−Ramos et al. 2014	finch	% chicks fledged	diet	52	methylmercury cysteine		0.047
□	ED20 for Varian−Ramos et al. 2014	finch	# of offspring	diet	52	methylmercury cysteine		0.043
□	ED20 for Varian−Ramos et al. 2014	finch	F1 # of offspring	diet	unclear	methylmercury cysteine		0.012

□ Tier 1

····· 80% effect relative to control

Figure E2−60. Dose−Response Data for the Avian Reproduction Endpoint for Methylmercury, Log−Transformed

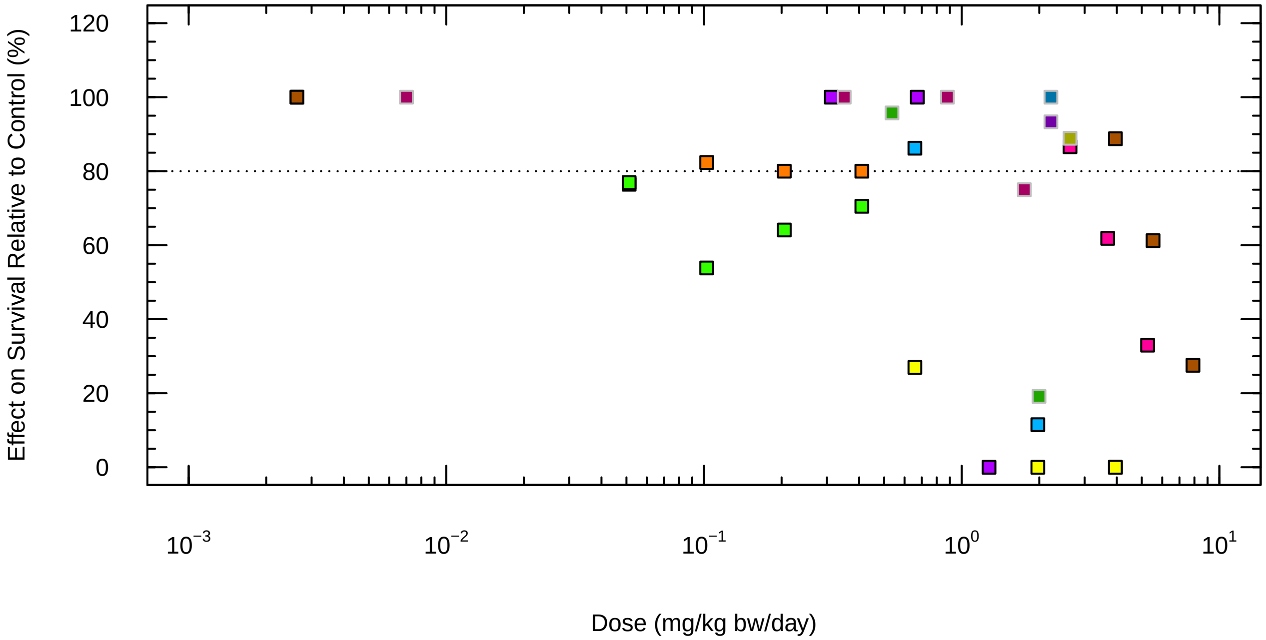


	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
■	Heinz et al. 2010	mallard	# of ducklings per hen	diet	3.7	methylmercury chloride	B	
■	Heinz et al. 2010	mallard	duckling body weight	diet	3.7	methylmercury chloride		
■	Heinz and Hoffman 1998	mallard	# of ducklings per hen	diet	up to 11	methylmercury chloride	B	
■	Heinz and Hoffman 1998	mallard	% hatchability	diet	up to 11	methylmercury chloride		
■	Heinz and Hoffman 1998	mallard	duckling survival	diet	up to 11	methylmercury chloride		
■	Albers et al. 2007	kestrel	egg production	diet	at least 11	methylmercury chloride		
■	Albers et al. 2007	kestrel	# of eggs hatched	diet	at least 11	methylmercury chloride		
■	Albers et al. 2007	kestrel	% eggs hatched	diet	at least 11	methylmercury chloride		
■	Albers et al. 2007	kestrel	% fledged	diet	at least 11	methylmercury chloride		
■	Varian−Ramos et al. 2014	finch	% hatchability	diet	52	methylmercury cysteine		
■	Varian−Ramos et al. 2014	finch	% chicks fledged	diet	52	methylmercury cysteine		
■	Varian−Ramos et al. 2014	finch	# of offspring	diet	52	methylmercury cysteine		
■	Varian−Ramos et al. 2014	finch	F1 % hatchability	diet	unclear	methylmercury cysteine		
■	Varian−Ramos et al. 2014	finch	F1 % chicks fledged	diet	unclear	methylmercury cysteine		
■	Varian−Ramos et al. 2014	finch	F1 # of offspring	diet	unclear	methylmercury cysteine		
■	Eskeland and Nafstad 1978	quail	chick survival	diet	6	methylmercury chloride		
■	Eskeland and Nafstad 1978	quail	hatch success	diet	6	methylmercury chloride		
■	El−Begearmi et al. 1977	quail	% egg fertility	diet	16	methylmercury hydroxide		
■	El−Begearmi et al. 1977	quail	egg production	diet	16	methylmercury hydroxide		
■	El−Begearmi et al. 1977	quail	% hatchability	diet	16	methylmercury hydroxide		
■	Scott et al. 1977	chicken	egg fertility	diet	8	methylmercury chloride		
■	Scott et al. 1977	chicken	egg production	diet	8	methylmercury chloride		
■	Scott et al. 1977	chicken	egg hatchability	diet	8	methylmercury chloride		
□	ED20 for Heinz et al. 2010	mallard	# of ducklings per hen	diet	3.7	methylmercury chloride	B	0.52
□	ED20 for Albers et al. 2007	kestrel	# of eggs hatched	diet	at least 11	methylmercury chloride		0.25
□	ED20 for Albers et al. 2007	kestrel	% eggs hatched	diet	at least 11	methylmercury chloride		0.35
□	ED20 for Albers et al. 2007	kestrel	% fledged	diet	at least 11	methylmercury chloride		0.26
□	ED20 for Varian−Ramos et al. 2014	finch	% chicks fledged	diet	52	methylmercury cysteine		0.047
□	ED20 for Varian−Ramos et al. 2014	finch	# of offspring	diet	52	methylmercury cysteine		0.043
□	ED20 for Varian−Ramos et al. 2014	finch	F1 # of offspring	diet	unclear	methylmercury cysteine		0.012

□ Tier 1

····· 80% effect relative to control

Figure E2−61. Dose−Response Data for the Avian Reproduction Endpoint for Methylmercury, Log−Transformed

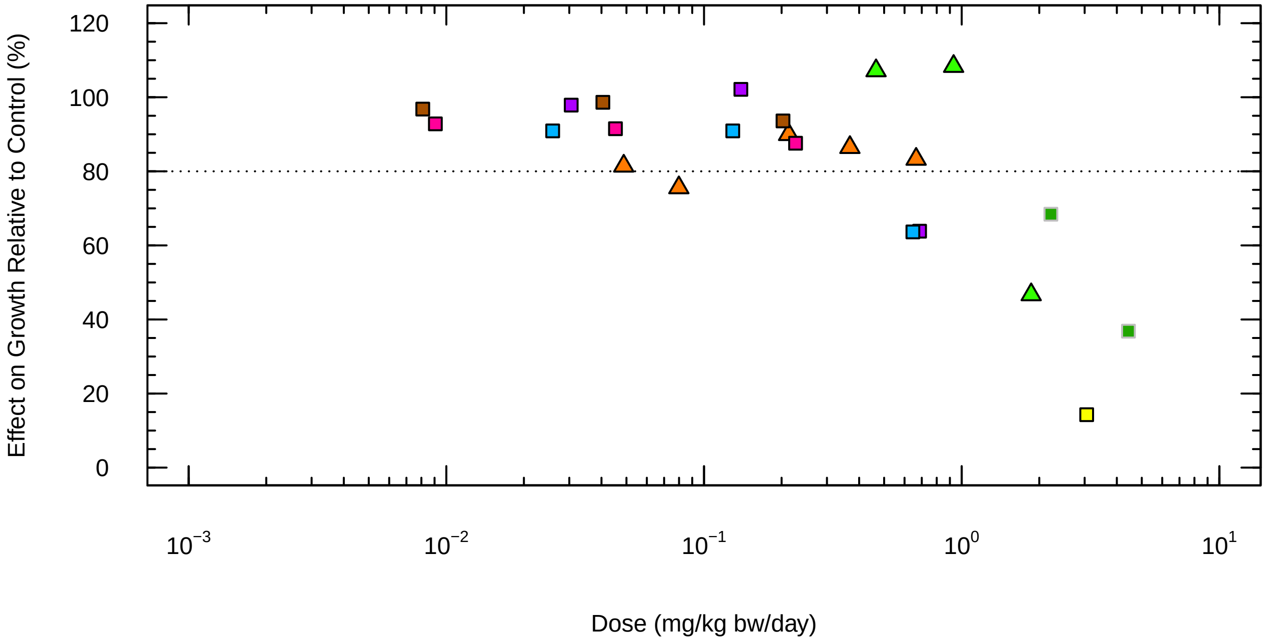


	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Varian−Ramos et al. 2014	finch	survival	diet	52	methylmercury cysteine	
🟩	Varian−Ramos et al. 2014	finch	F1 survival	diet	unclear	methylmercury cysteine	
🟪	Bennet et al. 2009	kestrel	survival	diet	5−7	methylmercury chloride	
🟦	El−Begearmi et al. 1977	quail	survival (female)	diet	16	methylmercury hydroxide	C
🟨	El−Begearmi et al. 1977	quail	survival (male)	diet	16	methylmercury hydroxide	C
🟥	Hill and Soares 1987	quail	survival	diet	0.71	methylmercury chloride	
🟫	Hill and Soares 1987	quail	survival	diet	0.71	methylmercury chloride	
🟩	Spann et al. 1986	quail	survival	diet	6	methylmercury chloride	
🟪	Sell and Horani 1976	chicken	survival (Exp 1)	diet	4	methylmercury chloride	
🟦	Sell and Horani 1976	chicken	survival (Exp 2)	diet	3.6	methylmercury chloride	
🟨	Sell and Horani 1976	quail	survival (Exp 2)	diet	3.3	methylmercury chloride	
🟥	Scheuhammer 1988	finch	survival	diet	11	methylmercury chloride	

☐ Tier 1

····· 80% effect relative to control

Figure E2−62. Dose−Response Data for the Avian Survival Endpoint for Methylmercury, Log−Transformed

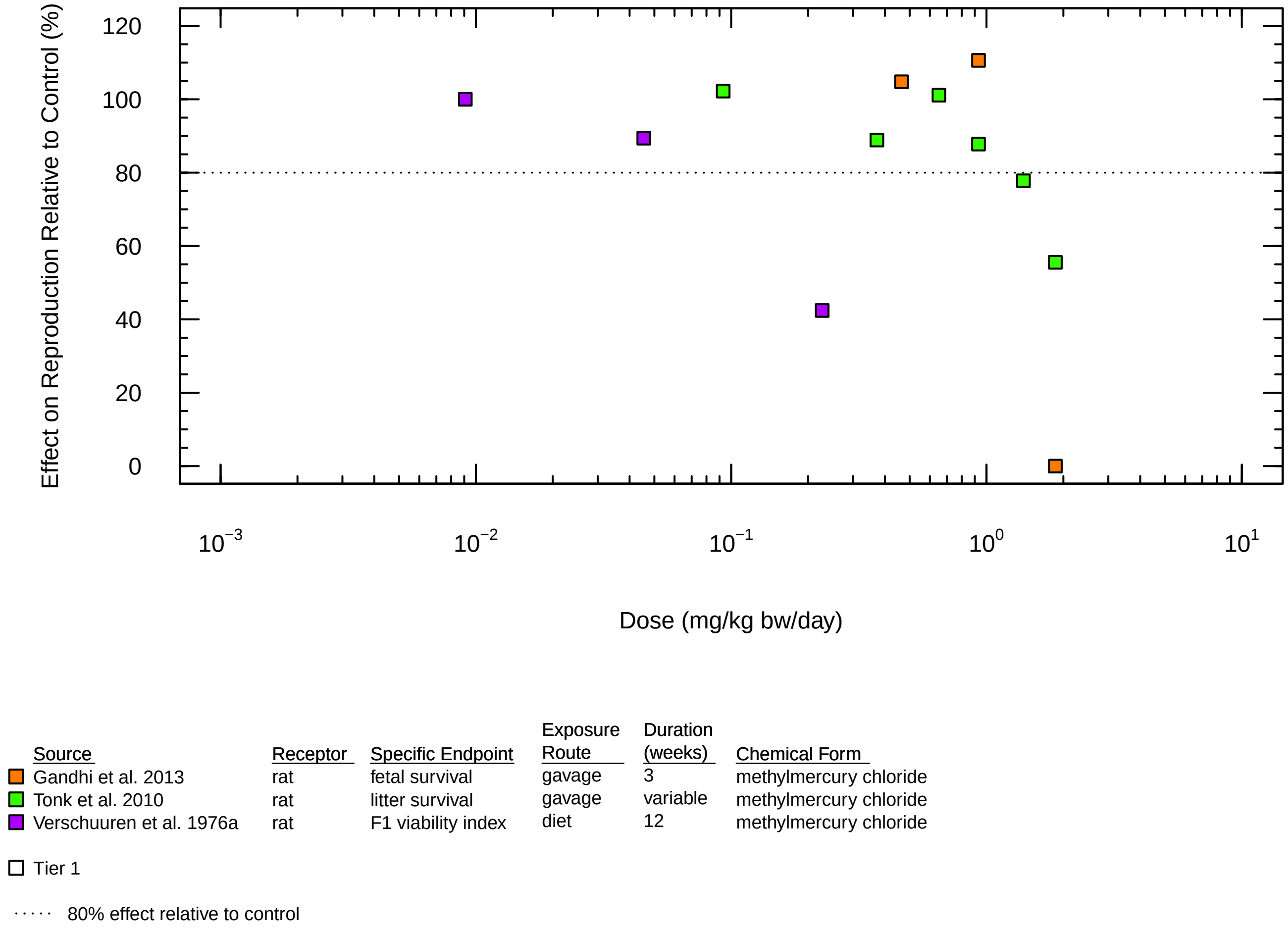


Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
▲ Wobeser et al. 1976	mink	body weight	diet	13	methylmercury chloride	
▲ Gandhi et al. 2013	rat	body weight gain	gavage	3	methylmercury chloride	
■ Mitsumori et al. 1990	mouse	body weight	diet	104	methylmercury chloride	
■ Mitsumori et al. 1983	rat	body weight	diet	130	methylmercury chloride	D
■ Stillings et al. 1974	rat	body weight gain	diet	4	methylmercury chloride	
■ Verschuuren et al. 1976a	rat	F2 body weight gain	diet	12	methylmercury chloride	
■ Verschuuren et al. 1976b	rat	body weight	diet	104	methylmercury chloride	D
■ Friedman et al. 1978	rat	body weight	diet	10	methlymercury chloride	

☐ Tier 1 △ Tier 2

····· 80% effect relative to control

Figure E2−63. Dose−Response Data for the Mammalian Growth Endpoint for Methylmercury, Log−Transformed

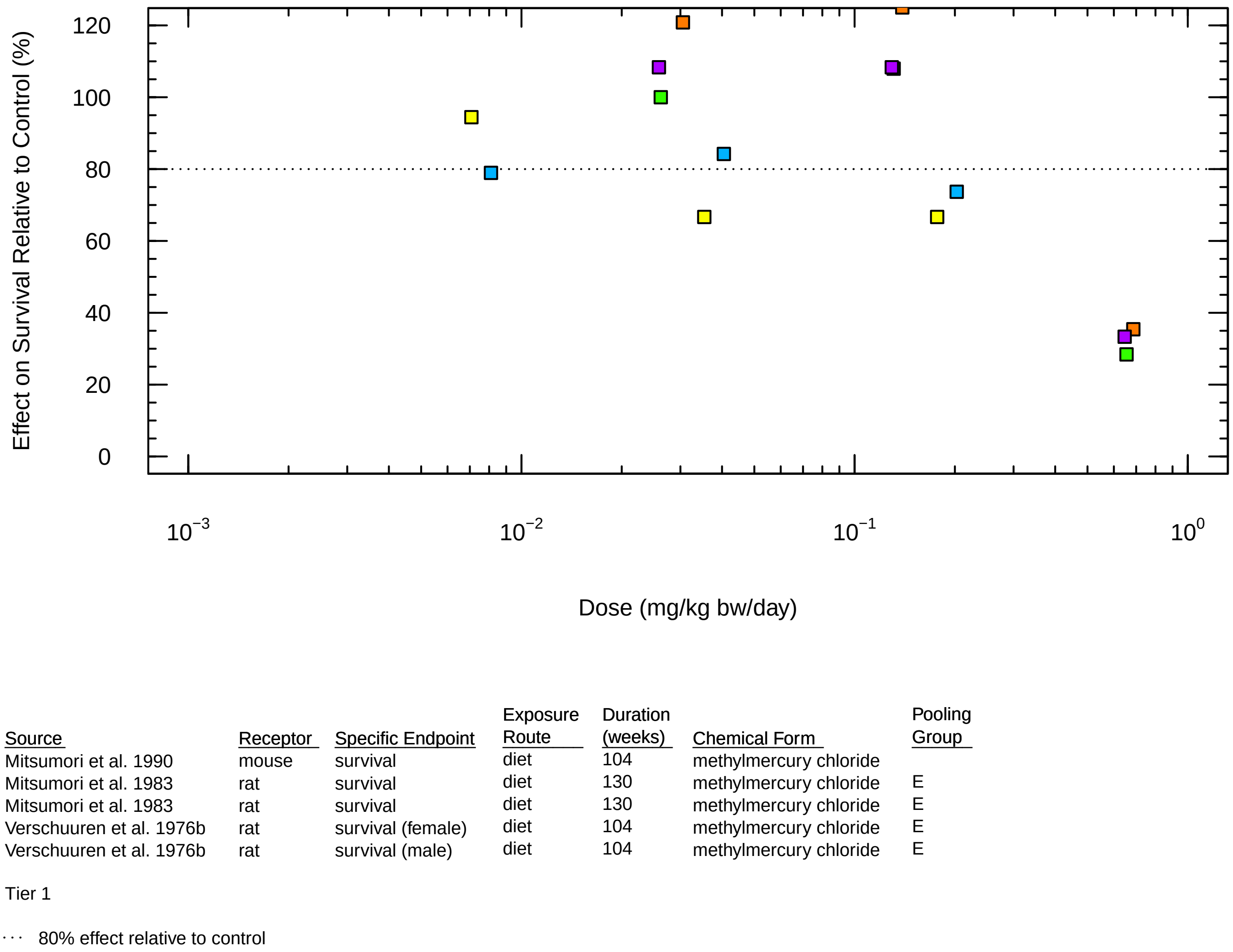


	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Gandhi et al. 2013	rat	fetal survival	gavage	3	methylmercury chloride
🟩	Tonk et al. 2010	rat	litter survival	gavage	variable	methylmercury chloride
🟪	Verschuuren et al. 1976a	rat	F1 viability index	diet	12	methylmercury chloride

☐ Tier 1

····· 80% effect relative to control

Figure E2−64. Dose−Response Data for the Mammalian Reproduction Endpoint for Methylmercury, Log−Transformed

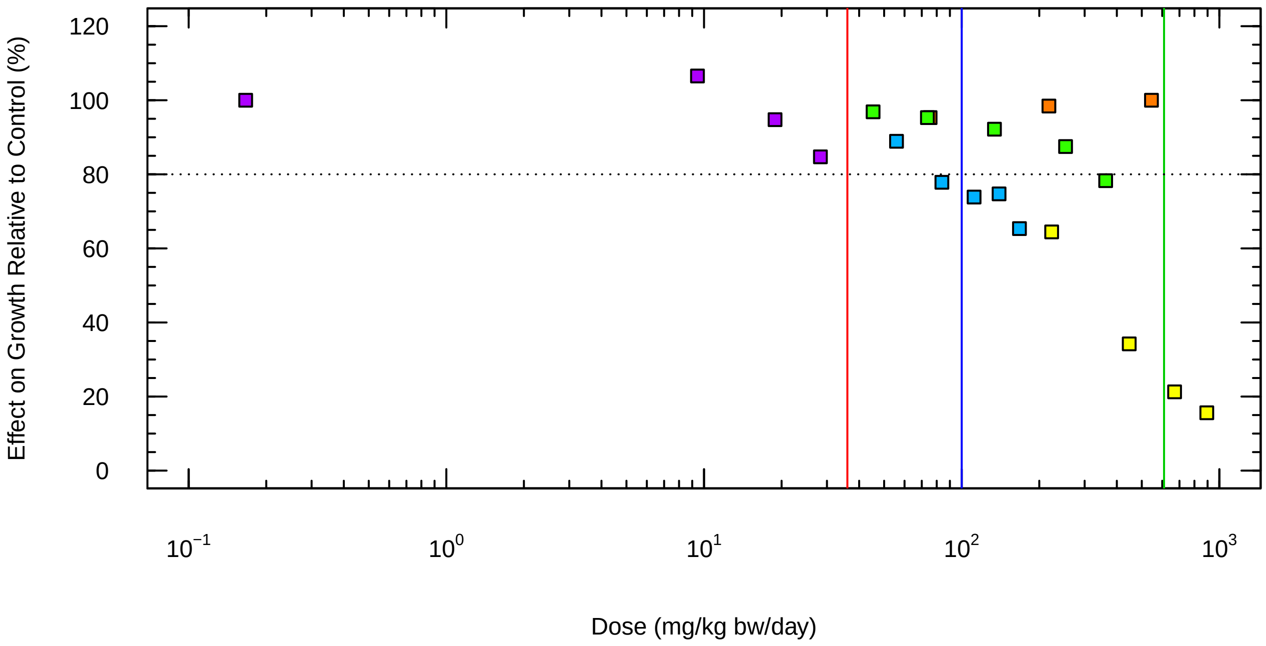


	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Mitsumori et al. 1990	mouse	survival	diet	104	methylmercury chloride	
🟩	Mitsumori et al. 1983	rat	survival	diet	130	methylmercury chloride	E
🟪	Mitsumori et al. 1983	rat	survival	diet	130	methylmercury chloride	E
🟦	Verschuuren et al. 1976b	rat	survival (female)	diet	104	methylmercury chloride	E
🟨	Verschuuren et al. 1976b	rat	survival (male)	diet	104	methylmercury chloride	E

☐ Tier 1

····· 80% effect relative to control

Figure E2−65. Dose−Response Data for the Mammalian Survival Endpoint for Methylmercury, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Stafford et al. 2015	bobwhite quail	body weight gain	diet	4.3	molydenum disulfide	
🟩	Stafford et al. 2015	bobwhite quail	body weight gain	diet	4.3	sodium molybdate	
🟪	Kratzer 1952	chicken	weight gain	diet	3.3	sodium molybdate	
🟦	Davies et al. 1960	chicken	body weight (Exp 1b)	diet	4	sodium molybdate	A
🟨	Davies et al. 1960	chicken	body weight (Exp 1c)	diet	4	sodium molybdate	A

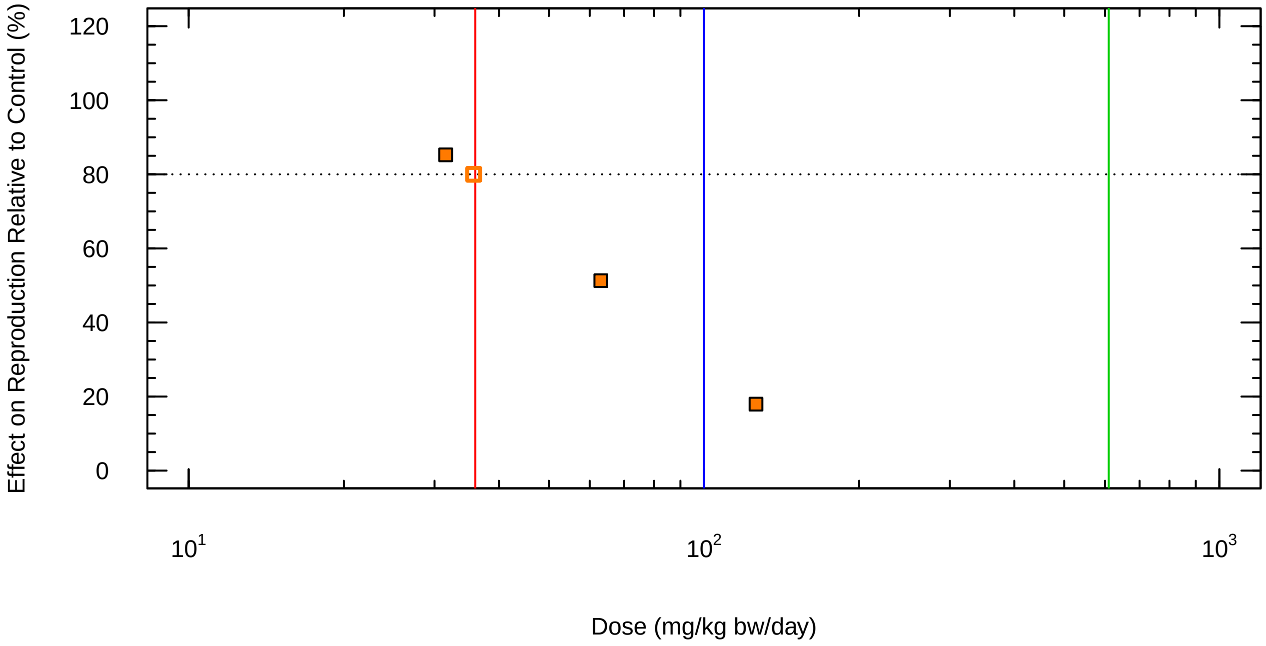
☐ Tier 1

— Selected TRV (Growth) = 100 mg/kg bw/day
— Selected TRV (Reproduction) = 36 mg/kg bw/day
— Selected TRV (Survival) = 610 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−66. Dose−Response Data for the Avian Growth Endpoint for Molybdenum, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	ED20 or Geomean (mg/kg bw/day)
■	Lepore and Miller 1965	chicken	egg production	diet	3	sodium molybdate	
□	ED20 for Lepore and Miller 1965	chicken	egg production	diet	3	sodium molybdate	36

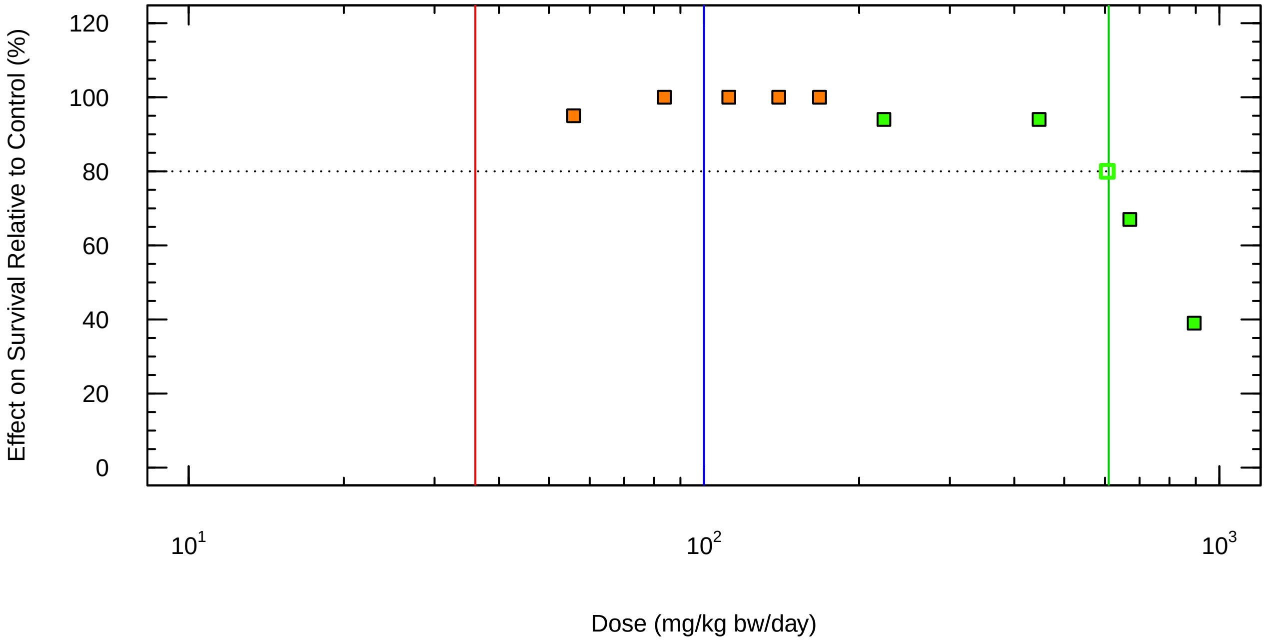
☐ Tier 1

— Selected TRV (Growth) = 100 mg/kg bw/day
— Selected TRV (Reproduction) = 36 mg/kg bw/day
— Selected TRV (Survival) = 610 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−67. Dose−Response Data for the Avian Reproduction Endpoint for Molybdenum, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	ED20 or Geomean (mg/kg bw/day)
🟧	Davies et al. 1960	chicken	survival (Exp 1b)	diet	4	sodium molybdate	
🟩	Davies et al. 1960	chicken	survival (Exp 1c)	diet	4	sodium molybdate	
□	ED20 for Davies et al. 1960	chicken	survival (Exp 1c)	diet	4	sodium molybdate	610

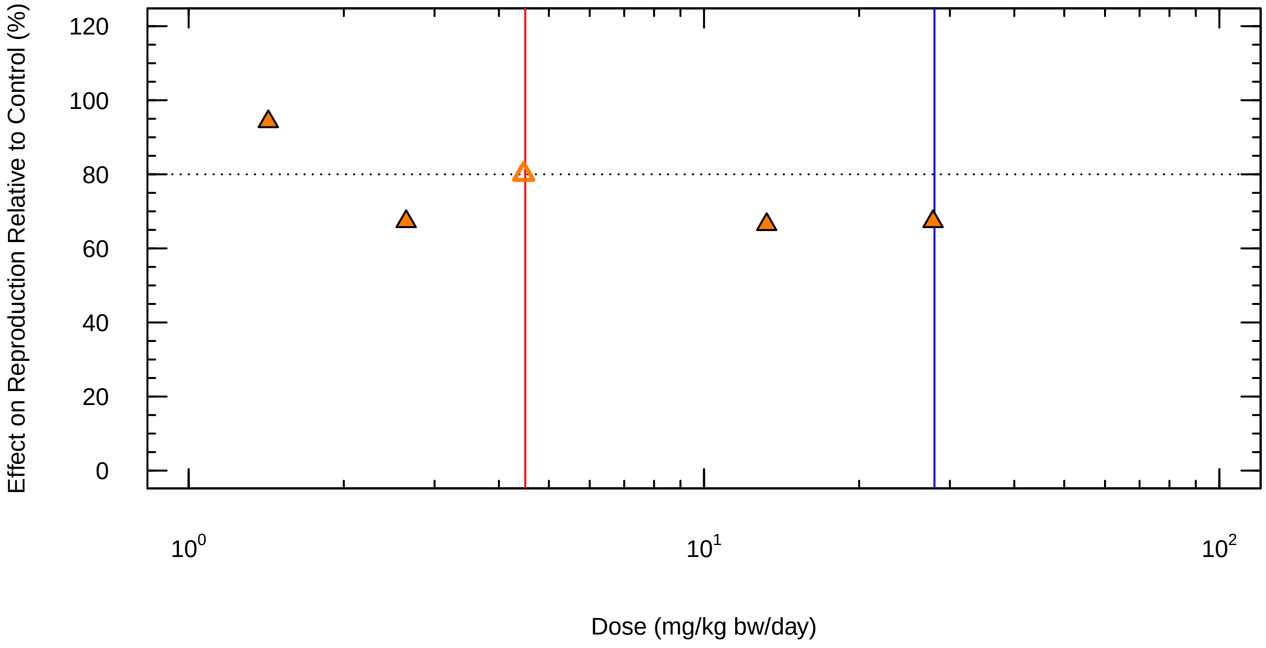
□ Tier 1

― Selected TRV (Growth) = 100 mg/kg bw/day
― Selected TRV (Reproduction) = 36 mg/kg bw/day
― Selected TRV (Survival) = 610 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−68. Dose−Response Data for the Avian Survival Endpoint for Molybdenum, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	ED20 or Geomean (mg/kg bw/day)
▲	Fungwe et al. 1990	rat	litter weight	drinking water	9	sodium molybdate	
△	ED20 for Fungwe et al. 1990	rat	litter weight	drinking water	9	sodium molybdate	4.5

△ Tier 2

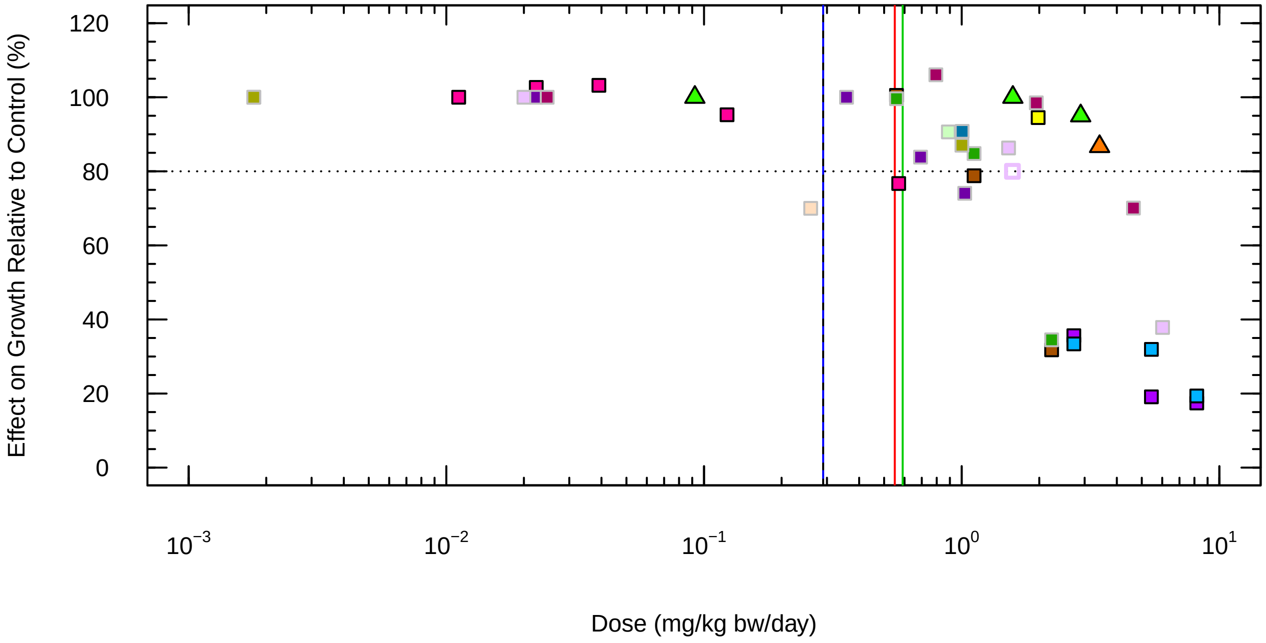
— Selected TRV (Growth) = 28 mg/kg bw/day

— Selected TRV (Reproduction) = 4.5 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−69. Dose−Response Data for the Mammalian Reproduction Endpoint for Molybdenum, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
▲	Gad and El−Twab 2009	quail	body weight	gavage	4	sodium selenite		
▲	Santolo et al. 2010	quail	body weight gain	diet	4	seleno−L−methionine		
■	El−Begearmi and Combs 1982	chicken	body weight (brewer's yeast diet)	diet	4	sodium selenite	A	
■	El−Begearmi and Combs 1982	chicken	body weight (corn−soy diet)	diet	4	sodium selenite	A	
■	Heinz and Fitzgerald 1993a	mallard	body weight	diet	21	seleno−DL−methionine	D	
■	Jensen 1986	chicken	body weight	diet	3	sodium selenite	A	
■	Hill 1979a	chicken	body weight gain (Exp 1)	diet	4−5	selenium dioxide	B	
■	Hill 1979a	chicken	body weight gain (Exp 2)	diet	4−5	selenium dioxide	B	
■	Echevarria et al. 1988	chicken	body weight gain	diet	3	sodium selenite	C	
■	Stowesand et al. 1977	quail	body weight	diet	10	sodium selenite		
■	Stowesand et al. 1977	quail	body weight	diet	10	seleniferous wheat		
■	O'Toole and Raisbeck 1997	mallard	body weight	diet	21	seleno−L−methionine	D	
■	Dafalla and Adam 1986	chicken	body weight	diet	4	sodium selenite	A	
■	Sell and Horani 1976	chicken	body weight gain	diet	4	sodium selenite	C	
■	Hoffman et al. 1992	mallard	body weight	diet	4	seleno−DL−methionine		
□	ED20 for Hoffman et al. 1992	mallard	body weight	diet	4	seleno−DL−methionine		1.6

□ Tier 1 △ Tier 2

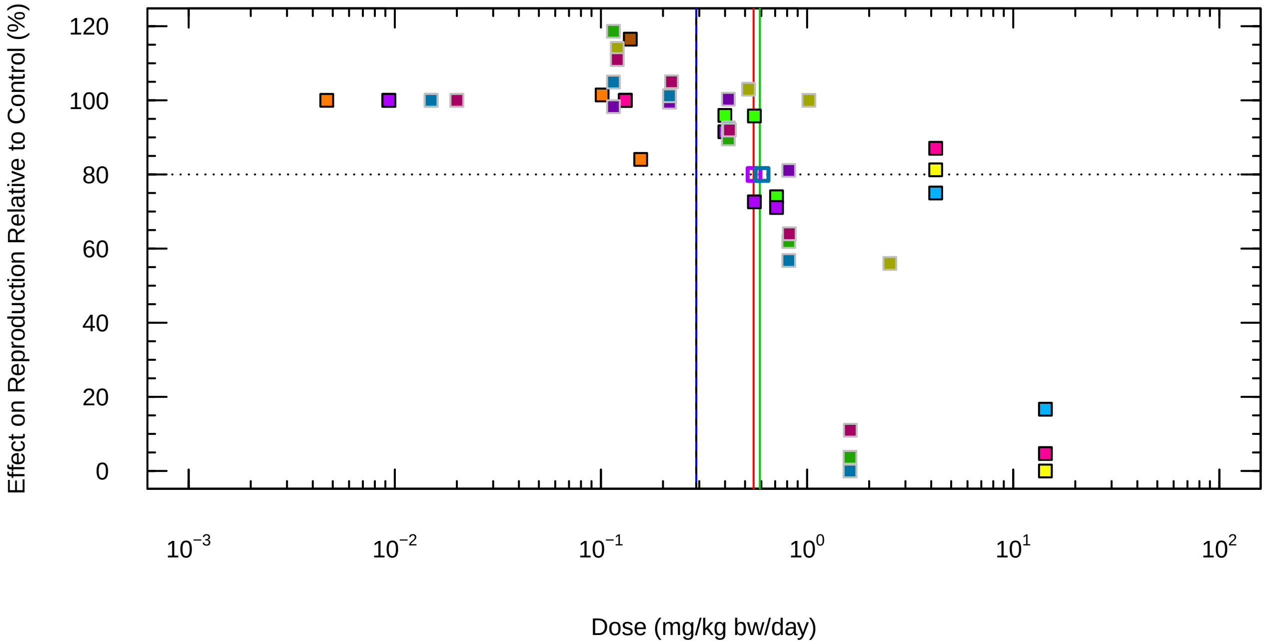
- - - Eco−SSL TRV = 0.29 mg/kg bw/day

— Selected TRV (Growth) = 0.29 mg/kg bw/day
— Selected TRV (Reproduction) = 0.55 mg/kg bw/day
— Selected TRV (Survival) = 0.59 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−70. Dose−Response Data for the Avian Growth Endpoint for Selenium, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
🟧	Kääntee and Kurbela 1980	chicken	egg production	diet	4	sodium selenite		
🟩	Ort and Latshaw 1978	chicken	egg production (Exp 2)	diet	16	sodium selenite		
🟪	Ort and Latshaw 1978	chicken	hatchability (Exp 2)	diet	16	sodium selenite		
🟦	Wiemeyer and Hoffman 1996	owl	% pairs with hatchlings	diet	12	seleno−DL−methionine		
🟨	Wiemeyer and Hoffman 1996	owl	# of pairs with 5−day−old young	diet	12	seleno−DL−methionine		
🟥	Wiemeyer and Hoffman 1996	owl	% hatch of eggs incubated	diet	12	seleno−DL−methionine		
🟫	Stone and Soares 1976	quail	egg production (Exp 1 and 3)	diet	3.9−4.6	sodium selenite		
🟩	Heinz et al. 1989	mallard	% hatch of fertile eggs	diet	>14	selenomethionine	E	
🟪	Heinz et al. 1989	mallard	duckling survival	diet	>14	selenomethionine		
🟦	Heinz et al. 1989	mallard	# of ducklings	diet	>14	selenomethionine		
🟨	Hoffman and Heinz 1988	mallard	hatching success	diet	NR	sodium selenite		
🟥	Hoffman and Heinz 1988	mallard	hatching success	diet	NR	seleno−methionine	E	
□	ED20 for Ort and Latshaw 1978	chicken	hatchability (Exp 2)	diet	16	sodium selenite		0.55
□	ED20 for Heinz et al. 1989	mallard	# of ducklings	diet	>14	selenomethionine		0.60

☐ Tier 1

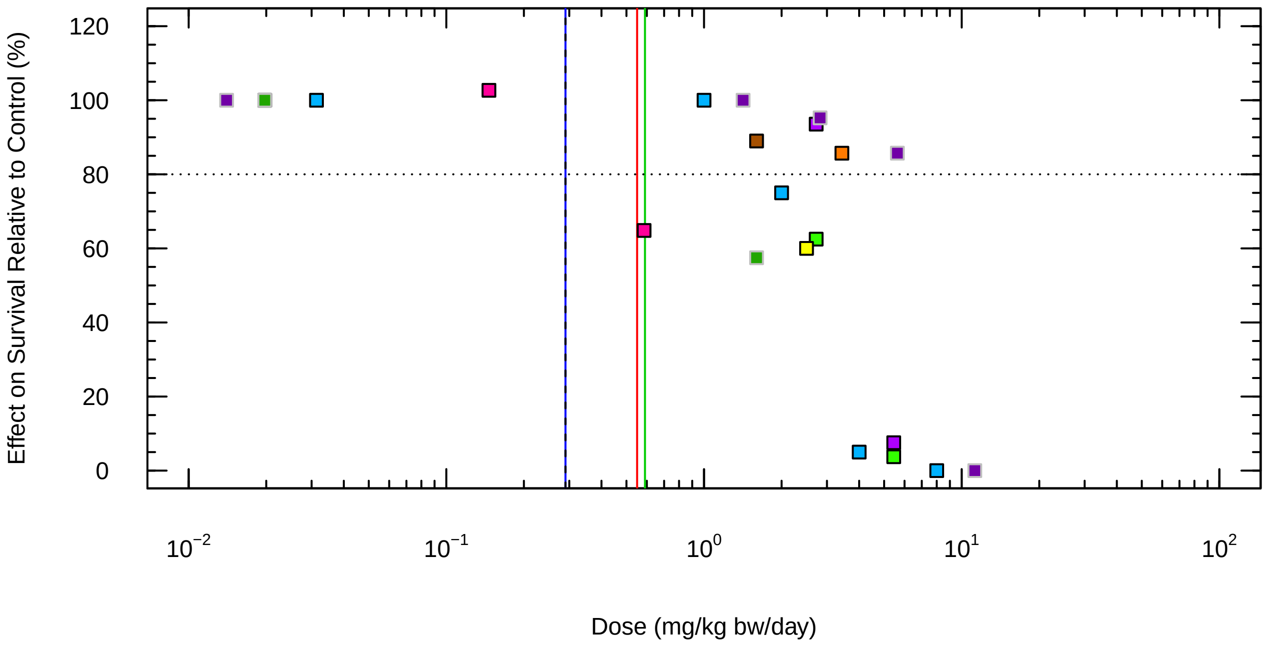
- - - Eco−SSL TRV = 0.29 mg/kg bw/day

— Selected TRV (Growth) = 0.29 mg/kg bw/day
— Selected TRV (Reproduction) = 0.55 mg/kg bw/day
— Selected TRV (Survival) = 0.59 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−71. Dose−Response Data for the Avian Reproduction Endpoint for Selenium, Log−Transformed



Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧 Gad and El−Twab 2009	quail	survival	gavage	4	sodium selenite	
🟩 El−Begearmi and Combs 1982	chicken	survival (brewer's yeast diet)	diet	4	sodium selenite	G
🟪 El−Begearmi and Combs 1982	chicken	survival (corn−soy diet)	diet	4	sodium selenite	G
🟦 Heinz and Fitzgerald 1993b	mallard	survival	diet	16	seleno−DL−methionine	I
🟨 Khan et al. 1993	chicken	survival	gavage	0.86	sodium selenite	
🟥 Arnold et al. 1973	chicken	survival	diet	64	sodium selenite	
🟫 El−Begearmi et al. 1977	quail	survival (males)	diet	16	sodium selenite	H
🟩 El−Begearmi et al. 1977	quail	survival (females)	diet	16	sodium selenite	H
🟪 Albers et al. 1996	mallard	survival	diet	16	seleno−DL−methionine	I

☐ Tier 1

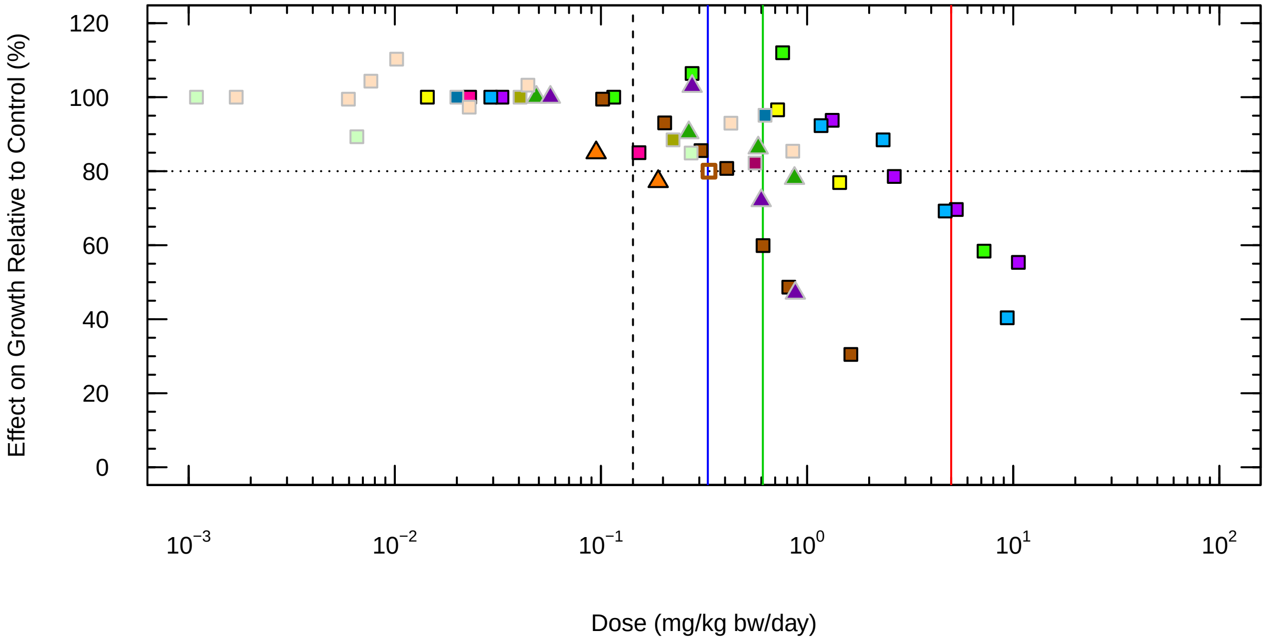
- - - Eco−SSL TRV = 0.29 mg/kg bw/day

— Selected TRV (Growth) = 0.29 mg/kg bw/day
— Selected TRV (Reproduction) = 0.55 mg/kg bw/day
— Selected TRV (Survival) = 0.59 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−72. Dose−Response Data for the Avian Survival Endpoint for Selenium, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
▲	Kaur and Parshad 1994	rat	body weight	diet	5.1	sodium selenite		
■	Spallholz et al. 1973	mouse	body weight gain	diet	5	sodium selenite		
■	Julius et al. 1983	hamster	body weight (male, Exp 1)	diet	3	sodium selenite	A	
■	Julius et al. 1983	hamster	body weight (female, Exp 1)	diet	3	sodium selenite	A	
■	Julius et al. 1983	hamster	body weight (male, Exp 2)	diet	3	sodium selenite	A	
■	Behne et al. 1992	rat	body weight	diet	14.3	L−selenomethionine		
■	Mahan and Moxon 1984	pig	body weight	diet	5.3	sodium selenite		
▲	Goehring et al. 1984	rat	body weight gain	diet	4	seleniferous grain		
▲	Goehring et al. 1984	rat	body weight gain	diet	4	sodium selenite		
■	Baker et al. 1989	pig	body weight	diet	3.7	sodium selenate		
■	Boylan et al. 1990	mouse	body weight	diet	26	sodium selenite		
■	Wahlstrom et al. 1956	pig	body weight	diet	14	sodium selenite		
■	Birt et al. 1983	hamster	body weight	diet	25	sodium selenite		
■	Birt et al. 1986	hamster	body weight	diet	64	sodium selenite		
□	ED20 for Mahan and Moxon 1984	pig	body weight	diet	5.3	sodium selenite		0.33

□ Tier 1 △ Tier 2

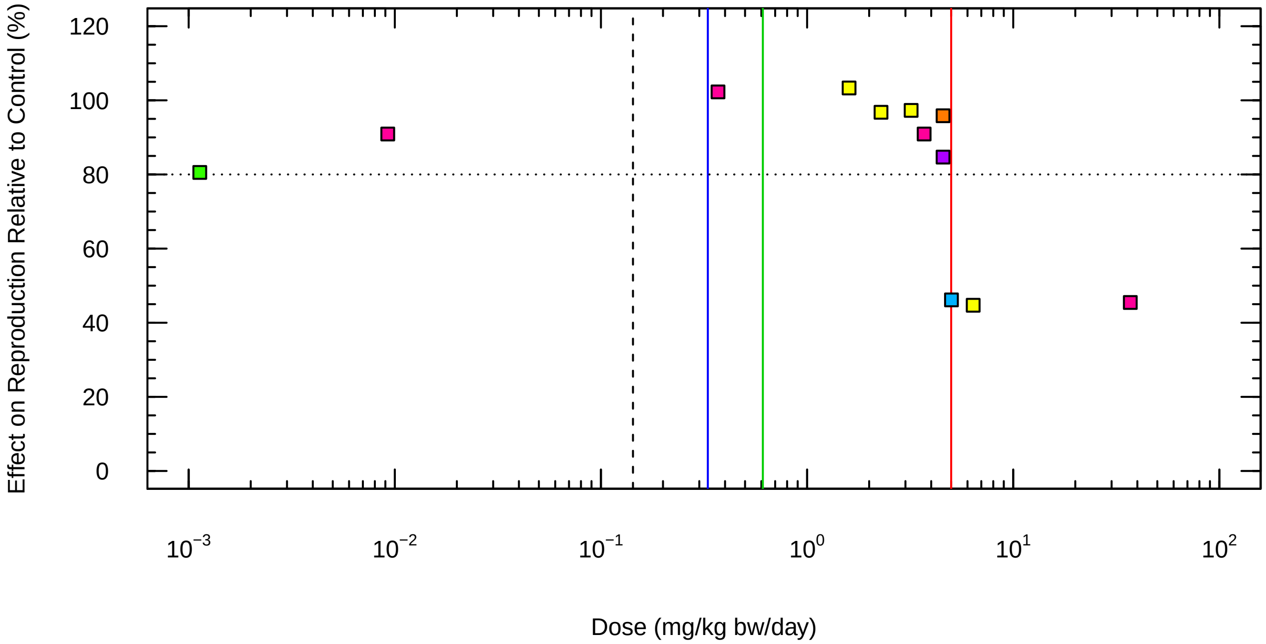
- - - Eco−SSL TRV = 0.143 mg/kg bw/day

— Selected TRV (Growth) = 0.33 mg/kg bw/day
— Selected TRV (Reproduction) = 5 mg/kg bw/day
— Selected TRV (Survival) = 0.61 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−73. Dose−Response Data for the Mammalian Growth Endpoint for Selenium, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Chernoff and Kavlock 1982	mouse	% pregnant	gavage	0.71	sodium selenite
🟩	Wahlstrom and Olson 1959	pig	# of live piglets	diet	34	sodium selenite
🟪	Gray and Kavlock 1984	mouse	# of live offspring	gavage	0.71	sodium selenite
🟦	Seidenberg et al. 1986	mouse	# of litters born	gavage	0.71	sodium selenate
🟨	Hardin et al. 1987	mouse	% viable litters	gavage	1.1	sodium selenite
🟥	Webster 1979	mouse	% with litters	diet	2.7	sodium selenite

☐ Tier 1

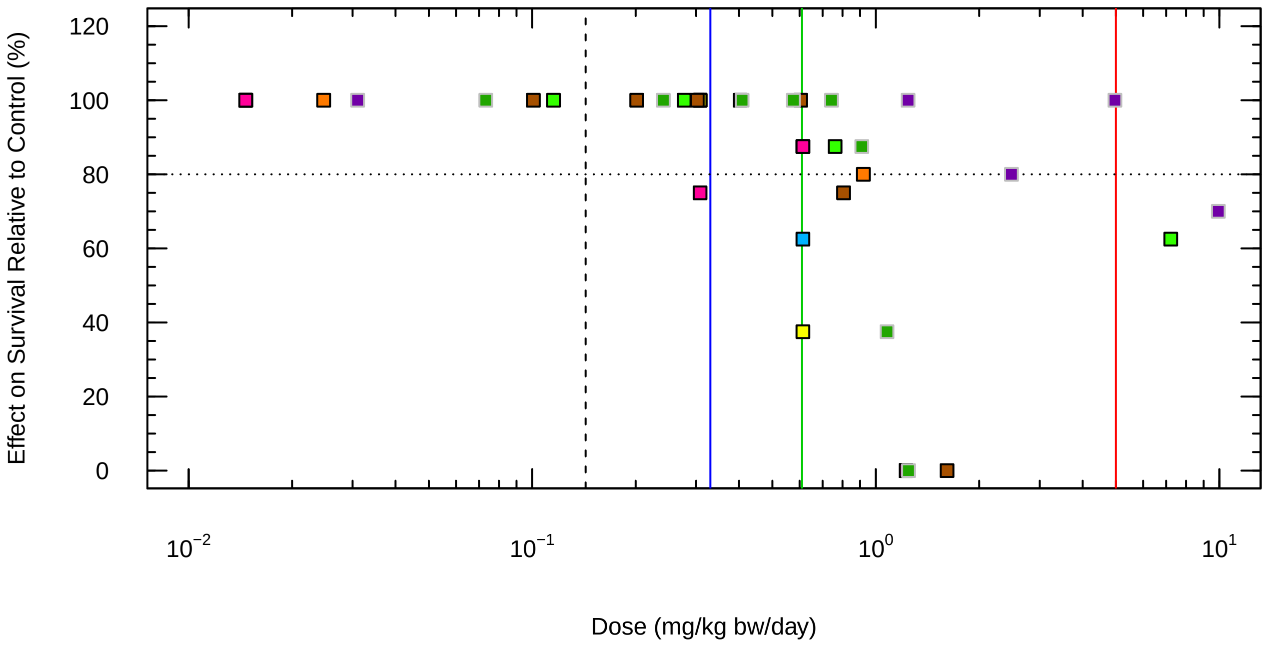
- - - Eco−SSL TRV = 0.143 mg/kg bw/day

— Selected TRV (Growth) = 0.33 mg/kg bw/day
— Selected TRV (Reproduction) = 5 mg/kg bw/day
— Selected TRV (Survival) = 0.61 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−74. Dose−Response Data for the Mammalian Reproduction Endpoint for Selenium, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Palmer et al. 1982	rat	survival	diet	4	seleniferous corn	B
🟩	Spallholz et al. 1973	mouse	survival	diet	5	sodium selenite	
🟪	McAdam and Levander 1987	rat	survival	diet	6	D−selenomethionine	B
🟦	McAdam and Levander 1987	rat	survival	diet	6	L−selenomethionine	B
🟨	McAdam and Levander 1987	rat	survival	diet	6	sodium selenite	
🟥	McAdam and Levander 1987	rat	survival	diet	6	sodium selenate	
🟫	Moxon and Mahan 1981	pig	survival	diet	5.3	sodium selenite	
🟩	Halverson et al. 1966	rat	survival	diet	6	seleniferous wheat	B
🟪	Julius et al. 1983	hamster	survival	diet	3	sodium selenite	

☐ Tier 1

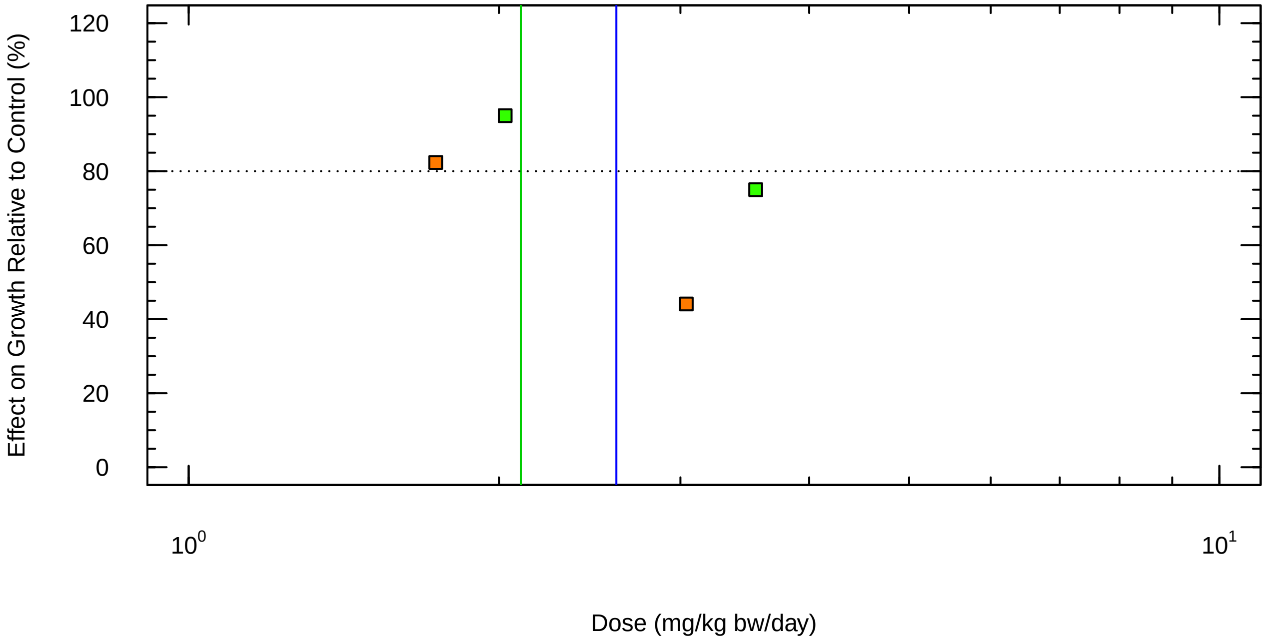
- - - Eco−SSL TRV = 0.143 mg/kg bw/day

— Selected TRV (Growth) = 0.33 mg/kg bw/day
— Selected TRV (Reproduction) = 5 mg/kg bw/day
— Selected TRV (Survival) = 0.61 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−75. Dose−Response Data for the Mammalian Survival Endpoint for Selenium, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Downs et al. 1960	rat (male)	body weight	diet	15	thallic oxide	A
🟩	Downs et al. 1960	rat (female)	body weight	diet	15	thallic oxide	A

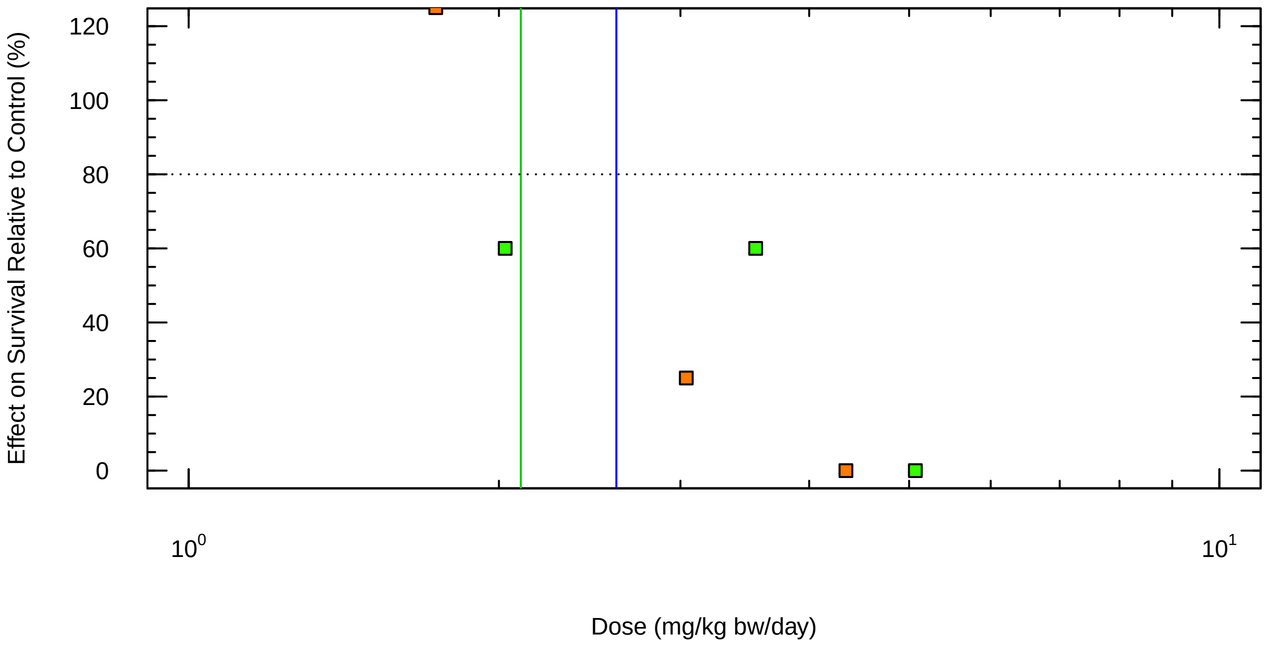
☐ Tier 1

— Selected TRV (Growth) = 2.6 mg/kg bw/day
— Selected TRV (Survival) = 2.1 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−76. Dose−Response Data for the Mammalian Growth Endpoint for Thallium, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Downs et al. 1960	rat (male)	survival	diet	15	thallic oxide	B
🟩	Downs et al. 1960	rat (female)	survival	diet	15	thallic oxide	B

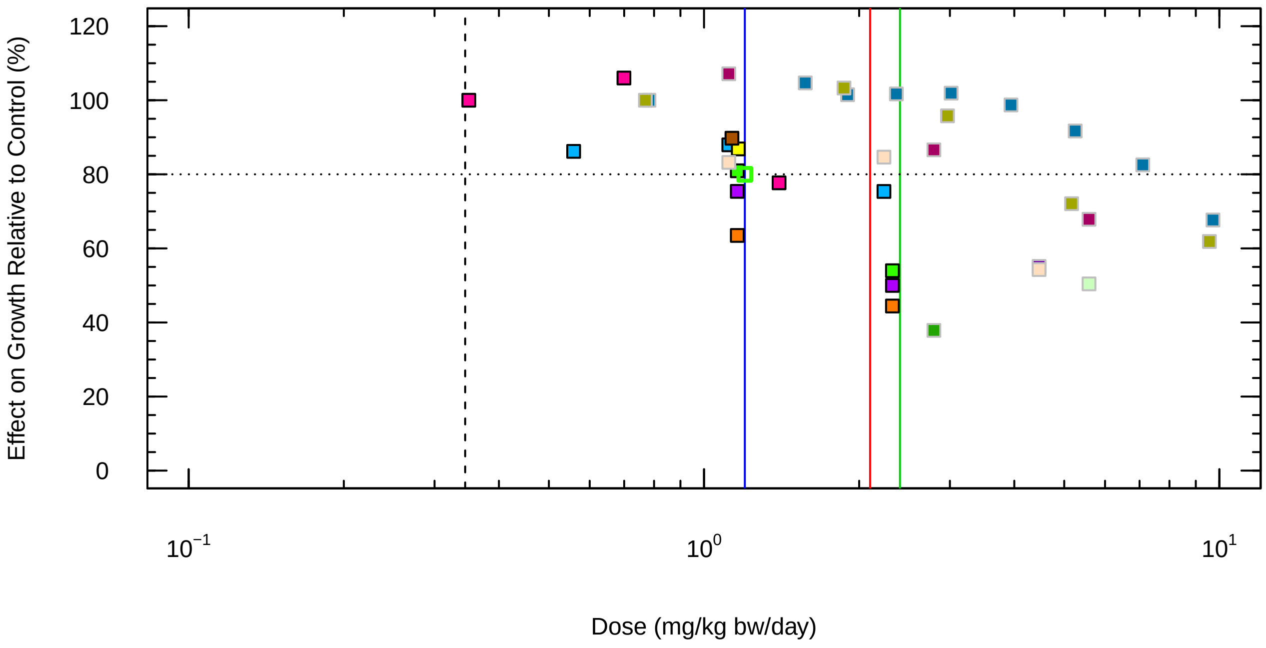
☐ Tier 1

— Selected TRV (Growth) = 2.6 mg/kg bw/day
— Selected TRV (Survival) = 2.1 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−77. Dose−Response Data for the Mammalian Survival Endpoint for Thallium, Log−Transformed



Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
🟧 Berg and Lawrence 1971	chicken	body weight	diet	2	ammonium metavanadate	A	
🟩 Berg and Lawrence 1971	chicken	body weight	diet	2	vanadyl sulfate		
🟪 Berg and Lawrence 1971	chicken	body weight	diet	2	vanadyl dichloride	E	
🟦 Cervantes and Jensen 1986	chicken	body weight	diet	4	ammonium metavanadate	A	
🟨 Hill 1974	chicken	body weight gain	diet	2	sodium metavanadate	B	
🟥 Hill 1979a	chicken	body weight gain	diet	2	sodium metavanadate	B	
🟫 Summers and Moran 1972	chicken	body weight gain	diet	3	NR		
🟩 Hill 1990b	chicken	body weight gain	diet	2.7	sodium metavanadate	B	
🟪 Hill 1990a	chicken	body weight gain	diet	2.7	sodium metavanadate	B	
🟦 Nelson et al. 1962	chicken	body weight	diet	4	ammonium metavanadate	A	
🟨 Nelson et al. 1962	chicken	body weight	diet	4	ammonium metavanadate	A	
🟥 Qureshi et al. 1999	chicken	body weight	diet	3	ammonium metavanadate	A	
🟧 Blalock and Hill 1987	chicken	body weight	diet	3	vanadyl chloride	E	
🟩 Hill 1994	chicken	body weight	diet	2.9	ammonium metavanadate	A	
☐ ED20 for Berg and Lawrence 1971	chicken	body weight	diet	2	vanadyl sulfate		1.2

☐ Tier 1

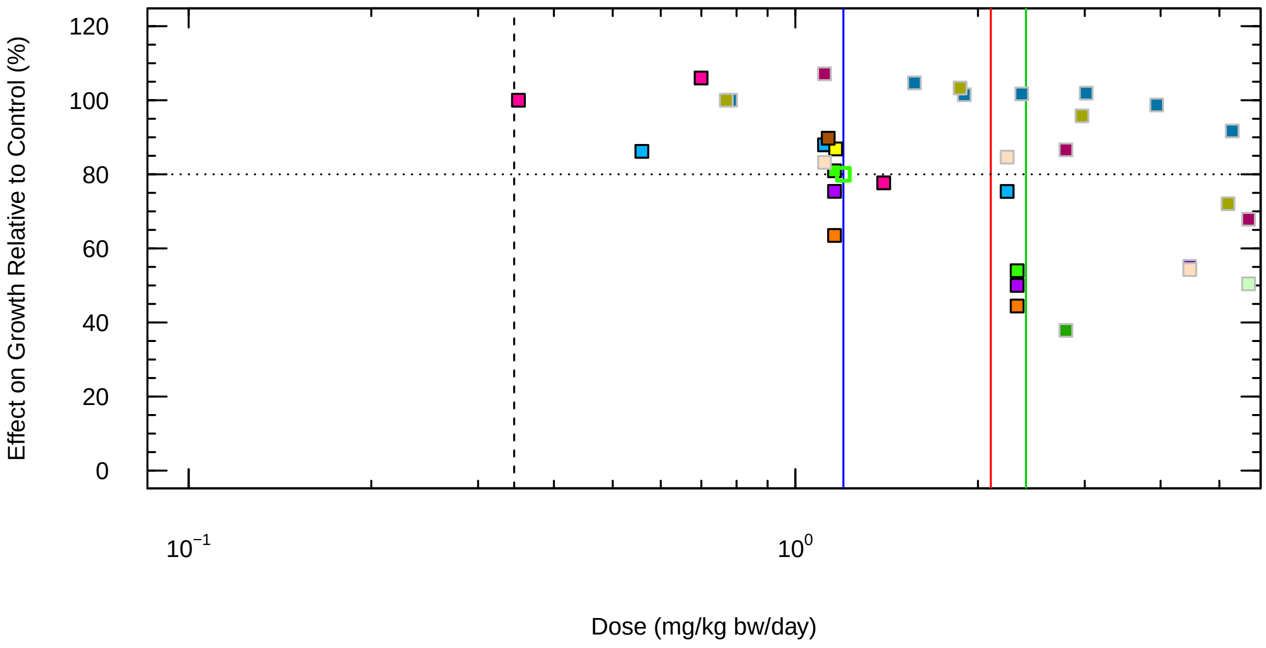
- - - Eco−SSL TRV = 0.344 mg/kg bw/day

— Selected TRV (Growth) = 1.2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.1 mg/kg bw/day
— Selected TRV (Survival) = 2.4 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−78. Dose−Response Data for the Avian Growth Endpoint for Vanadium, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
🟧	Berg and Lawrence 1971	chicken	body weight	diet	2	ammonium metavanadate	A	
🟩	Berg and Lawrence 1971	chicken	body weight	diet	2	vanadyl sulfate		
🟪	Berg and Lawrence 1971	chicken	body weight	diet	2	vanadyl dichloride	E	
🟦	Cervantes and Jensen 1986	chicken	body weight	diet	4	ammonium metavanadate	A	
🟨	Hill 1974	chicken	body weight gain	diet	2	sodium metavanadate	B	
🟥	Hill 1979a	chicken	body weight gain	diet	2	sodium metavanadate	B	
🟫	Summers and Moran 1972	chicken	body weight gain	diet	3	NR		
🟩	Hill 1990b	chicken	body weight gain	diet	2.7	sodium metavanadate	B	
🟪	Hill 1990a	chicken	body weight gain	diet	2.7	sodium metavanadate	B	
🟦	Nelson et al. 1962	chicken	body weight	diet	4	ammonium metavanadate	A	
🟨	Nelson et al. 1962	chicken	body weight	diet	4	ammonium metavanadate	A	
🟥	Qureshi et al. 1999	chicken	body weight	diet	3	ammonium metavanadate	A	
🟧	Blalock and Hill 1987	chicken	body weight	diet	3	vanadyl chloride	E	
🟩	Hill 1994	chicken	body weight	diet	2.9	ammonium metavanadate	A	
□	ED20 for Berg and Lawrence 1971	chicken	body weight	diet	2	vanadyl sulfate		1.2

□ Tier 1

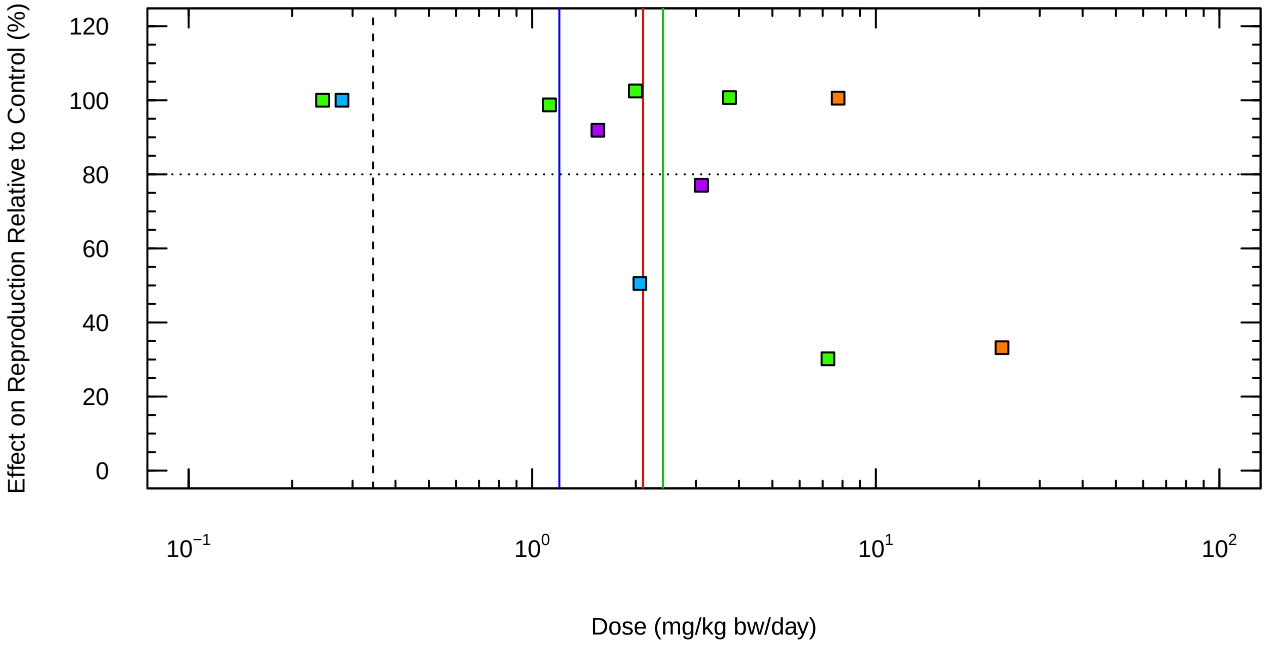
- - - Eco−SSL TRV = 0.344 mg/kg bw/day

— Selected TRV (Growth) = 1.2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.1 mg/kg bw/day
— Selected TRV (Survival) = 2.4 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−79. Dose−Response Data for the Avian Growth Endpoint for Vanadium, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Hafez and Kratzer 1976b	chicken	egg production	diet	NR	ammonium metavanadate	C
🟩	Kubena and Phillips 1982	chicken	egg production	diet	20	calcium orthovanadate	
🟪	Ousterhout and Berg 1980	chicken	egg production	diet	4	ammonium metavanadate	C
🟦	Toussant and Latshaw 1994	chicken	egg production	diet	4	ammonium metavanadate	C

☐ Tier 1

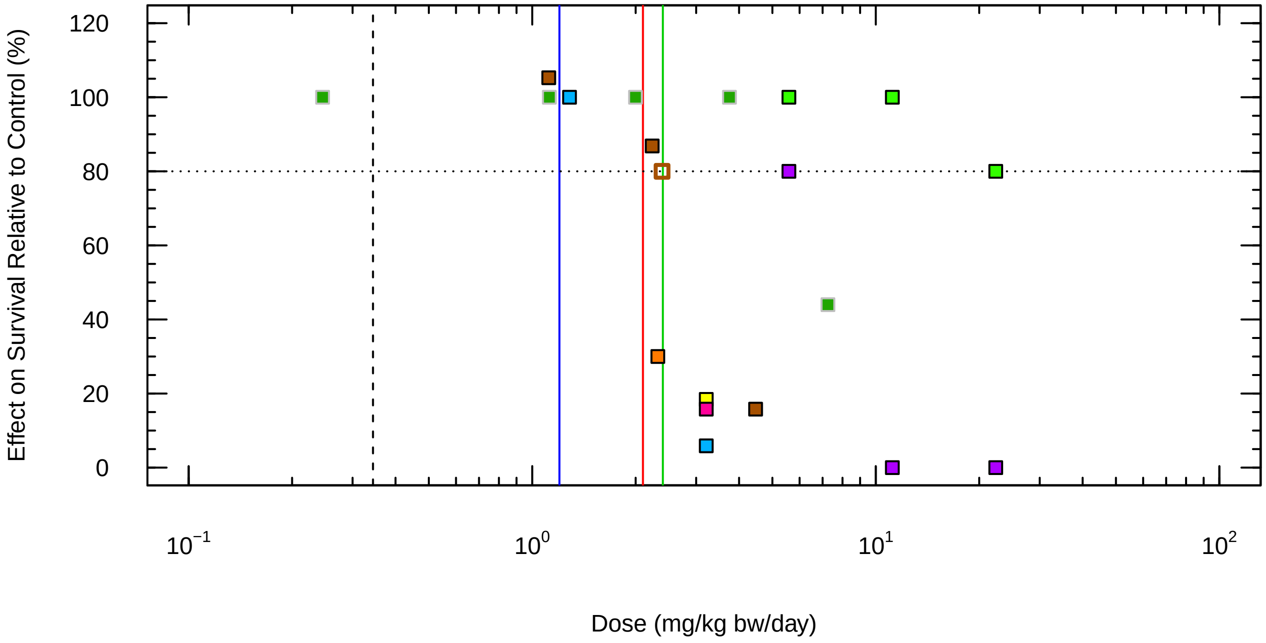
- - - Eco−SSL TRV = 0.344 mg/kg bw/day

— Selected TRV (Growth) = 1.2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.1 mg/kg bw/day
— Selected TRV (Survival) = 2.4 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−80. Dose−Response Data for the Avian Reproduction Endpoint for Vanadium, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group	ED20 or Geomean (mg/kg bw/day)
🟧	Berg and Lawrence 1971	chicken	survival	diet	2	ammonium metavanadate	D	
🟩	Hafez and Kratzer 1976a	chicken	survival (Exp 1)	diet	4	ammonium metavanadate	D	
🟪	Hafez and Kratzer 1976a	chicken	survival (Exp 2)	diet	4	ammonium metavanadate	D	
🟦	Hathcock et al. 1964	chicken	survival (Exp 1)	diet	2	ammonium metavanadate	D	
🟨	Hathcock et al. 1964	chicken	survival (Exp 2)	diet	2	ammonium metavanadate	D	
🟥	Hathcock et al. 1964	chicken	survival	diet	2	vanadyl sulfate		
🟫	Blalock and Hill 1987	chicken	survival	diet	3	vanadyl chloride		
🟩	Kubena and Phillips 1982	chicken	survival	diet	20	calcium orthovanadate		
☐	ED20 for Blalock and Hill 1987	chicken	survival	diet	3	vanadyl chloride		2.4

☐ Tier 1

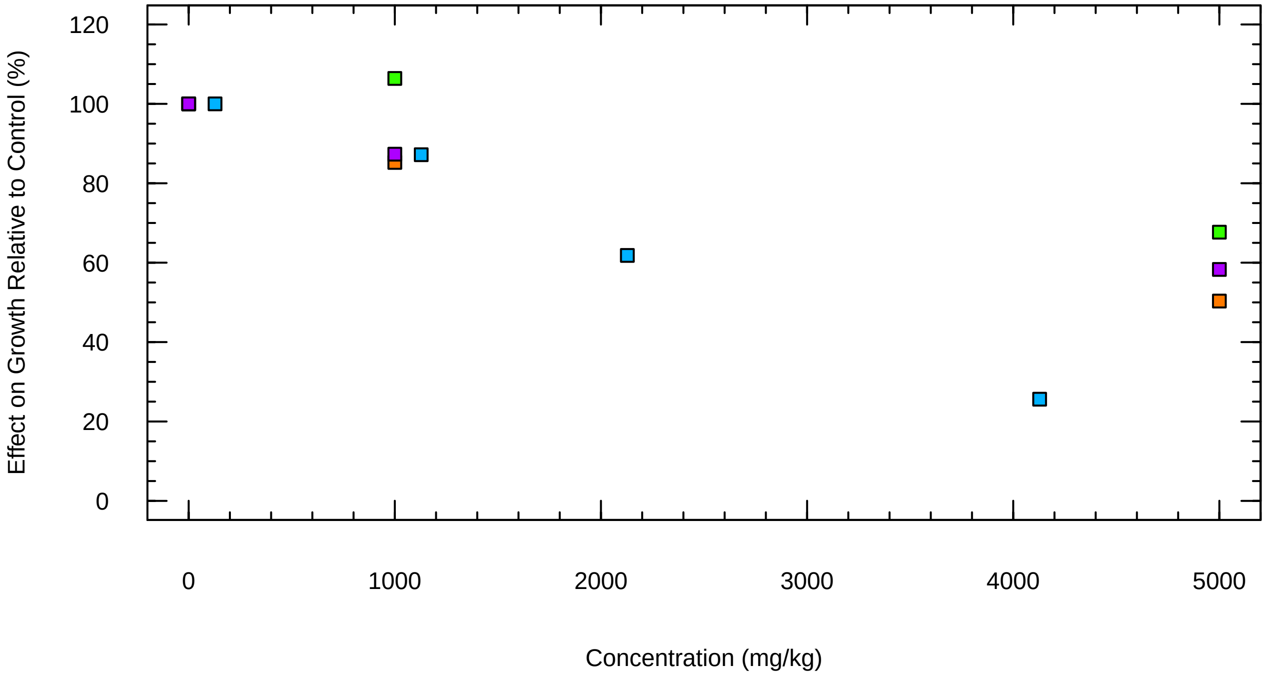
- - - Eco−SSL TRV = 0.344 mg/kg bw/day

— Selected TRV (Growth) = 1.2 mg/kg bw/day
— Selected TRV (Reproduction) = 2.1 mg/kg bw/day
— Selected TRV (Survival) = 2.4 mg/kg bw/day

····· 80% effect relative to control

Note: All selected toxicity reference values (TRVs) for this metal and receptor are shown for comparison across growth, reproduction, and survival endpoints. The relative weight of each TRV for use in the risk assessment will be discussed in a weight−of−evidence evaluation.

Figure E2−81. Dose−Response Data for the Avian Survival Endpoint for Vanadium, Log−Transformed



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Capdevielle and Scanes 1995a	chicken	body weight	diet	2	aluminum sulfate	
🟩	Capdevielle and Scanes 1995b	mallard	body weight	diet	2.1	aluminum sulfate	
🟪	Capdevielle et al. 1996	chicken	body weight	diet	1.5	aluminum sulfate	A
🟦	Elliot and Edwards 1991	chicken	body weight	diet	2.3	aluminum sulfate	A

☐ Tier 1

Figure E2−82. Concentration−Response Data for the Avian Growth Endpoint for Aluminum

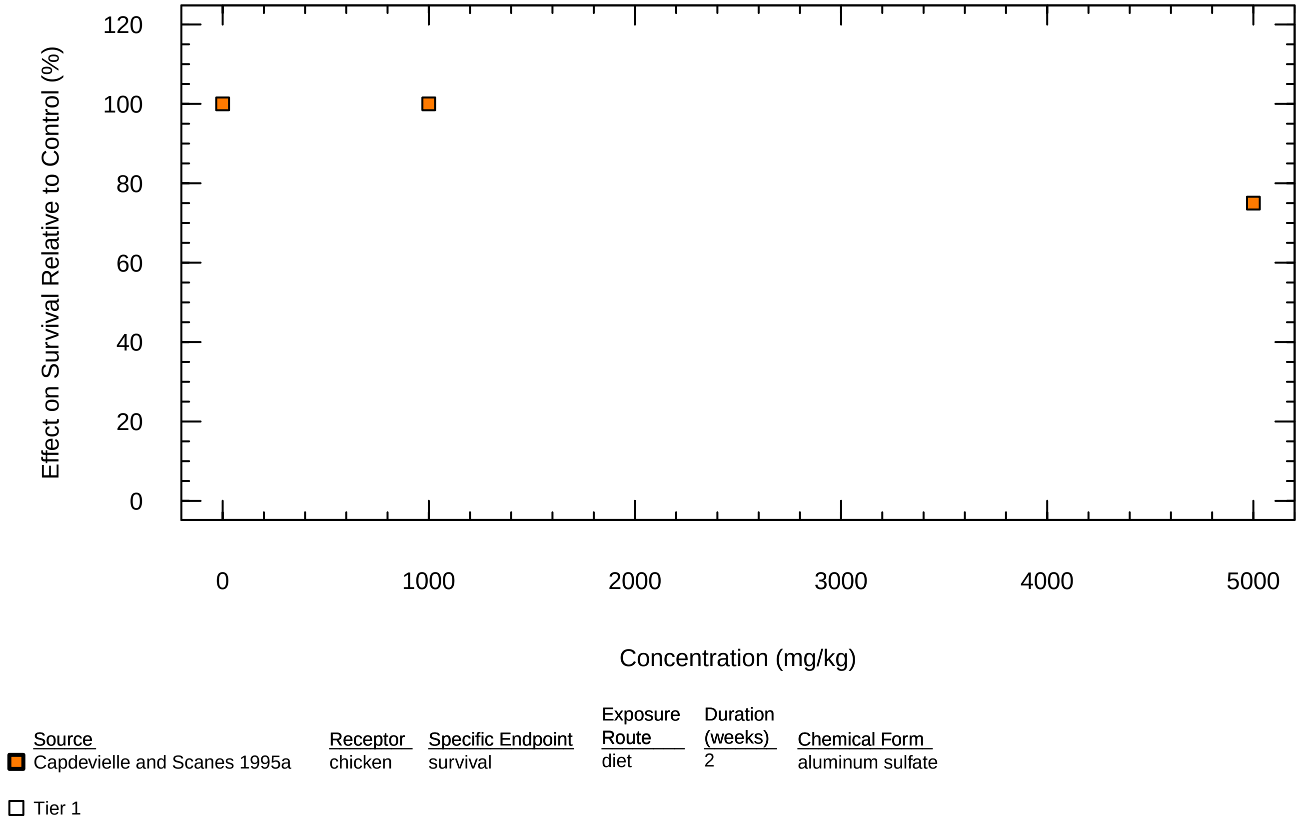
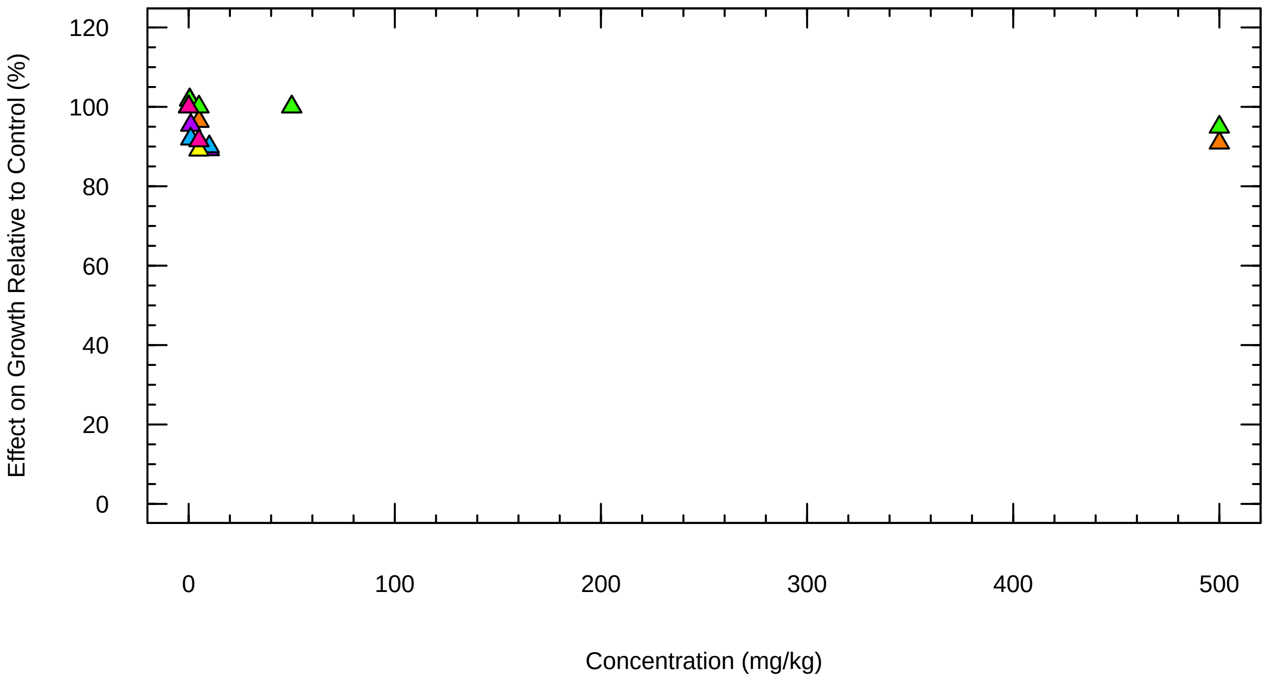


Figure E2−83. Concentration−Response Data for the Avian Survival Endpoint for Aluminum



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
▲	Poon et al. 1998	rat	body weight (male)	drinking water	13	potassium antimony tartrate
▲	Poon et al. 1998	rat	body weight (female)	drinking water	13	potassium antimony tartrate
▲	Rossi et al. 1987	rat	body weight	drinking water	8.6	antimony trichloride
▲	Rossi et al. 1987	rat	body weight	drinking water	6.3	antimony trichloride
▲	Shroeder et al. 1968	mouse	body weight (male)	drinking water	80	antimony potassium tartrate
▲	Shroeder et al. 1968	mouse	body weight (female)	drinking water	80	antimony potassium tartrate

△ Tier 2

Figure E2−84. Concentration−Response Data for the Mammalian Growth Endpoint for Antimony

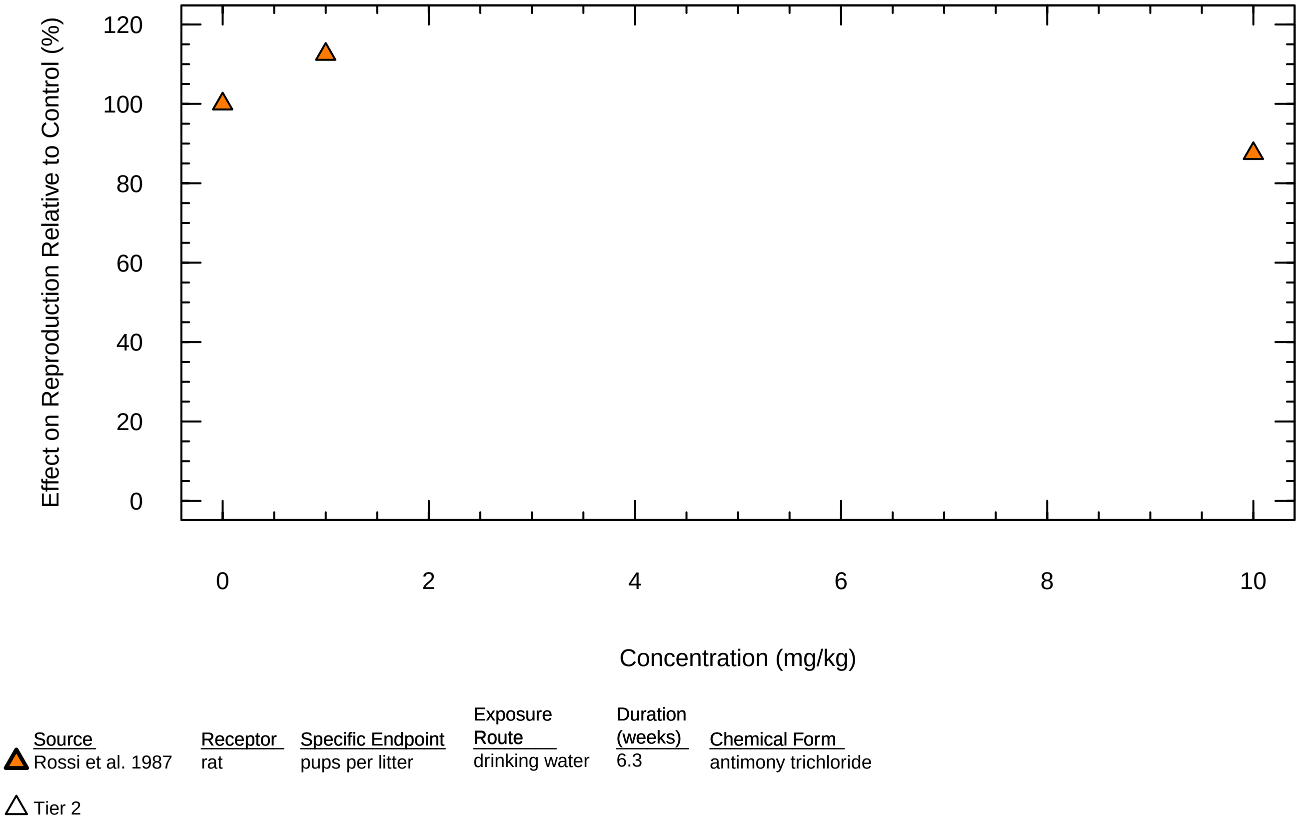
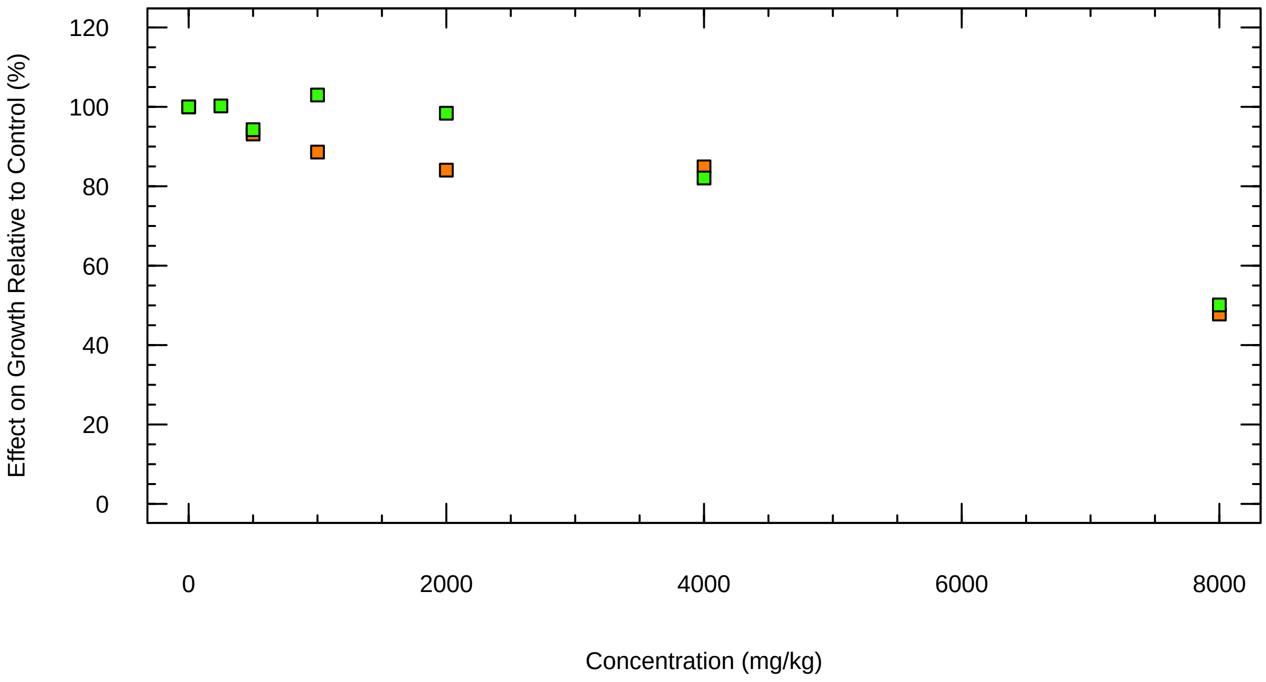


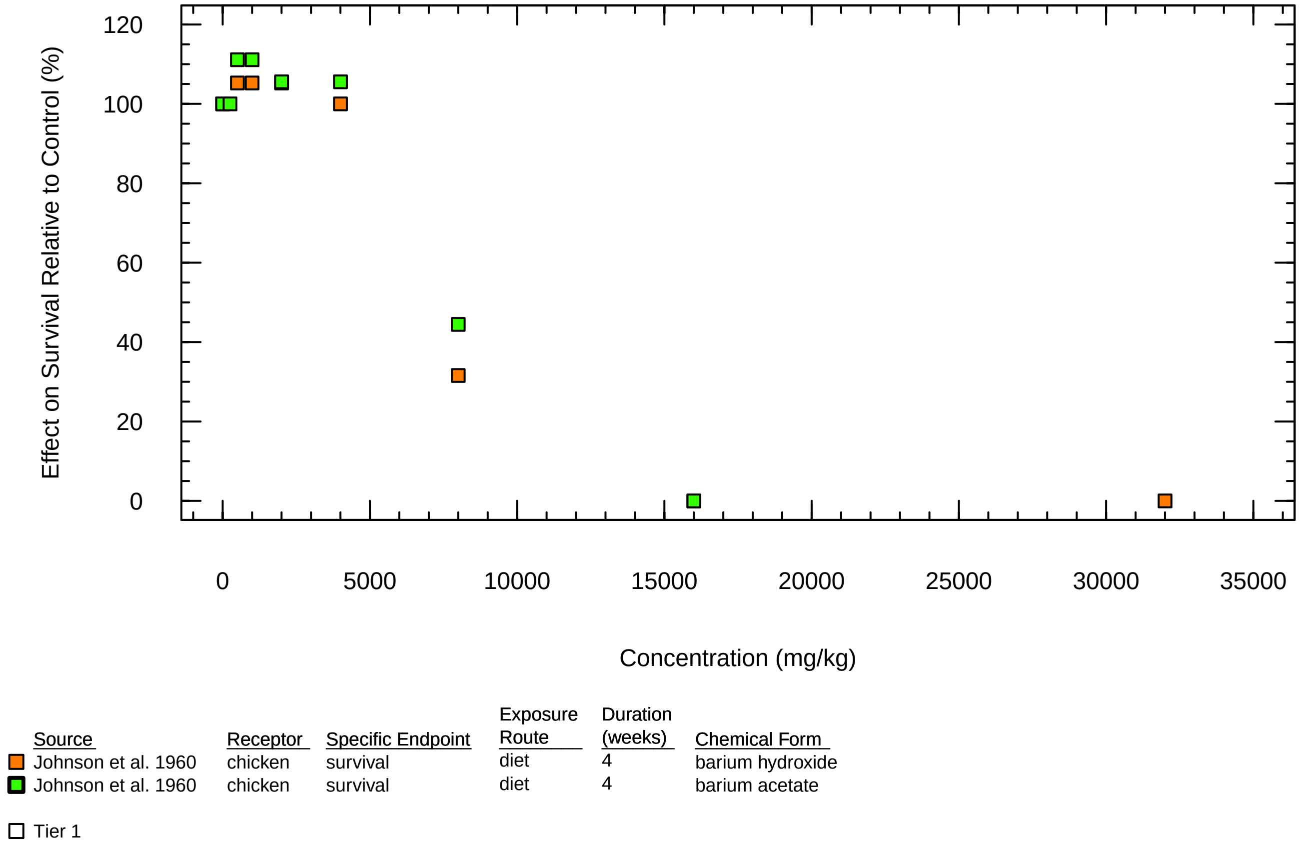
Figure E2−85. Concentration−Response Data for the Mammalian Reproduction Endpoint for Antimony



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Johnson et al. 1960	chicken	body weight gain	diet	4	barium hydroxide
🟩	Johnson et al. 1960	chicken	body weight gain	diet	4	barium acetate

☐ Tier 1

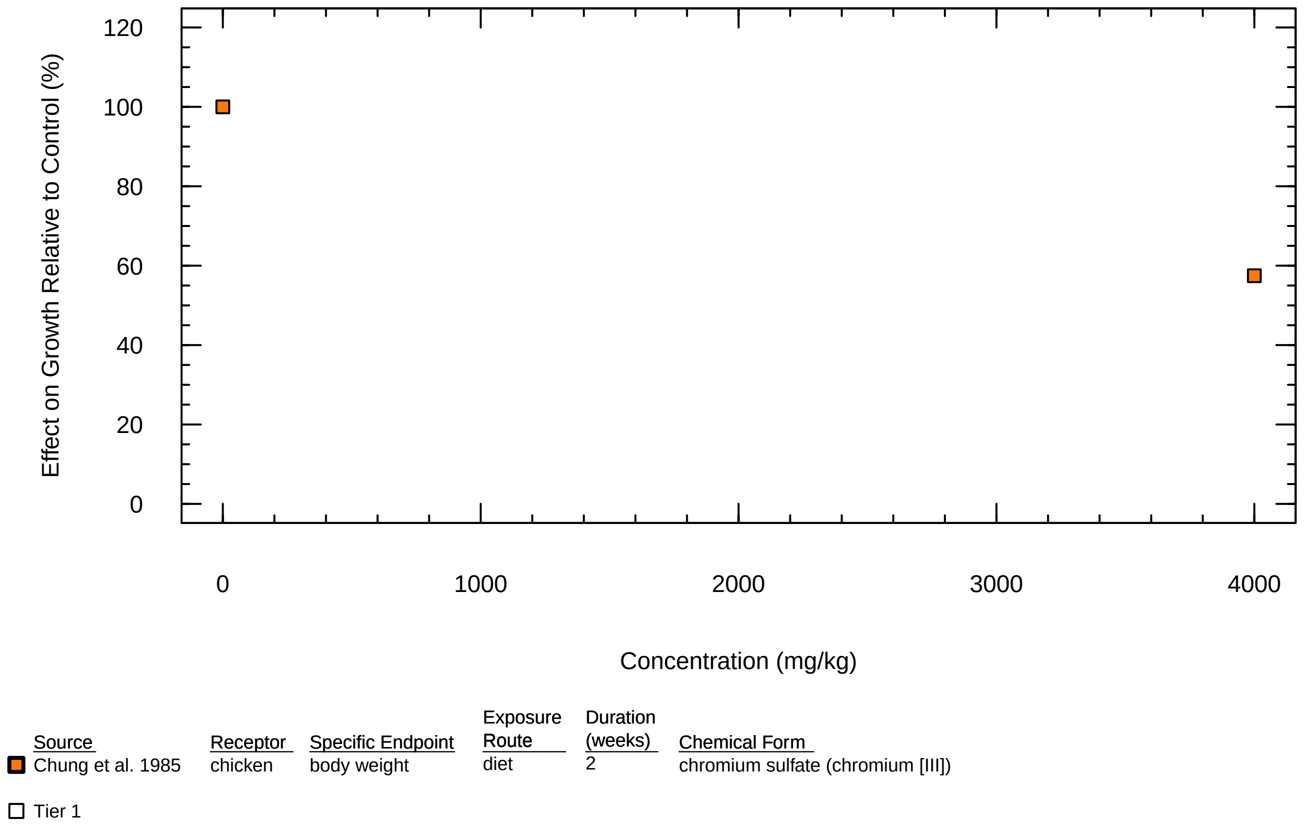
Figure E2−86. Concentration−Response Data for the Avian Growth Endpoint for Barium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Johnson et al. 1960	chicken	survival	diet	4	barium hydroxide
🟩	Johnson et al. 1960	chicken	survival	diet	4	barium acetate

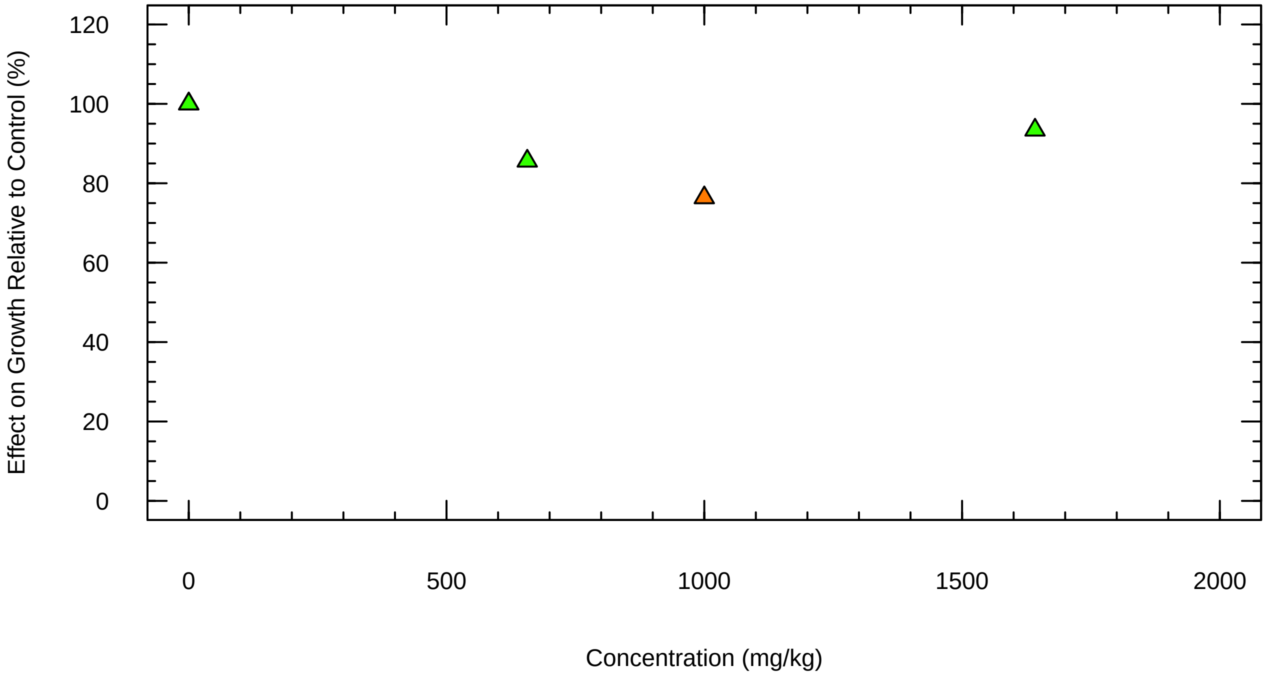
☐ Tier 1

Figure E2−87. Concentration−Response Data for the Avian Survival Endpoint for Barium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Chung et al. 1985	chicken	body weight	diet	2	chromium sulfate (chromium [III])
☐	Tier 1					

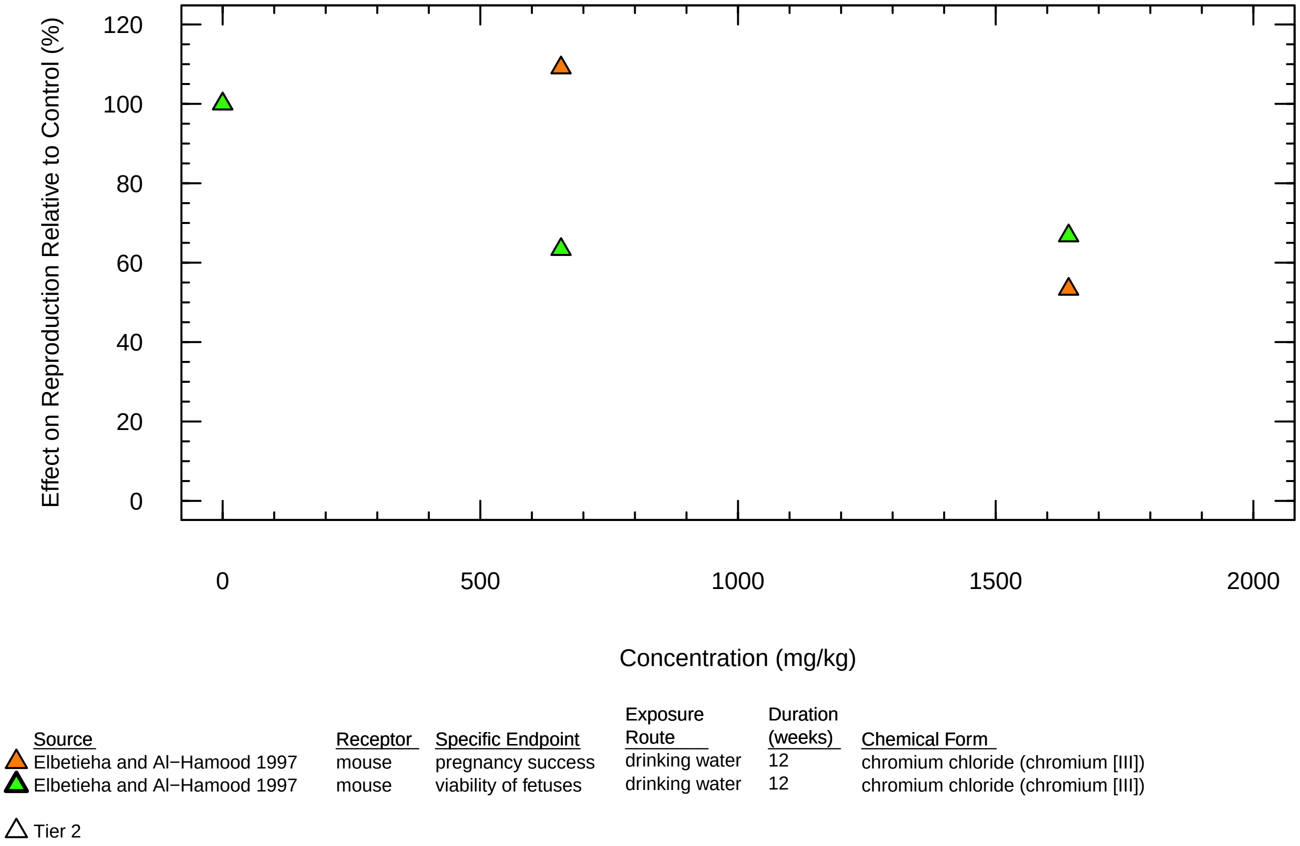
Figure E2−88. Concentration−Response Data for the Avian Growth Endpoint for Chromium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
▲	Bataineh et al. 1997	rat	body weight (male)	drinking water	12	chromium chloride (chromium [III])
▲	Elbetieha and Al−Hamood 1997	mouse	body weight	drinking water	12	chromium chloride (chromium [III])

△ Tier 2

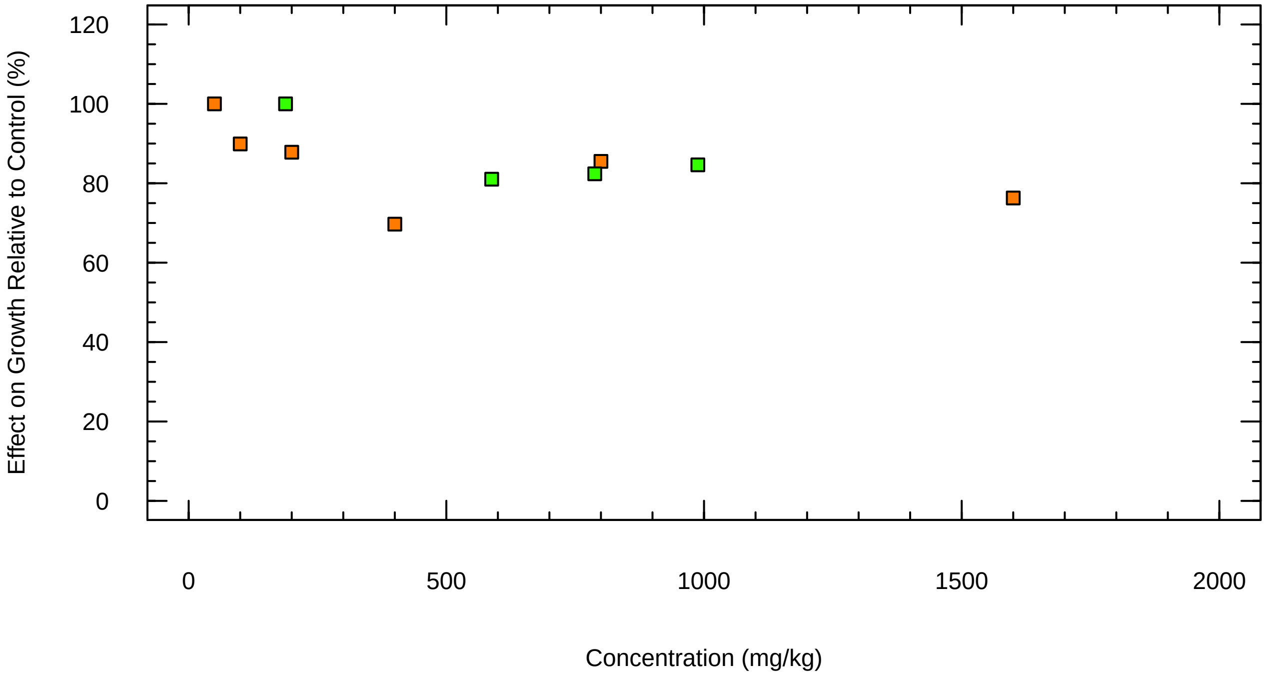
Figure E2−89. Concentration−Response Data for the Mammalian Growth Endpoint for Chromium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Elbetieha and Al−Hamood 1997	mouse	pregnancy success	drinking water	12	chromium chloride (chromium [III])
🟩	Elbetieha and Al−Hamood 1997	mouse	viability of fetuses	drinking water	12	chromium chloride (chromium [III])

△ Tier 2

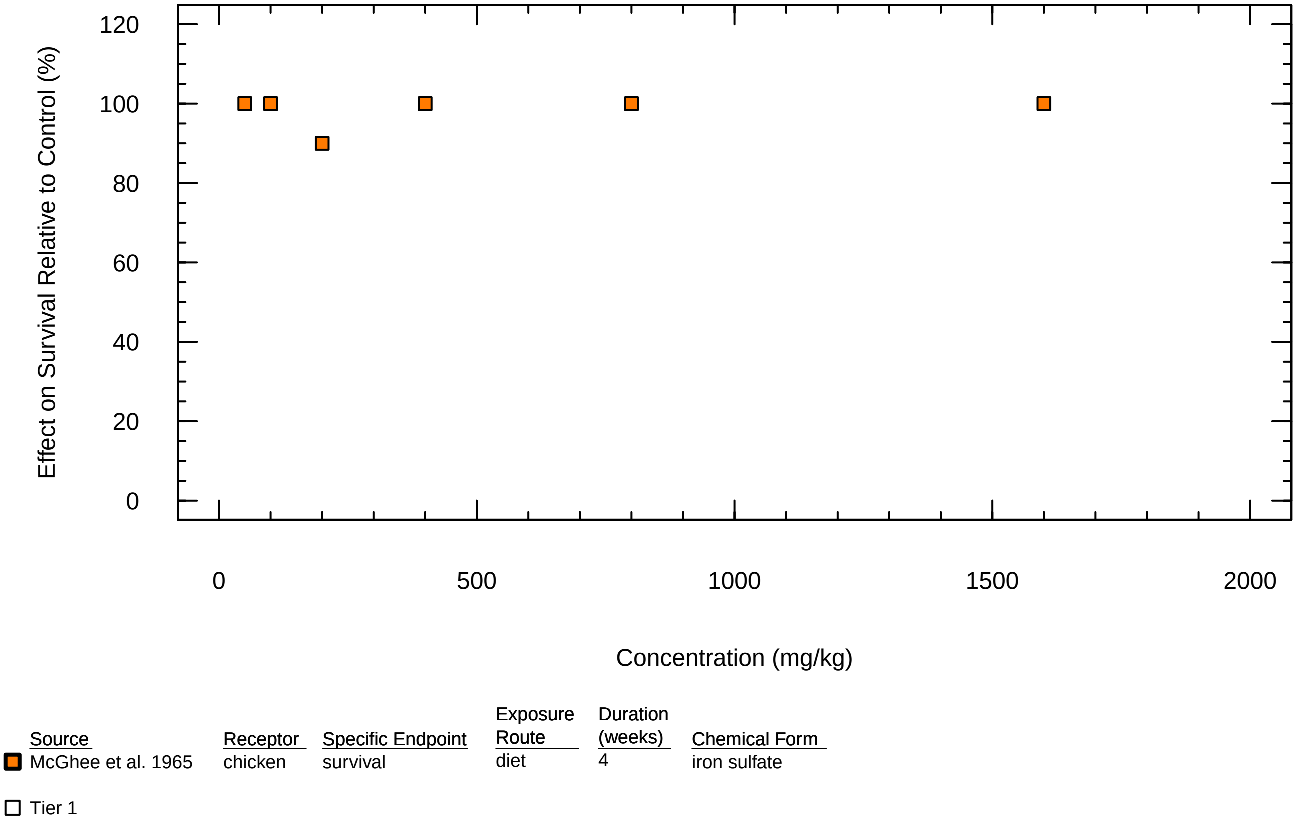
Figure E2−90. Concentration−Response Data for the Mammalian Reproduction Endpoint for Chromium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	McGhee et al. 1965	chicken	body weight	diet	4	iron sulfate
🟩	Cao et al. 1996	chicken	body weight	diet	3	iron sulfate

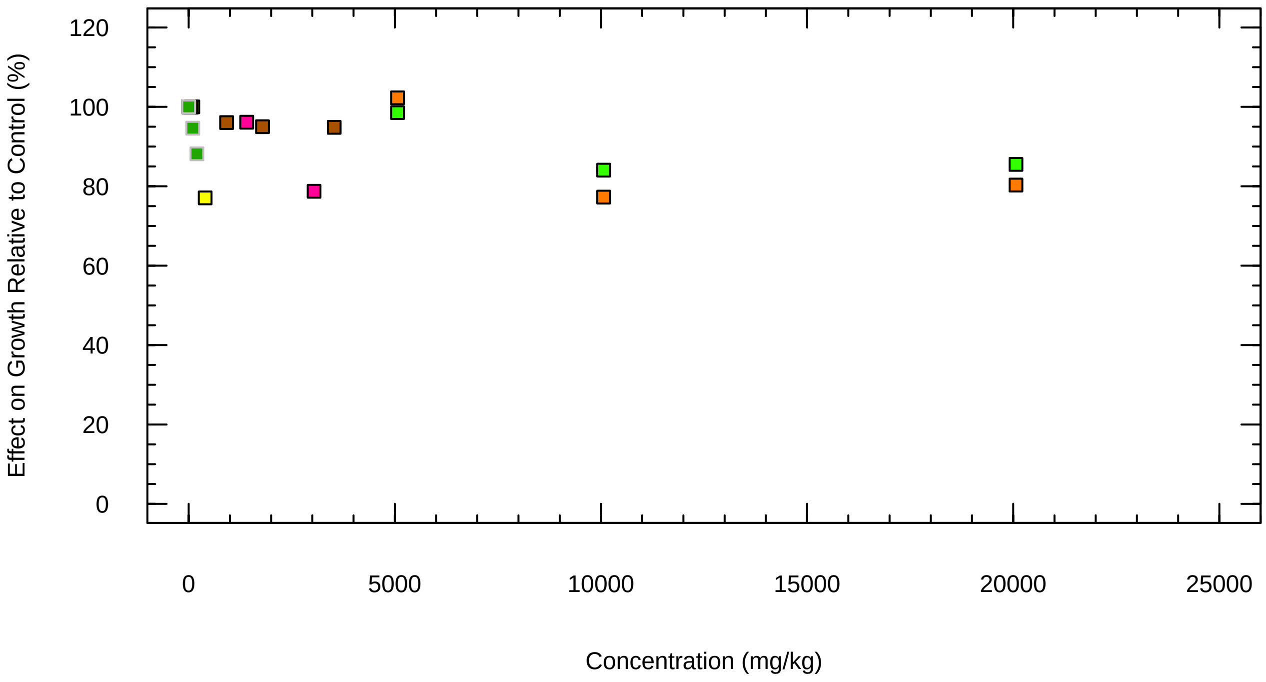
☐ Tier 1

Figure E2−91. Concentration−Response Data for the Avian Growth Endpoint for Iron



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
■	McGhee et al. 1965	chicken	survival	diet	4	iron sulfate
☐	Tier 1					

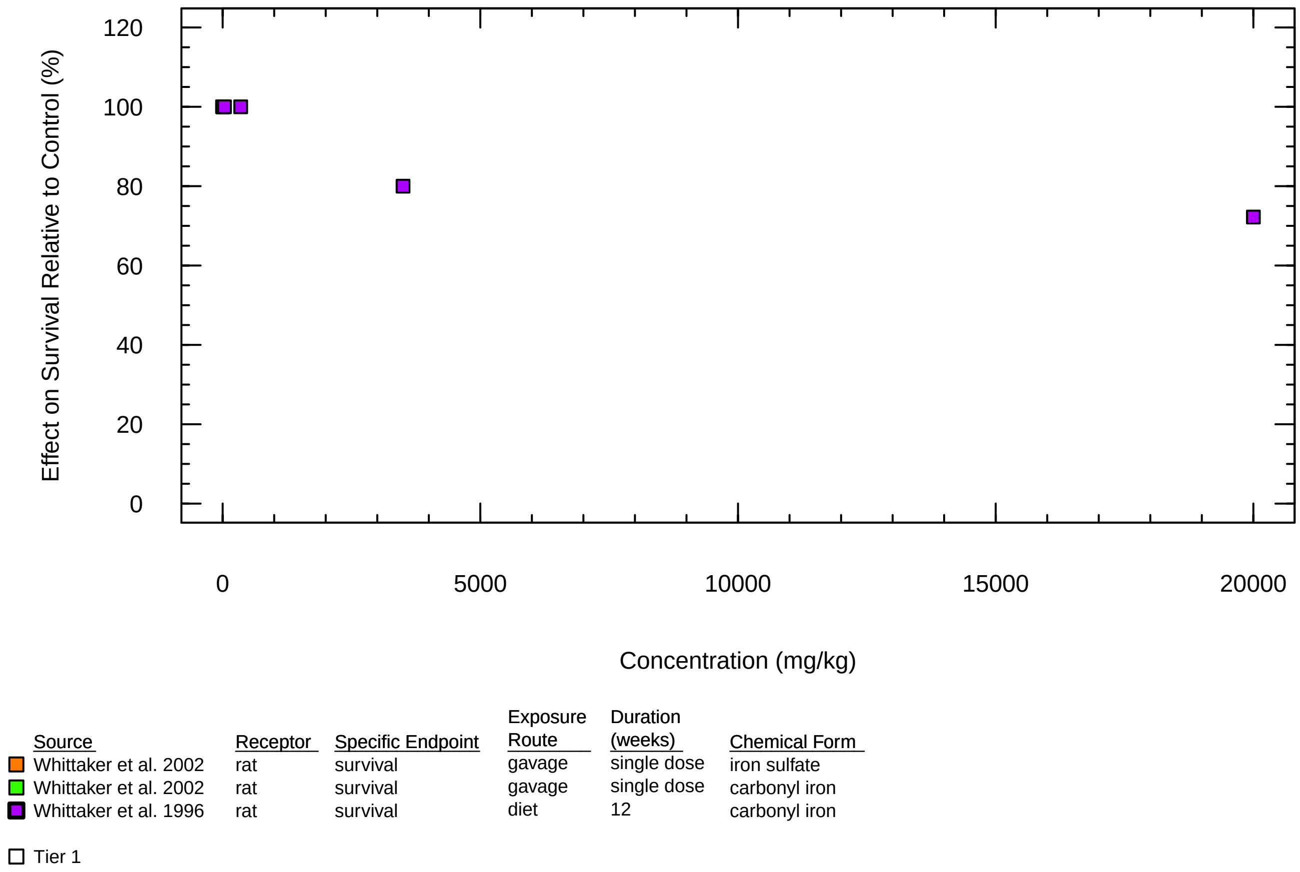
Figure E2−92. Concentration−Response Data for the Avian Survival Endpoint for Iron



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Plummer et al. 1997	rat (male)	body weight	diet	32	carbonyl iron	
🟩	Plummer et al. 1997	rat (female)	body weight	diet	32	carbonyl iron	
🟪	Whittaker et al. 2002	rat	body weight	gavage	single dose	iron sulfate	
🟦	Whittaker et al. 2002	rat	body weight	gavage	single dose	carbonyl iron	
🟨	Banis et al. 1969	rat	body weight	diet	4	iron sulfate	A
🟥	Storey and Greger 1987	rat	body weight	diet	3	iron sulfate	A
🟫	Prince et al. 1979	pig	body weight	diet	16	ferrous sulfide	
🟩	Zhu et al. 2016	rat	body weight	diet	13	carbonyl iron	

☐ Tier 1

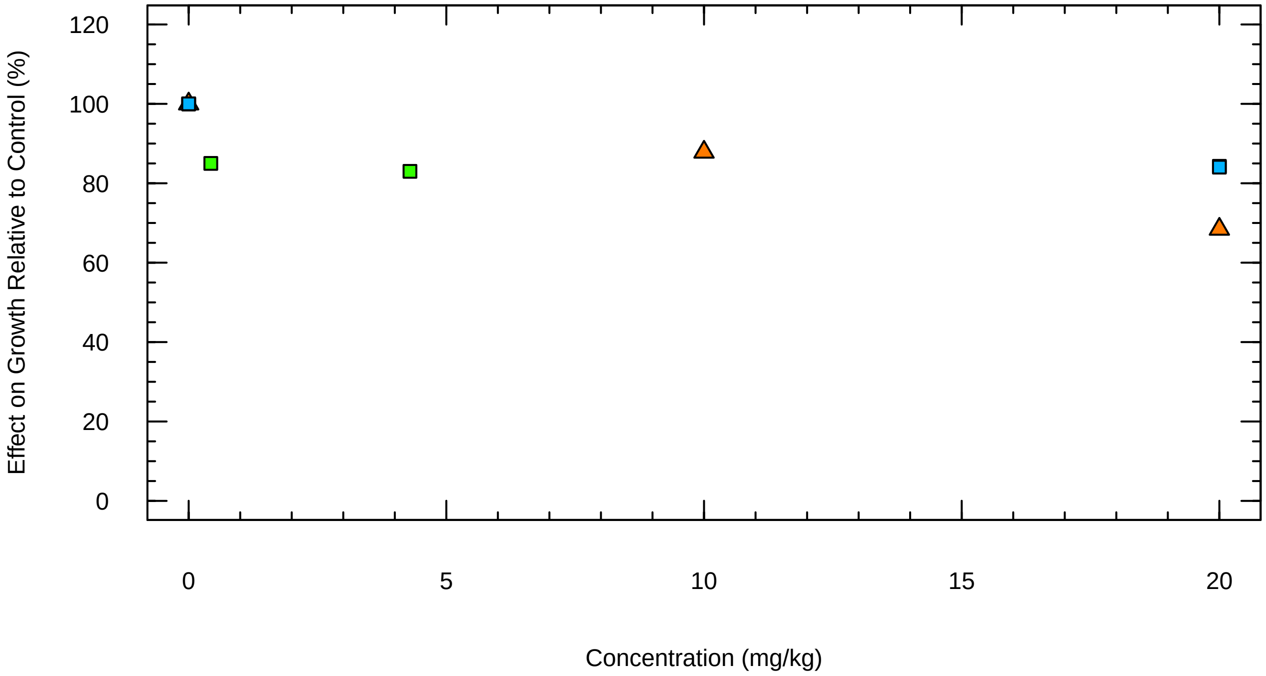
Figure E2−93. Concentration−Response Data for the Mammalian Growth Endpoint for Iron



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Whittaker et al. 2002	rat	survival	gavage	single dose	iron sulfate
🟩	Whittaker et al. 2002	rat	survival	gavage	single dose	carbonyl iron
🟪	Whittaker et al. 1996	rat	survival	diet	12	carbonyl iron

☐ Tier 1

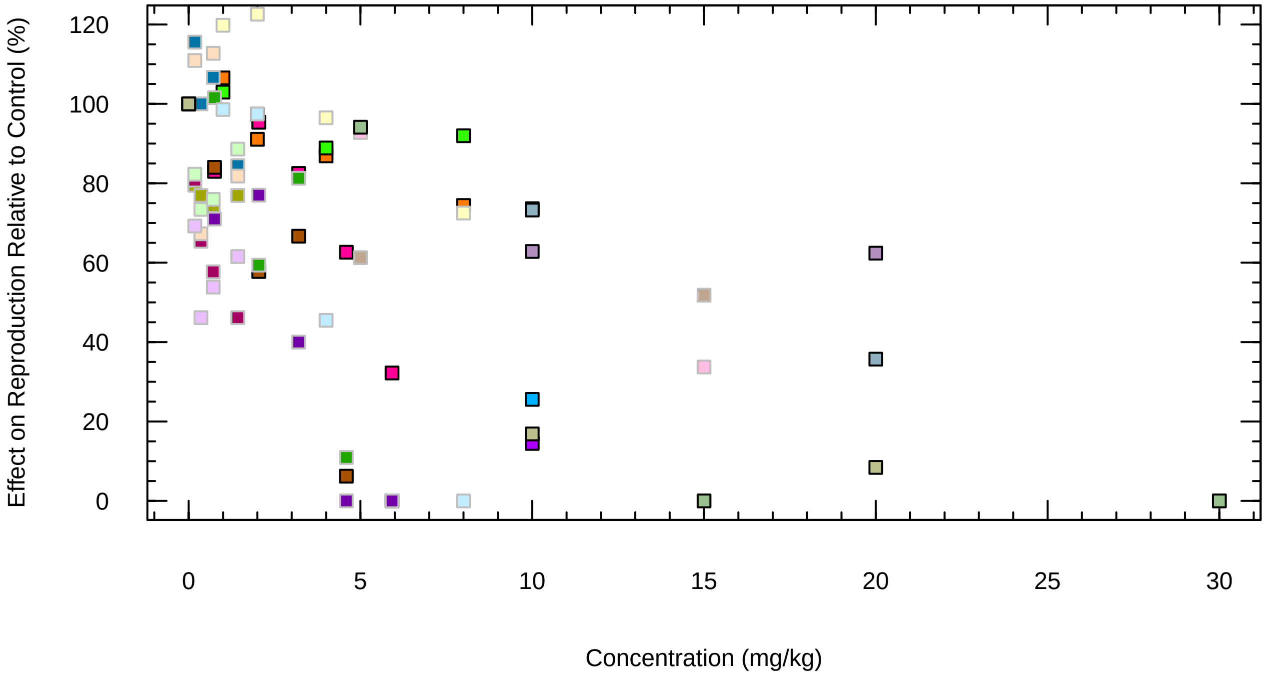
Figure E2−94. Concentration−Response Data for the Mammalian Survival Endpoint for Iron



Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
▲ Scott et al. 1977	chicken	body weight	diet	8	methylmercury chloride	
🟩 Spalding et al. 2000	egret	weight index	diet	14	methylmercury chloride	
🟪 Sell and Horani 1976	chicken	body weight gain (Exp 1)	diet	4	methylmercury chloride	A
🟦 Sell and Horani 1976	chicken	body weight gain (Exp 2)	diet	3.6	methylmercury chloride	A

☐ Tier 1 △ Tier 2

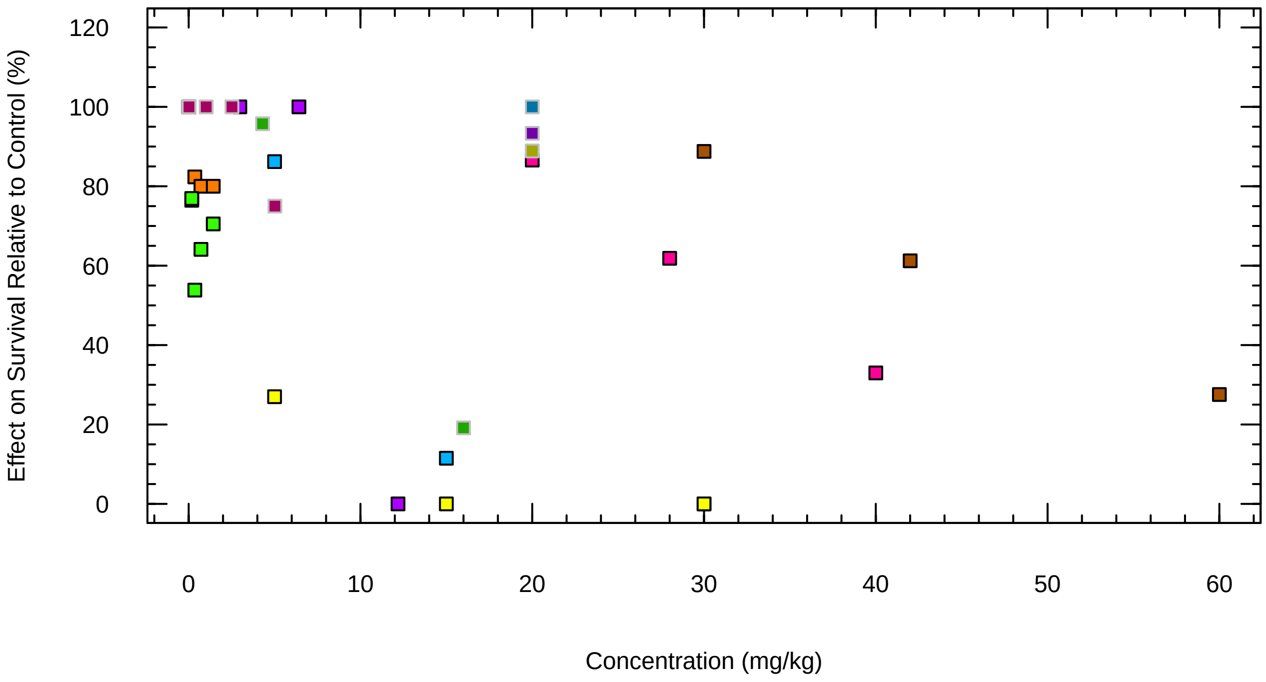
Figure E2−95. Concentration−Response Data for the Avian Growth Endpoint for Methylmercury



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Heinz et al. 2010	mallard	# of ducklings per hen	diet	3.7	methylmercury chloride	B
🟩	Heinz et al. 2010	mallard	duckling body weight	diet	3.7	methylmercury chloride	
🟪	Heinz and Hoffman 1998	mallard	# of ducklings per hen	diet	up to 11	methylmercury chloride	B
🟦	Heinz and Hoffman 1998	mallard	% hatchability	diet	up to 11	methylmercury chloride	
🟨	Heinz and Hoffman 1998	mallard	duckling survival	diet	up to 11	methylmercury chloride	
🟥	Albers et al. 2007	kestrel	egg production	diet	at least 11	methylmercury chloride	
🟫	Albers et al. 2007	kestrel	# of eggs hatched	diet	at least 11	methylmercury chloride	
🟩	Albers et al. 2007	kestrel	% eggs hatched	diet	at least 11	methylmercury chloride	
🟪	Albers et al. 2007	kestrel	% fledged	diet	at least 11	methylmercury chloride	
🟦	Varian−Ramos et al. 2014	finch	% hatchability	diet	52	methylmercury cysteine	
🟨	Varian−Ramos et al. 2014	finch	% chicks fledged	diet	52	methylmercury cysteine	
🟥	Varian−Ramos et al. 2014	finch	# of offspring	diet	52	methylmercury cysteine	
🟧	Varian−Ramos et al. 2014	finch	F1 % hatchability	diet	unclear	methylmercury cysteine	
🟩	Varian−Ramos et al. 2014	finch	F1 % chicks fledged	diet	unclear	methylmercury cysteine	
🟪	Varian−Ramos et al. 2014	finch	F1 # of offspring	diet	unclear	methylmercury cysteine	
🟦	Eskeland and Nafstad 1978	quail	chick survival	diet	6	methylmercury chloride	
🟨	Eskeland and Nafstad 1978	quail	hatch success	diet	6	methylmercury chloride	
🟥	El−Begearmi et al. 1977	quail	% egg fertility	diet	16	methylmercury hydroxide	
🟫	El−Begearmi et al. 1977	quail	egg production	diet	16	methylmercury hydroxide	
🟩	El−Begearmi et al. 1977	quail	% hatchability	diet	16	methylmercury hydroxide	
🟪	Scott et al. 1977	chicken	egg fertility	diet	8	methylmercury chloride	
🟦	Scott et al. 1977	chicken	egg production	diet	8	methylmercury chloride	
🟨	Scott et al. 1977	chicken	egg hatchability	diet	8	methylmercury chloride	

☐ Tier 1

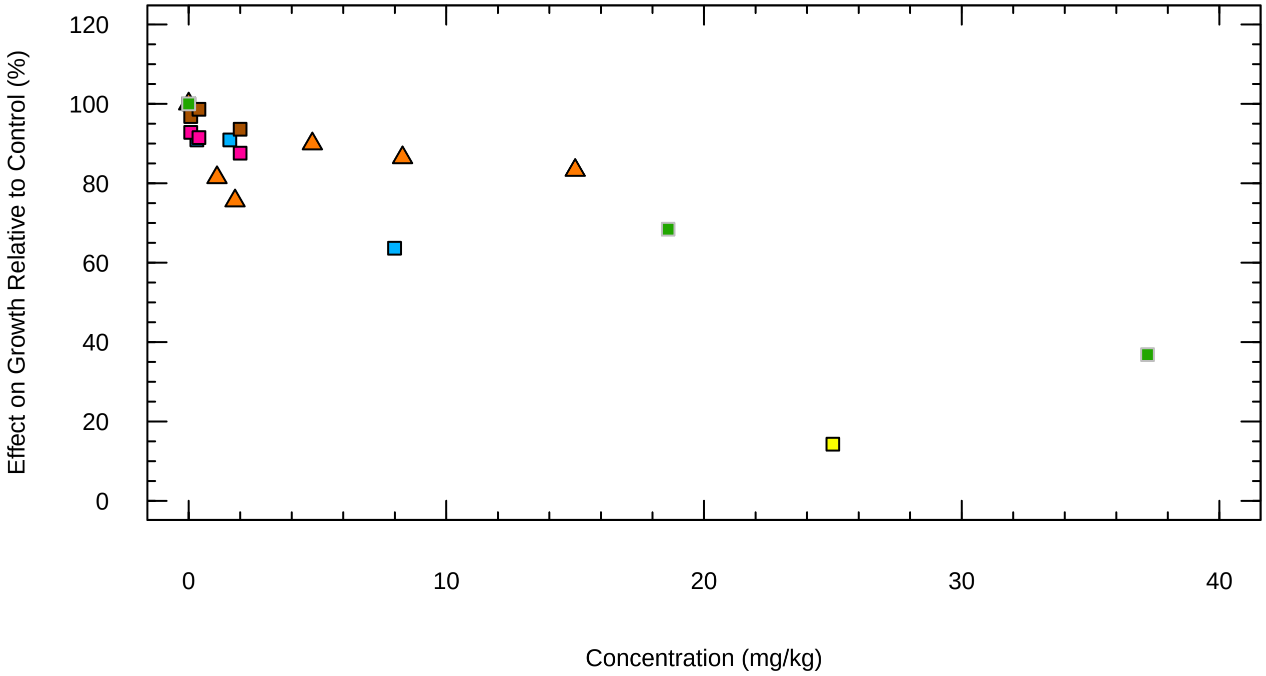
Figure E2−96. Concentration−Response Data for the Avian Reproduction Endpoint for Methylmercury



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Varian−Ramos et al. 2014	finch	survival	diet	52	methylmercury cysteine	
🟩	Varian−Ramos et al. 2014	finch	F1 survival	diet	unclear	methylmercury cysteine	
🟪	Bennet et al. 2009	kestrel	survival	diet	5−7	methylmercury chloride	
🟦	El−Begearmi et al. 1977	quail	survival (female)	diet	16	methylmercury hydroxide	C
🟨	El−Begearmi et al. 1977	quail	survival (male)	diet	16	methylmercury hydroxide	C
🟥	Hill and Soares 1987	quail	survival	diet	0.71	methylmercury chloride	
🟫	Hill and Soares 1987	quail	survival	diet	0.71	methylmercury chloride	
🟩	Spann et al. 1986	quail	survival	diet	6	methylmercury chloride	
🟪	Sell and Horani 1976	chicken	survival (Exp 1)	diet	4	methylmercury chloride	
🟦	Sell and Horani 1976	chicken	survival (Exp 2)	diet	3.6	methylmercury chloride	
🟨	Sell and Horani 1976	quail	survival (Exp 2)	diet	3.3	methylmercury chloride	
🟥	Scheuhammer 1988	finch	survival	diet	11	methylmercury chloride	

☐ Tier 1

Figure E2−97. Concentration−Response Data for the Avian Survival Endpoint for Methylmercury



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
▲	Wobeser et al. 1976	mink	body weight	diet	13	methylmercury chloride	
🟦	Mitsumori et al. 1983	rat	body weight	diet	130	methylmercury chloride	D
🟨	Stillings et al. 1974	rat	body weight gain	diet	4	methylmercury chloride	
🟪	Verschuuren et al. 1976a	rat	F2 body weight gain	diet	12	methylmercury chloride	
🟫	Verschuuren et al. 1976b	rat	body weight	diet	104	methylmercury chloride	D
🟩	Friedman et al. 1978	rat	body weight	diet	10	methlymercury chloride	

☐ Tier 1 △ Tier 2

Figure E2−98. Concentration−Response Data for the Mammalian Growth Endpoint for Methylmercury

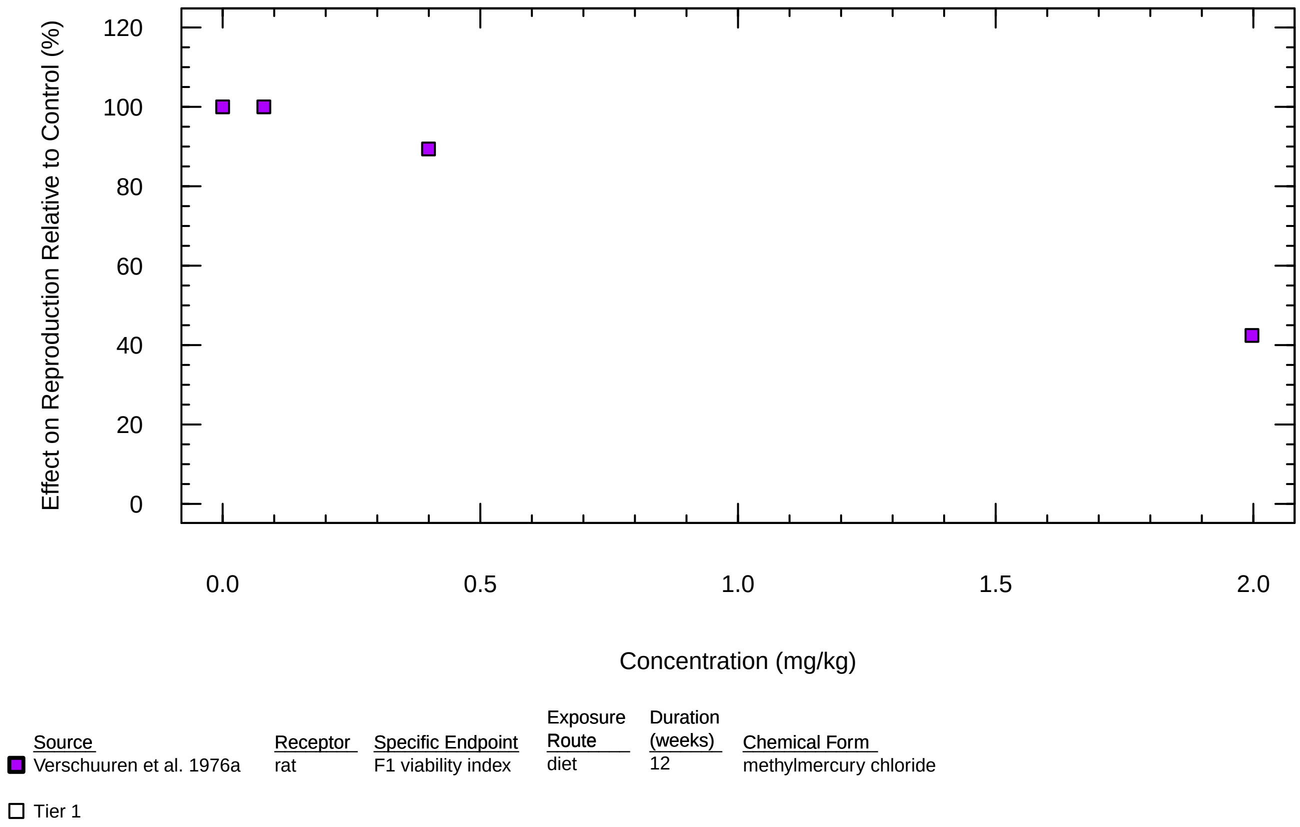
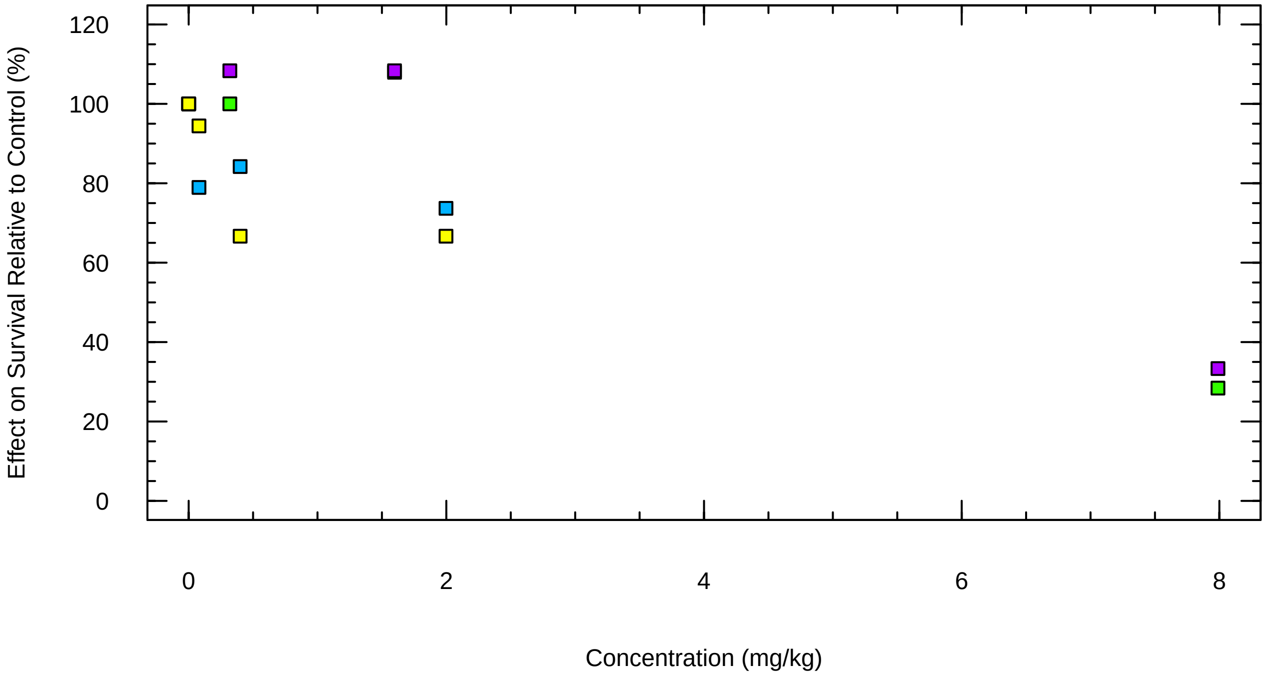


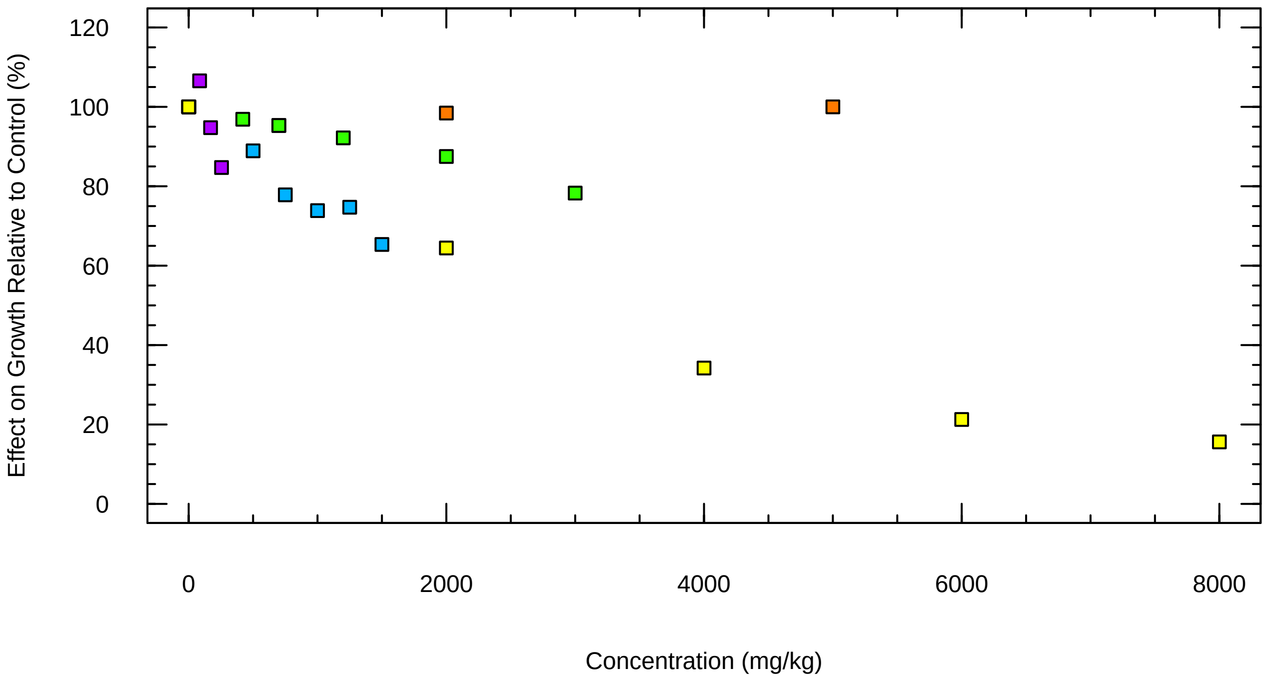
Figure E2−99. Concentration−Response Data for the Mammalian Reproduction Endpoint for Methylmercury



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟩	Mitsumori et al. 1983	rat	survival	diet	130	methylmercury chloride	E
🟪	Mitsumori et al. 1983	rat	survival	diet	130	methylmercury chloride	E
🟦	Verschuuren et al. 1976b	rat	survival (female)	diet	104	methylmercury chloride	E
🟨	Verschuuren et al. 1976b	rat	survival (male)	diet	104	methylmercury chloride	E

☐ Tier 1

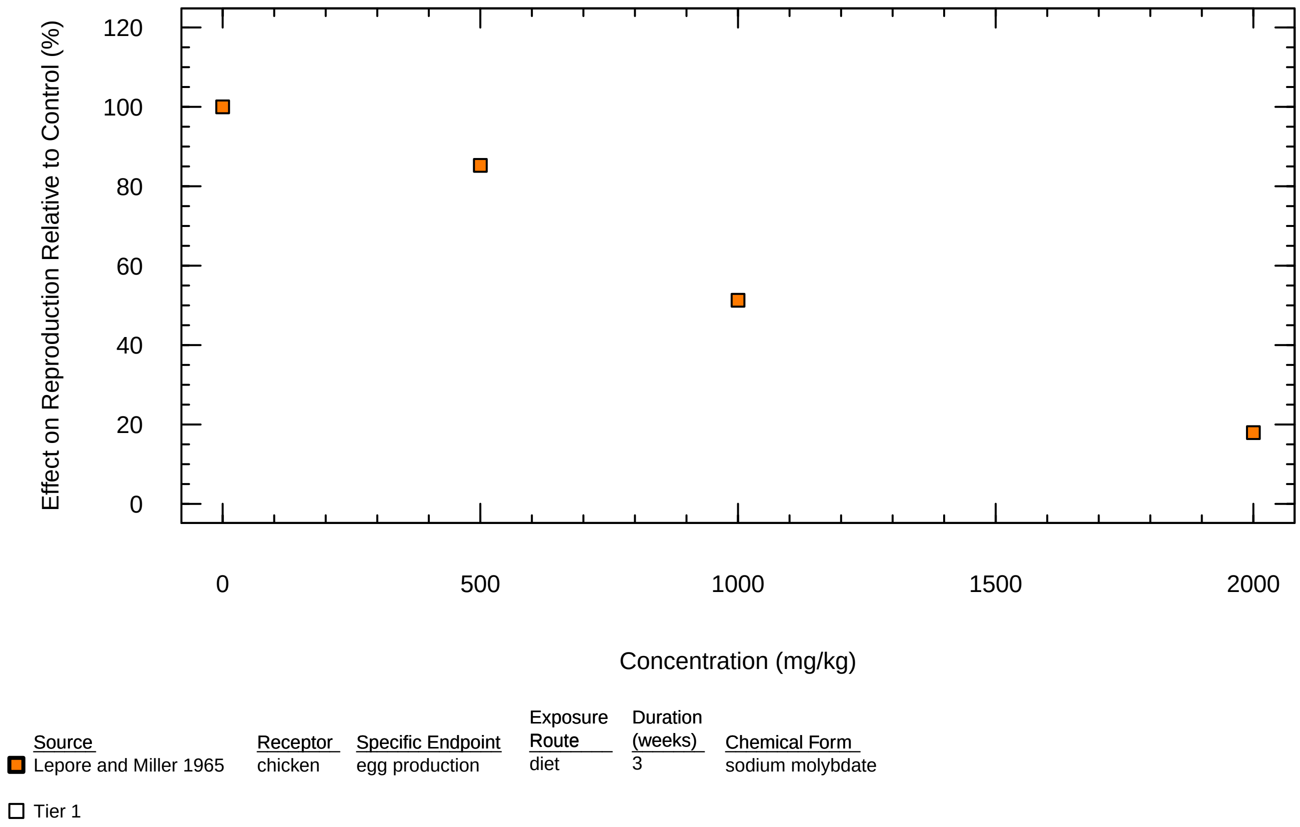
Figure E2−100. Concentration−Response Data for the Mammalian Survival Endpoint for Methylmercury



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Stafford et al. 2015	bobwhite quail	body weight gain	diet	4.3	molydenum disulfide	
🟩	Stafford et al. 2015	bobwhite quail	body weight gain	diet	4.3	sodium molybdate	
🟪	Kratzer 1952	chicken	weight gain	diet	3.3	sodium molybdate	
🟦	Davies et al. 1960	chicken	body weight (Exp 1b)	diet	4	sodium molybdate	A
🟨	Davies et al. 1960	chicken	body weight (Exp 1c)	diet	4	sodium molybdate	A

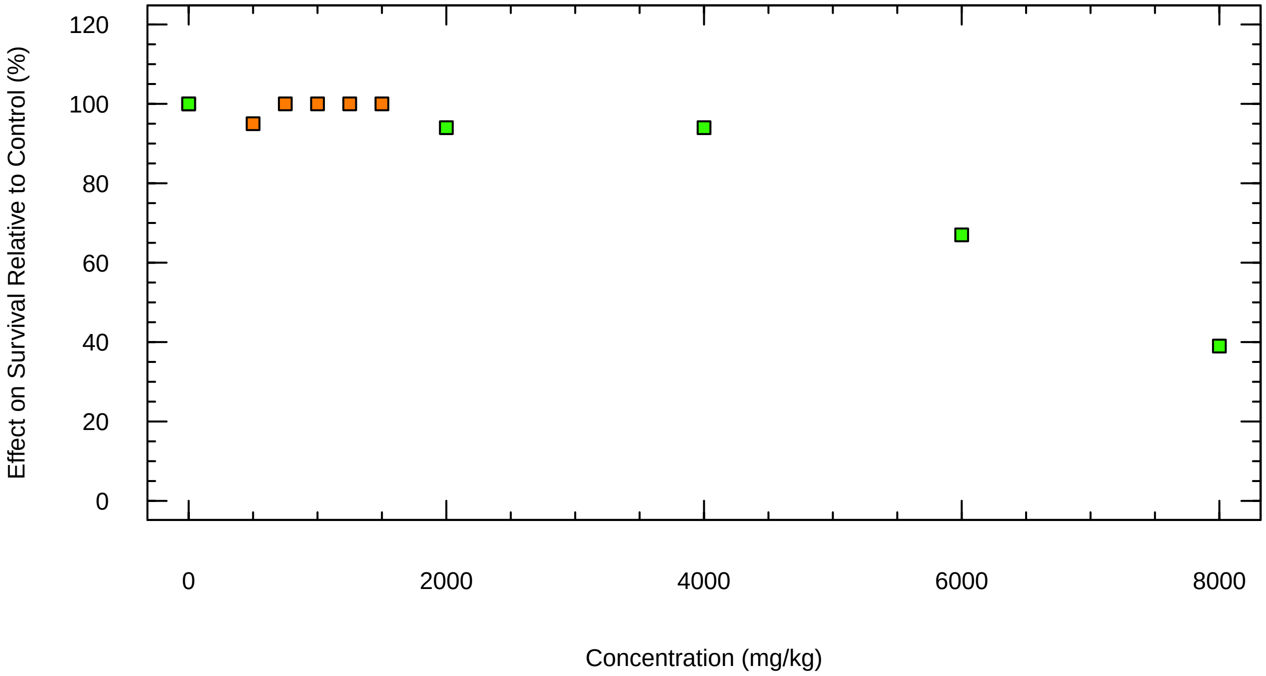
☐ Tier 1

Figure E2−101. Concentration−Response Data for the Avian Growth Endpoint for Molybdenum



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Lepore and Miller 1965	chicken	egg production	diet	3	sodium molybdate
☐	Tier 1					

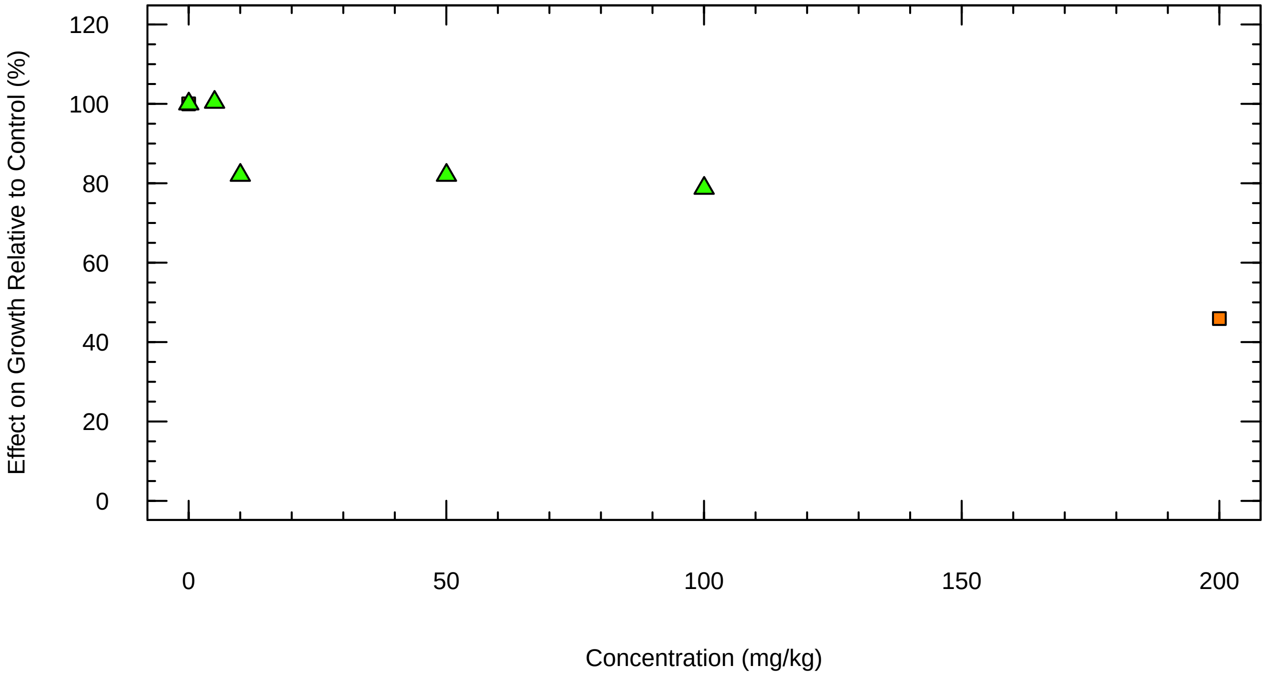
Figure E2−102. Concentration−Response Data for the Avian Reproduction Endpoint for Molybdenum



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Davies et al. 1960	chicken	survival (Exp 1b)	diet	4	sodium molybdate
🟩	Davies et al. 1960	chicken	survival (Exp 1c)	diet	4	sodium molybdate

☐ Tier 1

Figure E2−103. Concentration−Response Data for the Avian Survival Endpoint for Molybdenum



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟧	Brinkman and Miller 1961	rat	body weight gain	diet	6	sodium molybdate
▲	Fungwe et al. 1990	rat	body weight gain	drinking water	9	sodium molybdate

☐ Tier 1

△ Tier 2

Figure E2−104. Concentration−Response Data for the Mammalian Growth Endpoint for Molybdenum

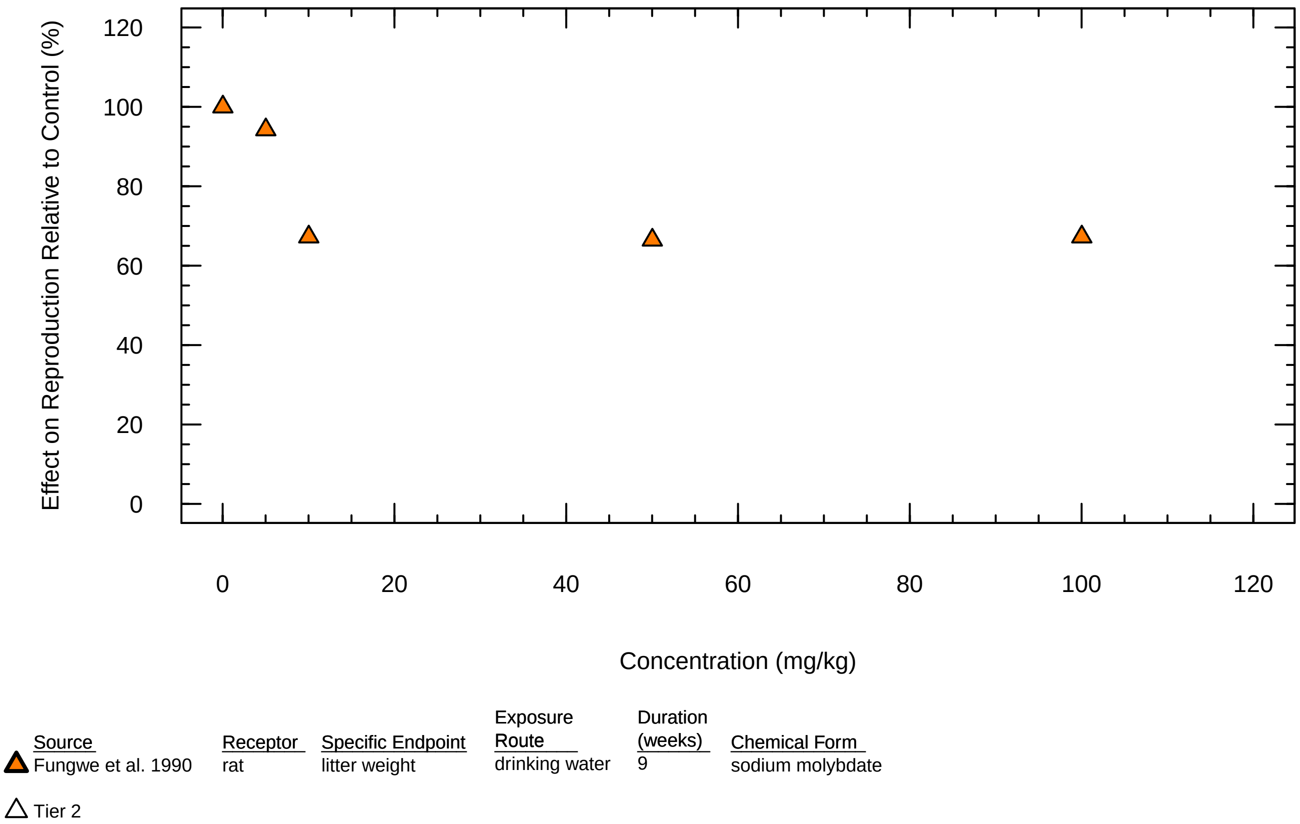
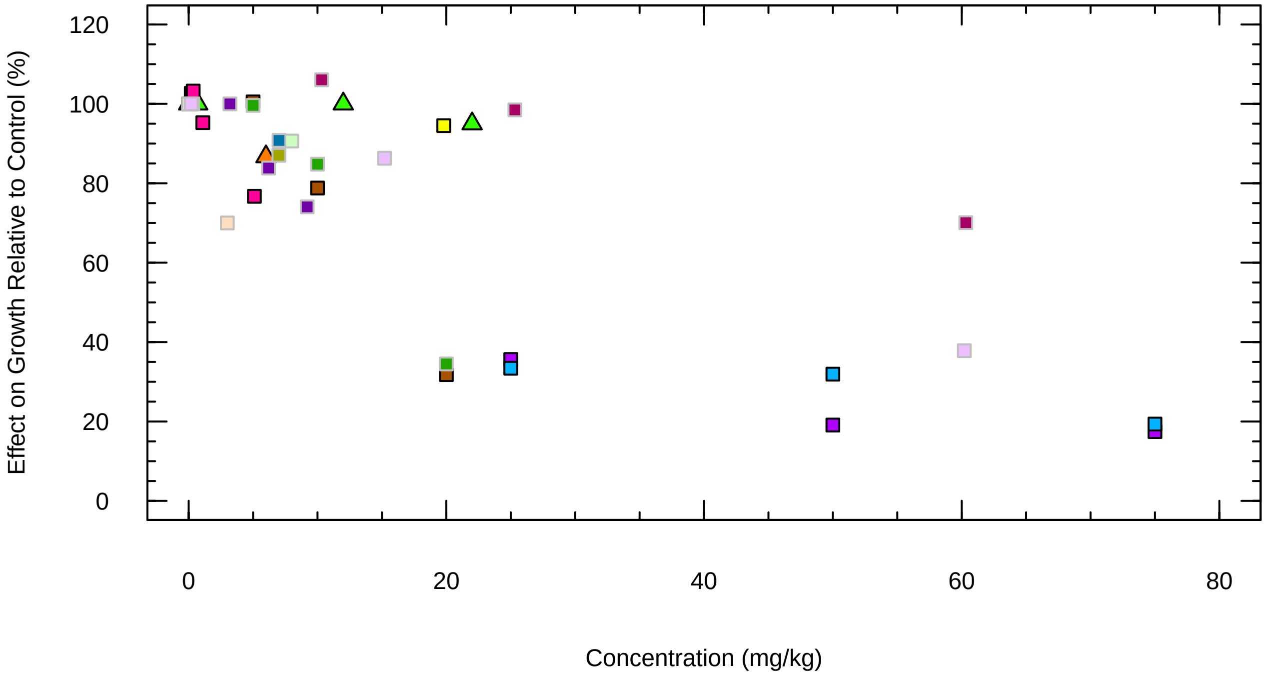


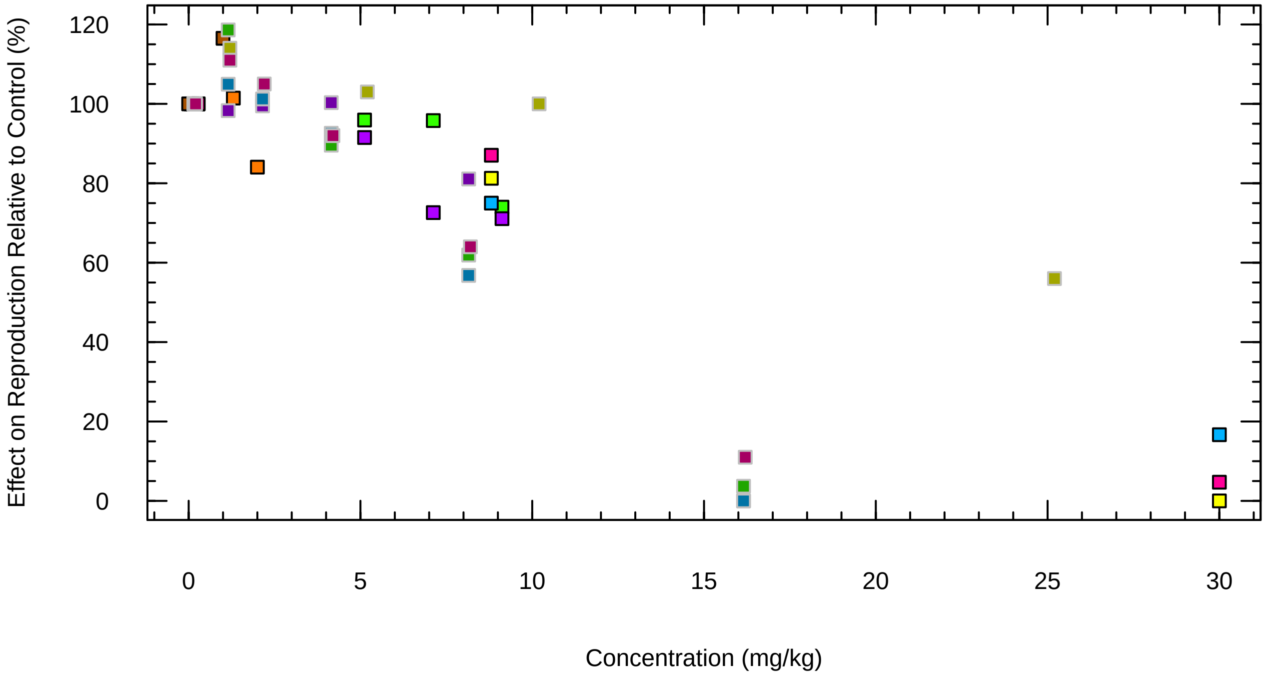
Figure E2−105. Concentration−Response Data for the Mammalian Reproduction Endpoint for Molybdenum



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
▲	Gad and El−Twab 2009	quail	body weight	gavage	4	sodium selenite	
▲	Santolo et al. 2010	quail	body weight gain	diet	4	seleno−L−methionine	
■	El−Begearmi and Combs 1982	chicken	body weight (brewer's yeast diet)	diet	4	sodium selenite	A
■	El−Begearmi and Combs 1982	chicken	body weight (corn−soy diet)	diet	4	sodium selenite	A
■	Heinz and Fitzgerald 1993a	mallard	body weight	diet	21	seleno−DL−methionine	D
■	Jensen 1986	chicken	body weight	diet	3	sodium selenite	A
■	Hill 1979a	chicken	body weight gain (Exp 1)	diet	4−5	selenium dioxide	B
■	Hill 1979a	chicken	body weight gain (Exp 2)	diet	4−5	selenium dioxide	B
■	Echevarria et al. 1988	chicken	body weight gain	diet	3	sodium selenite	C
■	Stowesand et al. 1977	quail	body weight	diet	10	sodium selenite	
■	Stowesand et al. 1977	quail	body weight	diet	10	seleniferous wheat	
■	O'Toole and Raisbeck 1997	mallard	body weight	diet	21	seleno−L−methionine	D
■	Dafalla and Adam 1986	chicken	body weight	diet	4	sodium selenite	A
■	Sell and Horani 1976	chicken	body weight gain	diet	4	sodium selenite	C
■	Hoffman et al. 1992	mallard	body weight	diet	4	seleno−DL−methionine	

☐ Tier 1 △ Tier 2

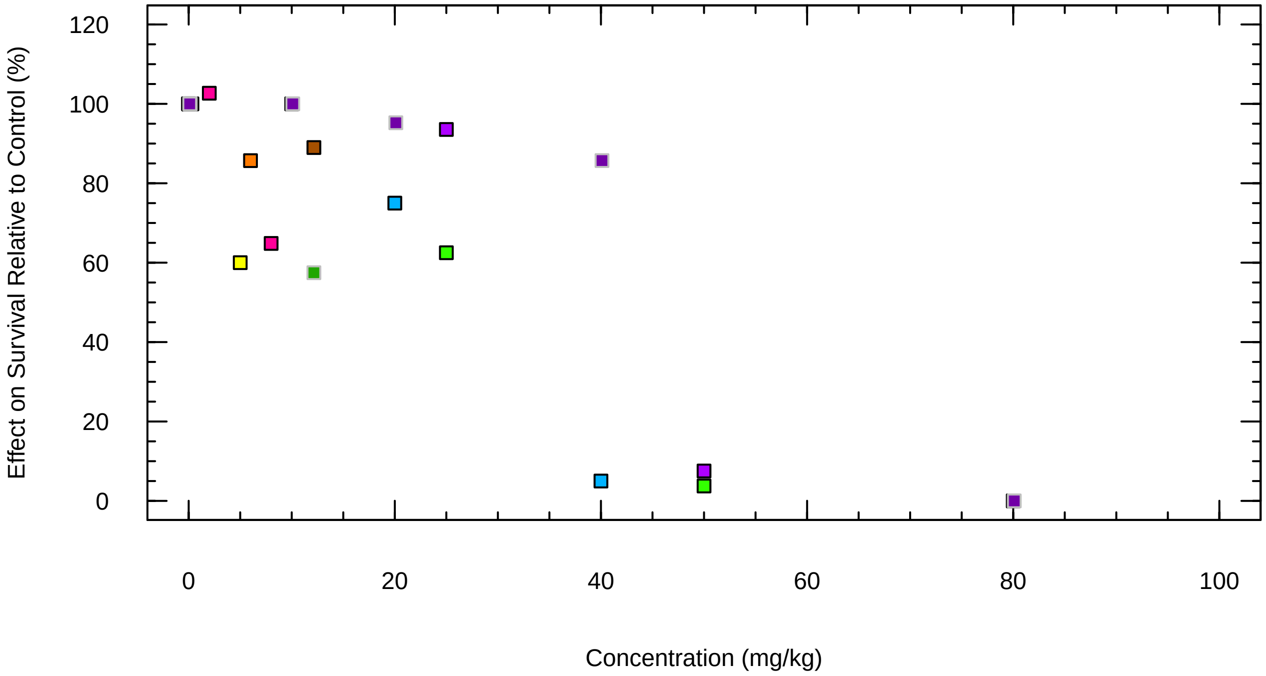
Figure E2−106. Concentration−Response Data for the Avian Growth Endpoint for Selenium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Kääntee and Kurbela 1980	chicken	egg production	diet	4	sodium selenite	
🟩	Ort and Latshaw 1978	chicken	egg production (Exp 2)	diet	16	sodium selenite	
🟪	Ort and Latshaw 1978	chicken	hatchability (Exp 2)	diet	16	sodium selenite	
🟦	Wiemeyer and Hoffman 1996	owl	% pairs with hatchlings	diet	12	seleno−DL−methionine	
🟨	Wiemeyer and Hoffman 1996	owl	# of pairs with 5−day−old young	diet	12	seleno−DL−methionine	
🟥	Wiemeyer and Hoffman 1996	owl	% hatch of eggs incubated	diet	12	seleno−DL−methionine	
🟫	Stone and Soares 1976	quail	egg production (Exp 1 and 3)	diet	3.9−4.6	sodium selenite	
🟩	Heinz et al. 1989	mallard	% hatch of fertile eggs	diet	>14	selenomethionine	E
🟪	Heinz et al. 1989	mallard	duckling survival	diet	>14	selenomethionine	
🟦	Heinz et al. 1989	mallard	# of ducklings	diet	>14	selenomethionine	
🟨	Hoffman and Heinz 1988	mallard	hatching success	diet	NR	sodium selenite	
🟥	Hoffman and Heinz 1988	mallard	hatching success	diet	NR	seleno−methionine	E

☐ Tier 1

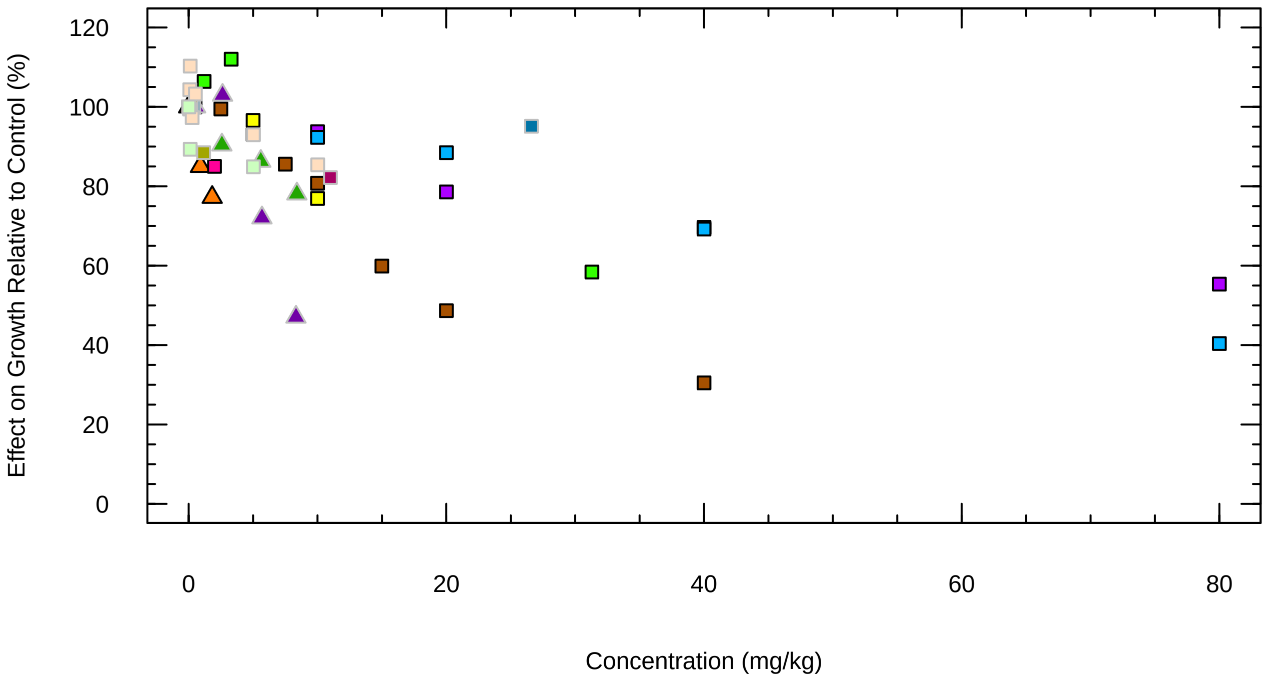
Figure E2−107. Concentration−Response Data for the Avian Reproduction Endpoint for Selenium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Gad and El−Twab 2009	quail	survival	gavage	4	sodium selenite	
🟩	El−Begearmi and Combs 1982	chicken	survival (brewer's yeast diet)	diet	4	sodium selenite	G
🟪	El−Begearmi and Combs 1982	chicken	survival (corn−soy diet)	diet	4	sodium selenite	G
🟦	Heinz and Fitzgerald 1993b	mallard	survival	diet	16	seleno−DL−methionine	I
🟨	Khan et al. 1993	chicken	survival	gavage	0.86	sodium selenite	
🟥	Arnold et al. 1973	chicken	survival	diet	64	sodium selenite	
🟫	El−Begearmi et al. 1977	quail	survival (males)	diet	16	sodium selenite	H
🟩	El−Begearmi et al. 1977	quail	survival (females)	diet	16	sodium selenite	H
🟪	Albers et al. 1996	mallard	survival	diet	16	seleno−DL−methionine	I

☐ Tier 1

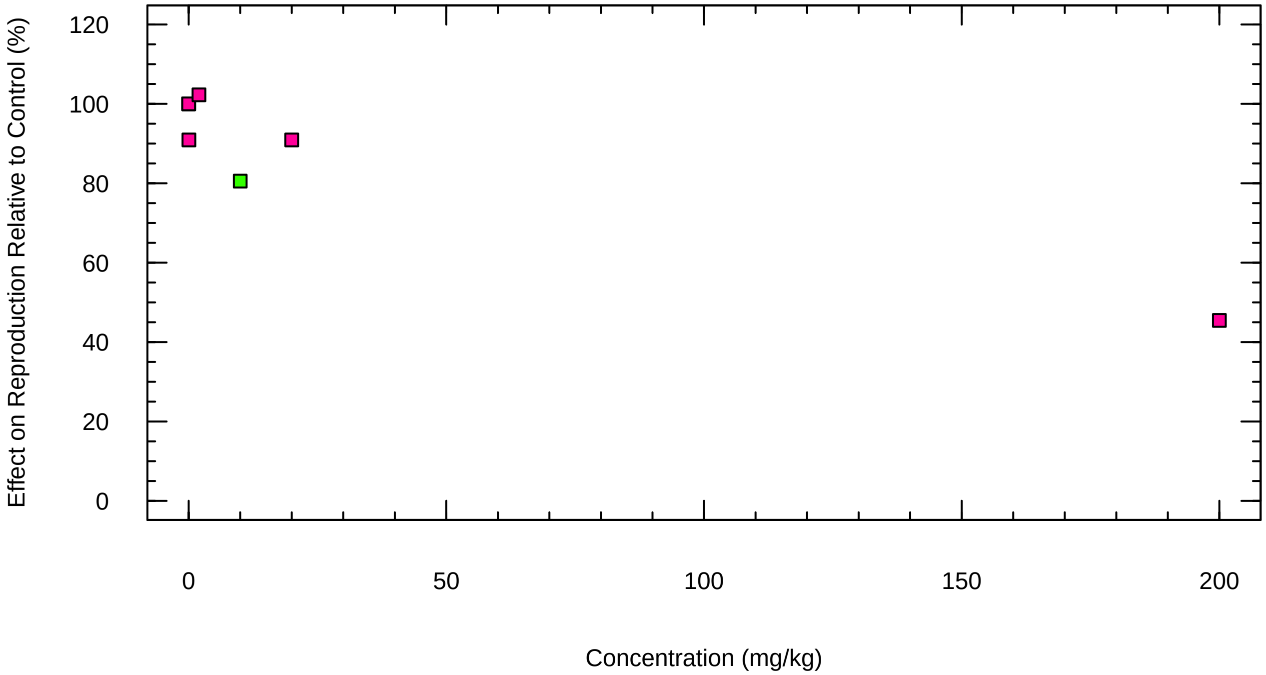
Figure E2−108. Concentration−Response Data for the Avian Survival Endpoint for Selenium



Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
▲ Kaur and Parshad 1994	rat	body weight	diet	5.1	sodium selenite	
🟩 Spallholz et al. 1973	mouse	body weight gain	diet	5	sodium selenite	
🟪 Julius et al. 1983	hamster	body weight (male, Exp 1)	diet	3	sodium selenite	A
🟦 Julius et al. 1983	hamster	body weight (female, Exp 1)	diet	3	sodium selenite	A
🟨 Julius et al. 1983	hamster	body weight (male, Exp 2)	diet	3	sodium selenite	A
🟥 Behne et al. 1992	rat	body weight	diet	14.3	L−selenomethionine	
🟫 Mahan and Moxon 1984	pig	body weight	diet	5.3	sodium selenite	
▲ Goehring et al. 1984	rat	body weight gain	diet	4	seleniferous grain	
▲ Goehring et al. 1984	rat	body weight gain	diet	4	sodium selenite	
■ Baker et al. 1989	pig	body weight	diet	3.7	sodium selenate	
■ Boylan et al. 1990	mouse	body weight	diet	26	sodium selenite	
■ Wahlstrom et al. 1956	pig	body weight	diet	14	sodium selenite	
■ Birt et al. 1983	hamster	body weight	diet	25	sodium selenite	
■ Birt et al. 1986	hamster	body weight	diet	64	sodium selenite	

☐ Tier 1 △ Tier 2

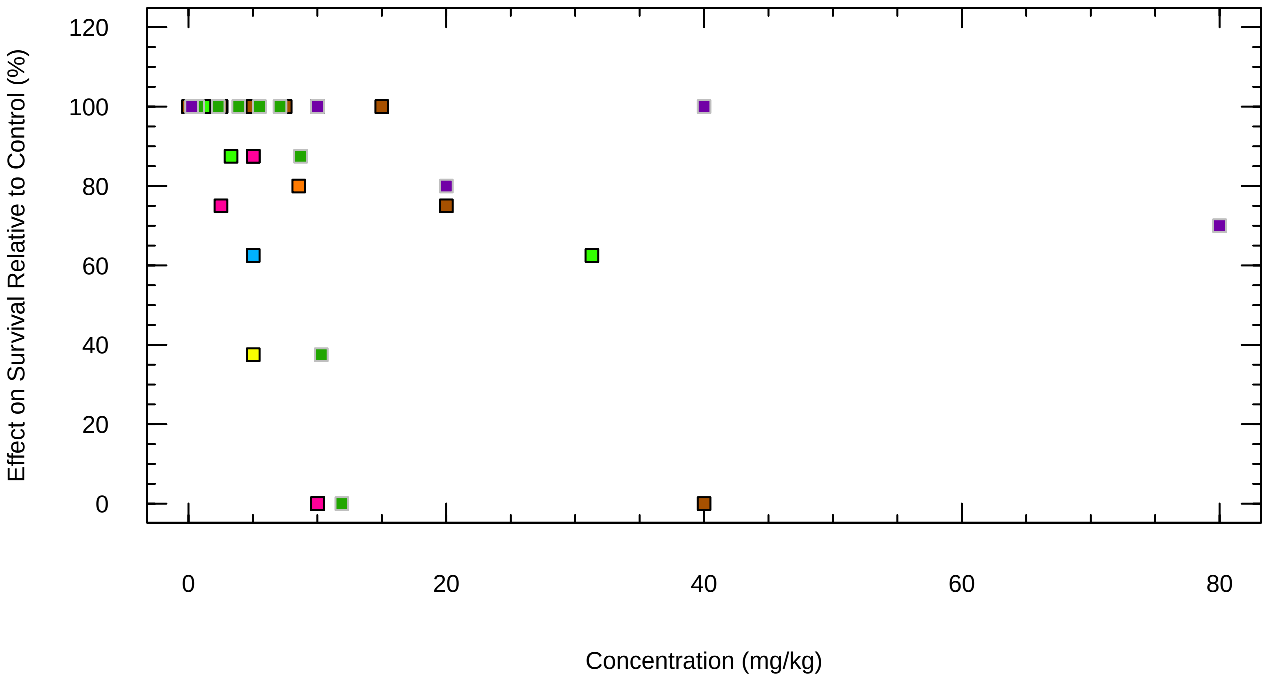
Figure E2−109. Concentration−Response Data for the Mammalian Growth Endpoint for Selenium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form
🟩	Wahlstrom and Olson 1959	pig	# of live piglets	diet	34	sodium selenite
🟪	Webster 1979	mouse	% with litters	diet	2.7	sodium selenite

☐ Tier 1

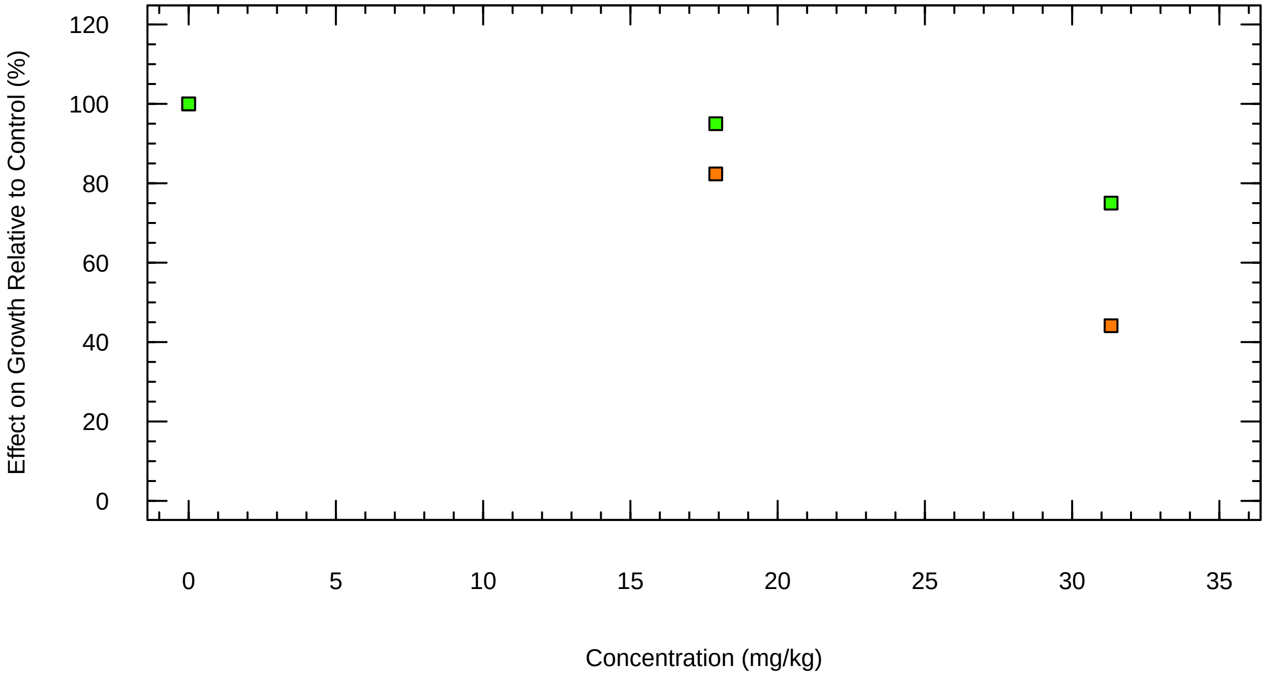
Figure E2−110. Concentration−Response Data for the Mammalian Reproduction Endpoint for Selenium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Palmer et al. 1982	rat	survival	diet	4	seleniferous corn	B
🟩	Spallholz et al. 1973	mouse	survival	diet	5	sodium selenite	
🟪	McAdam and Levander 1987	rat	survival	diet	6	D−selenomethionine	B
🟦	McAdam and Levander 1987	rat	survival	diet	6	L−selenomethionine	B
🟨	McAdam and Levander 1987	rat	survival	diet	6	sodium selenite	
🟥	McAdam and Levander 1987	rat	survival	diet	6	sodium selenate	
🟫	Moxon and Mahan 1981	pig	survival	diet	5.3	sodium selenite	
🟩	Halverson et al. 1966	rat	survival	diet	6	seleniferous wheat	B
🟪	Julius et al. 1983	hamster	survival	diet	3	sodium selenite	

☐ Tier 1

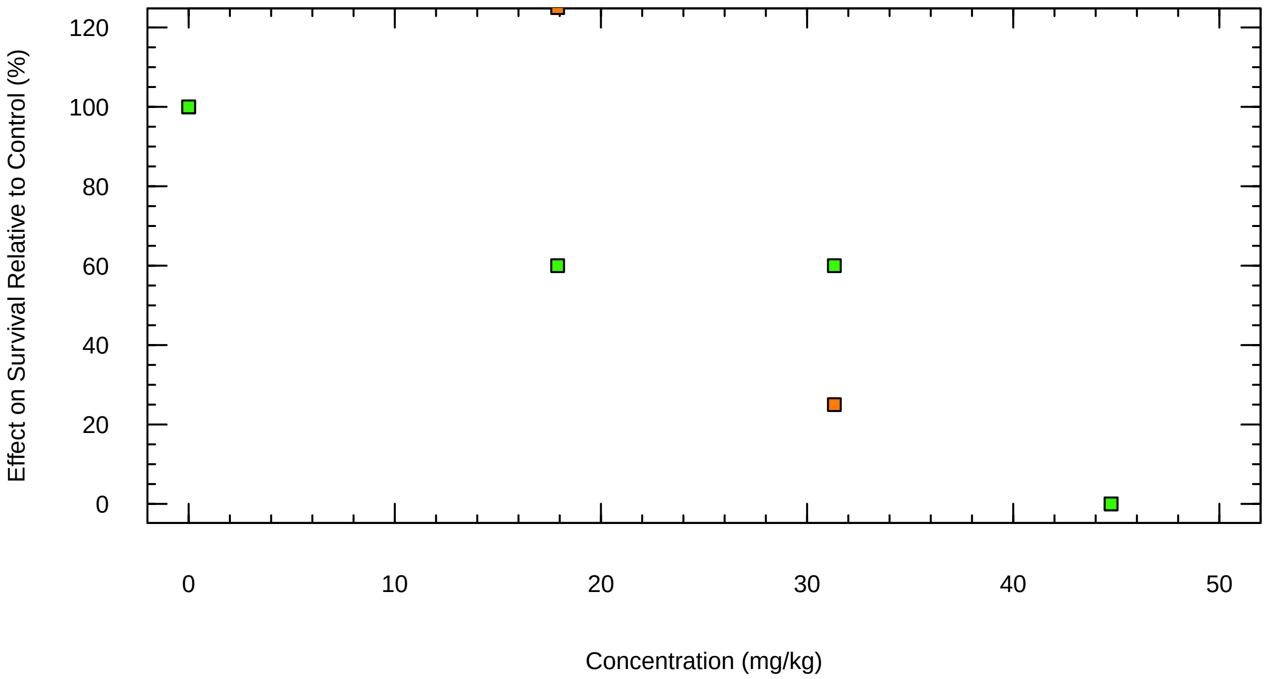
Figure E2−111. Concentration−Response Data for the Mammalian Survival Endpoint for Selenium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Downs et al. 1960	rat (male)	body weight	diet	15	thallic oxide	A
🟩	Downs et al. 1960	rat (female)	body weight	diet	15	thallic oxide	A

☐ Tier 1

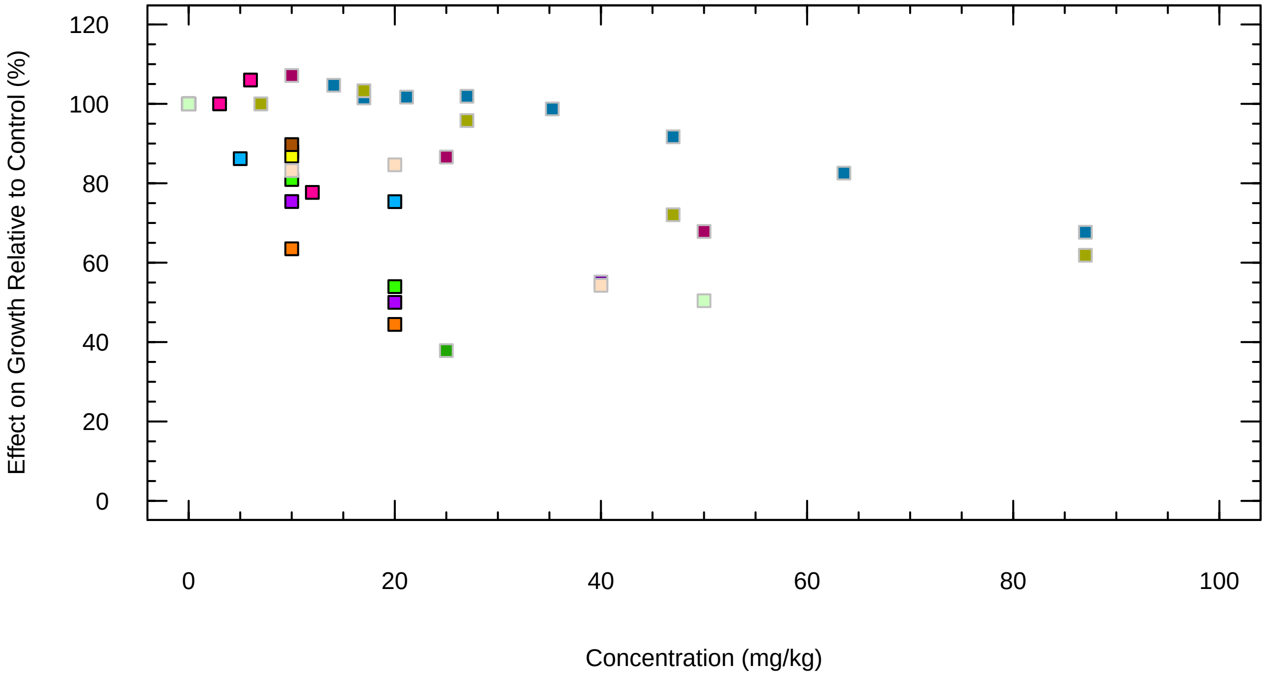
Figure E2−112. Concentration−Response Data for the Mammalian Growth Endpoint for Thallium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Downs et al. 1960	rat (male)	survival	diet	15	thallic oxide	B
🟩	Downs et al. 1960	rat (female)	survival	diet	15	thallic oxide	B

☐ Tier 1

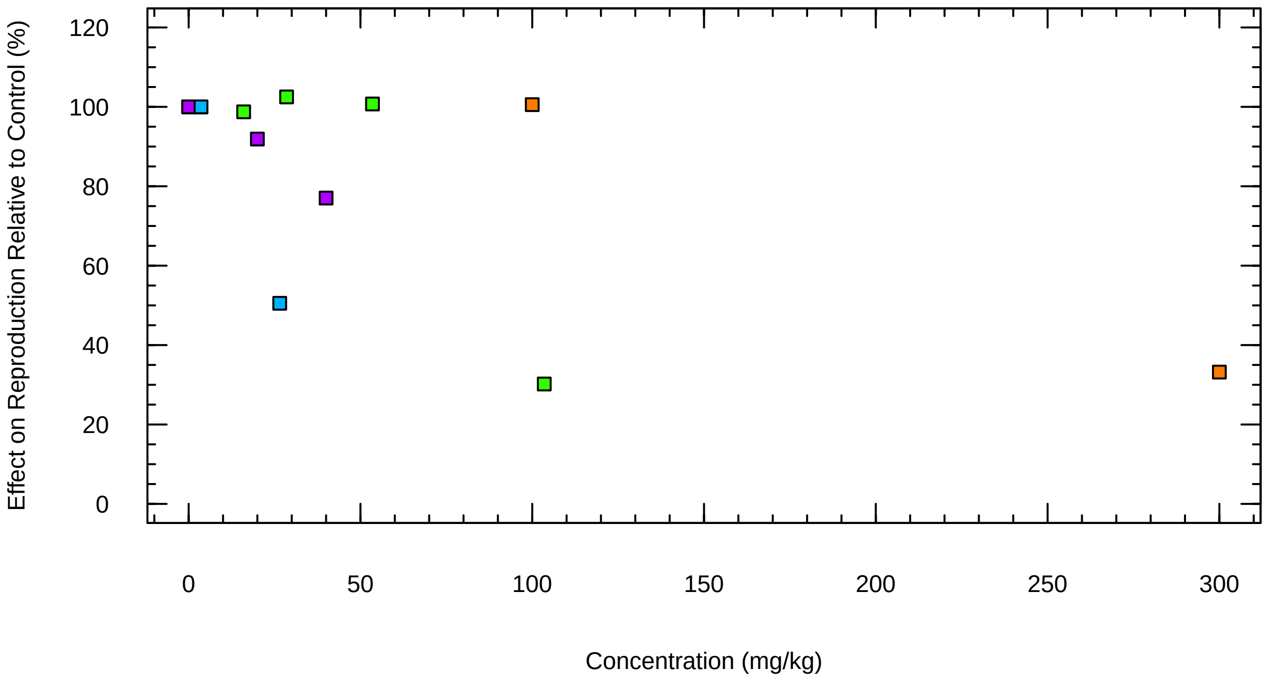
Figure E2−113. Concentration−Response Data for the Mammalian Survival Endpoint for Thallium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
■	Berg and Lawrence 1971	chicken	body weight	diet	2	ammonium metavanadate	A
■	Berg and Lawrence 1971	chicken	body weight	diet	2	vanadyl sulfate	
■	Berg and Lawrence 1971	chicken	body weight	diet	2	vanadyl dichloride	E
■	Cervantes and Jensen 1986	chicken	body weight	diet	4	ammonium metavanadate	A
■	Hill 1974	chicken	body weight gain	diet	2	sodium metavanadate	B
■	Hill 1979a	chicken	body weight gain	diet	2	sodium metavanadate	B
■	Summers and Moran 1972	chicken	body weight gain	diet	3	NR	
■	Hill 1990b	chicken	body weight gain	diet	2.7	sodium metavanadate	B
■	Hill 1990a	chicken	body weight gain	diet	2.7	sodium metavanadate	B
■	Nelson et al. 1962	chicken	body weight	diet	4	ammonium metavanadate	A
■	Nelson et al. 1962	chicken	body weight	diet	4	ammonium metavanadate	A
■	Qureshi et al. 1999	chicken	body weight	diet	3	ammonium metavanadate	A
■	Blalock and Hill 1987	chicken	body weight	diet	3	vanadyl chloride	E
■	Hill 1994	chicken	body weight	diet	2.9	ammonium metavanadate	A

□ Tier 1

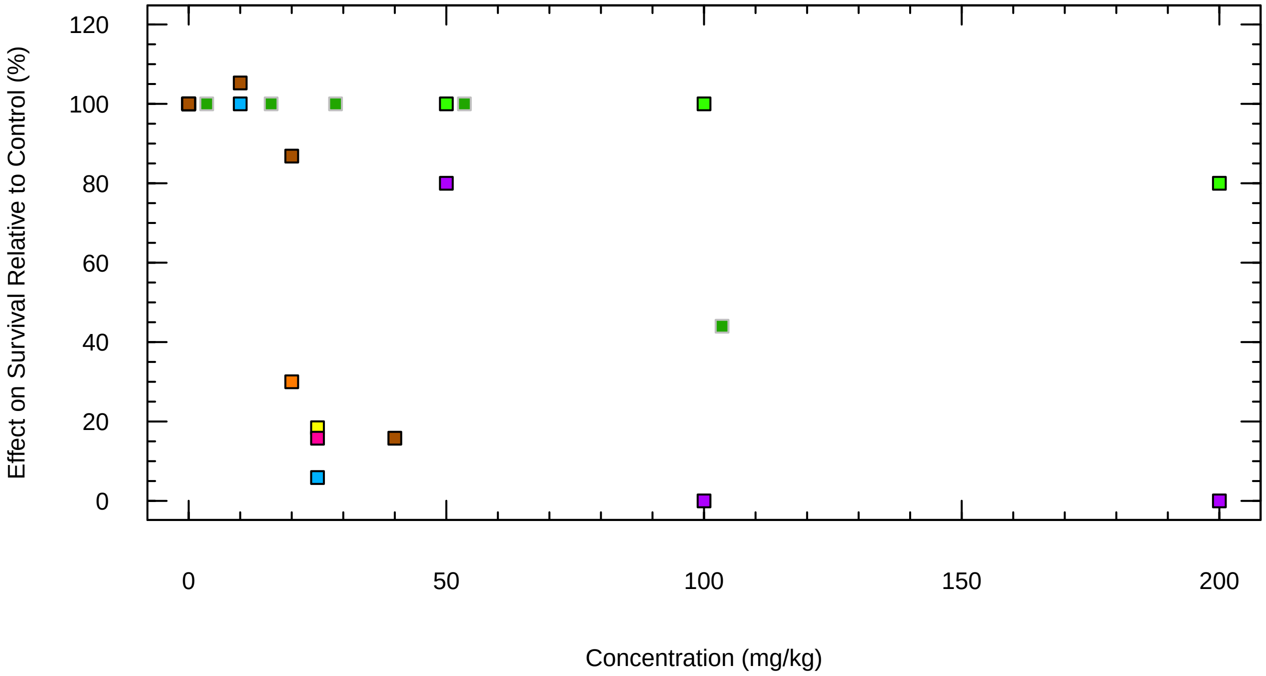
Figure E2−114. Concentration−Response Data for the Avian Growth Endpoint for Vanadium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Hafez and Kratzer 1976b	chicken	egg production	diet	NR	ammonium metavanadate	C
🟩	Kubena and Phillips 1982	chicken	egg production	diet	20	calcium orthovanadate	
🟪	Ousterhout and Berg 1980	chicken	egg production	diet	4	ammonium metavanadate	C
🟦	Toussant and Latshaw 1994	chicken	egg production	diet	4	ammonium metavanadate	C

☐ Tier 1

Figure E2−115. Concentration−Response Data for the Avian Reproduction Endpoint for Vanadium



	Source	Receptor	Specific Endpoint	Exposure Route	Duration (weeks)	Chemical Form	Pooling Group
🟧	Berg and Lawrence 1971	chicken	survival	diet	2	ammonium metavanadate	D
🟩	Hafez and Kratzer 1976a	chicken	survival (Exp 1)	diet	4	ammonium metavanadate	D
🟪	Hafez and Kratzer 1976a	chicken	survival (Exp 2)	diet	4	ammonium metavanadate	D
🟦	Hathcock et al. 1964	chicken	survival (Exp 1)	diet	2	ammonium metavanadate	D
🟨	Hathcock et al. 1964	chicken	survival (Exp 2)	diet	2	ammonium metavanadate	D
🟥	Hathcock et al. 1964	chicken	survival	diet	2	vanadyl sulfate	
🟫	Blalock and Hill 1987	chicken	survival	diet	3	vanadyl chloride	
🟩	Kubena and Phillips 1982	chicken	survival	diet	20	calcium orthovanadate	

☐ Tier 1

Figure E2−116. Concentration−Response Data for the Avian Survival Endpoint for Vanadium

TABLES

Table E2-1. Number of Wildlife Studies Reviewed and Usable Dose-Response Data Sets

Receptor Group	Endpoint	Number of Studies Reviewed [a]			Number of Usable Data Sets [a]		
		Tier 1 [b]	Tier 2 [c]	Total	Tier 1 [b]	Tier 2 [c]	Total
Aluminum							
Bird	growth	4	0	4	4	0	4
	reproduction	0	0	0	0	0	0
	survival	1	0	1	1	0	1
Mammal	growth	2	1	3	1	2	3
	reproduction	4	0	4	6	0	6
	survival	1	0	1	1	0	1
Antimony							
Bird	growth	0	0	0	0	0	0
	reproduction	0	0	0	0	0	0
	survival	0	0	0	0	0	0
Mammal	growth	0	3	3	0	0	0
	reproduction	0	1	1	0	0	0
	survival	0	1	1	0	0	0
Barium							
Bird	growth	1	0	1	2	0	2
	reproduction	0	0	0	0	0	0
	survival	1	0	1	2	0	2
Beryllium							
Bird	growth	0	0	0	0	0	0
	reproduction	0	0	0	0	0	0
	survival	0	0	0	0	0	0
Chromium							
Bird	growth	1	0	1	1	0	1
	reproduction	0	0	0	0	0	0
	survival	0	0	0	0	0	0
Mammal	growth	0	2	2	0	1	1
	reproduction	0	1	1	0	2	2
	survival	0	0	0	0	0	0
Iron							
Bird	growth	3	0	3	3	0	1
	reproduction	0	0	0	0	0	0
	survival	3	0	3	3	0	2
Mammal	growth	6	0	6	8	0	4
	reproduction	0	0	0	0	0	0
	survival	2	0	2	3	0	2
Methylmercury							
Bird	growth	2	1	3	0	1	1
	reproduction	7	0	7	21	0	21
	survival	7	0	7	9	0	9
Mammal	growth	6	2	8	4	2	6
	reproduction	3	0	3	3	0	3
	survival	3	0	3	5	0	5
Molybdenum							
Bird	growth	3	0	3	3	0	3
	reproduction	1	0	1	1	0	1
	survival	1	0	1	1	0	1
Mammal	growth	3	2	5	3	1	4
	reproduction	0	1	1	0	1	1
	survival	0	0	0	0	0	0

Table E2-1. Number of Wildlife Studies Reviewed and Usable Dose-Response Data Sets

		Number of Studies Reviewed [a]			Number of Usable Data Sets [a]		
Receptor Group	Endpoint	Tier 1 [b]	Tier 2 [c]	Total	Tier 1 [b]	Tier 2 [c]	Total
Selenium							
Bird	growth	10	2	12	9	0	9
	reproduction	6	0	6	10	0	10
	survival	7	0	7	7	0	7
Mammal	growth	9	2	11	5	3	8
	reproduction	5	0	5	2	0	2
	survival	6	0	6	9	0	9
Thallium							
Bird	growth	0	0	0	0	0	0
	reproduction	0	0	0	0	0	0
	survival	0	0	0	0	0	0
Mammal	growth	1	0	1	2	0	2
	reproduction	0	0	0	0	0	0
	survival	1	0	1	2	0	2
Vanadium							
Bird	growth	11	0	11	12	0	12
	reproduction	4	0	4	4	0	4
	survival	5	0	5	8	0	8

Notes:

[a] Number of studies and usable data sets includes those reviewed for the purposes of pooling and for inclusion of unique receptors. The number of usable data sets may be higher than the number of unique studies because some studies included multiple experiments and/or measurements.

[b] Tier 1 includes growth studies with exposure during the critical lifestage or with a duration of at least 10 percent of the lifespan, and all survival and reproduction studies regardless of exposure duration. The exposure route for all Tier 1 data is diet or gavage.

[c] Tier 2 includes studies with drinking water exposure or studies for the growth endpoint if exposure was not during the critical lifestage or if the study duration was less than 10 percent of the lifespan.

Table E2-2. Summary of Aluminum Dose-Response Data Sets

Source [a]	Effective Dose (mg/kg bw/day)	Type of Effect Level	Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group [b]	Modeling Category [c]
Bird Growth												
Capdevielle and Scanes (1995a)	**150**	**ED20**	**20**	**chicken**	**4-18 days**	**aluminum sulfate**	**body weight**	**diet**	**2**	**1**	**none**	1
Capdevielle and Scanes (1995b)	*500*	*LOAEL ≥ 20*	*68*	*mallard*	*duckling*	*aluminum sulfate*	*body weight*	*diet*	*2.1*	*1*	*none*	*4*
Pooling group A:	160	ED20	20	chicken	1- 4 days	aluminum sulfate	body weight	diet	1.5 - 2.3	1	A	5
Capdevielle et al. (1996)	640	LOAEL ≥ 20	58	chicken	4 days	aluminum sulfate	body weight	diet	1.5	1	A	
Elliot and Edwards (1991)	270	LOAEL ≥ 20	61	chicken	1 day	aluminum sulfate	body weight	diet	2.3	1	A	
Bird Survival												
Capdevielle and Scanes (1995a)	**560**	**LOAEL ≥ 20**	**75**	**chicken**	**4-18 days**	**aluminum sulfate**	**survival**	**diet**	**2**	**1**	**none**	**3**
Mammal Growth												
Belles et al. (1999)	**400**	**LOAEL ≥ 20**	**14**	**mouse**	**adult**	**aluminum nitrate nonahydrate**	**body weight gain**	**gavage**	**1.5**	**1**	**none**	**3**
Domingo et al. (1987a)	46	LOAEL ≥ 20	77	rat	adult	aluminum nitrate nonahydrate	body weight	drinking water	14	2	none	3
Domingo et al. (1987a)	460	LOAEL ≥ 20	65	rat	adult	aluminum nitrate nonahydrate	body weight	drinking water	14	2	none	3
Paternain et al. (1988)	no effect at 52	NA	NA	rat	adult	aluminum nitrate nonahydrate	body weight gain	gavage	1.3	1	none	3
Mammal Reproduction												
Belles et al. (1999)	400	LOAEL ≥ 20	58	mouse	adult	aluminum nitrate nonahydrate	fetal body weight	gavage	1.5	1	none	3
Bernuzzi et al. (1989)	270	LOAEL ≥ 20	53	rat	adult	aluminum chloride	postnatal survival	diet	2.6	1	none	4
Bernuzzi et al. (1989)	400	LOAEL ≥ 20	78	rat	adult	aluminum chloride	pup body weight	diet	2.6	1	none	4
Domingo et al. (1987b)	52	LOAEL ≥ 20	78	rat	adult	aluminum nitrate nonahydrate	pup survival	oral	unclear	1	none	3
Paternain et al. (1988) [d]	13	LOAEL ≥ 20	76	rat	adult	aluminum nitrate nonahydrate	fetal survival	gavage	1.3	1	none	3
Paternain et al. (1988)	**27**	**ED20**	**20**	**rat**	**adult**	**aluminum nitrate nonahydrate**	**fetal body weight**	**gavage**	**1.3**	**1**	**none**	**1**
Mammal Survival												
Belles et al. (1999)	**400**	**LOAEL ≥ 20**	**44**	**mouse**	**adult**	**aluminum nitrate nonahydrate**	**survival**	**gavage**	**1.5**	**1**	**none**	**3**

Notes:

Bold indicates the lowest effect level, selected from the lowest tier evaluated, and as the lowest value from the following:

1. Lowest-observed-adverse-effect level (LOAEL) with ≥ 20 percent reduction in the response relative to control (LOAEL ≥ 20) from an individual data set,
2. Modeled effective dose with a 20 percent reduction in the response relative to the control (ED20) from an individual data set, or
3. ED20 or geometric mean from a pooled data set that was selected for modeling because the effect concentration had the potential for being lower than other ED20s and/or LOAELs based on visual inspection of the plotted data (i.e., Category 2 or 5).

Italics indicate UCR receptor-specific toxicity response value (TRV) data set.

Yellow highlights indicate pooled data sets modeled in EPA's Toxicity Relationship Analysis Program (TRAP).

[a] References are cited in Attachment E1 or Attachment E2.

[b] Pooling groups were evaluated only as a group and not on an individual basis for the purposes of selecting data to model in TRAP. Not all pooling groups were run in TRAP.

[c] Modeling categories are defined as follows:

1. Data were modeled in TRAP as an individual data set to derive the ED20 presented in this table.
2. Data were selected for modeling as an individual or pooled data set, but an ED20 could not be generated or the ED20 was not used due to poor model fit.
3. Data do not meet criteria for modeling as an individual data set (e.g., no effect with a ≥ 20 percent reduction in response relative to control, lack of two consecutively lower and different effects less than the control or consecutively lower effects are followed by an increased effect, a lower tier data set is available).
4. Not selected for modeling because the effect concentration for the individual or pooled data set is substantially higher than other ED20s and/or LOAELs.
5. Modeled in TRAP as part of a pooled data set.

[d] Although statistically significant effects were observed at a dose of 13 mg/kg bw/day, no statistically significant effects were observed at the other higher doses of 26 and 52 mg/kg bw/day. The study concluded that the levels of aluminum used in the test did not significantly affect the number of live fetuses in the treated animals relative to the control (Paternain et al. 1988). Therefore, this LOAEL was not selected as the lowest effect level for TRV derivation.

NA - not applicable; the reduction in response was < 20 percent relative to the control

Table E2-3. Summary of Antimony Dose-Response Data Sets

Source [a]	Effective Dose (mg/kg bw/day)	Type of Effect Level	Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group [b]	Modeling Category [c]
Mammal Growth												
Poon et al. (1998)	no effect at 42	NA	NA	rat	127 g	potassium antimony tartrate	body weight (male)	drinking water	13	2	none	3
Poon et al. (1998)	no effect at 46	NA	NA	rat	136 g	potassium antimony tartrate	body weight (female)	drinking water	13	2	none	3
Rossi et al. (1987)	no effect at 1.2	NA	NA	rat	birth	antimony trichloride	body weight	drinking water	8.6	2	none	3
Rossi et al. (1987)	no effect at 1.1	NA	NA	rat	adult	antimony trichloride	body weight	drinking water	6.3	2	none	3
Shroeder et al. (1968)	no effect at 0.35	NA	NA	mouse	weanling	antimony potassium tartrate	body weight (male)	drinking water	80	2	none	3
Shroeder et al. (1968)	no effect at 0.35	NA	NA	mouse	weanling	antimony potassium tartrate	body weight (female)	drinking water	80	2	none	3
Mammal Reproduction												
Rossi et al. (1987)	no effect at 1.1	NA	NA	rat	adult	antimony trichloride	pups per litter	drinking water	6.3	2	none	3
Mammal Survival												
Dieter et al. (1991)	no effect at 74	NA	NA	mouse	~8 weeks	antimony potassium tartrate	survival (female)	drinking water	2	2	none	3

Notes:

No studies were found with at percent effect relative to the control of at least 20 percent, so no effect level was selected for antimony.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Pooling groups were evaluated only as a group and not on an individual basis for the purposes of selecting data to model in EPA's Toxicity Relationship Analysis Program (TRAP). Not all pooling groups were run in TRAP.

[c] Modeling categories are defined as follows:

1. Data were modeled in TRAP as an individual data set to derive the effective dose with a 20 percent reduction in the response relative to the control (ED20) presented in this table.
2. Data were selected for modeling as an individual or pooled data set, but an ED20 could not be generated or the ED20 was not used due to poor model fit.

3. Data do not meet criteria for modeling as an individual data set (e.g., no effect with a ≥ 20 percent reduction in response relative to control, lack of two consecutively lower and different effects less than the control or consecutively lower effects are followed by an increased effect, a lower tier data set is available).
4. Not selected for modeling because the effect concentration for the individual or pooled data set is substantially higher than other ED20s and/or lowest-observed-adverse-effect levels (LOAELs).
5. Modeled in TRAP as part of a pooled data set.

NA - not applicable; the reduction in response was < 20 percent relative to the control

Table E2-4. Summary of Barium Dose-Response Data Sets

Source [a]	Effective Dose (mg/kg bw/day)	Type of Effect Level	Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group [b]	Modeling Category [c]
Bird Growth												
Johnson et al. (1960)	530	ED20	20	chicken	1 day	barium hydroxide	body weight gain	diet	4	1	none	1
Johnson et al. (1960)	**480**	**ED20**	**20**	**chicken**	**1 day**	**barium acetate**	**body weight gain**	**diet**	**4**	**1**	**none**	**1**
Bird Survival												
Johnson et al. (1960)	**890**	**LOAEL ≥ 20**	**32**	**chicken**	**1 day**	**barium hydroxide**	**survival**	**diet**	**4**	**1**	**none**	**2**
Johnson et al. (1960)	**890**	**LOAEL ≥ 20**	**44**	**chicken**	**1 day**	**barium acetate**	**survival**	**diet**	**4**	**1**	**none**	**2**

Notes:

Bold indicates the lowest effect level, selected from the lowest tier evaluated, and as the lowest value from the following:

1. Lowest-observed-adverse-effect level (LOAEL) with ≥ 20 percent reduction in the response relative to control (LOAEL ≥ 20) from an individual data set,
2. Modeled effective dose with a 20 percent reduction in the response relative to the control (ED20) from an individual data set, or
3. ED20 or geometric mean from a pooled data set that was selected for modeling because the effect concentration had the potential for being lower than other ED20s and/or LOAELs based on visual inspection of the plotted data (i.e., Category 2 or 5).

[a] References are cited in Attachment E1 or Attachment E2.

[b] Pooling groups were evaluated only as a group and not on an individual basis for the purposes of selecting data to model in EPA's Toxicity Relationship Analysis Program (TRAP). Not all pooling groups were run in TRAP.

[c] Modeling categories are defined as follows:

1. Data were modeled in TRAP as an individual data set to derive the ED20 presented in this table.
2. Data were selected for modeling as an individual or pooled data set, but an ED20 could not be generated or the ED20 was not used due to poor model fit.
3. Data do not meet criteria for modeling as an individual data set (e.g., no effect with a ≥ 20 percent reduction in response relative to control, lack of two consecutively lower and different effects less than the control or consecutively lower effects are followed by an increased effect, a lower tier data set is available).
4. Not selected for modeling because the effect concentration for the individual or pooled data set is substantially higher than other ED20s and/or LOAELs.
5. Modeled in TRAP as part of a pooled data set.

Table E2-5. Summary of Chromium Dose-Response Data Sets

Source [a]	Effective Dose (mg/kg bw/day)	Type of Effect Level	Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group [b]	Modeling Category [c]
Bird Growth												
Chung et al. (1985)	**510**	**LOAEL ≥ 20**	**57**	**chicken**	**chick**	**chromium sulfate (chromium [III])**	**body weight**	**diet**	**2**	**1**	**none**	**3**
Mammal Growth												
Bataineh et al. (1997)	**110**	**LOAEL ≥ 20**	**76**	**rat**	**adult**	**chromium chloride (chromium [III])**	**body weight (male)**	**drinking water**	**12**	**2**	**none**	**3**
Elbetieha and Al-Hamood (1997)	no effect at 230	NA	NA	mouse	50 days	chromium chloride (chromium [III])	body weight	drinking water	12	2	none	3
Mammal Reproduction												
Elbetieha and Al-Hamood (1997)	230	LOAEL ≥ 20	53	mouse	50 days	chromium chloride (chromium [III])	pregnancy success	drinking water	12	2	none	4
Elbetieha and Al-Hamood (1997)	**91**	**LOAEL ≥ 20**	**63**	**mouse**	**50 days**	**chromium chloride (chromium [III])**	**viability of fetuses**	**drinking water**	**12**	**2**	**none**	**3**

Notes:

Bold indicates the lowest effect level, selected from the lowest tier evaluated, and as the lowest value from the following:

1. Lowest-observed-adverse-effect level (LOAEL) with ≥ 20 percent reduction in the response relative to control (LOAEL ≥ 20) from an individual data set,
2. Modeled effective dose with a 20 percent reduction in the response relative to the control (ED20) from an individual data set, or
3. ED20 or geometric mean from a pooled data set that was selected for modeling because the effect concentration had the potential for being lower than other ED20s and/or LOAELs based on visual inspection of the plotted data (i.e., Category 2 or 5).

[a] References are cited in Attachment E1 or Attachment E2.

[b] Pooling groups were evaluated only as a group and not on an individual basis for the purposes of selecting data to model in EPA's Toxicity Relationship Analysis Program (TRAP). Not all pooling groups were run in TRAP.

[c] Modeling categories are defined as follows:

1. Data were modeled in TRAP as an individual data set to derive the ED20 presented in this table.
2. Data were selected for modeling as an individual or pooled data set, but an ED20 could not be generated or the ED20 was not used due to poor model fit.
3. Data do not meet criteria for modeling as an individual data set (e.g., no effect with a ≥ 20 percent reduction in response relative to control, lack of two consecutively lower and different effects less than the control or consecutively lower effects are followed by an increased effect, a lower tier data set is available).
4. Not selected for modeling because the effect concentration for the individual or pooled data set is substantially higher than other ED20s and/or LOAELs.
5. Modeled in TRAP as part of a pooled data set.

NA - not applicable; the reduction in response was < 20 percent relative to the control

Table E2-6. Summary of Iron Dose-Response Data Sets

Source [a]	Effective Dose (mg/kg bw/day)	Type of Effect Level	Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group [b]	Modeling Category [c]
Bird Growth												
Cao et al. 1996	no effect at 80	NA	NA	chicken	1 day	iron sulfate	body weight	diet	3	1	none	3
McGhee et al. 1965	**160**	**LOAEL ≥ 20**	**76**	**chicken**	**juvenile**	**iron sulfate**	**body weight**	**diet**	**4**	**1**	**none**	**2**
Pescatore and Harter-Dennis 1989	no effect at 1,400	NA	NA	chicken	3 days	iron sulfate	body weight	gavage	single dose	1	none	3
Bird Survival												
McGhee et al. 1965	no effect at 160	NA	NA	chicken	juvenile	iron sulfate	survival	diet	4	1	none	3
Pooling group A:	**1,100**	**ED20**	**20**	**chicken**	**2-3 days**	**iron sulfate**	**survival**	**gavage**	**single dose**	**1**	**A**	2
Pescatore and Harter-Dennis 1989	1,200	LOAEL ≥ 20	74	chicken	3 days	iron sulfate	survival	gavage	single dose	1	A	
Wallner-Pendleton et al. 1986	2,010	LOAEL ≥ 20	80	chicken	2 days	iron sulfate	survival	gavage	single dose	1	A	
Mammal Growth												
Pooling group A:	**140**	**geometric mean**	**NA**	**rat**	**weanling**	**iron sulfate**	**body weight**	**diet**	**3-4**	**1**	**A**	**2**
Banis et al. 1969	47	LOAEL ≥ 20	77	rat	weanling	iron sulfate	body weight	diet	4	1	A	
Storey and Greger 1987	410	LOAEL ≥ 20	79	rat	weanling	iron sulfate	body weight	diet	3	1	A	
Plummer et al. 1997	650	LOAEL ≥ 20	77	rat	suckling	carbonyl iron	body weight (male)	diet	32	1	none	2
Plummer et al. 1997	no effect at 1,600	NA	NA	rat	suckling	carbonyl iron	body weight (female)	diet	32	1	none	3
Prince et al. 1979	no effect at 46	NA	NA	pig	70 days	ferrous sulfide	body weight	diet	16	1	none	3
Whittaker et al. 2002	no effect at 1,200	NA	NA	rat	young	iron sulfate	body weight	gavage	single dose	1	none	3
Whittaker et al. 2002	40000	LOAEL ≥ 20	74	rat	young	carbonyl iron	body weight	gavage	single dose	1	none	3, 4
Zhu et al. 2016	no effect at 320	NA	NA	rat	6 weeks	carbonyl iron	body weight	diet	13	1	none	3
Mammal Survival												
Whittaker et al. 1996	**870**	**ED20**	**20**	**rat**	**weanling**	**carbonyl iron**	**survival**	**diet**	**12**	**1**	**none**	**1**
Whittaker et al. 2002	1,000	ED20	20	rat	young	iron sulfate	survival	gavage	single dose	1	none	1
Whittaker et al. 2002	no effect at 50,000	NA	NA	rat	young	carbonyl iron	survival	gavage	single dose	1	none	3

Notes:

Bold indicates the lowest effect level, selected from the lowest tier evaluated, and as the lowest value from the following:

1. Lowest-observed-adverse-effect level (LOAEL) with ≥ 20 percent reduction in the response relative to control (LOAEL ≥ 20) from an individual data set,
2. Modeled effective dose with a 20 percent reduction in the response relative to the control (ED20) from an individual data set, or
3. ED20 or geometric mean from a pooled data set that was selected for modeling because the effect concentration had the potential for being lower than other ED20s and/or LOAELs based on visual inspection of the plotted data (i.e., Category 2 or 5).

[a] References are cited in Attachment E1 or Attachment E2.

[b] Pooling groups were evaluated only as a group and not on an individual basis for the purposes of selecting data to model in EPA's Toxicity Relationship Analysis Program (TRAP). Not all pooling groups were run in TRAP.

[c] Modeling categories are defined as follows:

1. Data were modeled in TRAP as an individual data set to derive the ED20 presented in this table.
2. Data were selected for modeling as an individual or pooled data set, but an ED20 could not be generated or the ED20 was not used due to poor model fit.
3. Data do not meet criteria for modeling as an individual data set (e.g., no effect with a ≥ 20 percent reduction in response relative to control, lack of two consecutively lower and different effects less than the control or consecutively lower effects are followed by an increased effect, a lower tier data set is available).
4. Not selected for modeling because the effect concentration for the individual or pooled data set is substantially higher than other ED20s and/or LOAELs.
5. Modeled in TRAP as part of a pooled data set.

NA - not applicable; the reduction in response was < 20 percent relative to the control

Table E2-7. Summary of Methylmercury Dose-Response Data Sets

Source [a]	Effective Dose (mg/kg bw/day)	Type of Effect Level	Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group [b]	Modeling Category [c]
Bird Growth												
Sell and Horani (1976)	no effect at 2.2	NA	NA	chicken	1 day	methylmercury chloride	body weight gain (Experiment 1)	diet	4	1	A	3
Sell and Horani (1976)	no effect at 2.2	NA	NA	chicken	6 days	methylmercury chloride	body weight gain (Experiment 2)	diet	3.6	1	A	3
Scott et al. (1975)	**0.97**	**ED20**	**20**	**chicken**	**12.5 months**	**methylmercury chloride**	**body weight**	**diet**	**8**	**2**	**none**	**1**
Spalding et al. (2000)	no effect at 0.70	NA	NA	egret	1 week	methylmercury chloride	weight index	diet	14	1	none	3
Bird Reproduction												
Albers et al. (2007)	0.48	LOAEL ≥ 20	63	kestrel	adult	methylmercury chloride	egg production	diet	at least 11	1	none	4
Albers et al. (2007)	*0.25*	*ED20*	*20*	*kestrel*	*adult*	*methylmercury chloride*	*number of eggs hatched*	*diet*	*at least 11*	*1*	*none*	*1*
Albers et al. (2007)	0.35	ED20	20	kestrel	adult	methylmercury chloride	% eggs hatched	diet	at least 11	1	none	1
Albers et al. (2007)	0.26	ED20	20	kestrel	adult	methylmercury chloride	% fledged	diet	at least 11	1	none	1
El-Begearmi et al. (1977)	2.0	LOAEL ≥ 20	34	quail	1 day	methylmercury hydroxide	% egg fertility	diet	16	1	none	4
El-Begearmi et al. (1977)	0.66	LOAEL ≥ 20	61	quail	1 day	methylmercury hydroxide	egg production	diet	16	1	none	4
El-Begearmi et al. (1977)	2.0	LOAEL ≥ 20	0	quail	1 day	methylmercury hydroxide	% hatchability	diet	16	1	none	4
Eskeland and Nafstad (1978)	0.53	LOAEL ≥ 20	45	quail	juvenile	methylmercury chloride	chick survival	diet	6	1	none	4
Eskeland and Nafstad (1978)	1.1	LOAEL ≥ 20	73	quail	juvenile	methylmercury chloride	hatch success	diet	6	1	none	4
Heinz and Hoffman (1998)	1.0	LOAEL ≥ 20	26	mallard	19 months	methylmercury chloride	% hatchability	diet	up to 11	1	none	4
Heinz and Hoffman (1998)	1.0	LOAEL ≥ 20	74	mallard	19 months	methylmercury chloride	duckling survival	diet	up to 11	1	none	4
Pooling Group B:	*0.68*	*ED20*	*20*	*mallard*	*adult*	*methylmercury chloride*	*ducklings per hen*	*diet*	*3.7 - 11*	*1*	*B*	5
Heinz and Hoffman (1998)	1.0	LOAEL ≥ 20	14	mallard	19 months	methylmercury chloride	ducklings per hen	diet	up to 11	1	B	
Heinz et al. (2010)	0.80	LOAEL ≥ 20	74	mallard	adult	methylmercury chloride	ducklings per hen	diet	3.7	1	B	
Heinz et al. (2010)	no effect at 0.80	NA	NA	mallard	adult	methylmercury chloride	duckling body weight	diet	3.7	1	none	3
Scott et al. (1975)	0.70	LOAEL ≥ 20	63	chicken	12.5 months	methylmercury chloride	egg fertility	diet	8	1	none	4
Scott et al. (1975)	0.70	LOAEL ≥ 20	73	chicken	12.5 months	methylmercury chloride	egg production	diet	8	1	none	4
Scott et al. (1975)	0.70	LOAEL ≥ 20	17	chicken	12.5 months	methylmercury chloride	egg hatchability	diet	8	1	none	4
Varian-Ramos et al. (2014)	no effect at 0.41	NA	NA	finch	adult	methylmercury cysteine	% hatchability	diet	52	1	none	3
Varian-Ramos et al. (2014)	0.047	ED20	20	finch	adult	methylmercury cysteine	% chicks fledged	diet	52	1	none	1
Varian-Ramos et al. (2014)	0.043	ED20	20	finch	adult	methylmercury cysteine	number of offspring	diet	52	1	none	1
Varian-Ramos et al. (2014)	0.10	LOAEL ≥ 20	67	finch	adult	methylmercury cysteine	F1 % hatchability	diet	unclear	1	none	4
Varian-Ramos et al. (2014)	0.10	LOAEL ≥ 20	73	finch	adult	methylmercury cysteine	F1 % chicks fledged	diet	unclear	1	none	2
Varian-Ramos et al. (2014)	**0.012**	**ED20**	**20**	**finch**	**adult**	**methylmercury cysteine**	**F1 number of offspring**	**diet**	**unclear**	**1**	**none**	**1**
Bird Survival												
Bennett et al. (2009) [d]	1.3	LOAEL ≥ 20	0	kestrel	adult	methylmercury chloride	survival	diet	5 - 7	1	none	3
El-Begearmi et al. (1977)	2.0	LOAEL ≥ 20	11	quail	hatchling	methylmercury hydroxide	survival (female)	diet	16	1	C	3
El-Begearmi et al. (1977)	2.0	LOAEL ≥ 20	27	quail	hatchling	methylmercury hydroxide	survival (male)	diet	16	1	C	3
Hill and Soares (1987)	3.7	LOAEL ≥ 20	62	quail	hatchling	methylmercury chloride	survival	diet	0.71	1	none	4
Hill and Soares (1987)	5.5	LOAEL ≥ 20	61	quail	14 days	methylmercury chloride	survival	diet	0.71	1	none	4
Scheuhammer (1988)	1.8	LOAEL ≥ 20	75	finch	adult	methylmercury chloride	survival	diet	11	1	none	3
Sell and Horani (1976)	no effect at 2.2	NA	NA	chicken	1 day	methylmercury chloride	survival (Experiment 1)	diet	4	1	none	3
Sell and Horani (1976)	no effect at 2.2	NA	NA	chicken	6 days	methylmercury chloride	survival (Experiment 2)	diet	3.6	1	none	3
Sell and Horani (1976)	no effect at 2.6	NA	NA	quail	8 days	methylmercury chloride	survival (Experiment 2)	diet	3.3	1	none	3
Spann et al. (1986)	2.0	LOAEL ≥ 20	19	quail	12 days	methylmercury chloride	survival	diet	6	1	none	4
Varian-Ramos et al. (2014)	**0.051**	**LOAEL ≥ 20**	**76**	**finch**	**adult**	**methylmercury cysteine**	**survival**	**diet**	**52**	**1**	**none**	**2**
Varian-Ramos et al. (2014)	**0.051**	**LOAEL ≥ 20**	**77**	**finch**	**adult**	**methylmercury cysteine**	**F1 survival**	**diet**	**unclear**	**1**	**none**	**3**

Table E2-7. Summary of Methylmercury Dose-Response Data Sets

Source [a]	Effective Dose (mg/kg bw/day)	Type of Effect Level	Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group [b]	Modeling Category [c]
Mammal Growth												
Friedman et al. (1978)	2.2	LOAEL ≥ 20	68	rat	unclear	methlymercury chloride	body weight	diet	10	1	none	4
Gandhi et al. (2013)	1.9	LOAEL ≥ 20	47	rat	adult	methlymercury chloride	body weight gain (female)	gavage	3	2	none	4
Mitsumori et al. (1983)	**0.65**	**LOAEL ≥ 20**	**64**	**rat**	**4 weeks**	**methylmercury chloride**	**body weight**	**diet**	**130**	**1**	**none**	**2**
Mitsumori et al. (1990)	0.69	LOAEL ≥ 20	64	mouse	4 weeks	methylmercury chloride	body weight	diet	104	1	none	2
Stillings et al. (1974)	3.1	LOAEL ≥ 20	14	rat	weanling	methylmercury chloride	body weight gain	diet	4	1	none	4
Verschuuren et al. (1976a)	no effect at 0.23	NA	NA	rat	4 weeks	methylmercury chloride	F2 body weight gain (female)	diet	12	1	none	3
Verschuuren et al. (1976b)	no effect at 0.20	NA	NA	rat	4 weeks	methylmercury chloride	body weight	diet	104	1	none	3
Wobeser et al. (1976)	0.080	LOAEL ≥ 20	76	mink	adult	methylmercury chloride	body weight (female)	diet	13	2	none	2
Mammal Reproduction												
Gandhi et al. (2013)	1.9	LOAEL ≥ 20	0	rat	adult	methylmercury chloride	fetal survival	gavage	3	1	none	4
Tonk et al. (2010)	1.4	LOAEL ≥ 20	78	rat	adult	methylmercury chloride	litter survival	gavage	variable	1	none	4
Verschuuren et al. (1976a)	**0.23**	**LOAEL ≥ 20**	**42**	**rat**	**4 weeks**	**methylmercury chloride**	**F1 viability index**	**diet**	**12**	**1**	**none**	**2**
Mammal Survival												
Pooling Group E:	**0.24**	**ED20**	**20**	**rat**	**4 weeks**	**methylmercury chloride**	**survival**	**diet**	**104 - 130**	**1**	**E**	**5**
Mitsumori et al. (1983)	0.65	LOAEL ≥ 20	28	rat	4 weeks	methylmercury chloride	survival	diet	130	1	E	
Mitsumori et al. (1983)	0.65	LOAEL ≥ 20	33	rat	4 weeks	methylmercury chloride	survival	diet	130	1	E	
Verschuuren et al. (1976b)	0.0081	LOAEL ≥ 20	79	rat	4 weeks	methylmercury chloride	survival (female)	diet	104	1	E	
Verschuuren et al. (1976b)	0.340	LOAEL ≥ 20	67	rat	4 weeks	methylmercury chloride	survival (male)	diet	104	1	E	
Mitsumori et al. (1990)	0.69	LOAEL ≥ 20	35	mouse	4 weeks	methylmercury chloride	survival	diet	104	1	none	2

Notes:

Bold indicates the lowest effect level, selected from the lowest tier evaluated, and as the lowest value from the following:

1. Lowest-observed-adverse-effect level (LOAEL) with ≥ 20 percent reduction in the response relative to control (LOAEL ≥ 20) from an individual data set,
2. Modeled effective dose with a 20 percent reduction in the response relative to the control (ED20) from an individual data set, or
3. ED20 or geometric mean from a pooled data set that was selected for modeling because the effect concentration had the potential for being lower than other ED20s and/or LOAELs based on visual inspection of the plotted data (i.e., Category 2 or 5).

Italics indicate UCR receptor-specific toxicity response value (TRV) data set.

Yellow and blue highlights indicate pooled data sets modeled in EPA's Toxicity Relationship Analysis Program (TRAP).

[a] References are cited in Attachment E1 or Attachment E2.

[b] Pooling groups were evaluated only as a group and not on an individual basis for the purposes of selecting data to model in TRAP. Not all pooling groups were run in TRAP.

[c] Modeling categories are defined as follows:

1. Data were modeled in TRAP as an individual data set to derive the ED20 presented in this table.
2. Data were selected for modeling as an individual or pooled data set, but an ED20 could not be generated or the ED20 was not used due to poor model fit.

3. Data do not meet criteria for modeling as an individual data set (e.g., no effect with a ≥ 20 percent reduction in response relative to control, lack of two consecutively lower and different effects less than the control or consecutively lower effects are followed by an increased effect, a lower tier data set is available).
4. Not selected for modeling because the effect concentration for the individual or pooled data set is substantially higher than other ED20s and/or LOAELs.
5. Modeled in TRAP as part of a pooled data set.

[d] The effect level from Bennett et al. (2009) was not selected as a receptor-specific TRV for survival because the LOAEL ≥ 20 was a level at which 100 percent mortality occurred, indicating that is not likely to be a protective value.

F1 - first filial generation

F2 - second filial generation

NA - not applicable; the reduction in response was < 20 percent relative to the control

Table E2-8. Summary of Molybdenum Dose-Response Data Sets

Source [a]	Effective Dose (mg/kg bw/day)	Type of Effect Level	Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group [b]	Modeling Category [c]
Bird Growth												
Pooling group A:	**100**	**ED20**	**20**	**chicken**	**1 day**	**sodium molybdate**	**body weight**	**diet**	**4**	**1**	**A**	5
Davies et al. (1960)	84	LOAEL ≥ 20	78	chicken	1 day	sodium molybdate	body weight (Experiment 1b)	diet	4	1	A	
Davies et al. (1960)	220	LOAEL ≥ 20	64	chicken	1 day	sodium molybdate	body weight (Experiment 1c)	diet	4	1	A	
Kratzer (1952)	no effect at 28	NA	NA	chicken	1 week	sodium molybdate	body weight gain	diet	3.3	1	none	3
Stafford et al. (2015)	no effect at 550	NA	NA	bobwhite quail	9 days	molydenum disulfide	body weight gain	diet	4.3	1	none	3
Stafford et al. (2015)	360	LOAEL ≥ 20	78	bobwhite quail	9 days	sodium molybdate	body weight gain	diet	4.3	1	none	4
Bird Reproduction												
Lepore and Miller (1965)	**36**	**ED20**	**20**	**chicken**	**7 months**	**sodium molybdate**	**egg production**	**diet**	**3**	**1**	**none**	**1**
Bird Survival												
Davies et al. (1960)	no effect at 170	NA	NA	chicken	1 day	sodium molybdate	survival (Experiment 1b)	diet	4	1	none	3
Davies et al. (1960)	**610**	**ED20**	**20**	**chicken**	**1 day**	**sodium molybdate**	**survival (Experiment 1c)**	**diet**	**4**	**1**	**none**	**1**
Mammal Growth												
Bandyopadhyay et al. (1981)	240	LOAEL ≥ 20	45	rat	juvenile	ammonium molybdate	body weight gain	oral	4	1	A	4
Bandyopadhyay et al. (1981)	240	LOAEL ≥ 20	62	rat	juvenile	ammonium molybdate	body weight gain	oral	4	1	A	4
Brinkman and Miller (1961)	**28**	**LOAEL ≥ 20**	**46**	**rat**	**weanling**	**sodium molybdate**	**body weight gain**	**diet**	**6**	**1**	**none**	**3**
Fungwe et al. (1990)	28	LOAEL ≥ 20	79	rat	21 days	sodium molybdate	body weight gain	drinking water	9	2	none	3
Lyubimov et al. (2004)	no effect at 24	NA	NA	rat	20-23 weeks	ammonium tetrathiomolybdate	body weight	gavage	8	2	none	3
Murray et al. (2013)	no effect at 55	NA	NA	rat	9 weeks	sodium molybdate dihydrate	body weight	diet	12	1	none	3
Mammal Reproduction												
Fungwe et al. (1990)	**4.5**	**ED20**	**20**	**rat**	**21 days**	**sodium molybdate**	**litter weight**	**drinking water**	**9**	**2**	**none**	**1**

Notes:

Bold indicates the lowest effect level, selected from the lowest tier evaluated, and as the lowest value from the following:

1. Lowest-observed-adverse-effect level (LOAEL) with ≥ 20 percent reduction in the response relative to control (LOAEL ≥ 20) from an individual data set,
2. Modeled effective dose with a 20 percent reduction in the response relative to the control (ED20) from an individual data set, or
3. ED20 or geometric mean from a pooled data set that was selected for modeling because the effect concentration had the potential for being lower than other ED20s and/or LOAELs based on visual inspection of the plotted data (i.e., Category 2 or 5).

Yellow highlights indicate pooled data sets modeled in EPA's Toxicity Relationship Analysis Program (TRAP).

[a] References are cited in Attachment E1 or Attachment E2.

[b] Pooling groups were evaluated only as a group and not on an individual basis for the purposes of selecting data to model in TRAP. Not all pooling groups were run in TRAP.

[c] Modeling categories are defined as follows:

1. Data were modeled in TRAP as an individual data set to derive the ED20 presented in this table.
2. Data were selected for modeling as an individual or pooled data set, but an ED20 could not be generated or the ED20 was not used due to poor model fit.
3. Data do not meet criteria for modeling as an individual data set (e.g., no effect with a ≥ 20 percent reduction in response relative to control, lack of two consecutively lower and different effects less than the control or consecutively lower effects are followed by an increased effect, a lower tier data set is available).
4. Not selected for modeling because the effect concentration for the individual or pooled data set is substantially higher than other ED20s and/or LOAELs.
5. Modeled in TRAP as part of a pooled data set.

NA - not applicable; the reduction in response was < 20 percent relative to the control

Table E2-9. Summary of Selenium Dose-Response Data Sets

Source [a]	Effective Dose (mg/kg bw/day)	Type of Effect Level	Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group [b]	Modeling Category [c]
Bird Growth												
Pooling group A:	**0.28**	**ED20**	**20**	**chicken**	**1 - 7 days**	**sodium selenite**	**body weight**	**diet**	**3 - 4**	**1**	**A**	**5**
Dafalla and Adam (1986)	0.26	LOAEL ≥ 20	70	chicken	1 week	sodium selenite	body weight	diet	4	1	A	
El-Begearmi and Combs (1982)	2.7	LOAEL ≥ 20	36	chicken	1 day	sodium selenite	body weight	diet	4	1	A	
El-Begearmi and Combs (1982)	2.7	LOAEL ≥ 20	33	chicken	1 day	sodium selenite	body weight	diet	4	1	A	
Jensen (1986)	0.57	LOAEL ≥ 20	77	chicken	1 day	sodium selenite	body weight	diet	3	1	A	
Echevarria et al. (1988)	1.0	LOAEL ≥ 20	74	chicken	1 day	sodium selenite	body weight gain	diet	3	1	C	4
Gad and El-Twab (2009)	no effect at 3.4	NA	NA	quail	adult	sodium selenite	body weight	gavage	4	2	none	3
Heinz and Fitzgerald (1993a)	no effect at 2.0	NA	NA	mallard	adult	seleno-DL-methionine	body weight	diet	21	1	D	4
Hill (1979a)	1.1	LOAEL ≥ 20	79	chicken	1 day	selenium dioxide	body weight gain	diet	4-5	1	B	4
Hill (1979a)	2.2	LOAEL ≥ 20	35	chicken	1 day	selenium dioxide	body weight gain	diet	4-5	1	B	4
Hoffman et al. (1992)	*1.6*	*ED20*	*20*	*mallard*	*1 day*	*seleno-DL-methionine*	*body weight*	*diet*	*4*	*1*	*none*	*1*
O'Toole and Raisbeck (1997)	4.6	LOAEL ≥ 20	70	mallard	adult	seleno-L-methionine	body weight	diet	21	1	D	4
Santolo et al. (2010)	no effect at 2.9	NA	NA	quail	adult	seleno-L-methionine	body weight gain	diet	4	2	none	3
Sell and Horani (1976)	no effect at 0.89	NA	NA	chicken	1 day	sodium selenite	body weight gain	diet	4	1	C	4
Stoewsand et al. (1977)	no effect at 1.0	NA	NA	quail	2 weeks	sodium selenite	body weight	diet	10	1	none	3
Stoewsand et al. (1977)	no effect at 1.0	NA	NA	quail	2 weeks	seleniferous wheat	body weight	diet	10	1	none	3
Bird Reproduction												
Kaantee and Kurbela (1980)	no effect at 0.16	NA	NA	chicken	18 months	sodium selenite	egg production	diet	4	1	none	3
Pooling group E:	*0.56*	*ED20*	*20*	*mallard*	*adult*	*selenomethionine*	*hatching success*	*diet*	*variable*	*1*	*E*	5
Heinz et al. (1989)	0.82	LOAEL ≥ 20	62	mallard	adult	selenomethionine	hatching success	diet	>14	1	E	
Hoffman and Heinz (1988)	0.82	LOAEL ≥ 20	64	mallard	adult	selenomethionine	hatching success	diet	at least 30 eggs produced	1	E	
Heinz et al. (1989)	1.6	LOAEL ≥ 20	0	mallard	adult	selenomethionine	duckling survival	diet	>14	1	none	4
Heinz et al. (1989)	0.60	ED20	20	mallard	adult	selenomethionine	number of 6-day-old ducklings	diet	>14	1	none	1
Hoffman and Heinz (1988)	2.5	LOAEL ≥ 20	56.0	mallard	adult	sodium selenite	hatching success	diet	at least 30 eggs produced	1	none	4
Ort and Latshaw (1978)	0.71	LOAEL ≥ 20	74	chicken	32 weeks	sodium selenite	egg production	diet	16	1	none	2
Ort and Latshaw (1978)	**0.55**	**ED20**	**20**	**chicken**	**32 weeks**	**sodium selenite**	**hatchability**	**diet**	**16**	**1**	**none**	**1**
Stone and Soares (1976)	no effect at 0.14	NA	NA	quail	adult	sodium selenite	egg production (Experiments 1 and 3)	diet	3.9 - 4.6	1	none	3
Wiemeyer and Hoffman (1996)	4.2	LOAEL ≥ 20	75	owl	adult	seleno-DL-methionine	% pairs with hatchlings	diet	12	1	none	4
Wiemeyer and Hoffman (1996)	14	LOAEL ≥ 20	0	owl	adult	seleno-DL-methionine	pairs with 5-day-old young	diet	12	1	none	4
Wiemeyer and Hoffman (1996)	14	LOAEL ≥ 20	5	owl	adult	seleno-DL-methionine	% hatch of eggs incubated	diet	12	1	none	4
Bird Survival												
Pooling group I:	*4.7*	*geometric mean*	*20*	*mallard*	*adult*	*seleno-DL-methionine*	*survival*	*diet*	*16*	*1*	*I*	2
Albers et al. (1996)	11	LOAEL ≥ 20	0	mallard	1 year	seleno-DL-methionine	survival	diet	16	1	I	
Heinz and Fitzgerald (1993b)	2.0	LOAEL ≥ 20	75	mallard	adult	seleno-DL-methionine	survival	diet	16	1	I	
Arnold et al. (1973)	**0.59**	**LOAEL ≥ 20**	**65**	**chicken**	**1 day**	**sodium selenite**	**survival**	**diet**	**64**	**1**	**none**	**3**
El-Begearmi and Combs (1982)	2.7	LOAEL ≥ 20	63	chicken	1 day	sodium selenite	survival	diet	4	1	G	4
El-Begearmi and Combs (1982)	5.4	LOAEL ≥ 20	8	chicken	1 day	sodium selenite	survival	diet	4	1	G	4
El-Begearmi et al. (1977)	no effect at 1.6	NA	NA	quail	1 day	sodium selenite	survival	diet	16	1	H	4
El-Begearmi et al. (1977)	1.6	LOAEL ≥ 20	57	quail	1 day	sodium selenite	survival	diet	16	1	H	4
Gad and El-Twab (2009)	no effect at 3.4	NA	NA	quail	adult	sodium selenite	survival	gavage	4	1	none	3
Khan et al. (1993)	2.5	LOAEL ≥ 20	60	chicken	2 weeks	sodium selenite	survival	gavage	0.86	1	none	3
Mammal Growth												
Baker et al. (1989)	no effect at 0.63	NA	NA	pig	8 - 14 weeks	sodium selenate	body weight	diet	3.7	1	none	3
Behne et al. (1992)	no effect at 0.15	NA	NA	rat	30 days	L-selenomethionine	body weight	diet	14	1	none	3
Birt et al. (1983)	no effect at 0.85	NA	NA	hamster	4 weeks	sodium selenite	body weight	diet	25	1	none	3
Birt et al. (1986)	no effect at 0.27	NA	NA	hamster	4 weeks	sodium selenite	body weight	diet	64	1	none	3
Boylan et al. (1990)	no effect at 0.22	NA	NA	mouse	NR	sodium selenite	body weight	diet	26	1	none	3
Goehring et al. (1984)	0.87	LOAEL ≥ 20	78	rat	adult (assumed)	seleniferous grain	body weight gain	diet	4	2	none	3
Goehring et al. (1984)	0.60	LOAEL ≥ 20	72	rat	adult (assumed)	sodium selenite	body weight gain	diet	4	2	none	3

Table E2-9. Summary of Selenium Dose-Response Data Sets

Source [a]	Effective Dose (mg/kg bw/day)	Type of Effect Level	Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group [b]	Modeling Category [c]
Mammal Growth (continued)												
Julius et al. (1983)	2.6	LOAEL ≥ 20	79	hamster	4 weeks	sodium selenite	body weight (male, Experiment 1)	diet	3	1	A	4
Julius et al. (1983)	4.7	LOAEL ≥ 20	69	hamster	4 weeks	sodium selenite	body weight (female, Experiment 1)	diet	3	1	A	4
Julius et al. (1983)	1.4	LOAEL ≥ 20	77	hamster	4 weeks	sodium selenite	body weight (male, Experiment 2)	diet	3	1	A	4
Kaur and Parshad (1994)	0.19	LOAEL ≥ 20	77	rat	adult	sodium selenite	body weight	diet	5.1	2	none	3
Mahan and Moxon (1984)	**0.33**	**ED20**	**-**	**pig**	**4 weeks**	**sodium selenite**	**body weight**	**diet**	**5.3**	**1**	**none**	**1**
Spallholz et al. (1973)	5.7	LOAEL ≥ 20	58	mouse	weanling	sodium selenite	body weight gain	diet	5	1	none	4
Wahlstrom et al. (1956)	no effect at 0.56	NA	NA	pig	weanling	sodium selenite	body weight	diet	14	1	none	3
Mammal Reproduction												
Chernoff and Kavlock (1982)	no effect at 4.6	NA	NA	mouse	60 days	sodium selenite	number pregnant	gavage	0.71	1	none	3
Gray and Kavlock (1984)	no effect at 4.6	NA	NA	mouse	90 days	sodium selenite	number of live offspring	gavage	0.71	1	none	3
Hardin et al. (1987)	6.4	LOAEL ≥ 20	45	mouse	adult	sodium selenite	% viable litters	gavage	1.1	1	none	4
Seidenberg et al. (1986)	**5.0**	**LOAEL ≥ 20**	**46**	**mouse**	**adult**	**sodium selenate**	**number of litters born**	**gavage**	**0.71**	**1**	**none**	**3**
Wahlstrom and Olson (1959)	no effect at 0.0011	NA	NA	pig	8 weeks	sodium selenite	number of live piglets	diet	34	1	none	3
Mammal Survival												
Halverson et al. (1966)	1.1	LOAEL ≥ 20	38	rat	weanling	seleniferous wheat	survival	diet	6	1	B	4
Julius et al. (1983)	9.9	LOAEL ≥ 20	70	hamster	4 weeks	sodium selenite	survival	diet	3	1	none	4
McAdam and Levander (1987)	1.2	LOAEL ≥ 20	0	rat	weanling	D-selenomethionine	survival	diet	6	1	B	4
McAdam and Levander (1987)	0.61	LOAEL ≥ 20	63	rat	weanling	L-selenomethionine	survival	diet	6	1	B	4
McAdam and Levander (1987)	**0.61**	**LOAEL ≥ 20**	**38**	**rat**	**weanling**	**sodium selenite**	**survival**	**diet**	**6**	**1**	**none**	**2**
McAdam and Levander (1987)	1.2	LOAEL ≥ 20	75	rat	weanling	sodium selenate	survival	diet	6	1	none	4
Moxon and Mahan (1981)	0.81	LOAEL ≥ 20	75	pig	weanling	sodium selenite	survival	diet	5.3	1	none	4
Palmer et al. (1982)	0.92	LOAEL ≥ 20	80	rat	NR	seleniferous corn	survival	diet	4	1	B	4
Spallholz et al. (1973)	5.7	LOAEL ≥ 20	63	mouse	weanling	sodium selenite	survival	diet	5	1	none	4

Notes:

Bold indicates the lowest effect level, selected from the lowest tier evaluated, and as the lowest value from the following:

1. Lowest-observed-adverse-effect level (LOAEL) with ≥ 20 percent reduction in the response relative to control (LOAEL ≥ 20) from an individual data set,
2. Modeled effective dose with a 20 percent reduction in the response relative to the control (ED20) from an individual data set, or
3. ED20 or geometric mean from a pooled data set that was selected for modeling because the effect concentration had the potential for being lower than other ED20s and/or LOAELs based on visual inspection of the plotted data (i.e., Category 2 or 5).

Italics indicate UCR receptor-specific toxicity reference value (TRV) data set.

Yellow and blue highlights indicate pooled data sets modeled in EPA's Toxicity Relationship Analysis Program (TRAP).

[a] References are cited in Attachment E1 or Attachment E2.

[b] Pooling groups were evaluated only as a group and not on an individual basis for the purposes of selecting data to model in TRAP. Not all pooling groups were run in TRAP.

[c] Modeling categories are defined as follows:

1. Data were modeled in TRAP as an individual data set to derive the ED20 presented in this table.
2. Data were selected for modeling as an individual or pooled data set, but an ED20 could not be generated or the ED20 was not used due to poor model fit.
3. Data do not meet criteria for modeling as an individual data set (e.g., no effect with a ≥ 20 percent reduction in response relative to control, lack of two consecutively lower and different effects less than the control or consecutively lower effects are followed by an increased effect, a lower tier data set is available).
4. Not selected for modeling because the effect concentration for the individual or pooled data set is substantially higher than other ED20s and/or LOAELs.
5. Modeled in TRAP as part of a pooled data set.

NA - not applicable; the reduction in response was < 20 percent relative to the control

NR - not reported

Table E2-10. Summary of Thallium Dose-Response Data Sets

Source [a]	Effective Dose (mg/kg bw/day)	Type of Effect Level	Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group [b]	Modeling Category [c]
Mammal Growth												
Pooling group A:	**2.6**	**ED20**	**20**	**rat**	**weanling**	**thallic oxide**	**body weight**	**diet**	**15**	**1**	**A**	**5**
Downs et al. (1960)	3.0	LOAEL ≥ 20	44	rat	weanling	thallic oxide	body weight	diet	15	1	A	
Downs et al. (1960)	3.5	LOAEL ≥ 20	75	rat	weanling	thallic oxide	body weight	diet	15	1	A	
Mammal Survival												
Pooling group B:	**2.1**	**ED20**	**20**	**rat**	**weanling**	**thallic oxide**	**survival**	**diet**	**15**	**1**	**B**	**5**
Downs et al. (1960)	3.0	LOAEL ≥ 20	25	rat	weanling	thallic oxide	survival	diet	15	1	B	
Downs et al. (1960)	2.0	LOAEL ≥ 20	60	rat	weanling	thallic oxide	survival	diet	15	1	B	

Notes:

[a] References are cited in Attachment E1 or Attachment E2.

[b] Pooling groups were evaluated only as a group and not on an individual basis for the purposes of selecting data to model in EPA's Toxicity Relationship Analysis Program (TRAP). Not all pooling groups were run in TRAP.

[c] Modeling categories are defined as follows:

1. Data were modeled in TRAP as an individual data set to derive the effective dose with a 20 % reduction in the response relative to the control (modeled) (ED20) presented in this table.
2. Data were selected for modeling as an individual or pooled data set but, an ED20 could not be generated or the ED20 was not used due to poor model fit.
3. Data do not meet criteria for modeling as an individual data set (e.g., no effect with a ≥ 20 percent reduction in response relative to control, lack of two consecutively lower and different effects less than the control or consecutively lower effects are followed by an increased effect, a lower tier data set is available).
4. Not selected for modeling because the effect concentration for the individual or pooled data set is substantially higher than other ED20s and/or lower-observed-adverse-effect levels (LOAELs).
5. Modeled in TRAP as part of a pooled data set.

LOAEL ≥ 20 - LOAEL with ≥ 20 percent reduction in the response relative to the control

Table E2-11. Summary of Vanadium Dose-Response Data Sets

Source [a]	Effective Dose (mg/kg bw/day)	Type of Effect Level	Percent Effect Relative to Control	Receptor	Lifestage/Age	Chemical Form	Effect Measure	Exposure Route	Exposure Duration (weeks unless noted otherwise)	Data Tier	Pooling Group [b]	Modeling Category [c]
Bird Growth												
Pooling group A:	5.2	ED20	20	chicken	chick	ammonium metavanadate	body weight	diet	2 - 4	1	A	5
Berg and Lawrence (1971)	1.2	LOAEL ≥ 20	63	chicken	chick	ammonium metavanadate	body weight	diet	2	1	A	
Cervantes and Jensen (1986)	2.2	LOAEL ≥ 20	75	chicken	1 day	ammonium metavanadate	body weight	diet	4	1	A	
Nelson et al. (1962)	9.7	LOAEL ≥ 20	68	chicken	chick	ammonium metavanadate	body weight	diet	4	1	A	
Nelson et al. (1962)	5.2	LOAEL ≥ 20	72	chicken	chick	ammonium metavanadate	body weight	diet	4	1	A	
Qureshi et al. (1999)	5.6	LOAEL ≥ 20	68	chicken	chick	ammonium metavanadate	body weight	diet	3	1	A	
Hill (1994)	5.6	LOAEL ≥ 20	50	chicken	hatchling	ammonium metavanadate	body weight	diet	2.9	1	A	
Pooling group B:	1.3	ED20	20	chicken	1 day	sodium metavanadate	body weight gain	diet	2 - 2.7	1	B	5
Hill (1974)	no effect at 1.2	NA	NA	chicken	1 day	sodium metavanadate	body weight gain	diet	2	1	B	
Hill (1979a)	1.4	LOAEL ≥ 20	78	chicken	1 day	sodium metavanadate	body weight gain	diet	2	1	B	
Hill (1990a)	4.5	LOAEL ≥ 20	55	chicken	1 day	sodium metavanadate	body weight gain	diet	2.7	1	B	
Hill (1990b)	2.8	LOAEL ≥ 20	38	chicken	1 day	sodium metavanadate	body weight gain	diet	2.7	1	B	
Pooling group E:	2.3	geometric mean	20	chicken	chick	vanadyl chloride	body weight	diet	2 - 3	1	E	2
Berg and Lawrence (1971)	1.2	LOAEL ≥ 20	75	chicken	chick	vanadyl dichloride	body weight	diet	2	1	E	
Blalock and Hill (1987)	4.5	LOAEL ≥ 20	54	chicken	1 day	vanadyl chloride	body weight	diet	3	1	E	
Berg and Lawrence (1971)	**1.2**	**ED20**	**20**	**chicken**	**chick**	**vanadyl sulfate**	**body weight**	**diet**	**2**	**1**	**none**	**1**
Summers and Moran (1972)	no effect at 1.1	NA	NA	chicken	chick	NR	body weight gain	diet	3	1	none	3
Bird Reproduction												
Hafez and Kratzer (1976b)	23	LOAEL ≥ 20	33	chicken	28 weeks	ammonium metavanadate	egg production	diet	NR	1	C	2
Kubena and Phillips (1982)	7.3	LOAEL ≥ 20	30	chicken	29 weeks	calcium orthovanadate	egg production	diet	20	1	none	2
Ousterhout and Berg (1980)	3.1	LOAEL ≥ 20	77	chicken	40 weeks	ammonium vanadate	egg production	diet	4	1	C	2
Toussant and Latshaw (1994)	**2.1**	**LOAEL ≥ 20**	**51**	**chicken**	**25 weeks**	**ammonium metavanadate**	**egg production**	**diet**	**4**	**1**	**C**	**2**
Bird Survival												
Pooling group D:	5.0	geometric mean	20	chicken	chick	ammonium metavanadate	survival	diet	2 - 4	1	D	2
Berg and Lawrence (1971)	2.3	LOAEL ≥ 20	30	chicken	chick	ammonium metavanadate	survival	diet	2	1	D	
Hafez and Kratzer (1976a)	22	LOAEL ≥ 20	80	chicken	1 day	ammonium metavanadate	survival (Experiment 1)	diet	4	1	D	
Hafez and Kratzer (1976a)	6.0	LOAEL ≥ 20	80	chicken	1 day	ammonium metavanadate	survival (Experiment 2)	diet	4	1	D	
Hathcock et al. (1964)	3.2	LOAEL ≥ 20	5.9	chicken	1 day	ammonium metavanadate	survival	diet	2	1	D	
Hathcock et al. (1964)	3.2	LOAEL ≥ 20	18	chicken	1 day	ammonium metavanadate	survival	diet	2	1	D	
Blalock and Hill (1987)	**2.4**	**ED20**	**20**	**chicken**	**1 day**	**vanadyl chloride**	**survival**	**diet**	**3**	**1**	**none**	**1**
Hathcock et al. (1964)	3.2	LOAEL ≥ 20	16	chicken	1 day	vanadyl sulfate	survival	diet	2	1	none	3
Kubena and Phillips (1982)	7.3	LOAEL ≥ 20	44	chicken	29 weeks	calcium orthovanadate	survival	diet	20	1	none	4

Notes:

Bold indicates the lowest effect level, selected from the lowest tier evaluated, and as the lowest value from the following:

1. Lowest-observed-adverse-effect level (LOAEL) with ≥ 20 percent reduction in the response relative to control (LOAEL ≥ 20) from an individual data set,
2. Modeled effective dose with a 20 percent reduction in the response relative to the control (ED20) from an individual data set, or
3. ED20 or geometric mean from a pooled data set that was selected for modeling because the effect concentration had the potential for being lower than other ED20s and/or LOAELs based on visual inspection of the plotted data (i.e., Category 2 or 5).

Yellow and blue highlights indicate pooled data sets modeled in EPA's Toxicity Relationship Analysis Program (TRAP).

[a] References are cited in Attachment E1 or Attachment E2.

[b] Pooling groups were evaluated only as a group and not on an individual basis for the purposes of selecting data to model in TRAP. Not all pooling groups were run in TRAP.

[c] Modeling categories are defined as follows:

1. Data were modeled in TRAP as an individual data set to derive the ED20 presented in this table.
2. Data were selected for modeling as an individual or pooled data set, but an ED20 could not be generated or the ED20 was not used due to poor model fit.
3. Data do not meet criteria for modeling as an individual data set (e.g., no effect with a ≥ 20 percent reduction in response relative to control, lack of two consecutively lower and different effects less than the control or consecutively lower effects are followed by an increased effect, a lower tier data set is available).
4. Not selected for modeling because the effect concentration for the individual or pooled data set is substantially higher than other ED20s and/or LOAELs.
5. Modeled in TRAP as part of a pooled data set.

NA - not applicable; the reduction in response was < percent relative to the control

NR - not reported

Table E2-12. Summary of Selected Effect Levels

		Growth					Reproduction				
Metal	Eco-SSL TRV (mg/kg bw/day)	Selected Effect Level (mg/kg bw/day)	Effect Level Type	LOAEL Effect Level (% Relative to Control)	Tier	Source[a]	Selected Effect Level (mg/kg bw/day)	Effect Level Type	LOAEL Effect Level (% Relative to Control)	Tier	Source[a]
Birds[b]											
Aluminum	na	150	ED20	NA	1	Capdevielle and Scanes (1995a)	no data	no data	no data	no data	no data
Antimony	na	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
Barium	na	480	ED20	NA	1	Johnson et al. (1960)	no data	no data	no data	no data	no data
Beryllium	na	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
Chromium (III)	2.66	510	LOAEL ≥ 20	57	1	Chung et al. (1985)	no data	no data	no data	no data	no data
Iron	na	160	LOAEL ≥ 20	76	1	McGhee et al. (1965)	no data	no data	no data	no data	no data
Methylmercury	na	0.97	ED20	NA	2	Scott et al. (1975)	0.012	ED20	NA	1	Varian-Ramos et al. (2014)
Molybdenum	na	100	ED20	NA	1	Davies et al. (1960) (two pooled data sets)	36	ED20	NA	1	Lepore and Miller (1965)
Thallium	na	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
Selenium	0.29	0.28	ED20	NA	1	Dafalla and Adam (1986); El-Begearmi and Combs (1982); Jensen (1986) (pooled)	0.55	ED20	NA	1	Ort and Latshaw (1978)
Vanadium	0.344	1.2	ED20	NA	1	Berg and Lawrence (1971)	2.1	LOAEL ≥ 20	51	1	Toussant and Latshaw (1994)
American Kestrel[b]											
Methylmercury	na	no data	no data	no data	no data	no data	0.25	ED20	NA	1	Albers et al. (2007)
Mammals											
Aluminum	na	400	LOAEL ≥ 20	14	1	Belles et al. (1999)	27	ED20	-	1	Paternain et al. (1988)
Antimony	0.059	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
Chromium (III)	2.4	110	LOAEL ≥ 20	76	2	Bataineh et al. (1997)	91	LOAEL ≥ 20	63	2	Elbetieha and Al-Hamood (1997)
Iron	na	140	geometric mean	NA	1	Banis et al. (1969); Storey and Greger (1987) (pooled)	no data	no data	no data	no data	no data
Methylmercury	na	0.65	LOAEL ≥ 20	64	1	Mitsumori et al. (1983)	0.23	LOAEL ≥ 20	42	1	Verschuuren et al. (1976a)
Molybdenum	na	28	LOAEL ≥ 20	46	1	Brinkman and Miller (1961)	4.5	ED20	NA	2	Fungwe et al. (1990)
Selenium	0.143	0.33	ED20	NA	1	Mahan and Moxon (1984)	5.0	LOAEL ≥ 20	46	1	Seidenberg et al. (1986)
Thallium	na	2.6	ED20	NA	1	Downs et al. (1960) (two pooled data sets)	no data	no data	no data	no data	no data

Notes:

Green shading indicates selected effect levels, which were derived from the modeled effective dose with a 20 percent reduction in the response relative to the control (ED20) or the lowest lowest-observed-adverse-effect level (LOAEL) with ≥ 20 percent reduction in the response relative to control (LOAEL ≥ 20) from the lowest tier study reviewed.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Effect levels for birds are generic levels applied to all representative receptors in the Upland BERA for which receptor-specific data are not available. American kestrel is a representative receptor for which receptor-specific data are available.

[c] The effect level from Bennett et al. (2009) is not selected as a receptor-specific toxicity reference value (TRV) for American kestrel survival because the LOAEL ≥ 20 is a level at which 100 percent mortality occurred, indicating that it is not likely to be a protective value.

Eco-SSL – ecological soil screening level

NA - not applicable

na - not available

UCR - Upper Columbia River

Table E2-12. Summary of Selected Effect Levels

		Survival				
Metal	Eco-SSL TRV (mg/kg bw/day)	Selected Effect Level (mg/kg bw/day)	Effect Level Type	LOAEL Effect Level (% Relative to Control)	Tier	Source [a]
Birds [b]						
Aluminum	na	560	LOAEL ≥ 20	75	1	Capdevielle and Scanes (1995a)
Antimony	na	no data	no data	no data	no data	no data
Barium	na	890	LOAEL ≥ 20	32, 44	1	Johnson et al. (1960) (two pooled data sets)
Beryllium	na	no data	no data	no data	no data	no data
Chromium (III)	2.66	no data	no data	no data	no data	no data
Iron	na	1,100	ED20	NA	1	Pescatore and Harter-Dennis (1989); Wallner-Pendleton et al. (1986) (pooled)
Methylmercury	na	0.051	LOAEL ≥ 20	76 - 77	1	Varian-Ramos et al. (2014)
Molybdenum	na	610	ED20	NA	1	Davies et al. (1960)
Thallium	na	no data	no data	no data	no data	no data
Selenium	0.29	0.59	LOAEL ≥ 20	65	1	Arnold et al. (1973)
Vanadium	0.344	2.4	ED20	-	1	Blalock and Hill (1987)
American Kestrel [b]						
Methylmercury	na	data not selected [c]	data not selected [c]	data not selected [c]	data not selected [c]	data not selected [c]
Mammals						
Aluminum	na	400	LOAEL ≥ 20	44	1	Belles et al. (1999)
Antimony	0.059	no data	no data	no data	no data	no data
Chromium (III)	2.4	no data	no data	no data	no data	no data
Iron	na	870	ED20	NA	1	Whittaker et al. (1996)
Methylmercury	na	0.24	ED20	NA	1	Mitsumori et al. (1983); Verschuuren et al. (1976b) (pooled)
Molybdenum	na	no data	no data	no data	no data	no data
Selenium	0.143	0.61	LOAEL ≥ 20	38	1	McAdam and Levander (1987)
Thallium	na	2.1	ED20	NA	1	Downs et al. (1960) (two pooled data sets)

Notes:

Green shading indicates selected effect levels, which were derived from the modeled effective dose with a 20 percent reduction in the response relative to the control (ED20) or the lowest lowest-observed-adverse-effect level (LOAEL) with ≥ 20 percent reduction in the response relative to control (LOAEL ≥ 20) from the lowest tier study reviewed.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Effect levels for birds are generic levels applied to all representative receptors in the Upland BERA for which receptor-specific data are not available. American kestrel is a representative receptor for which receptor-specific data are available.

[c] The effect level from Bennett et al. (2009) is not selected as a receptor-specific toxicity reference value (TRV) for American kestrel survival because the LOAEL ≥ 20 is a level at which 100 percent mortality occurred, indicating that it is not likely to be a protective value.

Eco-SSL – ecological soil screening level

NA - not applicable

na - not available

UCR - Upper Columbia River

Table E2-13. Summary of TRVs

	Growth		Reproduction		Survival	
Metal	TRV (mg/kg bw/day)	TRV Type	TRV (mg/kg bw/day)	TRV Type	TRV (mg/kg bw/day)	TRV Type
Birds [a]						
Aluminum	150	ED20	none	NA	560	LOAEL ≥ 20
Antimony	none	NA	none	NA	none	NA
Barium	480	ED20	none	NA	890	LOAEL ≥ 20
Beryllium	none	NA	none	NA	none	NA
Chromium (III)	510	LOAEL ≥ 20	none	NA	none	NA
Iron	160	LOAEL ≥ 20	none	NA	1,100	ED20
Methylmercury	0.97	ED20	0.012	ED20	0.051	LOAEL ≥ 20
Molybdenum	100	ED20	36	ED20	610	ED20
Selenium	0.29	Eco-SSL	0.55	ED20	0.59	LOAEL ≥ 20
Thallium	none	NA	none	NA	none	NA
Vanadium	1.2	ED20	2.1	LOAEL ≥ 20	2.4	ED20
American Kestrel [a]						
Methylmercury	none	NA	0.25	ED20	none	NA
Mammals						
Aluminum	400	LOAEL ≥ 20	27	ED20	400	LOAEL ≥ 20
Antimony	none	NA	none	NA	none	NA
Chromium (III)	110	LOAEL ≥ 20	91	LOAEL ≥ 20	none	NA
Iron	140	geometric mean	none	NA	870	ED20
Methylmercury	0.65	LOAEL ≥ 20	0.23	LOAEL ≥ 20	0.24	ED20
Molybdenum	28	LOAEL ≥ 20	4.5	ED20	none	NA
Selenium	0.33	ED20	5.0	LOAEL ≥ 20	0.61	LOAEL ≥ 20
Thallium	2.6	ED20	none	NA	2.1	ED20

Notes:

Green shading indicates selected toxicity reference values (TRVs). TRVs were derived from the lowest value from the lowest tier from among the following values: 1) modeled effective dose with a 20 percent reduction in the response relative to the control (ED20) from an individual data set; 2) lowest-observed-adverse-effect level (LOAEL) with ≥ 20 percent reduction in the response relative to control (LOAEL ≥ 20) from an individual data set; or 3) ED20 or geometric mean of LOAELs ≥ 20 from a pooled data set.

[a] TRVs for birds are generic levels applied to all representative receptors in the Upland BERA for which receptor-specific data are not available. American kestrel is a representative receptor for which receptor-specific data are available.

Eco-SSL - ecological soil screening level

NA - not applicable

Table E2-14. Updated Terrestrial Receptor-Specific TRVs

	Growth		Reproduction		Survival	
Metal - Receptor	TRV (mg/kg bw/day)	TRV Type	TRV (mg/kg bw/day)	TRV Type	TRV (mg/kg bw/day)	TRV Type
Cadmium - gray wolf	100 [a]	LOAEL ≥ 20	none	NA	none	NA

Notes:

[a] Data source: Hamada et al. (1991) in Attachment E2.

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

TRV - toxicity reference value

Table E2-15. Uncertainty Considerations for Selected Avian Effect Levels for Aluminum

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	150	no data	560
Reference [a]	Capdevielle and Scanes (1995a)	NA	Capdevielle and Scanes (1995a)
Receptor used in study	chicken	NA	chicken
Considerations in Study Used to Derive Selected Effect Level			
Is species a representative receptor for the Upland BERA?	no	NA	no
Dose administration	diet	NA	diet
Growth study exposure	critical lifestage	NA	NA
Chemical form	aluminum sulfate	NA	aluminum sulfate
Source of body weight and FIR	body weight and FIR – secondary source	NA	body weight and FIR – secondary source
Type of effect level	ED20	NA	LOAEL ≥ 20 (25% reduction in response relative to the control)
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias is indicated in parentheses)	not a representative receptor for the Upland BERA[b] (unknown) dose administration (unknown) estimated body weight and FIR (unknown)	NA	not a representative receptor for the Upland BERA[b] (unknown) dose administration (unknown) estimated body weight and FIR (unknown) effect level based on LOAEL ≥ 20 (high)
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	two (chicken, mallard)	NA	one (chicken)
Number of dose-response data sets evaluated	4 - Tier 1	NA	1 - Tier 1

Notes:

[a] References are cited in Attachment E1 or Attachment E2.

[b] Representative receptors are those selected for dietary modeling in the Upland BERA to represent the different feeding guilds.

ED20 - effective dose with a 20 percent reduction in the response relative to the control (modeled)

FIR - food ingestion rate

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

Table E2-16. Uncertainty Considerations for Selected Mammalian Effect Levels for Aluminum

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	400	27	400
Reference [a]	Belles et al. (1999)	Paternain et al. (1988)	Belles et al. (1999)
Receptor used in study	mouse	rat	mouse
Considerations in Study Used to Derive Selected Effect Level			
Is species a representative receptor for the Upland BERA?	no	no	no
Dose administration	gavage	gavage	gavage
Growth study exposure	non-critical lifestage, < 10% of lifespan	NA	NA
Chemical form	aluminum nitrate nonahydrate	aluminum nitrate nonahydrate	aluminum nitrate nonahydrate
Source of body weight and FIR	NA (doses reported in the study)	NA (doses reported in the study)	NA (doses reported in the study)
Type of effect level	LOAEL ≥ 20 (86% reduction in response relative to the control)	ED20	LOAEL ≥ 20 (56% reduction in response relative to the control)
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias is indicated in parentheses)	not a representative receptor for the Upland BERA [b] (unknown) dose administration (unknown) exposure life stage and duration (unknown) effect level based on LOAEL ≥ 20 (high)	not a receptor for the Upland BERA (unknown) dose administration (unknown)	not a representative receptor for the Upland BERA [b] (unknown) dose administration (unknown) effect level based on LOAEL ≥ 20 (high)
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	two (mouse, rat)	two (mouse, rat)	one (mouse)
Number of dose-response data sets evaluated	2 - Tier 1, 2 - Tier 2	6 - Tier 1	1 - Tier 1

Notes:

[a] References are cited in Attachment E1 or Attachment E2.

[b] Representative receptors are those selected for dietary modeling in the Upland BERA to represent the different feeding guilds.

ED20 - effective dose with a 20 percent reduction in the response relative to the control (modeled)

FIR - food ingestion rate

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

Table E2-17. Uncertainty Considerations for Selected Avian Effect Levels for Barium

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	480	no data	890
Reference [a]	Johnson et al. (1960)	NA	Johnson et al. (1960) (two data sets)
Receptor used in study	chicken	NA	chicken
Considerations in Study Used to Derive Selected Effect Level			
Is species a representative receptor for the Upland BERA?	no	NA	no
Dose administration	diet	NA	diet
Growth study exposure	critical lifestage	NA	NA
Chemical form	barium acetate	NA	barium hydroxide, barium acetate
Source of body weight and FIR	body weight and FIR – secondary source	NA	body weight and FIR – secondary source
Type of effect level	ED20 [b]	NA	LOAEL ≥ 20 (56% and 68% reduction in response relative to the control)
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias is indicated in parentheses)	not a representative receptor for the Upland BERA [c] (unknown) dose administration (unknown) estimated body weight and FIR (unknown)	NA	not a representative receptor for the Upland BERA [c] (unknown) dose administration (unknown) estimated body weight and FIR (unknown) effect level based on LOAEL ≥ 20 (high)
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	one (chicken)	NA	one (chicken)
Number of dose-response data sets evaluated	2 - Tier 1	NA	2 - Tier 1

Notes:

[a] References are cited in Attachment E1 or Attachment E2.

[b] Confidence limits associated with the modeled growth effective dose with a 20 percent reduction in the response relative to the control (ED20) are presented in Table E2.D-1 of Annex D.

[c] Representative receptors are those selected for dietary modeling in the Upland BERA to represent the different feeding guilds.

FIR - food ingestion rate

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

Table E2-18. Uncertainty Considerations for Selected Avian Effect Levels for Chromium

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	510	no data	no data
Reference [a]	Chung et al. (1985)	NA	NA
Receptor used in study	chicken	NA	NA
Considerations in Study Used to Derive Selected Effect Level			
Is species a representative receptor for the Upland BERA?	no	NA	NA
Dose administration	diet	NA	NA
Growth study exposure	critical lifestage	NA	NA
Chemical form	chromium sulfate	NA	NA
Source of body weight and FIR	body weight and FIR – secondary source	NA	NA
Type of effect level	LOAEL ≥ 20 (43% reduction in response relative to the control)	NA	NA
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias is indicated in parentheses)	not a representative receptor for the Upland BERA [b] (unknown) dose administration (unknown) estimated body weight and FIR (unknown) effect level based on LOAEL ≥ 20 (high)	NA	NA
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	one (chicken)	NA	NA
Number of dose-response data sets evaluated	2 - Tier 1	NA	NA

Notes:

[a] References are cited in Attachment E1 or Attachment E2.

[b] Representative receptors are those selected for dietary modeling in the Upland BERA to represent the different feeding guilds.

ED20 - effective dose with a 20 percent reduction in the response relative to the control (modeled)

FIR - food ingestion rate

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

Table E2-19. Uncertainty Considerations for Selected Mammalian Effect Levels for Chromium

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	110	91	no data
Reference [a]	Bataineh et al. (1997)	Elbetieha and Al-Hamood (1997)	NA
Receptor used in study	rat	mouse	NA
Considerations in Study Used to Derive Selected Effect Level			
Is species a representative receptor for the Upland BERA?	no	no	NA
Dose administration	drinking water	drinking water	NA
Growth study exposure	> 10% of lifespan	NA	NA
Chemical form	chromium chloride	chromium chloride	NA
Source of body weight and FIR	body weight – study; FIR – secondary source	body weight – study; water ingestion rate – secondary source	NA
Type of effect level	LOAEL ≥ 20 (24% reduction in response relative to the control)	LOAEL ≥ 20 (37% reduction in response relative to the control)	NA
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias is indicated in parentheses)	not a representative receptor for the Upland BERA [b] (unknown) dose administration (unknown) estimated FIR (unknown) effect level based on LOAEL ≥ 20 (high)	not a representative receptor for the Upland BERA [b] (unknown) dose administration (low) estimated water ingestion rate (unknown) effect level based on LOAEL ≥ 20 (high)	NA
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	one (rat)	one (mouse)	NA
Number of dose-response data sets evaluated	2 - Tier 2	2 - Tier 2	NA

Notes:

[a] References are cited in Attachment E1 or Attachment E2.

[b] Representative receptors are those selected for dietary modeling in the Upland BERA to represent the different feeding guilds.

ED20 - effective dose with a 20 percent reduction in the response relative to the control (modeled)

FIR - food ingestion rate

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

Table E2-20. Uncertainty Considerations for Selected Avian Effect Levels for Iron

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	160	no data	1,100
Reference [a]	McGhee et al. (1965)	NA	Pescatore and Harter-Dennis (1989); Wallner-Pendleton et al. (1986) (pooled)
Receptor used in study	chicken	NA	chicken
Considerations in Study Used to Derive Selected Effect Level			
Is species a representative receptor for the Upland BERA?	no	NA	no
Dose administration	diet	NA	gavage
Growth study exposure	critical lifestage	NA	NA
Chemical form	iron sulfate	NA	iron sulfate
Source of body weight and FIR	body weight – study; FIR – secondary source	NA	body weight – study and secondary source; FIR – NA (gavage study)
Type of effect level	LOAEL ≥ 20 (24% reduction in response relative to the control)	NA	ED20
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias is indicated in parentheses)	not a representative receptor for the Upland BERA [b] (unknown) dose administration (unknown) estimated FIR (unknown) effect level based on LOAEL ≥ 20 (high)	NA	not a representative receptor for the Upland BERA [b] (unknown) dose administration (high) [c] estimated body weight (unknown)
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	one (chicken)	NA	one (chicken)
Number of dose-response data sets evaluated	3 - Tier 1	NA	3 - Tier 1

Notes:

[a] References are cited in Attachment E1 or Attachment E2.

[b] Representative receptors are those selected for dietary modeling in the Upland BERA to represent the different feeding guilds.

[c] Dose was administered via gavage as a single dose, which could reflect a higher toxicity threshold than a chronic dose.

ED20 - effective dose with a 20 percent reduction in the response relative to the control (modeled)

FIR - food ingestion rate

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

Table E2-21. Uncertainty Considerations for Selected Mammalian Effect Levels for Iron

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	140	no data	870
Reference [a]	Banis et al. (1969); Storey and Greger (1987) (pooled)	NA	Whittaker et al. (1996)
Receptor used in study	rat	NA	rat
Considerations in Study Used to Derive Selected Effect Level			
Is species a representative receptor for the Upland BERA?	no	NA	no
Dose administration	diet	NA	diet
Growth study exposure	critical lifestage	NA	NA
Chemical form	iron sulfate	NA	carbonyl iron
Source of body weight and FIR	body weight - study and secondary source; FIR - secondary source	NA	body weight and FIR - secondary source
Type of effect level	geometric mean	NA	ED20
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias is indicated in parentheses)	not a representative receptor for the Upland BERA [b] (unknown) dose administration (unknown) estimated body weight and FIR (unknown)	NA	not a representative receptor for the Upland BERA [b] (unknown) dose administration (unknown) estimated body weight and FIR (unknown)
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	one (rat)	NA	one (rat)
Number of dose-response data sets evaluated	8 - Tier 1	NA	3 - Tier 1

Notes:

[a] References are cited in Attachment E1 or Attachment E2.

[b] Representative receptors are those selected for dietary modeling in the Upland BERA to represent the different feeding guilds.

ED20 - effective dose with a 20 percent reduction in the response relative to the control (modeled)

FIR - food ingestion rate

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

Table E2-22. Uncertainty Considerations for Selected Avian Effect Levels for Methylmercury

	Growth	Reproduction	Reproduction - American Kestrel [a]	Survival
Selected Effect Level Details				
Dose (mg/kg bw/day)	0.97	0.012	0.25	0.051
Reference [b]	Scott et al. (1975)	Varian-Ramos et al. (2014)	Albers et al. (2007)	Varian-Ramos et al. (2014)
Receptor used in study	chicken	finch	American kestrel	finch
Considerations in Study Used to Derive Selected Effect Level				
Is species a representative receptor for the Upland BERA?	no	no	yes	no
Dose administration	diet	diet	diet	diet
Growth study exposure	non-critical lifestage, <10% of lifespan	NA	NA	NA
Chemical form	methylmercury chloride	methylmercury cysteine	methylmercury chloride	methylmercury cysteine
Source of body weight and FIR	body weight and FIR – secondary source	body weight and FIR – secondary source	body weight and FIR – secondary source	body weight and FIR – secondary source
Type of effect level	ED20	ED20	ED20	LOAEL ≥ 20 (23-24% reduction in response relative to the control)
Level of Confidence and Bias				
Considerations decreasing the level of confidence in effect level (potential bias is indicated in parentheses)	not a representative receptor for the Upland BERA [c] (unknown) dose administration (unknown) exposure life stage and duration (unknown) estimated body weight and FIR (unknown)	not a representative receptor for the Upland BERA [c] (unknown) dose administration (unknown) estimated body weight and FIR (unknown)	dose administration (unknown) estimated body weight and FIR (unknown)	not a representative receptor for the Upland BERA [c] (unknown) dose administration (unknown) estimated body weight and FIR (unknown) effect level based on LOAEL ≥ 20 (high)
Considerations Associated with Available Literature				
Number of species with LOAEL ≥ 20 or ED20	one (chicken)	five (chicken, finch, kestrel, mallard, quail)	NA	three (finch, kestrel, quail)
Number of dose-response data sets evaluated	3 - Tier 1, 1 - Tier 2	23 - Tier 1	4 - Tier 1	12 - Tier 1

Notes:

[a] Effect level for the reproduction endpoint for American kestrel is receptor-specific and will be used to evaluate risk to American kestrels in the Upland BERA.

[b] References are cited in Attachment E1 or Attachment E2.

[c] Representative receptors are those selected for dietary modeling in the Upland BERA to represent the different feeding guilds.

ED20 - effective dose with a 20 percent reduction in the response relative to the control (modeled)

FIR - food ingestion rate

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

Table E2-23. Uncertainty Considerations for Selected Mammalian Effect Levels for Methylmercury

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	0.65	0.23	0.24
Reference [a]	Mitsumori et al. (1983)	Verschuuren et al. (1976a)	Mitsumori et al. (1983) (two data sets); Verschuuren et al. (1976b) (two data sets) (pooled)
Receptor used in study	rat	rat	rat
Considerations in Study Used to Derive Selected Effect Level			
Is species a representative receptor for the Upland BERA?	no	no	no
Dose administration	diet	diet	diet
Growth study exposure	critical lifestage, > 10% of lifespan	NA	NA
Chemical form	methylmercury chloride	methylmercury chloride	methylmercury chloride
Source of body weight and FIR	body weight - study; FIR - secondary source	body weight - study; FIR - secondary source	body weight - study; FIR - secondary source
Type of effect level	LOAEL ≥ 20 (36% reduction in response relative to the control)	LOAEL ≥ 20 (58% reduction in response relative to the control)	ED20 [b]
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias is indicated in parentheses)	not a representative receptor for the Upland BERA [c] (unknown) dose administration (unknown) estimated FIR (unknown)	not a representative receptor for the Upland BERA [c] (unknown) dose administration (unknown) estimated FIR (unknown) effect level based on LOAEL ≥ 20 (high)	not a representative receptor for the Upland BERA [c] (unknown) dose administration (unknown) estimated FIR (unknown)
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	three (mink, mouse, rat)	one (rat)	two (mouse, rat)
Number of dose-response data sets evaluated	6 - Tier 1, 2 - Tier 2	3 - Tier 1	5 - Tier 1

Notes:

[a] References are cited in Attachment E1 or Attachment E2.

[b] Confidence limits associated with the modeled growth and reproduction effective doses with a 20 percent reduction in the response relative to the control (ED20s) are presented in Table E2.D-1 of Annex D.

[c] Representative receptors are those selected for dietary modeling in the Upland BERA to represent the different feeding guilds.

FIR - food ingestion rate

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

Table E2-24. Uncertainty Considerations for Selected Avian Effect Levels for Molybdenum

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	100	36	610
Reference [a]	Davies et al. (1960) (two pooled data sets)	Lepore and Miller (1965)	Davies et al. (1960)
Receptor used in study	chicken	chicken	chicken
Considerations in Study Used to Derive Selected Effect Level			
Is species a representative receptor for the Upland BERA?	no	no	no
Dose administration	diet	diet	diet
Growth study exposure	critical lifestage	NA	NA
Chemical form	sodium molybdate	sodium molybdate	sodium molybdate
Source of body weight and FIR	body weight and FIR – secondary source	body weight and FIR – secondary source	body weight and FIR – secondary source
Type of effect level	ED20 [b]	ED20 [b]	ED20 [b]
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias is indicated in parentheses)	not a representative receptor for the Upland BERA [c] (unknown) dose administration (unknown) estimated body weight and FIR (unknown)	not a representative receptor for the Upland BERA [c] (unknown) dose administration (unknown) estimated body weight and FIR (unknown)	not a representative receptor for the Upland BERA [c] (unknown) dose administration (unknown) estimated body weight and FIR (unknown)
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	two (chicken, bobwhite quail)	one (chicken)	one (chicken)
Number of dose-response data sets evaluated	5 - Tier 1	1 - Tier 1	2 - Tier 1

Notes:

[a] References are cited in Attachment E1 or Attachment E2.

[b] Confidence limits associated with the modeled growth and survival growth effective doses with a 20 percent reduction in the response relative to the control (ED20s) are presented in Table E2.D-1 of Annex D. Data were insufficient to calculate confidence limits for the reproduction ED20.

[c] Representative receptors are those selected for dietary modeling in the Upland BERA to represent the different feeding guilds.

FIR - food ingestion rate

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

Table E2-25. Uncertainty Considerations for Selected Mammalian Effect Levels for Molybdenum

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	28	4.5	no data
Reference [a]	Brinkman and Miller (1961)	Fungwe et al. (1990)	NA
Receptor used in study	rat	rat	NA
Considerations in Study Used to Derive Selected Effect Level			
Is species a representative receptor for the Upland BERA?	no	no	NA
Dose administration	diet	drinking water	NA
Growth study exposure	critical lifestage	NA	NA
Chemical form	sodium molybdate	sodium molybdate	NA
Source of body weight and FIR	body weight and FIR – secondary source	body weight - secondary source; water ingestion rate - study	NA
Type of effect level	LOAEL ≥ 20 (54% reduction in response relative to the control)	ED20	NA
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias is indicated in parentheses)	not a representative receptor for the Upland BERA[b] (unknown) dose administration (unknown) estimated body weight and FIR (unknown) effect level based on LOAEL ≥ 20 (high)	not a representative receptor for the Upland BERA[b] (unknown) dose administration (low) estimated body weight (unknown)	NA
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	one (rat)	one (rat)	NA
Number of dose-response data sets evaluated	4 - Tier 1, 2 - Tier 2	1 - Tier 2	NA

Notes:

[a] References are cited in Attachment E1 or Attachment E2.

[b] Representative receptors are those selected for dietary modeling in the Upland BERA to represent the different feeding guilds.

ED20 - effective dose with a 20 percent reduction in the response relative to the control (modeled)

FIR - food ingestion rate

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

Table E2-26. Uncertainty Considerations for Selected Avian Effect Levels for Selenium

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	0.28	0.55	0.59
Reference[a]	Dafalla and Adam (1986); El-Begearmi and Combs (1982) (two data sets); Jensen (1986) (pooled)	Ort and Latshaw (1978)	Arnold et al. (1973)
Receptor used in study	chicken	chicken	chicken
Considerations in Study Used to Derive Selected Effect Level			
Is species a representative receptor for the Upland BERA?	no	no	no
Dose administration	diet	diet	diet
Growth study exposure	critical lifestage	NA	NA
Chemical form	sodium selenite	sodium selenite	sodium selenite
Source of body weight and FIR	body weight – study (one data set) and secondary source (three data sets); FIR – secondary source	body weight and FIR – secondary source	body weight - study; FIR - secondary source
Type of effect level	ED20[b]	ED20[b]	LOAEL ≥ 20 (35% reduction in response relative to the control)
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias is indicated in parentheses)	not a representative receptor for the Upland BERA[c] (unknown) dose administration (unknown) estimated body weight and FIR (unknown)	not a representative receptor for the Upland BERA[c] (unknown) dose administration (unknown) estimated body weight and FIR (unknown)	not a representative receptor for the Upland BERA[c] (unknown) dose administration (unknown) estimated FIR (unknown) effect level based on LOAEL ≥ 20 (high)
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	two (chicken, duck)	three (chicken, duck, owl)	three (chicken, duck, quail)
Number of dose-response data sets evaluated	13 - Tier 1, 2 - Tier 2	12 - Tier 1	9 - Tier 1

Notes:

[a] References are cited in Attachment E1 or Attachment E2.

[b] Confidence limits associated with the modeled growth effective dose with a 20 percent reduction in the response relative to the control (ED20) are presented in Table E2.D-1 of Annex D. Data were insufficient to calculate confidence limits for the reproduction ED20.

[c] Representative receptors are those selected for dietary modeling in the Upland BERA to represent the different feeding guilds.

FIR - food ingestion rate

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

Table E2-27. Uncertainty Considerations for Selected Mammalian Effect Levels for Selenium

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	0.33	5.0	0.61
Reference[a]	Mahan and Moxon (1984)	Seidenberg et al. (1986)	McAdam and Levander (1987)
Receptor used in study	pig	mouse	rat
Considerations in Study Used to Derive Selected Effect Level			
Is species a representative receptor for the Upland BERA?	no	no	no
Dose administration	diet	gavage	diet
Growth study exposure	critical lifestage	NA	NA
Chemical form	sodium selenite	sodium selenate	sodium selenite
Source of body weight and FIR	body weight and FIR – study	doses reported in the study	body weight and FIR – secondary source
Type of effect level	ED20[b]	LOAEL ≥ 20 (54% reduction in response relative to the control)	LOAEL ≥ 20 (62% reduction in response relative to the control)
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias is indicated in parentheses)	not a representative receptor for the Upland BERA[c] (unknown) dose administration (unknown)	not a representative receptor for the Upland BERA[c] (unknown) dose administration (unknown) effect level based on LOAEL ≥ 20 (high)	not a representative receptor for the Upland BERA[c] (unknown) dose administration (unknown) estimated body weight and FIR (unknown) effect level based on LOAEL ≥ 20 (high)
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	four (hamster, mouse, pig, rat)	one (mouse)	four (hamster, mouse, pig, rat)
Number of dose-response data sets evaluated	11 - Tier 1, 3 - Tier 2	6 - Tier 1	9 - Tier 1

Notes:

[a] References are cited in Attachment E1 or Attachment E2.

[b] Confidence limits associated with the modeled growth effective dose with a 20 percent reduction in the response relative to the control (ED20) are presented in Table E2.D-1 of Annex D.

[c] Representative receptors are those selected for dietary modeling in the Upland BERA to represent the different feeding guilds.

FIR - food ingestion rate

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

Table E2-28. Uncertainty Considerations for Selected Mammalian Effect Levels for Thallium

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	2.1	no data	2.6
Reference [a]	Downs et al. (1960) (pooled)	NA	Downs et al. (1960) (pooled)
Receptor used in study	rat	NA	rat
Considerations in Study Used to Derive Selected Effect Level			
Is species a representative receptor for the Upland BERA?	no	NA	no
Dose administration	diet	NA	diet
Growth study exposure	critical lifestage	NA	NA
Chemical form	thallic oxide	NA	thallic oxide
Source of body weight and FIR	body weight – study; FIR – secondary source	NA	body weight – study; FIR – secondary source
Type of effect level	ED20	NA	ED20
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias is indicated in parentheses)	not a representative receptor for the Upland BERA[b] (unknown) dose administration (unknown) estimated FIR (unknown)	NA	not a representative receptor for the Upland BERA[b] (unknown) dose administration (unknown) estimated FIR (unknown)
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	one (rat)	NA	one (rat)
Number of dose-response data sets evaluated	2 - Tier 1	NA	2 - Tier 1

Notes:

[a] References are cited in Attachment E1 or Attachment E2.

[b] Representative receptors are those selected for dietary modeling in the Upland BERA to represent the different feeding guilds.

ED20 - effective dose with a 20 percent reduction in the response relative to the control (modeled)

FIR - food ingestion rate

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

Table E2-29. Uncertainty Considerations for Selected Avian Effect Levels for Vanadium

	Growth	Reproduction	Survival
Selected Effect Level Details			
Dose (mg/kg bw/day)	1.2	2.1	2.4
Reference[a]	Berg and Lawrence (1971)	Toussant and Latshaw (1994)	Blalock and Hill (1987)
Receptor used in study	chicken	chicken	chicken
Considerations in Study Used to Derive Selected Effect Level			
Is species a representative receptor for the Upland BERA?	no	no	no
Dose administration	diet	diet	diet
Growth study exposure	critical lifestage	NA	NA
Chemical form	vanadyl sulfate	ammonium metavanadate	vanadyl chloride
Source of body weight and FIR	body weight and FIR – secondary source	body weight and FIR – secondary source	body weight and FIR – secondary source
Type of effect level	ED20	LOAEL ≥ 20 (49% reduction in response relative to the control)	ED20
Level of Confidence and Bias			
Considerations decreasing the level of confidence in effect level (potential bias is indicated in parentheses)	not a representative receptor for the Upland BERA[b] (unknown) dose administration (unknown) estimated body weight and FIR (unknown)	not a representative receptor for the Upland BERA[b] (unknown) dose administration (unknown) estimated body weight and FIR (unknown) effect level based on LOAEL ≥ 20 (high)	not a representative receptor for the Upland BERA[b] (unknown) dose administration (unknown) estimated body weight and FIR (unknown)
Considerations Associated with Available Literature			
Number of species with LOAEL ≥ 20 or ED20	one (chicken)	one (chicken)	one (chicken)
Number of dose-response data sets evaluated	15 - Tier 1	4 - Tier 1	9 - Tier 1

Notes:

[a] References are cited in Attachment E1 or Attachment E2.

[b] Representative receptors are those selected for dietary modeling in the Upland BERA to represent the different feeding guilds.

ED20 - effective dose with a 20 percent reduction in the response relative to the control (modeled)

FIR - food ingestion rate

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

Table E2-30. Uncertainty Considerations for Updated Terrestrial Receptor-Specific TRVs

	Cadmium Growth - Gray Wolf [a]
Selected Effect Level Details	
Dose (mg/kg bw/day)	100
Reference [b]	Hamada et al. (1991)
Receptor used in study	dog
Considerations in Study Used to Derive Selected Effect Level	
Is species a representative receptor for the Upland BERA?	yes
Dose administration	diet
Growth study exposure	critical lifestage, > 10% of lifespan
Chemical form	cadmium chloride
Source of body weight and FIR	NA (doses reported in the study)
Type of effect level	LOAEL ≥ 20 (30% reduction in response relative to the control)
Level of Confidence and Bias	
Considerations decreasing the level of confidence in effect level (potential bias)	dose administration (unknown) estimated body weight and FIR (unknown) effect level based on LOAEL ≥ 20 (high)
Considerations Associated with Available Literature	
Number of species with LOAEL ≥ 20 or ED20	NA
Number of dose-response data sets evaluated	1 - Tier 1

Notes:

[a] TRV is receptor-specific and will be used to evaluate risk to the listed receptor in the Upland BERA.

[b] References are cited in Attachment E1 or Attachment E2.

FIR - food ingestion rate

LOAEL ≥ 20 - lowest-observed-adverse-effect level with ≥ 20 percent reduction in the response relative to the control

NA - not applicable

TRV - toxicity reference value

Table E2-31. Summary of All TRVs for Terrestrial Birds and Mammals

	Growth		Reproduction		Survival	
Metal	TRV (mg/kg bw/day)	TRV Type	TRV (mg/kg bw/day)	TRV Type	TRV (mg/kg bw/day)	TRV Type
Birds [a]						
Aluminum	150	ED20	none	NA	560	LOAEL ≥ 20
Antimony	none	NA	none	NA	none	NA
Barium	480	ED20	none	NA	890	LOAEL ≥ 20
Beryllium	none	NA	none	NA	none	NA
Cadmium	2.0	ED20	2.3	ED20	7.4	ED20
Chromium (III)	510	LOAEL ≥ 20	none	NA	none	NA
Copper	62	ED20	28	ED20	67	ED20
Iron	160	LOAEL ≥ 20	none	NA	1,100	ED20
Lead	29	LOAEL ≥ 20	4.7	geometric mean	11	ED20
Methylmercury	0.97	ED20	0.012	ED20	0.051	LOAEL ≥ 20
Molybdenum	100	ED20	36	ED20	610	ED20
Selenium	0.29	Eco-SSL	0.55	ED20	0.59	LOAEL ≥ 20
Thallium	none	NA	none	NA	none	NA
Vanadium	1.2	ED20	2.1	LOAEL ≥ 20	2.4	ED20
Zinc	66 [b]	Eco-SSL	77	ED20	250	LOAEL ≥ 20
American Kestrel [a]						
Methylmercury	none	NA	0.25	ED20	none	NA
Mammals [a]						
Aluminum	400	LOAEL ≥ 20	27	ED20	400	LOAEL ≥ 20
Antimony	none	NA	none	NA	none	NA
Cadmium	4.2	ED20	2.7	ED20	1.5	ED20
Chromium (III)	110	LOAEL ≥ 20	91	LOAEL ≥ 20	none	NA
Copper	12	ED20	27	LOAEL ≥ 20	8.7	geometric mean
Iron	140	geometric mean	none	NA	870	ED20
Lead	20	LOAEL ≥ 20	4.7 [b]	Eco-SSL	7.6	ED20
Methylmercury	0.65	LOAEL ≥ 20	0.23	LOAEL ≥ 20	0.24	ED20
Molybdenum	28	LOAEL ≥ 20	4.5	ED20	none	NA
Selenium	0.33	ED20	5.0	LOAEL ≥ 20	0.61	LOAEL ≥ 20
Thallium	2.6	ED20	none	NA	2.1	ED20
Zinc	75 [b]	Eco-SSL	75 [b]	Eco-SSL	190	geometric mean
Gray Wolf [a]						
Cadmium	100	LOAEL ≥ 20	none	NA	none	NA

Notes:

Green shading indicates selected toxicity reference values (TRVs). TRVs were derived from the lowest value from the lowest tier from among the following values: 1) modeled effective dose with a 20 percent reduction in the response relative to the control (ED20) from an individual data set; 2) lowest-observed-adverse-effect level (LOAEL) with ≥ 20 percent reduction in the response relative to control (LOAEL ≥ 20) from an individual data set; or 3) ED20 or geometric mean of LOAELs ≥ 20 from a pooled data set.

[a] TRVs for birds and mammals are generic levels applied to all representative receptors in the Upland BERA for which receptor-specific data are not available. American kestrel and gray wolf are representative receptors for which receptor-specific data are available.

[b] The selected TRV is the ecological soil screening level (Eco-SSL) because the lowest effect level is less than the Eco-SSL.

NA - not applicable

ANNEX A

LITERATURE SEARCH AND STUDY REVIEW RESULTS

Table E2.A-1. Acronyms, Abbreviations, and Units of Measure

Term	Definition
Acronyms and Abbreviations	
A	additional studies reviewed if five data sets were not available from the top five studies
ABNM	abnormal
AD	adult
ALWT	albumin weight
BDWT	body weight changes
DEYO	death of young
DNF	data not found
DR	drinking water
Eco-SSL	ecological soil screening level
ED20	dose that causes a 20 percent effect
EG	egg response site
EGG	egg effect type
EGPN	egg production
EGWT	egg weight
EM	embryo
ENR	endpoint not relevant
EQUA	egg quality
ESQU	eggshell quality
ESTH	eggshell thickness
ESWT	eggshell weight
FD	food
GE	gestation
GGRO	general growth
GRO	growth
GREP	general reproduction
GV	gavage
HULT	humerus length
HM	humerus
HTCH	hatch
ICF	irrelevant chemical form
ID	insufficient data
IM	immature
JV	juvenile
LB	laying bird
LC	lactation
LOAEL	lowest-observed-adverse-effect level
M	measured
MA	mature
MOR	mortality effect type
MORT	mortality effect measure
MPH	morphology
NA	not applicable
na	not available
NDAY	number of days between eggs laid
NOAEL	no-observed-adverse-effect level
NR	not reported
NRV	not reviewed because five usable data sets were available in higher ranked studies
NT	no tier applied because study was not acceptable for TRV derivation
ODVP	offspring development
OR	oral
ORWT	organ weight changes
OV	ovary
P	studies included for pooling with a comparable study
PLBR	pairs with litter or brood
PROG	progeny numbers/counts
PRWT	progeny weight
REP	reproduction
RSEM	resorbed embryos
RSUC	reproductive success
RU	ruminant study
S	studies included for receptors not represented in the other studies reviewed
SDC	study design concern
SI	study inadequacies, as described in Lynch et al. 1999
SM	sexually mature
SPCL	sperm cell counts
SPCV	sperm cell viability
SURV	survival
T	top five study based on tier and lowest-observed-adverse-effect level (LOAEL)
TDTH	time to death
TE	testes
TERA	teratogenic measurements
TEWT	testes weight
TPRD	total production
TRV	toxicity reference value
U	unmeasured
UN	unbounded no-observed-adverse-effect level (NOAEL)
UX	measured but data not reported
WO	whole organism
YO	young
Units of Measure	
mg/kg bw	milligram(s) per kilogram of body weight
mg/kg bw/day	milligram(s) per kilogram of body weight per day

Table E2.A-2. Antimony Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result Number	Reference	Reference Number	Test Organism	Number of Concentrations or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation? [a]
Reproduction																			
12	Rossi et al. (1987)	231	rat (*Rattus norvegicus*)	3	U	DR	31	days	NR	NR	GE	female	REP	PRWT	WO	0.0590	0.590	78	yes
13	Gurnani et al. (1993)	225	mouse (*Mus musculus*)	4	U	GV	14	days	8	weeks	JV	male	REP	SPCV	WO	835	na	79	no (ENR, UN)
Growth																			
14	Shroeder et al. (1970)	252	rat (*Rattus norvegicus*)	2	U	DR	725	days	21	days	JV	male	GRO	BDWT	WO	0.533	na	67	no (UN)
15	Kanisawa and Shroeder (1969)	3701	mouse (*Mus musculus*)	2	U	DR	519	days	21	days	JV	both	GRO	BDWT	WO	0.664	na	67	no (UN)
16	Poon et al. (1998)	224	rat (*Rattus norvegicus*)	5	UX	DR	13	weeks	7	weeks	JV	male	GRO	BDWT	WO	5.60	42.0	82	yes
17	Dieter (1992)	3780	rat (*Rattus norvegicus*)	6	U	DR	14	days	8	weeks	JV	both	GRO	BDWT	WO	67.0	na	78	no (UN)
18	Dieter (1992)	3780	mouse (*Mus musculus*)	6	U	DR	14	days	8	weeks	JV	female	GRO	BDWT	WO	106	161	84	no (ID)
19	Hext et al. (1999)	189	rat (*Rattus norvegicus*)	4	UX	FD	90	days	NR	NR	AD	male	GRO	BDWT	WO	1410	na	85	no (UN)
20	Rossi et al. (1987)	231	rat (*Rattus norvegicus*)	3	U	DR	20	days	NR	NR	GE	female	GRO	BDWT	WO	na	0.0590	72	yes
21	Shroeder et al. (1968)	238	mouse (*Mus musculus*)	2	U	DR	339	days	21	days	JV	female	GRO	BDWT	WO	na	0.678	66	yes
Survival																			
22	Poon et al. (1998)	224	rat (*Rattus norvegicus*)	5	UX	DR	13	weeks	NR	NR	IM	female	MOR	MORT	WO	46.0	na	74	no (UN)
23	Ainsworth et al. (1991)	221	short-tailed vole (*Microtus agrestis*)	2	U	FD	60	days	35	days	NR	male	MOR	MORT	WO	60.9	na	70	no (UN)
24	Dieter (1992)	3780	rat (*Rattus norvegicus*)	6	U	DR	14	days	8	weeks	JV	both	MOR	SURV	WO	66.6	na	78	no (UN)
25	Dieter (1992)	3780	mouse (*Mus musculus*)	6	U	DR	14	days	8	weeks	JV	male	MOR	MORT	WO	108	161	84	yes
26	Gurnani et al. (1993)	225	mouse (*Mus musculus*)	4	U	GV	21	days	8	weeks	JV	male	MOR	MORT	WO	557	835	91	no (ID)
27	Ainsworth et al. (1991)	270	short-tailed vole (*Microtus agrestis*)	3	U	FD	21	days	NR	NR	NR	NR	MOR	MORT	WO	673	na	73	no (UN)
28	Ainsworth et al. (1991)	270	mouse (*Mus musculus*)	3	U	FD	18	days	NR	NR	NR	NR	MOR	MORT	WO	826	na	73	no (UN)
29	Hext et al. (1999)	189	rat (*Rattus norvegicus*)	4	UX	FD	90	days	NR	NR	AD	male	MOR	MORT	WO	1408	na	86	no (UN)
30	Ainsworth et al. (1991)	221	short-tailed vole (*Microtus agrestis*)	3	U	FD	12	days	35	days	NR	male	MOR	MORT	WO	2440	na	74	no (UN)
31	Shroeder et al. (1970)	252	rat (*Rattus norvegicus*)	2	U	DR	784	days	21	days	JV	female	MOR	TDTH	WO	na	0.533	68	no (SI)

Notes:

Acronyms, abbreviations, and units of measure are defined in Table E2.A-1.

Not all studies presented in the antimony ecological soil screening level (Eco-SSL) document for growth, reproduction, and survival were used to derive the Eco-SSL toxicity reference value (TRV).

See Eco-SSL document (USEPA 2005a) for the full reference list for studies cited in this table.

[a] Rationale for study unacceptability is in parentheses

Table E2.A-3. Chromium Data for Birds as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result Number	Reference	Reference Number	Test Organism	Number of Concentrations or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation? [a]
Reproduction																			
11	Jensen and Maurice (1980)	9749	chicken (*Gallus domesticus*)	2	U	FD	4	weeks	NR	NR	LB	female	REP	TPRD	WO	0.238	na	78	no (UN)
12	Maurice and Jensen (1979)	12571	chicken (*Gallus domesticus*)	2	U	FD	12	weeks	40	weeks	LB	female	REP	TPRD	WO	0.483	na	70	no (UN)
13	Jensen and Maurice (1980)	9749	chicken (*Gallus domesticus*)	2	U	FD	4	weeks	NR	NR	LB	female	REP	TPRD	WO	0.494	na	69	no (UN)
14	Haseltine et al. (unpublished)	3739	black duck (*Anas rubripes*)	3	U	FD	180-190	days	NR	NR	LB	female	REP	RSUC	WO	0.569	2.78	78	no (DNF)
15	Sauveur and Thapon (1983)	9621	chicken (*Gallus domesticus*)	2	U	FD	8	weeks	40	weeks	LB	female	REP	TPRD	WO	0.744	na	79	no (UN)
16	Ousterhout and Berg (1981)	6508	chicken (*Gallus domesticus*)	2	U	FD	6	days	50	weeks	LB	female	EGG	ESQU	SL	0.988	na	69	no (ENR, UN)
17	Meluzzi et al. (1996)	2771	chicken (*Gallus domesticus*)	4	U	FD	15	days	22	weeks	LB	female	EGG	ALWT	EG	37.7	75.4	81	no (ENR)
Growth																			
18	Maurice and Jensen (1979)	12571	chicken (*Gallus domesticus*)	2	U	FD	12	weeks	40	weeks	SM	female	GRO	BDWT	WO	0.483	na	68	no (UN)
19	Cupo and Donaldson (1987)	5971	chicken (*Gallus domesticus*)	2	U	FD	21	days	1	days	JV	male	GRO	BDWT	WO	1.45	na	77	no (UN)
20	Steele and Rosebrough (1979)	13720	turkey (*Meleagris gallopavo*)	4	U	FD	14	days	1	weeks	JV	both	GRO	BDWT	WO	6.42	na	77	no (UN)
21	Hill (1974)	92	chicken (*Gallus domesticus*)	2	U	FD	2	weeks	1	days	JV	both	GRO	BDWT	WO	85.9	na	76	no (UN)
22	Hafez and Kratzer (1976)	8663	chicken (*Gallus domesticus*)	3	U	FD	4	weeks	1	days	AD	male	GRO	BDWT	WO	359	na	76	no (UN)
23	Motozono et al. (1998)	3067	chicken (*Gallus domesticus*)	3	U	FD	35	days	7	days	JV	female	GRO	BDWT	WO	na	9.91	73	no (ICF)
24	Nielsen et al. (1980)	15690	chicken (*Gallus domesticus*)	2	U	FD	4	weeks	1	days	JV	male	GRO	BDWT	WO	na	28.7	72	no (UN [b])
Survival																			
25	Hossain et al. (1998)	11682	chicken (*Gallus domesticus*)	2	U	FD	19	days	28	days	JV	both	MOR	MORT	WO	0.0248	na	79	no (UN)
26	Haseltine et al. (unpublished)	3739	black duck (*Anas rubripes*)	3	U	FD	10	m	NR	NR	MA	male	MOR	MORT	WO	0.557	2.78	77	no (DNF)
27	Hill (1974)	92	chicken (*Gallus domesticus*)	2	U	FD	5	weeks	1	days	JV	both	MOR	MORT	WO	85.9	na	77	no (UN)
28	Hafez and Kratzer (1976)	8663	chicken (*Gallus domesticus*)	3	U	FD	4	weeks	1	days	AD	male	MOR	MORT	WO	359	na	77	no (UN)

Notes:

Acronyms, abbreviations, and units of measure are defined in Table E2.A-1.

Not all studies presented in the chromium ecological soil screening level (Eco-SSL) document for growth, reproduction, and survival were used to derive the Eco-SSL toxicity reference value (TRV).

See Eco-SSL document (USEPA 2008) for the full reference list for studies cited in this table.

[a] Rationale for study unacceptability is in parentheses

[b] Dose/response data set was reviewed and determined to be an unbounded no-observed-adverse-effect level (NOAEL) (differs from the Eco-SSL document).

Table E2.A-4. Chromium Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result Number	Reference	Reference Number	Test Organism	Number of Concentrations or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation? [a]
Reproduction																			
18	Zahid et al. (1990)	3098	mouse (*Mus musculus*)	4	U	FD	35	days	21	days	JV	male	REP	SPCL	TE	na	9.62	80	no (ENR)
19	Bataineh et al. (1997)	3009	rat (*Rattus norvegicus*)	2	U	DR	12	weeks	NR	NR	AD	male	REP	TEWT	TE	na	36.2	74	no (ENR)
20	Elbetieha and Al-Hamood (1997)	3025	mouse (*Mus musculus*)	3	U	DR	12	weeks	50	days	JV	female	REP	PROG	WO	na	91.1	73	yes
21	Elbetieha and Al-Hamood (1997)	3025	mouse (*Mus musculus*)	2	U	DR	12	weeks	50	days	JV	male	REP	ORWT	OV	na	228	74	no (ENR)
Growth																			
22	Van Heugten and Spears (1997)	25908	pig (*Sus scrofa*)	2	U	FD	32	days	3	weeks	JV	NR	GRO	BDWT	WO	0.00663	na	69	no (UN)
23	Kegley and Spears (1995)	25914	cattle (*Bos taurus*)	2	U	FD	56	days	NR	NR	JV	male	GRO	BDWT	WO	0.00933	na	69	no (UN)
24	Shroeder et al. (1963)	14446	rat (*Rattus norvegicus*)	2	U	DR	60	days	28	days	JV	male	GRO	BDWT	WO	0.537	na	66	no (UN)
25	Mooney and Cromwell (1997)	25905	pig (*Sus scrofa*)	2	M	FD	103	days	NR	NR	JV	both	GRO	BDWT	WO	0.595	na	74	no (UN)
26	Mooney and Cromwell (1997)	25905	pig (*Sus scrofa*)	3	M	FD	35	days	NR	NR	JV	both	GRO	BDWT	WO	0.927	na	74	no (UN)
27	Anderson et al. (1997)	3004	rat (*Rattus norvegicus*)	5	U	FD	20	weeks	4	weeks	JV	NR	GRO	BDWT	WO	8.09	na	68	no (UN)
28	Zahid et al. (1990)	3098	mouse (*Mus musculus*)	4	U	FD	35	days	21	days	JV	male	GRO	BDWT	WO	44.6	na	69	no (UN)
29	Elbetieha and Al-Hamood (1997)	3025	mouse (*Mus musculus*)	2	U	DR	12	weeks	50	days	JV	male	GRO	BDWT	WO	228	na	72	no (UN)
30	Ivankovic and Preussmann (1975)	3729	rat (*Rattus norvegicus*)	3	U	FD	90	days	100	days	SM	female	GRO	BDWT	WO	1770	na	72	no (UN)
31	Elbetieha and Al-Hamood (1997)	3025	mouse (*Mus musculus*)	3	U	DR	12	weeks	50	days	JV	male	GRO	BDWT	WO	na	92.1	72	yes
Survival																			
32	Meenakshi et al. (1989)	3061	rat (*Rattus norvegicus*)	2	U	GV	60	days	NR	NR	JV	male	MOR	MORT	WO	10.0	na	85	no (UN)
33	Mercado and Bibby (1973)	757	rat (*Rattus norvegicus*)	2	U	DR	50	days	23	days	JV	male	MOR	MORT	WO	na	2.82	72	no (ID)

Notes:

Acronyms, abbreviations, and units of measure are defined in Table E2.A-1.

Not all studies presented in the chromium ecological soil screening level (Eco-SSL) document for growth, reproduction, and survival were used to derive the Eco-SSL toxicity reference value (TRV).

See Eco-SSL document (USEPA 2008) for the full reference list for studies cited in this table.

[a] Rationale for study unacceptability is in parentheses

Table E2.A-5. Selenium Data for Birds as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result Number	Reference	Reference Number	Test Organism	Number of Concentrations or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation? [a]
Reproduction																			
85	Thapar et al. (1969)	1592	chicken (*Gallus domesticus*)	3	U	FD	76	weeks	1	days	LB	female	EGG	EGWT	EG	0.092	0.368	83	no (ENR)
86	Stanley et al. (1996)	1569	mallard (*Anas platyrhynchos*)	3	UX	FD	122	days	1	years	AD	both	REP	HTCH	WO	0.212	0.425	89	no (SDC)
87	Poley and Moxon (1937)	3788	chicken (*Gallus domesticus*)	4	U	FD	1	weeks	NR	NR	LB	female	REP	RSUC	WO	0.214	0.429	85	no (SDC)
88	Heinz et. al. (1989)	1354	duck (*Anas platyrhynchos*)	6	UX	FD	46	days	NR	NR	LB	both	REP	PROG	WO	0.219	0.438	90	yes
89	Ort and Latshaw (1978)	1489	chicken (*Gallus domesticus*)	4	U	FD	28	weeks	32	weeks	LB	female	REP	HTCH	WO	0.247	0.412	85	yes
90	Hoffman and Heinz (1988)	1372	mallard (*Anas platyrhynchos*)	5	UX	FD	6	weeks	NR	NR	LB	both	REP	RSUC	WO	0.273	0.546	89	yes
91	Moksnes and Norheim (1982)	1465	chicken (*Gallus domesticus*)	4	U	FD	31	weeks	20	weeks	LB	both	REP	PROG	WO	0.284	na	70	no (UN)
92	Moksnes (1983)	1464	chicken (*Gallus domesticus*)	6	U	FD	18	weeks	20	weeks	LB	female	EGG	EGWT	EG	0.292	na	79	no (UN)
93	Thapar et al. (1969)	1592	chicken (*Gallus domesticus*)	3	U	FD	105	weeks	1	days	LB	female	REP	PROG	WO	0.378	na	70	no (UN)
94	Albers et al. (1996)	1208	duck (*Anas platyrhynchos*)	5	U	FD	16	weeks	1	years	AD	male	REP	TEWT	TE	0.644	1.29	81	no (ENR)
95	Heinz et. al. (1989)	1354	duck (*Anas platyrhynchos*)	2	UX	FD	49	days	NR	NR	LB	both	REP	PROG	WO	0.890	na	70	no (UN)
96	Stoewsand et al. (1977)	1574	Japanese quail (*Coturnix japonica*)	2	U	FD	10	weeks	2	weeks	LB	both	EGG	ESTH	WO	0.896	na	75	no (UN)
97	Heinz and Hoffman (1987)	1356	mallard (*Anas platyrhynchos*)	6	UX	FD	57	weeks	2	years	LB	female	REP	NDAY	WO	1.03	2.58	87	no (ENR)
98	Santolo et al. (1999)	1535	American kestrel (*Falco sparverius*)	3	M	FD	11	weeks	NR	months	LB	female	EGG	EGWT	EM	1.37	na	83	no (UN)
99	Stoewsand et al. (1977)	1574	Japanese quail (*Coturnix japonica*)	2	M	FD	10	weeks	NR	NR	JV	both	EGG	ESTH	WO	3.64	na	80	no (UN)
100	Arnold et al. (1973)	69	chicken (*Gallus domesticus*)	3	U	FD	24	weeks	1	days	LB	female	EGG	EGWT	EG	na	0.0911	79	no (ENR)
101	Kaantee and Kurkela (1980)	36819	chicken (*Gallus domesticus*)	3	M	FD	2	weeks	18	months	LB	female	REP	PROG	WO	na	0.0988	85	yes
102	Stone and Soares (1976)	2898	Japanese quail (*Coturnix japonica*)	2	U	FD	32	days	NR	NR	LB	female	REP	PROG	WO	na	0.120	79	yes
103	Poley et al. (1937)	3787	chicken (*Gallus domesticus*)	2	M	FD	1	weeks	NR	NR	LB	female	REP	HTCH	WO	na	0.127	79	no (SDC)
104	Stanley et al. (1994)	1570	mallard (*Anas platyrhynchos*)	2	M	FD	93	days	1	years	LB	both	REP	TERA	EM	na	0.355	83	no (ENR)
105	Heinz and Hoffman (1998)	1353	mallard (*Anas platyrhynchos*)	2	M	FD	75	days	18	months	LB	female	REP	TERA	EM	na	0.456	84	no (ENR)
106	Heinz and Hoffman (1996)	1352	mallard (*Anas platyrhynchos*)	2	M	FD	4	weeks	NR	months	LB	female	REP	TERA	EM	na	0.524	83	no (ENR)
107	Hoffman and Heinz (1988)	1372	mallard (*Anas platyrhynchos*)	2	UX	FD	6	weeks	NR	NR	LB	both	REP	ABNM	WO	na	0.546	83	yes
108	Heinz and Hoffman (1996)	1352	mallard (*Anas platyrhynchos*)	2	M	FD	4	weeks	NR	months	LB	female	REP	TERA	EM	na	0.580	83	no (ENR)
109	Heinz and Hoffman (1996)	1352	mallard (*Anas platyrhynchos*)	2	M	FD	4	weeks	NR	months	LB	female	REP	TPRD	EM	na	0.614	77	yes
110	Smith et al. (1988)	1562	black-crowned night-heron (*Nycticorax nycti*)	2	UX	FD	92	days	NR	NR	LB	both	REP	ODVP	WO	na	0.675	76	no (ENR)
111	El-Begerami et al. (1977)	1291	Japanese quail (*Coturnix japonica*)	3	U	FD	16	weeks	1	days	JV	both	REP	ABNM	WO	na	0.702	78	no (ENR)
112	El-Begearmi et al. (1982)	6433	Japanese quail (*Coturnix japonica*)	2	U	FD	16	weeks	NR	NR	LB	female	REP	HTCH	WO	na	0.780	78	yes
113	Stoewsand et al. (1978)	1575	Japanese quail (*Coturnix japonica*)	2	U	FD	5	weeks	15	days	JV	female	REP	EGPN	WO	na	0.826	78	yes
114	Heinz and Hoffman (1987)	1356	mallard (*Anas platyrhynchos*)	2	UX	FD	41	days	2	years	LB	female	REP	PROG	WO	na	0.898	85	yes
115	Heinz and Fitzgerald (1993)	36813	mallard (*Anas platyrhynchos*)	2	M	FD	21	weeks	NR	NR	LB	female	REP	PROG	WO	na	1.19	84	yes
116	Wiemeyer and Hoffman (1996)	1622	owl (*Otus asio*)	3	M	FD	3	months	3	years	LB	both	REP	PLBR	WO	na	4.49	85	yes
Growth																			
117	Colnago et al. (1984)	9356	chicken (*Gallus domesticus*)	3	M	FD	24	days	1	days	JV	male	GRO	BDWT	WO	0.0632	na	73	no (UN)
118	Jensen (1986)	1402	chicken (*Gallus domesticus*)	4	U	FD	3	weeks	1	days	JV	male	GRO	BDWT	WO	0.0740	0.370	75	yes
119	Hegazy and Adachi (2000)	7725	chicken (*Gallus domesticus*)	2	U	FD	15	days	1	days	JV	NR	GRO	BDWT	WO	0.0859	na	70	no (UN)
120	Thapar et al. (1969)	1592	chicken (*Gallus domesticus*)	3	U	FD	4	weeks	1	days	JV	both	GRO	BDWT	WO	0.180	0.721	81	no (UN [b])
121	Hill (1979)	397	chicken (*Gallus domesticus*)	4	U	FD	5	weeks	1	days	JV	female	GRO	BDWT	WO	0.204	0.408	77	yes
122	Echevarria et al. (1988)	1289	chicken (*Gallus domesticus*)	4	U	FD	3	weeks	1	days	JV	male	GRO	BDWT	WO	0.213	0.426	82	yes
123	Moksnes and Norheim (1982)	1465	chicken (*Gallus domesticus*)	4	U	FD	31	weeks	20	weeks	JV	both	GRO	BDWT	WO	0.284	na	68	no (UN)
124	Moksnes (1983)	1464	chicken (*Gallus domesticus*)	6	U	FD	18	weeks	20	weeks	SM	female	GRO	BDWT	WO	0.292	na	77	no (UN)
125	Moksnes and Norheim (1982)	1465	chicken (*Gallus domesticus*)	4	U	FD	6	weeks	1	days	JV	both	GRO	BDWT	WO	0.319	na	68	no (UN)
126	Arnold et al. (1973)	69	chicken (*Gallus domesticus*)	3	U	FD	104	weeks	1	days	JV	both	GRO	BDWT	WO	0.371	na	68	no (UN)
127	Thapar et al. (1969)	1592	chicken (*Gallus domesticus*)	3	U	FD	105	weeks	1	days	JV	female	GRO	BDWT	WO	0.379	na	68	no (UN)
128	Poley and Moxon (1937)	3788	chicken (*Gallus domesticus*)	4	U	FD	6	weeks	NR	NR	SM	female	GRO	BDWT	WO	0.429	na	68	no (UN)
129	Hill (1974)	1369	chicken (*Gallus domesticus*)	6	U	FD	2	weeks	1	days	JV	both	GRO	BDWT	WO	0.429	0.859	82	yes
130	Jensen et al. (1977)	1404	chicken (*Gallus domesticus*)	5	U	FD	2	weeks	1	days	JV	both	GRO	BDWT	WO	0.617	1.23	77	yes
131	O'Toole and Raisbeck (1997)	1476	mallard (*Anas platyrhynchos*)	4	U	FD	21	days	NR	NR	JV	male	GRO	BDWT	WO	0.690	1.73	79	yes
132	Cantor et al. (1984)	1245	chicken (*Gallus domesticus*)	4	U	DR	7	days	6	days	JV	male	GRO	BDWT	WO	0.718	1.44	78	yes
133	Sell and Horani (1976)	1550	Japanese quail (*Coturnix japonica*)	2	U	FD	23	days	8	days	JV	both	GRO	BDWT	WO	0.909	na	69	no (UN)
134	Yamamoto et al. (1998)	1636	American kestrel (*Falco sparverius*)	3	M	FD	77	days	NR	NR	MA	male	GRO	BDWT	WO	1.06	na	68	no (UN)
135	Hoffman et al. (1991)	1377	mallard (*Anas platyrhynchos*)	3	UX	FD	4	weeks	1	days	JV	both	GRO	BDWT	WO	1.13	4.53	86	yes
136	Hoffman et al. (1992)	1378	mallard (*Anas platyrhynchos*)	3	UX	FD	4	weeks	1	days	JV	both	GRO	BDWT	WO	1.23	4.94	86	yes
137	Ansari and Britton (1974)	36789	chicken (*Gallus domesticus*)	2	U	FD	10	days	1	days	JV	male	GRO	BDWT	WO	1.38	na	67	no (UN)

Table E2.A-5. Selenium Data for Birds as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result Number	Reference	Reference Number	Test Organism	Number of Concentrations or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation? [a]
Growth (continued)																			
138	Howell and Hill (1978)	1387	chicken (*Gallus domesticus*)	2	U	FD	20	days	1	days	JV	both	GRO	BDWT	WO	1.42	na	67	no (UN)
139	Cantor et al. (1984)	1245	chicken (*Gallus domesticus*)	4	U	DR	7	days	9	days	JV	both	GRO	BDWT	WO	1.45	2.90	78	yes
140	Heinz et al. (1988)	1355	mallard (*Anas platyrhynchos*)	5	UX	FD	3	weeks	1	days	JV	NR	GRO	BDWT	WO	1.74	3.48	89	yes
141	Heinz et al. (1988)	1355	mallard (*Anas platyrhynchos*)	5	UX	FD	3	weeks	1	days	JV	NR	GRO	BDWT	WO	2.13	4.26	89	yes
142	Heinz et al. (1996)	1357	mallard (*Anas platyrhynchos*)	2	U	FD	2	weeks	1	days	JV	NR	GRO	BDWT	WO	3.04	na	72	no (UN)
143	Heinz et al. (1996)	1357	mallard (*Anas platyrhynchos*)	3	U	FD	2	weeks	1	days	JV	NR	GRO	BDWT	WO	4.16	8.32	84	yes
144	Heinz et al. (1996)	1357	mallard (*Anas platyrhynchos*)	3	U	FD	1	weeks	1	days	JV	NR	GRO	BDWT	WO	5.75	11.5	84	yes
145	Jensen et al. (1977)	1404	chicken (*Gallus domesticus*)	5	U	FD	2	weeks	1	days	JV	both	GRO	BDWT	WO	6.34	11.9	77	yes
146	Heinz et al. (1996)	1357	mallard (*Anas platyrhynchos*)	3	U	FD	2	weeks	1	days	JV	NR	GRO	BDWT	WO	7.31	na	72	no (UN)
147	El-Begearmi and Combs (1982)	1290	chicken (*Gallus domesticus*)	4	U	FD	4	weeks	1	days	JV	both	GRO	BDWT	WO	na	0.0912	77	yes
148	Poley et al. (1937)	3787	chicken (*Gallus domesticus*)	2	M	FD	1	weeks	NR	NR	SM	female	GRO	BDWT	WO	na	0.127	77	yes
149	El-Begearmi and Combs (1982)	1290	chicken (*Gallus domesticus*)	3	U	FD	4	weeks	1	days	JV	both	GRO	BDWT	WO	na	0.130	77	yes
150	El-Begearmi and Combs (1982)	1290	chicken (*Gallus domesticus*)	4	U	FD	4	weeks	1	days	JV	both	GRO	BDWT	WO	na	0.180	77	yes
151	Fairbrother and Fowles (1990)	1297	mallard (*Anas platyrhynchos*)	3	U	DR	9	days	9	months	JV	male	GRO	BDWT	WO	na	0.275	72	yes
152	Dafalla and Adam (1986)	1273	chicken (*Gallus domesticus*)	3	U	FD	2	weeks	7	days	JV	both	GRO	BDWT	WO	na	0.306	77	yes
153	Khan et al. (1993)	1415	chicken (*Gallus domesticus*)	2	U	GV	28	days	43	days	JV	both	GRO	BDWT	WO	na	0.50	84	yes
154	Khan et al. (1993)	5483	chicken (*Gallus domesticus*)	2	U	OR	4	weeks	NR	NR	JV	both	GRO	BDWT	WO	na	0.50	79	yes
155	Sell and Horani (1976)	1550	chicken (*Gallus domesticus*)	2	U	FD	28	days	1	days	JV	male	GRO	BDWT	WO	na	0.629	78	yes
156	Elzubeir and Davis (1988)	1294	chicken (*Gallus domesticus*)	2	U	FD	24	days	14	days	JV	male	GRO	BDWT	WO	na	0.788	77	yes
157	Davis et al. (1996)	1278	chicken (*Gallus domesticus*)	2	U	FD	21	days	14	days	JV	male	GRO	BDWT	WO	na	0.855	77	yes
158	Hill (1979)	1370	chicken (*Gallus domesticus*)	2	U	FD	2	weeks	1	days	JV	both	GRO	BDWT	WO	na	0.859	71	yes
159	Stoewsand et al. (1977)	1574	Japanese quail (*Coturnix japonica*)	2	U	FD	10	weeks	2	weeks	JV	both	GRO	BDWT	WO	na	0.896	77	yes
160	Heinz and Fitzgerald (1993)	36813	mallard (*Anas platyrhynchos*)	2	M	FD	21	weeks	NR	NR	SM	both	GRO	BDWT	WO	na	1.08	75	yes
161	Hoffman et al. (1992)	1376	duck (*Anas platyrhynchos*)	3	UX	FD	4	weeks	1	days	JV	both	GRO	BDWT	WO	na	1.20	82	yes
162	Berg and Martinson (1972)	93	chicken (*Gallus domesticus*)	3	U	FD	2	weeks	1	days	JV	NR	GRO	BDWT	WO	na	1.38	77	yes
163	Lowry and Baker (1989)	1445	chicken (*Gallus domesticus*)	2	U	FD	14	days	8	days	JV	male	GRO	BDWT	WO	na	1.55	77	yes
164	Hill (1979)	1370	chicken (*Gallus domesticus*)	2	U	FD	2	weeks	1	days	JV	both	GRO	BDWT	WO	na	1.72	71	yes
165	Howell and Hill (1978)	1387	chicken (*Gallus domesticus*)	2	U	FD	21	days	1	days	JV	both	GRO	BDWT	WO	na	1.78	76	yes
166	Donaldson and McGowan (1989)	1285	chicken (*Gallus domesticus*)	3	U	FD	20	days	1	days	JV	male	GRO	BDWT	WO	na	2.27	77	yes
167	Hill (1980)	395	chicken (*Gallus domesticus*)	2	U	FD	1	weeks	1	days	JV	female	GRO	BDWT	WO	na	2.76	71	yes
168	Stoewsand et al. (1977)	1574	Japanese quail (*Coturnix japonica*)	2	M	FD	10	weeks	NR	NR	JV	both	GRO	BDWT	WO	na	3.64	82	yes
Survival																			
169	Arnold et al. (1973)	69	chicken (*Gallus domesticus*)	3	U	FD	24	weeks	1	days	JV	female	MOR	MORT	WO	0.093	0.371	82	yes
170	Van Vleet et al. (1981)	80	duck (*Anas platyrhynchos*)	2	U	FD	15	days	1	days	JV	male	MOR	MORT	WO	0.153	na	77	no (UN)
171	El-Begearmi and Combs (1982)	1290	chicken (*Gallus domesticus*)	4	U	FD	2	weeks	1	days	JV	both	MOR	MORT	WO	0.290	0.579	84	yes
172	Moksnes (1983)	1464	chicken (*Gallus domesticus*)	6	U	FD	18	weeks	20	weeks	SM	female	MOR	MORT	WO	0.292	na	78	no (UN)
173	Thapar et al. (1969)	1592	chicken (*Gallus domesticus*)	3	U	FD	76	weeks	1	days	JV	female	MOR	MORT	WO	0.368	na	78	no (UN)
174	Thapar et al. (1969)	1592	chicken (*Gallus domesticus*)	3	U	FD	105	weeks	1	days	JV	both	MOR	MORT	WO	0.378	na	77	no (UN)
175	El-Begearmi and Combs (1982)	1290	chicken (*Gallus domesticus*)	3	U	FD	2	weeks	1	days	JV	both	MOR	MORT	WO	0.412	0.823	84	yes
176	Heinz and Fitzgerald (1993)	1350	mallard (*Anas platyrhynchos*)	5	UX	FD	13	weeks	NR	months	AD	male	MOR	MORT	WO	0.563	1.13	85	yes
177	El-Begearmi and Combs (1982)	1290	chicken (*Gallus domesticus*)	4	U	FD	2	weeks	1	days	JV	both	MOR	MORT	WO	0.572	1.14	84	yes
178	Stoewsand et al. (1974)	1577	Japanese quail (*Coturnix japonica*)	2	U	FD	4	weeks	1	days	JV	both	MOR	MORT	WO	0.610	na	77	no (UN)
179	Sell and Horani (1976)	1550	chicken (*Gallus domesticus*)	2	U	FD	28	days	1	days	JV	male	MOR	MORT	WO	0.629	na	79	no (UN)
180	Echevarria et al. (1988)	1289	chicken (*Gallus domesticus*)	4	U	FD	3	weeks	1	days	JV	male	MOR	MORT	WO	0.64	na	68	no (UN)
181	O'Toole and Raisbeck (1997)	1476	mallard (*Anas platyrhynchos*)	4	U	FD	50	days	NR	NR	AD	male	MOR	MORT	WO	0.699	4.19	82	yes
182	El-Begerami et al. (1977)	1291	Japanese quail (*Coturnix japonica*)	3	U	FD	12	weeks	1	days	JV	both	MOR	SURV	WO	0.702	1.40	83	yes
183	El-Begearmi et al. (1982)	6433	Japanese quail (*Coturnix japonica*)	2	U	FD	16	weeks	NR	NR	NR	both	MOR	SURV	WO	0.780	na	70	no (UN)
184	Heinz (1993)	1347	duck (*Anas platyrhynchos*)	2	U	FD	21	weeks	NR	NR	AD	male	MOR	MORT	WO	0.844	na	70	no (UN)
185	Hill (1979)	1370	chicken (*Gallus domesticus*)	2	U	FD	2	weeks	1	days	JV	both	MOR	MORT	WO	0.859	na	72	no (UN)
186	Heinz et. al. (1989)	1354	duck (*Anas platyrhynchos*)	2	UX	FD	49	days	NR	NR	SM	both	MOR	MORT	WO	0.890	na	76	no (UN)
187	Stoewsand et al. (1977)	1574	Japanese quail (*Coturnix japonica*)	2	U	FD	10	weeks	2	weeks	JV	both	MOR	MORT	WO	0.896	na	78	no (UN)
188	Sell and Horani (1976)	1550	Japanese quail (*Coturnix japonica*)	2	U	FD	23	days	8	days	JV	both	MOR	MORT	WO	0.909	na	78	no (UN)
189	Heinz et. al. (1989)	1354	duck (*Anas platyrhynchos*)	6	UX	FD	46	weeks	NR	NR	SM	both	MOR	MORT	WO	0.910	na	79	no (UN)
190	Yamamoto et al. (1998)	1636	American Kestrel (*Falco sparverius*)	2	M	FD	77	days	NR	NR	MA	both	MOR	MORT	WO	0.944	na	75	no (UN)

Table E2.A-5. Selenium Data for Birds as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result Number	Reference	Reference Number	Test Organism	Number of Concentrations or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation? [a]
Survival (continued)																			
191	Heinz and Hoffman (1987)	1356	mallard (*Anas platyrhynchos*)	2	UX	FD	41	days	2	years	SM	female	MOR	MORT	WO	1.01	na	84	no (UN)
192	Yamamoto et al. (1998)	1636	American Kestrel (*Falco sparverius*)	3	M	FD	77	days	NR	NR	MA	both	MOR	MORT	WO	1.06	na	78	no (UN)
193	Heinz and Fitzgerald (1993)	36813	mallard (*Anas platyrhynchos*)	2	M	FD	21	weeks	NR	NR	SM	both	MOR	MORT	WO	1.08	na	76	no (UN)
194	Hoffman et al. (1991)	1377	mallard (*Anas platyrhynchos*)	3	UX	FD	4	weeks	1	days	JV	both	MOR	SURV	WO	1.13	4.53	87	yes
195	Hoffman et al. (1992)	1376	duck (*Anas platyrhynchos*)	3	UX	FD	4	weeks	1	days	JV	both	MOR	SURV	WO	1.20	4.80	87	yes
196	Green and Albers (1997)	1319	mallard (*Anas platyrhynchos*)	5	U	FD	16	weeks	14	months	AD	male	MOR	MORT	WO	1.22	2.44	83	yes
197	Hoffman et al. (1992)	1378	mallard (*Anas platyrhynchos*)	3	UX	FD	4	weeks	1	days	JV	both	MOR	SURV	WO	1.23	4.94	87	yes
198	Santolo et al. (1999)	1535	American kestrel (*Falco sparverius*)	3	M	FD	11	weeks	NR	months	AD	both	MOR	MORT	WO	1.37	na	78	no (UN)
199	Ansari and Britton (1974)	36789	chicken (*Gallus domesticus*)	2	U	FD	10	days	1	days	JV	male	MOR	MORT	WO	1.38	na	77	no (UN)
200	Howell and Hill (1978)	1387	chicken (*Gallus domesticus*)	2	U	FD	20	days	1	days	JV	both	MOR	MORT	WO	1.42	na	77	no (UN)
214	Hill (1979)	1370	chicken (*Gallus domesticus*)	2	U	FD	2	weeks	1	days	JV	both	MOR	MORT	WO	1.72	na	72	no (UN)
201	Hoffman et al. (1991)	1374	mallard (*Anas platyrhynchos*)	7	U	FD	14	weeks	2	years	AD	male	MOR	SURV	WO	1.87	na	78	no (UN)
202	Smith et al. (1988)	1562	black-crowned night-heron (*Nycticorax nycti*)	3	UX	FD	92	days	NR	NR	AD	both	MOR	MORT	WO	2.03	na	78	no (UN)
203	Albers et al. (1996)	1208	duck (*Anas platyrhynchos*)	5	U	FD	16	weeks	1	years	AD	male	MOR	MORT	WO	2.38	4.75	80	yes
204	Heinz et al. (1996)	1357	mallard (*Anas platyrhynchos*)	2	U	FD	2	weeks	1	days	JV	NR	MOR	SURV	WO	3.04	na	73	no (UN)
205	Donaldson and McGowan (1989)	1285	chicken (*Gallus domesticus*)	3	U	FD	18	days	1	days	JV	male	MOR	MORT	WO	3.04	6.08	84	yes
206	Jensen et al. (1977)	1404	chicken (*Gallus domesticus*)	5	U	FD	2	weeks	1	days	JV	both	MOR	MORT	WO	3.07	6.14	78	yes
207	Heinz and Hoffman (1987)	1356	mallard (*Anas platyrhynchos*)	6	UX	FD	57	days	2	years	SM	both	MOR	MORT	WO	3.08	12.3	84	yes
208	Heinz et al.(1996)	1357	mallard (*Anas platyrhynchos*)	3	U	FD	1	weeks	1	days	JV	NR	MOR	SURV	WO	3.49	6.99	85	yes
209	Stoewsand et al. (1977)	1574	Japanese quail (*Coturnix japonica*)	2	M	FD	10	weeks	2	weeks	JV	both	MOR	MORT	WO	3.64	na	83	no (UN)
210	Heinz et al. (1996)	1357	mallard (*Anas platyrhynchos*)	3	U	FD	2	weeks	1	days	JV	NR	MOR	SURV	WO	3.72	na	79	no (UN)
211	Heinz et al. (1988)	1355	mallard (*Anas platyrhynchos*)	5	UX	FD	3	weeks	1	days	JV	NR	MOR	MORT	WO	3.99	7.98	90	yes
212	Heinz et al. (1988)	1355	mallard (*Anas platyrhynchos*)	5	UX	FD	2	weeks	1	days	JV	NR	MOR	MORT	WO	5.84	11.7	90	yes
213	Heinz et al. (1996)	1357	mallard (*Anas platyrhynchos*)	3	U	FD	2	weeks	1	days	JV	NR	MOR	SURV	WO	7.31	na	66	no (UN)
215	Jensen et al. (1977)	1404	chicken (*Gallus domesticus*)	5	U	FD	2	weeks	1	days	JV	both	MOR	MORT	WO	28.2	29.0	78	yes
216	Khan et al. (1993)	1415	chicken (*Gallus domesticus*)	2	U	GV	28	days	43	days	JV	female	MOR	MORT	WO	na	0.50	78	yes
217	Howell and Hill (1978)	1387	chicken (*Gallus domesticus*)	2	U	FD	21	days	1	days	JV	both	MOR	MORT	WO	na	1.78	77	yes
218	Hill (1974)	1369	chicken (*Gallus domesticus*)	2	U	FD	2	weeks	1	days	JV	both	MOR	MORT	WO	na	3.44	77	yes
219	Heinz (1993)	1347	duck (*Anas platyrhynchos*)	2	U	FD	5	weeks	NR	NR	AD	male	MOR	MORT	WO	na	5.75	71	yes

Notes:

Acronyms, abbreviations, and units of measure are defined in Table E2.A-1.

Not all studies presented in the selenium ecological soil screening level (Eco-SSL) document for growth reproduction and survival were used to derive the Eco-SSL toxicity reference value (TRV).

See Eco-SSL document (USEPA 2007b) for the full reference list for studies cited in this table.

[a] Rationale for study unacceptability is in parentheses.

[b] Dose/response data set was reviewed and determined to be an unbounded no-observed-adverse-effect level (NOAEL) (differs from the Eco-SSL document).

Table E2.A-6. Selenium Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result Number	Reference	Reference Number	Test Organism	Number of Concentrations or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation? [a]
Reproduction																			
231	Nobunaga et al. (1979)	1473	mouse (*Mus musculus*)	3	U	DR	56	days	60	days	GE	female	REP	PRWT	WO	0.072	0.145	81	yes
232	Fredriksson et al. (1993)	1304	rat (*Rattus norvegicus*)	2	M	FD	14	weeks	NR	NR	GE	female	REP	ODVP	WO	0.108	na	74	no (UN)
233	Gunter et al. (2003)	25959	cattle (*Bos taurus*)	2	U	FD	42	weeks	NR	NR	GE	female	REP	PRWT	WO	0.173	na	70	no (UN)
234	Nebbia et al. (1987)	1471	rat (*Rattus norvegicus*)	4	U	DR	240	days	NR	NR	JV	male	REP	TEWT	TE	0.384	0.768	80	no (ENR)
235	Kezhou et al. (1987)	1413	rat (*Rattus norvegicus*)	4	U	FD	5	weeks	NR	NR	JV	male	REP	SPCL	GO	0.388	0.776	86	no (ENR)
236	Abdo (1994)	1475	rat (*Rattus norvegicus*)	6	UX	DR	13	weeks	6	weeks	JV	female	REP	GREP	WO	0.393	0.763	95	yes
237	Halverson (1974)	1329	rat (*Rattus norvegicus*)	5	U	FD	42	days	90	days	GE	female	REP	PROG	WO	0.456	na	71	no (UN)
238	Abdo (1994)	1475	mouse (*Mus musculus*)	6	UX	DR	13	weeks	6	weeks	JV	male	REP	GREP	WO	0.735	1.51	92	yes
239	Panter et al. (1995)	1498	sheep (*Ovis aries*)	2	M	FD	88	days	NR	months	GE	female	REP	PRWT	WO	0.780	na	77	no (UN)
240	Panter et al. (1995)	1498	sheep (*Ovis aries*)	2	M	FD	88	days	NR	NR	GE	female	REP	PRWT	WO	0.945	na	69	no (UN)
241	Hau et al. (1987)	1344	mouse (*Mus musculus*)	4	U	DR	29	days	8	weeks	GE	female	REP	PRWT	WO	1.21	6.03	78	yes
242	Piccirillo et al. (1983)	1507	mouse (*Mus musculus*)	2	U	GV	8	days	64	days	GE	female	REP	PRWT	WO	1.60	na	86	no (UN)
243	Abdo (1994)	1475	mouse (*Mus musculus*)	6	UX	DR	13	weeks	6	weeks	JV	both	REP	SPCL	TE	2.28	na	85	no (ENR, UN)
244	Webster (1979)	823	mouse (*Mus musculus*)	5	U	FD	19	days	4	months	GE	female	REP	PRWT	WO	2.54	25.4	78	yes
245	Hardin et al. (1987)	1335	mouse (*Mus musculus*)	5	U	GV	8	days	6-8	weeks	GE	female	REP	PRWT	WO	3.20	6.39	87	yes
246	Plasterer et al. (1985)	1509	mouse (*Mus musculus*)	2	U	GV	8	days	61-71	days	GE	female	REP	PRWT	WO	3.20	na	86	no (UN)
247	Booth et al. (1983)	1234	mouse (*Mus musculus*)	2	U	GV	8	days	NR	NR	GE	female	REP	PROG	WO	7.0	na	90	no (UN)
248	Kaur and Parshad (1994)	1411	rat (*Rattus norvegicus*)	3	U	FD	5	weeks	NR	NR	JV	male	REP	SPCV	TE	na	0.089	79	no (ENR)
249	Abdo (1994)	1475	rat (*Rattus norvegicus*)	6	UX	DR	13	weeks	6	weeks	JV	female	REP	GREP	WO	na	0.130	89	yes
250	Wahlstrom and Olson (1959)	14497	pig (*Sus scrofa*)	2	U	FD	239	days	8	weeks	GE	female	REP	PRWT	WO	na	0.296	79	yes
251	Schroeder and Mitchener (1971)	66	mouse (*Mus musculus*)	2	U	DR	6	months	21	days	JV	female	REP	DEYO	WO	na	0.434	73	yes
252	Thorlacius-Ussing (1990)	1595	rat (*Rattus norvegicus*)	3	U	DR	21	days	NR	NR	LC	female	REP	PRWT	WO	na	0.504	73	yes
253	Parshad and Sud (1989)	1500	rat (*Rattus norvegicus*)	2	M	FD	4	weeks	NR	NR	JV	male	REP	TEWT	TE	na	0.550	79	no (ENR)
254	Thorlacius-Ussing et al. (1987)	1596	rat (*Rattus norvegicus*)	2	U	DR	21	days	NR	months	LC	female	REP	PRWT	WO	na	0.749	73	yes
255	Chermoff and Kavlock (1982)	1259	mouse (*Mus musculus*)	2	U	GV	5	days	60	days	GE	female	REP	PROG	WO	na	4.18	86	yes
256	Gray and Kavlock (1984)	1316	mouse (*Mus musculus*)	2	U	OR	5	days	90	days	GE	female	REP	PROG	WO	na	4.57	81	yes
Growth																			
258	Shull and Checke (1973)	1557	rat (*Rattus norvegicus*)	3	U	FD	8	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.053	0.265	82	yes
259	Meyer et al. (1982)	662	rat (*Rattus norvegicus*)	2	U	FD	30	days	NR	NR	JV	male	GRO	BDWT	WO	0.0642	na	78	no (UN)
260	Palmer et al. (1982)	1496	rat (*Rattus norvegicus*)	3	M	FD	4	weeks	NR	NR	JV	NR	GRO	BDWT	WO	0.0838	0.763	86	yes
261	Chen et al. (1990)	1255	rat (*Rattus norvegicus*)	2	U	FD	2	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.0869	na	77	no (UN)
262	Glattre et al. (1995)	11361	rat (*Rattus norvegicus*)	2	U	DR	4	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.090	na	67	no (UN)
263	Debski et al. (1992)	1280	rat (*Rattus norvegicus*)	2	U	FD	2	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.110	na	81	no (UN)
264	Kim and Mahan (2001)	25957	pig (*Sus scrofa*)	6	U	FD	12	weeks	NR	NR	JV	both	GRO	BDWT	WO	0.112	0.157	84	no (SDC)
265	Kim and Mahan (2001)	25948	pig (*Sus scrofa*)	4	U	FD	12	weeks	8	weeks	JV	both	GRO	BDWT	WO	0.137	0.273	84	yes
266	Mahan and Moxon (1984)	1450	pig (*Sus scrofa*)	7	U	FD	37	days	4	weeks	JV	both	GRO	BDWT	WO	0.143	0.215	84	yes
267	Goehring et. al. (1983)	1313	pig (*Sus scrofa*)	6	M	FD	5	weeks	NR	NR	JV	both	GRO	BDWT	WO	0.146	0.273	89	yes
268	Liu et al. (1994)	1442	rat (*Rattus norvegicus*)	4	M	FD	2	weeks	45	days	JV	female	GRO	BDWT	WO	0.151	0.304	89	yes
269	Liu and Milner (1992)	12370	rat (*Rattus norvegicus*)	2	M	FD	2	weeks	41	days	JV	female	GRO	BDWT	WO	0.153	na	76	no (UN)
270	Kim and Mahan (2001)	25958	pig (*Sus scrofa*)	2	UX	FD	14	weeks	NR	NR	JV	female	GRO	BDWT	WO	0.155	0.221	89	yes
271	Behne et al. (1992)	1224	rat (*Rattus norvegicus*)	2	U	FD	110	days	30	days	JV	male	GRO	BDWT	WO	0.163	na	77	no (UN)
272	Jenkins and Hidiroglou (1986)	1401	cattle (*Bos taurus*)	5	U	FD	6	weeks	3	days	JV	male	GRO	BDWT	WO	0.165	0.330	83	no (RU)
273	Mahan and Magee (1991)	1448	pig (*Sus scrofa*)	3	UX	FD	35	days	23	days	JV	both	GRO	BDWT	WO	0.170	0.510	89	yes
274	Gunter et al. (2003)	25959	cattle (*Bos taurus*)	2	U	FD	42	weeks	NR	NR	GE	female	GRO	BDWT	WO	0.173	na	68	no (UN)
275	Nehru et al. (1997)	2788	rat (*Rattus norvegicus*)	2	U	GV	8	weeks	NR	NR	JV	female	GRO	BDWT	WO	0.175	na	79	no (UN)
276	Palmer and Olson (1974)	1497	rat (*Rattus norvegicus*)	3	M	DR	42	days	21	days	JV	male	GRO	BDWT	WO	0.181	na	76	no (UN)
277	Mahan and Magee (1991)	1448	pig (*Sus scrofa*)	3	UX	FD	35	days	23	days	JV	both	GRO	BDWT	WO	0.183	0.548	89	yes
278	Mandisodza et al. (1979)	1454	pig (*Sus scrofa*)	3	M	FD	61	days	5-7	weeks	JV	both	GRO	BDWT	WO	0.189	na	74	no (UN)
279	Palmer and Olson (1974)	1497	rat (*Rattus norvegicus*)	3	M	DR	42	days	21	days	JV	male	GRO	BDWT	WO	0.191	na	78	no (UN)
280	Coudray et. al. (1996)	1271	rat (*Rattus norvegicus*)	2	U	FD	8	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.198	na	77	no (UN)
281	Mandisodza et al. (1979)	1454	pig (*Sus scrofa*)	3	M	FD	61	days	5-7	weeks	JV		GRO	BDWT	WO	0.202	na	68	no (UN)
282	Salbe and Levander (1990)	1533	rat (*Rattus norvegicus*)	3	UX	FD	6	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.214	na	82	no (UN)
283	McAdam and Levander (1987)	1457	rat (*Rattus norvegicus*)	4	U	FD	6	weeks	21	days	JV	male	GRO	BDWT	WO	0.217	0.435	82	yes
284	Goehring et al. (1984)	1312	rat (*Rattus norvegicus*)	4	M	FD	4	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.217	0.470	88	yes
285	Salbe and Levander (1990)	1533	rat (*Rattus norvegicus*)	3	UX	FD	6	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.217	na	82	no (UN)
286	Moxon and Mahan (1981 [b])	1468	pig (*Sus scrofa*)	8	UX	FD	37	days	NR	NR	JV	NR	GRO	BDWT	WO	0.227	0.340	89	yes
287	Kim and Mahan (2001)	25958	pig (*Sus scrofa*)	4	UX	FD	14	weeks	NR	NR	JV	female	GRO	BDWT	WO	0.236	na	74	no (UN)
288	Tsunoda et al. (2000)	36834	mouse (*Mus musculus*)	4	U	DR	14	days	7-8	weeks	JV	male	GRO	BDWT	WO	0.240	0.580	79	yes

Table E2.A-6. Selenium Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result Number	Reference	Reference Number	Test Organism	Number of Concentrations or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation? [a]
Growth (continued)																			
289	Lane et al. (1984)	1429	mouse (*Mus musculus*)	2	U	FD	26	weeks	4	weeks	JV	female	GRO	BDWT	WO	0.254	na	77	no (UN)
290	LeBoeuf et al. (1985)	1433	rat (*Rattus norvegicus*)	3	U	FD	6	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.261	0.521	82	yes
291	Goehring et al. (1984)	1312	pig (*Sus scrofa*)	4	M	FD	6	weeks	NR	NR	JV	both	GRO	BDWT	WO	0.265	na	74	no (UN)
292	Palmer and Olson (1974)	1497	rat (*Rattus norvegicus*)	4	M	DR	7	days	21	days	JV	male	GRO	BDWT	WO	0.274	0.540	84	yes
293	Turan et al. (1997)	1602	rabbit (*Oryctolagus cuniculus*)	2	U	FD	12	weeks	NR	NR	JV	both	GRO	BDWT	WO	0.277	na	73	no (UN)
294	Wahlstrom and Olson (1959)	14497	pig (*Sus scrofa*)	2	U	FD	239	days	8	weeks	GE	female	GRO	BDWT	WO	0.296	na	68	no (UN)
295	Bioulac-Sage et al. (1992)	1228	rat (*Rattus norvegicus*)	3	U	FD	2	months	NR	NR	JV	male	GRO	BDWT	WO	0.318	na	70	no (UN)
296	Julius et al. (1983)	1408	hamster (*Mesocricetus auratus*)	3	U	FD	21	days	4	weeks	JV	both	GRO	BDWT	WO	0.356	0.712	84	yes
297	Kim and Mahan (2001)	25948	pig (*Sus scrofa*)	4	U	FD	12	weeks	8	weeks	JV	both	GRO	BDWT	WO	0.367	0.489	79	yes
298	Yeh et al. (1997)	1640	rat (*Rattus norvegicus*)	4	U	FD	8	weeks	NR	NR	JV	both	GRO	BDWT	WO	0.367	na	77	no (UN)
299	Abdo (1994)	1475	rat (*Rattus norvegicus*)	6	U	DR	13	weeks	6	weeks	JV	female	GRO	BDWT	WO	0.368	0.564	93	yes
300	Kiremidjian-Schumacher et al. (1992)	1422	mouse (*Mus musculus*)	2	U	FD	8	weeks	6	weeks	JV	male	GRO	BDWT	WO	0.371	na	69	no (UN)
301	Julius et al. (1983)	1408	hamster (*Mesocricetus auratus*)	3	U	FD	21	days	4	weeks	JV	male	GRO	BDWT	WO	0.374	0.747	84	yes
302	Dausch and Fullerton (1993)	1276	rat (*Rattus norvegicus*)	2	U	FD	5	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.375	na	76	no (UN)
303	Spallholz et al. (1973)	1566	mouse (*Mus musculus*)	10	U	FD	5	weeks	NR	NR	JV	both	GRO	BDWT	WO	0.384	0.523	83	yes
304	Nebbia et al. (1987)	1471	rat (*Rattus norvegicus*)	4	U	DR	240	days	NR	NR	JV	male	GRO	BDWT	WO	0.384	0.768	78	yes
305	Kezhou et al. (1987)	1413	rat (*Rattus norvegicus*)	4	U	FD	5	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.388	0.776	84	yes
306	Abdo (1994)	1475	rat (*Rattus norvegicus*)	6	U	DR	13	weeks	6	weeks	JV	female	GRO	BDWT	WO	0.393	0.763	93	yes
307	Schroeder and Mitchener (1972)	3725	mouse (*Mus musculus*)	2	U	DR	360	days	NR	lf	JV	male	GRO	BDWT	WO	0.407	na	68	no (UN)
308	Halverson et al. (1966)	1332	rat (*Rattus norvegicus*)	8	U	FD	6	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.425	0.567	77	yes
309	Dausch and Fullerton (1993)	1276	rat (*Rattus norvegicus*)	2	U	FD	5	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.426	na	74	no (UN)
310	Halverson et al. (1966)	1332	rat (*Rattus norvegicus*)	7	U	FD	6	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.432	0.577	83	yes
311	McAdam and Levander (1987)	1457	rat (*Rattus norvegicus*)	4	U	FD	6	weeks	21	days	JV	male	GRO	BDWT	WO	0.435	0.869	82	yes
312	McAdam and Levander (1987)	1457	rat (*Rattus norvegicus*)	4	U	FD	6	weeks	21	days	JV	male	GRO	BDWT	WO	0.435	0.869	82	yes
313	McAdam and Levander (1987)	1457	rat (*Rattus norvegicus*)	4	U	FD	6	weeks	21	days	JV	male	GRO	BDWT	WO	0.435	0.869	82	yes
314	Johnson et al. (2000)	36818	mouse (*Mus musculus*)	4	U	DR	14	days	6-7	weeks	JV	male	GRO	BDWT	WO	0.438	1.31	78	yes
315	Jacobs and Forst (1981)	1393	rat (*Rattus norvegicus*)	6	U	DR	35	days	5, 12	weeks	JV	both	GRO	BDWT	WO	0.452	0.904	77	yes
316	Goehring et al. (1984)	1312	pig (*Sus scrofa*)	4	M	FD	17	weeks	NR	NR	JV	both	GRO	BDWT	WO	0.464	na	74	no (UN)
317	Whanger and Butler (1988)	1618	rat (*Rattus norvegicus*)	4	U	FD	9	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.490	na	78	no (UN)
318	Whanger and Butler (1988)	1618	rat (*Rattus norvegicus*)	4	U	FD	9	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.500	na	78	no (UN)
319	Dausch and Fullerton (1993)	1276	rat (*Rattus norvegicus*)	5	U	FD	5	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.515	1.54	77	yes
320	Beems and van Beek (1985)	1223	hamster (*Mesocricetus auratus*)	5	M	FD	42	days	NR	NR	JV	male	GRO	BDWT	WO	0.610	1.21	92	yes
321	Turan et al. (1997)	1603	rabbit (*Oryctolagus cuniculus*)	2	U	FD	14	weeks	NR	NR	JV	both	GRO	BDWT	WO	0.652	na	68	no (UN)
322	Hadjimarkos (1970)	14488	hamster (*Mesocricetus auratus*)	4	U	DR	4	weeks	NR	NR	JV	male	GRO	BDWT	WO	0.680	0.88	82	yes
323	Abdo (1994)	1475	mouse (*Mus musculus*)	6	U	DR	13	weeks	6	weeks	JV	male	GRO	BDWT	WO	0.735	1.51	90	yes
324	Panter et al. (1995)	1498	sheep (*Ovis aries*)	2	M	FD	88	days	NR	NR	GE	female	GRO	BDWT	WO	0.780	na	73	no (UN)
325	Abdo (1994)	1475	mouse (*Mus musculus*)	6	U	DR	13	weeks	6	weeks	JV	both	GRO	BDWT	WO	0.781	1.23	93	yes
326	Jacobs and Forst (1981)	1394	mouse (*Mus musculus*)	4	U	DR	47	weeks	6	weeks	JV	female	GRO	BDWT	WO	0.784	1.21	78	yes
327	Julius et al. (1983)	1408	hamster (*Mesocricetus auratus*)	5	U	FD	21	days	4	weeks	JV	both	GRO	BDWT	WO	0.810	1.62	84	yes
328	Panter et al. (1995)	1498	sheep (*Ovis aries*)	2	M	FD	88	days	NR	NR	GE	female	GRO	BDWT	WO	0.945	na	67	no (UN)
329	Hermann et.al. (1991)	1364	rat (*Rattus norvegicus*)	3	U	FD	8	weeks	NR	NR	JV	female	GRO	BDWT	WO	0.996	1.59	82	yes
330	Hermann et.al. (1991)	1364	rat (*Rattus norvegicus*)	3	U	FD	8	weeks	NR	NR	JV	female	GRO	BDWT	WO	0.996	1.59	82	yes
331	Ishikawa et al. (1992)	1392	mouse (*Mus musculus*)	5	U	DR	12	weeks	5	weeks	JV	male	GRO	BDWT	WO	1.09	na	72	no (UN)
332	Jacobs and Forst (1981)	1394	mouse (*Mus musculus*)	7	U	DR	46	days	7	weeks	JV	male	GRO	BDWT	WO	1.14	2.27	77	yes
333	Beems and van Beek (1985)	1223	hamster (*Mesocricetus auratus*)	5	M	FD	42	days	NR	NR	JV	female	GRO	BDWT	WO	1.26	na	77	no (UN)
334	Piccirillo et al. (1983)	1507	mouse (*Mus musculus*)	2	U	GV	8	days	64	days	GE	female	GRO	BDWT	WO	1.60	na	84	no (UN)
335	Tsunoda et al. (2000)	36834	mouse (*Mus musculus*)	4	U	DR	14	days	7-8	weeks	JV	male	GRO	BDWT	WO	1.96	na	71	no (UN)
336	Hardin et al. (1987)	1335	mouse (*Mus musculus*)	5	U	GV	8	days	6-8	weeks	JV	female	GRO	BDWT	WO	3.20	6.39	85	yes
337	Plasterer et al. (1985)	1509	mouse (*Mus musculus*)	2	U	GV	8	days	61-71	days	GE	female	GRO	BDWT	WO	3.20	na	84	no (UN)
338	Piccirillo et al. (1983)	1507	mouse (*Mus musculus*)	6	U	GV	8	days	64	days	JV	female	GRO	BDWT	WO	4.57	na	84	no (UN)
339	Plasterer et al. (1985)	1509	mouse (*Mus musculus*)	4	U	GV	8	days	61-71	days	JV	female	GRO	BDWT	WO	4.57	na	84	no (UN)
340	Booth et al. (1983)	1234	mouse (*Mus musculus*)	4	U	GV	8	days	68-81	days	JV	female	GRO	BDWT	WO	10.0	na	90	no (UN)
341	Sayato et al. (1993)	1538	mouse (*Mus musculus*)	5	U	GV	30	days	5	weeks	JV	male	GRO	BDWT	WO	10.0	20.0	85	yes
342	Kaur and Parshad (1994)	1411	rat (*Rattus norvegicus*)	3	U	FD	1	weeks	NR	NR	JV	male	GRO	BDWT	WO	na	0.0908	77	yes
343	Spallholz et al. (1973)	1566	mouse (*Mus musculus*)	3	U	FD	5	weeks	NR	NR	JV	both	GRO	BDWT	WO	na	0.0968	77	yes
344	Boylan et al. (1990)	1239	mouse (*Mus musculus*)	2	M	FD	6	months	NR	NR	JV	female	GRO	BDWT	WO	na	0.156	82	yes
345	Wahlstrom et al. (1956)	14498	pig (*Sus scrofa*)	2	U	FD	108	days	NR	NR	JV	NR	GRO	BDWT	WO	na	0.163	78	yes
346	Behne et al. (1992)	1224	rat (*Rattus norvegicus*)	2	U	FD	110	days	30	days	JV	male	GRO	BDWT	WO	na	0.166	77	yes

Table E2.A-6. Selenium Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result Number	Reference	Reference Number	Test Organism	Number of Concentrations or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation? [a]
Growth (continued)																			
347	Baker et al. (1989)	1219	pig (*Sus scrofa*)	2	M	FD	9	weeks	8-14	weeks	JV	both	GRO	BDWT	WO	na	0.205	81	yes
348	Rhian and Moxon (1943)	14494	dog (*Canis familiaris*)	2	U	FD	8	weeks	150	days	JV	female	GRO	BDWT	WO	na	0.209	77	no (ID)
349	Goehring et al. (1984)	1312	rat (*Rattus norvegicus*)	4	M	FD	4	weeks	NR	NR	JV	male	GRO	BDWT	WO	na	0.215	82	yes
350	Chen et al. (1985)	1256	rat (*Rattus norvegicus*)	4	U	DR	32	days	NR	NR	JV	male	GRO	BDWT	WO	na	0.232	72	yes
351	Miller (1938)	14492	pig (*Sus scrofa*)	5	U	FD	63	days	4	months	JV	both	GRO	BDWT	WO	na	0.235	78	yes
352	Wahlstrom et al. (1956)	14498	pig (*Sus scrofa*)	2	U	FD	3	months	NR	NR	JV	NR	GRO	BDWT	WO	na	0.254	78	yes
353	Schroeder (1967)	1540	rat (*Rattus norvegicus*)	2	U	DR	30	days	21	days	JV	both	GRO	BDWT	WO	na	0.267	72	yes
354	Schroeder (1967)	1540	mouse (*Mus musculus*)	2	U	DR	99	days	21	days	JV	female	GRO	BDWT	WO	na	0.274	72	yes
355	Schroeder (1967)	1540	rat (*Rattus norvegicus*)	2	U	DR	30	days	21	days	JV	both	GRO	BDWT	WO	na	0.276	72	yes
356	Mercado and Bibby (1973)	757	rat (*Rattus norvegicus*)	2	U	DR	50	days	23	days	JV	male	GRO	BDWT	WO	na	0.282	71	yes
357	Wahlstrom et al. (1984)	1612	pig (*Sus scrofa*)	2	U	FD	6	weeks	5-6	weeks	JV	male	GRO	BDWT	WO	na	0.303	82	yes
358	Baker et al. (1989)	1219	pig (*Sus scrofa*)	2	M	FD	9	weeks	8-14	weeks	JV	both	GRO	BDWT	WO	na	0.307	81	yes
359	Wahlstrom et al. (1956)	14498	pig (*Sus scrofa*)	2	U	FD	98	days	NR	NR	JV	NR	GRO	BDWT	WO	na	0.323	78	yes
360	Birt et al. (1983)	1233	hamster (*Mesocricetus auratus*)	3	U	FD	25	weeks	4	weeks	JV	female	GRO	BDWT	WO	na	0.345	82	yes
361	Baker et al. (1989)	1219	pig (*Sus scrofa*)	2	M	FD	9	weeks	8-14	weeks	JV	both	GRO	BDWT	WO	na	0.352	81	yes
362	Thorlacius-Ussing et al. (1988)	1597	rat (*Rattus norvegicus*)	2	U	DR	21	days	25	days	JV	female	GRO	BDWT	WO	na	0.378	72	yes
363	Dausch and Fullerton (1993)	1276	rat (*Rattus norvegicus*)	3	U	FD	3	weeks	NR	NR	JV	male	GRO	BDWT	WO	na	0.390	76	yes
364	Thorlacius-Ussing et al. (1988)	1598	rat (*Rattus norvegicus*)	2	U	DR	21	days	21	days	JV	male	GRO	BDWT	WO	na	0.411	72	yes
365	Liu and Boylan (1994)	1443	rat (*Rattus norvegicus*)	2	M	FD	8	weeks	NR	NR	JV	male	GRO	BDWT	WO	na	0.420	82	yes
366	Schroeder and Mitchener (1972)	3725	mouse (*Mus musculus*)	2	U	DR	90	days	NR	lf	JV	male	GRO	BDWT	WO	na	0.425	72	yes
367	Dausch and Fullerton (1993)	1276	rat (*Rattus norvegicus*)	3	U	FD	5	weeks	NR	NR	JV	male	GRO	BDWT	WO	na	0.441	76	yes
368	Carmichael and Fowler (1980)	1249	rat (*Rattus norvegicus*)	2	U	DR	22	weeks	NR	NR	JV	male	GRO	BDWT	WO	na	0.454	73	yes
369	Birt et al. (1986)	1232	hamster (*Mesocricetus auratus*)	2	U	FD	10	weeks	4	weeks	JV	male	GRO	BDWT	WO	na	0.490	77	yes
370	Raisbeck et al. (1996)	1521	pronghorn (*Antilocapra americana*)	2	M	FD	164	days	6-96	months	JV	male	GRO	BDWT	WO	na	0.493	81	no (RU)
371	Salbe et al. (1990)	1532	rat (*Rattus norvegicus*)	3	U	DR	21	days	21	days	JV	both	GRO	BDWT	WO	na	0.498	72	yes
372	LeBoeuf and Hoekstra (1983)	1432	rat (*Rattus norvegicus*)	2	U	FD	6	weeks	NR	NR	JV	male	GRO	BDWT	WO	na	0.521	76	yes
373	Thorlacius-Ussing (1990)	1595	rat (*Rattus norvegicus*)	2	U	DR	21	days	21	days	JV	both	GRO	BDWT	WO	na	0.543	71	yes
374	Parshad and Sud (1989)	1500	rat (*Rattus norvegicus*)	2	M	FD	4	weeks	NR	NR	JV	male	GRO	BDWT	WO	na	0.550	77	yes
375	Gronbaek et al. (1995)	1323	rat (*Rattus norvegicus*)	2	U	DR	14	days	3-4	weeks	JV	male	GRO	BDWT	WO	na	0.570	73	yes
376	Dausch and Fullerton (1993)	1276	rat (*Rattus norvegicus*)	4	U	FD	3	weeks	NR	NR	JV	male	GRO	BDWT	WO	na	0.589	76	yes
377	Kezhou et al. (1987)	1413	rat (*Rattus norvegicus*)	4	U	FD	5	weeks	NR	NR	JV	male	GRO	BDWT	WO	na	0.653	78	yes
378	Hadjimarkos (1967)	1327	rat (*Rattus norvegicus*)	2	U	DR	21	days	NR	NR	JV	male	GRO	BDWT	WO	na	0.667	73	yes
379	Palmer et al. (1983)	15262	rat (*Rattus norvegicus*)	2	M	FD	4	weeks	NR	NR	JV	male	GRO	BDWT	WO	na	0.704	76	yes
380	Palmer et al. (1983)	15262	rat (*Rattus norvegicus*)	2	U	FD	4	weeks	NR	NR	JV	male	GRO	BDWT	WO	na	0.754	77	yes
381	Palmer and Olson (1974)	1497	rat (*Rattus norvegicus*)	4	M	DR	7	days	21	days	JV	male	GRO	BDWT	WO	na	0.767	78	yes
382	Cabe et al. (1979)	1244	rat (*Rattus norvegicus*)	2	U	DR	13	weeks	50	days	JV	male	GRO	BDWT	WO	na	0.769	72	yes
383	Panter et al. (1996)	1499	pig (*Sus scrofa*)	2	U	FD	6	weeks	8-10	weeks	JV	both	GRO	BDWT	WO	na	0.794	70	yes
384	Panter et al. (1996)	1499	pig (*Sus scrofa*)	2	U	FD	6	weeks	8-10	weeks	JV	both	GRO	BDWT	WO	na	0.794	76	yes
385	Palmer et al. (1982)	1496	rat (*Rattus norvegicus*)	2	M	FD	4	weeks	NR	NR	JV	NR	GRO	BDWT	WO	na	0.794	82	yes
386	Panter et al. (1996)	1499	pig (*Sus scrofa*)	2	U	FD	6	weeks	8-10	weeks	JV	both	GRO	BDWT	WO	na	0.794	76	yes
387	Palmer et al. (1982)	1496	rat (*Rattus norvegicus*)	2	M	FD	4	weeks	NR	NR	JV	NR	GRO	BDWT	WO	na	0.809	82	yes
388	Palmer et al. (1982)	1496	rat (*Rattus norvegicus*)	2	M	FD	4	weeks	NR	NR	JV	NR	GRO	BDWT	WO	na	0.817	82	yes
389	Palmer et al. (1983)	15262	rat (*Rattus norvegicus*)	2	U	FD	8	weeks	NR	NR	JV	male	GRO	BDWT	WO	na	0.823	77	yes
390	Obermeyer et al. (1971)	12934	rat (*Rattus norvegicus*)	2	U	FD	4	weeks	NR	NR	JV	NR	GRO	BDWT	WO	na	0.903	77	yes
391	Halverson and Monty (1960)	36812	rat (*Rattus norvegicus*)	2	U	FD	28	days	NR	NR	JV	male	GRO	BDWT	WO	na	0.968	77	yes
392	Halverson et al. (1962)	14489	rat (*Rattus norvegicus*)	2	U	FD	18	days	NR	NR	NR	male	GRO	BDWT	WO	na	0.984	77	yes
393	Halverson and Monty (1960)	36812	rat (*Rattus norvegicus*)	2	U	FD	28	days	NR	NR	JV	male	GRO	BDWT	WO	na	0.988	77	yes
394	Halverson et al. (1962)	14489	rat (*Rattus norvegicus*)	2	U	FD	18	days	NR	NR	NR	male	GRO	BDWT	WO	na	1.02	77	yes
395	Cutler (1974)	21137	rat (*Rattus norvegicus*)	2	U	DR	5	months	NR	NR	JV	male	GRO	BDWT	WO	na	1.11	72	yes
396	Hermann et.al. (1991)	1364	rat (*Rattus norvegicus*)	2	U	FD	8	weeks	NR	NR	JV	female	GRO	BDWT	WO	na	1.59	76	yes
397	Rastogi et al. (1976)	1523	rat (*Rattus norvegicus*)	2	U	DR	1	weeks	1	months	JV	both	GRO	BDWT	WO	na	1.59	73	yes
398	Franke and Moxon (1937)	14508	rat (*Rattus norvegicus*)	2	U	FD	65	days	28	days	JV	both	GRO	BDWT	WO	na	1.79	81	yes
399	Halverson et al. (1962)	14489	rat (*Rattus norvegicus*)	2	M	FD	18	days	NR	NR	NR	male	GRO	BDWT	WO	na	1.94	71	yes
400	Franke and Moxon (1937)	14508	rat (*Rattus norvegicus*)	2	U	FD	5	days	28	days	JV	male	GRO	BDWT	WO	na	3.54	81	yes
401	Franke and Moxon (1937)	14508	rat (*Rattus norvegicus*)	2	U	FD	5	days	28	days	JV	both	GRO	BDWT	WO	na	3.74	78	yes
402	Chermoff and Kavlock (1982)	1259	mouse (*Mus musculus*)	2	U	GV	5	days	60	days	GE	female	GRO	BDWT	WO	na	4.18	84	yes

Table E2.A-6. Selenium Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result Number	Reference	Reference Number	Test Organism	Number of Concentrations or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation? [a]
Survival																			
403	Spallholz et al. (1973)	1566	mouse (*Mus musculus*)	3	U	FD	5	weeks	NR	NR	JV	both	MOR	SURV	WO	0.0961	0.385	82	yes
404	Spallholz et al. (1973)	1566	mouse (*Mus musculus*)	10	U	FD	5	weeks	NR	NR	JV	both	MOR	SURV	WO	0.101	0.168	84	no (SDC)
405	Palmer and Olson (1974)	1497	rat (*Rattus norvegicus*)	3	M	DR	42	days	21	days	JV	male	MOR	MORT	WO	0.181	na	79	no (UN)
406	Palmer and Olson (1974)	1497	rat (*Rattus norvegicus*)	3	M	DR	42	days	21	days	JV	male	MOR	MORT	WO	0.186	na	79	no (UN)
407	McAdam and Levander (1987)	1457	rat (*Rattus norvegicus*)	4	U	FD	6	weeks	21	days	JV	male	MOR	MORT	WO	0.217	0.435	83	yes
408	McAdam and Levander (1987)	1457	rat (*Rattus norvegicus*)	4	U	FD	6	weeks	21	days	JV	male	MOR	MORT	WO	0.217	0.435	83	yes
409	Schroeder (1967)	1540	rat (*Rattus norvegicus*)	2	U	DR	180	days	21	days	JV	both	MOR	MORT	WO	0.221	na	73	no (UN)
410	Gronbaek and Thorlacius-Ussing (1990)	1324	rat (*Rattus norvegicus*)	4	U	DR	2	weeks	NR	NR	NR	male	MOR	SURV	WO	0.239	na	68	no (UN)
411	Palmer and Olson (1974)	1497	rat (*Rattus norvegicus*)	4	M	DR	21	days	21	days	JV	male	MOR	MORT	WO	0.274	0.540	85	yes
412	Jenkins and Hidiroglou (1986)	1401	cattle (*Bos taurus*)	5	U	FD	6	weeks	3	days	JV	male	MOR	MORT	WO	0.334	na	78	no (UN)
413	Birt et al. (1983)	1233	hamster (*Mesocricetus auratus*)	2	U	FD	25	weeks	4	weeks	JV	both	MOR	MORT	WO	0.350	na	79	no (UN)
414	Dausch and Fullerton (1993)	1276	rat (*Rattus norvegicus*)	2	U	FD	3	weeks	NR	NR	JV	male	MOR	SURV	WO	0.375	na	77	no (UN)
415	Abdo (1994)	1475	rat (*Rattus norvegicus*)	6	UX	DR	13	weeks	6	weeks	JV	female	MOR	MORT	WO	0.393	0.763	94	yes
416	Dausch and Fullerton (1993)	1276	rat (*Rattus norvegicus*)	4	U	FD	3	weeks	NR	NR	JV	male	MOR	MORT	WO	0.426	1.28	83	yes
417	McAdam and Levander (1987)	1457	rat (*Rattus norvegicus*)	4	U	FD	6	weeks	21	days	JV	male	MOR	MORT	WO	0.435	0.869	83	yes
418	McAdam and Levander (1987)	1457	rat (*Rattus norvegicus*)	4	U	FD	6	weeks	21	days	JV	male	MOR	MORT	WO	0.435	0.869	83	yes
419	Moxon and Mahan (1981 [b])	1468	pig (*Sus scrofa*)	8	UX	FD	37	days	NR	NR	JV	NR	MOR	MORT	WO	0.474	0.632	90	yes
420	Abdo (1994)	1475	rat (*Rattus norvegicus*)	6	UX	DR	13	weeks	6	weeks	JV	female	MOR	MORT	WO	0.564	0.769	94	yes
421	Halverson et al. (1966)	1332	rat (*Rattus norvegicus*)	8	U	FD	4	weeks	NR	NR	JV	male	MOR	MORT	WO	0.576	0.720	78	yes
422	Halverson et al. (1966)	1332	rat (*Rattus norvegicus*)	7	U	FD	4	weeks	NR	NR	JV	male	MOR	MORT	WO	0.587	0.733	84	yes
423	Palmer and Olson (1974)	1497	rat (*Rattus norvegicus*)	4	M	DR	21	days	21	days	JV	male	MOR	MORT	WO	0.595	0.892	85	yes
424	Wilson et al. (1988)	1629	pig (*Sus scrofa*)	4	U	OR	9	days	6	weeks	JV	male	MOR	MORT	WO	0.639	1.19	91	yes
425	Birt et al. (1983)	1233	hamster (*Mesocricetus auratus*)	3	U	FD	25	weeks	4	weeks	JV	both	MOR	MORT	WO	0.652	na	72	no (UN)
426	Turan et al. (1997)	1603	rabbit (*Oryctolagus cuniculus*)	2	U	FD	14	weeks	NR	NR	JV	both	MOR	MORT	WO	0.652	na	78	no (UN)
427	Kezhou et al. (1987)	1413	rat (*Rattus norvegicus*)	4	U	FD	22	days	NR	NR	JV	male	MOR	MORT	WO	0.653	0.980	85	yes
428	Chen et al. (1982)	1254	rat (*Rattus norvegicus*)	3	U	FD	4	weeks	NR	NR	JV	male	MOR	MORT	WO	0.680	na	78	no (UN)
429	Palmer et al. (1983)	15262	rat (*Rattus norvegicus*)	2	M	FD	4	weeks	NR	NR	JV	male	MOR	MORT	WO	0.704	na	77	no (UN)
430	Palmer et al. (1983)	15262	rat (*Rattus norvegicus*)	2	U	FD	4	weeks	NR	NR	JV	male	MOR	MORT	WO	0.754	na	78	no (UN)
431	Cabe et al. (1979)	1244	rat (*Rattus norvegicus*)	2	U	DR	18	weeks	50	days	JV	male	MOR	MORT	WO	0.769	na	73	no (UN)
432	Palmer et al. (1982)	1496	rat (*Rattus norvegicus*)	2	M	FD	4	weeks	NR	NR	JV	NR	MOR	MORT	WO	0.794	na	83	no (UN)
433	Palmer et al. (1982)	1496	rat (*Rattus norvegicus*)	3	M	FD	4	weeks	NR	NR	JV	NR	MOR	MORT	WO	0.820	na	83	no (UN)
434	Kezhou et al. (1987)	1413	rat (*Rattus norvegicus*)	4	U	FD	22	days	NR	NR	JV	male	MOR	MORT	WO	0.857	1.71	85	yes
435	Dausch and Fullerton (1993)	1276	rat (*Rattus norvegicus*)	3	U	FD	3	weeks	NR	NR	JV	male	MOR	SURV	WO	0.881	na	77	no (UN)
436	Jacobs and Forst (1981)	1393	rat (*Rattus norvegicus*)	6	U	DR	35	days	5, 12	weeks	JV	both	MOR	SURV	WO	0.904	1.81	78	yes
437	Rastogi et al. (1976)	1523	rat (*Rattus norvegicus*)	2	U	DR	8	weeks	1	months	JV	both	MOR	MORT	WO	0.953	na	74	no (UN)
438	Piccirillo et al. (1983)	1507	mouse (*Mus musculus*)	6	U	GV	8	days	64	days	JV	female	MOR	MORT	WO	1.14	2.28	91	yes
439	Dausch and Fullerton (1993)	1276	rat (*Rattus norvegicus*)	3	U	FD	3	weeks	NR	NR	JV	male	MOR	MORT	WO	1.17	na	77	no (UN)
440	Hadjimarkos (1970)	14488	hamster (*Mesocricetus auratus*)	4	U	DR	4	weeks	NR	NR	JV	male	MOR	MORT	WO	1.17	na	77	no (UN)
441	Jacobs and Forst (1981)	1394	mouse (*Mus musculus*)	4	U	DR	47	weeks	6	weeks	JV	female	MOR	MORT	WO	1.21	na	73	no (UN)
442	Beems and van Beek (1985)	1223	hamster (*Mesocricetus auratus*)	5	M	FD	42	days	NR	NR	JV	male	MOR	MORT	WO	1.21	na	87	no (UN)
443	Beems and van Beek (1985)	1223	hamster (*Mesocricetus auratus*)	5	M	FD	42	days	NR	NR	JV	female	MOR	MORT	WO	1.26	na	87	no (UN)
444	Miller (1938)	14492	pig (*Sus scrofa*)	5	U	FD	63	days	4	months	JV	both	MOR	MORT	WO	1.49	5.96	83	yes
445	Abdo (1994)	1475	mouse (*Mus musculus*)	6	UX	DR	13	weeks	6	weeks	JV	male	MOR	MORT	WO	1.51	na	85	no (UN)
446	Piccirillo et al. (1983)	1507	mouse (*Mus musculus*)	2	U	GV	8	days	64	days	GE	female	MOR	MORT	WO	1.60	na	85	no (UN)
447	Jacobs and Forst (1981)	1394	mouse (*Mus musculus*)	7	U	DR	46	days	7	weeks	JV	both	MOR	MORT	WO	2.27	4.55	78	yes
448	Abdo (1994)	1475	mouse (*Mus musculus*)	6	UX	DR	13	weeks	6	weeks	JV	both	MOR	MORT	WO	2.28	na	88	no (UN)
449	Plasterer et al. (1985)	1509	mouse (*Mus musculus*)	6	U	GV	8	days	61-71	days	JV	female	MOR	MORT	WO	2.28	4.57	91	yes
450	Pathak and Datta (1984)	1501	goat (*Capra hircus*)	4	U	OR	17	days	6	months	MA	NR	MOR	MORT	WO	3.0	6.0	87	no (RU)
451	Julius et al. (1983)	1408	hamster (*Mesocricetus auratus*)	5	U	FD	21	days	4	weeks	JV	both	MOR	MORT	WO	3.18	6.36	85	yes
452	Hardin et al. (1987)	1335	mouse (*Mus musculus*)	5	U	GV	8	days	6-8	weeks	GE	female	MOR	MORT	WO	3.20	6.39	86	yes
453	Plasterer et al. (1985)	1509	mouse (*Mus musculus*)	2	U	GV	8	days	61-71	days	GE	female	MOR	SURV	WO	3.20	na	85	no (UN)
454	Dausch and Fullerton (1993)	1276	rat (*Rattus norvegicus*)	4	U	FD	3	weeks	NR	NR	JV	male	MOR	SURV	WO	3.53	na	77	no (UN)
455	Chermoff and Kavlock (1982)	1259	mouse (*Mus musculus*)	2	U	GV	5	days	60	days	GE	female	MOR	MORT	WO	4.18	na	85	no (UN)
456	Booth et al. (1983)	1234	mouse (*Mus musculus*)	6	U	GV	8	days	68-81	days	JV	female	MOR	MORT	WO	10.0	20	97	yes
457	Dausch and Fullerton (1993)	1276	rat (*Rattus norvegicus*)	5	U	FD	3	weeks	NR	NR	JV	male	MOR	SURV	WO	15.4	na	78	no (UN)
458	Schroeder (1967)	1540	rat (*Rattus norvegicus*)	2	U	DR	16	days	21	days	JV	both	MOR	MORT	WO	na	0.275	73	yes
459	Jacobs and Forst (1981)	1393	rat (*Rattus norvegicus*)	2	U	DR	10	weeks	5	weeks	JV	male	MOR	SURV	WO	na	0.440	73	yes

Table E2.A-6. Selenium Data for Mammals as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result Number	Reference	Reference Number	Test Organism	Number of Concentrations or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation? [a]
Survival (continued)																			
460	Palmer et al. (1982)	1496	rat (*Rattus norvegicus*)	2	M	FD	4	weeks	NR	NR	JV	NR	MOR	MORT	WO	na	0.809	83	yes
461	Palmer et al. (1982)	1496	rat (*Rattus norvegicus*)	2	M	FD	4	weeks	NR	NR	JV	NR	MOR	MORT	WO	na	0.817	83	yes
462	Palmer et al. (1983)	15262	rat (*Rattus norvegicus*)	2	U	FD	8	weeks	NR	NR	JV	male	MOR	SURV	WO	na	0.823	72	yes
463	Halverson et al. (1962)	14489	rat (*Rattus norvegicus*)	2	U	FD	18	days	NR	NR	NR	male	MOR	MORT	WO	na	0.975	78	yes
464	Halverson et al. (1962)	14489	rat (*Rattus norvegicus*)	2	U	FD	18	days	NR	NR	NR	male	MOR	MORT	WO	na	0.984	78	yes
465	Cutler (1974)	21137	rat (*Rattus norvegicus*)	2	U	DR	5	months	NR	NR	JV	male	MOR	MORT	WO	na	1.11	73	yes
466	Franke and Moxon (1937)	14508	rat (*Rattus norvegicus*)	2	U	FD	100	days	28	days	JV	male	MOR	MORT	WO	na	1.79	82	yes
467	Halverson et al. (1962)	14489	rat (*Rattus norvegicus*)	2	M	FD	18	days	NR	NR	NR	male	MOR	MORT	WO	na	1.94	72	yes
468	Franke and Moxon (1937)	14508	rat (*Rattus norvegicus*)	2	U	FD	100	days	28	days	JV	both	MOR	MORT	WO	na	3.54	82	yes
469	Franke and Moxon (1937)	14508	rat (*Rattus norvegicus*)	2	U	FD	100	days	28	days	JV	both	MOR	MORT	WO	na	3.74	79	yes
470	Davidson-York et al. (1999)	1277	pig (*Sus scrofa*)	2	M	FD	19	days	NR	NR	NR	both	MOR	MORT	WO	na	4.17	76	yes
471	Seidenberg et al. (1986)	113	mouse (*Mus musculus*)	2	U	GV	4	days	NR	NR	GE	female	MOR	MORT	WO	na	5.01	85	yes

Notes:

Acronyms, abbreviations, and units of measure are defined in Table E2.A-1.

Not all studies presented in the selenium ecological soil screening level (Eco-SSL) document for growth, reproduction, and survival were used to derive the Eco-SSL toxicity reference value (TRV).

See Eco-SSL document (USEPA 2007b) for the full reference list for studies cited in this table.

[a] Rationale for study unacceptability is in parentheses.

[b] Publication year was listed as 1982 in the Eco-SSL document. The correct year is 1981.

Table E2.A-7. Vanadium Data for Birds as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result Number	Reference	Reference Number	Test Organism	Number of Concentrations or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation? [a]
Reproduction																			
37	Sell et al. (1982)	8577	chicken (*Gallus domesticus*)	4	U	FD	7	days	41	weeks	LB	female	EGG	EQUA	EG	0.275	0.413	85	no (ENR)
38	Sell et al. (1986)	6469	chicken (*Gallus domesticus*)	3	M	FD	4	weeks	25	weeks	LB	female	EGG	EQUA	EG	0.325	0.524	90	no (ENR)
39	Benabdeljelil and Jensen (1989)	5843	chicken (*Gallus domesticus*)	2	U	FD	6	weeks	72	weeks	LB	female	EGG	EGWT	EG	0.366	na	70	no (UN)
40	Ousterhout and Berg (1981)	6508	chicken (*Gallus domesticus*)	3	U	FD	4	weeks	40	weeks	LB	female	EGG	EQUA	EG	0.988	1.98	80	no (ENR)
41	Ousterhout and Berg (1981)	6508	chicken (*Gallus domesticus*)	3	U	FD	4	weeks	35-40	weeks	LB	female	EGG	EQUA	EG	0.988	1.98	84	no (ENR)
42	Kubena and Phillips (1982)	6388	chicken (*Gallus domesticus*)	5	UX	FD	84	days	29	weeks	LB	female	REP	TPRD	WO	1.25	2.50	90	yes
43	Ousterhout and Berg (1981)	6508	chicken (*Gallus domesticus*)	4	U	FD	4	weeks	50	weeks	LB	female	EGG	EQUA	EG	3.95	na	69	no (UN)
44	Hafez and Kratzer (1976)	6848	chicken (*Gallus domesticus*)	3	U	FD	1	months	28	weeks	LB	female	REP	PROG	WO	4.94	14.8	84	yes
45	Hafez and Kratzer (1976)	6848	Japanese quail (*Coturnix japonica*)	5	U	FD	1	months	NR	NR	LB	female	REP	PROG	WO	39.0	na	74	no (UN)
46	Benabdeljelil and Jensen (1989)	5843	chicken (*Gallus domesticus*)	2	U	FD	8	weeks	25	weeks	LB	female	EGG	EQUA	EG	na	0.319	79	no (ENR)
47	Jensen and Maurice (1980)	9749	chicken (*Gallus domesticus*)	2	U	FD	6	weeks	NR	NR	LB	female	EGG	EQUA	EG	na	0.475	79	no (ENR)
48	Jensen and Maurice (1980)	9749	chicken (*Gallus domesticus*)	3	U	FD	4	weeks	NR	NR	LB	female	REP	EQUA	EG	na	0.494	78	no (ENR)
49	Benabdeljelil and Jensen (1990)	5749	chicken (*Gallus domesticus*)	4	U	FD	2	weeks	43	weeks	LB	female	EGG	EQUA	EG	na	0.669	79	no (ENR)
50	Sell et al. (1982)	8577	chicken (*Gallus domesticus*)	4	M	FD	7	days	41	weeks	LB	female	EGG	EQUA	EG	na	0.740	84	no (ENR)
51	Jensen and Maurice (1980)	9749	chicken (*Gallus domesticus*)	2	U	FD	4	weeks	NR	NR	LB	female	EGG	EQUA	EG	na	0.988	78	no (ENR)
52	Ousterhout and Berg (1981)	6508	chicken (*Gallus domesticus*)	3	U	FD	4	weeks	35-40	weeks	LB	female	EGG	EQUA	EG	na	0.988	78	no (ENR)
53	Bressman et al. (2002)	25961	chicken (*Gallus domesticus*)	4	U	FD	14	days	32	weeks	LB	female	EGG	ESQU	EG	na	1.31	79	no (ENR)
54	Toussant and Latshaw (1994)	5456	chicken (*Gallus domesticus*)	2	M	FD	9	days	25	weeks	LB	female	REP	PROG	WO	na	1.33	84	yes
55	Ousterhout and Berg (1981)	6508	chicken (*Gallus domesticus*)	3	U	FD	4	weeks	48	weeks	LB	female	EGG	EGWT	EG	na	1.98	79	no (ENR)
56	Ousterhout and Berg (1981)	6508	chicken (*Gallus domesticus*)	2	U	FD	7	weeks	40-60	weeks	LB	female	REP	TPRD	WO	na	2.75	79	yes
Growth																			
57	Phillips et al. (1982)	6412	chicken (*Gallus domesticus*)	4	U	FD	25	weeks	1	days	JV	female	GRO	BDWT	WO	0.244	0.489	82	no (ID)
58	Cervantes and Jensen (1986)	6085	chicken (*Gallus domesticus*)	2	U	FD	4	weeks	1	days	JV	male	GRO	BDWT	WO	0.279	na	69	no (UN)
59	Nielsen et al. (1980)	15690	chicken (*Gallus domesticus*)	2	U	FD	4	weeks	1	days	JV	male	GRO	BDWT	WO	0.284	na	68	no (UN)
60	Cervantes and Jensen (1986)	6085	chicken (*Gallus domesticus*)	4	U	FD	4	weeks	1	days	JV	male	GRO	BDWT	WO	0.295	0.589	84	yes
61	Hill (1979)	397	chicken (*Gallus domesticus*)	4	U	FD	5	weeks	1	days	JV	female	GRO	BDWT	WO	0.344	0.688	82	yes
62	Benabdeljelil and Jensen (1989)	5843	chicken (*Gallus domesticus*)	2	U	FD	8	weeks	25	weeks	SM	female	GRO	BDWT	WO	0.366	na	68	no (UN)
63	Jensen and Maurice (1980)	9749	chicken (*Gallus domesticus*)	2	U	FD	6	weeks	NR	NR	SM	female	GRO	BDWT	WO	0.475	na	68	no (UN)
64	Hill (1990)	8125	chicken (*Gallus domesticus*)	4	U	FD	19	days	1	days	JV	female	GRO	BDWT	WO	0.711	1.42	82	yes
65	Hill (1990)	8125	chicken (*Gallus domesticus*)	4	U	FD	19	days	1	days	JV	female	GRO	BDWT	WO	0.711	1.42	82	yes
66	Hathcock et al. (1964)	14512	chicken (*Gallus domesticus*)	3	U	FD	14	days	1	days	JV	NR	GRO	BDWT	WO	0.904	2.26	82	yes
67	Ousterhout and Berg (1981)	6508	chicken (*Gallus domesticus*)	3	U	FD	4	weeks	35-40	weeks	SM	female	GRO	BDWT	WO	0.988	1.98	82	yes
68	Romoser,et al. (1961)	3740	chicken (*Gallus domesticus*)	6	U	FD	21	days	7	days	JV	male	GRO	BDWT	WO	1.050	1.59	82	yes
69	Qureshi et al. (1999)	5079	chicken (*Gallus domesticus*)	4	U	FD	14	days	1	days	JV	both	GRO	BDWT	WO	1.22	3.05	83	yes
70	Kubena and Phillips (1982)	6388	chicken (*Gallus domesticus*)	5	UX	FD	56	days	29	weeks	SM	female	GRO	BDWT	WO	1.26	2.51	88	yes
71	Benabdeljelil and Jensen (1990)	5749	chicken (*Gallus domesticus*)	4	U	FD	4	weeks	43	weeks	SM	female	GRO	BDWT	WO	1.84	6.13	81	yes
72	Ousterhout and Berg (1981)	6508	chicken (*Gallus domesticus*)	3	U	FD	4	weeks	40	weeks	SM	female	GRO	BDWT	WO	1.98	na	67	no (UN)
73	Ousterhout and Berg (1981)	6508	chicken (*Gallus domesticus*)	3	U	FD	4	weeks	40	weeks	SM	female	GRO	BDWT	WO	1.98	na	67	no (UN)
74	Sell et al. (1982)	8577	chicken (*Gallus domesticus*)	4	M	FD	4	weeks	41	weeks	SM	female	GRO	BDWT	WO	2.20	na	73	no (UN)
75	Nelson et al. (1962)	14516	chicken (*Gallus domesticus*)	5	U	FD	4	weeks	NR	NR	JV	male	GRO	BDWT	WO	2.34	4.08	83	yes
76	Kubena et al. (1986)	6041	chicken (*Gallus domesticus*)	3	U	FD	28	days	1	days	JV	male	GRO	BDWT	WO	2.36	na	68	no (UN)
77	Nelson et al. (1962)	14516	chicken (*Gallus domesticus*)	10	U	FD	4	weeks	NR	NR	JV	male	GRO	BDWT	WO	2.68	3.58	83	yes
78	Hafez and Kratzer (1976)	8663	chicken (*Gallus domesticus*)	4	U	FD	4	weeks	1	days	JV	male	GRO	BDWT	WO	2.87	5.74	82	yes
79	Hafez and Kratzer (1976)	6848	Japanese quail (*Coturnix japonica*)	5	U	FD	4	weeks	1	days	JV	male	GRO	BDWT	WO	46.1	na	74	no (UN)
80	Summers and Moran (1972)	7051	chicken (*Gallus domesticus*)	2	U	FD	3	weeks	NR	NR	JV	NR	GRO	BDWT	WO	na	0.339	71	yes
81	Hill (1974)	92	chicken (*Gallus domesticus*)	6	U	FD	2	weeks	1	days	JV	both	GRO	BDWT	WO	na	0.429	76	yes
82	Berg and Lawrence (1971)	9290	chicken (*Gallus domesticus*)	3	U	FD	2	weeks	NR	NR	JV	male	GRO	BDWT	WO	na	0.859	76	yes
83	Berg and Lawrence (1971)	9290	chicken (*Gallus domesticus*)	3	U	FD	2	weeks	NR	NR	JV	male	GRO	BDWT	WO	na	0.859	76	yes
84	Berg and Lawrence (1971)	9290	chicken (*Gallus domesticus*)	3	U	FD	2	weeks	NR	NR	JV	male	GRO	BDWT	WO	na	0.859	76	yes
85	Blalock and Hill (1987)	5927	chicken (*Gallus domesticus*)	4	U	FD	3	weeks	1	days	JV	female	GRO	BDWT	WO	na	0.968	77	yes
86	Romoser,et al. (1961)	3740	chicken (*Gallus domesticus*)	4	U	FD	21	days	9	days	JV	male	GRO	BDWT	WO	na	1.32	76	yes
87	Toussant and Latshaw (1994)	5456	chicken (*Gallus domesticus*)	2	M	FD	14	days	25	weeks	SM	female	GRO	BDWT	WO	na	1.33	82	yes
88	Hill (1979)	1370	chicken (*Gallus domesticus*)	2	U	FD	2	weeks	1	days	JV	both	GRO	BDWT	WO	na	1.72	76	yes
89	Hill (1990)	5736	chicken (*Gallus domesticus*)	2	U	FD	18	days	1	days	JV	female	GRO	BDWT	WO	na	1.77	77	yes
90	Hill (1990)	8125	chicken (*Gallus domesticus*)	2	U	FD	19	days	1	days	JV	female	GRO	BDWT	WO	na	1.78	76	yes
91	Cupo and Donaldson (1987)	5971	chicken (*Gallus domesticus*)	2	U	FD	21	days	1	days	JV	male	GRO	BDWT	WO	na	2.00	77	yes

Table E2.A-7. Vanadium Data for Birds as Presented in Eco-SSL Document, Including Study Acceptability Determination

Result Number	Reference	Reference Number	Test Organism	Number of Concentrations or Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score	Study Acceptable for TRV Derivation? [a]
Growth (continued)																			
92	Romoser,et al. (1961)	3740	chicken (*Gallus domesticus*)	7	U	FD	21	days	11	days	JV	male	GRO	BDWT	WO	na	2.12	76	yes
93	Hill (1990)	5736	chicken (*Gallus domesticus*)	2	U	FD	18	days	1	days	JV	female	GRO	BDWT	WO	na	2.13	76	yes
94	Hill (1979)	1370	chicken (*Gallus domesticus*)	2	U	FD	2	weeks	1	days	JV	both	GRO	BDWT	WO	na	2.15	76	yes
95	Hathcock et al. (1964)	14512	chicken (*Gallus domesticus*)	2	U	FD	14	days	1	days	JV	NR	GRO	BDWT	WO	na	2.15	76	yes
96	Hill (1980)	395	chicken (*Gallus domesticus*)	2	U	FD	1	weeks	1	days	JV	female	GRO	BDWT	WO	na	2.15	76	yes
97	Hill (1974)	92	chicken (*Gallus domesticus*)	3	U	FD	2	weeks	1	days	JV	female	GRO	BDWT	WO	na	2.15	76	yes
98	Ousterhout and Berg (1981)	6508	chicken (*Gallus domesticus*)	2	U	FD	7	weeks	40-60	weeks	SM	female	GRO	BDWT	WO	na	2.75	77	yes
99	Hill (1990)	5734	chicken (*Gallus domesticus*)	2	U	FD	19	days	1	days	JV	female	GRO	BDWT	WO	na	2.84	76	yes
100	Hafez and Kratzer (1976)	8663	chicken (*Gallus domesticus*)	4	U	FD	4	weeks	1	days	JV	male	GRO	BDWT	WO	na	2.87	76	yes
101	Hafez and Kratzer (1976)	8663	chicken (*Gallus domesticus*)	3	U	FD	4	weeks	1	days	JV	male	GRO	BDWT	WO	na	2.87	76	yes
102	Hill (1994)	5453	chicken (*Gallus domesticus*)	2	U	FD	21	days	1	days	JV	male	GRO	BDWT	WO	na	3.55	76	yes
103	Hill (1992)	8028	chicken (*Gallus domesticus*)	2	U	FD	19	days	1	days	JV	NR	GRO	BDWT	WO	na	3.55	76	yes
104	Hathcock et al. (1964)	14512	chicken (*Gallus domesticus*)	2	U	FD	14	days	1	days	JV	NR	GRO	BDWT	WO	na	4.29	76	yes
105	Burt et al. (1991)	5295	chicken (*Gallus domesticus*)	2	U	FD	14	days	1	days	JV	NR	GRO	BDWT	WO	na	4.29	76	yes
106	Kubena et al. (1985)	6192	chicken (*Gallus domesticus*)	2	U	FD	14	days	1	days	JV	male	GRO	BDWT	WO	na	4.76	77	yes
107	Hafez and Kratzer (1976)	8663	chicken (*Gallus domesticus*)	3	U	FD	4	weeks	1	days	JV	male	GRO	BDWT	WO	na	5.74	76	yes
108	Hafez and Kratzer (1976)	6876	chicken (*Gallus domesticus*)	2	U	FD	8	weeks	1	days	JV	male	GRO	BDWT	WO	na	8.36	77	yes
Survival																			
109	Hathcock et al. (1964)	14512	chicken (*Gallus domesticus*)	3	U	FD	14	days	1	days	JV	NR	MOR	MORT	WO	0.859	2.15	83	yes
110	Blalock and Hill (1987)	5927	chicken (*Gallus domesticus*)	4	U	FD	3	weeks	1	days	JV	female	MOR	MORT	WO	0.962	1.92	84	yes
111	Hill (1979)	1370	chicken (*Gallus domesticus*)	2	U	FD	2	weeks	1	days	JV	both	MOR	MORT	WO	1.72	na	68	no (UN)
112	Hill (1974)	92	chicken (*Gallus domesticus*)	3	U	FD	5	weeks	1	days	JV	both	MOR	MORT	WO	2.15	4.294	83	yes
113	Hill (1979)	1370	chicken (*Gallus domesticus*)	2	U	FD	2	weeks	1	days	JV	both	MOR	MORT	WO	2.15	na	68	no (UN)
114	Hill (1974)	92	chicken (*Gallus domesticus*)	6	U	FD	5	weeks	1	days	JV	female	MOR	MORT	WO	2.15	na	77	no (UN)
115	Kubena et al. (1986)	6041	chicken (*Gallus domesticus*)	3	U	FD	28	days	1	days	JV	male	MOR	MORT	WO	2.36	na	78	no (UN)
116	Kubena and Phillips (1982)	6388	chicken (*Gallus domesticus*)	5	UX	FD	84	days	29	weeks	SM	female	MOR	MORT	WO	2.50	4.99	89	yes
117	Hafez and Kratzer (1976)	8663	chicken (*Gallus domesticus*)	3	U	FD	4	weeks	1	days	JV	male	MOR	MORT	WO	2.87	5.74	83	yes
118	Hafez and Kratzer (1976)	8663	chicken (*Gallus domesticus*)	4	U	FD	4	weeks	1	days	JV	male	MOR	MORT	WO	2.87	5.74	83	yes
119	Hill (1994)	5453	chicken (*Gallus domesticus*)	2	U	FD	21	days	1	days	JV	male	MOR	MORT	WO	3.55	na	70	no (UN)
120	Kubena et al. (1985)	6192	chicken (*Gallus domesticus*)	2	U	FD	28	days	1	days	JV	male	MOR	MORT	WO	4.76	na	78	no (UN)
121	Hafez and Kratzer (1976)	8663	chicken (*Gallus domesticus*)	4	U	FD	4	weeks	1	days	JV	male	MOR	MORT	WO	5.74	11.5	83	yes
122	Romoser,et al. (1961)	3740	chicken (*Gallus domesticus*)	7	U	FD	21	days	11	days	JV	male	MOR	MORT	WO	6.37	10.6	83	yes
123	Qureshi et al. (1999)	5079	chicken (*Gallus domesticus*)	4	U	FD	14	days	1	days	JV	both	MOR	MORT	WO	7.15	na	78	no (UN)
124	White and Dieter (1978)	6727	duck (*Anas platyrhynchos*)	4	M	FD	12	weeks	1	years	AD	both	MOR	MORT	WO	12.0	na	80	no (UN)
125	Van Vleet et al. (1981)	80	duck (*Anas* sp.)	2	U	FD	15	days	1	days	JV	male	MOR	MORT	WO	13.4	na	68	no (UN)
126	Hafez and Kratzer (1976)	6848	chicken (*Gallus domesticus*)	3	U	FD	1	months	28	weeks	JV	female	MOR	MORT	WO	14.8	na	77	no (UN)
127	Hafez and Kratzer (1976)	6848	Japanese quail (*Coturnix japonica*)	5	U	FD	4	weeks	1	days	JV	male	MOR	MORT	WO	98.7	na	77	no (UN)
128	Berg and Lawrence (1971)	9290	chicken (*Gallus domesticus*)	2	U	FD	2	weeks	NR	NR	JV	male	MOR	MORT	WO	na	1.72	77	yes
129	Hathcock et al. (1964)	14512	chicken (*Gallus domesticus*)	2	U	FD	14	days	1	days	JV	NR	MOR	MORT	WO	na	2.15	77	yes
130	Hathcock et al. (1964)	14512	chicken (*Gallus domesticus*)	2	U	FD	14	days	1	days	JV	NR	MOR	MORT	WO	na	4.29	77	yes
131	Hafez and Kratzer (1976)	8663	chicken (*Gallus domesticus*)	3	U	FD	4	weeks	1	days	JV	male	MOR	MORT	WO	na	5.74	77	yes

Notes:

Acronyms, abbreviations, and units of measure are defined in Table E2.A-1.

Not all studies presented in the vanadium ecological soil screening level (Eco-SSL) document for growth, reproduction, and survival were used to derive the Eco-SSL toxicity reference value (TRV).

See Eco-SSL document (USEPA 2005c) for the full reference list for studies cited in this table.

[a] Rationale for study unacceptability is in parentheses.

Table E2.A-8. Wildlife Chromium (III) TRV References Not Included in Eco-SSL Documents

Receptor	Test Organism	Reference[a]	Information Used to Determine Tier	Tier
Growth				
Bird	chicken (*Gallus domesticus*)	Chung et al. (1985)	FD	1
Bird	chicken (*Gallus domesticus*)	Bahrami et al. (2012)	UN	NT
Bird	chicken (*Gallus domesticus*)	Nielsen et al. (1980)	UN	NT
Bird	chicken (*Gallus domesticus*)	Romoser et al. (1961)	UN	NT
Bird	Japanese quail (*Coturnix japonica*)	Rouhalamini and Salarmoini (2014)	UN	NT
Mammal	rat (*Rattus norvegicus*)	Bataineh et al. (1997)	UN	NT
Mammal	rat (*Rattus norvegicus*)	Hasten et al. (1997a)	UN	NT
Mammal	rat (*Rattus norvegicus*)	Hasten et al. (1997b)	UN	NT
Mammal	mouse (*Mus musculus*)	Junaid et al. (1996)	ICF[b]	NT
Mammal	rat (*Rattus norvegicus*)	MacKenzie et al. (1958)	UN	NT
Mammal	rat (*Rattus norvegicus*)	Mercado and Bibby (1973)	UN	NT
Reproduction				
Mammal	mouse (*Mus musculus*)	Junaid et al. (1996)	ICF[b]	NT
Mammal	rat (*Rattus norvegicus*)	Gross and Heller (1946)	ID	NT
Mammal	rat (*Rattus norvegicus*)	Kajojia et al. (1998)	ICF[b]	NT
Mammal	mouse (*Mus musculus*)	Trivedi et al. (1989)	ICF[b], UN	NT
Survival				
Bird	chicken (*Gallus domesticus*)	Lien et al. (2004)	UN	NT
Bird	chicken (*Gallus domesticus*)	Ma et al. (2014)	UN	NT
Bird	chicken (*Gallus domesticus*)	Torki et al. (2013)	UN	NT
Mammal	rat (*Rattus norvegicus*)	Anderson et al. (1997)	UN	NT
Mammal	rat (*Rattus norvegicus*)	Ivankovic and Preussman (1975)	UN	NT
Mammal	rat (*Rattus norvegicus*)	MacKenzie et al. (1958)	UN	NT
Mammal	rat (*Rattus norvegicus*)	Schroeder et al. (1963)	UN	NT
Mammal	rat (*Rattus norvegicus*)	Schroeder et al. (1965)	SDC, UN	NT
Mammal	mouse (*Mus musculus*)	Trivedi et al. (1989)	UN	NT

Notes:

Acronyms, abbreviations, and units of measure are defined in Table E2.A-1.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Chemical form evaluated was chromium (VI).

Table E2.A-9. Wildlife TRV References with Unbounded NOAELs Not Included for TRV Derivation [a]

Receptor	Test Organism	Reference [b]
Aluminum		
Growth		
Bird	ring dove (*Streptopelia risoria*)	Carriere et al. (1986)
Reproduction		
Mammal	rat (*Rattus norvegicus*)	Bataineh et al. (1998)
Mammal	rat (*Rattus norvegicus*)	Gomez et al. (1991)
Mammal	rat (*Rattus norvegicus*)	McCormack et al. (1979)
Iron		
Growth		
Bird	chicken (*Gallus domesticus*)	Jensen and Maurice (1978)
Mammal	bank vole (*Clethrionomys glareolus*)	Bonda et al. (2004)
Reproduction		
Mammal	rat (*Rattus norvegicus*)	Webster (1979)
Methylmercury		
Growth		
Mammal	rat (*Rattus norvegicus*)	Fredriksson et al. (1993)
Molybdenum		
Growth		
Mammal	rat (*Rattus norvegicus*)	Ale-Ebrahim et al. (2015)
Mammal	rat (*Rattus norvegicus*)	Franke and Moxon (1937)
Mammal	rat (*Rattus norvegicus*)	Murray et al. (2014)
Mammal	rat (*Rattus norvegicus*)	Seaborn and Yang (1993)
Mammal	rat (*Rattus norvegicus*)	Wang et al. (1992)
Mammal	rat (*Rattus norvegicus*)	Yang and Yang (1989)
Reproduction		
Mammal	rat (*Rattus norvegicus*)	Dulak et al. (1984)
Mammal	rat (*Rattus norvegicus*)	Murray et al. (2014)
Thallium		
Growth		
Mammal	rat (*Rattus norvegicus*)	MRI (1988)

Notes:

Acronyms, abbreviations, and units of measure are defined in Table E2.A-1.

[a] Chemicals included in this table are those for which an ecological soil screening level (Eco-SSL) document was not developed. These studies were excluded from the toxicity reference value (TRV) derivation process beause the study concluded that there were no effects on growth, survival, and/or reproduction at the lowest dose tested.

[b] References are cited in Attachment E1 or Attachment E2.

Table E2.A-10. Tier Determination and Results of Study Selection Process for Acceptable Antimony Studies for Mammals from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Reference Number	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifespan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection	Number of Usable Data Sets
Reproduction										
Rossi et al. (1987)	231	rat (*Rattus norvegicus*)	0.590	NA	NA	yes	2	1	T	0
Growth										
Rossi et al. (1987)	231	rat (*Rattus norvegicus*)	0.0590	na	no	yes	2	1	T	0
Shroeder et al. (1968)	238	mouse *(Mus musculus)*	0.678	yes	yes	yes	2	2	T	0
Poon et al. (1998)	224	rat (*Rattus norvegicus*)	42.0	yes	yes	yes	2	3	T	0
Survival										
Shroeder et al. (1970)	252	rat (*Rattus norvegicus*)	0.533	NA	NA	yes	2	1	T	0
Dieter (1991)	3780	mouse (*Mus musculus*)	161	NA	NA	yes	2	2	T	0

Notes:

Acronyms, abbreviations, and units of measure are defined in Table E2.A-1.

See ecological soil screening level (Eco-SSL) document (USEPA 2005a) for the full reference list for studies cited in this table.

Table E2.A-11. Tier Determination and Results of Study Selection Process for Acceptable Chromium Studies for Mammals from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Reference Number	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifespan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection	Number of Usable Data Sets
Reproduction										
Elbetieha and Al-Hamood (1997)	3025	mouse (*Mus musculus*)	91.1	NA	NA	yes	2	1	T	2
Growth										
Elbetieha and Al-Hamood (1997)	3025	mouse (*Mus musculus*)	92.1	no	yes	yes	2	1	T	0

Notes:

Acronyms, abbreviations, and units of measure are defined in Table E2.A-1.

See ecological soil screening level (Eco-SSL) document (USEPA 2008) for the full reference list for studies cited in this table.

Table E2.A-12. Tier Determination and Results of Study Selection Process for Acceptable Selenium Studies for Birds from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Reference Number	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifespan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection	Number of Usable Data Sets
Reproduction										
Kaantee and Kurkela (1980)	36819	chicken (*Gallus domesticus*)	0.0988	NA	NA	no	1	1	T	0
Stone and Soares (1976)	2898	Japanese quail (*Coturnix japonica*)	0.120	NA	NA	no	1	2	T	1
Ort and Latshaw (1978)	1489	chicken (*Gallus domesticus*)	0.412	NA	NA	no	1	3	T	2
Heinz et. al. (1989)	1354	duck (*Anas platyrhynchos*)	0.438	NA	NA	no	1	4	T	3
Hoffman and Heinz (1988)	1372	mallard (*Anas platyrhynchos*)	0.546	NA	NA	no	1	5	T	2
Heinz and Hoffman (1996)	1352	mallard (*Anas platyrhynchos*)	0.614	NA	NA	no	1	6	NRV	NRV
El-Begearmi et al. (1982)	6433	Japanese quail (*Coturnix japonica*)	0.780	NA	NA	no	1	7	NRV	NRV
Stoewsand et al. (1978)	1575	Japanese quail (*Coturnix japonica*)	0.826	NA	NA	no	1	8	NRV	NRV
Heinz and Hoffman (1987)	1356	mallard (*Anas platyrhynchos*)	0.898	NA	NA	no	1	9	NRV	NRV
Heinz and Fitzgerald (1993)	36813	mallard (*Anas platyrhynchos*)	1.19	NA	NA	no	1	10	NRV	NRV
Wiemeyer and Hoffman (1996)	1622	owl (*Otus asio*)	4.49	NA	NA	no	1	11	S	3
Growth										
El-Begearmi and Combs (1982)	1290	chicken (*Gallus domesticus*)	0.0912	yes	no	no	1	1	T	2
Dafalla and Adam (1986)	1273	chicken (*Gallus domesticus*)	0.306	yes	no	no	1	2	T	1
Jensen (1986)	1402	chicken (*Gallus domesticus*)	0.370	yes	no	no	1	3	T	1
Hill (1979)	397	chicken (*Gallus domesticus*)	0.408	yes	no	no	1	4	T	2
Echevarria et al. (1988)	1289	chicken (*Gallus domesticus*)	0.426	yes	no	no	1	5	T	1
Khan et al. (1993)	1415	chicken (*Gallus domesticus*)	0.50	yes	no	no	1	6	NRV	NRV
Khan et al. (1993)	5483	chicken (*Gallus domesticus*)	0.50	yes	no	no	1	7	NRV	NRV
Sell and Horani (1976)	1550	chicken (*Gallus domesticus*)	0.629	yes	no	no	1	8	P	0
Elzubeir and Davis (1988)	1294	chicken (*Gallus domesticus*)	0.788	yes	no	no	1	9	NRV	NRV
Davis el. al. (1996)	1278	chicken (*Gallus domesticus*)	0.855	yes	no	no	1	10	NRV	NRV
Hill (1974)	1369	chicken (*Gallus domesticus*)	0.859	yes	no	no	1	11	NRV	NRV
Hill (1979)	1370	chicken (*Gallus domesticus*)	0.859	yes	no	no	1	12	NRV	NRV
Stoewsand et al. (1977)	1574	Japanese quail (*Coturnix japonica*)	0.896	yes	no	no	1	13	S	0
Heinz and Fitzgerald (1993)	36813	mallard (*Anas platyrhynchos*)	1.08	no	yes	no	1	14	S	0
Hoffman et al. (1992)	1376	duck (*Anas platyrhynchos*)	1.20	yes	no	no	1	15	S	1
Jensen et al. (1977)	1404	chicken (*Gallus domesticus*)	1.23	yes	no	no	1	16	NRV	NRV
Berg and Martinson (1972)	93	chicken (*Gallus domesticus*)	1.38	yes	no	no	1	17	NRV	NRV
Lowry and Baker (1989)	1445	chicken (*Gallus domesticus*)	1.55	yes	no	no	1	18	NRV	NRV
O'Toole and Raisbeck (1997)	1476	mallard (*Anas platyrhynchos*)	1.73	yes	no	no	1	19	S	1
Howell and Hill (1978)	1387	chicken (*Gallus domesticus*)	1.78	yes	no	no	1	20	NRV	NRV
Donaldson and McGowan (1989)	1285	chicken (*Gallus domesticus*)	2.27	yes	no	no	1	21	NRV	NRV
Hill (1980)	395	chicken (*Gallus domesticus*)	2.76	yes	no	no	1	22	NRV	NRV
Heinz et al. (1988)	1355	mallard (*Anas platyrhynchos*)	3.48	yes	no	no	1	23	NRV	NRV

Table E2.A-12. Tier Determination and Results of Study Selection Process for Acceptable Selenium Studies for Birds from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Reference Number	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifespan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection	Number of Usable Data Sets
Growth (continued)										
Hoffman et al. (1991)	1377	mallard (*Anas platyrhynchos*)	4.53	yes	no	no	1	24	NRV	NRV
Hoffman et al. (1992)	1378	mallard (*Anas platyrhynchos*)	4.94	yes	no	no	1	25	NRV	NRV
Heinz et al. (1996)	1357	mallard (*Anas platyrhynchos*)	8.32	yes	no	no	1	26	NRV	NRV
Poley et al. (1937)	3787	chicken (*Gallus domesticus*)	0.127	no	no	no	2	27	NRV	NRV
Fairbrother and Fowles (1990)	1297	mallard (*Anas platyrhynchos*)	0.275	no	no	yes	2	28	NRV	NRV
Cantor et al. (1984)	1245	chicken (*Gallus domesticus*)	1.44	yes	no	yes	2	29	NRV	NRV
Survival										
Arnold et al. (1973)	69	chicken (*Gallus domesticus*)	0.371	NA	NA	no	1	1	T	1
Khan et al. (1993)	1415	chicken (*Gallus domesticus*)	0.50	NA	NA	no	1	2	T	1
El-Begearmi and Combs (1982)	1290	chicken (*Gallus domesticus*)	0.579	NA	NA	no	1	3	T	2
Heinz and Fitzgerald (1993)	1350	mallard (*Anas platyrhynchos*)	1.13	NA	NA	no	1	4	T	1
El-Begerami et al. (1977)	1291	Japanese quail (*Coturnix japonica*)	1.40	NA	NA	no	1	5	T	1
Howell and Hill (1978)	1387	chicken (*Gallus domesticus*)	1.78	NA	NA	no	1	6	NRV	NRV
Green and Albers (1997)	1319	mallard (*Anas platyrhynchos*)	2.44	NA	NA	no	1	7	NRV	NRV
Hill (1974)	1369	chicken (*Gallus domesticus*)	3.44	NA	NA	no	1	8	NRV	NRV
O'Toole and Raisbeck (1997)	1476	mallard (*Anas platyrhynchos*)	4.19	NA	NA	no	1	9	NRV	NRV
Hoffman et al. (1991)	1377	mallard (*Anas platyrhynchos*)	4.53	NA	NA	no	1	10	NRV	NRV
Albers et al. (1996)	1208	duck (*Anas platyrhynchos*)	4.75	NA	NA	no	1	11	P	1
Hoffman et al. (1992)	1376	duck (*Anas platyrhynchos*)	4.80	NA	NA	no	1	12	NRV	NRV
Hoffman et al. (1992)	1378	mallard (*Anas platyrhynchos*)	4.94	NA	NA	no	1	13	NRV	NRV
Heinz (1993)	1347	duck (*Anas platyrhynchos*)	5.75	NA	NA	no	1	14	NRV	NRV
Donaldson and McGowan (1989)	1285	chicken (*Gallus domesticus*)	6.08	NA	NA	no	1	15	NRV	NRV
Jensen et al. (1977)	1404	chicken (*Gallus domesticus*)	6.14	NA	NA	no	1	16	NRV	NRV
Heinz et al. (1996)	1357	mallard (*Anas platyrhynchos*)	6.99	NA	NA	no	1	17	NRV	NRV
Heinz et al. (1988)	1355	mallard (*Anas platyrhynchos*)	7.98	NA	NA	no	1	18	NRV	NRV
Heinz and Hoffman (1987)	1356	mallard (*Anas platyrhynchos*)	12.3	NA	NA	no	1	19	NRV	NRV

Notes:

Acronyms, abbreviations, and units of measure are defined in Table E2.A-1.

See ecological soil screening level (Eco-SSL) document (USEPA 2007b) for the full reference list for studies cited in this table.

Table E2.A-13. Tier Determination and Results of Study Selection Process for Acceptable Selenium Studies for Mammals from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Reference Number	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifespan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection	Number of Usable Data Sets
Reproduction										
Wahlstrom and Olson (1959)	14497	pig (*Sus scrofa*)	0.296	NA	NA	no	1	1	T	0
Chermoff and Kavlock (1982)	1259	mouse (*Mus musculus*)	4.18	NA	NA	no	1	2	T	1
Gray and Kavlock (1984)	1316	mouse (*Mus musculus*)	4.57	NA	NA	no	1	3	T	0
Seidenberg et al. (1986)	113	mouse (*Mus musculus*)	5.01	NA	NA	no	1	4	T	1
Hardin et al. (1987)	1335	mouse (*Mus musculus*)	6.39	NA	NA	no	1	5	T	1
Webster (1979)	823	mouse (*Mus musculus*)	25.4	NA	NA	no	1	6	A	1
Abdo (1994)	1475	rat (*Rattus norvegicus*)	0.130	NA	NA	yes	2	7	NRV[a]	NRV
Nobunaga et al. (1979)	1473	mouse (*Mus musculus*)	0.145	NA	NA	yes	2	8	NRV[a]	NRV
Schroeder and Mitchener (1971)	66	mouse (*Mus musculus*)	0.434	NA	NA	yes	2	9	NRV[a]	NRV
Thorlacius-Ussing (1990)	1595	rat (*Rattus norvegicus*)	0.504	NA	NA	yes	2	10	NRV[a]	NRV
Thorlacius-Ussing et al. (1987)	1596	rat (*Rattus norvegicus*)	0.749	NA	NA	yes	2	11	NRV[a]	NRV
Hau et al. (1987)	1344	mouse (*Mus musculus*)	6.03	NA	NA	yes	2	12	NRV[a]	NRV
Growth										
Kaur and Parshad (1994)	1411	rat (*Rattus norvegicus*)	0.0908	yes	no	no	1	1	T	1
Spallholz et al. (1973)	1566	mouse (*Mus musculus*)	0.0968	yes	no	no	1	2	T	1
Boylan et al. (1990)	1239	mouse (*Mus musculus*)	0.156	yes	yes	no	1	3	T	0
Wahlstrom et al. (1956)	14498	pig (*Sus scrofa*)	0.163	yes	yes	no	1	4	T	0
Behne et al. (1992)	1224	rat (*Rattus norvegicus*)	0.166	yes	yes	no	1	5	T	0
Baker et al. (1989)	1219	pig (*Sus scrofa*)	0.205	yes	no	no	1	6	A	0
Mahan and Moxon (1984)	1450	pig (*Sus scrofa*)	0.215	yes	no	no	1	7	A	1
Goehring et al. (1984)	1312	rat (*Rattus norvegicus*)	0.215	yes	no	no	1	8	A	2
Kim and Mahan (2001)	25958	pig (*Sus scrofa*)	0.221	yes	yes	no	1	9	NRV	NRV
Miller (1938)	14492	pig (*Sus scrofa*)	0.235	yes	no	no	1	10	NRV	NRV
Shull and Checke (1973)	1557	rat (*Rattus norvegicus*)	0.265	yes	no	no	1	11	NRV	NRV
Kim and Mahan (2001)	25948	pig (*Sus scrofa*)	0.273	yes	yes	no	1	12	NRV	NRV
Goehring et al. (1983)	1313	pig (*Sus scrofa*)	0.273	yes	no	no	1	13	NRV	NRV
Wahlstrom et al. (1984)	1612	pig (*Sus scrofa*)	0.303	yes	no	no	1	14	NRV	NRV
Liu et al. (1994)	1442	rat (*Rattus norvegicus*)	0.304	yes	no	no	1	15	NRV	NRV
Baker et al. (1989)	1219	pig (*Sus scrofa*)	0.307	yes	no	no	1	16	NRV	NRV
Moxon and Mahan (1981)[b]	1468	pig (*Sus scrofa*)	0.340	yes	no	no	1	17	NRV	NRV
Birt et al. (1983)	1233	hamster (*Mesocricetus auratus*)	0.345	yes	yes	no	1	18	S	0
Dausch and Fullerton (1993)	1276	rat (*Rattus norvegicus*)	0.390	yes	no	no	1	19	NRV	NRV
Liu and Boylan (1994)	1443	rat (*Rattus norvegicus*)	0.420	yes	no	no	1	20	NRV	NRV
McAdam and Levander (1987)	1457	rat (*Rattus norvegicus*)	0.435	yes	no	no	1	21	NRV	NRV
Birt et al. (1986)	1232	hamster (*Mesocricetus auratus*)	0.490	yes	no	no	1	22	S	0
Mahan and Magee (1991)	1448	pig (*Sus scrofa*)	0.510	yes	no	no	1	23	NRV	NRV

Table E2.A-13. Tier Determination and Results of Study Selection Process for Acceptable Selenium Studies for Mammals from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Reference Number	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifespan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection	Number of Usable Data Sets
Growth (continued)										
LeBoeuf et al. (1985)	1433	rat (*Rattus norvegicus*)	0.521	yes	no	no	1	24	NRV	NRV
LeBoeuf and Hoekstra (1983)	1432	rat (*Rattus norvegicus*)	0.521	yes	no	no	1	25	NRV	NRV
Parshad and Sud (1989)	1500	rat (*Rattus norvegicus*)	0.550	yes	no	no	1	26	NRV	NRV
Halverson et al. (1966)	1332	rat (*Rattus norvegicus*)	0.567	yes	no	no	1	27	NRV	NRV
Kezhou et al. (1987)	1413	rat (*Rattus norvegicus*)	0.653	yes	no	no	1	28	NRV	NRV
Palmer et al. (1983)	15262	rat (*Rattus norvegicus*)	0.704	yes	no	no	1	29	NRV	NRV
Julius et al. (1983)	1408	hamster (*Mesocricetus auratus*)	0.712	yes	no	no	1	30	S	3
Palmer et al. (1982)	1496	rat (*Rattus norvegicus*)	0.763	yes	no	no	1	31	NRV	NRV
Panter et al. (1996)	1499	pig (*Sus scrofa*)	0.794	yes	no	no	1	32	NRV	NRV
Obermeyer et al. (1971)	12934	rat (*Rattus norvegicus*)	0.903	yes	no	no	1	33	NRV	NRV
Halverson and Monty (1960)	36812	rat (*Rattus norvegicus*)	0.968	yes	no	no	1	34	NRV	NRV
Beems and van Beek (1985)	1223	hamster (*Mesocricetus auratus*)	1.21	yes	no	no	1	35	NRV	NRV
Hermann etal. (1991)	1364	rat (*Rattus norvegicus*)	1.59	yes	no	no	1	36	NRV	NRV
Franke and Moxon (1937)	14508	rat (*Rattus norvegicus*)	1.79	yes	no	no	1	37	NRV	NRV
Chermoff and Kavlock (1982)	1259	mouse (*Mus musculus*)	4.18	no	no	no	1	38	NRV	NRV
Hardin et al. (1987)	1335	mouse (*Mus musculus*)	6.39	yes	no	no	1	39	NRV	NRV
Sayato et al. (1993)	1538	mouse (*Mus musculus*)	20.0	yes	no	no	1	40	NRV	NRV
Chen et al. (1985)	1256	rat (*Rattus norvegicus*)	0.232	yes	no	yes	2	41	NRV	NRV
Schroeder (1967)	1540	rat (*Rattus norvegicus*), mouse (Mus musculus)	0.267	yes	no	yes	2	42	NRV	NRV
Mercado and Bibby (1973)	757	rat (*Rattus norvegicus*)	0.282	yes	no	yes	2	43	NRV	NRV
Thorlacius-Ussing et al. (1988)	1597	rat (*Rattus norvegicus*)	0.378	yes	no	yes	2	44	NRV	NRV
Thorlacius-Ussing et al. (1988)	1598	rat (*Rattus norvegicus*)	0.411	yes	no	yes	2	45	NRV	NRV
Schroeder and Mitchener (1972)	3725	mouse (*Mus musculus*)	0.425	yes	no	yes	2	46	NRV	NRV
Carmichael and Fowler (1980)	1249	rat (*Rattus norvegicus*)	0.454	yes	no	yes	2	47	NRV	NRV
Salbe et al. (1990)	1532	rat (*Rattus norvegicus*)	0.498	yes	no	yes	2	48	NRV	NRV
Palmer and Olson (1974)	1497	rat (*Rattus norvegicus*)	0.540	yes	no	yes	2	49	NRV	NRV
Thorlacius-Ussing (1990)	1595	rat (*Rattus norvegicus*)	0.543	yes	no	yes	2	50	NRV	NRV
Abdo (1994)	1475	rat (*Rattus norvegicus*), mouse (Mus musculus)	0.564	yes	no	yes	2	51	NRV	NRV
Gronbaek et al. (1995)	1323	rat (*Rattus norvegicus*)	0.570	yes	no	yes	2	52	NRV	NRV
Tsunoda et al. (2000)	36834	mouse (*Mus musculus*)	0.580	yes	no	yes	2	53	NRV	NRV
Hadjimarkos (1967)	1327	rat (*Rattus norvegicus*)	0.667	yes	no	yes	2	54	NRV	NRV
Nebbia et al. (1987)	1471	rat (*Rattus norvegicus*)	0.768	yes	no	yes	2	55	NRV	NRV
Cabe et al. (1979)	1244	rat (*Rattus norvegicus*)	0.769	yes	no	yes	2	56	NRV	NRV
Hadjimarkos (1970)	14488	hamster (*Mesocricetus auratus*)	0.88	yes	no	yes	2	57	NRV	NRV
Jacobs and Forst (1981)	1393	rat (*Rattus norvegicus*)	0.904	yes	no	yes	2	58	NRV	NRV

Table E2.A-13. Tier Determination and Results of Study Selection Process for Acceptable Selenium Studies for Mammals from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Reference Number	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifespan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection	Number of Usable Data Sets
Growth (continued)										
Halverson et al. (1962)	14489	rat (*Rattus norvegicus*)	0.984	yes	no	no	2	59	NRV	NRV
Cutler (1974)	21137	rat (*Rattus norvegicus*)	1.11	yes	no	yes	2	60	NRV	NRV
Jacobs and Forst (1981)	1394	mouse (*Mus musculus*)	1.21	yes	no	yes	2	61	NRV	NRV
Johnson et al. (2000)	36818	mouse (*Mus musculus*)	1.31	yes	no	yes	2	62	NRV	NRV
Rastogi et al. (1976)	1523	rat (*Rattus norvegicus*)	1.59	yes	no	yes	2	63	NRV	NRV
Survival										
Spallholz et al. (1973)	1566	mouse (*Mus musculus*)	0.168	NA	NA	no	1	1	T	1
McAdam and Levander (1987)	1457	rat (*Rattus norvegicus*)	0.435	NA	NA	no	1	2	T	4
Moxon and Mahan (1982c)	1468	pig (*Sus scrofa*)	0.632	NA	NA	no	1	3	T	1
Halverson et al. (1966)	1332	rat (*Rattus norvegicus*)	0.720	NA	NA	no	1	4	T	1
Palmer et al. (1982)	1496	rat (*Rattus norvegicus*)	0.809	NA	NA	no	1	5	T	1
Palmer et al. (1983)	15262	rat (*Rattus norvegicus*)	0.823	NA	NA	no	1	6	NRV	NRV
Halverson et al. (1962)	14489	rat (*Rattus norvegicus*)	0.975	NA	NA	no	1	7	NRV	NRV
Kezhou et al. (1987)	1413	rat (*Rattus norvegicus*)	0.980	NA	NA	no	1	8	NRV	NRV
Wilson et al. (1988)	1629	pig (*Sus scrofa*)	1.19	NA	NA	no	1	9	NRV	NRV
Dausch and Fullerton (1993)	1276	rat (*Rattus norvegicus*)	1.28	NA	NA	no	1	10	NRV	NRV
Franke and Moxon (1937)	14508	rat (*Rattus norvegicus*)	1.79	NA	NA	no	1	11	NRV	NRV
Piccirillo et al. (1983)	1507	mouse (*Mus musculus*)	2.28	NA	NA	no	1	12	NRV	NRV
Davidson-York et al. (1999)	1277	pig (*Sus scrofa*)	4.17	NA	NA	no	1	13	NRV	NRV
Plasterer et al. (1985)	1509	mouse (*Mus musculus*)	4.57	NA	NA	no	1	14	NRV	NRV
Seidenberg et al. (1986)	113	mouse (*Mus musculus*)	5.01	NA	NA	no	1	15	NRV	NRV
Miller (1938)	14492	pig (*Sus scrofa*)	5.96	NA	NA	no	1	16	NRV	NRV
Julius et al. (1983)	1408	hamster (*Mesocricetus auratus*)	6.36	NA	NA	no	1	17	A	1
Hardin et al. (1987)	1335	mouse (*Mus musculus*)	6.39	NA	NA	no	1	18	NRV	NRV
Booth et al. (1983)	1234	mouse (*Mus musculus*)	20	NA	NA	no	1	19	NRV	NRV
Schroeder (1967)	1540	rat (*Rattus norvegicus*)	0.275	NA	NA	yes	2	20	NRV	NRV
Jacobs and Forst (1981)	1393	rat (*Rattus norvegicus*)	0.440	NA	NA	yes	2	21	NRV	NRV
Palmer and Olson (1974)	1497	rat (*Rattus norvegicus*)	0.540	NA	NA	yes	2	22	NRV	NRV
Abdo (1994)	1475	rat (*Rattus norvegicus*)	0.763	NA	NA	yes	2	23	NRV	NRV
Cutler (1974)	21137	rat (*Rattus norvegicus*)	1.11	NA	NA	yes	2	24	NRV	NRV
Jacobs and Forst (1981)	1394	mouse (*Mus musculus*)	4.55	NA	NA	yes	2	25	NRV	NRV

Notes:

Acronyms, abbreviations, and units of measure are defined in Table E2.A-1.

See ecological soil screening level (Eco-SSL) document (USEPA 2007b) for the full reference list for studies cited in this table.

[a] Four usable growth data sets were available from the six Tier 1 studies reviewed. Tier 2 studies were not reviewed because the toxicity reference value (TRV) was selected from the Tier 1 studies, which are preferred over Tier 2.

[b] Publication year was listed as 1982 in the Eco-SSL document. The correct year is 1981.

Table E2.A-14. Tier Determination and Results of Study Selection Process for Acceptable Vanadium Studies for Birds from the Eco-SSL Document

				Results of Study Selection Process						
Reference	Reference Number	Test Organism	LOAEL Dose (mg/kg bw/day)	Critical Lifestage?	Length of Study > 10% of Species Lifespan?	Drinking Water Exposure?	Tier	Study Rank	Rationale for Study Selection	Number of Usable Data Sets
Reproduction										
Toussant and Latshaw (1994)	5456	chicken (*Gallus domesticus*)	1.33	NA	NA	no	1	1	T	1
Kubena and Phillips (1982)	6388	chicken (*Gallus domesticus*)	2.50	NA	NA	no	1	2	T	1
Ousterhout and Berg (1981)	6508	chicken (*Gallus domesticus*)	2.75	NA	NA	no	1	3	T	1
Hafez and Kratzer (1976)	6848	chicken (*Gallus domesticus*)	14.8	NA	NA	no	1	4	T	1
Growth										
Summers and Moran (1972)	7051	chicken (*Gallus domesticus*)	0.339	yes	no	no	1	1	T	0
Hill (1974)	92	chicken (*Gallus domesticus*)	0.429	yes	no	no	1	2	T	0
Cervantes and Jensen (1986)	6085	chicken (*Gallus domesticus*)	0.589	yes	no	no	1	3	T	1
Hill (1979)	397	chicken (*Gallus domesticus*)	0.688	yes	no	no	1	4	T	1
Berg and Lawrence (1971)	9290	chicken (*Gallus domesticus*)	0.859	yes	no	no	1	5	T	3
Blalock and Hill (1987)	5927	chicken (*Gallus domesticus*)	0.968	yes	no	no	1	6	P	1
Romoser et al. (1961)	3740	chicken (*Gallus domesticus*)	1.32	yes	no	no	1	7	NRV	NRV
Hill (1990)	8125	chicken (*Gallus domesticus*)	1.42	yes	no	no	1	8	P	1
Hill (1979)	1370	chicken (*Gallus domesticus*)	1.72	yes	no	no	1	9	NRV	NRV
Hill (1990)	5736	chicken (*Gallus domesticus*)	1.77	yes	no	no	1	10	NRV	NRV
Cupo and Donaldson (1987)	5971	chicken (*Gallus domesticus*)	2.00	yes	no	no	1	11	NRV	NRV
Hathcock et al. (1964)	14512	chicken (*Gallus domesticus*)	2.15	yes	no	no	1	12	NRV	NRV
Hill (1980)	395	chicken (*Gallus domesticus*)	2.15	yes	no	no	1	13	NRV	NRV
Hill (1990)	5734	chicken (*Gallus domesticus*)	2.84	yes	no	no	1	14	P	1
Hafez and Kratzer (1976)	8663	chicken (*Gallus domesticus*)	2.87	yes	no	no	1	15	NRV	NRV
Qureshi et al. (1999)	5079	chicken (*Gallus domesticus*)	3.05	yes	no	no	1	16	P	1
Hill (1994)	5453	chicken (*Gallus domesticus*)	3.55	yes	no	no	1	17	P	1
Hill (1992)	8028	chicken (*Gallus domesticus*)	3.55	yes	no	no	1	18	NRV	NRV
Nelson et al. (1962)	14516	chicken (*Gallus domesticus*)	3.58	yes	no	no	1	19	P	2
Burt et al. (1991)	5295	chicken (*Gallus domesticus*)	4.29	yes	no	no	1	20	NRV	NRV
Kubena et al. (1985)	6192	chicken (*Gallus domesticus*)	4.76	yes	no	no	1	21	NRV	NRV
Hafez and Kratzer (1976)	6876	chicken (*Gallus domesticus*)	8.36	yes	no	no	1	22	NRV	NRV
Toussant and Latshaw (1994)	5456	chicken (*Gallus domesticus*)	1.33	yes	no	no	2	23	NRV	NRV
Ousterhout and Berg (1981)	6508	chicken (*Gallus domesticus*)	1.98	yes	no	no	2	24	NRV	NRV
Kubena and Phillips (1982)	6388	chicken (*Gallus domesticus*)	2.51	yes	no	no	2	25	NRV	NRV
Benabdeljelil and Jensen (1990)	5749	chicken (*Gallus domesticus*)	6.13	yes	no	no	2	26	NRV	NRV
Survival										
Berg and Lawrence (1971)	9290	chicken (*Gallus domesticus*)	1.72	NA	NA	no	1	1	T	1
Blalock and Hill (1987)	5927	chicken (*Gallus domesticus*)	1.92	NA	NA	no	1	2	T	1
Hathcock et al. (1964)	14512	chicken (*Gallus domesticus*)	2.15	NA	NA	no	1	3	T	3
Hill (1974)	92	chicken (*Gallus domesticus*)	4.294	NA	NA	no	1	4	T	1
Kubena and Phillips (1982)	6388	chicken (*Gallus domesticus*)	4.99	NA	NA	no	1	5	T	1
Hafez and Kratzer (1976)	8663	chicken (*Gallus domesticus*)	5.74	NA	NA	no	1	6	P	2
Romoser et al. (1961)	3740	chicken (*Gallus domesticus*)	10.6	NA	NA	no	1	7	NRV	NRV

Notes:

Acronyms, abbreviations, and units of measure are defined in Table E2.A-1.

See ecological soil screening level (Eco-SSL) document (USEPA 2005c) for the full reference list for studies cited in this table.

Table E2.A-15. Number of LOAELs in Eco-SSL Documents Less Than the Selected TRVs

					Number of Eco-SSL LOAELs < Selected TRV [a]										
					Acceptable Data Sets Reviewed Based on Tiered Process					Acceptable Data Sets Not Reviewed Based on Tiered Process [b]		Unacceptable Data Sets			
Endpoint	Selected TRV	Number of LOAELs	Number of LOAELs < Selected TRV	% LOAELs < Selected TRV	Tier 2 Study	Different Body Weight and Food Ingestion Rate Used	Effect Not < 80% Relative to the Control [c]	ED20 Calculated	Other Reason	Tier 2 Study	Based on LOAEL Ranking	Endpoint or Chemical Form Not Relevant	NOAEL	Concerns with Study Design	Insufficient Data
Birds															
Chromium (III)															
Growth	510	2	2	100	0	0	0	0	0	0	0	1	1	0	0
Reproduction	no TRV	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Survival	no TRV	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium															
Growth	0.29 [d]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Reproduction	0.55	25	12	48	0	0	2	2	0	0	0	5	0	3	0
Survival	0.59	23	3	13	0	2	0	0	1 [e]	0	0	0	0	0	0
Vanadium															
Growth	1.2	43	9	21	0	1	6	1	0	0	0	0	0	0	1
Reproduction	2.1	17	14	82	0	0	1	0	0	0	0	13	0	0	0
Survival	2.4	12	4	33	0	3	1	0	0	0	0	0	0	0	0
Mammals															
Chromium (III)															
Growth	110	1	1	100	0	0	1	0	0	0	0	0	0	0	0
Reproduction	91	4	2	50	0	0	0	0	0	0	0	2	0	0	0
Survival	no TRV	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium															
Growth	0.33	105	25	24	0	0	9	1	0	5	8	0	0	1	1
Reproduction	5.0	18	14	78	0	0	3	0	0	7	0	4	0	0	0
Survival	0.61	40	7	18	0	2	1	0	0	3	0	0	0	1	0

Notes:

Acronyms, abbreviations, and units of measure are defined in Table E2.A-1.

[a] There may be more than one reason why a lowest-observed-adverse-effect level (LOAEL) is less than the selected toxicity reference value (TRV). In such cases the primary reason is shown (e.g., the body weight and food ingestion rate may be different, but the primary reason is that the effect at the LOAEL selected in the ecological soil screening level [Eco-SSL] document is not < 80 percent relative to the control).

[b] See Figure E2-1 for a description of the process by which studies were selected for review.

[c] The dose reported as an LOAEL in the Eco-SSL document did not have an effect < 80 percent relative to the control. If an LOAEL ≥ 20 was reported in this document, it was at a higher dose level than the LOAEL in the Eco-SSL document.

[d] Eco-SSL was selected as the TRV.

[e] In the Khan et al. (1993) study, the dose via gavage was presented as mg/kg bw. In this document the exposure period included only the period during which birds were dosed, whereas in the Eco-SSL document the exposure period included the monitoring period after dosing was conducted, resulting in different daily doses.

ANNEX B

EXTRACTED DATA FROM REVIEWED STUDIES

Table E2.B-1. Acronyms, Abbreviations, and Units of Measure

Term	Definition
Acronyms and Abbreviations	
BW	body weight
DW	drinking water
dw	dry weight
ED20	modeled concentration resulting in a 20 percent effect relative to the control
F1	first filial generation
F2	second filial generation
FD	food (diet)
FIR	food ingestion rate
GV	gavage
IG	ingestion rate
LOAEL	lowest-observed-adverse-effect level
LOAEL ≥ 20	LOAEL representing a ≥ 20 percent reduction in the response compared to the control
NA	not applicable
NR	not reported
stats	statistical analyses
TRV	toxicity reference value
ww	wet weight
Units of Measure	
g	gram(s)
kg	kilogram(s)
kg/day	kilogram(s) per day
L/day	liter(s) per day
lb	pound(s)
mg/kg	milligram(s) per kilogram
mg/kg bw/day	milligram(s) per kilogram of body weight per day

Table E2.B-2. Aluminum TRV Data for Birds

									Dose (mg/kg bw/day)					Body Weight (kg)				
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	Notes	Control	Dose 1	Dose 2	Dose 3	Source[a]
Growth																		
Capdevielle and Scanes (1995a)	558	ED20	aluminum sulfate	chicken (*Gallus gallus domesticus*)	4-18 days	body weight	FD	2	0.0	112	558	NA	calculated from body weight and FIR	0.36	0.36	0.36	NA	NRC 1994
Capdevielle and Scanes (1995b)	500	500	aluminum sulfate	mallard (*Anas platyrhynchos*)	duckling	body weight	FD	2.1	0.0	100	500	NA	calculated from body weight and FIR	0.17	0.17	0.17	NA	presented in paper
Capdevielle et al. (1996)	128	642	aluminum sulfate	chicken (*Gallus gallus domesticus*)	4 days	body weight	FD	1.5	0.0	128	642	NA	calculated from body weight and FIR	0.15	0.15	0.15	NA	NRC 1994
Elliot and Edwards (1991)	no stats	273	aluminum sulfate	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	2.3	16	145	273	530	calculated from body weight and FIR	0.15	0.15	0.15	0.15	NRC 1994
Survival																		
Capdevielle and Scanes (1995a)	no stats	558	aluminum sulfate	chicken (*Gallus gallus domesticus*)	4-18 days	survival	FD	2	0.0	112	558	NA	calculated from body weight and FIR	0.36	0.36	0.36	NA	NRC 1994

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-2. Aluminum TRV Data for Birds

									Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)						Concentration in Food (mg/kg)				
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Source [a]	Wet or Dry Weight Basis	Control [c]	Dose 1	Dose 2	Dose 3	Wet or Dry Weight Basis
Growth																			
Capdevielle and Scanes (1995a)	558	ED20	aluminum sulfate	chicken (*Gallus gallus domesticus*)	4-18 days	body weight	FD	2	0.040	0.040	0.040	NA	NRC 1994	dw	0.0	1000	5000	NA	dw
Capdevielle and Scanes (1995b)	500	500	aluminum sulfate	mallard (*Anas platyrhynchos*)	duckling	body weight	FD	2.1	0.017	0.017	0.017	NA	Heinz et al. 1987	dw	0.0	1000	5000	NA	dw
Capdevielle et al. (1996)	128	642	aluminum sulfate	chicken (*Gallus gallus domesticus*)	4 days	body weight	FD	1.5	0.019	0.019	0.019	NA	NRC 1994	dw	0.0	1000	5000	NA	dw
Elliot and Edwards (1991)	no stats	273	aluminum sulfate	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	2.3	0.019	0.019	0.019	0.019	NRC 1994	dw	128	1128	2128	4128	dw
Survival																			
Capdevielle and Scanes (1995a)	no stats	558	aluminum sulfate	chicken (*Gallus gallus domesticus*)	4-18 days	survival	FD	2	0.040	0.040	0.040	NA	NRC 1994	dw	0	1000	5000	NA	dw

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-2. Aluminum TRV Data for Birds

									Effect					Effect Relative to Control (%)		
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Measurement	Dose 1	Dose 2	Dose 3
Growth																
Capdevielle and Scanes (1995a)	558	ED20	aluminum sulfate	chicken (*Gallus gallus domesticus*)	4-18 days	body weight	FD	2	610	520	307	NA	mean body weight (g)	85	50	NA
Capdevielle and Scanes (1995b)	500	500	aluminum sulfate	mallard (*Anas platyrhynchos*)	duckling	body weight	FD	2.1	297	316	201	NA	mean body weight (g)	106	68	NA
Capdevielle et al. (1996)	128	642	aluminum sulfate	chicken (*Gallus gallus domesticus*)	4 days	body weight	FD	1.5	434	379	253	NA	mean body weight (g)	87	58	NA
Elliot and Edwards (1991)	no stats	273	aluminum sulfate	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	2.3	406	354	251	104	body weight after 16 days of exposure (g)	87	62	26
Survival																
Capdevielle and Scanes (1995a)	no stats	558	aluminum sulfate	chicken (*Gallus gallus domesticus*)	4-18 days	survival	FD	2	100	100	75	NA	% survival (reported as % mortality in paper)	100	75	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-3. Aluminum TRV Data for Mammals

									Dose (mg/kg bw/day)					Body Weight (kg)				
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	Notes	Control	Dose 1	Dose 2	Dose 3	Source
Growth																		
Belles et al. (1999)	398	398	aluminum nitrate nonahydrate	mouse (*Mus musculus*)	adult (25 - 32 g body weight)	body weight gain	GV	1.5	0.0	398	NA	NA	presented in paper	NA	NA	NA	NA	NA (doses presented in paper)
Domingo et al. (1987a)	46	46	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (70.5 +/-4.4 g)	body weight	DW	14	0.0	46	91	456	presented in paper	NA	NA	NA	NA	NA (doses presented in paper)
Domingo et al. (1987a)	456	456	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (70.5 +/-4.4 g)	body weight	DW	14	0.0	46	91	456	presented in paper	NA	NA	NA	NA	NA (doses presented in paper)
Paternain et al. (1988)	13	no effect	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (240 to 280 g body weight)	body weight gain	GV	1.3	0.0	13	26	52	presented in paper	NA	NA	NA	NA	NA (doses presented in paper)
Reproduction																		
Belles et al. (1999)	398	398	aluminum nitrate nonahydrate	mouse (*Mus musculus*)	adult (25 - 32 g body weight)	fetal body weight	GV	1.5	0.0	398	NA	NA	presented in paper	NA	NA	NA	NA	NA (doses presented in paper)
Bernuzzi et al. (1989)	273	273	aluminum chloride	rat (*Rattus norvegicus*)	adult (precise age not provided; sexually mature)	postnatal survival	FD	2.6	0.0	96	273	399	presented in paper	NA	NA	NA	NA	NA (doses presented in paper)
Bernuzzi et al. (1989)	273	399	aluminum chloride	rat (*Rattus norvegicus*)	adult (precise age not provided; sexually mature)	pup body weight	FD	2.6	0.0	96	273	399	presented in paper	NA	NA	NA	NA	NA (doses presented in paper)
Domingo et al. (1987b)	no effect	52	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (240 to 280 g body weight)	pup survival	oral	unclear	0.0	13	26	52	presented in paper	NA	NA	NA	NA	NA (doses presented in paper)
Paternain et al. (1988)	13	13	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (240 to 280 g body weight)	fetal survival	GV	1.3	0.0	13	26	52	presented in paper	NA	NA	NA	NA	NA (doses presented in paper)
Paternain et al. (1988)	13	ED20	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (240 to 280 g body weight)	fetal body weight	GV	1.3	0.0	13	26	52	presented in paper	NA	NA	NA	NA	NA (doses presented in paper)
Survival																		
Belles et al. (1999)	no stats	398	aluminum nitrate nonahydrate	mouse (*Mus musculus*)	adult (25 - 32 g body weight)	survival	GV	1.5	0.0	398	NA	NA	presented in paper	NA	NA	NA	NA	NA (doses presented in paper)

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-3. Aluminum TRV Data for Mammals

									Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)					
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Source	Wet or Dry Weight Basis
Growth														
Belles et al. (1999)	398	398	aluminum nitrate nonahydrate	mouse (*Mus musculus*)	adult (25 - 32 g body weight)	body weight gain	GV	1.5	NA	NA	NA	NA	NA (doses presented in paper)	NA
Domingo et al. (1987a)	46	46	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (70.5 +/-4.4 g)	body weight	DW	14	NA	NA	NA	NA	NA (doses presented in paper)	NA
Domingo et al. (1987a)	456	456	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (70.5 +/-4.4 g)	body weight	DW	14	NA	NA	NA	NA	NA (doses presented in paper)	NA
Paternain et al. (1988)	13	no effect	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (240 to 280 g body weight)	body weight gain	GV	1.3	NA	NA	NA	NA	NA (doses presented in paper)	NA
Reproduction														
Belles et al. (1999)	398	398	aluminum nitrate nonahydrate	mouse (*Mus musculus*)	adult (25 - 32 g body weight)	fetal body weight	GV	1.5	NA	NA	NA	NA	NA (doses presented in paper)	NA
Bernuzzi et al. (1989)	273	273	aluminum chloride	rat (*Rattus norvegicus*)	adult (precise age not provided; sexually mature)	postnatal survival	FD	2.6	NA	NA	NA	NA	NA (doses presented in paper)	NA
Bernuzzi et al. (1989)	273	399	aluminum chloride	rat (*Rattus norvegicus*)	adult (precise age not provided; sexually mature)	pup body weight	FD	2.6	NA	NA	NA	NA	NA (doses presented in paper)	NA
Domingo et al. (1987b)	no effect	52	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (240 to 280 g body weight)	pup survival	oral	unclear	NA	NA	NA	NA	NA (doses presented in paper)	NA
Paternain et al. (1988)	13	13	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (240 to 280 g body weight)	fetal survival	GV	1.3	NA	NA	NA	NA	NA (doses presented in paper)	NA
Paternain et al. (1988)	13	ED20	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (240 to 280 g body weight)	fetal body weight	GV	1.3	NA	NA	NA	NA	NA (doses presented in paper)	NA
Survival														
Belles et al. (1999)	no stats	398	aluminum nitrate nonahydrate	mouse (*Mus musculus*)	adult (25 - 32 g body weight)	survival	GV	1.5	NA	NA	NA	NA	NA (doses presented in paper)	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-3. Aluminum TRV Data for Mammals

Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Concentration in Food (mg/kg)				
									Control[c]	Dose 1	Dose 2	Dose 3	Wet or Dry Weight Basis
Growth													
Belles et al. (1999)	398	398	aluminum nitrate nonahydrate	mouse (*Mus musculus*)	adult (25 - 32 g body weight)	body weight gain	GV	1.5	NA	NA	NA	NA	NA (doses presented in paper)
Domingo et al. (1987a)	46	46	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (70.5 +/-4.4 g)	body weight	DW	14	NA	NA	NA	NA	NA (doses presented in paper)
Domingo et al. (1987a)	456	456	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (70.5 +/-4.4 g)	body weight	DW	14	NA	NA	NA	NA	NA (doses presented in paper)
Paternain et al. (1988)	13	no effect	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (240 to 280 g body weight)	body weight gain	GV	1.3	NA	NA	NA	NA	NA (doses presented in paper)
Reproduction													
Belles et al. (1999)	398	398	aluminum nitrate nonahydrate	mouse (*Mus musculus*)	adult (25 - 32 g body weight)	fetal body weight	GV	1.5	NA	NA	NA	NA	NA (doses presented in paper)
Bernuzzi et al. (1989)	273	273	aluminum chloride	rat (*Rattus norvegicus*)	adult (precise age not provided; sexually mature)	postnatal survival	FD	2.6	NA	NA	NA	NA	NA (doses presented in paper)
Bernuzzi et al. (1989)	273	399	aluminum chloride	rat (*Rattus norvegicus*)	adult (precise age not provided; sexually mature)	pup body weight	FD	2.6	NA	NA	NA	NA	NA (doses presented in paper)
Domingo et al. (1987b)	no effect	52	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (240 to 280 g body weight)	pup survival	oral	unclear	NA	NA	NA	NA	NA (doses presented in paper)
Paternain et al. (1988)	13	13	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (240 to 280 g body weight)	fetal survival	GV	1.3	NA	NA	NA	NA	NA (doses presented in paper)
Paternain et al. (1988)	13	ED20	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (240 to 280 g body weight)	fetal body weight	GV	1.3	NA	NA	NA	NA	NA (doses presented in paper)
Survival													
Belles et al. (1999)	no stats	398	aluminum nitrate nonahydrate	mouse (*Mus musculus*)	adult (25 - 32 g body weight)	survival	GV	1.5	NA	NA	NA	NA	NA (doses presented in paper)

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-3. Aluminum TRV Data for Mammals

									Effect					Effect Relative to Control (%)		
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Measurement	Dose 1	Dose 2	Dose 3
Growth																
Belles et al. (1999)	398	398	aluminum nitrate nonahydrate	mouse (*Mus musculus*)	adult (25 - 32 g body weight)	body weight gain	GV	1.5	8.5	1.2	NA	NA	body weight (corrected weight change during gestation) (g)	14	NA	NA
Domingo et al. (1987a)	46	46	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (70.5 +/-4.4 g)	body weight	DW	14	79	61	84	63	body weight at "7th fortnight" calculated from weight gain (g)	77	107	80
Domingo et al. (1987a)	456	456	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (70.5 +/-4.4 g)	body weight	DW	14	263	268	257	171	body weight at "8th fortnight" calculated from weight gain (g)	102	98	65
Paternain et al. (1988)	13	no effect	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (240 to 280 g body weight)	body weight gain	GV	1.3	122	99	98	99	weight gain during gestation (critical life stage) (g)	81	80	81
Reproduction																
Belles et al. (1999)	398	398	aluminum nitrate nonahydrate	mouse (*Mus musculus*)	adult (25 - 32 g body weight)	fetal body weight	GV	1.5	1.3	0.72	NA	NA	mean fetal body weight per litter (g)	58	NA	NA
Bernuzzi et al. (1989)	273	273	aluminum chloride	rat (*Rattus norvegicus*)	adult (precise age not provided; sexually mature)	postnatal survival	FD	2.6	98	92	51	43	% of initial litter size on day 18	94	53	44
Bernuzzi et al. (1989)	273	399	aluminum chloride	rat (*Rattus norvegicus*)	adult (precise age not provided; sexually mature)	pup body weight	FD	2.6	5.8	5.6	4.9	4.5	pup growth (body weight on day 1) (g)	97	84	78
Domingo et al. (1987b)	no effect	52	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (240 to 280 g body weight)	pup survival	oral	unclear	12	12	13	9.4	mean alive neonates/litter (at age 1 day)	96	108	78
Paternain et al. (1988)	13	13	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (240 to 280 g body weight)	fetal survival	GV	1.3	12	9.3	13	13	mean number of live fetuses per dam	76	102	104
Paternain et al. (1988)	13	ED20	aluminum nitrate nonahydrate	rat (*Rattus norvegicus*)	adult (240 to 280 g body weight)	fetal body weight	GV	1.3	3.3	2.8	2.8	2.2	fetal growth (mean fetal body weight) (g)	86	84	67
Survival																
Belles et al. (1999)	no stats	398	aluminum nitrate nonahydrate	mouse (*Mus musculus*)	adult (25 - 32 g body weight)	survival	GV	1.5	100	44	NA	NA	% maternal survival	44	NA	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-4. Antimony TRV Data for Mammals

Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Dose (mg/kg bw/day) Control	1	2	3	4	5	Notes
Growth															
Poon et al. (1998)	42	no effect	potassium antimony tartrate	rat (*Rattus norvegicus*)	127 g (young; based on USEPA [1988] growth curves)	body weight (male)	DW	13	0.0	0.060	0.56	5.6	42	NA	presented in paper
Poon et al. (1998)	46	no effect	potassium antimony tartrate	rat (*Rattus norvegicus*)	136 g (young; based on USEPA [1988] growth curves)	body weight (female)	DW	13	0.0	0.060	0.64	6.1	46	NA	presented in paper
Rossi et al. (1987)	1.2	no effect	antimony trichloride	rat (*Rattus norvegicus*)	birth	body weight	DW	8.6	0.0	0.12	1.2	NA	NA	NA	calculated from body weight and FIR
Rossi et al. (1987)	0.11	no effect	antimony trichloride	rat (*Rattus norvegicus*)	adult	body weight	DW	6.3	0.0	0.11	1.1	NA	NA	NA	calculated from body weight and FIR
Shroeder et al. (1968)	0.35	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	weanling	body weight (male)	DW	80	0.0	0.35	NA	NA	NA	NA	presented in paper
Shroeder et al. (1968)	0.35	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	weanling	body weight (female)	DW	80	0.0	0.35	NA	NA	NA	NA	presented in paper
Reproduction															
Rossi et al. (1987)	1.1	no effect	antimony trichloride	rat (*Rattus norvegicus*)	adult	pups per litter	DW	6.3	0.0	0.11	1.1	NA	NA	NA	calculated from body weight and FIR
Survival															
Dieter et al. (1991)	no stats	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	~8 weeks	survival	DW	2	0.0	11	18	32	50	74	presented in paper

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-4. Antimony TRV Data for Mammals

Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Body Weight (kg)						
									Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source
Growth															
Poon et al. (1998)	42	no effect	potassium antimony tartrate	rat (*Rattus norvegicus*)	127 g (young; based on USEPA [1988] growth curves)	body weight (male)	DW	13	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)
Poon et al. (1998)	46	no effect	potassium antimony tartrate	rat (*Rattus norvegicus*)	136 g (young; based on USEPA [1988] growth curves)	body weight (female)	DW	13	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)
Rossi et al. (1987)	1.2	no effect	antimony trichloride	rat (*Rattus norvegicus*)	birth	body weight	DW	8.6	0.10	0.10	0.10	NA	NA	NA	presented in paper
Rossi et al. (1987)	0.11	no effect	antimony trichloride	rat (*Rattus norvegicus*)	adult	body weight	DW	6.3	0.31	0.31	0.31	NA	NA	NA	presented in paper
Shroeder et al. (1968)	0.35	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	weanling	body weight (male)	DW	80	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)
Shroeder et al. (1968)	0.35	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	weanling	body weight (female)	DW	80	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)
Reproduction															
Rossi et al. (1987)	1.1	no effect	antimony trichloride	rat (*Rattus norvegicus*)	adult	pups per litter	DW	6.3	0.31	0.31	0.31	NA	NA	NA	presented in paper
Survival															
Dieter et al. (1991)	no stats	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	~8 weeks	survival	DW	2	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-4. Antimony TRV Data for Mammals

									Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)							
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source[a]	Wet or Dry Weight Basis
Growth																
Poon et al. (1998)	42	no effect	potassium antimony tartrate	rat (*Rattus norvegicus*)	127 g (young; based on USEPA [1988] growth curves)	body weight (male)	DW	13	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Poon et al. (1998)	46	no effect	potassium antimony tartrate	rat (*Rattus norvegicus*)	136 g (young; based on USEPA [1988] growth curves)	body weight (female)	DW	13	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Rossi et al. (1987)	1.2	no effect	antimony trichloride	rat (*Rattus norvegicus*)	birth	body weight	DW	8.6	0.012	0.012	0.0	NA	NA	NA	Calder and Braun (1983) (DW ingestion for mammals)	NA
Rossi et al. (1987)	0.11	no effect	antimony trichloride	rat (*Rattus norvegicus*)	adult	body weight	DW	6.3	0.034	0.034	0.034	NA	NA	NA	Calder and Braun (1983) (DW ingestion for mammals)	NA
Shroeder et al. (1968)	0.35	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	weanling	body weight (male)	DW	80	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Shroeder et al. (1968)	0.35	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	weanling	body weight (female)	DW	80	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Reproduction																
Rossi et al. (1987)	1.1	no effect	antimony trichloride	rat (*Rattus norvegicus*)	adult	pups per litter	DW	6.3	0.034	0.034	0.034	NA	NA	NA	Calder and Braun (1983)	NA
Survival																
Dieter et al. (1991)	no stats	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	~8 weeks	survival	DW	2	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-4. Antimony TRV Data for Mammals

Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Concentration in Food (mg/kg)						
									Control[c]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Wet or Dry Weight Basis
Growth															
Poon et al. (1998)	42	no effect	potassium antimony tartrate	rat (*Rattus norvegicus*)	127 g (young; based on USEPA [1988] growth curves)	body weight (male)	DW	13	0.0	0.50	5.0	50	500	NA	NA (DW study)
Poon et al. (1998)	46	no effect	potassium antimony tartrate	rat (*Rattus norvegicus*)	136 g (young; based on USEPA [1988] growth curves)	body weight (female)	DW	13	0.0	0.50	5.0	50	500	NA	NA (DW study)
Rossi et al. (1987)	1.2	no effect	antimony trichloride	rat (*Rattus norvegicus*)	birth	body weight	DW	8.6	0.0	1.0	10	NA	NA	NA	NA (DW study)
Rossi et al. (1987)	0.11	no effect	antimony trichloride	rat (*Rattus norvegicus*)	adult	body weight	DW	6.3	0.0	1.0	10	NA	NA	NA	NA (DW study)
Shroeder et al. (1968)	0.35	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	weanling	body weight (male)	DW	80	0.0	5.0	NA	NA	NA	NA	NA (DW study)
Shroeder et al. (1968)	0.35	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	weanling	body weight (female)	DW	80	0.0	5.0	NA	NA	NA	NA	NA (DW study)
Reproduction															
Rossi et al. (1987)	1.1	no effect	antimony trichloride	rat (*Rattus norvegicus*)	adult	pups per litter	DW	6.3	0.0	1.0	10	NA	NA	NA	NA (DW study)
Survival															
Dieter et al. (1991)	no stats	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	~8 weeks	survival	DW	2	NA	NA	NA	NA	NA	NA	NA (DW study)

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-4. Antimony TRV Data for Mammals

									Effect						
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Measurement
Growth															
Poon et al. (1998)	42	no effect	potassium antimony tartrate	rat (*Rattus norvegicus*)	127 g (young; based on USEPA [1988] growth curves)	body weight (male)	DW	13	550	560	530	550	500	NA	male body weight (g) estimated from Figure 2 in paper
Poon et al. (1998)	46	no effect	potassium antimony tartrate	rat (*Rattus norvegicus*)	136 g (young; based on USEPA [1988] growth curves)	body weight (female)	DW	13	295	300	295	295	280	NA	female body weight (g) estimated from Figure 2 in paper
Rossi et al. (1987)	1.2	no effect	antimony trichloride	rat (*Rattus norvegicus*)	birth	body weight	DW	8.6	195	186	174	NA	NA	NA	pup body weight (g)
Rossi et al. (1987)	0.11	no effect	antimony trichloride	rat (*Rattus norvegicus*)	adult	body weight	DW	6.3	359	330	323	NA	NA	NA	maternal body weight (g)
Shroeder et al. (1968)	0.35	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	weanling	body weight (male)	DW	80	58	52	NA	NA	NA	NA	mean final body weight (g) for males
Shroeder et al. (1968)	0.35	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	weanling	body weight (female)	DW	80	55	51	NA	NA	NA	NA	mean final body weight (g) for females
Reproduction															
Rossi et al. (1987)	1.1	no effect	antimony trichloride	rat (*Rattus norvegicus*)	adult	pups per litter	DW	6.3	8.0	9.0	7.0	NA	NA	NA	newborns per litter
Survival															
Dieter et al. (1991)	no stats	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	~8 weeks	survival	DW	2	100	100	100	100	100	90	% survival

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-4. Antimony TRV Data for Mammals

									Effect Relative to Control (%)				
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth													
Poon et al. (1998)	42	no effect	potassium antimony tartrate	rat (*Rattus norvegicus*)	127 g (young; based on USEPA [1988] growth curves)	body weight (male)	DW	13	102	96	100	91	NA
Poon et al. (1998)	46	no effect	potassium antimony tartrate	rat (*Rattus norvegicus*)	136 g (young; based on USEPA [1988] growth curves)	body weight (female)	DW	13	102	100	100	95	NA
Rossi et al. (1987)	1.2	no effect	antimony trichloride	rat (*Rattus norvegicus*)	birth	body weight	DW	8.6	95	89	NA	NA	NA
Rossi et al. (1987)	0.11	no effect	antimony trichloride	rat (*Rattus norvegicus*)	adult	body weight	DW	6.3	92	90	NA	NA	NA
Shroeder et al. (1968)	0.35	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	weanling	body weight (male)	DW	80	89	NA	NA	NA	NA
Shroeder et al. (1968)	0.35	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	weanling	body weight (female)	DW	80	91	NA	NA	NA	NA
Reproduction													
Rossi et al. (1987)	1.1	no effect	antimony trichloride	rat (*Rattus norvegicus*)	adult	pups per litter	DW	6.3	113	88	NA	NA	NA
Survival													
Dieter et al. (1991)	no stats	no effect	antimony potassium tartrate	mouse (*Mus musculus*)	~8 weeks	survival	DW	2	100	100	100	100	90

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-5. Barium TRV Data for Birds

									Dose (mg/kg bw/day)								
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	4	5	6	7	Notes
Growth																	
Johnson et al. (1960)	no stats	527	barium hydroxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	0.0	56	112	223	447	893	NA	NA	calculated from body weight and FIR
Johnson et al. (1960)	no stats	483	barium acetate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	0.0	28	56	112	223	447	893	NA	calculated from body weight and FIR
Survival																	
Johnson et al. (1960)	no stats	893	barium hydroxide	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	0.0	56	112	223	447	893	1787	3573	calculated from body weight and FIR
Johnson et al. (1960)	no stats	893	barium acetate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	0.0	28	56	112	223	447	893	1787	calculated from body weight and FIR

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-5. Barium TRV Data for Birds

									Body Weight (kg)									
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Source[a]
Growth																	
Johnson et al. (1960)	no stats	527	barium hydroxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	0.4	0.4	0.4	0.4	0.4	0.4	NA	NA	NRC 1994
Johnson et al. (1960)	no stats	483	barium acetate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	NA	NRC 1994
Survival																	
Johnson et al. (1960)	no stats	893	barium hydroxide	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	NRC 1994
Johnson et al. (1960)	no stats	893	barium acetate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	NRC 1994

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-5. Barium TRV Data for Birds

									Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)									
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Source[a]	Wet or Dry Weight Basis
Growth																		
Johnson et al. (1960)	no stats	527	barium hydroxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	0.040	0.040	0.040	0.040	0.040	0.040	NA	NA	NRC 1994	dw
Johnson et al. (1960)	no stats	483	barium acetate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	0.040	0.040	0.040	0.040	0.040	0.040	0.040	NA	NRC 1994	dw
Survival																		
Johnson et al. (1960)	no stats	893	barium hydroxide	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	NRC 1994	dw
Johnson et al. (1960)	no stats	893	barium acetate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	NRC 1994	dw

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-5. Barium TRV Data for Birds

									Concentration in Food (mg/kg)								
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control[c]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Wet or Dry Weight Basis
Growth																	
Johnson et al. (1960)	no stats	527	barium hydroxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	0	500	1000.0	2000	4000	8000	NA	NA	dw assumed
Johnson et al. (1960)	no stats	483	barium acetate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	0	250	500	1000	2000	4000	8000	NA	dw assumed
Survival																	
Johnson et al. (1960)	no stats	893	barium hydroxide	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	0	500	1000	2000	4000	8000	16000	32000	dw assumed
Johnson et al. (1960)	no stats	893	barium acetate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	0	250	500	1000	2000	4000	8000	16000	dw assumed

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected t

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-5. Barium TRV Data for Birds

									Effect									
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Measurement
Growth																	
Johnson et al. (1960)	no stats	527	barium hydroxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	483	450	428	406	410	231	NA	NA	body weight gain (g)
Johnson et al. (1960)	no stats	483	barium acetate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	435	436	410	448	428	357	218	NA	body weight gain (g)
Survival																	
Johnson et al. (1960)	no stats	893	barium hydroxide	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	19	20	20	20	19	6.0	0.0	0.0	number of chicks surviving
Johnson et al. (1960)	no stats	893	barium acetate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	18	18	20	20	19	19	8.0	0.0	number of chicks surviving

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-5. Barium TRV Data for Birds

Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Effect Relative to Control (%)						
									Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7
Growth															
Johnson et al. (1960)	no stats	527	barium hydroxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	93	89	84	85	48	NA	NA
Johnson et al. (1960)	no stats	483	barium acetate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	100	94	103	98	82	50	NA
Survival															
Johnson et al. (1960)	no stats	893	barium hydroxide	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	105	105	105	100	32	0	0
Johnson et al. (1960)	no stats	893	barium acetate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	100	111	111	106	106	44	0

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-6. Chromium TRV Data for Birds

									Dose (mg/kg bw/day)				Body Weight (kg)			
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	Notes	Control	Dose 1	Dose 2	Source[a]
Growth																
Chung et al. (1985)	514	514	chromium sulfate (chromium [III])	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	0.0	514	NA	calculated from body weight and FIR	0.15	0.15	NA	NRC 1994

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-6. Chromium TRV Data for Birds

									Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)				
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Source[a]	Wet or Dry Weight Basis
Growth													
Chung et al. (1985)	514	514	chromium sulfate (chromium [III])	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	0.019	0.019	NA	NRC 1994	ww

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-6. Chromium TRV Data for Birds

									Concentration in Food (mg/kg)			
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control[c]	Dose 1	Dose 2	Wet or Dry Weight Basis
Growth												
Chung et al. (1985)	514	514	chromium sulfate (chromium [III])	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	0.0	4000	NA	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-6. Chromium TRV Data for Birds

									Effect				Effect Relative to Control (%)	
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Measurement	Dose 1	Dose 2
Growth														
Chung et al. (1985)	514	514	chromium sulfate (chromium [III])	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	174	100	NA	body weight gain at 2 weeks (g assumed)	57	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-7. Chromium TRV Data for Mammals

									Dose (mg/kg bw/day)				Body Weight (kg)			
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	Notes	Control	Dose 1	Dose 2	Source
Growth																
Bataineh et al. (1997)	112	112	chromium chloride (chromium [III])	rat (*Rattus norvegicus*)	adult	body weight (male)	DW	12	0.0	112	NA	calculated from body weight and FIR	0.30	0.30	NA	presented in paper
Elbetieha and Al-Hamood (1997)	91	no effect	chromium chloride (chromium [III])	mouse (*Mus musculus*)	50 days	body weight	DW	12	0.0	91	227	calculated from body weight and FIR	0.036	0.036	0.036	presented in paper
Reproduction																
Elbetieha and Al-Hamood (1997)	227	227	chromium chloride (chromium [III])	mouse (*Mus musculus*)	50 days	pregnancy success	DW	12	0.0	91	227	calculated from body weight and FIR	0.036	0.036	0.036	presented in paper
Elbetieha and Al-Hamood (1997)	91	91	chromium chloride (chromium [III])	mouse (*Mus musculus*)	50 days	viability of fetuses	DW	12	0.0	91	227	calculated from body weight and FIR	0.036	0.036	0.036	presented in paper

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-7. Chromium TRV Data for Mammals

									Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)					Concentration in Food (mg/kg)			
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Source[a]	Wet or Dry Weight Basis	Control[c]	Dose 1	Dose 2	Wet or Dry Weight Basis
Growth																	
Bataineh et al. (1997)	112	112	chromium chloride (chromium [III])	rat (*Rattus norvegicus*)	adult	body weight (male)	DW	12	0.033	0.033	NA	Calder and Braun (1983)	NA (DW)	0.0	1000	NA	NA (DW)
Elbetieha and Al-Hamood (1997)	91	no effect	chromium chloride (chromium [III])	mouse (*Mus musculus*)	50 days	body weight	DW	12	0.0049	0.0049	0.0049	Calder and Braun (1983)	NA (DW)	0.0	657	1642	NA (DW)
Reproduction																	
Elbetieha and Al-Hamood (1997)	227	227	chromium chloride (chromium [III])	mouse (*Mus musculus*)	50 days	pregnancy success	DW	12	0.0049	0.0049	0.0049	Calder and Braun (1983)	NA (DW)	0.0	657	1642	NA (DW)
Elbetieha and Al-Hamood (1997)	91	91	chromium chloride (chromium [III])	mouse (*Mus musculus*)	50 days	viability of fetuses	DW	12	0.0049	0.0049	0.005	Calder and Braun (1983)	NA (DW)	0.0	657	1642	NA (DW)

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-7. Chromium TRV Data for Mammals

									Effect				Effect Relative to Control (%)	
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Measurement	Dose 1	Dose 2
Growth														
Bataineh et al. (1997)	112	112	chromium chloride (chromium [III])	rat (*Rattus norvegicus*)	adult	body weight (male)	DW	12	446	341	NA	body weight (g) (Table IV in paper)	76	NA
Elbetieha and Al-Hamood (1997)	91	no effect	chromium chloride (chromium [III])	mouse (*Mus musculus*)	50 days	body weight	DW	12	0.036	0.031	0.033	average male final weight (kg)	86	93
Reproduction														
Elbetieha and Al-Hamood (1997)	227	227	chromium chloride (chromium [III])	mouse (*Mus musculus*)	50 days	pregnancy success	DW	12	83	90	44	% pregnant females	109	53
Elbetieha and Al-Hamood (1997)	91	91	chromium chloride (chromium [III])	mouse (*Mus musculus*)	50 days	viability of fetuses	DW	12	8.8	5.6	5.9	number of viable fetuses (Experiment 2)	63	67

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the

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[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-8. Iron TRV Data for Birds

									Dose (mg/kg bw/day)						
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	4	5	Notes
Growth															
Cao et al. (1996)	not clear	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	15.3	47.9	64.1	80.4	NA	NA	calculated from body weight and FIR
McGhee et al. (1965)	no stats	156	iron sulfate	chicken (*Gallus gallus domesticus*)	juvenile	body weight	FD	4	4.9	9.8	19.5	39.1	78.1	156.3	calculated from body weight and FIR
Pescatore and Harter-Dennis (1989)	1418	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	3 days	body weight	GV	single dose	0	709	945	1182	1418	NA	calculated from body weight
Survival															
McGhee et al. (1965)	no stats	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	juvenile	survival	FD	4	4.9	9.8	19.5	39.1	78.1	156.3	calculated from body weight and FIR
Pescatore and Harter-Dennis (1989)	709	1182	iron sulfate	chicken (*Gallus gallus domesticus*)	3 days	survival	GV	single dose	0	709	945	1182	1418	2836	calculated from body weight
Wallner-Pendleton et al. (1986)	no stats	2009	iron sulfate	chicken (*Gallus gallus domesticus*)	2 days	survival	GV	single dose	0	6.7	67.0	670	2009	NA	calculated from body weight

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-8. Iron TRV Data for Birds

									Body Weight (kg)						
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source [a]
Growth															
Cao et al. (1996)	not clear	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	0.378	0.378	0.378	0.378	NA	NA	presented in paper
McGhee et al. (1965)	no stats	156	iron sulfate	chicken (*Gallus gallus domesticus*)	juvenile	body weight	FD	4	0.1822	0.1822	0.1822	0.1822	0.1822	0.1822	presented in paper
Pescatore and Harter-Dennis (1989)	1418	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	3 days	body weight	GV	single dose	0.051	0.051	0.051	0.051	0.051	NA	presented in paper
Survival															
McGhee et al. (1965)	no stats	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	juvenile	survival	FD	4	0.1822	0.1822	0.1822	0.1822	0.1822	0.1822	presented in paper
Pescatore and Harter-Dennis (1989)	709	1182	iron sulfate	chicken (*Gallus gallus domesticus*)	3 days	survival	GV	single dose	0.051	0.051	0.051	0.051	0.051	0.051	presented in paper
Wallner-Pendleton et al. (1986)	no stats	2009	iron sulfate	chicken (*Gallus gallus domesticus*)	2 days	survival	GV	single dose	0.03	0.03	0.03	0.03	0.03	NA	USEPA (1988)

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the bas

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-8. Iron TRV Data for Birds

									Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)							
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source[a]	Wet or Dry Weight Basis
Growth																
Cao et al. (1996)	not clear	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	0.031	0.031	0.031	0.031	NA	NA	presented in paper	dw
McGhee et al. (1965)	no stats	156	iron sulfate	chicken (*Gallus gallus domesticus*)	juvenile	body weight	FD	4	0.018	0.018	0.018	0.018	0.018	0.018	USEPA (1988)	dw
Pescatore and Harter-Dennis (1989)	1418	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	3 days	body weight	GV	single dose	NA	NA	NA	NA	NA	NA	NA (gavage study)	NA
Survival																
McGhee et al. (1965)	no stats	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	juvenile	survival	FD	4	0.018	0.018	0.018	0.018	0.018	0.018	USEPA (1988)	dw
Pescatore and Harter-Dennis (1989)	709	1182	iron sulfate	chicken (*Gallus gallus domesticus*)	3 days	survival	GV	single dose	NA	NA	NA	NA	NA	NA	NA (gavage study)	NA
Wallner-Pendleton et al. (1986)	no stats	2009	iron sulfate	chicken (*Gallus gallus domesticus*)	2 days	survival	GV	single dose	NA	NA	NA	NA	NA	NA	NA (gavage study)	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the bas

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-8. Iron TRV Data for Birds

									Concentration in Food (mg/kg)						
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control [c]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Wet or Dry Weight Basis
Growth															
Cao et al. (1996)	not clear	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	188	588	788	988	NA	NA	dw
McGhee et al. (1965)	no stats	156	iron sulfate	chicken (*Gallus gallus domesticus*)	juvenile	body weight	FD	4	50	100	200	400	800	1600	dw
Pescatore and Harter-Dennis (1989)	1418	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	3 days	body weight	GV	single dose	NA	NA	NA	NA	NA	NA	NA
Survival															
McGhee et al. (1965)	no stats	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	juvenile	survival	FD	4	50	100	200	400	800	1600	dw
Pescatore and Harter-Dennis (1989)	709	1182	iron sulfate	chicken (*Gallus gallus domesticus*)	3 days	survival	GV	single dose	NA	NA	NA	NA	NA	NA	NA
Wallner-Pendleton et al. (1986)	no stats	2009	iron sulfate	chicken (*Gallus gallus domesticus*)	2 days	survival	GV	single dose	NA	NA	NA	NA	NA	NA	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the bas

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-8. Iron TRV Data for Birds

Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Effect						
									Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Measurement
Growth															
Cao et al. (1996)	not clear	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	0.66	0.54	0.55	0.56	NA	NA	final body weight (week 3) (kg)
McGhee et al. (1965)	no stats	156	iron sulfate	chicken (*Gallus gallus domesticus*)	juvenile	body weight	FD	4	0.1822	0.1638	0.16	0.127	0.156	0.139	average body weight (kg)
Pescatore and Harter-Dennis (1989)	1418	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	3 days	body weight	GV	single dose	0.26	0.23	0.23	0.22	0.21	NA	final body weight (12 days after dosing) (kg)
Survival															
McGhee et al. (1965)	no stats	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	juvenile	survival	FD	4	100	100	90	100	100	100	% survival
Pescatore and Harter-Dennis (1989)	709	1182	iron sulfate	chicken (*Gallus gallus domesticus*)	3 days	survival	GV	single dose	100	93.4	83.9	73.5	48.9	8.3	% survival after 24 hours
Wallner-Pendleton et al. (1986)	no stats	2009	iron sulfate	chicken (*Gallus gallus domesticus*)	2 days	survival	GV	single dose	100	100	100	100	80	NA	% survival after 24 hours

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the bas

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-8. Iron TRV Data for Birds

Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Effect Relative to Control (%)				
									Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth													
Cao et al. (1996)	not clear	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	81	82	85	NA	NA
McGhee et al. (1965)	no stats	156	iron sulfate	chicken (*Gallus gallus domesticus*)	juvenile	body weight	FD	4	90	88	70	86	76
Pescatore and Harter-Dennis (1989)	1418	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	3 days	body weight	GV	single dose	88	88	85	81	NA
Survival													
McGhee et al. (1965)	no stats	no effect	iron sulfate	chicken (*Gallus gallus domesticus*)	juvenile	survival	FD	4	100	90	100	100	100
Pescatore and Harter-Dennis (1989)	709	1182	iron sulfate	chicken (*Gallus gallus domesticus*)	3 days	survival	GV	single dose	93	84	74	49	8.3
Wallner-Pendleton et al. (1986)	no stats	2009	iron sulfate	chicken (*Gallus gallus domesticus*)	2 days	survival	GV	single dose	100	100	100	80	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the bas

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[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-9. Iron TRV Data for Mammals

									Dose (mg/kg bw/day)							
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	4	5	6	Notes
Growth																
Banis et al. (1969)	no stats	47	iron sulfate	rat (*Rattus norvegicus*)	weanling	body weight	FD	4	11.7	47	NA	NA	NA	NA	NA	calculated from body weight and FIR
Plummer et al. (1997)	not clear	649	carbonyl iron	rat (*Rattus norvegicus*)	suckling to juvenile	body weight (male)	FD	32	4.3	327	649	1294	NA	NA	NA	calculated from body weight and FIR
Plummer et al. (1997)	not clear	no effect	carbonyl iron	rat (*Rattus norvegicus*)	suckling to juvenile	body weight (female)	FD	32	5.3	407	808	1612	NA	NA	NA	calculated from body weight and FIR
Prince et al. (1979)	not clear	no effect	ferrous sulfide	pig (*Sus domesticus*)	70 days	body weight	FD	16	0.6	12	23	46	NA	NA	NA	calculated from body weight and FIR
Storey and Greger (1987)	410	410	iron sulfate	rat (*Rattus norvegicus*)	weanling	body weight (male)	FD	3	4.7	190	410	NA	NA	NA	NA	calculated from body weight and FIR
Whittaker et al. (2002)	no stats	no effect	iron sulfate	rat (*Rattus norvegicus*)	young	body weight	GV	single dose	0.0	900	1000	1100	1200	NA	NA	presented in paper
Whittaker et al. (2002)	no stats	40000	carbonyl iron	rat (*Rattus norvegicus*)	young	body weight	GV	single dose	0.0	40000	50000	NA	NA	NA	NA	presented in paper
Zhu et al. (2016)	no stats	no effect	carbonyl iron	rat (*Rattus norvegicus*)	6 weeks	body weight (male)	FD	13	0.0	159	317	NA	NA	NA	NA	calculated from body weight and FIR
Survival																
Whittaker et al. (1996)	no stats	373	carbonyl iron	rat (*Rattus norvegicus*)	weanling	survival	FD	12	3.7	37	373	2,130	NA	NA	NA	calculated from body weight and FIR
Whittaker et al. (2002)	no stats	1000	iron sulfate	rat (*Rattus norvegicus*)	young	survival	GV	single dose	0.0	900	1000	1100	1200	1300	1400	presented in paper
Whittaker et al. (2002)	no stats	no effect	carbonyl iron	rat (*Rattus norvegicus*)	young	survival	GV	single dose	0.0	40000	50000	NA	NA	NA	NA	presented in paper

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

[d] Final body weight calculated from weight gain per day and initial body weight.

Table E2.B-9. Iron TRV Data for Mammals

									Body Weight (kg)							
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Source[a]
Growth																
Banis et al. (1969)	no stats	47	iron sulfate	rat (*Rattus norvegicus*)	weanling	body weight	FD	4	0.1146	0.1146	NA	NA	NA	NA	NA	presented in paper
Plummer et al. (1997)	not clear	649	carbonyl iron	rat (*Rattus norvegicus*)	suckling to juvenile	body weight (male)	FD	32	0.66	0.66	0.66	0.66	NA	NA	NA	presented in paper
Plummer et al. (1997)	not clear	no effect	carbonyl iron	rat (*Rattus norvegicus*)	suckling to juvenile	body weight (female)	FD	32	0.345	0.345	0.345	0.345	NA	NA	NA	presented in paper
Prince et al. (1979)	not clear	no effect	ferrous sulfide	pig (*Sus domesticus*)	70 days	body weight	FD	16	53.6	53.6	53.6	53.6	NA	NA	NA	presented in paper
Storey and Greger (1987)	410	410	iron sulfate	rat (*Rattus norvegicus*)	weanling	body weight (male)	FD	3	0.075	0.075	0.075	NA	NA	NA	NA	USEPA (1988)
Whittaker et al. (2002)	no stats	no effect	iron sulfate	rat (*Rattus norvegicus*)	young	body weight	GV	single dose	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)
Whittaker et al. (2002)	no stats	40000	carbonyl iron	rat (*Rattus norvegicus*)	young	body weight	GV	single dose	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)
Zhu et al. (2016)	no stats	no effect	carbonyl iron	rat (*Rattus norvegicus*)	6 weeks	body weight (male)	FD	13	0.41	0.41	0.41	NA	NA	NA	NA	presented in paper
Survival																
Whittaker et al. (1996)	no stats	373	carbonyl iron	rat (*Rattus norvegicus*)	weanling	survival	FD	12	0.15	0.15	0.15	0.15	NA	NA	NA	USEPA (1988)
Whittaker et al. (2002)	no stats	1000	iron sulfate	rat (*Rattus norvegicus*)	young	survival	GV	single dose	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)
Whittaker et al. (2002)	no stats	no effect	carbonyl iron	rat (*Rattus norvegicus*)	young	survival	GV	single dose	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis o

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

[d] Final body weight calculated from weight gain per day and initial body weight.

Table E2.B-9. Iron TRV Data for Mammals

									Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)								
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Source[a]	Wet or Dry Weight Basis
Growth																	
Banis et al. (1969)	no stats	47	iron sulfate	rat (*Rattus norvegicus*)	weanling	body weight	FD	4	0.0134	0.0134	NA	NA	NA	NA	NA	USEPA (1988)	dw
Plummer et al. (1997)	not clear	649	carbonyl iron	rat (*Rattus norvegicus*)	suckling to juvenile	body weight (male)	FD	32	0.043	0.043	0.043	0.043	NA	NA	NA	USEPA (1988)	dw
Plummer et al. (1997)	not clear	no effect	carbonyl iron	rat (*Rattus norvegicus*)	suckling to juvenile	body weight (female)	FD	32	0.028	0.028	0.028	0.028	NA	NA	NA	USEPA (1988)	dw
Prince et al. (1979)	not clear	no effect	ferrous sulfide	pig (*Sus domesticus*)	70 days	body weight	FD	16	0.69	0.69	0.69	0.69	NA	NA	NA	Nagy (2001)	dw
Storey and Greger (1987)	410	410	iron sulfate	rat (*Rattus norvegicus*)	weanling	body weight (male)	FD	3	0.010	0.010	0.010	NA	NA	NA	NA	USEPA (1988)	dw
Whittaker et al. (2002)	no stats	no effect	iron sulfate	rat (*Rattus norvegicus*)	young	body weight	GV	single dose	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Whittaker et al. (2002)	no stats	40000	carbonyl iron	rat (*Rattus norvegicus*)	young	body weight	GV	single dose	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Zhu et al. (2016)	no stats	no effect	carbonyl iron	rat (*Rattus norvegicus*)	6 weeks	body weight (male)	FD	13	0.65	0.65	0.65	NA	NA	NA	NA	presented in paper	dw
Survival																	
Whittaker et al. (1996)	no stats	373	carbonyl iron	rat (*Rattus norvegicus*)	weanling	survival	FD	12	0.016	0.016	0.016	0.016	NA	NA	NA	USEPA (1988)	dw
Whittaker et al. (2002)	no stats	1000	iron sulfate	rat (*Rattus norvegicus*)	young	survival	GV	single dose	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Whittaker et al. (2002)	no stats	no effect	carbonyl iron	rat (*Rattus norvegicus*)	young	survival	GV	single dose	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis o

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

[d] Final body weight calculated from weight gain per day and initial body weight.

Table E2.B-9. Iron TRV Data for Mammals

									Concentration in Food (mg/kg)							
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control[c]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Wet or Dry Weight Basis
Growth																
Banis et al. (1969)	no stats	47	iron sulfate	rat (*Rattus norvegicus*)	weanling	body weight	FD	4	100	400	NA	NA	NA	NA	NA	dw
Plummer et al. (1997)	not clear	649	carbonyl iron	rat (*Rattus norvegicus*)	suckling to juvenile	body weight (male)	FD	32	66	5066	10066	20066	NA	NA	NA	dw
Plummer et al. (1997)	not clear	no effect	carbonyl iron	rat (*Rattus norvegicus*)	suckling to juvenile	body weight (female)	FD	32	66	5066	10066	20066	NA	NA	NA	dw
Prince et al. (1979)	not clear	no effect	ferrous sulfide	pig (*Sus domesticus*)	70 days	body weight	FD	16	50	920	1790	3530	NA	NA	NA	dw
Storey and Greger (1987)	410	410	iron sulfate	rat (*Rattus norvegicus*)	weanling	body weight (male)	FD	3	35.2	1408	3042	NA	NA	NA	NA	dw
Whittaker et al. (2002)	no stats	no effect	iron sulfate	rat (*Rattus norvegicus*)	young	body weight	GV	single dose	NA	NA	NA	NA	NA	NA	NA	NA
Whittaker et al. (2002)	no stats	40000	carbonyl iron	rat (*Rattus norvegicus*)	young	body weight	GV	single dose	NA	NA	NA	NA	NA	NA	NA	NA
Zhu et al. (2016)	no stats	no effect	carbonyl iron	rat (*Rattus norvegicus*)	6 weeks	body weight (male)	FD	13	0	100	200	NA	NA	NA	NA	dw
Survival																
Whittaker et al. (1996)	no stats	373	carbonyl iron	rat (*Rattus norvegicus*)	weanling	survival	FD	12	35	350	3500	20000	NA	NA	NA	dw
Whittaker et al. (2002)	no stats	1000	iron sulfate	rat (*Rattus norvegicus*)	young	survival	GV	single dose	NA	NA	NA	NA	NA	NA	NA	NA
Whittaker et al. (2002)	no stats	no effect	carbonyl iron	rat (*Rattus norvegicus*)	young	survival	GV	single dose	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis o

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

[d] Final body weight calculated from weight gain per day and initial body weight.

Table E2.B-9. Iron TRV Data for Mammals

									Effect							
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Measurement
Growth																
Banis et al. (1969)	no stats	47	iron sulfate	rat (*Rattus norvegicus*)	weanling	body weight	FD	4	0.183	0.141	NA	NA	NA	NA	NA	final body weight (kg) [d]
Plummer et al. (1997)	not clear	649	carbonyl iron	rat (*Rattus norvegicus*)	suckling to juvenile	body weight (male)	FD	32	0.66	0.68	0.51	0.53	NA	NA	NA	final body weight (kg)
Plummer et al. (1997)	not clear	no effect	carbonyl iron	rat (*Rattus norvegicus*)	suckling to juvenile	body weight (female)	FD	32	0.345	0.340	0.290	0.295	NA	NA	NA	final body weight (kg)
Prince et al. (1979)	not clear	no effect	ferrous sulfide	pig (*Sus domesticus*)	70 days	body weight	FD	16	89.8	86.3	85.4	85.2	NA	NA	NA	final body weight (kg) [d]
Storey and Greger (1987)	410	410	iron sulfate	rat (*Rattus norvegicus*)	weanling	body weight (male)	FD	3	0.181	0.174	0.137	NA	NA	NA	NA	final body weight (kg)
Whittaker et al. (2002)	no stats	no effect	iron sulfate	rat (*Rattus norvegicus*)	young	body weight	GV	single dose	0.12	0.12	0.13	0.14	0.14	NA	NA	final body weight (kg)
Whittaker et al. (2002)	no stats	40000	carbonyl iron	rat (*Rattus norvegicus*)	young	body weight	GV	single dose	0.121	0.089	0.092	NA	NA	NA	NA	final body weight (kg)
Zhu et al. (2016)	no stats	no effect	carbonyl iron	rat (*Rattus norvegicus*)	6 weeks	body weight (male)	FD	13	0.47	0.44	0.41	NA	NA	NA	NA	final body weight (kg)
Survival																
Whittaker et al. (1996)	no stats	373	carbonyl iron	rat (*Rattus norvegicus*)	weanling	survival	FD	12	100	100	80	72.2	NA	NA	NA	% survival
Whittaker et al. (2002)	no stats	1000	iron sulfate	rat (*Rattus norvegicus*)	young	survival	GV	single dose	100	87.5	75	50	12.5	0	0	% survival
Whittaker et al. (2002)	no stats	no effect	carbonyl iron	rat (*Rattus norvegicus*)	young	survival	GV	single dose	100	100	100	NA	NA	NA	NA	% survival

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis o

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

[d] Final body weight calculated from weight gain per day and initial body weight.

Table E2.B-9. Iron TRV Data for Mammals

									Effect Relative to Control (%)					
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6
Growth														
Banis et al. (1969)	no stats	47	iron sulfate	rat (*Rattus norvegicus*)	weanling	body weight	FD	4	77	NA	NA	NA	NA	NA
Plummer et al. (1997)	not clear	649	carbonyl iron	rat (*Rattus norvegicus*)	suckling to juvenile	body weight (male)	FD	32	102	77	80	NA	NA	NA
Plummer et al. (1997)	not clear	no effect	carbonyl iron	rat (*Rattus norvegicus*)	suckling to juvenile	body weight (female)	FD	32	99	84	86	NA	NA	NA
Prince et al. (1979)	not clear	no effect	ferrous sulfide	pig (*Sus domesticus*)	70 days	body weight	FD	16	96	95	95	NA	NA	NA
Storey and Greger (1987)	410	410	iron sulfate	rat (*Rattus norvegicus*)	weanling	body weight (male)	FD	3	96	79	NA	NA	NA	NA
Whittaker et al. (2002)	no stats	no effect	iron sulfate	rat (*Rattus norvegicus*)	young	body weight	GV	single dose	98	107	114	116	NA	NA
Whittaker et al. (2002)	no stats	40000	carbonyl iron	rat (*Rattus norvegicus*)	young	body weight	GV	single dose	74	76	NA	NA	NA	NA
Zhu et al. (2016)	no stats	no effect	carbonyl iron	rat (*Rattus norvegicus*)	6 weeks	body weight (male)	FD	13	95	88	NA	NA	NA	NA
Survival														
Whittaker et al. (1996)	no stats	373	carbonyl iron	rat (*Rattus norvegicus*)	weanling	survival	FD	12	100	80	72.2	NA	NA	NA
Whittaker et al. (2002)	no stats	1000	iron sulfate	rat (*Rattus norvegicus*)	young	survival	GV	single dose	87.5	75	50	12.5	0	0
Whittaker et al. (2002)	no stats	no effect	carbonyl iron	rat (*Rattus norvegicus*)	young	survival	GV	single dose	100	100.0	NA	NA	NA	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis o

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

[d] Final body weight calculated from weight gain per day and initial body weight.

Table E2.B-10. Methylmercury TRV Data for Birds

Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Dose (mg/kg bw/day)						
									Control	1	2	3	4	5	Notes
Growth															
Scott et al. (1975)	no stats	ED20	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	body weight	FD	8	0.0	0.70	1.4	NA	NA	NA	calculated from body weight and FIR
Sell and Horani (1976)	2.2	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 1)	FD	4	0.0	2.2	NA	NA	NA	NA	calculated from body weight and FIR
Sell and Horani (1976)	2.2	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	6 days	body weight gain (Experiment 2)	FD	3.6	0.0	2.2	NA	NA	NA	NA	calculated from body weight and FIR
Spalding et al. (2000)	0.070	no effect	methylmercury chloride	egret (*Ardea alba)*	1 week	weight index	FD	14	0.0	0.070	0.70	NA	NA	NA	calculated from body weight and FIR
Reproduction															
Albers et al. (2007)	stats not clearly presented	0.48	methylmercury chloride	kestrel (*Falco sparverius*)	adult	egg production	FD	at least 11	0.0	0.079	0.21	0.34	0.48	0.62	calculated from body weight and FIR
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	number of eggs hatched	FD	at least 11	0.0	0.079	0.21	0.34	0.48	0.62	calculated from body weight and FIR
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	% eggs hatched	FD	at least 11	0.0	0.079	0.21	0.34	0.48	0.62	calculated from body weight and FIR
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	% fledged	FD	at least 11	0.0	0.079	0.21	0.34	0.48	0.62	calculated from body weight and FIR
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	% egg fertility	FD	16	0.0	0.66	2.0	3.9	NA	NA	calculated from body weight and FIR
El-Begearmi et al. (1977)	no stats	0.66	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	egg production	FD	16	0.0	0.66	2.0	3.9	NA	NA	calculated from body weight and FIR
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	% hatchability	FD	16	0.0	0.66	2.0	3.9	NA	NA	calculated from body weight and FIR
Eskeland and Nafstad (1978)	0.53	0.53	methylmercury chloride	quail (*Coturnix japonica*)	6 weeks (juvenile)	chick survival	FD	6	0.0	0.13	0.26	0.53	1.1	NA	calculated from body weight and FIR
Eskeland and Nafstad (1978)	1.1	1.1	methylmercury chloride	quail (*Coturnix japonica*)	6 weeks (juvenile)	hatch success	FD	6	0.0	0.13	0.26	0.53	1.1	NA	calculated from body weight and FIR
Heinz et al. (2010)	no effect	0.80	methylmercury chloride	mallard (*Anas platyrhynchos*)	adult	ducklings per female	FD	3.7	0.0	0.10	0.20	0.40	0.80	NA	calculated from body weight and FIR
Heinz et al. (2010)	0.40	no effect	methylmercury chloride	mallard (*Anas platyrhynchos*)	adult	duckling body weight	FD	3.7	0.0	0.10	0.20	0.40	0.80	NA	calculated from body weight and FIR
Heinz and Hoffman (1998)	1.0	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	ducklings per female	FD	up to 11	0.0	1.0	NA	NA	NA	NA	calculated from body weight and FIR
Heinz and Hoffman (1998)	1.0	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	% hatchability	FD	up to 11	0.0	1.0	NA	NA	NA	NA	calculated from body weight and FIR
Heinz and Hoffman (1998)	no effect	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	duckling survival	FD	up to 11	0.0	1.0	NA	NA	NA	NA	calculated from body weight and FIR
Scott et al. (1975)	0.70	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg fertility	FD	8	0.0	0.70	1.4	NA	NA	NA	calculated from body weight and FIR
Scott et al. (1975)	1.4	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg production	FD	8	0.0	0.70	1.4	NA	NA	NA	calculated from body weight and FIR
Scott et al. (1975)	0.70	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg hatchability	FD	8	0.0	0.70	1.4	NA	NA	NA	calculated from body weight and FIR
Varian-Ramos et al. (2014)	0.41	no effect	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	% hatchability	FD	52	0.0	0.051	0.10	0.20	0.41	NA	calculated from body weight and FIR
Varian-Ramos et al. (2014)	0.051	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	% chicks fledged	FD	52	0.0	0.051	0.10	0.20	0.41	NA	calculated from body weight and FIR
Varian-Ramos et al. (2014)	0.051	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	number of offspring	FD	52	0.0	0.051	0.10	0.20	0.41	NA	calculated from body weight and FIR
Varian-Ramos et al. (2014)	no stats	0.10	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 % hatchability	FD	unclear	0.0	0.051	0.10	0.20	0.41	NA	calculated from body weight and FIR
Varian-Ramos et al. (2014)	no stats	0.10	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 % chicks fledged	FD	unclear	0.0	0.051	0.10	0.20	0.41	NA	calculated from body weight and FIR
Varian-Ramos et al. (2014)	no stats	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 number of offspring	FD	unclear	0.0	0.051	0.10	0.20	0.41	NA	calculated from body weight and FIR
Survival															
Bennet et al. (2009)	no stats	1.3	methylmercury chloride	kestrel (*Falco sparverius*)	adult	survival	FD	5-7	0.0	0.31	0.67	1.3	NA	NA	calculated from body weight and FIR
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling	survival (female)	FD	16	0.0	0.66	2.0	3.9	NA	NA	calculated from body weight and FIR
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling	survival (male)	FD	16	0.0	0.66	2.0	3.9	NA	NA	calculated from body weight and FIR
Hill and Soares (1987)	no stats	3.7	methylmercury chloride	quail (*Coturnix japonica*)	hatchling	survival	FD	0.71	0.0	2.6	3.7	5.3	NA	NA	calculated from body weight and FIR
Hill and Soares (1987)	no stats	5.5	methylmercury chloride	quail (*Coturnix japonica*)	14 days	survival	FD	0.71	0.0	3.9	5.5	7.9	NA	NA	calculated from body weight and FIR
Scheuhammer (1988)	no stats	1.8	methylmercury chloride	finch (*Taeniopygia guttata*)	adult	survival	FD	11	0.0	0.35	0.88	1.8	NA	NA	doses presented in paper
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	4	0.0	2.2	NA	NA	NA	NA	calculated from body weight and FIR
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	6 days	survival (Experiment 2)	FD	3.6	0.0	2.2	NA	NA	NA	NA	calculated from body weight and FIR
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	quail (*Coturnix japonica*)	8 days	survival (Experiment 2)	FD	3.3	0.0	2.6	NA	NA	NA	NA	calculated from body weight and FIR
Spann et al. (1986)	no stats	2.0	methylmercury chloride	quail (*Coturnix japonica*)	12 days	survival	FD	6	0.0	0.54	2.0	NA	NA	NA	calculated from body weight and FIR
Varian-Ramos et al. (2014)	no effect	0.051	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	survival	FD	52	0.0	0.051	0.10	0.20	0.41	NA	calculated from body weight and FIR
Varian-Ramos et al. (2014)	no stats	0.051	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 survival	FD	unclear	0.0	0.051	0.10	0.20	0.41	NA	calculated from body weight and FIR

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-10. Methylmercury TRV Data for Birds

									Body Weight (kg)						
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source[a]
Growth															
Scott et al. (1975)	no stats	ED20	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	body weight	FD	8	1.6	1.6	1.6	NA	NA	NA	USEPA (1988)
Sell and Horani (1976)	2.2	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 1)	FD	4	0.080	0.080	NA	NA	NA	NA	USEPA (1988)
Sell and Horani (1976)	2.2	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	6 days	body weight gain (Experiment 2)	FD	3.6	0.080	0.080	NA	NA	NA	NA	USEPA (1988)
Spalding et al. (2000)	0.070	no effect	methylmercury chloride	egret (*Ardea alba)*	1 week	weight index	FD	14	NA	NA	NA	NA	NA	NA	NA (FIR/body weight reported)
Reproduction															
Albers et al. (2007)	stats not clearly presented	0.48	methylmercury chloride	kestrel (*Falco sparverius*)	adult	egg production	FD	at least 11	0.13	0.13	0.13	0.13	0.13	0.13	Pattee (1984)
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	number of eggs hatched	FD	at least 11	0.13	0.13	0.13	0.13	0.13	0.13	Pattee (1984)
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	% eggs hatched	FD	at least 11	0.13	0.13	0.13	0.13	0.13	0.13	Pattee (1984)
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	% fledged	FD	at least 11	0.13	0.13	0.13	0.13	0.13	0.13	Pattee (1984)
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	% egg fertility	FD	16	0.15	0.15	0.15	0.15	NA	NA	Vos et al. (1971)
El-Begearmi et al. (1977)	no stats	0.66	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	egg production	FD	16	0.15	0.15	0.15	0.15	NA	NA	Vos et al. (1971)
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	% hatchability	FD	16	0.15	0.15	0.15	0.15	NA	NA	Vos et al. (1971)
Eskeland and Nafstad (1978)	0.53	0.53	methylmercury chloride	quail (*Coturnix japonica*)	6 weeks (juvenile)	chick survival	FD	6	0.15	0.15	0.15	0.15	0.15	NA	Vos et al. (1971)
Eskeland and Nafstad (1978)	1.1	1.1	methylmercury chloride	quail (*Coturnix japonica*)	6 weeks (juvenile)	hatch success	FD	6	0.15	0.15	0.15	0.15	0.15	NA	Vos et al. (1971)
Heinz et al. (2010)	no effect	0.80	methylmercury chloride	mallard (*Anas platyrhynchos*)	adult	ducklings per female	FD	3.7	1.2	1.2	1.2	1.2	1.2	NA	presented in paper
Heinz et al. (2010)	0.40	no effect	methylmercury chloride	mallard (*Anas platyrhynchos*)	adult	duckling body weight	FD	3.7	1.2	1.2	1.2	1.2	1.2	NA	presented in paper
Heinz and Hoffman (1998)	1.0	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	ducklings per female	FD	up to 11	1.2	1.2	NA	NA	NA	NA	presented in paper
Heinz and Hoffman (1998)	1.0	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	% hatchability	FD	up to 11	1.2	1.2	NA	NA	NA	NA	presented in paper
Heinz and Hoffman (1998)	no effect	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	duckling survival	FD	up to 11	1.2	1.2	NA	NA	NA	NA	presented in paper
Scott et al. (1975)	0.70	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg fertility	FD	8	1.6	1.6	1.6	NA	NA	NA	USEPA (1988)
Scott et al. (1975)	1.4	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg production	FD	8	1.6	1.6	1.6	NA	NA	NA	USEPA (1988)
Scott et al. (1975)	0.70	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg hatchability	FD	8	1.6	1.6	1.6	NA	NA	NA	USEPA (1988)
Varian-Ramos et al. (2014)	0.41	no effect	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	% hatchability	FD	52	0.012	0.012	0.012	0.012	0.012	NA	Dunning (1993)
Varian-Ramos et al. (2014)	0.051	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	% chicks fledged	FD	52	0.012	0.012	0.012	0.012	0.012	NA	Dunning (1993)
Varian-Ramos et al. (2014)	0.051	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	number of offspring	FD	52	0.012	0.012	0.012	0.012	0.012	NA	Dunning (1993)
Varian-Ramos et al. (2014)	no stats	0.10	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 % hatchability	FD	unclear	0.012	0.012	0.012	0.012	0.012	NA	Dunning (1993)
Varian-Ramos et al. (2014)	no stats	0.10	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 % chicks fledged	FD	unclear	0.012	0.012	0.012	0.012	0.012	NA	Dunning (1993)
Varian-Ramos et al. (2014)	no stats	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 number of offspring	FD	unclear	0.012	0.012	0.012	0.012	0.012	NA	Dunning (1993)
Survival															
Bennet et al. (2009)	no stats	1.3	methylmercury chloride	kestrel (*Falco sparverius*)	adult	survival	FD	5-7	0.13	0.13	0.13	0.13	NA	NA	Pattee (1984)
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling	survival (female)	FD	16	0.15	0.15	0.15	0.15	NA	NA	Vos et al. (1971)
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling	survival (male)	FD	16	0.15	0.15	0.15	0.15	NA	NA	Vos et al. (1971)
Hill and Soares (1987)	no stats	3.7	methylmercury chloride	quail (*Coturnix japonica*)	hatchling	survival	FD	0.71	0.15	0.15	0.15	0.15	NA	NA	Vos et al. (1971)
Hill and Soares (1987)	no stats	5.5	methylmercury chloride	quail (*Coturnix japonica*)	14 days	survival	FD	0.71	0.15	0.15	0.15	0.15	NA	NA	Vos et al. (1971)
Scheuhammer (1988)	no stats	1.8	methylmercury chloride	finch (*Taeniopygia guttata*)	adult	survival	FD	11	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	4	0.080	0.080	NA	NA	NA	NA	USEPA (1988)
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	6 days	survival (Experiment 2)	FD	3.6	0.080	0.080	NA	NA	NA	NA	USEPA (1988)
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	quail (*Coturnix japonica*)	8 days	survival (Experiment 2)	FD	3.3	0.15	0.15	NA	NA	NA	NA	Vos et al. (1971)
Spann et al. (1986)	no stats	2.0	methylmercury chloride	quail (*Coturnix japonica*)	12 days	survival	FD	6	0.18	0.18	0.18	NA	NA	NA	Dunning (1993)
Varian-Ramos et al. (2014)	no effect	0.051	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	survival	FD	52	0.012	0.012	0.012	0.012	0.012	NA	Dunning (1993)
Varian-Ramos et al. (2014)	no stats	0.051	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 survival	FD	unclear	0.012	0.012	0.012	0.012	0.012	NA	Dunning (1993)

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-10. Methylmercury TRV Data for Birds

									Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)							
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source[a]	Wet or Dry Weight Basis
Growth																
Scott et al. (1975)	no stats	ED20	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	body weight	FD	8	0.11	0.11	0.11	NA	NA	NA	USEPA (1988)	dw
Sell and Horani (1976)	2.2	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 1)	FD	4	0.0089	0.0089	NA	NA	NA	NA	USEPA (1988)	dw
Sell and Horani (1976)	2.2	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	6 days	body weight gain (Experiment 2)	FD	3.6	0.0089	0.0089	NA	NA	NA	NA	USEPA (1988)	dw
Spalding et al. (2000)	0.070	no effect	methylmercury chloride	egret (*Ardea alba)*	1 week	weight index	FD	14	0.18	0.18	0.18	NA	NA	NA	presented in paper	ww
Reproduction																
Albers et al. (2007)	stats not clearly presented	0.48	methylmercury chloride	kestrel (*Falco sparverius*)	adult	egg production	FD	at least 11	0.014	0.014	0.014	0.014	0.014	0.014	Nagy (2001) (for Eurasian kestrel)	dw
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	number of eggs hatched	FD	at least 11	0.014	0.014	0.014	0.014	0.014	0.014	Nagy (2001) (for Eurasian kestrel)	dw
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	% eggs hatched	FD	at least 11	0.014	0.014	0.014	0.014	0.014	0.014	Nagy (2001) (for Eurasian kestrel)	dw
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	% fledged	FD	at least 11	0.014	0.014	0.014	0.014	0.014	0.014	Nagy (2001) (for Eurasian kestrel)	dw
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	% egg fertility	FD	16	0.020	0.020	0.020	0.020	NA	NA	Nagy (2001) (for all birds)	dw
El-Begearmi et al. (1977)	no stats	0.66	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	egg production	FD	16	0.020	0.020	0.020	0.020	NA	NA	Nagy (2001) (for all birds)	dw
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	% hatchability	FD	16	0.020	0.020	0.020	0.020	NA	NA	Nagy (2001) (for all birds)	dw
Eskeland and Nafstad (1978)	0.53	0.53	methylmercury chloride	quail (*Coturnix japonica*)	6 weeks (juvenile)	chick survival	FD	6	0.020	0.020	0.020	0.020	0.020	NA	Nagy (2001) (for all birds)	dw
Eskeland and Nafstad (1978)	1.1	1.1	methylmercury chloride	quail (*Coturnix japonica*)	6 weeks (juvenile)	hatch success	FD	6	0.020	0.020	0.020	0.020	0.020	NA	Nagy (2001) (for all birds)	dw
Heinz et al. (2010)	no effect	0.80	methylmercury chloride	mallard (*Anas platyrhynchos*)	adult	ducklings per female	FD	3.7	0.12	0.12	0.12	0.12	0.12	NA	Heinz et al. (1987)	dw
Heinz et al. (2010)	0.40	no effect	methylmercury chloride	mallard (*Anas platyrhynchos*)	adult	duckling body weight	FD	3.7	0.12	0.12	0.12	0.12	0.12	NA	Heinz et al. (1987)	dw
Heinz and Hoffman (1998)	1.0	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	ducklings per female	FD	up to 11	0.12	0.12	NA	NA	NA	NA	Heinz et al. (1987)	dw
Heinz and Hoffman (1998)	1.0	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	% hatchability	FD	up to 11	0.12	0.12	NA	NA	NA	NA	Heinz et al. (1987)	dw
Heinz and Hoffman (1998)	no effect	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	duckling survival	FD	up to 11	0.12	0.12	NA	NA	NA	NA	Heinz et al. (1987)	dw
Scott et al. (1975)	0.70	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg fertility	FD	8	0.11	0.11	0.11	NA	NA	NA	USEPA (1988)	dw
Scott et al. (1975)	1.4	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg production	FD	8	0.11	0.11	0.11	NA	NA	NA	USEPA (1988)	dw
Scott et al. (1975)	0.70	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg hatchability	FD	8	0.11	0.11	0.11	NA	NA	NA	USEPA (1988)	dw
Varian-Ramos et al. (2014)	0.41	no effect	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	% hatchability	FD	52	0.0034	0.0034	0.0034	0.0034	0.0034	NA	Nagy (2001) (for passerines)	dw
Varian-Ramos et al. (2014)	0.051	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	% chicks fledged	FD	52	0.0034	0.0034	0.0034	0.0034	0.0034	NA	Nagy (2001) (for passerines)	dw
Varian-Ramos et al. (2014)	0.051	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	number of offspring	FD	52	0.0034	0.0034	0.0034	0.0034	0.0034	NA	Nagy (2001) (for passerines)	dw
Varian-Ramos et al. (2014)	no stats	0.10	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 % hatchability	FD	unclear	0.0034	0.0034	0.0034	0.0034	0.0034	NA	Nagy (2001) (for passerines)	dw
Varian-Ramos et al. (2014)	no stats	0.10	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 % chicks fledged	FD	unclear	0.0034	0.0034	0.0034	0.0034	0.0034	NA	Nagy (2001) (for passerines)	dw
Varian-Ramos et al. (2014)	no stats	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 number of offspring	FD	unclear	0.0034	0.0034	0.0034	0.0034	0.0034	NA	Nagy (2001) (for passerines)	dw
Survival																
Bennet et al. (2009)	no stats	1.3	methylmercury chloride	kestrel (*Falco sparverius*)	adult	survival	FD	5-7	0.014	0.014	0.014	0.014	NA	NA	Nagy (2001) (for Eurasian kestrel)	dw
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling	survival (female)	FD	16	0.020	0.020	0.020	0.020	NA	NA	Nagy (2001) (for all birds)	dw
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling	survival (male)	FD	16	0.020	0.020	0.020	0.020	NA	NA	Nagy (2001) (for all birds)	dw
Hill and Soares (1987)	no stats	3.7	methylmercury chloride	quail (*Coturnix japonica*)	hatchling	survival	FD	0.71	0.020	0.020	0.020	0.020	NA	NA	Nagy (2001) (for all birds)	dw
Hill and Soares (1987)	no stats	5.5	methylmercury chloride	quail (*Coturnix japonica*)	14 days	survival	FD	0.71	0.020	0.020	0.020	0.020	NA	NA	Nagy (2001) (for all birds)	dw
Scheuhammer (1988)	no stats	1.8	methylmercury chloride	finch (*Taeniopygia guttata*)	adult	survival	FD	11	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	4	0.0089	0.0089	NA	NA	NA	NA	USEPA (1988)	dw
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	6 days	survival (Experiment 2)	FD	3.6	0.0089	0.0089	NA	NA	NA	NA	USEPA (1988)	dw
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	quail (*Coturnix japonica*)	8 days	survival (Experiment 2)	FD	3.3	0.020	0.020	NA	NA	NA	NA	Nagy (2001) (for all birds)	dw
Spann et al. (1986)	no stats	2.0	methylmercury chloride	quail (*Coturnix japonica*)	12 days	survival	FD	6	0.022	0.022	0.022	NA	NA	NA	Nagy (2001) (for all birds)	dw
Varian-Ramos et al. (2014)	no effect	0.051	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	survival	FD	52	0.0034	0.0034	0.0034	0.0034	0.0034	NA	Nagy (2001) (for passerines)	dw
Varian-Ramos et al. (2014)	no stats	0.051	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 survival	FD	unclear	0.0034	0.0034	0.0034	0.0034	0.0034	NA	Nagy (2001) (for passerines)	dw

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-10. Methylmercury TRV Data for Birds

									Concentration in Food (mg/kg)						
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control[c]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Wet or Dry Weight Basis
Growth															
Scott et al. (1975)	no stats	ED20	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	body weight	FD	8	0.0	10	20	NA	NA	NA	dw
Sell and Horani (1976)	2.2	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 1)	FD	4	0.0	20	NA	NA	NA	NA	dw
Sell and Horani (1976)	2.2	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	6 days	body weight gain (Experiment 2)	FD	3.6	0.0	20	NA	NA	NA	NA	dw
Spalding et al. (2000)	0.070	no effect	methylmercury chloride	egret (*Ardea alba)*	1 week	weight index	FD	14	0.0	0.43	4.3	NA	NA	NA	ww
Reproduction															
Albers et al. (2007)	stats not clearly presented	0.48	methylmercury chloride	kestrel (*Falco sparverius*)	adult	egg production	FD	at least 11	0.0	0.75	2.0	3.2	4.6	5.9	dw
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	number of eggs hatched	FD	at least 11	0.0	0.75	2.0	3.2	4.6	5.9	dw
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	% eggs hatched	FD	at least 11	0.0	0.75	2.0	3.2	4.6	5.9	dw
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	% fledged	FD	at least 11	0.0	0.75	2.0	3.2	4.6	5.9	dw
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	% egg fertility	FD	16	0.0	5.0	15	30	NA	NA	dw
El-Begearmi et al. (1977)	no stats	0.66	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	egg production	FD	16	0.0	5.0	15	30	NA	NA	dw
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	% hatchability	FD	16	0.0	5.0	15	30	NA	NA	dw
Eskeland and Nafstad (1978)	0.53	0.53	methylmercury chloride	quail (*Coturnix japonica*)	6 weeks (juvenile)	chick survival	FD	6	0.0	1.0	2.0	4.0	8.0	NA	dw
Eskeland and Nafstad (1978)	1.1	1.1	methylmercury chloride	quail (*Coturnix japonica*)	6 weeks (juvenile)	hatch success	FD	6	0.0	1.0	2.0	4.0	8.0	NA	dw
Heinz et al. (2010)	no effect	0.80	methylmercury chloride	mallard (*Anas platyrhynchos*)	adult	ducklings per female	FD	3.7	0.0	1.0	2.0	4.0	8.0	NA	dw
Heinz et al. (2010)	0.40	no effect	methylmercury chloride	mallard (*Anas platyrhynchos*)	adult	duckling body weight	FD	3.7	0.0	1.0	2.0	4.0	8.0	NA	dw
Heinz and Hoffman (1998)	1.0	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	ducklings per female	FD	up to 11	0.0	10	NA	NA	NA	NA	dw
Heinz and Hoffman (1998)	1.0	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	% hatchability	FD	up to 11	0.0	10	NA	NA	NA	NA	dw
Heinz and Hoffman (1998)	no effect	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	duckling survival	FD	up to 11	0.0	10	NA	NA	NA	NA	dw
Scott et al. (1975)	0.70	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg fertility	FD	8	0.0	10	20	NA	NA	NA	dw
Scott et al. (1975)	1.4	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg production	FD	8	0.0	10	20	NA	NA	NA	dw
Scott et al. (1975)	0.70	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg hatchability	FD	8	0.0	10	20	NA	NA	NA	dw
Varian-Ramos et al. (2014)	0.41	no effect	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	% hatchability	FD	52	0.0	0.18	0.36	0.71	1.4	NA	dw
Varian-Ramos et al. (2014)	0.051	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	% chicks fledged	FD	52	0.0	0.18	0.36	0.71	1.4	NA	dw
Varian-Ramos et al. (2014)	0.051	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	number of offspring	FD	52	0.0	0.18	0.36	0.71	1.4	NA	dw
Varian-Ramos et al. (2014)	no stats	0.10	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 % hatchability	FD	unclear	0.0	0.18	0.36	0.71	1.4	NA	dw
Varian-Ramos et al. (2014)	no stats	0.10	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 % chicks fledged	FD	unclear	0.0	0.18	0.36	0.71	1.4	NA	dw
Varian-Ramos et al. (2014)	no stats	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 number of offspring	FD	unclear	0.0	0.18	0.36	0.71	1.4	NA	dw
Survival															
Bennet et al. (2009)	no stats	1.3	methylmercury chloride	kestrel (*Falco sparverius*)	adult	survival	FD	5-7	0.0	3.0	6.4	12	NA	NA	dw
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling	survival (female)	FD	16	0.0	5.0	15	30	NA	NA	dw
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling	survival (male)	FD	16	0.0	5.0	15	30	NA	NA	dw
Hill and Soares (1987)	no stats	3.7	methylmercury chloride	quail (*Coturnix japonica*)	hatchling	survival	FD	0.71	0.0	20	28	40	NA	NA	dw
Hill and Soares (1987)	no stats	5.5	methylmercury chloride	quail (*Coturnix japonica*)	14 days	survival	FD	0.71	0.0	30	42	60	NA	NA	dw
Scheuhammer (1988)	no stats	1.8	methylmercury chloride	finch (*Taeniopygia guttata*)	adult	survival	FD	11	0.0	1.0	2.5	5.0	NA	NA	dw
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	4	0.0	20	NA	NA	NA	NA	dw
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	6 days	survival (Experiment 2)	FD	3.6	0.0	20	NA	NA	NA	NA	dw
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	quail (*Coturnix japonica*)	8 days	survival (Experiment 2)	FD	3.3	0.0	20	NA	NA	NA	NA	dw
Spann et al. (1986)	no stats	2.0	methylmercury chloride	quail (*Coturnix japonica*)	12 days	survival	FD	6	0.0	4.3	16	NA	NA	NA	dw
Varian-Ramos et al. (2014)	no effect	0.051	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	survival	FD	52	0.0	0.18	0.36	0.7	1.4	NA	dw
Varian-Ramos et al. (2014)	no stats	0.051	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 survival	FD	unclear	0.0	0.18	0.36	0.7	1.4	NA	dw

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-10. Methylmercury TRV Data for Birds

Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Effect						
									Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Measurement
Growth															
Scott et al. (1975)	no stats	ED20	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	body weight	FD	8	1.7	1.5	1.1	NA	NA	NA	Paper only presented weight change results (not body weights themselves). Mean body weight from USEPA (1988) (1.55 kg) used to calculate final body weights (with weight change results in paper).
Sell and Horani (1976)	2.2	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 1)	FD	4	267	225	NA	NA	NA	NA	weight gain (g)
Sell and Horani (1976)	2.2	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	6 days	body weight gain (Experiment 2)	FD	3.6	251	211	NA	NA	NA	NA	weight gain (g)
Spalding et al. (2000)	0.070	no effect	methylmercury chloride	egret (*Ardea alba)*	1 week	weight index	FD	14	0.10	0.085	0.083	NA	NA	NA	weight index (weight/bill length) (unitless)
Reproduction															
Albers et al. (2007)	stats not clearly presented	0.48	methylmercury chloride	kestrel (*Falco sparverius*)	adult	egg production	FD	at least 11	3.9	3.2	3.7	3.2	2.4	1.3	mean number of eggs laid
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	number of eggs hatched	FD	at least 11	2.3	1.9	1.3	1.5	0.1	0.0	mean number of eggs hatched
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	% eggs hatched	FD	at least 11	64	65	38	52	7.0	0.0	% eggs hatched
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	% fledged	FD	at least 11	100	71	77	40	0.0	0.0	% fledged
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	% egg fertility	FD	16	97	90	33	0.0	NA	NA	% egg fertility (number of fertile eggs per total eggs set)
El-Begearmi et al. (1977)	no stats	0.66	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	egg production	FD	16	72	44	37	0.0	NA	NA	% egg production (% hen-day)
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	% hatchability	FD	16	68	64	0.0	0.0	NA	NA	% hatchability (number of chicks / number of fertile eggs)
Eskeland and Nafstad (1978)	0.53	0.53	methylmercury chloride	quail (*Coturnix japonica*)	6 weeks (juvenile)	chick survival	FD	6	90	89	88	41	0.0	NA	% survival (originally reported as % mortality)
Eskeland and Nafstad (1978)	1.1	1.1	methylmercury chloride	quail (*Coturnix japonica*)	6 weeks (juvenile)	hatch success	FD	6	57	68	70	55	41	NA	% hatchability
Heinz et al. (2010)	no effect	0.80	methylmercury chloride	mallard (*Anas platyrhynchos*)	adult	ducklings per female	FD	3.7	17	18	15	15	13	NA	number of 6-day-old ducklings produced
Heinz et al. (2010)	0.40	no effect	methylmercury chloride	mallard (*Anas platyrhynchos*)	adult	duckling body weight	FD	3.7	81	83	79	72	75	NA	duckling body weight at 6 days old (g)
Heinz and Hoffman (1998)	1.0	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	ducklings per female	FD	up to 11	7.6	1.1	NA	NA	NA	NA	number of 7-day-old ducklings produced per female
Heinz and Hoffman (1998)	1.0	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	% hatchability	FD	up to 11	44	11	NA	NA	NA	NA	% hatchability (number of ducklings / number of fertile eggs)
Heinz and Hoffman (1998)	no effect	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	duckling survival	FD	up to 11	96	71	NA	NA	NA	NA	% duckling survival (reaching 7 days old)
Scott et al. (1975)	0.70	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg fertility	FD	8	92	58	57	NA	NA	NA	% fertile eggs
Scott et al. (1975)	1.4	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg production	FD	8	70	52	25	NA	NA	NA	% egg production (authors did not define egg production)
Scott et al. (1975)	0.70	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg hatchability	FD	8	91	15	7.7	NA	NA	NA	% hatch of fertile eggs
Varian-Ramos et al. (2014)	0.41	no effect	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	% hatchability	FD	52	45	52	45	48	38	NA	% hatchability
Varian-Ramos et al. (2014)	0.051	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	% chicks fledged	FD	52	78	62	60	58	60	NA	% chicks fledged
Varian-Ramos et al. (2014)	0.051	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	number of offspring	FD	52	13	11	8.5	7.5	6.0	NA	number of independent offspring in 1 year
Varian-Ramos et al. (2014)	no stats	0.10	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 % hatchability	FD	unclear	55	61	37	62	45	NA	F1 % hatchability
Varian-Ramos et al. (2014)	no stats	0.10	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 % chicks fledged	FD	unclear	79	65	58	60	70	NA	F1 % chicks fledged
Varian-Ramos et al. (2014)	no stats	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 number of offspring	FD	unclear	13	9.0	6.0	7.0	8.0	NA	F1 number of independent offspring in 1 year
Survival															
Bennet et al. (2009)	no stats	1.3	methylmercury chloride	kestrel (*Falco sparverius*)	adult	survival	FD	5-7	100	100	100	0.0	NA	NA	% survival
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling	survival (female)	FD	16	87	75	10	0.0	NA	NA	female % survival after 16 weeks (last time point)
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling	survival (male)	FD	16	100	27	0.0	0.0	NA	NA	male % survival after 16 weeks (last time point)
Hill and Soares (1987)	no stats	3.7	methylmercury chloride	quail (*Coturnix japonica*)	hatchling	survival	FD	0.71	97	84	60	32	NA	NA	% survival (originally reported as % mortality)
Hill and Soares (1987)	no stats	5.5	methylmercury chloride	quail (*Coturnix japonica*)	14 days	survival	FD	0.71	98	87	60	27	NA	NA	% survival (originally reported as % mortality)
Scheuhammer (1988)	no stats	1.8	methylmercury chloride	finch (*Taeniopygia guttata*)	adult	survival	FD	11	100	100	100	75	NA	NA	% survival
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	4	100	93	NA	NA	NA	NA	% survival
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	6 days	survival (Experiment 2)	FD	3.6	100	100	NA	NA	NA	NA	% survival
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	quail (*Coturnix japonica*)	8 days	survival (Experiment 2)	FD	3.3	100	89	NA	NA	NA	NA	% survival
Spann et al. (1986)	no stats	2.0	methylmercury chloride	quail (*Coturnix japonica*)	12 days	survival	FD	6	94	90	18	NA	NA	NA	Figure 1 in paper. Values for control and low dose (5.4 mg/kg) are
Varian-Ramos et al. (2014)	no effect	0.051	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	survival	FD	52	85	65	70	68	68	NA	% adult survival
Varian-Ramos et al. (2014)	no stats	0.051	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 survival	FD	unclear	78	60	42	50	55	NA	F1 % adult survival

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-10. Methylmercury TRV Data for Birds

									Effect Relative to Control (%)				
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth													
Scott et al. (1975)	no stats	ED20	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	body weight	FD	8	88	68	NA	NA	NA
Sell and Horani (1976)	2.2	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 1)	FD	4	84	NA	NA	NA	NA
Sell and Horani (1976)	2.2	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	6 days	body weight gain (Experiment 2)	FD	3.6	84	NA	NA	NA	NA
Spalding et al. (2000)	0.070	no effect	methylmercury chloride	egret (*Ardea alba)*	1 week	weight index	FD	14	85	83	NA	NA	NA
Reproduction													
Albers et al. (2007)	stats not clearly presented	0.48	methylmercury chloride	kestrel (*Falco sparverius*)	adult	egg production	FD	at least 11	83	95	82	63	32
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	number of eggs hatched	FD	at least 11	84	58	67	6.2	0.0
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	% eggs hatched	FD	at least 11	102	59	81	11	0.0
Albers et al. (2007)	stats not clearly presented	ED20	methylmercury chloride	kestrel (*Falco sparverius*)	adult	% fledged	FD	at least 11	71	77	40	0.0	0.0
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	% egg fertility	FD	16	93	34	0.0	NA	NA
El-Begearmi et al. (1977)	no stats	0.66	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	egg production	FD	16	61	52	0.0	NA	NA
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling to adult (1 day to 12 weeks old)	% hatchability	FD	16	94	0.0	0.0	NA	NA
Eskeland and Nafstad (1978)	0.53	0.53	methylmercury chloride	quail (*Coturnix japonica*)	6 weeks (juvenile)	chick survival	FD	6	99	97	45	0.0	NA
Eskeland and Nafstad (1978)	1.1	1.1	methylmercury chloride	quail (*Coturnix japonica*)	6 weeks (juvenile)	hatch success	FD	6	120	123	96	73	NA
Heinz et al. (2010)	no effect	0.80	methylmercury chloride	mallard (*Anas platyrhynchos*)	adult	ducklings per female	FD	3.7	107	91	87	74	NA
Heinz et al. (2010)	0.40	no effect	methylmercury chloride	mallard (*Anas platyrhynchos*)	adult	duckling body weight	FD	3.7	103	97	89	92	NA
Heinz and Hoffman (1998)	1.0	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	ducklings per female	FD	up to 11	14	NA	NA	NA	NA
Heinz and Hoffman (1998)	1.0	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	% hatchability	FD	up to 11	26	NA	NA	NA	NA
Heinz and Hoffman (1998)	no effect	1.0	methylmercury chloride	mallard (*Anas platyrhynchos*)	19 months	duckling survival	FD	up to 11	74	NA	NA	NA	NA
Scott et al. (1975)	0.70	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg fertility	FD	8	63	62	NA	NA	NA
Scott et al. (1975)	1.4	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg production	FD	8	73	36	NA	NA	NA
Scott et al. (1975)	0.70	0.70	methylmercury chloride	chicken (*Gallus gallus domesticus*)	12.5 months	egg hatchability	FD	8	17	8.4	NA	NA	NA
Varian-Ramos et al. (2014)	0.41	no effect	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	% hatchability	FD	52	116	100	107	84	NA
Varian-Ramos et al. (2014)	0.051	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	% chicks fledged	FD	52	79	77	74	77	NA
Varian-Ramos et al. (2014)	0.051	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	number of offspring	FD	52	81	65	58	46	NA
Varian-Ramos et al. (2014)	no stats	0.10	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 % hatchability	FD	unclear	111	67	113	82	NA
Varian-Ramos et al. (2014)	no stats	0.10	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 % chicks fledged	FD	unclear	82	73	76	89	NA
Varian-Ramos et al. (2014)	no stats	ED20	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 number of offspring	FD	unclear	69	46	54	62	NA
Survival													
Bennet et al. (2009)	no stats	1.3	methylmercury chloride	kestrel (*Falco sparverius*)	adult	survival	FD	5-7	100	100	0.0	NA	NA
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling	survival (female)	FD	16	86	11	0.0	NA	NA
El-Begearmi et al. (1977)	no stats	2.0	methylmercury hydroxide	quail (*Coturnix japonica*)	hatchling	survival (male)	FD	16	27	0.0	0.0	NA	NA
Hill and Soares (1987)	no stats	3.7	methylmercury chloride	quail (*Coturnix japonica*)	hatchling	survival	FD	0.71	87	62	33	NA	NA
Hill and Soares (1987)	no stats	5.5	methylmercury chloride	quail (*Coturnix japonica*)	14 days	survival	FD	0.71	89	61	28	NA	NA
Scheuhammer (1988)	no stats	1.8	methylmercury chloride	finch (*Taeniopygia guttata*)	adult	survival	FD	11	100	100	75	NA	NA
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	4	93	NA	NA	NA	NA
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	chicken (*Gallus gallus domesticus*)	6 days	survival (Experiment 2)	FD	3.6	100	NA	NA	NA	NA
Sell and Horani (1976)	no stats	no effect	methylmercury chloride	quail (*Coturnix japonica*)	8 days	survival (Experiment 2)	FD	3.3	89	NA	NA	NA	NA
Spann et al. (1986)	no stats	2.0	methylmercury chloride	quail (*Coturnix japonica*)	12 days	survival	FD	6	96	19	NA	NA	NA
Varian-Ramos et al. (2014)	no effect	0.051	methylmercury cysteine	finch (*Taeniopygia guttata*)	adult	survival	FD	52	76	82	80	80	NA
Varian-Ramos et al. (2014)	no stats	0.051	methylmercury cysteine	finch (*Taeniopygia guttata*)	F1 adult offspring of exposed parents	F1 survival	FD	unclear	77	54	64	71	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-11. Methylmercury TRV Data for Mammals

									Dose (mg/kg bw/day)							
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	4	5	6	Notes
Growth																
Friedman et al. (1978)	no stats	2.2	methylmercury chloride	rat (*Rattus norvegicus*)	NR	body weight	FD	10	0.0	2.2	4.4	NA	NA	NA	NA	calculated from body weight and FIR
Gandhi et al. (2013)	1.9	1.9	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature (weighing 180-200 g; gestational exposure)	body weight gain	GV	3	0.0	0.47	0.93	1.9	NA	NA	NA	presented in paper
Mitsumori et al. (1990)	no stats	0.69	methylmercury chloride	mouse (*Mus musculus*)	4 weeks	body weight	FD	104	0.0	0.031	0.14	0.69	NA	NA	NA	presented in paper
Mitsumori et al. (1983)	0.65	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	body weight	FD	130	0.0	0.026	0.13	0.65	NA	NA	NA	calculated from body weight and FIR
Stillings et al. (1974)	no stats	3.1	methylmercury chloride	rat (*Rattus norvegicus*)	weanling (24 days)	body weight gain	FD	4	0.0	3.1	NA	NA	NA	NA	NA	calculated from body weight and FIR
Verschuuren et al. (1976a)	0.0091	no effect	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	F2 body weight gain	FD	12	0.0	0.0091	0.045	0.23	NA	NA	NA	calculated from body weight and FIR
Verschuuren et al. (1976b)	0.20	no effect	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	body weight	FD	104	0.0	0.0081	0.040	0.20	NA	NA	NA	calculated from body weight and FIR
Wobeser et al. (1976)	no stats	0.080	methylmercury chloride	mink (*Neovison vison)*	adult (female)	body weight	FD	13	0.0	0.049	0.080	0.21	0.37	0.67	NA	calculated from body weight and FIR
Reproduction																
Gandhi et al. (2013)	1.9	1.9	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature (weighing 180-200 g; gestational exposure)	fetal survival	GV	3	0.0	0.47	0.93	1.9	NA	NA	NA	presented in paper
Tonk et al. (2010)	no stats	1.4	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature females	litter survival	GV	variable (gestational day 6 to postnatal day 13)	0.0	0.093	0.37	0.65	0.93	1.4	1.9	presented in paper
Verschuuren et al. (1976a)	no stats	0.23	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	F1 viability index	FD	12	0.0	0.0091	0.045	0.23	NA	NA	NA	calculated from body weight and FIR
Survival																
Mitsumori et al. (1990)	no stats	0.69	methylmercury chloride	mouse (*Mus musculus*)	4 weeks	survival	FD	104	0.0	0.031	0.14	0.69	NA	NA	NA	presented in paper
Mitsumori et al. (1983)	no stats	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (male)	FD	130	0.0	0.026	0.13	0.65	NA	NA	NA	calculated from body weight and FIR
Mitsumori et al. (1983)	no stats	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (female)	FD	130	0.0	0.026	0.13	0.65	NA	NA	NA	calculated from body weight and FIR
Verschuuren et al. (1976b)	no stats	0.0081	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (female)	FD	104	0.0	0.0081	0.040	0.20	NA	NA	NA	calculated from body weight and FIR
Verschuuren et al. (1976b)	no stats	0.035	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (male)	FD	104	0.0	0.0071	0.035	0.18	NA	NA	NA	calculated from body weight and FIR

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-11. Methylmercury TRV Data for Mammals

Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Body Weight (kg)							
									Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Source[a]
Growth																
Friedman et al. (1978)	no stats	2.2	methylmercury chloride	rat (*Rattus norvegicus*)	NR	body weight	FD	10	0.11	0.11	0.11	NA	NA	NA	NA	presented in paper
Gandhi et al. (2013)	1.9	1.9	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature (weighing 180-200 g; gestational exposure)	body weight gain	GV	3	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)
Mitsumori et al. (1990)	no stats	0.69	methylmercury chloride	mouse (*Mus musculus*)	4 weeks	body weight	FD	104	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)
Mitsumori et al. (1983)	0.65	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	body weight	FD	130	0.34	0.34	0.34	0.34	NA	NA	NA	average initial and final control female body weight estimated from Figure 2
Stillings et al. (1974)	no stats	3.1	methylmercury chloride	rat (*Rattus norvegicus*)	weanling (24 days)	body weight gain	FD	4	0.10	0.10	NA	NA	NA	NA	NA	USEPA (1988)
Verschuuren et al. (1976a)	0.0091	no effect	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	F2 body weight gain	FD	12	0.12	0.12	0.12	0.12	NA	NA	NA	presented in paper
Verschuuren et al. (1976b)	0.20	no effect	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	body weight	FD	104	0.17	0.17	0.17	0.17	NA	NA	NA	presented in paper
Wobeser et al. (1976)	no stats	0.080	methylmercury chloride	mink (*Neovison vison)*	adult (female)	body weight	FD	13	1.3	1.3	1.3	1.3	1.3	1.3	NA	Bleavins and Aulerich (1981)
Reproduction																
Gandhi et al. (2013)	1.9	1.9	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature (weighing 180-200 g; gestational exposure)	fetal survival	GV	3	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)
Tonk et al. (2010)	no stats	1.4	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature females	litter survival	GV	variable (gestational day 6 to postnatal day 13)	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)
Verschuuren et al. (1976a)	no stats	0.23	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	F1 viability index	FD	12	0.12	0.12	0.12	0.12	NA	NA	NA	presented in paper
Survival																
Mitsumori et al. (1990)	no stats	0.69	methylmercury chloride	mouse (*Mus musculus*)	4 weeks	survival	FD	104	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)
Mitsumori et al. (1983)	no stats	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (male)	FD	130	0.33	0.33	0.33	0.33	NA	NA	NA	average initial and final control male body weight estimated from Figure 2
Mitsumori et al. (1983)	no stats	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (female)	FD	130	0.34	0.34	0.34	0.34	NA	NA	NA	average initial and final control female body weight estimated from Figure 2
Verschuuren et al. (1976b)	no stats	0.0081	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (female)	FD	104	0.17	0.17	0.17	0.17	NA	NA	NA	presented in paper
Verschuuren et al. (1976b)	no stats	0.035	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (male)	FD	104	0.26	0.26	0.26	0.26	NA	NA	NA	presented in paper

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-11. Methylmercury TRV Data for Mammals

									Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)									
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Source [a]	Wet or Dry Weight Basis
Growth																	
Friedman et al. (1978)	no stats	2.2	methylmercury chloride	rat (*Rattus norvegicus*)	NR	body weight	FD	10	0.013	0.013	0.013	NA	NA	NA	NA	USEPA (1988)	dw
Gandhi et al. (2013)	1.9	1.9	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature (weighing 180-200 g; gestational exposure)	body weight gain	GV	3	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Mitsumori et al. (1990)	no stats	0.69	methylmercury chloride	mouse (*Mus musculus*)	4 weeks	body weight	FD	104	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Mitsumori et al. (1983)	0.65	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	body weight	FD	130	0.027	0.027	0.027	0.027	NA	NA	NA	USEPA (1988)	dw
Stillings et al. (1974)	no stats	3.1	methylmercury chloride	rat (*Rattus norvegicus*)	weanling (24 days)	body weight gain	FD	4	0.012	0.012	NA	NA	NA	NA	NA	USEPA (1988)	dw
Verschuuren et al. (1976a)	0.0091	no effect	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	F2 body weight gain	FD	12	0.014	0.014	0.014	0.014	NA	NA	NA	USEPA (1988)	dw
Verschuuren et al. (1976b)	0.20	no effect	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	body weight	FD	104	0.018	0.018	0.018	0.018	NA	NA	NA	USEPA (1988)	dw
Wobeser et al. (1976)	no stats	0.080	methylmercury chloride	mink (*Neovison vison)*	adult (female)	body weight	FD	13	0.059	0.059	0.059	0.059	0.059	0.059		Bleavins and Aulerich (1981)	dw
Reproduction																	
Gandhi et al. (2013)	1.9	1.9	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature (weighing 180-200 g; gestational exposure)	fetal survival	GV	3	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Tonk et al. (2010)	no stats	1.4	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature females	litter survival	GV	variable (gestational day 6 to postnatal day 13)	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Verschuuren et al. (1976a)	no stats	0.23	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	F1 viability index	FD	12	0.014	0.014	0.014	0.014	NA	NA	NA	USEPA (1988)	dw
Survival																	
Mitsumori et al. (1990)	no stats	0.69	methylmercury chloride	mouse (*Mus musculus*)	4 weeks	survival	FD	104	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Mitsumori et al. (1983)	no stats	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (male)	FD	130	0.027	0.027	0.027	0.027	NA	NA	NA	USEPA (1988)	dw
Mitsumori et al. (1983)	no stats	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (female)	FD	130	0.027	0.027	0.027	0.027	NA	NA	NA	USEPA (1988)	dw
Verschuuren et al. (1976b)	no stats	0.0081	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (female)	FD	104	0.018	0.018	0.018	0.018	NA	NA	NA	USEPA (1988)	dw
Verschuuren et al. (1976b)	no stats	0.035	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (male)	FD	104	0.023	0.023	0.023	0.023	NA	NA	NA	USEPA (1988)	dw

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-11. Methylmercury TRV Data for Mammals

									Concentration in Food (mg/kg)							
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control [c]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Wet or Dry Weight Basis
Growth																
Friedman et al. (1978)	no stats	2.2	methylmercury chloride	rat (*Rattus norvegicus*)	NR	body weight	FD	10	0.0	19	37	NA	NA	NA	NA	dw
Gandhi et al. (2013)	1.9	1.9	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature (weighing 180-200 g; gestational exposure)	body weight gain	GV	3	NA	NA	NA	NA	NA	NA	NA	NA
Mitsumori et al. (1990)	no stats	0.69	methylmercury chloride	mouse (*Mus musculus*)	4 weeks	body weight	FD	104	NA	NA	NA	NA	NA	NA	NA	NA
Mitsumori et al. (1983)	0.65	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	body weight	FD	130	0.0	0.32	1.6	8.0	NA	NA	NA	dw
Stillings et al. (1974)	no stats	3.1	methylmercury chloride	rat (*Rattus norvegicus*)	weanling (24 days)	body weight gain	FD	4	0.0	25	NA	NA	NA	NA	NA	dw
Verschuuren et al. (1976a)	0.0091	no effect	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	F2 body weight gain	FD	12	0.0	0.080	0.40	2.0	NA	NA	NA	dw
Verschuuren et al. (1976b)	0.20	no effect	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	body weight	FD	104	0.0	0.080	0.40	2.0	NA	NA	NA	dw
Wobeser et al. (1976)	no stats	0.080	methylmercury chloride	mink (*Neovison vison)*	adult (female)	body weight	FD	13	0.0	1.1	1.8	4.8	8.3	15	NA	dw
Reproduction																
Gandhi et al. (2013)	1.9	1.9	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature (weighing 180-200 g; gestational exposure)	fetal survival	GV	3	NA	NA	NA	NA	NA	NA	NA	NA
Tonk et al. (2010)	no stats	1.4	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature females	litter survival	GV	variable (gestational day 6 to postnatal day 13)	NA	NA	NA	NA	NA	NA	NA	NA
Verschuuren et al. (1976a)	no stats	0.23	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	F1 viability index	FD	12	0.0	0.1	0.4	1.99725	NA	NA	NA	dw
Survival																
Mitsumori et al. (1990)	no stats	0.69	methylmercury chloride	mouse (*Mus musculus*)	4 weeks	survival	FD	104	NA	NA	NA	NA	NA	NA	NA	NA
Mitsumori et al. (1983)	no stats	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (male)	FD	130	0.0	0.32	1.6	8.0	NA	NA	NA	dw
Mitsumori et al. (1983)	no stats	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (female)	FD	130	0.0	0.32	1.6	8.0	NA	NA	NA	dw
Verschuuren et al. (1976b)	no stats	0.0081	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (female)	FD	104	0.0	0.08	0.40	2.0	NA	NA	NA	dw
Verschuuren et al. (1976b)	no stats	0.035	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (male)	FD	104	0.0	0.08	0.40	2.0	NA	NA	NA	dw

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-11. Methylmercury TRV Data for Mammals

									Effect							
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Measurement
Growth																
Friedman et al. (1978)	no stats	2.2	methylmercury chloride	rat (*Rattus norvegicus*)	NR	body weight	FD	10	0.38	0.26	0.14	NA	NA	NA	NA	body weight (kg) estimated based on treatments without acetaldehyde (Figure 1 in paper)
Gandhi et al. (2013)	1.9	1.9	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature (weighing 180-200 g; gestational exposure)	body weight gain	GV	3	44	47	48	21	NA	NA	NA	maternal weight gain (%)
Mitsumori et al. (1990)	no stats	0.69	methylmercury chloride	mouse (*Mus musculus*)	4 weeks	body weight	FD	104	47	46	48	30	NA	NA	NA	Approximate male body weight (g) at end of exposure period (104 weeks). Values estimated from Figure 2 in paper .
Mitsumori et al. (1983)	0.65	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	body weight	FD	130	550	500	500	350	NA	NA	NA	Approximate mean female body weight (g) at 124 weeks exposure. Values estimated from Figure 2 in paper.
Stillings et al. (1974)	no stats	3.1	methylmercury chloride	rat (*Rattus norvegicus*)	weanling (24 days)	body weight gain	FD	4	140	20	NA	NA	NA	NA	NA	Approximate weight gain (g) at 4 weeks (all methylmercury treated rats died after 4 weeks). Values estimated from Figure 1 in paper.
Verschuuren et al. (1976a)	0.0091	no effect	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	F2 body weight gain	FD	12	153	142	140	134	NA	NA	NA	F2 female weight gain (g) at 12 weeks of exposure
Verschuuren et al. (1976b)	0.20	no effect	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	body weight	FD	104	219	212	216	205	NA	NA	NA	Female weight gain (g) at week 60 (only females had significant effect). Authors reported weight gain at several time points between weeks 6 and 104, but only week 60 had a significant difference relative to control.
Wobeser et al. (1976)	no stats	0.080	methylmercury chloride	mink (*Neovison vison)*	adult (female)	body weight	FD	13	1.3	1.1	1.0	1.2	1.1	1.1	NA	body weight (kg) (calculated using % change in body weight reported in paper and mean body weight from Bleavins and Aulerich [1981])
Reproduction																
Gandhi et al. (2013)	1.9	1.9	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature (weighing 180-200 g; gestational exposure)	fetal survival	GV	3	9.4	9.9	10	0.00	NA	NA	NA	live fetuses per litter
Tonk et al. (2010)	no stats	1.4	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature females	litter survival	GV	variable (gestational day 6 to postnatal day 13)	0.90	0.92	0.80	0.91	0.79	0.70	0.50	Fraction of dams with litter survival (reported in paper as fraction of dams with complete litter loss). Values estimated from Figure 2 in paper.
Verschuuren et al. (1976a)	no stats	0.23	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	F1 viability index	FD	12	66	66	59	28	NA	NA	NA	F1 viability index ("number of pups alive at day 5 x 100 divided by the number of pups born")
Survival																
Mitsumori et al. (1990)	no stats	0.69	methylmercury chloride	mouse (*Mus musculus*)	4 weeks	survival	FD	104	48	58	60	17	NA	NA	NA	% male survival at end of exposure period (104 weeks). Values for middle two doses estimated from survival curve graph (Figure 1 in paper).
Mitsumori et al. (1983)	no stats	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (male)	FD	130	88	88	95	25	NA	NA	NA	Approximate % male survival at 80 weeks (within the 130-week exposure period, the largest difference between the control and treated group occurred at approximately 80 weeks). Values estimated from Figure 1 in paper.
Mitsumori et al. (1983)	no stats	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (female)	FD	130	60	65	65	20	NA	NA	NA	Approximate % female survival at 112 weeks (within the 130-week exposure period, the largest difference between the control and treated group occurred at approximately 112 weeks). Values estimated from Figure 1 in paper.
Verschuuren et al. (1976b)	no stats	0.0081	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (female)	FD	104	19	15	16	14	NA	NA	NA	Female survival. Final number of surviving rats at week 104. Initial group sizes were 25 rats (all groups).
Verschuuren et al. (1976b)	no stats	0.035	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (male)	FD	104	18	17	12	12	NA	NA	NA	Male survival. Final number of surviving rats at week 104. Initial group sizes were 25 rats (all groups).

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-11. Methylmercury TRV Data for Mammals

Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Effect Relative to Control (%) Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6
Growth														
Friedman et al. (1978)	no stats	2.2	methylmercury chloride	rat (*Rattus norvegicus*)	NR	body weight	FD	10	68	37		NA	NA	NA
Gandhi et al. (2013)	1.9	1.9	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature (weighing 180-200 g; gestational exposure)	body weight gain	GV	3	107	108	47	NA	NA	NA
Mitsumori et al. (1990)	no stats	0.69	methylmercury chloride	mouse (*Mus musculus*)	4 weeks	body weight	FD	104	98	102	64	NA	NA	NA
Mitsumori et al. (1983)	0.65	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	body weight	FD	130	91	91	64	NA	NA	NA
Stillings et al. (1974)	no stats	3.1	methylmercury chloride	rat (*Rattus norvegicus*)	weanling (24 days)	body weight gain	FD	4	14	NA	NA	NA	NA	NA
Verschuuren et al. (1976a)	0.0091	no effect	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	F2 body weight gain	FD	12	93	92	88	NA	NA	NA
Verschuuren et al. (1976b)	0.20	no effect	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	body weight	FD	104	97	99	94	NA	NA	NA
Wobeser et al. (1976)	no stats	0.080	methylmercury chloride	mink (*Neovison vison)*	adult (female)	body weight	FD	13	81	76	90	86	83	NA
Reproduction														
Gandhi et al. (2013)	1.9	1.9	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature (weighing 180-200 g; gestational exposure)	fetal survival	GV	3	105	111	0.0	NA	NA	NA
Tonk et al. (2010)	no stats	1.4	methylmercury chloride	rat (*Rattus norvegicus*)	sexually mature females	litter survival	GV	variable (gestational day 6 to postnatal day 13)	102	89	101	88	78	56
Verschuuren et al. (1976a)	no stats	0.23	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	F1 viability index	FD	12	100	89	42	NA	NA	NA
Survival														
Mitsumori et al. (1990)	no stats	0.69	methylmercury chloride	mouse (*Mus musculus*)	4 weeks	survival	FD	104	121	125	35	NA	NA	NA
Mitsumori et al. (1983)	no stats	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (male)	FD	130	100	108	28	NA	NA	NA
Mitsumori et al. (1983)	no stats	0.65	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (female)	FD	130	108	108	33	NA	NA	NA
Verschuuren et al. (1976b)	no stats	0.0081	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (female)	FD	104	79	84	74	NA	NA	NA
Verschuuren et al. (1976b)	no stats	0.035	methylmercury chloride	rat (*Rattus norvegicus*)	4 weeks	survival (male)	FD	104	94	67	67	NA	NA	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-12. Molybdenum TRV Data for Birds

Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Dose (mg/kg bw/day)						
									Control	1	2	3	4	5	Notes
Growth															
Davies et al. (1960)	no stats	84	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	body weight (Experiment 1b)	FD	4	0.0	56	84	112	140	168	calculated from body weight and FIR
Davies et al. (1960)	no stats	223	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	body weight (Experiment 1c)	FD	4	0.0	223	447	670	894	NA	calculated from body weight and FIR
Kratzer (1952)	no stats	no effect	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 week	weight gain	FD	3.3	0.2	9.4	19	28	NA	NA	calculated from body weight and FIR
Stafford et al. (2015)	no effect	no effect	molydenum disulfide	bobwhite quail (*Colinus virginianus*)	9 days	body weight gain	FD	4.3	0.0	75	218	545	NA	NA	presented in the paper
Stafford et al. (2015)	253.00	362	sodium molybdate	bobwhite quail (*Colinus virginianus*)	9 days	body weight gain	FD	4.3	0.0	45	74	134	253	362	presented in the paper
Reproduction															
Lepore and Miller (1965)	no stats	35.7	sodium molybdate	chicken (*Gallus gallus domesticus*)	7 months	egg production	FD	3	0.0	32	63	126	NA	NA	calculated from body weight and FIR
Survival															
Davies et al. (1960)	no stats	no effect	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	0.0	56	84	112	140	168	calculated from body weight and FIR
Davies et al. (1960)	no stats	606	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	0.0	223	447	670	894	NA	calculated from body weight and FIR

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-12. Molybdenum TRV Data for Birds

									Body Weight (kg)						
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source [a]
Growth															
Davies et al. (1960)	no stats	84	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	body weight (Experiment 1b)	FD	4	0.36	0.36	0.36	0.36	0.36	0.36	NRC (1994)
Davies et al. (1960)	no stats	223	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	body weight (Experiment 1c)	FD	4	0.36	0.36	0.36	0.36	0.36	NA	NRC (1994)
Kratzer (1952)	no stats	no effect	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 week	weight gain	FD	3.3	0.08	0.08	0.08	0.08	NA	NA	USEPA (1988)
Stafford et al. (2015)	no effect	no effect	molydenum disulfide	bobwhite quail (*Colinus virginianus*)	9 days	body weight gain	FD	4.3	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)
Stafford et al. (2015)	253.00	362	sodium molybdate	bobwhite quail (*Colinus virginianus*)	9 days	body weight gain	FD	4.3	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)
Reproduction															
Lepore and Miller (1965)	no stats	35.7	sodium molybdate	chicken (*Gallus gallus domesticus*)	7 months	egg production	FD	3	3.20	3.20	3.20	3.20	NA	NA	NRC (1994)
Survival															
Davies et al. (1960)	no stats	no effect	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	0.36	0.36	0.36	0.36	0.36	0.36	NRC (1994)
Davies et al. (1960)	no stats	606	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	0.36	0.36	0.36	0.36	0.36	NA	NRC (1994)

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the f

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-12. Molybdenum TRV Data for Birds

									Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)							
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source [a]	Wet or Dry Weight Basis
Growth																
Davies et al. (1960)	no stats	84	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	body weight (Experiment 1b)	FD	4	0.04	0.04	0.04	0.04	0.04	0.04	NRC (1994)	dw
Davies et al. (1960)	no stats	223	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	body weight (Experiment 1c)	FD	4	0.04	0.04	0.04	0.04	0.04	NA	NRC (1994)	dw
Kratzer (1952)	no stats	no effect	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 week	weight gain	FD	3.3	0.01	0.01	0.01	0.01	NA	NA	USEPA (1988)	dw
Stafford et al. (2015)	no effect	no effect	molydenum disulfide	bobwhite quail (*Colinus virginianus*)	9 days	body weight gain	FD	4.3	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA (doses presented in paper)
Stafford et al. (2015)	253.00	362	sodium molybdate	bobwhite quail (*Colinus virginianus*)	9 days	body weight gain	FD	4.3	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA (doses presented in paper)
Reproduction																
Lepore and Miller (1965)	no stats	35.7	sodium molybdate	chicken (*Gallus gallus domesticus*)	7 months	egg production	FD	3	0.20	0.20	0.20	0.20	NA	NA	NRC (1994)	dw
Survival																
Davies et al. (1960)	no stats	no effect	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	0.04	0.04	0.04	0.04	0.04	0.04	NRC (1994)	dw
Davies et al. (1960)	no stats	606	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	0.04	0.04	0.04	0.04	0.04	NA	NRC (1994)	dw

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-12. Molybdenum TRV Data for Birds

									Concentration in Food (mg/kg)						
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control[c]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Wet or Dry Weight Basis
Growth															
Davies et al. (1960)	no stats	84	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	body weight (Experiment 1b)	FD	4	0	500	750	1000	1250	1500	dw
Davies et al. (1960)	no stats	223	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	body weight (Experiment 1c)	FD	4	0	2000	4000	6000	8000	NA	dw
Kratzer (1952)	no stats	no effect	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 week	weight gain	FD	3.3	2	85	170	255	NA	NA	dw
Stafford et al. (2015)	no effect	no effect	molydenum disulfide	bobwhite quail (*Colinus virginianus*)	9 days	body weight gain	FD	4.3	0	700	2000	5000	NA	NA	dw
Stafford et al. (2015)	253.00	362	sodium molybdate	bobwhite quail (*Colinus virginianus*)	9 days	body weight gain	FD	4.3	0	420	700	1200	2000	3000	dw
Reproduction															
Lepore and Miller (1965)	no stats	35.7	sodium molybdate	chicken (*Gallus gallus domesticus*)	7 months	egg production	FD	3	0	500	1000	2000	NA	NA	dw
Survival															
Davies et al. (1960)	no stats	no effect	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	0	500	750	1000	1250	1500	dw
Davies et al. (1960)	no stats	606	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	0	2000	4000	6000	8000	NA	dw

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-12. Molybdenum TRV Data for Birds

Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Effect						
									Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Measurement
Growth															
Davies et al. (1960)	no stats	84	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	body weight (Experiment 1b)	FD	4	352	313	274	260	263	230	final body weight for Experiment 1b (g)
Davies et al. (1960)	no stats	223	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	body weight (Experiment 1c)	FD	4	301	194	103	64	47	NA	final body weight for Experiment 1c (g)
Kratzer (1952)	no stats	no effect	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 week	weight gain	FD	3.3	229	244	217	194	NA	NA	average weight gain (g)
Stafford et al. (2015)	no effect	no effect	molydenum disulfide	bobwhite quail (*Colinus virginianus*)	9 days	body weight gain	FD	4.3	3.2	3.05	3.2	3.2	NA	NA	proportional body weight change at day 30
Stafford et al. (2015)	253.00	362	sodium molybdate	bobwhite quail (*Colinus virginianus*)	9 days	body weight gain	FD	4.3	3.2	3.1	3.1	3.0	2.8	2.5	proportional body weight change at day 30
Reproduction															
Lepore and Miller (1965)	no stats	35.7	sodium molybdate	chicken (*Gallus gallus domesticus*)	7 months	egg production	FD	3	15.6	13.3	8.0	2.8	NA	NA	number of eggs per hen
Survival															
Davies et al. (1960)	no stats	no effect	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	100	95	100	100	100	100	% survival for Experiment 1b
Davies et al. (1960)	no stats	606	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	100	94	94	67	39	NA	% survival for Experiment 1c

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-12. Molybdenum TRV Data for Birds

									Effect Relative to Control (%)				
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth													
Davies et al. (1960)	no stats	84	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	body weight (Experiment 1b)	FD	4	89	78	74	75	65
Davies et al. (1960)	no stats	223	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	body weight (Experiment 1c)	FD	4	64	34	21	16	NA
Kratzer (1952)	no stats	no effect	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 week	weight gain	FD	3.3	107	95	85	NA	NA
Stafford et al. (2015)	no effect	no effect	molydenum disulfide	bobwhite quail (*Colinus virginianus*)	9 days	body weight gain	FD	4.3	95	98	100	NA	NA
Stafford et al. (2015)	253.00	362	sodium molybdate	bobwhite quail (*Colinus virginianus*)	9 days	body weight gain	FD	4.3	97	95	92	88	78
Reproduction													
Lepore and Miller (1965)	no stats	35.7	sodium molybdate	chicken (*Gallus gallus domesticus*)	7 months	egg production	FD	3	85	51	18	NA	NA
Survival													
Davies et al. (1960)	no stats	no effect	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	95	100	100	100	100
Davies et al. (1960)	no stats	606	sodium molybdate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	4	94	94	67	39	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-13. Molybdenum TRV Data for Mammals

									Dose (mg/kg bw/day)					
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	4	Notes
Growth														
Bandyopadhyay et al. (1981)	242	242	ammonium molybdate	rat (*Rattus norvegicus*)	juvenile	body weight gain	oral	4	0.0	242	NA	NA	NA	presented in paper
Bandyopadhyay et al. (1981)	242	242	ammonium molybdate	rat (*Rattus norvegicus*)	juvenile	body weight gain	oral	4	0.0	242	NA	NA	NA	presented in paper
Brinkman and Miller (1961)	no stats	28	sodium molybdate	rat (*Rattus norvegicus*)	weanling	body weight gain	FD	6	0.0	28	NA	NA	NA	calculated from body weight and FIR
Fungwe et al. (1990)	2.6	28	sodium molybdate	rat (*Rattus norvegicus*)	21 days	body weight gain	DW	9	0.0	1.4	2.6	13	28	weighed average from Table 1 in paper
Lyubimov et al. (2004)	24	no effect	ammonium tetrathiomolybdate	rat (*Rattus norvegicus*)	~20-23 weeks	body weight	GV	8	0.0	2.0	8.0	24	NA	presented in paper
Murray et al. (2013)	NR	no effect	sodium molybdate dihydrate	rat (*Rattus norvegicus*)	9 weeks	body weight	FD	12	0.08	4.5	15	55	NA	presented in paper
Reproduction														
Fungwe et al. (1990)	2.6	ED20	sodium molybdate	rat (*Rattus norvegicus*)	21 days	litter weight	DW	9	0.0	1.4	2.6	13	28	weighed average from Table 1 in paper

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-13. Molybdenum TRV Data for Mammals

									Body Weight (kg)					
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Source [a]
Growth														
Bandyopadhyay et al. (1981)	242	242	ammonium molybdate	rat (*Rattus norvegicus*)	juvenile	body weight gain	oral	4	NA	NA	NA	NA	NA	NA (doses presented)
Bandyopadhyay et al. (1981)	242	242	ammonium molybdate	rat (*Rattus norvegicus*)	juvenile	body weight gain	oral	4	NA	NA	NA	NA	NA	NA (doses presented)
Brinkman and Miller (1961)	no stats	28	sodium molybdate	rat (*Rattus norvegicus*)	weanling	body weight gain	FD	6	0.070	0.070	NA	NA	NA	USEPA (1988)
Fungwe et al. (1990)	2.6	28	sodium molybdate	rat (*Rattus norvegicus*)	21 days	body weight gain	DW	9	0.070	0.070	0.070	0.070	0.070	USEPA (1988)
Lyubimov et al. (2004)	24	no effect	ammonium tetrathiomolybdate	rat (*Rattus norvegicus*)	~20-23 weeks	body weight	GV	8	NA	NA	NA	NA	NA	NA (doses presented)
Murray et al. (2013)	NR	no effect	sodium molybdate dihydrate	rat (*Rattus norvegicus*)	9 weeks	body weight	FD	12	NA	NA	NA	NA	NA	NA (doses presented)
Reproduction														
Fungwe et al. (1990)	2.6	ED20	sodium molybdate	rat (*Rattus norvegicus*)	21 days	litter weight	DW	9	0.070	0.070	0.070	0.070	0.070	USEPA (1988)

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-13. Molybdenum TRV Data for Mammals

									Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)						
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Source [a]	Wet or Dry Weight Basis
Growth															
Bandyopadhyay et al. (1981)	242	242	ammonium molybdate	rat (*Rattus norvegicus*)	juvenile	body weight gain	oral	4	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Bandyopadhyay et al. (1981)	242	242	ammonium molybdate	rat (*Rattus norvegicus*)	juvenile	body weight gain	oral	4	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Brinkman and Miller (1961)	no stats	28	sodium molybdate	rat (*Rattus norvegicus*)	weanling	body weight gain	FD	6	0.010	0.010	NA	NA	NA	USEPA (1988)	NA
Fungwe et al. (1990)	2.6	28	sodium molybdate	rat (*Rattus norvegicus*)	21 days	body weight gain	DW	9	NA	NA	NA	NA	NA	NA (doses calculated using FIR data in Table 1)	NA
Lyubimov et al. (2004)	24	no effect	ammonium tetrathiomolybdate	rat (*Rattus norvegicus*)	~20-23 weeks	body weight	GV	8	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Murray et al. (2013)	NR	no effect	sodium molybdate dihydrate	rat (*Rattus norvegicus*)	9 weeks	body weight	FD	12	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Reproduction															
Fungwe et al. (1990)	2.6	ED20	sodium molybdate	rat (*Rattus norvegicus*)	21 days	litter weight	DW	9	NA	NA	NA	NA	NA	NA (doses calculated using FIR data in Table 1)	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-13. Molybdenum TRV Data for Mammals

									Concentration in Food (mg/kg)					
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control[c]	Dose 1	Dose 2	Dose 3	Dose 4	Wet or Dry Weight Basis
Growth														
Bandyopadhyay et al. (1981)	242	242	ammonium molybdate	rat (*Rattus norvegicus*)	juvenile	body weight gain	oral	4	NA	NA	NA	NA	NA	NA
Bandyopadhyay et al. (1981)	242	242	ammonium molybdate	rat (*Rattus norvegicus*)	juvenile	body weight gain	oral	4	NA	NA	NA	NA	NA	NA
Brinkman and Miller (1961)	no stats	28	sodium molybdate	rat (*Rattus norvegicus*)	weanling	body weight gain	FD	6	0.0	200	NA	NA	NA	dw
Fungwe et al. (1990)	2.6	28	sodium molybdate	rat (*Rattus norvegicus*)	21 days	body weight gain	DW	9	0.025	5.0	10	50	100	NA
Lyubimov et al. (2004)	24	no effect	ammonium tetrathiomolybdate	rat (*Rattus norvegicus*)	~20-23 weeks	body weight	GV	8	NA	NA	NA	NA	NA	NA
Murray et al. (2013)	NR	no effect	sodium molybdate dihydrate	rat (*Rattus norvegicus*)	9 weeks	body weight	FD	12	NA	NA	NA	NA	NA	NA
Reproduction														
Fungwe et al. (1990)	2.6	ED20	sodium molybdate	rat (*Rattus norvegicus*)	21 days	litter weight	DW	9	0.025	5.0	10	50	100	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-13. Molybdenum TRV Data for Mammals

									Effect					
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Measurement
Growth														
Bandyopadhyay et al. (1981)	242	242	ammonium molybdate	rat (*Rattus norvegicus*)	juvenile	body weight gain	oral	4	54	24	NA	NA	NA	weight gain (g assumed)
Bandyopadhyay et al. (1981)	242	242	ammonium molybdate	rat (*Rattus norvegicus*)	juvenile	body weight gain	oral	4	65	40	NA	NA	NA	weight gain (g assumed)
Brinkman and Miller (1961)	no stats	28	sodium molybdate	rat (*Rattus norvegicus*)	weanling	body weight gain	FD	6	135	62	NA	NA	NA	6 weeks weight gain (g)
Fungwe et al. (1990)	2.6	28	sodium molybdate	rat (*Rattus norvegicus*)	21 days	body weight gain	DW	9	119	120	98	98	94	gestation weight gain (g)
Lyubimov et al. (2004)	24	no effect	ammonium tetrathiomolybdate	rat (*Rattus norvegicus*)	~20-23 weeks	body weight	GV	8	580	575	560	540	NA	final body weight (g) (Figure 1 in paper)
Murray et al. (2013)	NR	no effect	sodium molybdate dihydrate	rat (*Rattus norvegicus*)	9 weeks	body weight	FD	12	578	578	570	485	NA	body weight (g) (Figure 1 in paper)
Reproduction														
Fungwe et al. (1990)	2.6	ED20	sodium molybdate	rat (*Rattus norvegicus*)	21 days	litter weight	DW	9	50	48	34	34	34	total litter weight (g)

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-13. Molybdenum TRV Data for Mammals

									Effect Relative to Control (%)			
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Dose 1	Dose 2	Dose 3	Dose 4
Growth												
Bandyopadhyay et al. (1981)	242	242	ammonium molybdate	rat (*Rattus norvegicus*)	juvenile	body weight gain	oral	4	45	NA	NA	NA
Bandyopadhyay et al. (1981)	242	242	ammonium molybdate	rat (*Rattus norvegicus*)	juvenile	body weight gain	oral	4	62	NA	NA	NA
Brinkman and Miller (1961)	no stats	28	sodium molybdate	rat (*Rattus norvegicus*)	weanling	body weight gain	FD	6	46	NA	NA	NA
Fungwe et al. (1990)	2.6	28	sodium molybdate	rat (*Rattus norvegicus*)	21 days	body weight gain	DW	9	100	82	82	79
Lyubimov et al. (2004)	24	no effect	ammonium tetrathiomolybdate	rat (*Rattus norvegicus*)	~20-23 weeks	body weight	GV	8	99	97	93	NA
Murray et al. (2013)	NR	no effect	sodium molybdate dihydrate	rat (*Rattus norvegicus*)	9 weeks	body weight	FD	12	100	99	84	NA
Reproduction												
Fungwe et al. (1990)	2.6	ED20	sodium molybdate	rat (*Rattus norvegicus*)	21 days	litter weight	DW	9	94	67	66	67

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-14. Selenium TRV Data for Birds

Source [a]	Reported LOAEL [b] (mg/kg	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Dose (mg/kg bw/day)						
									Control	1	2	3	4	5	Notes
Growth															
Dafalla and Adam (1986)	no stats	0.26	sodium selenite	chicken (*Gallus gallus domesticus*)	1 week	body weight	FD	4	0.0	0.26	NA	NA	NA	NA	calculated from body weight and FIR
Echevarria et al. (1988)	0.69	1.0	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	3	0.022	0.36	0.69	1.0	NA	NA	calculated from body weight and FIR
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight (brewer's yeast diet)	FD	4	0.0	2.7	5.4	8.2	NA	NA	calculated from body weight and FIR
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight (corn-soy diet)	FD	4	0.0	2.7	5.4	8.2	NA	NA	calculated from body weight and FIR
Gad and El-Twab (2009)	3.4	no effect	sodium selenite	quail (*Coturnix coturnix*)	adult	body weight	GV	4	0.0	3.4	NA	NA	NA	NA	presented in paper
Heinz and Fitzgerald (1993a)	2.0	no effect	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	adult	body weight	FD	21	0.0	2.0	NA	NA	NA	NA	calculated from body weight and FIR
Hill (1979a)	NR	1.1	selenium dioxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 1)	FD	4-5	0.0	0.56	1.1	2.2	NA	NA	calculated from body weight and FIR
Hill (1979a)	NR	2.2	selenium dioxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 2)	FD	4-5	0.0	0.56	1.1	2.2	NA	NA	calculated from body weight and FIR
Hoffman et al. (1992)	1.5	ED20	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	1 day	body weight	FD	4	0.020	1.5	6.0	NA	NA	NA	calculated from body weight and FIR
Jensen (1986)	NR	0.57	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	0.011	0.022	0.039	0.12	0.57	NA	calculated from body weight and FIR
O'Toole and Raisbeck (1997)	4.6	4.6	seleno-L-methionine	mallard (*Anas platyrhynchos*)	adult	body weight	FD	21	0.025	0.79	1.9	4.6	NA	NA	calculated from body weight and FIR
Santolo et al (2010)	2.9	no effect	seleno-L-methionine	quail (*Coturnix coturnix*)	adult	body weight gain	FD	4	0.092	1.6	2.9	NA	NA	NA	calculated from body weight and FIR
Sell and Horani (1976)	0.89	no effect	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	0.0	0.89	NA	NA	NA	NA	calculated from body weight and FIR
Stoewsand et al. (1977)	1.0	no effect	sodium selenite	quail (*Coturnix japonica*)	2 weeks	body weight	FD	10	0.0018	1.0	NA	NA	NA	NA	calculated from body weight and FIR
Stoewsand et al. (1977)	1.0	no effect	seleniferous wheat	quail (*Coturnix japonica*)	2 weeks	body weight	FD	10	0.0018	1.0	NA	NA	NA	NA	calculated from body weight and FIR
Reproduction															
Heinz et al. (1989)	1.6	0.82	selenomethionine	mallard (*Anas platyrhynchos*)	adult	% hatch of fertile eggs	FD	>14	0.015	0.12	0.22	0.42	0.82	1.6	calculated from body weight and FIR
Heinz et al. (1989)	0.82	1.6	selenomethionine	mallard (*Anas platyrhynchos*)	adult	duckling survival	FD	>14	0.015	0.12	0.22	0.42	0.82	1.6	calculated from body weight and FIR
Heinz et al. (1989)	0.82	ED20	selenomethionine	mallard (*Anas platyrhynchos*)	adult	number of ducklings	FD	>14	0.015	0.12	0.22	0.42	0.82	1.6	calculated from body weight and FIR
Hoffman and Heinz (1988)	2.5	2.5	sodium selenite	mallard (*Anas platyrhynchos*)	adult	hatching success	FD	NR	0.020	0.12	0.52	1.0	2.5	NA	calculated from body weight and FIR
Hoffman and Heinz (1988)	0.82	0.82	seleno-methionine	mallard (*Anas platyrhynchos*)	adult	hatching success	FD	NR	0.020	0.12	0.22	0.42	0.82	1.6	calculated from body weight and FIR
Kaantee and Kurkela (1980)	no stats	no effect	sodium selenite	chicken (*Gallus gallus domesticus*)	18 months	egg production	FD	4	0.0047	0.10	0.16	NA	NA	NA	calculated from body weight and FIR
Ort and Latshaw (1978)	0.71	0.71	sodium selenite	chicken (*Gallus gallus domesticus*)	32 weeks	egg production (Experiment 2)	FD	16	0.0094	0.40	0.55	0.71	NA	NA	calculated from body weight and FIR
Ort and Latshaw (1978)	0.71	ED20	sodium selenite	chicken (*Gallus gallus domesticus*)	32 weeks	hatchability (Experiment 2)	FD	16	0.0094	0.40	0.55	0.71	NA	NA	calculated from body weight and FIR
Stone and Soares (1976)	0.14/no effect	no effect	sodium selenite	quail (*Coturnix japonica*)	adult	egg production (Experiments 1 and 3)	FD	3.9-4.6	0.0	0.14	NA	NA	NA	NA	calculated from body weight and FIR
Wiemeyer and Hoffman (1996)	4.2	4.2	seleno-DL-methionine	owl (*Otus asio*)	adult	% pairs with hatchlings	FD	12	0.13	4.2	14	NA	NA	NA	calculated from body weight and FIR
Wiemeyer and Hoffman (1996)	NR	14	seleno-DL-methionine	owl (*Otus asio*)	adult	pairs with 5 day young	FD	12	0.13	4.2	14	NA	NA	NA	calculated from body weight and FIR
Wiemeyer and Hoffman (1996)	14	14	seleno-DL-methionine	owl (*Otus asio*)	adult	% hatch of eggs incubated	FD	12	0.13	4.2	14	NA	NA	NA	calculated from body weight and FIR
Survival															
Albers et al. (1996)	11	11	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	1 year	survival	FD	16	0.014	1.4	2.8	5.6	11	NA	calculated from body weight and FIR
Arnold et al. (1973)	no stats	0.59	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	64	0.0	0.15	0.59	NA	NA	NA	calculated from body weight and FIR
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival (brewer's yeast diet)	FD	4	0.0	2.7	5.4	NA	NA	NA	calculated from body weight and FIR
El-Begearmi and Combs (1982)	5.4	5.4	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival (corn-soy diet)	FD	4	0.0	2.7	5.4	NA	NA	NA	calculated from body weight and FIR
El-Begearmi et al. (1977)	no stats	no effect	sodium selenite	quail (*Coturnix japonica*)	1 day	survival (males)	FD	16	0.020	1.6	NA	NA	NA	NA	calculated from body weight and FIR
El-Begearmi et al. (1977)	no stats	1.6	sodium selenite	quail (*Coturnix japonica*)	1 day	survival (females)	FD	16	0.020	1.6	NA	NA	NA	NA	calculated from body weight and FIR
Gad and El-Twab (2009)	no stats	no effect	sodium selenite	quail (*Coturnix japonica*)	adult	survival	GV	4	0.0	3.4	NA	NA	NA	NA	presented in paper
Heinz and Fitzgerald (1993b)	2.0	2.0	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	adult (male)	survival	FD	16	0.031	1.0	2.0	4.0	8.0	NA	calculated from body weight and FIR
Khan et al. (1993)	no stats	2.5	sodium selenite	chicken (*Gallus gallus domesticus*)	2 weeks	survival	GV	0.86	0.0	2.5	NA	NA	NA	NA	presented in paper

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-14. Selenium TRV Data for Birds

									Body Weight (kg)							
Source [a]	Reported LOAEL [b] (mg/kg	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source [a]
Growth															
Dafalla and Adam (1986)	no stats	0.26	sodium selenite	chicken (*Gallus gallus domesticus*)	1 week	body weight	FD	4	0.40	0.40	NA	NA	NA	NA	presented in paper
Echevarria et al. (1988)	0.69	1.0	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	3	0.36	0.36	0.36	0.36	NA	NA	NRC (1994)
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight (brewer's yeast diet)	FD	4	0.090	0.090	0.090	0.090	NA	NA	USEPA (1988)
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight (corn-soy diet)	FD	4	0.090	0.090	0.090	0.090	NA	NA	USEPA (1988)
Gad and El-Twab (2009)	3.4	no effect	sodium selenite	quail (*Coturnix coturnix*)	adult	body weight	GV	4	NA	NA	NA	NA	NA	NA	NA (dose presented in paper)
Heinz and Fitzgerald (1993a)	2.0	no effect	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	adult	body weight	FD	21	0.99	0.99	NA	NA	NA	NA	presented in paper
Hill (1979a)	NR	1.1	selenium dioxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 1)	FD	4-5	0.36	0.36	0.36	0.36	NA	NA	NRC (1994)
Hill (1979a)	NR	2.2	selenium dioxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 2)	FD	4-5	0.36	0.36	0.36	0.36	NA	NA	NRC (1994)
Hoffman et al. (1992)	1.5	ED20	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	1 day	body weight	FD	4	0.56	0.56	0.56	NA	NA	NA	presented in paper
Jensen (1986)	NR	0.57	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	0.36	0.36	0.36	0.36	0.36	NA	NRC (1994)
O'Toole and Raisbeck (1997)	4.6	4.6	seleno-L-methionine	mallard (*Anas platyrhynchos*)	adult	body weight	FD	21	1.3	1.3	1.3	1.3	NA	NA	presented in paper
Santolo et al (2010)	2.9	no effect	seleno-L-methionine	quail (*Coturnix coturnix*)	adult	body weight gain	FD	4	0.15	0.15	0.15	NA	NA	NA	Vos et al. (1971)
Sell and Horani (1976)	0.89	no effect	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	0.080	0.080	NA	NA	NA	NA	USEPA (1988)
Stoewsand et al. (1977)	1.0	no effect	sodium selenite	quail (*Coturnix japonica*)	2 weeks	body weight	FD	10	0.12	0.12	NA	NA	NA	NA	presented in paper
Stoewsand et al. (1977)	1.0	no effect	seleniferous wheat	quail (*Coturnix japonica*)	2 weeks	body weight	FD	10	0.12	0.12	NA	NA	NA	NA	presented in paper
Reproduction															
Heinz et al. (1989)	1.6	0.82	selenomethionine	mallard (*Anas platyrhynchos*)	adult	% hatch of fertile eggs	FD	>14	1.1	1.1	1.1	1.1	1.1	1.1	presented in paper
Heinz et al. (1989)	0.82	1.6	selenomethionine	mallard (*Anas platyrhynchos*)	adult	duckling survival	FD	>14	1.1	1.1	1.1	1.1	1.1	1.1	presented in paper
Heinz et al. (1989)	0.82	ED20	selenomethionine	mallard (*Anas platyrhynchos*)	adult	number of ducklings	FD	>14	1.1	1.1	1.1	1.1	1.1	1.1	presented in paper
Hoffman and Heinz (1988)	2.5	2.5	sodium selenite	mallard (*Anas platyrhynchos*)	adult	hatching success	FD	NR	1.1	1.1	1.1	1.1	1.1	NA	Dunning (1993)
Hoffman and Heinz (1988)	0.82	0.82	seleno-methionine	mallard (*Anas platyrhynchos*)	adult	hatching success	FD	NR	1.1	1.1	1.1	1.1	1.1	1.1	Dunning (1993)
Kaantee and Kurkela (1980)	no stats	no effect	sodium selenite	chicken (*Gallus gallus domesticus*)	18 months	egg production	FD	4	0.78	0.78	0.78	NA	NA	NA	USEPA (1988)
Ort and Latshaw (1978)	0.71	0.71	sodium selenite	chicken (*Gallus gallus domesticus*)	32 weeks	egg production (Experiment 2)	FD	16	0.78	0.78	0.78	0.78	NA	NA	USEPA (1988)
Ort and Latshaw (1978)	0.71	ED20	sodium selenite	chicken (*Gallus gallus domesticus*)	32 weeks	hatchability (Experiment 2)	FD	16	0.78	0.78	0.78	0.78	NA	NA	USEPA (1988)
Stone and Soares (1976)	0.14/no effect	no effect	sodium selenite	quail (*Coturnix japonica*)	adult	egg production (Experiments 1 and 3)	FD	3.9-4.6	0.13	0.13	NA	NA	NA	NA	presented in paper
Wiemeyer and Hoffman (1996)	4.2	4.2	seleno-DL-methionine	owl (*Otus asio*)	adult	% pairs with hatchlings	FD	12	0.21	0.21	0.21	NA	NA	NA	presented in paper
Wiemeyer and Hoffman (1996)	NR	14	seleno-DL-methionine	owl (*Otus asio*)	adult	pairs with 5 day young	FD	12	0.21	0.21	0.21	NA	NA	NA	presented in paper
Wiemeyer and Hoffman (1996)	14	14	seleno-DL-methionine	owl (*Otus asio*)	adult	% hatch of eggs incubated	FD	12	0.21	0.21	0.21	NA	NA	NA	presented in paper
Survival															
Albers et al. (1996)	11	11	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	1 year	survival	FD	16	1.1	1.1	1.1	1.1	1.1	NA	presented in paper
Arnold et al. (1973)	no stats	0.59	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	64	1.2	1.2	1.2	NA	NA	NA	presented in paper
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival (brewer's yeast diet)	FD	4	0.090	0.090	0.090	NA	NA	NA	USEPA (1988)
El-Begearmi and Combs (1982)	5.4	5.4	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival (corn-soy diet)	FD	4	0.090	0.090	0.090	NA	NA	NA	USEPA (1988)
El-Begearmi et al. (1977)	no stats	no effect	sodium selenite	quail (*Coturnix japonica*)	1 day	survival (males)	FD	16	0.15	0.15	NA	NA	NA	NA	Vos et al. (1971)
El-Begearmi et al. (1977)	no stats	1.6	sodium selenite	quail (*Coturnix japonica*)	1 day	survival (females)	FD	16	0.15	0.15	NA	NA	NA	NA	Vos et al. (1971)
Gad and El-Twab (2009)	no stats	no effect	sodium selenite	quail (*Coturnix japonica*)	adult	survival	GV	4	NA	NA	NA	NA	NA	NA	NA (dose presented in paper)
Heinz and Fitzgerald (1993b)	2.0	2.0	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	adult (male)	survival	FD	16	1.2	1.2	1.2	1.2	1.2	NA	presented in paper
Khan et al. (1993)	no stats	2.5	sodium selenite	chicken (*Gallus gallus domesticus*)	2 weeks	survival	GV	0.86	NA	NA	NA	NA	NA	NA	NA (dose presented in paper)

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-14. Selenium TRV Data for Birds

Source[a]	Reported LOAEL[b] (mg/kg	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)							
									Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Source[a]	Wet or Dry Weight
Growth																
Dafalla and Adam (1986)	no stats	0.26	sodium selenite	chicken (*Gallus gallus domesticus*)	1 week	body weight	FD	4	0.035	0.035	NA	NA	NA	NA	USEPA (1988)	dw
Echevarria et al. (1988)	0.69	1.0	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	3	0.040	0.040	0.040	0.040	NA	NA	NRC (1994)	dw
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight (brewer's yeast diet)	FD	4	0.010	0.010	0.010	0.010	NA	NA	USEPA (1988)	dw
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight (corn-soy diet)	FD	4	0.010	0.010	0.010	0.010	NA	NA	USEPA (1988)	dw
Gad and El-Twab (2009)	3.4	no effect	sodium selenite	quail (*Coturnix coturnix*)	adult	body weight	GV	4	0.57	0.57	NA	NA	NA	NA	NA (dose presented in paper)	-
Heinz and Fitzgerald (1993a)	2.0	no effect	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	adult	body weight	FD	21	0.099	0.099	NA	NA	NA	NA	Heinz et al. (1987)	dw
Hill (1979a)	NR	1.1	selenium dioxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 1)	FD	4-5	0.040	0.040	0.040	0.040	NA	NA	NRC (1994)	dw
Hill (1979a)	NR	2.2	selenium dioxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 2)	FD	4-5	0.040	0.040	0.040	0.040	NA	NA	NRC (1994)	dw
Hoffman et al. (1992)	1.5	ED20	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	1 day	body weight	FD	4	0.056	0.056	0.056	NA	NA	NA	Heinz et al. (1987)	dw
Jensen (1986)	NR	0.57	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	0.040	0.040	0.040	0.040	0.040	NA	NRC (1994)	dw
O'Toole and Raisbeck (1997)	4.6	4.6	seleno-L-methionine	mallard (*Anas platyrhynchos*)	adult	body weight	FD	21	0.10	0.10	0.10	0.10	NA	NA	presented in paper	dw
Santolo et al (2010)	2.9	no effect	seleno-L-methionine	quail (*Coturnix coturnix*)	adult	body weight gain	FD	4	0.020	0.020	0.020	NA	NA	NA	Nagy (2001)	dw
Sell and Horani (1976)	0.89	no effect	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	0.0089	0.0089	NA	NA	NA	NA	USEPA (1988)	dw
Stoewsand et al. (1977)	1.0	no effect	sodium selenite	quail (*Coturnix japonica*)	2 weeks	body weight	FD	10	0.016	0.016	NA	NA	NA	NA	Nagy (2001)	dw
Stoewsand et al. (1977)	1.0	no effect	seleniferous wheat	quail (*Coturnix japonica*)	2 weeks	body weight	FD	10	0.016	0.016	NA	NA	NA	NA	Nagy (2001)	dw
Reproduction																
Heinz et al. (1989)	1.6	0.82	selenomethionine	mallard (*Anas platyrhynchos*)	adult	% hatch of fertile eggs	FD	>14	0.11	0.11	0.11	0.11	0.11	0.11	Heinz et al. (1987)	dw
Heinz et al. (1989)	0.82	1.6	selenomethionine	mallard (*Anas platyrhynchos*)	adult	duckling survival	FD	>14	0.11	0.11	0.11	0.11	0.11	0.11	Heinz et al. (1987)	dw
Heinz et al. (1989)	0.82	ED20	selenomethionine	mallard (*Anas platyrhynchos*)	adult	number of ducklings	FD	>14	0.11	0.11	0.11	0.11	0.11	0.11	Heinz et al. (1987)	dw
Hoffman and Heinz (1988)	2.5	2.5	sodium selenite	mallard (*Anas platyrhynchos*)	adult	hatching success	FD	NR	0.11	0.11	0.11	0.11	0.11	NA	Heinz et al. (1987)	dw
Hoffman and Heinz (1988)	0.82	0.82	seleno-methionine	mallard (*Anas platyrhynchos*)	adult	hatching success	FD	NR	0.11	0.11	0.11	0.11	0.11	0.11	Heinz et al. (1987)	dw
Kaantee and Kurkela (1980)	no stats	no effect	sodium selenite	chicken (*Gallus gallus domesticus*)	18 months	egg production	FD	4	0.061	0.061	0.061	NA	NA	NA	USEPA (1988)	dw
Ort and Latshaw (1978)	0.71	0.71	sodium selenite	chicken (*Gallus gallus domesticus*)	32 weeks	egg production (Experiment 2)	FD	16	0.061	0.061	0.1	0.061	NA	NA	USEPA (1988)	dw
Ort and Latshaw (1978)	0.71	ED20	sodium selenite	chicken (*Gallus gallus domesticus*)	32 weeks	hatchability (Experiment 2)	FD	16	0.061	0.061	0.061	0.061	NA	NA	USEPA (1988)	dw
Stone and Soares (1976)	0.14/no effect	no effect	sodium selenite	quail (*Coturnix japonica*)	adult	egg production (Experiments 1 and 3)	FD	3.9-4.6	0.018	0.018	NA	NA	NA	NA	Nagy (2001)	dw
Wiemeyer and Hoffman (1996)	4.2	4.2	seleno-DL-methionine	owl (*Otus asio*)	adult	% pairs with hatchlings	FD	12	0.10	0.10	0.10	NA	NA	NA	presented in paper	dw
Wiemeyer and Hoffman (1996)	NR	14	seleno-DL-methionine	owl (*Otus asio*)	adult	pairs with 5 day young	FD	12	0.10	0.10	0.10	NA	NA	NA	presented in paper	dw
Wiemeyer and Hoffman (1996)	14	14	seleno-DL-methionine	owl (*Otus asio*)	adult	% hatch of eggs incubated	FD	12	0.10	0.10	0.10	NA	NA	NA	presented in paper	dw
Survival																
Albers et al. (1996)	11	11	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	1 year	survival	FD	16	0.16	0.16	0.16	0.16	0.16	NA	presented in paper	dw
Arnold et al. (1973)	no stats	0.59	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	64	0.086	0.086	0.09	NA	NA	NA	USEPA (1988)	dw
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival (brewer's yeast diet)	FD	4	0.010	0.010	0.010	NA	NA	NA	USEPA (1988)	dw
El-Begearmi and Combs (1982)	5.4	5.4	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival (corn-soy diet)	FD	4	0.010	0.010	0.010	NA	NA	NA	USEPA (1988)	dw
El-Begearmi et al. (1977)	no stats	no effect	sodium selenite	quail (*Coturnix japonica*)	1 day	survival (males)	FD	16	0.020	0.020	NA	NA	NA	NA	Nagy (2001)	dw
El-Begearmi et al. (1977)	no stats	1.6	sodium selenite	quail (*Coturnix japonica*)	1 day	survival (females)	FD	16	0.020	0.020	NA	NA	NA	NA	Nagy (2001)	dw
Gad and El-Twab (2009)	no stats	no effect	sodium selenite	quail (*Coturnix japonica*)	adult	survival	GV	4	0.57	0.57	NA	NA	NA	NA	NA (dose presented in paper)	NA
Heinz and Fitzgerald (1993b)	2.0	2.0	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	adult (male)	survival	FD	16	0.12	0.12	0.12	0.12	0.12	NA	Heinz et al. (1987)	dw
Khan et al. (1993)	no stats	2.5	sodium selenite	chicken (*Gallus gallus domesticus*)	2 weeks	survival	GV	0.86	NA	NA	NA	NA	NA	NA	NA (dose presented in paper)	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-14. Selenium TRV Data for Birds

Source[a]	Reported LOAEL[b] (mg/kg	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Concentration in Food (mg/kg)						
									Control[c]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Wet or Dry Weight
Growth															
Dafalla and Adam (1986)	no stats	0.26	sodium selenite	chicken (*Gallus gallus domesticus*)	1 week	body weight	FD	4	0.0	3.0	NA	NA	NA	NA	dw
Echevarria et al. (1988)	0.69	1.0	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	3	0.20	3.2	6.2	9.2	NA	NA	dw
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight (brewer's yeast diet)	FD	4	0.0	25	50	75	NA	NA	dw
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight (corn-soy diet)	FD	4	0.0	25	50	75	NA	NA	dw
Gad and El-Twab (2009)	3.4	no effect	sodium selenite	quail (*Coturnix coturnix*)	adult	body weight	GV	4	0.0	6.0	NA	NA	NA	NA	NA
Heinz and Fitzgerald (1993a)	2.0	no effect	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	adult	body weight	FD	21	0.0	20	NA	NA	NA	NA	dw
Hill (1979a)	NR	1.1	selenium dioxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 1)	FD	4-5	0.0	5.0	10	20	NA	NA	dw
Hill (1979a)	NR	2.2	selenium dioxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 2)	FD	4-5	0.0	5.0	10	20	NA	NA	dw
Hoffman et al. (1992)	1.5	ED20	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	1 day	body weight	FD	4	0.20	15	60	NA	NA	NA	dw
Jensen (1986)	NR	0.57	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	0.10	0.20	0.35	1.1	5.1	NA	dw
O'Toole and Raisbeck (1997)	4.6	4.6	seleno-L-methionine	mallard (*Anas platyrhynchos*)	adult	body weight	FD	21	0.32	10	25	60	NA	NA	dw
Santolo et al (2010)	2.9	no effect	seleno-L-methionine	quail (*Coturnix coturnix*)	adult	body weight gain	FD	4	0.70	12	22	NA	NA	NA	dw
Sell and Horani (1976)	0.89	no effect	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	0.0	8.0	NA	NA	NA	NA	dw
Stoewsand et al. (1977)	1.0	no effect	sodium selenite	quail (*Coturnix japonica*)	2 weeks	body weight	FD	10	0.013	7.0	NA	NA	NA	NA	dw
Stoewsand et al. (1977)	1.0	no effect	seleniferous wheat	quail (*Coturnix japonica*)	2 weeks	body weight	FD	10	0.013	7.0	NA	NA	NA	NA	dw
Reproduction															
Heinz et al. (1989)	1.6	0.82	selenomethionine	mallard (*Anas platyrhynchos*)	adult	% hatch of fertile eggs	FD	>14	0.15	1.2	2.2	4.2	8.2	16	dw
Heinz et al. (1989)	0.82	1.6	selenomethionine	mallard (*Anas platyrhynchos*)	adult	duckling survival	FD	>14	0.15	1.2	2.2	4.2	8.2	16	dw
Heinz et al. (1989)	0.82	ED20	selenomethionine	mallard (*Anas platyrhynchos*)	adult	number of ducklings	FD	>14	0.15	1.2	2.2	4.2	8.2	16	dw
Hoffman and Heinz (1988)	2.5	2.5	sodium selenite	mallard (*Anas platyrhynchos*)	adult	hatching success	FD	NR	0.20	1.2	5.2	10	25	NA	dw
Hoffman and Heinz (1988)	0.82	0.82	seleno-methionine	mallard (*Anas platyrhynchos*)	adult	hatching success	FD	NR	0.20	1.2	2.2	4.2	8.2	16	dw
Kaantee and Kurkela (1980)	no stats	no effect	sodium selenite	chicken (*Gallus gallus domesticus*)	18 months	egg production	FD	4	0.060	1.3	2.0	NA	NA	NA	dw
Ort and Latshaw (1978)	0.71	0.71	sodium selenite	chicken (*Gallus gallus domesticus*)	32 weeks	egg production (Experiment 2)	FD	16	0.12	5.1	7.1	9.1	NA	NA	dw
Ort and Latshaw (1978)	0.71	ED20	sodium selenite	chicken (*Gallus gallus domesticus*)	32 weeks	hatchability (Experiment 2)	FD	16	0.12	5.1	7.1	9.1	NA	NA	dw
Stone and Soares (1976)	0.14/no effect	no effect	sodium selenite	quail (*Coturnix japonica*)	adult	egg production (Experiments 1 and 3)	FD	3.9-4.6	0.00	1.0	NA	NA	NA	NA	dw
Wiemeyer and Hoffman (1996)	4.2	4.2	seleno-DL-methionine	owl (*Otus asio*)	adult	% pairs with hatchlings	FD	12	0.28	8.8	30	NA	NA	NA	dw
Wiemeyer and Hoffman (1996)	NR	14	seleno-DL-methionine	owl (*Otus asio*)	adult	pairs with 5 day young	FD	12	0.28	8.8	30	NA	NA	NA	dw
Wiemeyer and Hoffman (1996)	14	14	seleno-DL-methionine	owl (*Otus asio*)	adult	% hatch of eggs incubated	FD	12	0.28	8.8	30	NA	NA	NA	dw
Survival															
Albers et al. (1996)	11	11	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	1 year	survival	FD	16	0.10	10	20	40	80	NA	dw
Arnold et al. (1973)	no stats	0.59	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	64	0.0	2.0	8.0	NA	NA	NA	dw
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival (brewer's yeast diet)	FD	4	0.0	25	50	NA	NA	NA	dw
El-Begearmi and Combs (1982)	5.4	5.4	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival (corn-soy diet)	FD	4	0.0	25	50	NA	NA	NA	dw
El-Begearmi et al. (1977)	no stats	no effect	sodium selenite	quail (*Coturnix japonica*)	1 day	survival (males)	FD	16	0.15	12	NA	NA	NA	NA	dw
El-Begearmi et al. (1977)	no stats	1.6	sodium selenite	quail (*Coturnix japonica*)	1 day	survival (females)	FD	16	0.15	12	NA	NA	NA	NA	dw
Gad and El-Twab (2009)	no stats	no effect	sodium selenite	quail (*Coturnix japonica*)	adult	survival	GV	4	0.0	6.0	NA	NA	NA	NA	NA
Heinz and Fitzgerald (1993b)	2.0	2.0	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	adult (male)	survival	FD	16	0.31	10	20	40	80	NA	dw
Khan et al. (1993)	no stats	2.5	sodium selenite	chicken (*Gallus gallus domesticus*)	2 weeks	survival	GV	0.86	0.0	5.0	NA	NA	NA	NA	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-14. Selenium TRV Data for Birds

Source[a]	Reported LOAEL[b] (mg/kg	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Effect						
									Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Measurement
Growth															
Dafalla and Adam (1986)	no stats	0.26	sodium selenite	chicken (*Gallus gallus domesticus*)	1 week	body weight	FD	4	1000	700	NA	NA	NA	NA	body weight at week 4 (end of exposure period) (g) estimated from Figure 1 in paper
Echevarria et al. (1988)	0.69	1.0	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	3	27	27	22	20	NA	NA	average daily gain (g) at week 3
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight (brewer's yeast diet)	FD	4	0.34	0.12	0.065	0.059	NA	NA	final body weight (calculated from daily weight gain [g per day] * 28 days + initial body weight estimated as 0.09 kg)
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight (corn-soy diet)	FD	4	0.38	0.13	0.121	0.073	NA	NA	final body weight (calculated from daily weight gain [g per day] * 28 days + initial body weight estimated as 0.09 kg)
Gad and El-Twab (2009)	3.4	no effect	sodium selenite	quail (*Coturnix coturnix*)	adult	body weight	GV	4	188	163	NA	NA	NA	NA	final body weight estimated from an average starting body weight of 180 g and body weight gain in g estimated at week 4 from Figure 2 in paper
Heinz and Fitzgerald (1993a)	2.0	no effect	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	adult	body weight	FD	21	0.97	0.91	NA	NA	NA	NA	final female body weight
Hill (1979a)	NR	1.1	selenium dioxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 1)	FD	4-5	228	NR	NR	NR	NA	NA	mean body weight gain (g) reported for control; other treatments report mean body weight gain as % of control (see Effect Relative to Control cells)
Hill (1979a)	NR	2.2	selenium dioxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 2)	FD	4-5	226	NR	NR	NR	NA	NA	mean body weight gain (g) reported for control, other treatments report mean body weight gain as % of control (see Effect Relative to Control cells)
Hoffman et al. (1992)	1.5	ED20	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	1 day	body weight	FD	4	555	479	210	NA	NA	NA	final body weight
Jensen (1986)	NR	0.57	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	528	542	545	503	405	NA	body weight at 3 weeks
O'Toole and Raisbeck (1997)	4.6	4.6	seleno-L-methionine	mallard (*Anas platyrhynchos*)	adult	body weight	FD	21	1320	1400	1300	925	NA	NA	final body weight (estimated from Figure 1 in paper)
Santolo et al (2010)	2.9	no effect	seleno-L-methionine	quail (*Coturnix coturnix*)	adult	body weight gain	FD	4	102	102	97	NA	NA	NA	% body weight gain in comparison to initial body mass
Sell and Horani (1976)	0.89	no effect	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	267	242	NA	NA	NA	NA	weight gain
Stoewsand et al. (1977)	1.0	no effect	sodium selenite	quail (*Coturnix japonica*)	2 weeks	body weight	FD	10	115	104	NA	NA	NA	NA	final body weight (g)
Stoewsand et al. (1977)	1.0	no effect	seleniferous wheat	quail (*Coturnix japonica*)	2 weeks	body weight	FD	10	115	100	NA	NA	NA	NA	final body weight (g)
Reproduction															
Heinz et al. (1989)	1.6	0.82	selenomethionine	mallard (*Anas platyrhynchos*)	adult	% hatch of fertile eggs	FD	>14	60	71	60	53	37	2.2	% hatch of fertile eggs
Heinz et al. (1989)	0.82	1.6	selenomethionine	mallard (*Anas platyrhynchos*)	adult	duckling survival	FD	>14	99	98	99	100	81	0.0	% duckling survival to 6 days
Heinz et al. (1989)	0.82	ED20	selenomethionine	mallard (*Anas platyrhynchos*)	adult	number of ducklings	FD	>14	8.1	8.5	8.2	7.5	4.6	0.0	number of 6-day-old ducklings produced per hen
Hoffman and Heinz (1988)	2.5	2.5	sodium selenite	mallard (*Anas platyrhynchos*)	adult	hatching success	FD	NR	100	114	103	100	56	NA	hatching success as % of control
Hoffman and Heinz (1988)	0.82	0.82	seleno-methionine	mallard (*Anas platyrhynchos*)	adult	hatching success	FD	NR	100	111	105	92	64	11.0	hatching success as % of control
Kaantee and Kurkela (1980)	no stats	no effect	sodium selenite	chicken (*Gallus gallus domesticus*)	18 months	egg production	FD	4	207	210	174	NA	NA	NA	total number of eggs over 4-week trial
Ort and Latshaw (1978)	0.71	0.71	sodium selenite	chicken (*Gallus gallus domesticus*)	32 weeks	egg production (Experiment 2)	FD	16	69	66	66	51	NA	NA	average egg producton for a 4-week period
Ort and Latshaw (1978)	0.71	ED20	sodium selenite	chicken (*Gallus gallus domesticus*)	32 weeks	hatchability (Experiment 2)	FD	16	92	84	67	65	NA	NA	% average hatchability
Stone and Soares (1976)	0.14/no effect	no effect	sodium selenite	quail (*Coturnix japonica*)	adult	egg production (Experiments 1 and 3)	FD	3.9-4.6	0.52	0.60	NA	NA	NA	NA	eggs per hen per day, average of two experiments
Wiemeyer and Hoffman (1996)	4.2	4.2	seleno-DL-methionine	owl (*Otus asio*)	adult	% pairs with hatchlings	FD	12	100	75	17	NA	NA	NA	% pairs with hatchlings
Wiemeyer and Hoffman (1996)	NR	14	seleno-DL-methionine	owl (*Otus asio*)	adult	pairs with 5 day young	FD	12	92	75	0.0	NA	NA	NA	% pairs with 5-day-old young
Wiemeyer and Hoffman (1996)	14	14	seleno-DL-methionine	owl (*Otus asio*)	adult	% hatch of eggs incubated	FD	12	85	74	4.0	NA	NA	NA	% hatch of eggs incubated
Survival															
Albers et al. (1996)	11	11	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	1 year	survival	FD	16	21	21	20	18	0.0	NA	number surviving
Arnold et al. (1973)	no stats	0.59	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	64	82	84	53	NA	NA	NA	% survival at 64 weeks
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival (brewer's yeast diet)	FD	4	80	50	3.0	NA	NA	NA	survival
El-Begearmi and Combs (1982)	5.4	5.4	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival (corn-soy diet)	FD	4	93	87	7.0	NA	NA	NA	survival
El-Begearmi et al. (1977)	no stats	no effect	sodium selenite	quail (*Coturnix japonica*)	1 day	survival (males)	FD	16	100	89	NA	NA	NA	NA	% survival at 16 weeks (males) (Experiment 3)
El-Begearmi et al. (1977)	no stats	1.6	sodium selenite	quail (*Coturnix japonica*)	1 day	survival (females)	FD	16	87	50	NA	NA	NA	NA	% survival at 16 weeks (females) (Experiment 3)
Gad and El-Twab (2009)	no stats	no effect	sodium selenite	quail (*Coturnix japonica*)	adult	survival	GV	4	12	10.3	NA	NA	NA	NA	Mortality was reported at 14.3% of 12 birds. Assumed that 100% of control survived.
Heinz and Fitzgerald (1993b)	2.0	2.0	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	adult (male)	survival	FD	16	100	100	75	5.0	0.0	NA	survival at end of experiment
Khan et al. (1993)	no stats	2.5	sodium selenite	chicken (*Gallus gallus domesticus*)	2 weeks	survival	GV	0.86	10	6.0	NA	NA	NA	NA	survival

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-14. Selenium TRV Data for Birds

Source[a]	Reported LOAEL[b] (mg/kg	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Effect Relative to Control (%)				
									Dose 1	Dose 2	Dose 3	Dose 4	Dose 5
Growth													
Dafalla and Adam (1986)	no stats	0.26	sodium selenite	chicken (*Gallus gallus domesticus*)	1 week	body weight	FD	4	70	NA	NA	NA	NA
Echevarria et al. (1988)	0.69	1.0	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	3	100	84	74	NA	NA
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight (brewer's yeast diet)	FD	4	36	19	17	NA	NA
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight (corn-soy diet)	FD	4	33	32	19	NA	NA
Gad and El-Twab (2009)	3.4	no effect	sodium selenite	quail (*Coturnix coturnix*)	adult	body weight	GV	4	87	NA	NA	NA	NA
Heinz and Fitzgerald (1993a)	2.0	no effect	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	adult	body weight	FD	21	95	NA	NA	NA	NA
Hill (1979a)	NR	1.1	selenium dioxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 1)	FD	4-5	101	79	32	NA	NA
Hill (1979a)	NR	2.2	selenium dioxide	chicken (*Gallus gallus domesticus*)	1 day	body weight gain (Experiment 2)	FD	4-5	100	85	35	NA	NA
Hoffman et al. (1992)	1.5	ED20	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	1 day	body weight	FD	4	86	38	NA	NA	NA
Jensen (1986)	NR	0.57	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	103	103	95	77	NA
O'Toole and Raisbeck (1997)	4.6	4.6	seleno-L-methionine	mallard (*Anas platyrhynchos*)	adult	body weight	FD	21	106	98	70	NA	NA
Santolo et al (2010)	2.9	no effect	seleno-L-methionine	quail (*Coturnix coturnix*)	adult	body weight gain	FD	4	100	95	NA	NA	NA
Sell and Horani (1976)	0.89	no effect	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	4	91	NA	NA	NA	NA
Stoewsand et al. (1977)	1.0	no effect	sodium selenite	quail (*Coturnix japonica*)	2 weeks	body weight	FD	10	91	NA	NA	NA	NA
Stoewsand et al. (1977)	1.0	no effect	seleniferous wheat	quail (*Coturnix japonica*)	2 weeks	body weight	FD	10	87	NA	NA	NA	NA
Reproduction													
Heinz et al. (1989)	1.6	0.82	selenomethionine	mallard (*Anas platyrhynchos*)	adult	% hatch of fertile eggs	FD	>14	119	101	90	62	4
Heinz et al. (1989)	0.82	1.6	selenomethionine	mallard (*Anas platyrhynchos*)	adult	duckling survival	FD	>14	98	99	100	81	0.0
Heinz et al. (1989)	0.82	ED20	selenomethionine	mallard (*Anas platyrhynchos*)	adult	number of ducklings	FD	>14	105	101	93	57	0.0
Hoffman and Heinz (1988)	2.5	2.5	sodium selenite	mallard (*Anas platyrhynchos*)	adult	hatching success	FD	NR	114	103	100	56	NA
Hoffman and Heinz (1988)	0.82	0.82	seleno-methionine	mallard (*Anas platyrhynchos*)	adult	hatching success	FD	NR	111	105	92	64	11
Kaantee and Kurkela (1980)	no stats	no effect	sodium selenite	chicken (*Gallus gallus domesticus*)	18 months	egg production	FD	4	101	84	NA	NA	NA
Ort and Latshaw (1978)	0.71	0.71	sodium selenite	chicken (*Gallus gallus domesticus*)	32 weeks	egg production (Experiment 2)	FD	16	96	96	74	NA	NA
Ort and Latshaw (1978)	0.71	ED20	sodium selenite	chicken (*Gallus gallus domesticus*)	32 weeks	hatchability (Experiment 2)	FD	16	92	73	71	NA	NA
Stone and Soares (1976)	0.14/no effect	no effect	sodium selenite	quail (*Coturnix japonica*)	adult	egg production (Experiments 1 and 3)	FD	3.9-4.6	117	NA	NA	NA	NA
Wiemeyer and Hoffman (1996)	4.2	4.2	seleno-DL-methionine	owl (*Otus asio*)	adult	% pairs with hatchlings	FD	12	75	17	NA	NA	NA
Wiemeyer and Hoffman (1996)	NR	14	seleno-DL-methionine	owl (*Otus asio*)	adult	pairs with 5 day young	FD	12	81	0.0	NA	NA	NA
Wiemeyer and Hoffman (1996)	14	14	seleno-DL-methionine	owl (*Otus asio*)	adult	% hatch of eggs incubated	FD	12	87	4.7	NA	NA	NA
Survival													
Albers et al. (1996)	11	11	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	1 year	survival	FD	16	100	95	86	0.0	NA
Arnold et al. (1973)	no stats	0.59	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	64	103	65	NA	NA	NA
El-Begearmi and Combs (1982)	2.7	2.7	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival (brewer's yeast diet)	FD	4	63	3.8	NA	NA	NA
El-Begearmi and Combs (1982)	5.4	5.4	sodium selenite	chicken (*Gallus gallus domesticus*)	1 day	survival (corn-soy diet)	FD	4	94	7.5	NA	NA	NA
El-Begearmi et al. (1977)	no stats	no effect	sodium selenite	quail (*Coturnix japonica*)	1 day	survival (males)	FD	16	89	NA	NA	NA	NA
El-Begearmi et al. (1977)	no stats	1.6	sodium selenite	quail (*Coturnix japonica*)	1 day	survival (females)	FD	16	57	NA	NA	NA	NA
Gad and El-Twab (2009)	no stats	no effect	sodium selenite	quail (*Coturnix japonica*)	adult	survival	GV	4	86	NA	NA	NA	NA
Heinz and Fitzgerald (1993b)	2.0	2.0	seleno-DL-methionine	mallard (*Anas platyrhynchos*)	adult (male)	survival	FD	16	100	75	5.0	0.0	NA
Khan et al. (1993)	no stats	2.5	sodium selenite	chicken (*Gallus gallus domesticus*)	2 weeks	survival	GV	0.86	60	NA	NA	NA	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-15. Selenium TRV Data for Mammals

									Dose (mg/kg bw/day)								
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	4	5	6	7	Notes
Growth																	
Baker et al. (1989)	no stats	no effect	sodium selenate	pig (*Sus domesticus*)	8-14 weeks	body weight	FD	3.7	0.020	0.63	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Behne et al. (1992)	0.15	no effect	L-selenomethionine	rat (*Rattus norvegicus*)	30 days	body weight	FD	14	0.023	0.15	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Birt et al. (1983)	0.43	no effect	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	body weight	FD	25	0.0017	0.0060	0.0077	0.010	0.023	0.044	0.43	0.85	calculated from body weight and FIR
Birt et al. (1986)	0.0065	no effect	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	body weight	FD	64	0.0011	0.0065	0.27	NA	NA	NA	NA	NA	calculated from body weight and FIR
Boylan et al. (1990)	0.22	no effect	sodium selenite	mouse (*Mus musculus*)	NR	body weight	FD	26	0.041	0.22	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Goehring et al. (1984)	0.58	0.87	seleniferous grain	rat (*Rattus norvegicus*)	adult assumed based on body weight	body weight gain	FD	4	0.049	0.27	0.58	0.87	NA	NA	NA	NA	calculated from body weight and FIR
Goehring et al. (1984)	0.60	0.60	sodium selenite	rat (*Rattus norvegicus*)	adult assumed based on body weight	body weight gain	FD	4	0.057	0.28	0.60	0.88	NA	NA	NA	NA	calculated from body weight and FIR
Kaur and Parshad (1994)	0.095	0.19	sodium selenite	rat (*Rattus norvegicus*)	adult	body weight	FD	5.1	0.0	0.095	0.19	NA	NA	NA	NA	NA	calculated from body weight and FIR
Julius et al. (1983)	2.6	2.6	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	male body weight (Experiment 1)	FD	3	0.033	1.3	2.6	5.3	11	NA	NA	NA	calculated from body weight and FIR
Julius et al. (1983)	2.3	4.7	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	female body weight (Experiment 1)	FD	3	0.029	1.2	2.3	4.7	9.4	NA	NA	NA	calculated from body weight and FIR
Julius et al. (1983)	1.4	1.4	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	male body weight (Experiment 2)	FD	3	0.014	0.72	1.4	NA	NA	NA	NA	NA	calculated from body weight and FIR
Mahan and Moxon (1984)	no stats	ED20	sodium selenite	pig (*Sus domesticus*)	weanlings, 4 weeks	body weight	FD	5.3	0.0	0.10	0.20	0.31	0.41	0.61	0.82	1.6	calculated from body weight and FIR
Spallholz et al. (1973)	no stats	5.7	sodium selenite	mouse (*Mus musculus*)	weanling	body weight gain	FD	5	0.12	0.28	0.76	5.7	NA	NA	NA	NA	calculated from body weight and FIR
Wahlstrom et al. (1956)	0.56	no effect	sodium selenite	pig (*Sus domesticus*)	weanling	body weight	FD	14	0.0	0.56	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Reproduction																	
Chernoff and Kavlock (1982)	no stats	no effect	sodium selenite	mouse (*Mus musculus*)	60 days	% pregnant	GV	0.71	0.0	4.6	NA	NA	NA	NA	NA	NA	presented in paper
Gray and Kavlock (1984)	4.6	no effect	sodium selenite	mouse (*Mus musculus*)	90 days	live offspring	GV	0.71	0.0	4.6	NA	NA	NA	NA	NA	NA	presented in paper
Hardin et al. (1987)	6.4	6.4	sodium selenite	mouse (*Mus musculus*)	adult	% viable litters	GV	1.1	0.0	1.6	2.3	3.2	6.4	NA	NA	NA	presented in paper
Seidenberg et al. (1986)	no stats	5.0	sodium selenate	mouse (*Mus musculus*)	adult	number of litters born	GV	0.71	0.0	5.0	NA	NA	NA	NA	NA	NA	presented in paper
Wahlstrom and Olson (1959)	0.0011	no effect	sodium selenite	pig (*Sus domesticus*)	8 weeks	number of live piglets	FD	34	0.0	0.0011	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Webster (1979)	37	37	sodium selenite	mouse (*Mus musculus*)	adult	% with litters	FD	2.7	0.0	0.0092	0.37	3.7	37	NA	NA	NA	calculated from body weight and FIR
Survival																	
Halverson et al. (1966)	no stats	1.1	seleniferous wheat	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.073	0.24	0.41	0.58	0.74	0.91	1.1	1.2	calculated from body weight and FIR
Julius et al. (1983)	no stats	10	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	survival	FD	3	0.031	1.2	2.5	5.0	9.9	NA	NA	NA	calculated from body weight and FIR
McAdam and Levander (1987)	NR	1.2	D-selenomethionine	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.015	0.31	0.61	1.2	NA	NA	NA	NA	calculated from body weight and FIR
McAdam and Levander (1987)	NR	0.61	L-selenomethionine	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.015	0.31	0.61	1.2	NA	NA	NA	NA	calculated from body weight and FIR
McAdam and Levander (1987)	NR	0.61	sodium selenite	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.015	0.31	0.61	1.2	NA	NA	NA	NA	calculated from body weight and FIR
McAdam and Levander (1987)	NR	1.2	sodium selenate	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.015	0.31	0.61	1.2	NA	NA	NA	NA	calculated from body weight and FIR
Moxon and Mahan (1981)	no stats	0.81	sodium selenite	pig (*Sus domesticus*)	weanling	survival	FD	5.3	0.0	0.10	0.20	0.30	0.40	0.60	0.81	1.6	calculated from body weight and FIR
Palmer et al. (1982)	no stats	0.92	seleniferous corn	rat (*Rattus norvegicus*)	NR	survival	FD	4	0.025	0.92	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Spallholz et al. (1973)	no stats	5.7	sodium selenite	mouse (*Mus musculus*)	weanling	survival	FD	5	0.12	0.28	0.76	5.7	NA	NA	NA	NA	presented in paper

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-15. Selenium TRV Data for Mammals

									Body Weight (kg)								
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Source[a]
Growth																	
Baker et al. (1989)	no stats	no effect	sodium selenate	pig (*Sus domesticus*)	8-14 weeks	body weight	FD	3.7	20	20	NA	NA	NA	NA	NA	NA	Cai et al. (2009)
Behne et al. (1992)	0.15	no effect	L-selenomethionine	rat (*Rattus norvegicus*)	30 days	body weight	FD	14	0.40	0.40	NA	NA	NA	NA	NA	NA	presented in paper
Birt et al. (1983)	0.43	no effect	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	body weight	FD	25	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	presented in paper
Birt et al. (1986)	0.0065	no effect	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	body weight	FD	64	0.12	0.12	0.12	NA	NA	NA	NA	NA	presented in paper
Boylan et al. (1990)	0.22	no effect	sodium selenite	mouse (*Mus musculus*)	NR	body weight	FD	26	0.026	0.026	NA	NA	NA	NA	NA	NA	presented in paper
Goehring et al. (1984)	0.58	0.87	seleniferous grain	rat (*Rattus norvegicus*)	adult assumed based on body weight	body weight gain	FD	4	0.16	0.16	0.16	0.16	NA	NA	NA	NA	presented in paper
Goehring et al. (1984)	0.60	0.60	sodium selenite	rat (*Rattus norvegicus*)	adult assumed based on body weight	body weight gain	FD	4	0.16	0.16	0.16	0.16	NA	NA	NA	NA	presented in paper
Kaur and Parshad (1994)	0.095	0.19	sodium selenite	rat (*Rattus norvegicus*)	adult	body weight	FD	5.1	0.16	0.16	0.16	NA	NA	NA	NA	NA	presented in paper
Julius et al. (1983)	2.6	2.6	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	male body weight (Experiment 1)	FD	3	0.068	0.068	0.068	0.068	0.068	NA	NA	NA	presented in paper
Julius et al. (1983)	2.3	4.7	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	female body weight (Experiment 1)	FD	3	0.077	0.077	0.077	0.077	0.077	NA	NA	NA	presented in paper
Julius et al. (1983)	1.4	1.4	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	male body weight (Experiment 2)	FD	3	0.057	0.057	0.057	NA	NA	NA	NA	NA	presented in paper
Mahan and Moxon (1984)	no stats	ED20	sodium selenite	pig (*Sus domesticus*)	weanlings, 4 weeks	body weight	FD	5.3	13	13	13	13	13	13	13	13	presented in paper
Spallholz et al. (1973)	no stats	5.7	sodium selenite	mouse (*Mus musculus*)	weanling	body weight gain	FD	5	0.015	0.015	0.015	0.015		NA	NA	NA	presented in paper
Wahlstrom et al. (1956)	0.56	no effect	sodium selenite	pig (*Sus domesticus*)	weanling	body weight	FD	14	38	38	NA	NA	NA	NA	NA	NA	presented in paper
Reproduction																	
Chernoff and Kavlock (1982)	no stats	no effect	sodium selenite	mouse (*Mus musculus*)	60 days	% pregnant	GV	0.71	NA	NA	NA	NA	NA	NA	NA	NA	NA (dose presented)
Gray and Kavlock (1984)	4.6	no effect	sodium selenite	mouse (*Mus musculus*)	90 days	live offspring	GV	0.71	NA	NA	NA	NA	NA	NA	NA	NA	NA (dose presented)
Hardin et al. (1987)	6.4	6.4	sodium selenite	mouse (*Mus musculus*)	adult	% viable litters	GV	1.1	NA	NA	NA	NA	NA	NA	NA	NA	NA (doses presented)
Seidenberg et al. (1986)	no stats	5.0	sodium selenate	mouse (*Mus musculus*)	adult	number of litters born	GV	0.71	NA	NA	NA	NA	NA	NA	NA	NA	NA (dose presented)
Wahlstrom and Olson (1959)	0.0011	no effect	sodium selenite	pig (*Sus domesticus*)	8 weeks	number of live piglets	FD	34	64	64	NA	NA	NA	NA	NA	NA	presented in paper
Webster (1979)	37	37	sodium selenite	mouse (*Mus musculus*)	adult	% with litters	FD	2.7	0.0295	0.0295	0.0	0.0	0.0	NA	NA	NA	presented in paper
Survival																	
Halverson et al. (1966)	no stats	1.1	seleniferous wheat	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.158	0.158	0.158	0.158	0.2	0.2	0.2	0.2	presented in paper
Julius et al. (1983)	no stats	10	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	survival	FD	3	0.0725	0.0725	0.1	0.1	0.1	NA	NA	NA	presented in paper
McAdam and Levander (1987)	NR	1.2	D-selenomethionine	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.1	0.1	0.1	0.1	NA	NA	NA	NA	USEPA (1988)
McAdam and Levander (1987)	NR	0.61	L-selenomethionine	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.1	0.1	0.1	0.1	NA	NA	NA	NA	USEPA (1988)
McAdam and Levander (1987)	NR	0.61	sodium selenite	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.100	0.100	0.100	0.100	NA	NA	NA	NA	USEPA (1988)
McAdam and Levander (1987)	NR	1.2	sodium selenate	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.1	0.1	0.1	0.1	NA	NA	NA	NA	USEPA (1988)
Moxon and Mahan (1981)	no stats	0.81	sodium selenite	pig (*Sus domesticus*)	weanling	survival	FD	5.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	presented in paper
Palmer et al. (1982)	no stats	0.92	seleniferous corn	rat (*Rattus norvegicus*)	NR	survival	FD	4	0.1	0.1	NA	NA	NA	NA	NA	NA	presented in paper
Spallholz et al. (1973)	no stats	5.7	sodium selenite	mouse (*Mus musculus*)	weanling	survival	FD	5	0.0	0.0	0.0	0.0	NA	NA	NA	NA	presented in paper

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-15. Selenium TRV Data for Mammals

									Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)										
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Source [a]	Wet or Dry Weight Basis
Growth																		
Baker et al. (1989)	no stats	no effect	sodium selenate	pig (*Sus domesticus*)	8-14 weeks	body weight	FD	3.7	NA	NA	NA	NA	NA	NA	NA	NA	not needed (paper presents dose as mg per pig per day in Table 1)	dw
Behne et al. (1992)	0.15	no effect	L-selenomethionine	rat (*Rattus norvegicus*)	30 days	body weight	FD	14	0.031	0.031	NA	NA	NA	NA	NA	NA	USEPA (1988)	dw
Birt et al. (1983)	0.43	no effect	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	body weight	FD	25	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	presented in paper	dw
Birt et al. (1986)	0.0065	no effect	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	body weight	FD	64	0.0063	0.0063	0.0063	NA	NA	NA	NA	NA	presented in paper	dw
Boylan et al. (1990)	0.22	no effect	sodium selenite	mouse (*Mus musculus*)	NR	body weight	FD	26	0.0050	0.0050	NA	NA	NA	NA	NA	NA	USEPA (1988)	dw
Goehring et al. (1984)	0.58	0.87	seleniferous grain	rat (*Rattus norvegicus*)	adult assumed based on body weight	body weight gain	FD	4	0.017	0.017	0.017	0.017	NA	NA	NA	NA	USEPA (1988)	dw
Goehring et al. (1984)	0.60	0.60	sodium selenite	rat (*Rattus norvegicus*)	adult assumed based on body weight	body weight gain	FD	4	0.016	0.016	0.016	0.016	NA	NA	NA	NA	USEPA (1988)	dw
Kaur and Parshad (1994)	0.095	0.19	sodium selenite	rat (*Rattus norvegicus*)	adult	body weight	FD	5.1	0.017	0.017	0.017	NA	NA	NA	NA	NA	USEPA (1988)	dw
Julius et al. (1983)	2.6	2.6	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	male body weight (Experiment 1)	FD	3	0.0090	0.0090	0.0090	0.0090	0.0090	NA	NA	NA	presented in paper	dw
Julius et al. (1983)	2.3	4.7	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	female body weight (Experiment 1)	FD	3	0.0090	0.009	0.0090	0.0090	0.0090	NA	NA	NA	presented in paper	dw
Julius et al. (1983)	1.4	1.4	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	male body weight (Experiment 2)	FD	3	0.0082	0.0082	0.0082	NA	NA	NA	NA	NA	presented in paper	dw
Mahan and Moxon (1984)	no stats	ED20	sodium selenite	pig (*Sus domesticus*)	weanlings, 4 weeks	body weight	FD	5.3	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	presented in paper	dw
Spallholz et al. (1973)	no stats	5.7	sodium selenite	mouse (*Mus musculus*)	weanling	body weight gain	FD	5	0.0035	0.0035	0.0035	0.0035	NA	NA	NA	NA	USEPA (1988)	dw
Wahlstrom et al. (1956)	0.56	no effect	sodium selenite	pig (*Sus domesticus*)	weanling	body weight	FD	14	1.9	1.9	NA	NA	NA	NA	NA	NA	presented in paper	dw
Reproduction																		
Chernoff and Kavlock (1982)	no stats	no effect	sodium selenite	mouse (*Mus musculus*)	60 days	% pregnant	GV	0.71	NA	NA	NA	NA	NA	NA	NA	NA	NA (dose presented in paper)	NA
Gray and Kavlock (1984)	4.6	no effect	sodium selenite	mouse (*Mus musculus*)	90 days	live offspring	GV	0.71	NA	NA	NA	NA	NA	NA	NA	NA	NA (dose presented in paper)	NA
Hardin et al. (1987)	6.4	6.4	sodium selenite	mouse (*Mus musculus*)	adult	% viable litters	GV	1.1	NA	NA	NA	NA	NA	NA	NA	NA	NA (doses presented in paper)	NA
Seidenberg et al. (1986)	no stats	5.0	sodium selenate	mouse (*Mus musculus*)	adult	number of litters born	GV	0.71	NA	NA	NA	NA	NA	NA	NA	NA	NA (dose presented in paper)	NA
Wahlstrom and Olson (1959)	0.0011	no effect	sodium selenite	pig (*Sus domesticus*)	8 weeks	number of live piglets	FD	34	0.0072	0.0072	NA	NA	NA	NA	NA	NA	Nagy (2001)	dw
Webster (1979)	37	37	sodium selenite	mouse (*Mus musculus*)	adult	% with litters	FD	2.7	0.0055	0.0055	0.0055	0.0055	0.0055	NA	NA	NA	USEPA (1988)	dw
Survival																		
Halverson et al. (1966)	no stats	1.1	seleniferous wheat	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	USEPA (1988)	dw
Julius et al. (1983)	no stats	10	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	survival	FD	3	0.0090	0.0090	0.0090	0.0090	0.0090	NA	NA	NA	presented in paper	dw
McAdam and Levander (1987)	NR	1.2	D-selenomethionine	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.012	0.012	0.012	0.012	NA	NA	NA	NA	USEPA (1988)	dw
McAdam and Levander (1987)	NR	0.61	L-selenomethionine	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.012	0.012	0.012	0.012	NA	NA	NA	NA	USEPA (1988)	dw
McAdam and Levander (1987)	NR	0.61	sodium selenite	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.012	0.012	0.012	0.012	NA	NA	NA	NA	USEPA (1988)	dw
McAdam and Levander (1987)	NR	1.2	sodium selenate	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.012	0.012	0.012	0.012	NA	NA	NA	NA	USEPA (1988)	dw
Moxon and Mahan (1981)	no stats	0.81	sodium selenite	pig (*Sus domesticus*)	weanling	survival	FD	5.3	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	presented in paper	dw
Palmer et al. (1982)	no stats	0.92	seleniferous corn	rat (*Rattus norvegicus*)	NR	survival	FD	4	0.016	0.016	NA	NA	NA	NA	NA	NA	USEPA (1988)	dw
Spallholz et al. (1973)	no stats	5.7	sodium selenite	mouse (*Mus musculus*)	weanling	survival	FD	5	0.0035	0.0035	0.0035	0.0035	NA	NA	NA	NA	USEPA (1988)	dw

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-15. Selenium TRV Data for Mammals

									Concentration in Food (mg/kg)								
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control[c]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Wet or Dry Weight Basis
Growth																	
Baker et al. (1989)	no stats	no effect	sodium selenate	pig (*Sus domesticus*)	8-14 weeks	body weight	FD	3.7	0.40	27	NA	NA	NA	NA	NA	NA	dw
Behne et al. (1992)	0.15	no effect	L-selenomethionine	rat (*Rattus norvegicus*)	30 days	body weight	FD	14	0.30	2.0	NA	NA	NA	NA	NA	NA	dw
Birt et al. (1983)	0.43	no effect	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	body weight	FD	25	0.020	0.070	0.090	0.12	0.27	0.52	5.0	10	dw
Birt et al. (1986)	0.0065	no effect	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	body weight	FD	64	0.020	0.12	5.0	NA	NA	NA	NA	NA	dw
Boylan et al. (1990)	0.22	no effect	sodium selenite	mouse (*Mus musculus*)	NR	body weight	FD	26	0.21	1.2	NA	NA	NA	NA	NA	NA	dw
Goehring et al. (1984)	0.58	0.87	seleniferous grain	rat (*Rattus norvegicus*)	adult assumed based on body weight	body weight gain	FD	4	0.47	2.6	5.6	8.4	NA	NA	NA	NA	dw
Goehring et al. (1984)	0.60	0.60	sodium selenite	rat (*Rattus norvegicus*)	adult assumed based on body weight	body weight gain	FD	4	0.54	2.6	5.7	8.3	NA	NA	NA	NA	dw
Kaur and Parshad (1994)	0.095	0.19	sodium selenite	rat (*Rattus norvegicus*)	adult	body weight	FD	5.1	0.0	0.91	1.8	NA	NA	NA	NA	NA	dw
Julius et al. (1983)	2.6	2.6	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	male body weight (Experiment 1)	FD	3	0.25	10	20	40	80	NA	NA	NA	dw
Julius et al. (1983)	2.3	4.7	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	female body weight (Experiment 1)	FD	3	0.25	10	20	40	80	NA	NA	NA	dw
Julius et al. (1983)	1.4	1.4	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	male body weight (Experiment 2)	FD	3	0.10	5.0	10	NA	NA	NA	NA	NA	dw
Mahan and Moxon (1984)	no stats	ED20	sodium selenite	pig (*Sus domesticus*)	weanlings, 4 weeks	body weight	FD	5.3	0.0	2.5	5.0	7.5	10	15	20	40	dw
Spallholz et al. (1973)	no stats	5.7	sodium selenite	mouse (*Mus musculus*)	weanling	body weight gain	FD	5	0.50	1.2	3.3	NA	NA	NA	NA	NA	dw
Wahlstrom et al. (1956)	0.56	no effect	sodium selenite	pig (*Sus domesticus*)	weanling	body weight	FD	14	0.0	11	NA	NA	NA	NA	NA	NA	dw
Reproduction																	
Chernoff and Kavlock (1982)	no stats	no effect	sodium selenite	mouse (*Mus musculus*)	60 days	% pregnant	GV	0.71	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gray and Kavlock (1984)	4.6	no effect	sodium selenite	mouse (*Mus musculus*)	90 days	live offspring	GV	0.71	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hardin et al. (1987)	6.4	6.4	sodium selenite	mouse (*Mus musculus*)	adult	% viable litters	GV	1.1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Seidenberg et al. (1986)	no stats	5.0	sodium selenate	mouse (*Mus musculus*)	adult	number of litters born	GV	0.71	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wahlstrom and Olson (1959)	0.0011	no effect	sodium selenite	pig (*Sus domesticus*)	8 weeks	number of live piglets	FD	34	0.00	10	NA	NA	NA	NA	NA	NA	dw
Webster (1979)	37	37	sodium selenite	mouse (*Mus musculus*)	adult	% with litters	FD	2.7	0.0	0.050	2.0	20	200	NA	NA	NA	dw
Survival																	
Halverson et al. (1966)	no stats	1.1	seleniferous wheat	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.70	2.3	3.9	5.5	7.1	8.7	10	12	dw
Julius et al. (1983)	no stats	10	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	survival	FD	3	0.25	10	20	40	80	NA	NA	NA	dw
McAdam and Levander (1987)	NR	1.2	D-selenomethionine	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.12	2.5	5.0	10	NA	NA	NA	NA	dw
McAdam and Levander (1987)	NR	0.61	L-selenomethionine	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.12	2.5	5.0	10	NA	NA	NA	NA	dw
McAdam and Levander (1987)	NR	0.61	sodium selenite	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.12	2.5	5.0	10	NA	NA	NA	NA	dw
McAdam and Levander (1987)	NR	1.2	sodium selenate	rat (*Rattus norvegicus*)	weanling	survival	FD	6	0.12	2.5	5.0	10	NA	NA	NA	NA	dw
Moxon and Mahan (1981)	no stats	0.81	sodium selenite	pig (*Sus domesticus*)	weanling	survival	FD	5.3	0.0	2.5	5.0	7.5	10	15	20	40	dw
Palmer et al. (1982)	no stats	0.92	seleniferous corn	rat (*Rattus norvegicus*)	NR	survival	FD	4	0.23	8.6	NA	NA	NA	NA	NA	NA	dw
Spallholz et al. (1973)	no stats	5.7	sodium selenite	mouse (*Mus musculus*)	weanling	survival	FD	5	0.50	1.2	3.3	NA	NA	NA	NA	NA	dw

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-15. Selenium TRV Data for Mammals

									Effect								
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Measurement
Growth																	
Baker et al. (1989)	no stats	no effect	sodium selenate	pig (*Sus domesticus*)	8-14 weeks	body weight	FD	3.7	27	25	NA	NA	NA	NA	NA	NA	final body weight, calculated as initial body weight (kg) plus weight gain after 26 days (some were euthanized starting at this date)
Behne et al. (1992)	0.15	no effect	L-selenomethionine	rat (*Rattus norvegicus*)	30 days	body weight	FD	14	400	340	NA	NA	NA	NA	NA	NA	final body weight (g)
Birt et al. (1983)	0.43	no effect	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	body weight	FD	25	185	184	193	204	180	191	172	158	final weight (g) = body weight gain + initial weight (62 g)
Birt et al. (1986)	0.0065	no effect	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	body weight	FD	64	159	142	135	NA	NA	NA	NA	NA	male body weight (g) at 64 weeks estimated from Figure 1 for semi-purified diet
Boylan et al. (1990)	0.22	no effect	sodium selenite	mouse (*Mus musculus*)	NR	body weight	FD	26	26	23	NA	NA	NA	NA	NA	NA	mean body weight (g)
Goehring et al. (1984)	0.58	0.87	seleniferous grain	rat (*Rattus norvegicus*)	adult assumed based on body weight	body weight gain	FD	4	7.3	6.6	6.3	5.7	NA	NA	NA	NA	average daily weight gain (g)
Goehring et al. (1984)	0.60	0.60	sodium selenite	rat (*Rattus norvegicus*)	adult assumed based on body weight	body weight gain	FD	4	6.8	7.0	4.9	3.2	NA	NA	NA	NA	average daily weight gain (g)
Kaur and Parshad (1994)	0.095	0.19	sodium selenite	rat (*Rattus norvegicus*)	adult	body weight	FD	5.1	0.18	0.15	0.14	NA	NA	NA	NA	NA	mean body weight (kg), estimated from Figure 1A in paper
Julius et al. (1983)	2.6	2.6	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	male body weight (Experiment 1)	FD	3	112	105	88	78	62	NA	NA	NA	final body weight male - calculated from initial body weight (68 g) + body weight gain in Table 2 in paper
Julius et al. (1983)	2.3	4.7	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	female body weight (Experiment 1)	FD	3	104	96	92	72	42	NA	NA	NA	final body weight female - calculated from initial body weight (77 g) + body weight gain in Table 2 in paper
Julius et al. (1983)	1.4	1.4	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	male body weight (Experiment 2)	FD	3	117	113	90	NA	NA	NA	NA	NA	final body weight male - calculated from initial body weight (68 g) + body weight gain in Table 5 in paper
Mahan and Moxon (1984)	no stats	ED20	sodium selenite	pig (*Sus domesticus*)	weanlings, 4 weeks	body weight	FD	5.3	19	19	17	16	15	11	9.1	5.7	final weight (kg)
Spallholz et al. (1973)	no stats	5.7	sodium selenite	mouse (*Mus musculus*)	weanling	body weight gain	FD	5	13	13	14	7.3	NA	NA	NA	NA	body weight gain (g)
Wahlstrom et al. (1956)	0.56	no effect	sodium selenite	pig (*Sus domesticus*)	weanling	body weight	FD	14	64	53	NA	NA	NA	NA	NA	NA	final weight, reported in lb and converted to kg
Reproduction																	
Chernoff and Kavlock (1982)	no stats	no effect	sodium selenite	mouse (*Mus musculus*)	60 days	% pregnant	GV	0.71	80	77	NA	NA	NA	NA	NA	NA	% pregnant
Gray and Kavlock (1984)	4.6	no effect	sodium selenite	mouse (*Mus musculus*)	90 days	live offspring	GV	0.71	11	9.4	NA	NA	NA	NA	NA	NA	number of live offspring at day 3
Hardin et al. (1987)	6.4	6.4	sodium selenite	mouse (*Mus musculus*)	adult	% viable litters	GV	1.1	each treatment group had its own control; calculations provided in Effect Relative to Control cells								% viable litters
Seidenberg et al. (1986)	no stats	5.0	sodium selenate	mouse (*Mus musculus*)	adult	number of litters born	GV	0.71	26	12	NA	NA	NA	NA	NA	NA	number of litters born
Wahlstrom and Olson (1959)	0.0011	no effect	sodium selenite	pig (*Sus domesticus*)	8 weeks	number of live piglets	FD	34	9.3	7.5	NA	NA	NA	NA	NA	NA	average number of live piglets farrowed
Webster (1979)	37	37	sodium selenite	mouse (*Mus musculus*)	adult	% with litters	FD	2.7	88	80	90	80	40	NA	NA	NA	% with litters
Survival																	
Halverson et al. (1966)	no stats	1.1	seleniferous wheat	rat (*Rattus norvegicus*)	weanling	survival	FD	6	100	100	100	100	100	88	38	0.0	% survival
Julius et al. (1983)	no stats	10	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	survival	FD	3	100	100	80	100	70	NA	NA	NA	% survival
McAdam and Levander (1987)	NR	1.2	D-selenomethionine	rat (*Rattus norvegicus*)	weanling	survival	FD	6	100	100	88	0.0	NA	NA	NA	NA	survival
McAdam and Levander (1987)	NR	0.61	L-selenomethionine	rat (*Rattus norvegicus*)	weanling	survival	FD	6	100	100	63	0.0	NA	NA	NA	NA	survival
McAdam and Levander (1987)	NR	0.61	sodium selenite	rat (*Rattus norvegicus*)	weanling	survival	FD	6	100	100	38	0.0	NA	NA	NA	NA	survival
McAdam and Levander (1987)	NR	1.2	sodium selenate	rat (*Rattus norvegicus*)	weanling	survival	FD	6	100	75	88	0.0	NA	NA	NA	NA	survival
Moxon and Mahan (1981)	no stats	0.81	sodium selenite	pig (*Sus domesticus*)	weanling	survival	FD	5.3	100	100	100	100	100	100	75	0.0	survival
Palmer et al. (1982)	no stats	0.92	seleniferous corn	rat (*Rattus norvegicus*)	NR	survival	FD	4	100	80	NA	NA	NA	NA	NA	NA	% survival
Spallholz et al. (1973)	no stats	5.7	sodium selenite	mouse (*Mus musculus*)	weanling	survival	FD	5	8.0	8.0	7.0	5.0	NA	NA	NA	NA	number surviving

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-15. Selenium TRV Data for Mammals

									Effect Relative to Control (%)						
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7
Growth															
Baker et al. (1989)	no stats	no effect	sodium selenate	pig (*Sus domesticus*)	8-14 weeks	body weight	FD	3.7	95	NA	NA	NA	NA	NA	NA
Behne et al. (1992)	0.15	no effect	L-selenomethionine	rat (*Rattus norvegicus*)	30 days	body weight	FD	14	85	NA	NA	NA	NA	NA	NA
Birt et al. (1983)	0.43	no effect	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	body weight	FD	25	99	104	110	97	103	93	85
Birt et al. (1986)	0.0065	no effect	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	body weight	FD	64	89	85	NA	NA	NA	NA	NA
Boylan et al. (1990)	0.22	no effect	sodium selenite	mouse (*Mus musculus*)	NR	body weight	FD	26	88	NA	NA	NA	NA	NA	NA
Goehring et al. (1984)	0.58	0.87	seleniferous grain	rat (*Rattus norvegicus*)	adult assumed based on body weight	body weight gain	FD	4	90	86	78	NA	NA	NA	NA
Goehring et al. (1984)	0.60	0.60	sodium selenite	rat (*Rattus norvegicus*)	adult assumed based on body weight	body weight gain	FD	4	103	72	47	NA	NA	NA	NA
Kaur and Parshad (1994)	0.095	0.19	sodium selenite	rat (*Rattus norvegicus*)	adult	body weight	FD	5.1	85	77	NA	NA	NA	NA	NA
Julius et al. (1983)	2.6	2.6	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	male body weight (Experiment 1)	FD	3	94	79	70	55	NA	NA	NA
Julius et al. (1983)	2.3	4.7	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	female body weight (Experiment 1)	FD	3	92	88	69	40	NA	NA	NA
Julius et al. (1983)	1.4	1.4	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	male body weight (Experiment 2)	FD	3	97	77	NA	NA	NA	NA	NA
Mahan and Moxon (1984)	no stats	ED20	sodium selenite	pig (*Sus domesticus*)	weanlings, 4 weeks	body weight	FD	5.3	99	93	86	81	60	49	30
Spallholz et al. (1973)	no stats	5.7	sodium selenite	mouse (*Mus musculus*)	weanling	body weight gain	FD	5	106	112	58	NA	NA	NA	NA
Wahlstrom et al. (1956)	0.56	no effect	sodium selenite	pig (*Sus domesticus*)	weanling	body weight	FD	14	82	NA	NA	NA	NA	NA	NA
Reproduction															
Chernoff and Kavlock (1982)	no stats	no effect	sodium selenite	mouse (*Mus musculus*)	60 days	% pregnant	GV	0.71	96	NA	NA	NA	NA	NA	NA
Gray and Kavlock (1984)	4.6	no effect	sodium selenite	mouse (*Mus musculus*)	90 days	live offspring	GV	0.71	85	NA	NA	NA	NA	NA	NA
Hardin et al. (1987)	6.4	6.4	sodium selenite	mouse (*Mus musculus*)	adult	% viable litters	GV	1.1	103	97	97	45	NA	NA	NA
Seidenberg et al. (1986)	no stats	5.0	sodium selenate	mouse (*Mus musculus*)	adult	number of litters born	GV	0.71	46	NA	NA	NA	NA	NA	NA
Wahlstrom and Olson (1959)	0.0011	no effect	sodium selenite	pig (*Sus domesticus*)	8 weeks	number of live piglets	FD	34	81	NA	NA	NA	NA	NA	NA
Webster (1979)	37	37	sodium selenite	mouse (*Mus musculus*)	adult	% with litters	FD	2.7	91	102	91	45	NA	NA	NA
Survival															
Halverson et al. (1966)	no stats	1.1	seleniferous wheat	rat (*Rattus norvegicus*)	weanling	survival	FD	6	100	100	100	100	88	38	0.0
Julius et al. (1983)	no stats	10	sodium selenite	hamster (*Mesocricetus auratus*)	4 weeks	survival	FD	3	100	80	100	70	NA	NA	NA
McAdam and Levander (1987)	NR	1.2	D-selenomethionine	rat (*Rattus norvegicus*)	weanling	survival	FD	6	100	88	0.0	NA	NA	NA	NA
McAdam and Levander (1987)	NR	0.61	L-selenomethionine	rat (*Rattus norvegicus*)	weanling	survival	FD	6	100	63	0.0	NA	NA	NA	NA
McAdam and Levander (1987)	NR	0.61	sodium selenite	rat (*Rattus norvegicus*)	weanling	survival	FD	6	100	38	0.0	NA	NA	NA	NA
McAdam and Levander (1987)	NR	1.2	sodium selenate	rat (*Rattus norvegicus*)	weanling	survival	FD	6	75	88	0.0	NA	NA	NA	NA
Moxon and Mahan (1981)	no stats	0.81	sodium selenite	pig (*Sus domesticus*)	weanling	survival	FD	5.3	100	100	100	100	100	75	0.0
Palmer et al. (1982)	no stats	0.92	seleniferous corn	rat (*Rattus norvegicus*)	NR	survival	FD	4	80	NA	NA	NA	NA	NA	NA
Spallholz et al. (1973)	no stats	5.7	sodium selenite	mouse (*Mus musculus*)	weanling	survival	FD	5	100	88	63	NA	NA	NA	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-16. Thallium TRV Data for Mammals

									Dose (mg/kg bw/day)					Body Weight (kg)				
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	Notes	Control	Dose 1	Dose 2	Dose 3	Source
Growth																		
Downs et al. (1960)	no stats	3.0	thallic oxide	rat (*Rattus norvegicus*)	weanling (male)	body weight	FD	15	0.0	1.7	3.0	NA	calculated from body weight and FIR	0.198	0.198	0.198	NA	presented in paper
Downs et al. (1960)	no stats	3.5	thallic oxide	rat (*Rattus norvegicus*)	weanling (female)	body weight	FD	15	0.0	2.0	3.5	NA	calculated from body weight and FIR	0.125	0.125	0.125	NA	presented in paper
Survival																		
Downs et al. (1960)	no stats	3.0	thallic oxide	rat (*Rattus norvegicus*)	weanling (male)	survival	FD	15	0.0	1.7	3.0	4.3	calculated from body weight and FIR	0.198	0.198	0.198	0.198	presented in paper
Downs et al. (1960)	no stats	2.0	thallic oxide	rat (*Rattus norvegicus*)	weanling (female)	survival	FD	15	0.0	2.0	3.5	5.1	calculated from body weight and FIR	0.125	0.125	0.125	0.125	presented in paper

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-16. Thallium TRV Data for Mammals

									Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)						Concentration in Food (mg/kg)				
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Source [a]	Wet or Dry Weight Basis	Control [c]	Dose 1	Dose 2	Dose 3	Wet or Dry Weight Basis
Growth																			
Downs et al. (1960)	no stats	3.0	thallic oxide	rat (*Rattus norvegicus*)	weanling (male)	body weight	FD	15	0.019	0.019	0.019	NA	USEPA (1988)	dw	0.0	17.9	31.3	NA	dw
Downs et al. (1960)	no stats	3.5	thallic oxide	rat (*Rattus norvegicus*)	weanling (female)	body weight	FD	15	0.014	0.014	0.014	NA	USEPA (1988)	dw	0.0	17.9	31.3	NA	dw
Survival																			
Downs et al. (1960)	no stats	3.0	thallic oxide	rat (*Rattus norvegicus*)	weanling (male)	survival	FD	15	0.019	0.019	0.019	0.019	USEPA (1988)	dw	0.0	17.9	31.3	44.7	dw
Downs et al. (1960)	no stats	2.0	thallic oxide	rat (*Rattus norvegicus*)	weanling (female)	survival	FD	15	0.014	0.014	0.014	0.014	USEPA (1988)	dw	0.0	17.9	31.3	44.7	dw

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match th

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-16. Thallium TRV Data for Mammals

									Effect					Effect Relative to Control (%)		
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Measurement	Dose 1	Dose 2	Dose 3
Growth																
Downs et al. (1960)	no stats	3.0	thallic oxide	rat (*Rattus norvegicus*)	weanling (male)	body weight	FD	15	0.34	0.28	0.15	NA	final average body weight (kg)	82	44	NA
Downs et al. (1960)	no stats	3.5	thallic oxide	rat (*Rattus norvegicus*)	weanling (female)	body weight	FD	15	0.20	0.19	0.15	NA	final average body weight (kg)	95	75	NA
Survival																
Downs et al. (1960)	no stats	3.0	thallic oxide	rat (*Rattus norvegicus*)	weanling (male)	survival	FD	15	80	100	20	0	% survival	125	25	0
Downs et al. (1960)	no stats	2.0	thallic oxide	rat (*Rattus norvegicus*)	weanling (female)	survival	FD	15	100	60	60	0	% survival	60	60	0

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match th

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-17. Vanadium TRV Data for Birds

									Dose (mg/kg bw/day)										
Source [a]	Reported LOAEL [b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	1	2	3	4	5	6	7	8	9	Notes
Growth																			
Berg and Lawrence (1971)	no stats	1.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	0.0	1.2	2.3	NA	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Berg and Lawrence (1971)	no stats	ED20	vanadyl sulfate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	0.0	1.2	2.3	NA	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Berg and Lawrence (1971)	no stats	1.2	vanadyl dichloride	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	0.0	1.2	2.3		NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Blalock and Hill (1987)	not clear	4.5	vanadyl chloride	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	0.0	1.1	2.2	4.5	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Cervantes and Jensen (1986)	no stats	2.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	4	0.0	0.56	1.1	2.2	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Hill (1974)	1.2	no effect	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2	0.0	1.2	NA	NA	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Hill (1979a)	1.4	1.4	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2	0.0	0.35	0.70	1.4	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Hill (1990b)	2.8	2.8	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2.7	0.0	2.8	NA	NA	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Hill (1990a)	no stats	4.5	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2.7	0.0	4.5	NA	NA	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Hill (1994)	5.6	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	hatchling	body weight	FD	2.9	0.0	5.6	NA	NA	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Nelson et al. (1962)	5.3	9.7	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	4	0.78	1.6	1.9	2.4	3.0	3.9	5.3	7.1	9.7	13	calculated from body weight and FIR
Nelson et al. (1962)	5.2	5.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	4	0.77	1.9	3.0	5.2	9.6	NA	NA	NA	NA	NA	calculated from body weight and FIR
Summers and Moran (1972)	1.1	no effect	NR	chicken (*Gallus gallus domesticus*)	chick	body weight gain	FD	3	0.0	1.1	NA	NA	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Qureshi et al. (1999)	no stats	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	3	0.0	1.1	2.8	5.6	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Reproduction																			
Hafez and Kratzer (1976b)	23	23	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	28 weeks	egg production	FD	NR	0.0	7.8	23	NA	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Kubena and Phillips (1982)	7.3	7.3	calcium orthovanadate	chicken (*Gallus gallus domesticus*)	29 weeks	egg production	FD	20	0.25	1.1	2.0	3.7	7.3	NA	NA	NA	NA	NA	calculated from body weight and FIR
Ousterhout and Berg (1980)	3.1	3.1	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	40 weeks	egg production	FD	4	0.0	1.6	3.1	NA	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Toussant and Latshaw (1994)	2.1	2.1	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	25 weeks	egg production	FD	4	0.28	2.1	NA	NA	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Survival																			
Berg and Lawrence (1971)	no stats	2.3	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	survival	FD	2	0.0	2.3	NA	NA	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Blalock and Hill (1987)	not clear	4.5	vanadyl chloride	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	3	0.0	1.1	2.2	4.5	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Hafez and Kratzer (1976a)	no stats	22	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	4	0.0	5.6	11	22	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Hafez and Kratzer (1976a)	no stats	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 2)	FD	4	0.0	5.6	11	22	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Hathcock et al. (1964)	3.2	3.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	2	0.0	1.3	3.2	NA	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Hathcock et al. (1964)	3.2	3.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 2)	FD	2	0.0	3.2	NA	NA	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Hathcock et al. (1964)	3.2	3.2	vanadyl sulfate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	2	0.0	3.2	NA	NA	NA	NA	NA	NA	NA	NA	calculated from body weight and FIR
Kubena and Phillips (1982)	no stats	7.3	calcium orthovanadate	chicken (*Gallus gallus domesticus*)	29 weeks	survival	FD	20	0.2	1.1	2.0	3.7	7.3	NA	NA	NA	NA	NA	calculated from body weight and FIR

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentration.

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-17. Vanadium TRV Data for Birds

									Body Weight (kg)										
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Dose 8	Dose 9	Source[a]
Growth																			
Berg and Lawrence (1971)	no stats	1.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	0.060	0.060	0.060	NA	NA	NA	NA	NA	NA	NA	USEPA (1988)
Berg and Lawrence (1971)	no stats	ED20	vanadyl sulfate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	0.060	0.060	0.060	NA	NA	NA	NA	NA	NA	NA	USEPA (1988)
Berg and Lawrence (1971)	no stats	1.2	vanadyl dichloride	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	0.060	0.060	0.060	NA	NA	NA	NA	NA	NA	NA	USEPA (1988)
Blalock and Hill (1987)	not clear	4.5	vanadyl chloride	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	0.36	0.36	0.36	0.36	NA	NA	NA	NA	NA	NA	NRC (1994)
Cervantes and Jensen (1986)	no stats	2.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	4	0.36	0.36	0.36	0.36	NA	NA	NA	NA	NA	NA	NRC (1994)
Hill (1974)	1.2	no effect	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2	0.25	0.25	NA	NA	NA	NA	NA	NA	NA	NA	NRC (1994)
Hill (1979a)	1.4	1.4	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2	0.25	0.25	0.25	0.25	NA	NA	NA	NA	NA	NA	NRC (1994)
Hill (1990b)	2.8	2.8	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2.7	0.36	0.36	NA	NA	NA	NA	NA	NA	NA	NA	NRC (1994)
Hill (1990a)	no stats	4.5	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2.7	0.36	0.36	NA	NA	NA	NA	NA	NA	NA	NA	NRC (1994)
Hill (1994)	5.6	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	hatchling	body weight	FD	2.9	0.36	0.36	NA	NA	NA	NA	NA	NA	NA	NA	NRC (1994)
Nelson et al. (1962)	5.3	9.7	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	4	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	NRC (1994)
Nelson et al. (1962)	5.2	5.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	4	0.085	0.085	0.085	0.085	0.085	NA	NA	NA	NA	NA	USEPA (1988)
Summers and Moran (1972)	1.1	no effect	NR	chicken (*Gallus gallus domesticus*)	chick	body weight gain	FD	3	0.070	0.070	NA	NA	NA	NA	NA	NA	NA	NA	USEPA (1988)
Qureshi et al. (1999)	no stats	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	3	0.36	0.36	0.36	0.36	NA	NA	NA	NA	NA	NA	NRC (1994)
Reproduction																			
Hafez and Kratzer (1976b)	23	23	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	28 weeks	egg production	FD	NR	0.80	0.80	0.80	NA	NA	NA	NA	NA	NA	NA	USEPA (1988)
Kubena and Phillips (1982)	7.3	7.3	calcium orthovanadate	chicken (*Gallus gallus domesticus*)	29 weeks	egg production	FD	20	1.5	1.5	1.5	1.5	1.5	NA	NA	NA	NA	NA	presented in paper
Ousterhout and Berg (1980)	3.1	3.1	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	40 weeks	egg production	FD	4	0.80	0.80	0.80	NA	NA	NA	NA	NA	NA	NA	USEPA (1988)
Toussant and Latshaw (1994)	2.1	2.1	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	25 weeks	egg production	FD	4	0.80	0.80	NA	NA	NA	NA	NA	NA	NA	NA	USEPA (1988)
Survival																			
Berg and Lawrence (1971)	no stats	2.3	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	survival	FD	2	0.060	0.060	NA	NA	NA	NA	NA	NA	NA	NA	USEPA (1988)
Blalock and Hill (1987)	not clear	4.5	vanadyl chloride	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	3	0.36	0.36	0.36	0.36	NA	NA	NA	NA	NA	NA	NRC (1994)
Hafez and Kratzer (1976a)	no stats	22	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	4	0.36	0.36	0.36	0.36	NA	NA	NA	NA	NA	NA	NRC (1994)
Hafez and Kratzer (1976a)	no stats	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 2)	FD	4	0.36	0.36	0.36	0.36	NA	NA	NA	NA	NA	NA	NRC (1994)
Hathcock et al. (1964)	3.2	3.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	2	0.15	0.15	0.15	NA	NA	NA	NA	NA	NA	NA	NRC (1994)
Hathcock et al. (1964)	3.2	3.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 2)	FD	2	0.15	0.15	0.15	NA	NA	NA	NA	NA	NA	NA	NRC (1994)
Hathcock et al. (1964)	3.2	3.2	vanadyl sulfate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	2	0.15	0.15	NA	NA	NA	NA	NA	NA	NA	NA	NRC (1994)
Kubena and Phillips (1982)	no stats	7.3	calcium orthovanadate	chicken (*Gallus gallus domesticus*)	29 weeks	survival	FD	20	1.55	1.55	1.5	1.5	1.5	NA	NA	NA	NA	NA	presented in paper

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentra

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-17. Vanadium TRV Data for Birds

Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Food Ingestion Rate (kg/day) or Drinking Water Ingestion Rate (L/day)											
									Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Dose 8	Dose 9	Source[a]	Wet or Dry Weight Basis
Growth																				
Berg and Lawrence (1971)	no stats	1.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	0.0070	0.0070	0.0070	NA	NA	NA	NA	NA	NA	NA	USEPA (1988)	FIR for chickens
Berg and Lawrence (1971)	no stats	ED20	vanadyl sulfate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	0.0070	0.0070	0.0070	NA	NA	NA	NA	NA	NA	NA	USEPA (1988)	FIR for chickens
Berg and Lawrence (1971)	no stats	1.2	vanadyl dichloride	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	0.0070	0.0070	0.0070	NA	NA	NA	NA	NA	NA	NA	USEPA (1988)	FIR for chickens
Blalock and Hill (1987)	not clear	4.5	vanadyl chloride	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	0.040	0.040	0.040	0.040	NA	NA	NA	NA	NA	NA	NRC (1994)	FIR for 2-week-old broiler chickens
Cervantes and Jensen (1986)	no stats	2.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	4	0.040	0.040	0.040	0.040	NA	NA	NA	NA	NA	NA	NRC (1994)	FIR for 2-week-old broiler chickens
Hill (1974)	1.2	no effect	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2	0.030	0.030	0.030	NA	NA	NA	NA	NA	NA	NA	NRC (1994)	average of 1- and 2-week FIR of broiler chickens
Hill (1979a)	1.4	1.4	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2	0.030	0.030	0.030	0.030	NA	NA	NA	NA	NA	NA	NRC (1994)	average of 1- and 2-week FIR of broiler chickens
Hill (1990b)	2.8	2.8	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2.7	0.040	0.040	NA	NA	NA	NA	NA	NA	NA	NA	NRC (1994)	FIR for 2-week-old broiler chickens
Hill (1990a)	no stats	4.5	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2.7	0.040	0.040	NA	NA	NA	NA	NA	NA	NA	NA	NRC (1994)	FIR for 2-week-old broiler chickens
Hill (1994)	5.6	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	hatchling	body weight	FD	2.9	0.040	0.040	NA	NA	NA	NA	NA	NA	NA	NA	NRC (1994)	FIR for 2-week-old broiler chickens
Nelson et al. (1962)	5.3	9.7	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	4	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	NRC (1994)	FIR for 2-week-old broiler chickens
Nelson et al. (1962)	5.2	5.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	4	0.0093	0.0093	0.0093	0.0093	0.0093	NA	NA	NA	NA	NA	USEPA (1988)	FIR for chickens
Summers and Moran (1972)	1.1	no effect	NR	chicken (*Gallus gallus domesticus*)	chick	body weight gain	FD	3	0.008	0.008	NA	NA	NA	NA	NA	NA	NA	NA	USEPA (1988)	FIR for chickens
Qureshi et al. (1999)	no stats	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	3	0.040	0.040	0.040	0.040	NA	NA	NA	NA	NA	NA	NRC (1994)	FIR for 2-week-old broiler chickens
Reproduction																				
Hafez and Kratzer (1976b)	23	23	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	28 weeks	egg production	FD	NR	0.062	0.062	0.062	NA	NA	NA	NA	NA	NA	NA	USEPA (1988)	FIR for chickens
Kubena and Phillips (1982)	7.3	7.3	calcium orthovanadate	chicken (*Gallus gallus domesticus*)	29 weeks	egg production	FD	20	0.11	0.11	0.11	0.11	0.11	NA	NA	NA	NA	NA	USEPA (1988)	FIR for chickens
Ousterhout and Berg (1980)	3.1	3.1	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	40 weeks	egg production	FD	4	0.062	0.062	0.062	NA	NA	NA	NA	NA	NA	NA	USEPA (1988)	FIR for chickens
Toussant and Latshaw (1994)	2.1	2.1	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	25 weeks	egg production	FD	4	0.062	0.062	NA	NA	NA	NA	NA	NA	NA	NA	USEPA (1988)	FIR for chickens
Survival																				
Berg and Lawrence (1971)	no stats	2.3	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	survival	FD	2	0.0070	0.0070	NA	NA	NA	NA	NA	NA	NA	NA	USEPA (1988)	FIR for chickens
Blalock and Hill (1987)	not clear	4.5	vanadyl chloride	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	3	0.040	0.040	0.040	0.040	NA	NA	NA	NA	NA	NA	NRC (1994)	FIR for 2-week-old broiler chickens
Hafez and Kratzer (1976a)	no stats	22	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	4	0.040	0.040	0.040	0.040	NA	NA	NA	NA	NA	NA	NRC (1994)	FIR for 2-week-old broiler chickens
Hafez and Kratzer (1976a)	no stats	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 2)	FD	4	0.040	0.040	0.040	0.040	NA	NA	NA	NA	NA	NA	NRC (1994)	FIR for 2-week-old broiler chickens
Hathcock et al. (1964)	3.2	3.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	2	0.019	0.019	0.019	NA	NA	NA	NA	NA	NA	NA	NRC (1994)	FIR for 1-week-old broiler chickens
Hathcock et al. (1964)	3.2	3.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 2)	FD	2	0.019	0.019	NA	NA	NA	NA	NA	NA	NA	NA	NRC (1994)	FIR for 1-week-old broiler chickens
Hathcock et al. (1964)	3.2	3.2	vanadyl sulfate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	2	0.019	0.019	NA	NA	NA	NA	NA	NA	NA	NA	NRC (1994)	FIR for 1-week-old broiler chickens
Kubena and Phillips (1982)	no stats	7.3	calcium orthovanadate	chicken (*Gallus gallus domesticus*)	29 weeks	survival	FD	20	0.11	0.11	0.11	0.11	0.11	NA	NA	NA	NA	NA	USEPA (1988)	FIR for chickens

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentra

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-17. Vanadium TRV Data for Birds

									Concentration in Food (mg/kg)										
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control[c]	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Dose 8	Dose 9	Wet or Dry Weight Basis
Growth																			
Berg and Lawrence (1971)	no stats	1.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	0.0	10	20	NA	NA	NA	NA	NA	NA	NA	dw
Berg and Lawrence (1971)	no stats	ED20	vanadyl sulfate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	0.0	10	20	NA	NA	NA	NA	NA	NA	NA	dw
Berg and Lawrence (1971)	no stats	1.2	vanadyl dichloride	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	0.0	10	20	NA	NA	NA	NA	NA	NA	NA	dw
Blalock and Hill (1987)	not clear	4.5	vanadyl chloride	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	0.0	10	20	40	NA	NA	NA	NA	NA	NA	dw
Cervantes and Jensen (1986)	no stats	2.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	4	0.0	5.0	10	20	NA	NA	NA	NA	NA	NA	dw
Hill (1974)	1.2	no effect	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2	0.0	10	NA	NA	NA	NA	NA	NA	NA	NA	dw
Hill (1979a)	1.4	1.4	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2	0.0	3.0	6.0	12	NA	NA	NA	NA	NA	NA	dw
Hill (1990b)	2.8	2.8	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2.7	0.0	25	NA	NA	NA	NA	NA	NA	NA	NA	dw
Hill (1990a)	no stats	4.5	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2.7	0.0	40	NA	NA	NA	NA	NA	NA	NA	NA	dw
Hill (1994)	5.6	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	hatchling	body weight	FD	2.9	0.0	50	NA	NA	NA	NA	NA	NA	NA	NA	dw
Nelson et al. (1962)	5.3	9.7	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	4	7.0	14	17	21	27	35	47	64	87	120	dw
Nelson et al. (1962)	5.2	5.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	4	7.0	17	27	47	87	NA	NA	NA	NA	NA	dw
Summers and Moran (1972)	1.1	no effect	NR	chicken (*Gallus gallus domesticus*)	chick	body weight gain	FD	3	0.0	10	NA	NA	NA	NA	NA	NA	NA	NA	dw
Qureshi et al. (1999)	no stats	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	3	0.0	10	25	50	NA	NA	NA	NA	NA	NA	dw
Reproduction																			
Hafez and Kratzer (1976b)	23	23	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	28 weeks	egg production	FD	NR	0.0	100	300	NA	NA	NA	NA	NA	NA	NA	dw
Kubena and Phillips (1982)	7.3	7.3	calcium orthovanadate	chicken (*Gallus gallus domesticus*)	29 weeks	egg production	FD	20	3.5	16	29	54	104	NA	NA	NA	NA	NA	dw
Ousterhout and Berg (1980)	3.1	3.1	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	40 weeks	egg production	FD	4	0.0	20	40	NA	NA	NA	NA	NA	NA	NA	dw
Toussant and Latshaw (1994)	2.1	2.1	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	25 weeks	egg production	FD	4	3.6	27	NA	NA	NA	NA	NA	NA	NA	NA	dw
Survival																			
Berg and Lawrence (1971)	no stats	2.3	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	survival	FD	2	0.0	20	NA	NA	NA	NA	NA	NA	NA	NA	dw
Blalock and Hill (1987)	not clear	4.5	vanadyl chloride	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	3	0.0	10	20	40	NA	NA	NA	NA	NA	NA	dw
Hafez and Kratzer (1976a)	no stats	22	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	4	0.0	50	100	200	NA	NA	NA	NA	NA	NA	dw
Hafez and Kratzer (1976a)	no stats	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 2)	FD	4	0.0	50	100	NA	NA	NA	NA	NA	NA	NA	dw
Hathcock et al. (1964)	3.2	3.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	2	0.0	10	25	NA	NA	NA	NA	NA	NA	NA	dw
Hathcock et al. (1964)	3.2	3.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 2)	FD	2	0.0	25	NA	NA	NA	NA	NA	NA	NA	NA	dw
Hathcock et al. (1964)	3.2	3.2	vanadyl sulfate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	2	0.0	25	NA	NA	NA	NA	NA	NA	NA	NA	dw
Kubena and Phillips (1982)	no stats	7.3	calcium orthovanadate	chicken (*Gallus gallus domesticus*)	29 weeks	survival	FD	20	3.5	16	29	54	104	NA	NA	NA	NA	NA	dw

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentra

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses.

[c] If reported, the basal diet concentration is included in the control diet concentration.

Table E2.B-17. Vanadium TRV Data for Birds

									Effect										
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Control	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Dose 8	Dose 9	Measurement
Growth																			
Berg and Lawrence (1971)	no stats	1.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	126	80	56	NA	NA	NA	NA	NA	NA	NA	final body weight (g) (Table 9 in paper)
Berg and Lawrence (1971)	no stats	ED20	vanadyl sulfate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	126	102	68	NA	NA	NA	NA	NA	NA	NA	final body weight (g) (Table 9 in paper)
Berg and Lawrence (1971)	no stats	1.2	vanadyl dichloride	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	126	95	63	NA	NA	NA	NA	NA	NA	NA	final body weight (g) (Table 9 in paper)
Blalock and Hill (1987)	not clear	4.5	vanadyl chloride	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	280	233	237	152	NA	NA	NA	NA	NA	NA	body weight (g) (adequate iron group) at 3 weeks
Cervantes and Jensen (1986)	no stats	2.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	4	739	637	650	557	NA	NA	NA	NA	NA	NA	final body weight (g) at 4 weeks (Table 2 in paper)
Hill (1974)	1.2	no effect	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2	213	185	NA	NA	NA	NA	NA	NA	NA	NA	weight gain (g)
Hill (1979a)	1.4	1.4	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2	202	202	214	157	NA	NA	NA	NA	NA	NA	weight gain (converted from % of control; with sufficient protein: 20%)
Hill (1990b)	2.8	2.8	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2.7	177	67	NA	NA	NA	NA	NA	NA	NA	NA	body weight gain (g) at 19 days (from Table 4 in paper)
Hill (1990a)	no stats	4.5	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2.7	419	231	NA	NA	NA	NA	NA	NA	NA	NA	body weight gain (g) at 19 days (from Table 1 in paper)
Hill (1994)	5.6	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	hatchling	body weight	FD	2.9	478	241	NA	NA	NA	NA	NA	NA	NA	NA	body weight (g) for 0.5% phosphorus group
Nelson et al. (1962)	5.3	9.7	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	4	470	492	477	478	479	464	431	388	318	235	body weight (g)
Nelson et al. (1962)	5.2	5.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	4	333	344	319	240	206	NA	NA	NA	NA	NA	body weight (g)
Summers and Moran (1972)	1.1	no effect	NR	chicken (*Gallus gallus domesticus*)	chick	body weight gain	FD	3	234	210	NA	NA	NA	NA	NA	NA	NA	NA	weight gain (g) for 0.7% calcium and 0.2% phosphorus group
Qureshi et al. (1999)	no stats	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	3	112	120	97	76	NA	NA	NA	NA	NA	NA	body weight (g)
Reproduction																			
Hafez and Kratzer (1976b)	23	23	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	28 weeks	egg production	FD	NR	72	73	24	NA	NA	NA	NA	NA	NA	NA	% egg production
Kubena and Phillips (1982)	7.3	7.3	calcium orthovanadate	chicken (*Gallus gallus domesticus*)	29 weeks	egg production	FD	20	56	55	57	56	17	NA	NA	NA	NA	NA	final hen-day egg production (%)
Ousterhout and Berg (1980)	3.1	3.1	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	40 weeks	egg production	FD	4	74	68	57	NA	NA	NA	NA	NA	NA	NA	% rate of lay
Toussant and Latshaw (1994)	2.1	2.1	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	25 weeks	egg production	FD	4	95	48	NA	NA	NA	NA	NA	NA	NA	NA	egg production (14 days; estimated from Figure 1 in paper)
Survival																			
Berg and Lawrence (1971)	no stats	2.3	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	survival	FD	2	100	30	NA	NA	NA	NA	NA	NA	NA	NA	% survival
Blalock and Hill (1987)	not clear	4.5	vanadyl chloride	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	3	95	100	83	15	NA	NA	NA	NA	NA	NA	% survival (for adequate iron group)
Hafez and Kratzer (1976a)	no stats	22	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	4	100	100	100	80	NA	NA	NA	NA	NA	NA	% survival
Hafez and Kratzer (1976a)	no stats	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 2)	FD	4	100	80	0.0	0.0	NA	NA	NA	NA	NA	NA	% survival
Hathcock et al. (1964)	3.2	3.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	2	85	85	5	NA	NA	NA	NA	NA	NA	NA	% survival
Hathcock et al. (1964)	3.2	3.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 2)	FD	2	95	18	NA	NA	NA	NA	NA	NA	NA	NA	% survival
Hathcock et al. (1964)	3.2	3.2	vanadyl sulfate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	2	95	15	NA	NA	NA	NA	NA	NA	NA	NA	% survival
Kubena and Phillips (1982)	no stats	7.3	calcium orthovanadate	chicken (*Gallus gallus domesticus*)	29 weeks	survival	FD	20	100	100	100	100	44	NA	NA	NA	NA	NA	% survival

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentra

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

Table E2.B-17. Vanadium TRV Data for Birds

									Effect Relative to Control (%)								
Source[a]	Reported LOAEL[b] (mg/kg bw/day)	LOAEL ≥ 20 (mg/kg bw/day)	Chemical Form	Receptor	Lifestage	Endpoint Detail	Exposure Mode	Exposure Duration (weeks unless noted otherwise)	Dose 1	Dose 2	Dose 3	Dose 4	Dose 5	Dose 6	Dose 7	Dose 8	Dose 9
Growth																	
Berg and Lawrence (1971)	no stats	1.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	63	44	NA	NA	NA	NA	NA	NA	NA
Berg and Lawrence (1971)	no stats	ED20	vanadyl sulfate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	81	54	NA	NA	NA	NA	NA	NA	NA
Berg and Lawrence (1971)	no stats	1.2	vanadyl dichloride	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	2	75	50	NA	NA	NA	NA	NA	NA	NA
Blalock and Hill (1987)	not clear	4.5	vanadyl chloride	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	3	83	85	54	NA	NA	NA	NA	NA	NA
Cervantes and Jensen (1986)	no stats	2.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight	FD	4	86	88	75	NA	NA	NA	NA	NA	NA
Hill (1974)	1.2	no effect	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2	87	NA	NA	NA	NA	NA	NA	NA	NA
Hill (1979a)	1.4	1.4	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2	100	106	78	NA	NA	NA	NA	NA	NA
Hill (1990b)	2.8	2.8	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2.7	38	NA	NA	NA	NA	NA	NA	NA	NA
Hill (1990a)	no stats	4.5	sodium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	body weight gain	FD	2.7	55	NA	NA	NA	NA	NA	NA	NA	NA
Hill (1994)	5.6	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	hatchling	body weight	FD	2.9	50	NA	NA	NA	NA	NA	NA	NA	NA
Nelson et al. (1962)	5.3	9.7	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	4	105	101	102	102	99	92	83	68	50
Nelson et al. (1962)	5.2	5.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	4	103	96	72	62	NA	NA	NA	NA	NA
Summers and Moran (1972)	1.1	no effect	NR	chicken (*Gallus gallus domesticus*)	chick	body weight gain	FD	3	90	NA	NA	NA	NA	NA	NA	NA	NA
Qureshi et al. (1999)	no stats	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	body weight	FD	3	107	87	68	NA	NA	NA	NA	NA	NA
Reproduction																	
Hafez and Kratzer (1976b)	23	23	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	28 weeks	egg production	FD	NR	101	33	NA	NA	NA	NA	NA	NA	NA
Kubena and Phillips (1982)	7.3	7.3	calcium orthovanadate	chicken (*Gallus gallus domesticus*)	29 weeks	egg production	FD	20	99	103	101	30	NA	NA	NA	NA	NA
Ousterhout and Berg (1980)	3.1	3.1	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	40 weeks	egg production	FD	4	92	77	NA	NA	NA	NA	NA	NA	NA
Toussant and Latshaw (1994)	2.1	2.1	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	25 weeks	egg production	FD	4	51	NA	NA	NA	NA	NA	NA	NA	NA
Survival																	
Berg and Lawrence (1971)	no stats	2.3	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	chick	survival	FD	2	30	NA	NA	NA	NA	NA	NA	NA	NA
Blalock and Hill (1987)	not clear	4.5	vanadyl chloride	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	3	105	87	16	NA	NA	NA	NA	NA	NA
Hafez and Kratzer (1976a)	no stats	22	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	4	100	100	80	NA	NA	NA	NA	NA	NA
Hafez and Kratzer (1976a)	no stats	5.6	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 2)	FD	4	80	0.0	0.0	NA	NA	NA	NA	NA	NA
Hathcock et al. (1964)	3.2	3.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 1)	FD	2	100	5.9	NA	NA	NA	NA	NA	NA	NA
Hathcock et al. (1964)	3.2	3.2	ammonium metavanadate	chicken (*Gallus gallus domesticus*)	1 day	survival (Experiment 2)	FD	2	18	NA	NA	NA	NA	NA	NA	NA	NA
Hathcock et al. (1964)	3.2	3.2	vanadyl sulfate	chicken (*Gallus gallus domesticus*)	1 day	survival	FD	2	16	NA	NA	NA	NA	NA	NA	NA	NA
Kubena and Phillips (1982)	no stats	7.3	calcium orthovanadate	chicken (*Gallus gallus domesticus*)	29 weeks	survival	FD	20	100	100	100	44	NA	NA	NA	NA	NA

Notes:

Concentrations in food were assumed to be reported on a dry weight (dw) basis unless clearly stated otherwise in the study. The wet weight (ww) or dw basis of the food ingestion rate (FIR) was selected to match the basis of the food concentra

[a] References are cited in Attachment E1 or Attachment E2.

[b] Lowest-observed-adverse-effect level (LOAEL) determined by study based on statistical analyses

[c] If reported, the basal diet concentration is included in the control diet concentration

ANNEX C

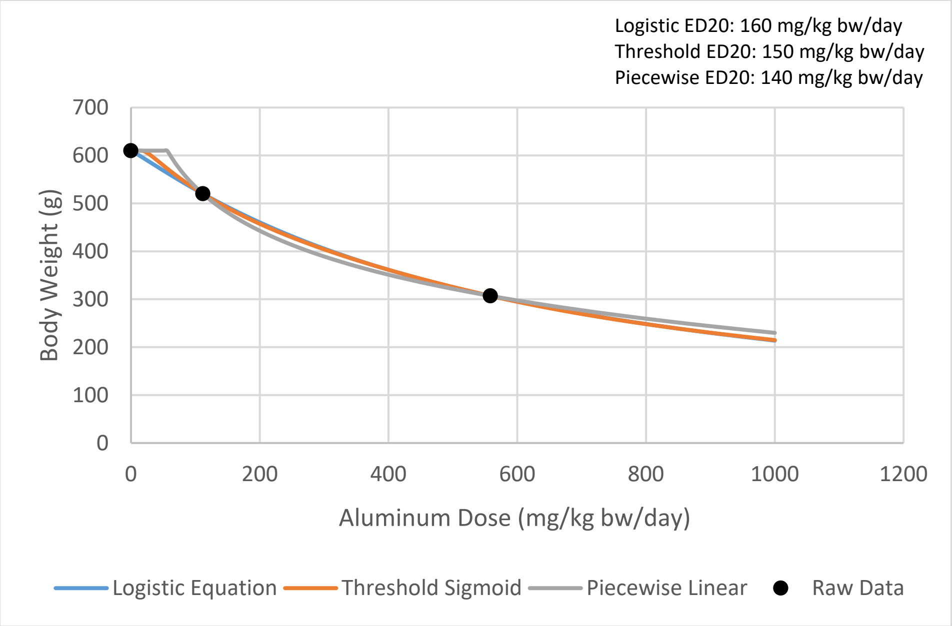
MODELED DOSE-RESPONSE CURVES

ACRONYMS AND ABBREVIATIONS

ED20	effective dose with 20 percent reduction in the response relative to the control
Exp	experiment
F1	first filial generation

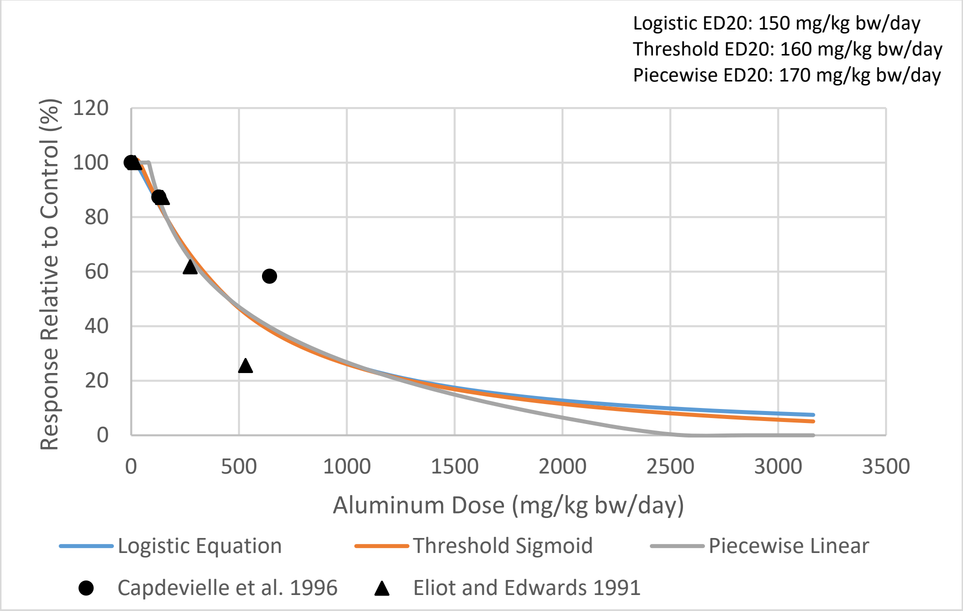
UNITS OF MEASURE

g	gram(s)
kg	kilogram(s)
mg/kg bw/day	milligram(s) per kilogram of body weight per day



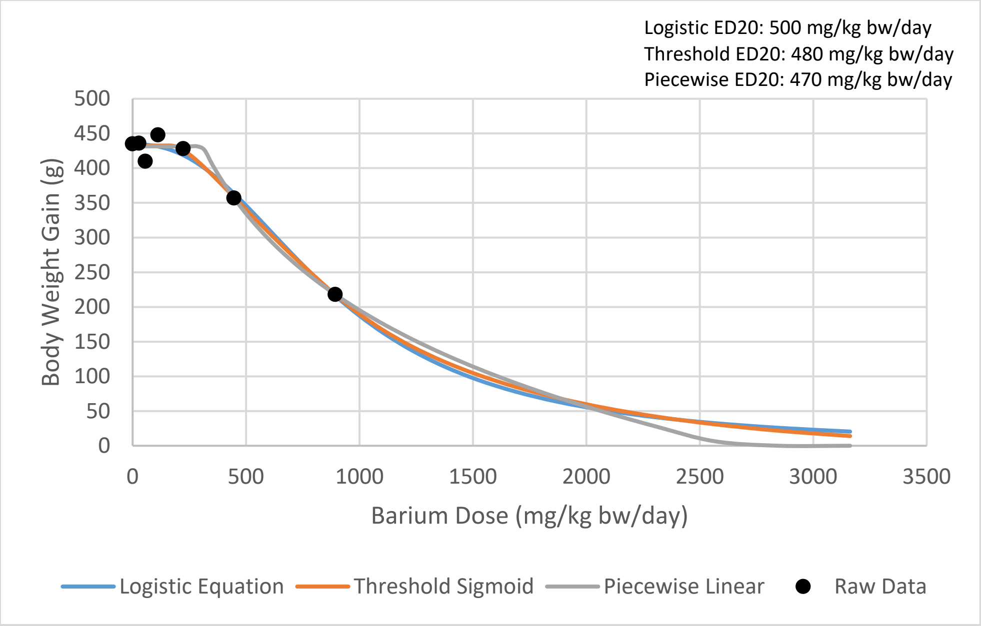
Note: Model based on log-transformed data from Capdevielle and Scanes (1995a).

Figure E2.C-1. Dose-Response Curves for Avian Growth Endpoint for Aluminum



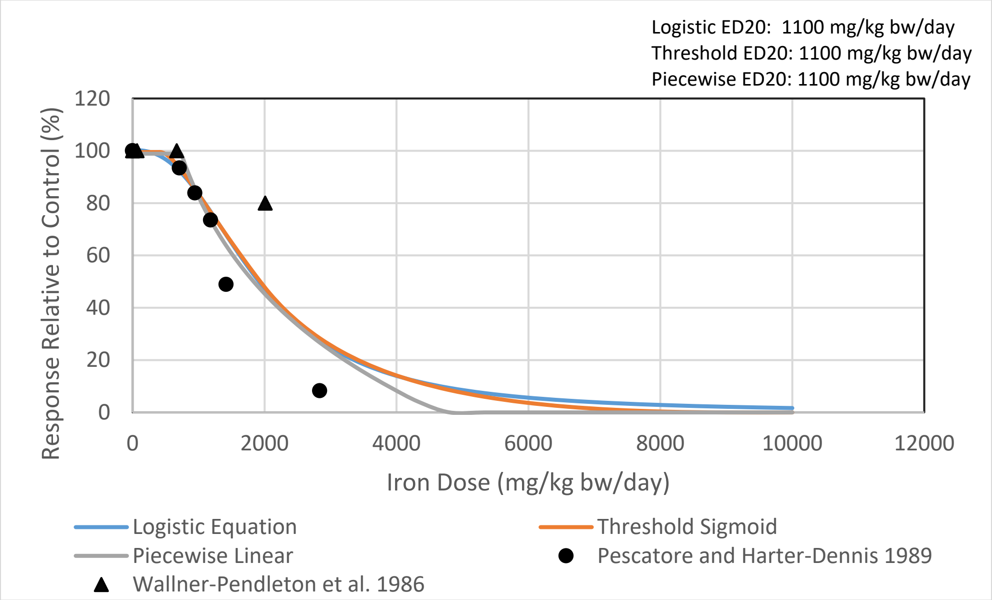
Note: Model based on log-transformed data from pooling group A.

Figure E2.C-2. Dose-Response Curves for Avian Growth Endpoint for Aluminum



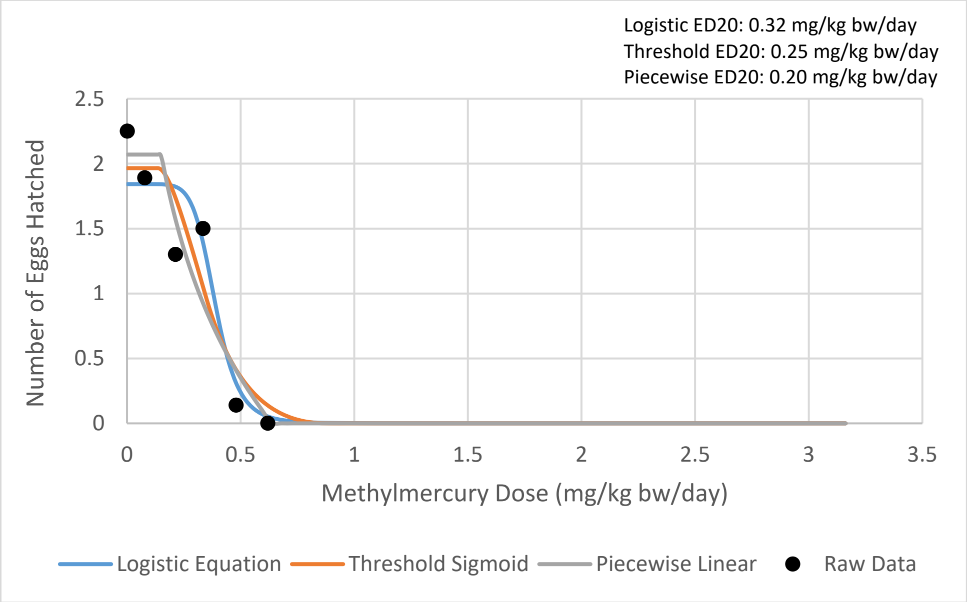
Note: Model based on log-transformed data from Johnson et al. (1960).

Figure E2.C-3. Dose-Response Curves for Avian Growth Endpoint for Barium



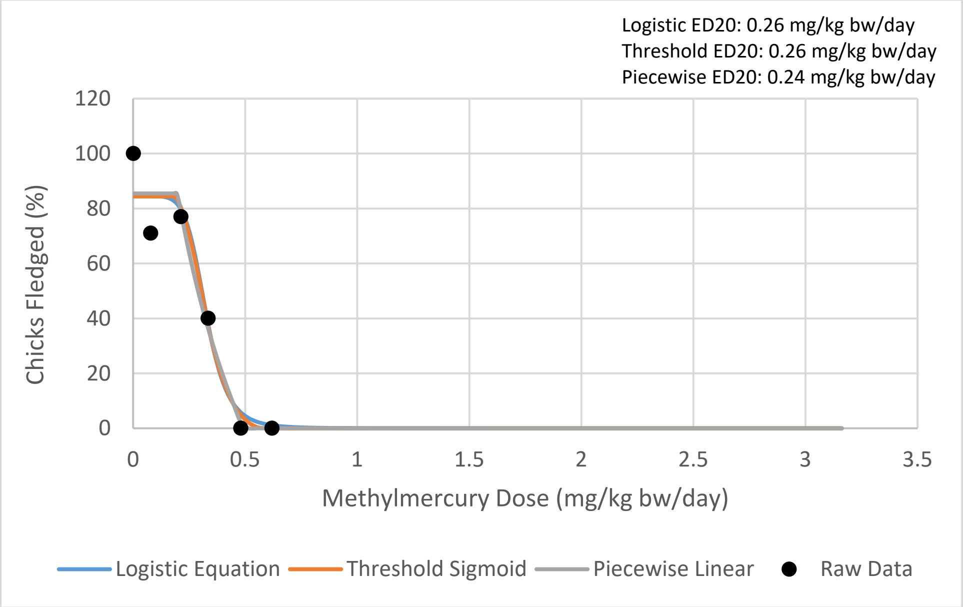
Note: Model based on log-transformed data from pooling group A.

Figure E2.C-4. Dose-Response Curves for Avian Survival Endpoint for Iron



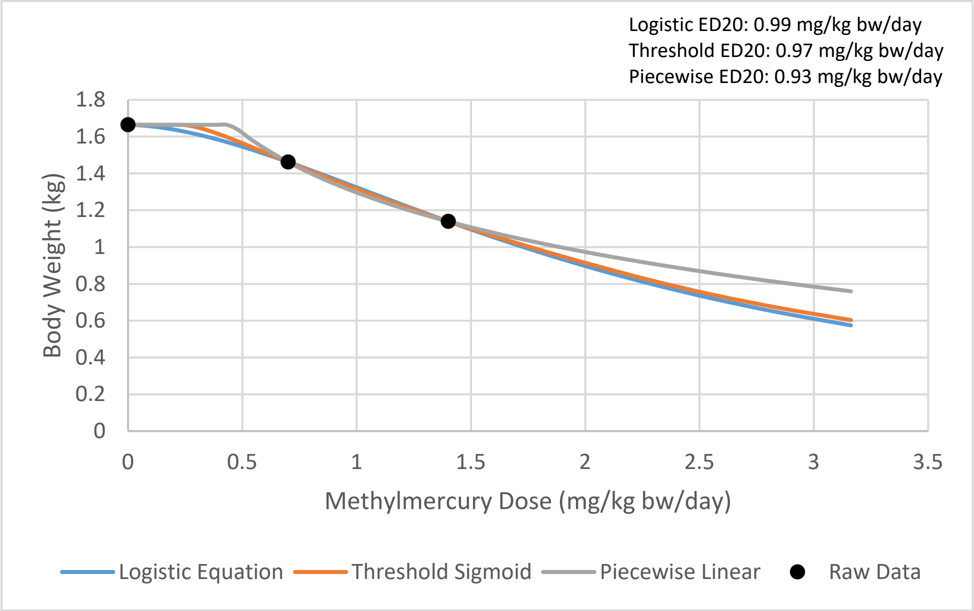
Note: Model based on log-transformed data from Albers et al. (2007).

Figure E2.C-5. Dose-Response Curves for Kestrel Reproduction Endpoint for Methylmercury



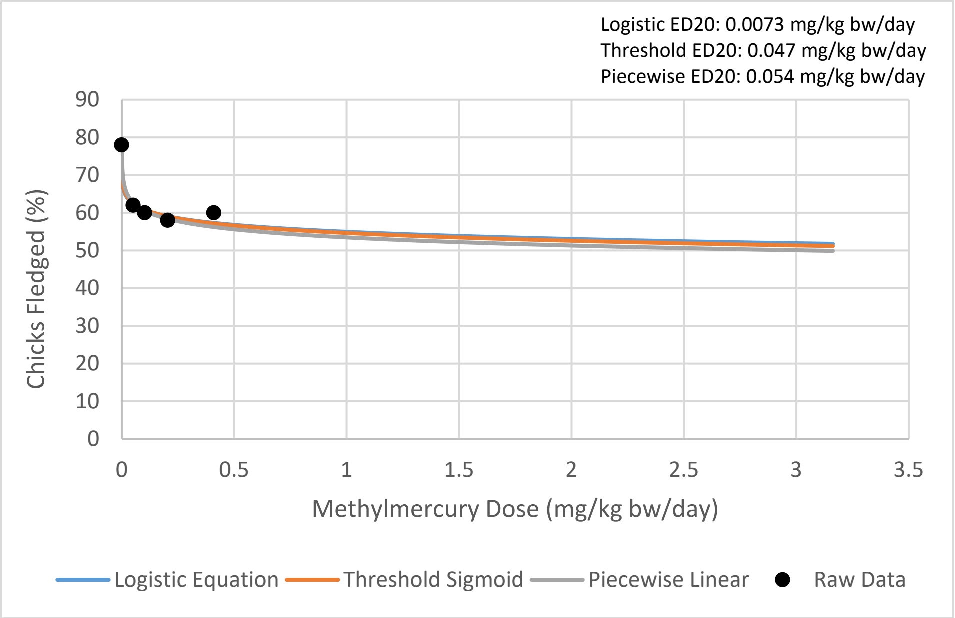
Note: Model based on log-transformed data from Albers et al. (2007).

Figure E2.C-6. Dose-Response Curves for Kestrel Reproduction Endpoint for Methylmercury



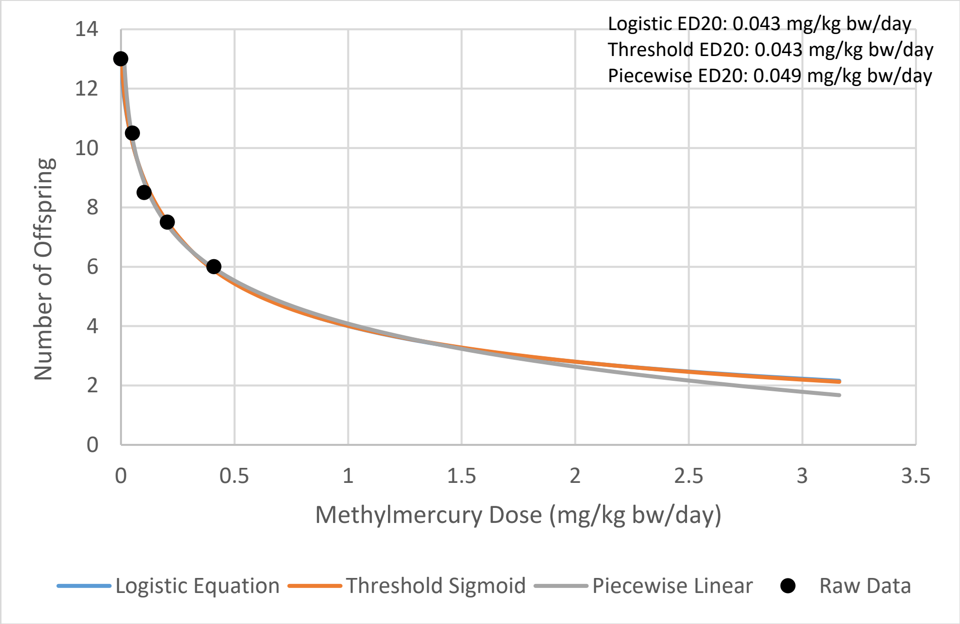
Note: Model based on log-transformed data from Scott et al. (1975).

Figure E2.C-7. Dose-Response Curves for Avian Growth Endpoint for Methylmercury



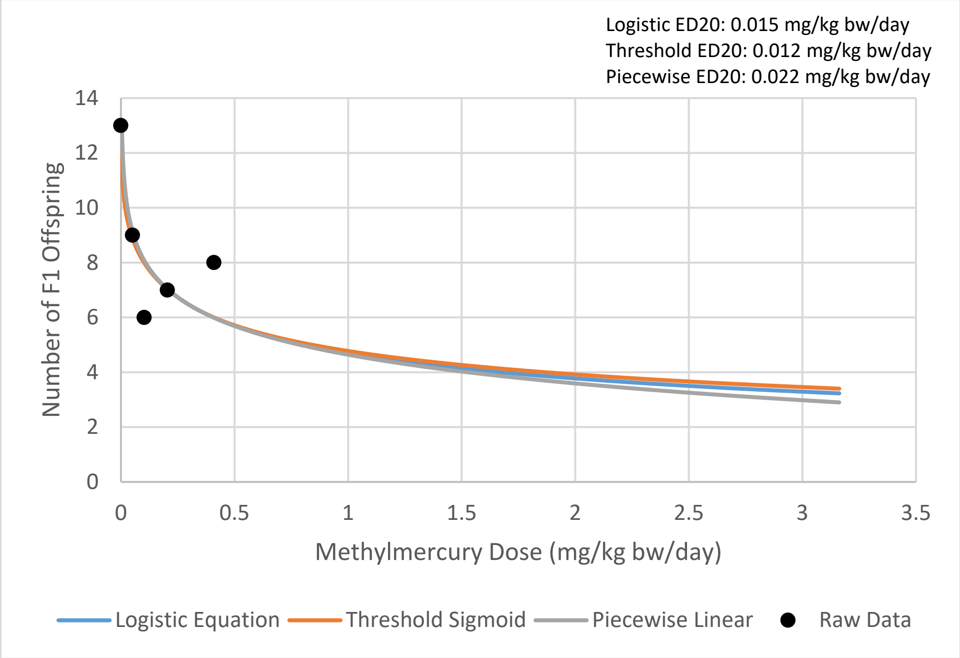
Note: Model based on log-transformed data from Varian-Ramos et al. (2014).

Figure E2.C-8. Dose-Response Curves for Avian Reproduction Endpoint for Methylmercury



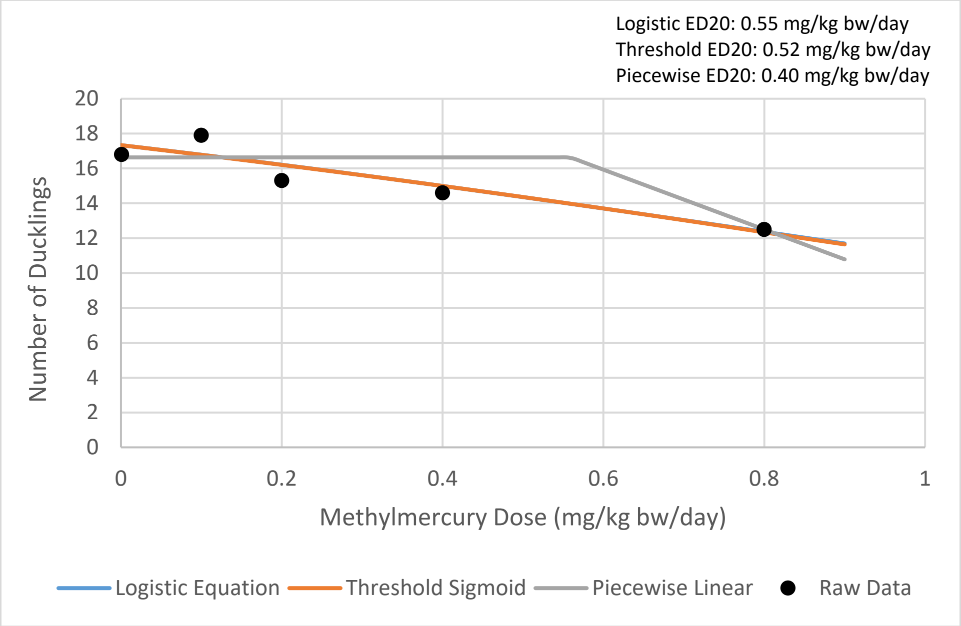
Note: Model based on log-transformed data from Varian-Ramos et al. (2014).

Figure E2.C-9. Dose-Response Curves for Avian Reproduction Endpoint for Methylmercury



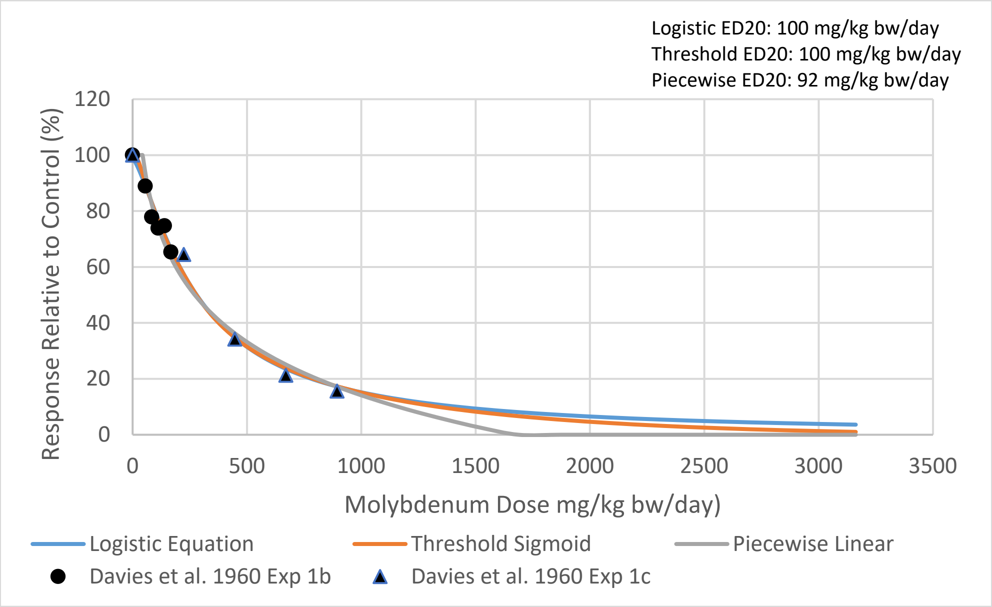
Note: Model based on log-transformed data from Varian-Ramos et al. (2014).

Figure E2.C-10. Dose-Response Curves for Avian Reproduction Endpoint for Methylmercury



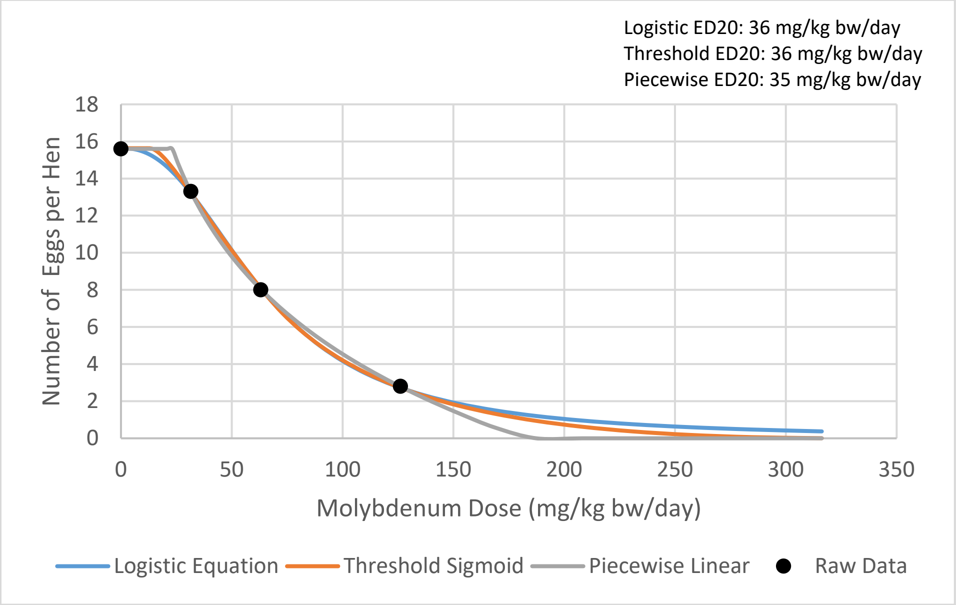
Note: Model based on log-transformed data from Heinz et al. (2010).

Figure E2.C-11. Dose-Response Curves for Avian Reproduction Endpoint for Methylmercury



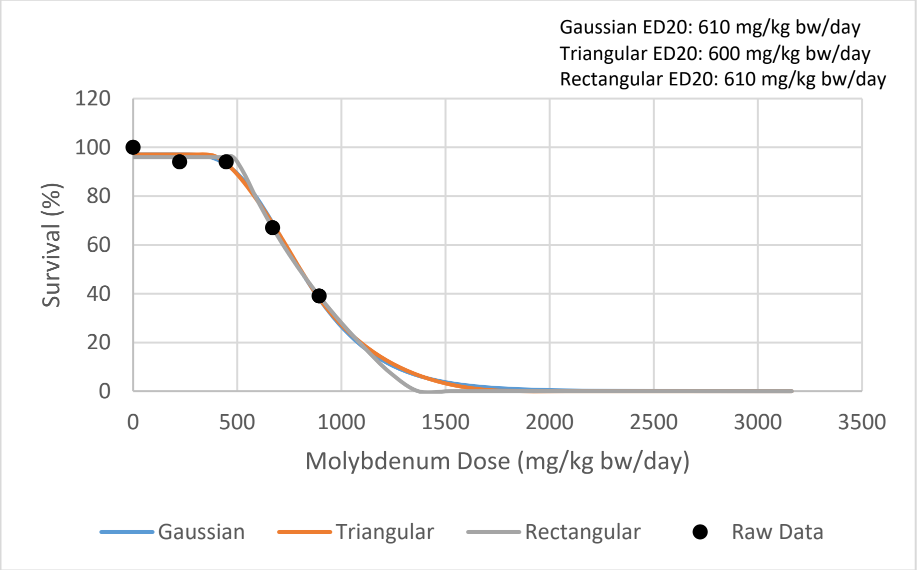
Note: Model based on log-transformed data from pooling group A.

Figure E2.C-12. Dose-Response Curves for Avian Growth Endpoint for Molybdenum



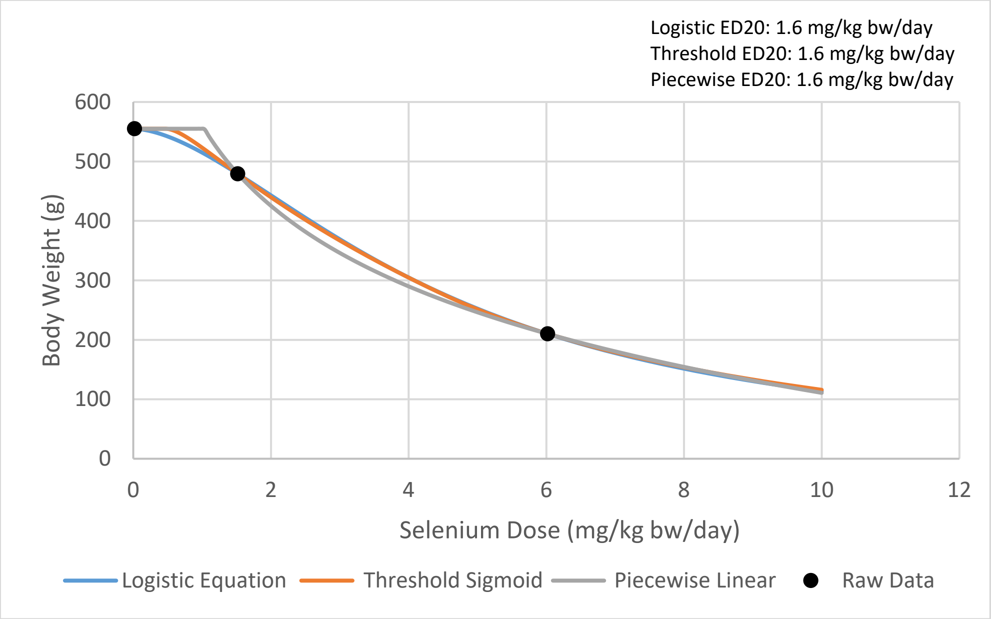
Note: Model based on log-transformed data from Lepore and Miller (1965) (egg production).

Figure E2.C-13. Dose-Response Curves for Avian Reproduction Endpoint for Molybdenum



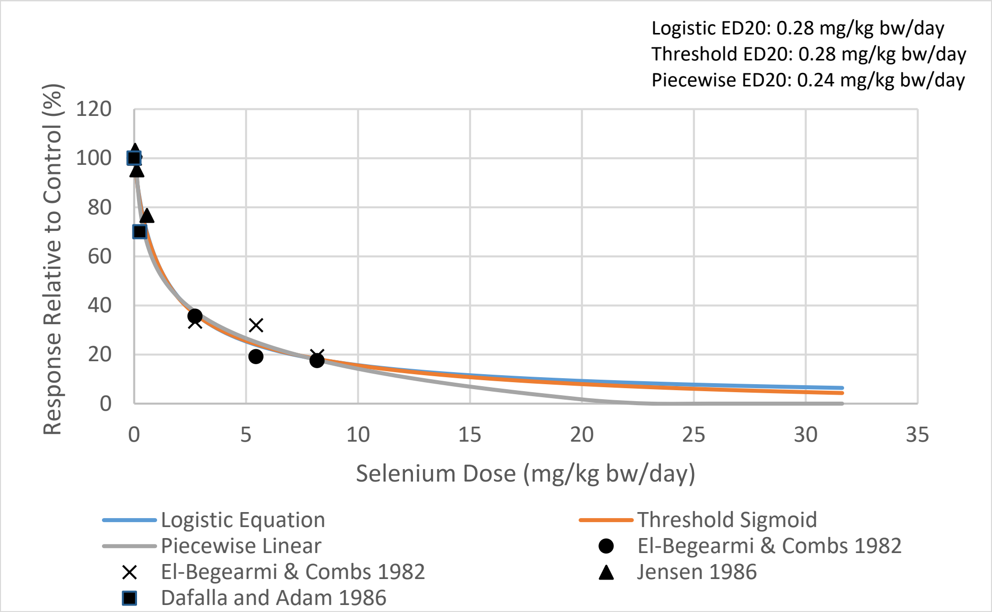
Note: Model based on log-transformed data from Davies et al. (1960) (Experiment 1c).

Figure E2.C-14. Dose-Response Curves for Avian Survival Endpoint for Molybdenum



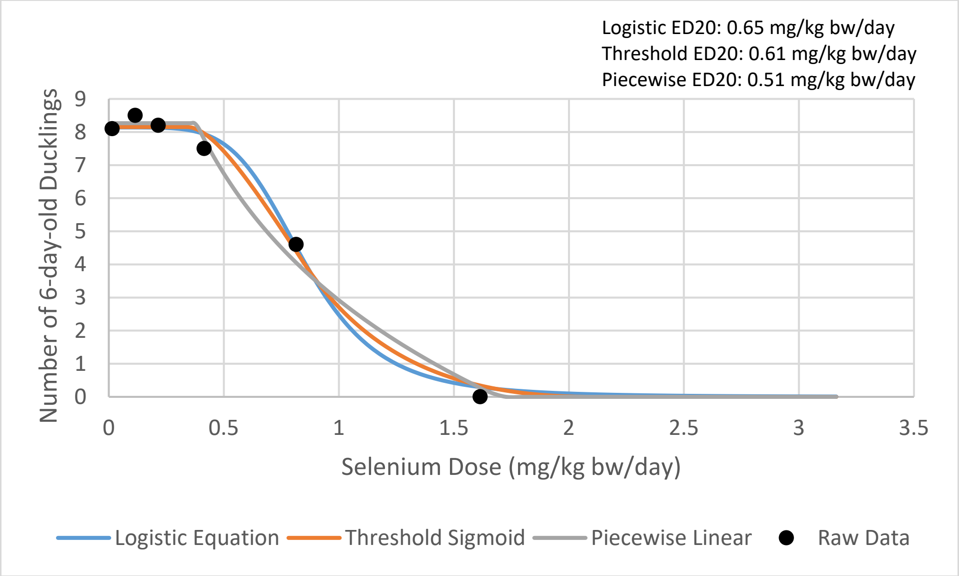
Note: Model based on log-transformed data from Hoffman et al. (1992).

Figure E2.C-15. Dose-Response Curves for Avian Growth Endpoint for Selenium



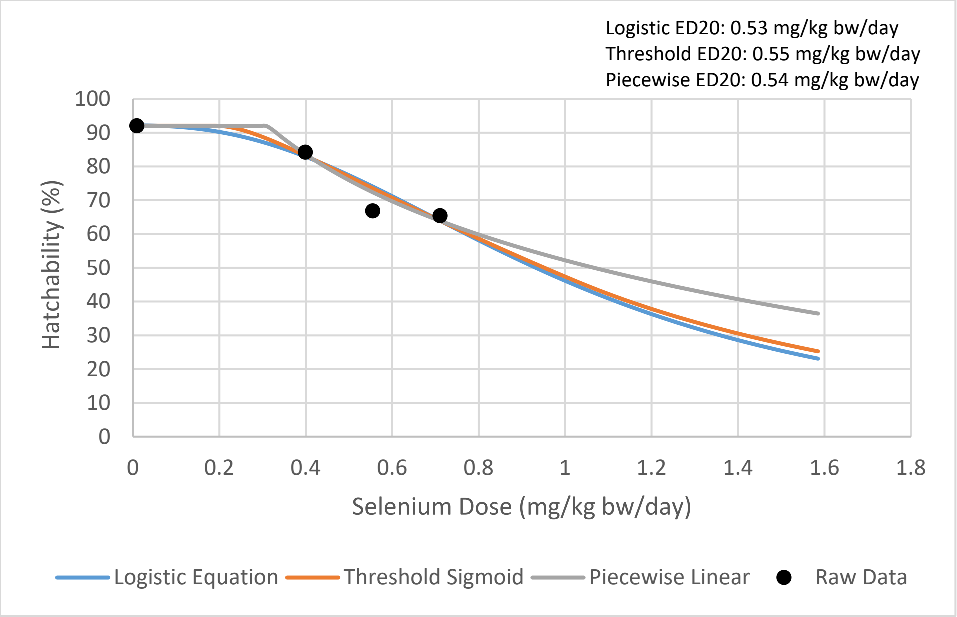
Note: Model based on log-transformed data from pooling group A.

Figure E2.C-16. Dose-Response Curves for Avian Growth Endpoint for Selenium



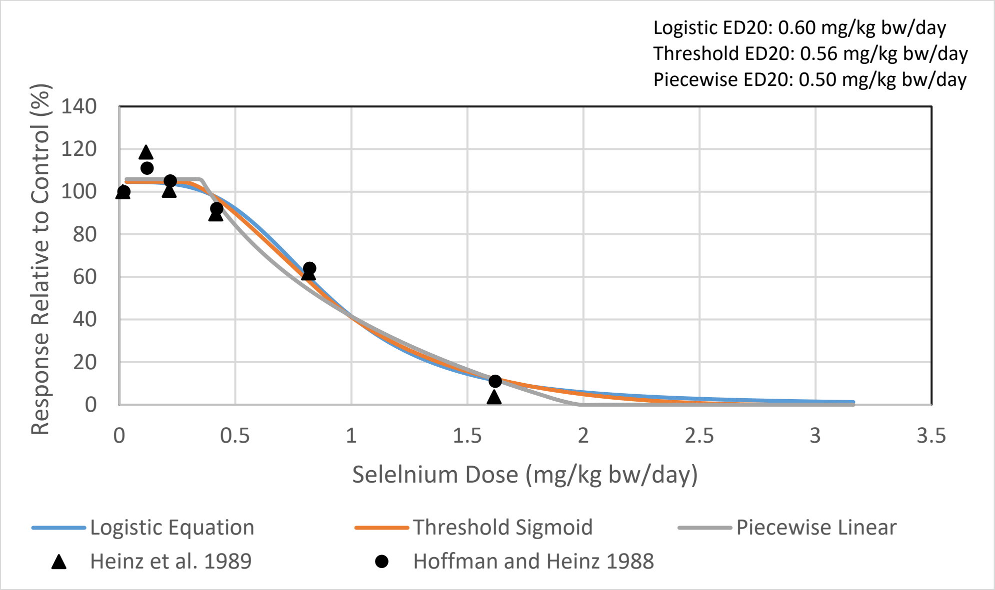
Note: Model based on log-transformed data from Heinz et al. (1989).

Figure E2.C-17. Dose-Response Curves for Avian Reproduction Endpoint for Selenium



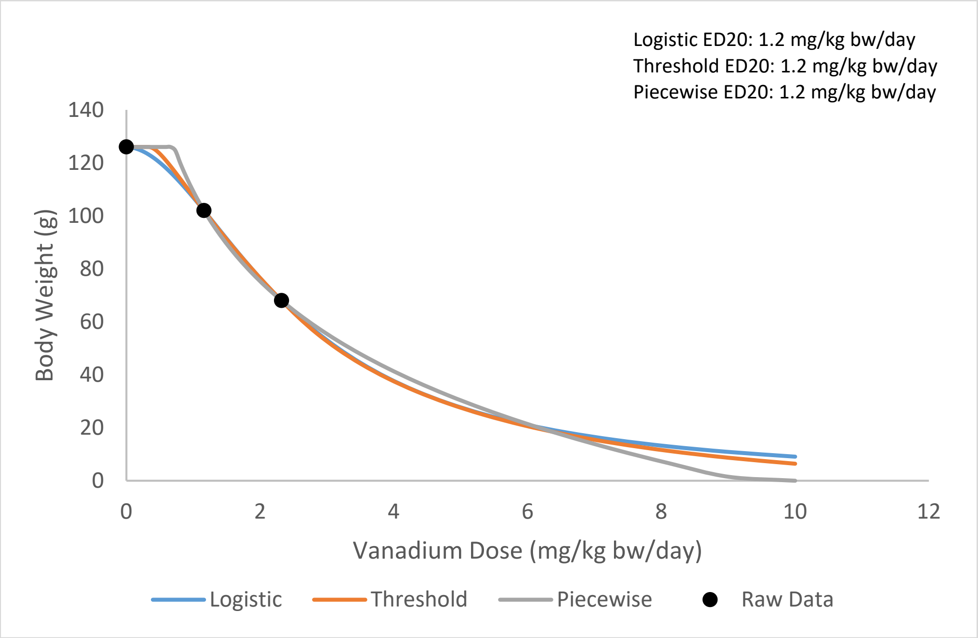
Note: Model based on log-transformed data from Ort and Latshaw (1978).

Figure E2.C-18. Dose-Response Curves for Avian Reproduction Endpoint for Selenium



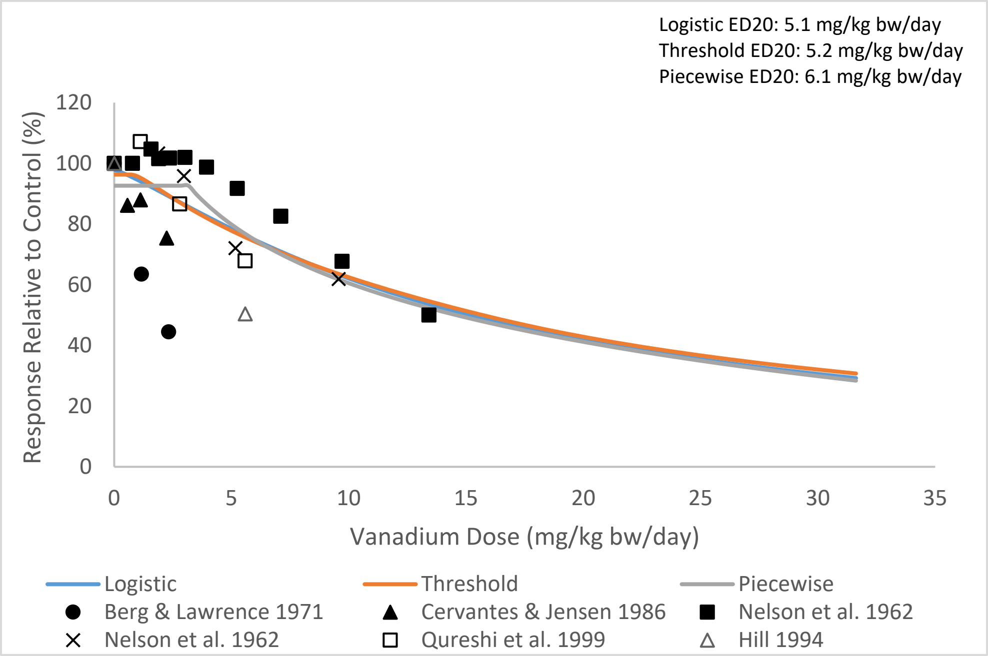
Note: Model based on log-transformed data from pooling group E.

Figure E2.C-19. Dose-Response Curves for Avian Reproduction Endpoint for Selenium



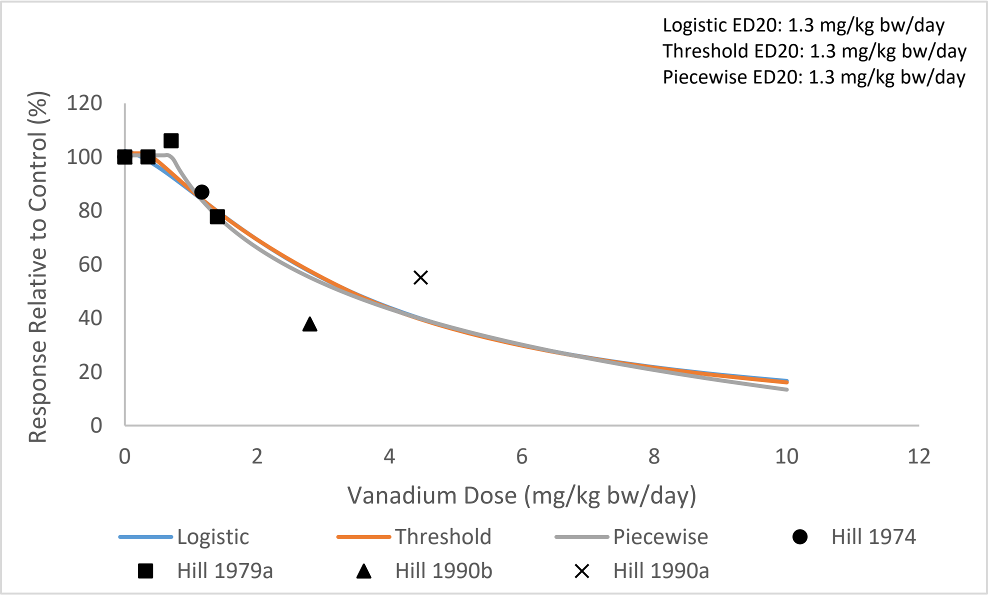
Note: Model based on log-transformed data from Berg and Lawrence (1971).

Figure E2.C-20. Dose-Response Curves for Avian Growth Endpoint for Vanadium



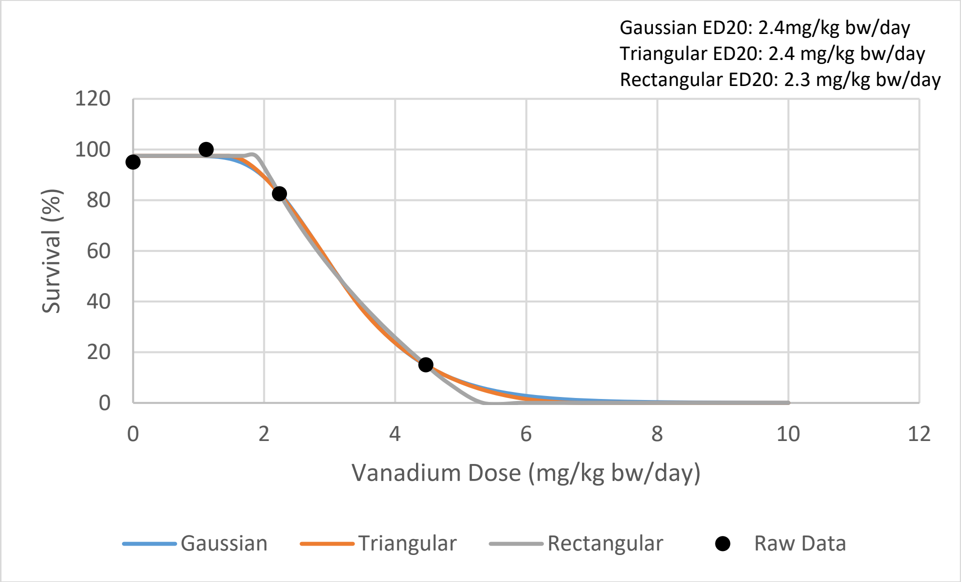
Note: Model based on log-transformed data from pooling group A.

Figure E2.C-21. Dose-Response Curves for Avian Growth Endpoint for Vanadium



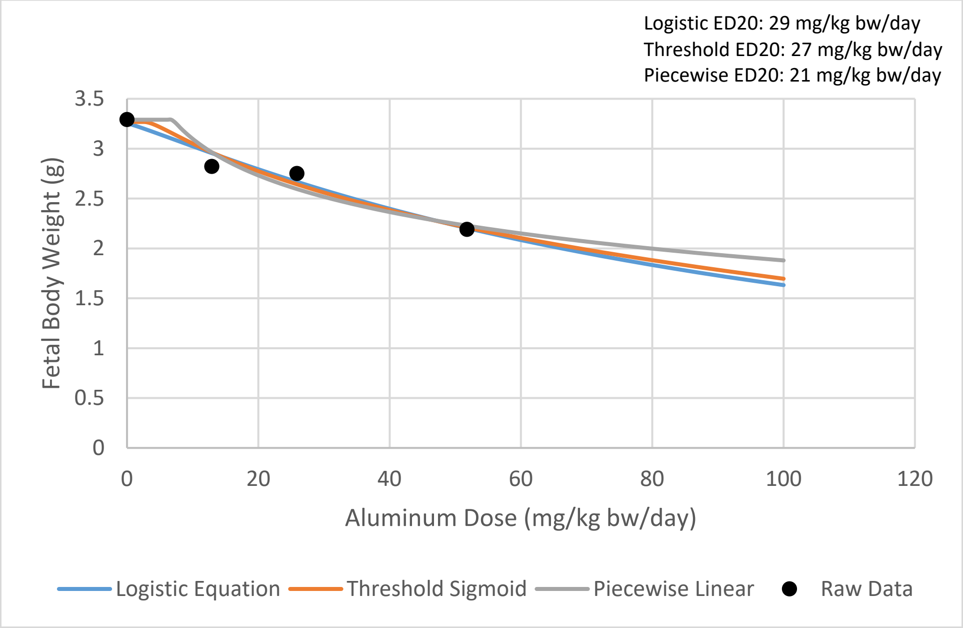
Note: Model based on log-transformed data from pooling group B.

Figure E2.C-22. Dose-Response Curves for Avian Growth Endpoint for Vanadium



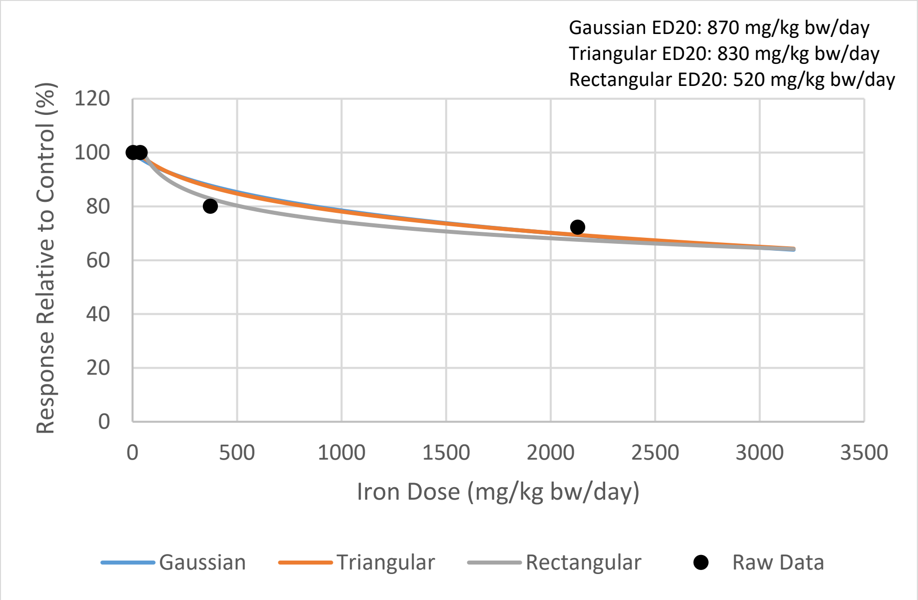
Note: Model based on log-transformed data from Blalock and Hill (1987).

Figure E2.C-23. Dose-Response Curves for Avian Survival Endpoint for Vanadium



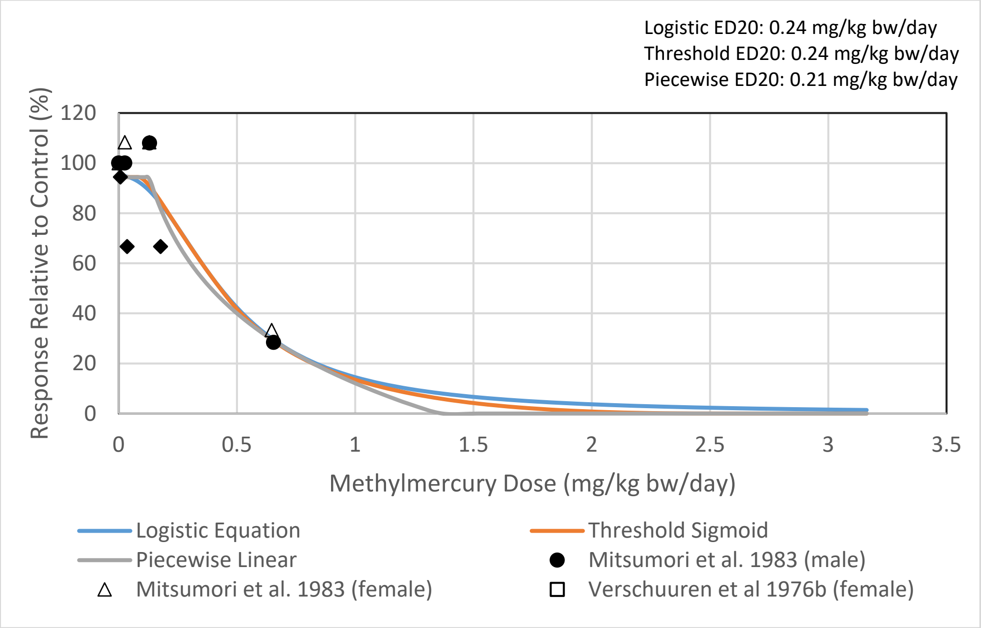
Note: Model based on log-transformed data from Paternain et al. (1988).

Figure E2.C-24. Dose-Response Curves for Mammalian Reproduction Endpoint for Aluminum



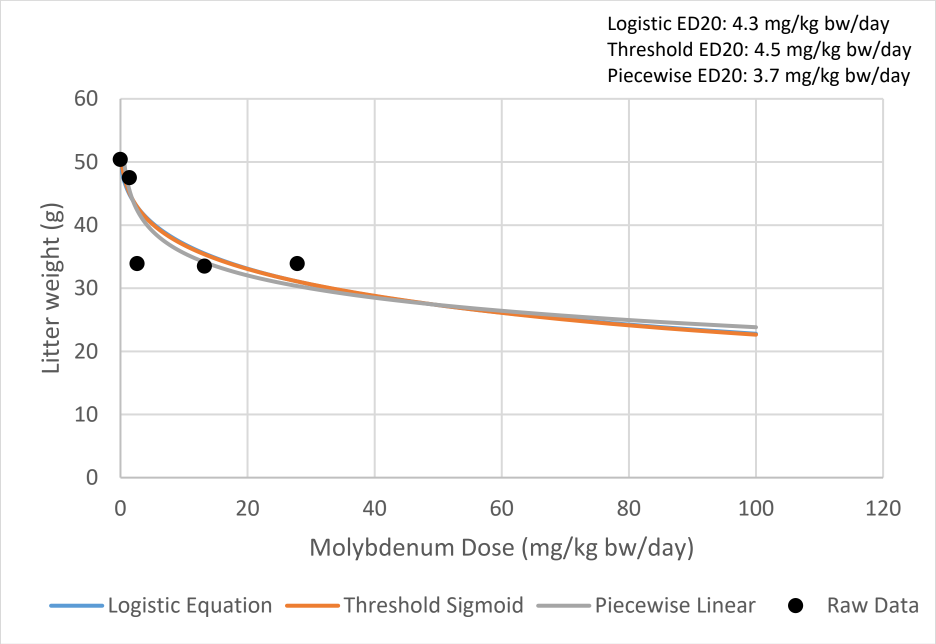
Note: Model based on log-transformed data from Whittaker et al. (1996).

Figure E2.C-25. Dose-Response Curves for Mammalian Survival Endpoint for Iron



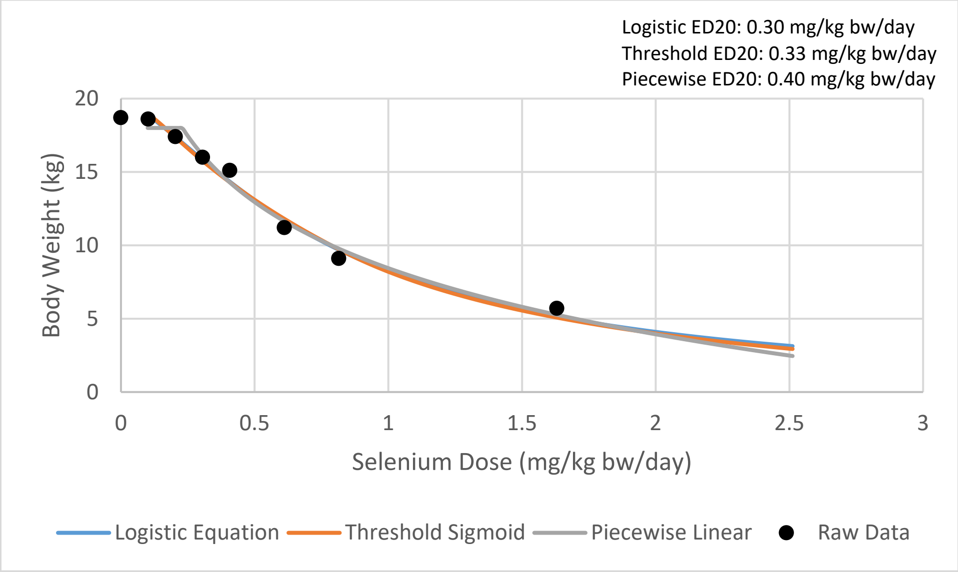
Note: Model based on log-transformed data from pooling group E.

Figure E2.C-26. Dose-Response Curves for Mammalian Survival Endpoint for Methylmercury



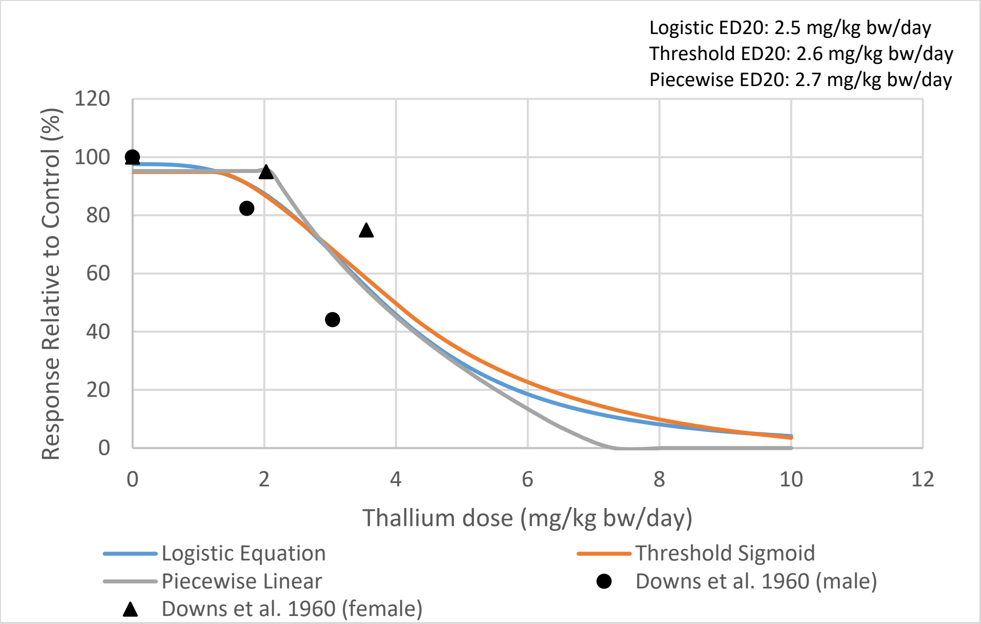
Note: Model based on log-transformed data from Fungwe et al. (1990).

Figure E2.C-27. Dose-Response Curves for Mammalian Reproduction Endpoint for Molybdenum



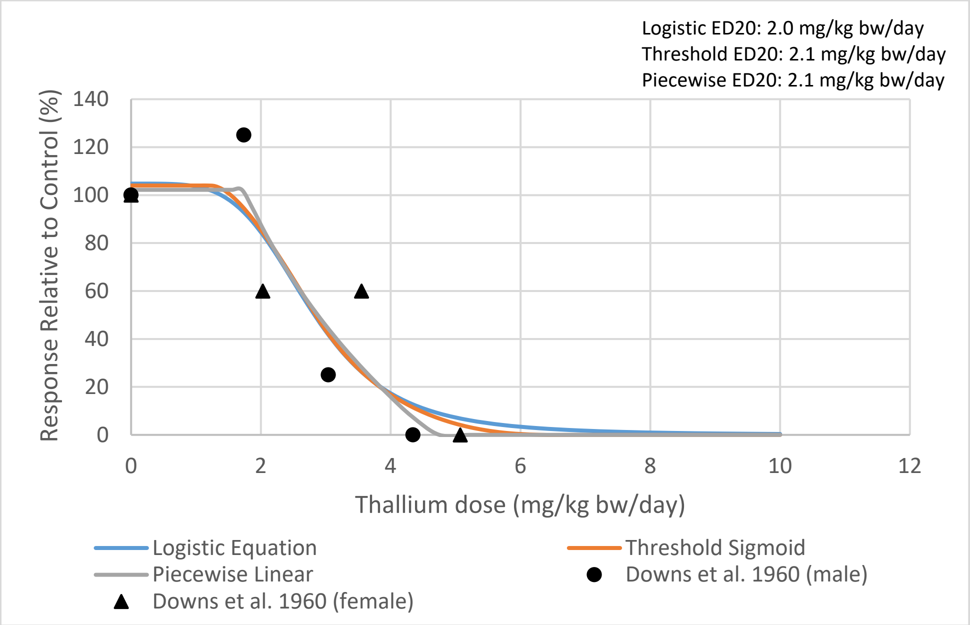
Note: Model based on log-transformed data from Mahan and Moxon (1984).

Figure E2.C-28. Dose-Response Curves for Mammalian Growth Endpoint for Selenium



Note: Model based on log-transformed data from pooling group A.

Figure E2.C-29. Dose-Response Curves for Mammalian Growth Endpoint for Thallium



Note: Model based on log-transformed data from pooling group B.

Figure E2.C-30. Dose-Response Curves for Mammalian Survival Endpoint for Thallium

ANNEX D

TRAP OUTPUT FOR TRVS BASED ON ED20S

Table E2.D-1. TRAP Output for TRVs Based on ED20s

							Dose-Response Model Parameters [b]			Dose-Response Effect Values			ED20 Confidence Limits [c]	
TRAP Output Table	Receptor Group	Endpoint	ED20 TRV (mg/kg bw/day)	Data Source(s) [a]	Selected Model	Number of Data Points	Log X50	S	Y0	ED20 (mg/kg bw/day)	ED50 (mg/kg bw/day)	ED80 (mg/kg bw/day)	95 LCL (mg/kg bw/day)	95 UCL (mg/kg bw/day)
Aluminum														
E2.D-2a	bird	growth	150	Capdevielle and Scanes (1995a)	threshold sigmoid, log	3	2.752	0.64881	610	150	560	2100	NC	NC
E2.D-2b	mammal	reproduction	27	Paternain et al. (1988)	threshold sigmoid, log	4	2.0311	0.61703	3.2678	27	110	420	NC	NC
Barium														
E2.D-3	bird	growth	480	Johnson et al. (1960)	threshold sigmoid, log	7	2.9533	1.36	433	480	900	1700	380	610
Cadmium														
E2.D-4a	bird	growth	2.0	Bokori et al. (1995b)	threshold sigmoid, log	4	0.96588	0.551	1.48	2.0	9.2	43	NC	NC
E2.D-4b	bird	reproduction	2.3	Leach et al. (1979)	threshold sigmoid, log	4	1.0222	0.564	66.6	2.3	11	47	NC	NC
E2.D-4c	bird	survival	7.4	pooling group C: Bokori et al. (1995a); Olgun (2015)	threshold sigmoid, log	10	1.3431	0.777	102	7.4	22	65	2.7	20
E2.D-4d	mammal	growth	4.2	Wilson et al. (1941)	threshold sigmoid, log	6	1.25	0.585	0.199	4.2	18	76	2.0	8.7
E2.D-4e	mammal	reproduction	2.7	Sutou et al. (1980)	threshold sigmoid, log	4	1.0215	0.623	14	2.7	11	41	NC	NC
E2.D-4f	mammal	survival	1.5	Swiergosz et al. (1998)	gaussian, log	3	1.032	1.01	0.87155	1.5	11	76	NC	NC
Copper														
E2.D-5a	bird	growth	62	pooling group D: Poupoulis and Jensen (1976) (three data sets); Wang et al. (1987) (two data sets)	threshold sigmoid, log	18	2.0187	1.61	100	62	100	180	53	72
E2.D-5b	bird	reproduction	28	pooling group A: Chiou et al. (1997); Harms and Buresh (1986); Pearce et al. (1983); Stevenson and Jackson (1980a); Stevenson and Jackson (1980b)	threshold sigmoid, log	21	1.624	2.09	102.09	28	42	63	22	35
E2.D-5c	bird	survival	67	Mehring et al. (1960)	gaussian, log	5	2.0245	0.239	0.96229	67	110	170	47	93
E2.D-5d	mammal	growth	12	Allcroft et al. (1961)	threshold sigmoid, log	4	1.1682	3.45	1.24	12	15	19	NC	NC
Iron														
E2.D-6a	bird	survival	1100	pooling group A: Pescatore and Harter-Dennis (1989); Wallner-Pendleton et al. (1986)	threshold sigmoid, log	11	3.2886	1.49	99.5	1100	1900	3400	620	1900
			NA	Pescatore and Harter-Dennis (1989)	threshold sigmoid, log	6	3.1671	2.23	99.7	1000	1500	NA	820	1200
			NA	Wallner-Pendleton et al. (1986)	threshold sigmoid, log	5	NC	NC	NC	NC	NC	NC	NC	NC
E2.D-6b	mammal	survival	870	Whittaker et al. (1996)	gaussian, log	4	3.9108	1.15	0.9999	870	8100	75000	NC	NC
Lead														
E2.D-7a	bird	survival	11	pooling group F: Anders et al. (1982); Barthalmus et al. (1977)	threshold sigmoid, log	6	1.4101	1.0403	99.58	11	26	58	5.5	24
E2.D-7b	mammal	survival	7.6	Lorenzo et al. (1978)	gaussian, log	5	1.0683	0.22	0.82602	7.6	12	18	5.9	9.9
Methylmercury														
E2.D-8a	bird	growth	0.97	Scott et al. (1975)	threshold sigmoid, log	3	0.3518	1.002	1.664	0.97	2.2	5.2	NC	NC
E2.D-8b	bird	reproduction	0.012	Varian-Ramos et al. (2014)	threshold sigmoid, log	5	-0.53774	0.26716	13.025	0.012	0.29	6.9	NC	NC
E2.D-8c	kestrel	reproduction	0.25	Albers et al. (2007)	threshold sigmoid, log	6	-0.46109	2.4701	1.9651	0.25	0.35	0.49	NC	NC
E2.D-8d	mammal	survival	0.24	pooling group E: Mitsumori et al. (1983) (two data sets); Verschuuren et al. (1976b) (two data sets)	threshold sigmoid, log	16	-0.34567	1.3454	94.426	0.24	0.45	0.85	0.13	0.44

Table E2.D-1. TRAP Output for TRVs Based on ED20s

							Dose-Response Model Parameters[b]			Dose-Response Effect Values			ED20 Confidence Limits[c]	
TRAP Output Table	Receptor Group	Endpoint	ED20 TRV (mg/kg bw/day)	Data Source(s)[a]	Selected Model	Number of Data Points	Log X50	S	Y0	ED20 (mg/kg bw/day)	ED50 (mg/kg bw/day)	ED80 (mg/kg bw/day)	95 LCL (mg/kg bw/day)	95 UCL (mg/kg bw/day)
Molybdenum														
E2.D-9a	bird	growth	100	pooling group A: Davies et al. (1960) (two data sets)	threshold sigmoid, log	11	2.4528	0.818	98.8	100	280	800	77	130
			NA	Davies et al. (1960) (Experiment 1b)	threshold sigmoid, log	6	2.5138	0.637	100	86	330	NC	49	150
			NA	Davies et al. (1960) (Experiment 1c)	threshold sigmoid, log	5	2.4942	1.02	100	140	310	NC	100	180
E2.D-9b	bird	reproduction	36	Lepore and Miller (1965)	threshold sigmoid, log	4	1.8122	1.42	15.6	36	65	120	NC	NC
E2.D-9c	bird	survival	610	Davies et al. (1960)	gaussian, log	5	2.9093	0.15	0.97147	610	810	1100	480	770
E2.D-9d	mammal	reproduction	4.5	Fungwe et al. (1990)	threshold sigmoid, log	5	1.8206	0.31401	50.852	4.5	66	980	NC	NC
Selenium														
E2.D-10a	bird	growth	0.28[d]	pooling group A: El-Begearmi and Combs (1982) (two data sets); Jensen (1986); Dafalla and Adam (1986)	threshold sigmoid, log	15	0.14871	0.52361	101.04	0.28	1.4	7.1	0.16	0.49
E2.D-10b	bird	reproduction	0.55	Ort and Latshaw (1978)	threshold sigmoid, log	4	0.010778	1.3706	92.077	0.55	1.0	1.9	NC	NC
E2.D-10c	mammal	growth	0.33	Mahan and Moxon (1984)	threshold sigmoid, log	8	-0.080362	0.92942	19.152	0.33	0.83	2.1	0.19	0.58
Thallium														
E2.D-11a	mammal	growth	2.6	pooling group A: Downs et al. (1960) (two data sets)	threshold sigmoid, log	6	0.61471	1.89	94.9	2.6	4.1	6.4	NC	NC
E2.D-11b	mammal	survival	2.1	pooling group B: Downs et al. (1960) (two data sets)	threshold sigmoid, log	8	0.44655	2.7753	104	2.1	2.8	3.8	NC	NC
Vanadium														
E2.D-12a	bird	growth	1.2	Berg and Lawrence (1971)	threshold sigmoid, log	3	0.40122	1.14	126	1.2	2.5	5.3	NC	NC
E2.D-12b	bird	survival	2.4	Blalock and Hill (1987)	gaussian, log	4	0.5004	0.14567	0.97473	2.4	3.2	4.2	NC	NC
Zinc														
E2.D-13	bird	reproduction	77	Gibson et al. (1986)	threshold sigmoid, log	6	2.0517	2.23	6.418	77	110	160	57	100

Notes:

[a] References are cited in Attachment E1 or Attachment E2.

[b] Dose-Response model parameter values are those calculated using EPA's Toxicity Relationship Analysis Program (TRAP).

[c] For pooled data sets, confidence limits were calculated for the individual data sets for comparison purposes if at least two of the data sets had five or more data points. Confidence limits calculated by TRAP are not reliable unless there are at least five data points.

[d] Selected toxicity reference value (TRV) is based on the ecological soil screening level (Eco-SSL) of 0.29 mg/kg bw/day instead of the ED20

95 LCL - 95 percent lower confidence limit of the mean

95 UCL - 95 percent upper confidence limit of the mean

ED20 - modeled effective dose with a 20 percent reduction in the response relative to the control, as provided by TRAP

ED50 - modeled effective dose with a 50 percent reduction in the response relative to the control, as provided by TRAP

ED80 - modeled effective dose with a 80 eprcent reduction in the response relative to the control, as calculated using the dose-response model provided by TRAP

NA - not applicable; these values or calculations are only presented for data sets used to derive TRVs

NC - not calculated; warning messages in TRAP indicated that the model was unreliable, error estimates could not be determined, or there was a large standard error for model parameters

S - measure of the steepness of the relationship

X50 - value associated with a 50 percent reduction in the effect variable from its control value

Y0 - control value

Table E2.D-2a. TRAP Model Output for Aluminum Data for the Bird Growth Endpoint (Capdevielle and Scanes 1995a)

Chemical:	Aluminum
Study Authors:	Capdevielle and Scanes 1995a
Receptor Group:	Bird
Effect Description:	Growth

Input Data:

Dose	Effect	SE
1.00E-06	610	13.4
111.67	520	13.8
558.33	307	5.45

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined	yes	yes	yes
Large Standard Error for X50			
Large Standard Error for Steepness			
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL		Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL		Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	2.7522	2.7522				LogX50	2.7522	2.752				LogX50	2.7522	2.7535			
S	0.62267	6.23E-01				S	0.62267	6.49E-01				S	0.62267	0.49956			
Y0	6.10E+02	6.10E+02				Y0	6.10E+02	6.10E+02				Y0	6.10E+02	6.10E+02			

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp	p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp	p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	565.14				2.7522	50	564.88				2.752	50	566.84				2.7535
20	1.57E+02				2.1956	20	153.27				2.1855	20	142.21				2.1529
10	7.41E+01				1.87	10	7.94E+01				1.9	10	89.693				1.9528
5	3.72E+01				1.57	5	49.897				1.6981	5	71.231				1.8527
0						0	16.244				1.21E+00	0	56.57				1.7526

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var
1	-6.00E+00	6.10E+02	6.10E+02	1	-6.00E+00	6.10E+02	6.10E+02	1	-6.00E+00	6.10E+02	6.10E+02
2	2.05E+00	5.20E+02	5.20E+02	2	2.05E+00	5.20E+02	5.20E+02	2	2.05E+00	5.20E+02	5.20E+02
3	2.75E+00	3.07E+02	3.07E+02	3	2.75E+00	3.07E+02	3.07E+02	3	2.75E+00	3.07E+02	3.07E+02
4				4				4			
5				5				5			
6				6				6			

Analysis of Variance

R-squared 0.759 | R-squared 0.759 | R-squared 0.759

	DF	SS	MS	F	Sig		DF	SS	MS	F	Sig		DF	SS	MS	F	Sig
Total (adj)	6	4439.4	739.9			Total (adj)	6	4439.4	739.9			Total (adj)	6	4439.4	739.9		
Regression	2	3368.6	1684.3	6.2914	0.0582	Regression	2	3368.6	1684.3	6.2914	0.0582	Regression	2	3368.6	1684.3	6.2914	0.0582
Error	4	1070.8	267.71			Error	4	1070.8	267.71			Error	4	1070.8	267.71		

Prediction Line

	X	Y		X	Y		X	Y
1	-1	6.10E+02	1	-1	6.10E+02	1	-1	6.10E+02
2	-9.60E-01	6.10E+02	2	-9.60E-01	6.10E+02	2	-9.60E-01	6.10E+02
3	-9.19E-01	6.10E+02	3	-9.19E-01	6.10E+02	3	-9.19E-01	6.10E+02
4	-8.79E-01	6.10E+02	4	-8.79E-01	6.10E+02	4	-8.79E-01	6.10E+02
5	-8.38E-01	6.10E+02	5	-8.38E-01	6.10E+02	5	-8.38E-01	6.10E+02
6	-7.98E-01	6.10E+02	6	-7.98E-01	6.10E+02	6	-7.98E-01	6.10E+02
7	-7.58E-01	6.10E+02	7	-7.58E-01	6.10E+02	7	-7.58E-01	6.10E+02
8	-7.17E-01	6.10E+02	8	-7.17E-01	6.10E+02	8	-7.17E-01	6.10E+02
9	-6.77E-01	6.10E+02	9	-6.77E-01	6.10E+02	9	-6.77E-01	6.10E+02
10	-6.36E-01	6.10E+02	10	-6.36E-01	6.10E+02	10	-6.36E-01	6.10E+02
11	-5.96E-01	6.10E+02	11	-5.96E-01	6.10E+02	11	-5.96E-01	6.10E+02
12	-5.56E-01	6.10E+02	12	-5.56E-01	6.10E+02	12	-5.56E-01	6.10E+02
13	-5.15E-01	6.10E+02	13	-5.15E-01	6.10E+02	13	-5.15E-01	6.10E+02
14	-0.47475	6.10E+02	14	-0.47475	6.10E+02	14	-0.47475	6.10E+02
15	-0.43434	6.10E+02	15	-0.43434	6.10E+02	15	-0.43434	6.10E+02
16	-0.39394	6.10E+02	16	-0.39394	6.10E+02	16	-0.39394	6.10E+02
17	-0.35354	6.10E+02	17	-0.35354	6.10E+02	17	-0.35354	6.10E+02
18	-0.31313	6.10E+02	18	-0.31313	6.10E+02	18	-0.31313	6.10E+02
19	-0.27273	6.10E+02	19	-0.27273	6.10E+02	19	-0.27273	6.10E+02
20	-0.23232	6.10E+02	20	-0.23232	6.10E+02	20	-0.23232	6.10E+02
21	-1.92E-01	6.10E+02	21	-1.92E-01	6.10E+02	21	-1.92E-01	6.10E+02
22	-1.52E-01	6.10E+02	22	-1.52E-01	6.10E+02	22	-1.52E-01	6.10E+02
23	-1.11E-01	6.10E+02	23	-1.11E-01	6.10E+02	23	-1.11E-01	6.10E+02
24	-7.07E-02	6.09E+02	24	-7.07E-02	6.10E+02	24	-7.07E-02	6.10E+02
25	-3.03E-02	6.09E+02	25	-3.03E-02	6.10E+02	25	-3.03E-02	6.10E+02
26	1.01E-02	6.09E+02	26	1.01E-02	6.10E+02	26	1.01E-02	6.10E+02
27	5.05E-02	6.09E+02	27	5.05E-02	6.10E+02	27	5.05E-02	6.10E+02
28	9.09E-02	6.09E+02	28	9.09E-02	6.10E+02	28	9.09E-02	6.10E+02
29	1.31E-01	6.09E+02	29	1.31E-01	6.10E+02	29	1.31E-01	6.10E+02
30	1.72E-01	6.09E+02	30	1.72E-01	6.10E+02	30	1.72E-01	6.10E+02
31	0.21212	6.09E+02	31	0.21212	6.10E+02	31	0.21212	6.10E+02
32	0.25253	6.09E+02	32	0.25253	6.10E+02	32	0.25253	6.10E+02
33	0.29293	6.09E+02	33	0.29293	6.10E+02	33	0.29293	6.10E+02
34	0.33333	6.09E+02	34	0.33333	6.10E+02	34	0.33333	6.10E+02
35	0.37374	6.08E+02	35	0.37374	6.10E+02	35	0.37374	6.10E+02
36	0.41414	6.08E+02	36	0.41414	6.10E+02	36	0.41414	6.10E+02
37	0.45455	6.08E+02	37	0.45455	6.10E+02	37	0.45455	6.10E+02
38	0.49495	6.08E+02	38	0.49495	6.10E+02	38	0.49495	6.10E+02
39	0.53535	6.08E+02	39	0.53535	6.10E+02	39	0.53535	6.10E+02
40	0.57576	6.07E+02	40	0.57576	6.10E+02	40	0.57576	6.10E+02
41	0.61616	6.07E+02	41	0.61616	6.10E+02	41	0.61616	6.10E+02
42	0.65657	6.07E+02	42	0.65657	6.10E+02	42	0.65657	6.10E+02
43	0.69697	6.06E+02	43	0.69697	6.10E+02	43	0.69697	6.10E+02
44	0.73737	6.06E+02	44	0.73737	6.10E+02	44	0.73737	6.10E+02
45	0.77778	6.06E+02	45	0.77778	6.10E+02	45	0.77778	6.10E+02
46	0.81818	6.05E+02	46	0.81818	6.10E+02	46	0.81818	6.10E+02
47	0.85859	6.05E+02	47	0.85859	6.10E+02	47	0.85859	6.10E+02
48	0.89899	6.04E+02	48	0.89899	6.10E+02	48	0.89899	6.10E+02
49	0.93939	6.03E+02	49	0.93939	6.10E+02	49	0.93939	6.10E+02
50	0.9798	6.03E+02	50	0.9798	6.10E+02	50	0.9798	6.10E+02
51	1.0202	6.02E+02	51	1.0202	6.10E+02	51	1.0202	6.10E+02
52	1.0606	6.01E+02	52	1.0606	6.10E+02	52	1.0606	6.10E+02
53	1.101	6.00E+02	53	1.101	6.10E+02	53	1.101	6.10E+02
54	1.1414	5.99E+02	54	1.1414	6.10E+02	54	1.1414	6.10E+02
55	1.1818	5.98E+02	55	1.1818	6.10E+02	55	1.1818	6.10E+02
56	1.2222	5.97E+02	56	1.2222	6.10E+02	56	1.2222	6.10E+02
57	1.2626	5.95E+02	57	1.2626	6.10E+02	57	1.2626	6.10E+02
58	1.303	5.94E+02	58	1.303	6.09E+02	58	1.303	6.10E+02
59	1.3434	5.92E+02	59	1.3434	6.08E+02	59	1.3434	6.10E+02
60	1.3838	5.90E+02	60	1.3838	6.06E+02	60	1.3838	6.10E+02
61	1.4242	5.88E+02	61	1.4242	6.04E+02	61	1.4242	6.10E+02
62	1.4646	5.86E+02	62	1.4646	6.02E+02	62	1.4646	6.10E+02
63	1.5051	5.84E+02	63	1.5051	5.99E+02	63	1.5051	6.10E+02
64	1.5455	5.81E+02	64	1.5455	5.96E+02	64	1.5455	6.10E+02
65	1.5859	5.78E+02	65	1.5859	5.92E+02	65	1.5859	6.10E+02
66	1.6263	5.75E+02	66	1.6263	5.88E+02	66	1.6263	6.10E+02
67	1.6667	5.72E+02	67	1.6667	5.83E+02	67	1.6667	6.10E+02
68	1.7071	5.68E+02	68	1.7071	5.78E+02	68	1.7071	6.10E+02

Prediction Line

	X	Y
69	1.7475	5.64E+02
70	1.7879	5.59E+02
71	1.8283	5.54E+02
72	1.8687	5.49E+02
73	1.9091	5.43E+02
74	1.9495	5.37E+02
75	1.9899	5.31E+02
76	2.0303	5.23E+02
77	2.0707	5.16E+02
78	2.1111	5.07E+02
79	2.1515	4.98E+02
80	2.1919	4.89E+02
81	2.2323	4.79E+02
82	2.2727	4.68E+02
83	2.3131	4.57E+02
84	2.3535	4.45E+02
85	2.3939	4.33E+02
86	2.4343	4.20E+02
87	2.4747	4.06E+02
88	2.5152	3.93E+02
89	2.5556	3.78E+02
90	2.596	3.64E+02
91	2.6364	3.49E+02
92	2.6768	3.34E+02
93	2.7172	3.18E+02
94	2.7576	3.03E+02
95	2.798	2.88E+02
96	2.8384	2.72E+02
97	2.8788	2.57E+02
98	2.9192	2.42E+02
99	2.9596	2.28E+02
100	3	2.14E+02

	X	Y
69	1.7475	5.73E+02
70	1.7879	5.67E+02
71	1.8283	5.61E+02
72	1.8687	5.54E+02
73	1.9091	5.47E+02
74	1.9495	5.40E+02
75	1.9899	5.32E+02
76	2.0303	5.24E+02
77	2.0707	5.15E+02
78	2.1111	5.06E+02
79	2.1515	4.96E+02
80	2.1919	4.86E+02
81	2.2323	4.76E+02
82	2.2727	4.65E+02
83	2.3131	4.54E+02
84	2.3535	4.42E+02
85	2.3939	4.30E+02
86	2.4343	4.18E+02
87	2.4747	4.05E+02
88	2.5152	3.92E+02
89	2.5556	3.78E+02
90	2.596	3.64E+02
91	2.6364	3.49E+02
92	2.6768	3.34E+02
93	2.7172	3.19E+02
94	2.7576	3.03E+02
95	2.798	2.87E+02
96	2.8384	2.72E+02
97	2.8788	2.57E+02
98	2.9192	2.42E+02
99	2.9596	2.28E+02
100	3	2.15E+02

	X	Y
69	1.7475	6.10E+02
70	1.7879	5.99E+02
71	1.8283	5.87E+02
72	1.8687	5.75E+02
73	1.9091	5.62E+02
74	1.9495	5.50E+02
75	1.9899	5.38E+02
76	2.0303	5.25E+02
77	2.0707	5.13E+02
78	2.1111	5.01E+02
79	2.1515	4.88E+02
80	2.1919	4.76E+02
81	2.2323	4.64E+02
82	2.2727	4.51E+02
83	2.3131	4.39E+02
84	2.3535	4.27E+02
85	2.3939	4.15E+02
86	2.4343	4.02E+02
87	2.4747	3.90E+02
88	2.5152	3.78E+02
89	2.5556	3.65E+02
90	2.596	3.53E+02
91	2.6364	3.41E+02
92	2.6768	3.28E+02
93	2.7172	3.16E+02
94	2.7576	3.04E+02
95	2.798	2.91E+02
96	2.8384	2.79E+02
97	2.8788	2.67E+02
98	2.9192	2.54E+02
99	2.9596	2.42E+02
100	3	2.30E+02

Table E2.D-2b. TRAP Model Output for Aluminum Data for the Mammal Reproduction Endpoint (Paternain et al. 1988)

Chemical:	Aluminum
Study Authors:	Paternain et al. 1988 fetal growth
Receptor Group:	Mammal
Effect Description:	Reproduction

Input Data:

Dose	Effect	SE
1.00E-06	3.29	0.72
12.92	2.82	0.68
25.89	2.75	0.5
51.79	2.19	0.35

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined	yes	yes	yes
Large Standard Error for X50			
Large Standard Error for Steepness			
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

Logistic Equation:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	2.1616	2.0026			
S	0.45724	6.43E-01			
Y0	3.29E+00	3.25E+00			

Threshold Sigmoid:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	2.1616	2.0311			
S	0.45724	6.17E-01			
Y0	3.29E+00	3.27E+00			

Piecewise Linear:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	2.1616	2.1925			
S	0.45724	0.37054			
Y0	3.29E+00	3.29E+00			

Xp Estimates

Logistic Equation:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	100.61	3.1079	3256.8	0.11885	2.0026
20	2.91E+01	4.23E-01	2.00E+03	0.1446	1.4633
10	1.41E+01	8.43E-03	2.34E+04	0.25358	1.1479
5	7.20E+00	1.88E-04	2.75E+05	0.36062	0.85717
0					

Threshold Sigmoid:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	107.42	1.3597	8486.4	0.14935	2.0311
20	27.254	1.98E-01	3742.3	0.16824	1.4354
10	1.37E+01	5.59E-03	3.34E+04	0.26665	1.1352
5	8.3739	3.70E-04	1.89E+05	0.34271	0.92293
0	2.5729	4.32E-07	1.53E+07	0.53317	4.10E-01

Piecewise Linear:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	155.77	3.59E-02	6.75E+05	0.28625	2.1925
20	24.146	5.00E-02	11656	0.21121	1.3829
10	12.971	4.01E-03	41928	0.27621	1.113
5	9.5068	8.95E-04	1.01E+05	0.31686	0.97804
0	6.9678	1.83E-04	2.66E+05	0.36059	0.8431

Model Fit Summary

Dataset

Logistic Equation:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	3.29E+00	3.25E+00
2	1.11E+00	2.82E+00	2.95E+00
3	1.41E+00	2.75E+00	2.67E+00
4	1.71E+00	2.19E+00	2.20E+00
5			
6			

Threshold Sigmoid:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	3.29E+00	3.27E+00
2	1.11E+00	2.82E+00	2.96E+00
3	1.41E+00	2.75E+00	2.64E+00
4	1.71E+00	2.19E+00	2.21E+00
5			
6			

Piecewise Linear:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	3.29E+00	3.29E+00
2	1.11E+00	2.82E+00	2.96E+00
3	1.41E+00	2.75E+00	2.60E+00
4	1.71E+00	2.19E+00	2.23E+00
5			
6			

Analysis of Variance

Logistic Equation: R-squared 0.998

	DF	SS	MS	F	Sig
Total (adj)	3	29.235	9.7451		
Regression	2	29.165	14.582	206.57	0.0491
Error	1	7.06E-02	7.06E-02		

Threshold Sigmoid: R-squared 0.997

	DF	SS	MS	F	Sig
Total (adj)	3	29.235	9.7451		
Regression	2	29.141	14.571	154.3	0.0568
Error	1	9.44E-02	9.44E-02		

Piecewise Linear: R-squared 0.995

	DF	SS	MS	F	Sig
Total (adj)	3	29.235	9.7451		
Regression	2	29.083	14.542	95.63	0.0721
Error	1	0.15206	0.15206		

Prediction Line

	X	Y
1	-2	3.25E+00
2	-1.96E+00	3.25E+00
3	-1.92E+00	3.25E+00
4	-1.88E+00	3.25E+00
5	-1.84E+00	3.25E+00
6	-1.80E+00	3.25E+00
7	-1.76E+00	3.25E+00
8	-1.72E+00	3.25E+00
9	-1.68E+00	3.25E+00
10	-1.64E+00	3.25E+00
11	-1.60E+00	3.25E+00
12	-1.56E+00	3.25E+00
13	-1.52E+00	3.25E+00
14	-1.4747	3.25E+00
15	-1.4343	3.25E+00
16	-1.3939	3.25E+00
17	-1.3535	3.25E+00
18	-1.3131	3.25E+00
19	-1.2727	3.25E+00
20	-1.2323	3.25E+00
21	-1.19E+00	3.25E+00
22	-1.15E+00	3.25E+00
23	-1.11E+00	3.25E+00
24	-1.07E+00	3.25E+00
25	-1.03E+00	3.25E+00
26	-9.90E-01	3.25E+00
27	-9.49E-01	3.25E+00
28	-9.09E-01	3.25E+00
29	-8.69E-01	3.25E+00
30	-8.28E-01	3.25E+00
31	-0.78788	3.25E+00
32	-0.74747	3.25E+00
33	-0.70707	3.25E+00
34	-0.66667	3.25E+00
35	-0.62626	3.25E+00
36	-0.58586	3.25E+00
37	-0.54545	3.25E+00
38	-0.50505	3.25E+00
39	-0.46465	3.25E+00
40	-0.42424	3.25E+00
41	-0.38384	3.25E+00
42	-0.34343	3.25E+00
43	-0.30303	3.25E+00
44	-0.26263	3.24E+00
45	-0.22222	3.24E+00
46	-0.18182	3.24E+00
47	-0.14141	3.24E+00
48	-0.10101	3.24E+00
49	-6.06E-02	3.24E+00
50	-2.02E-02	3.24E+00
51	2.02E-02	3.23E+00
52	6.06E-02	3.23E+00
53	0.10101	3.23E+00
54	0.14141	3.23E+00
55	0.18182	3.22E+00
56	0.22222	3.22E+00
57	0.26263	3.22E+00
58	0.30303	3.21E+00
59	0.34343	3.21E+00
60	0.38384	3.20E+00
61	0.42424	3.20E+00
62	0.46465	3.19E+00
63	0.50505	3.19E+00
64	0.54545	3.18E+00
65	0.58586	3.17E+00
66	0.62626	3.16E+00
67	0.66667	3.15E+00
68	0.70707	3.14E+00

	X	Y
1	-2	3.27E+00
2	-1.96E+00	3.27E+00
3	-1.92E+00	3.27E+00
4	-1.88E+00	3.27E+00
5	-1.84E+00	3.27E+00
6	-1.80E+00	3.27E+00
7	-1.76E+00	3.27E+00
8	-1.72E+00	3.27E+00
9	-1.68E+00	3.27E+00
10	-1.64E+00	3.27E+00
11	-1.60E+00	3.27E+00
12	-1.56E+00	3.27E+00
13	-1.52E+00	3.27E+00
14	-1.4747	3.27E+00
15	-1.4343	3.27E+00
16	-1.3939	3.27E+00
17	-1.3535	3.27E+00
18	-1.3131	3.27E+00
19	-1.2727	3.27E+00
20	-1.2323	3.27E+00
21	-1.19E+00	3.27E+00
22	-1.15E+00	3.27E+00
23	-1.11E+00	3.27E+00
24	-1.07E+00	3.27E+00
25	-1.03E+00	3.27E+00
26	-9.90E-01	3.27E+00
27	-9.49E-01	3.27E+00
28	-9.09E-01	3.27E+00
29	-8.69E-01	3.27E+00
30	-8.28E-01	3.27E+00
31	-0.78788	3.27E+00
32	-0.74747	3.27E+00
33	-0.70707	3.27E+00
34	-0.66667	3.27E+00
35	-0.62626	3.27E+00
36	-0.58586	3.27E+00
37	-0.54545	3.27E+00
38	-0.50505	3.27E+00
39	-0.46465	3.27E+00
40	-0.42424	3.27E+00
41	-0.38384	3.27E+00
42	-0.34343	3.27E+00
43	-0.30303	3.27E+00
44	-0.26263	3.27E+00
45	-0.22222	3.27E+00
46	-0.18182	3.27E+00
47	-0.14141	3.27E+00
48	-0.10101	3.27E+00
49	-6.06E-02	3.27E+00
50	-2.02E-02	3.27E+00
51	2.02E-02	3.27E+00
52	6.06E-02	3.27E+00
53	0.10101	3.27E+00
54	0.14141	3.27E+00
55	0.18182	3.27E+00
56	0.22222	3.27E+00
57	0.26263	3.27E+00
58	0.30303	3.27E+00
59	0.34343	3.27E+00
60	0.38384	3.27E+00
61	0.42424	3.27E+00
62	0.46465	3.27E+00
63	0.50505	3.26E+00
64	0.54545	3.26E+00
65	0.58586	3.25E+00
66	0.62626	3.24E+00
67	0.66667	3.23E+00
68	0.70707	3.21E+00

	X	Y
1	-2	3.29E+00
2	-1.96E+00	3.29E+00
3	-1.92E+00	3.29E+00
4	-1.88E+00	3.29E+00
5	-1.84E+00	3.29E+00
6	-1.80E+00	3.29E+00
7	-1.76E+00	3.29E+00
8	-1.72E+00	3.29E+00
9	-1.68E+00	3.29E+00
10	-1.64E+00	3.29E+00
11	-1.60E+00	3.29E+00
12	-1.56E+00	3.29E+00
13	-1.52E+00	3.29E+00
14	-1.4747	3.29E+00
15	-1.4343	3.29E+00
16	-1.3939	3.29E+00
17	-1.3535	3.29E+00
18	-1.3131	3.29E+00
19	-1.2727	3.29E+00
20	-1.2323	3.29E+00
21	-1.19E+00	3.29E+00
22	-1.15E+00	3.29E+00
23	-1.11E+00	3.29E+00
24	-1.07E+00	3.29E+00
25	-1.03E+00	3.29E+00
26	-9.90E-01	3.29E+00
27	-9.49E-01	3.29E+00
28	-9.09E-01	3.29E+00
29	-8.69E-01	3.29E+00
30	-8.28E-01	3.29E+00
31	-0.78788	3.29E+00
32	-0.74747	3.29E+00
33	-0.70707	3.29E+00
34	-0.66667	3.29E+00
35	-0.62626	3.29E+00
36	-0.58586	3.29E+00
37	-0.54545	3.29E+00
38	-0.50505	3.29E+00
39	-0.46465	3.29E+00
40	-0.42424	3.29E+00
41	-0.38384	3.29E+00
42	-0.34343	3.29E+00
43	-0.30303	3.29E+00
44	-0.26263	3.29E+00
45	-0.22222	3.29E+00
46	-0.18182	3.29E+00
47	-0.14141	3.29E+00
48	-0.10101	3.29E+00
49	-6.06E-02	3.29E+00
50	-2.02E-02	3.29E+00
51	2.02E-02	3.29E+00
52	6.06E-02	3.29E+00
53	0.10101	3.29E+00
54	0.14141	3.29E+00
55	0.18182	3.29E+00
56	0.22222	3.29E+00
57	0.26263	3.29E+00
58	0.30303	3.29E+00
59	0.34343	3.29E+00
60	0.38384	3.29E+00
61	0.42424	3.29E+00
62	0.46465	3.29E+00
63	0.50505	3.29E+00
64	0.54545	3.29E+00
65	0.58586	3.29E+00
66	0.62626	3.29E+00
67	0.66667	3.29E+00
68	0.70707	3.29E+00

Prediction Line

	X	Y
69	0.74747	3.13E+00
70	0.78788	3.12E+00
71	0.82828	3.10E+00
72	0.86869	3.09E+00
73	0.90909	3.07E+00
74	0.94949	3.05E+00
75	0.9899	3.03E+00
76	1.0303	3.01E+00
77	1.0707	2.98E+00
78	1.1111	2.96E+00
79	1.1515	2.93E+00
80	1.1919	2.89E+00
81	1.2323	2.86E+00
82	1.2727	2.82E+00
83	1.3131	2.78E+00
84	1.3535	2.74E+00
85	1.3939	2.69E+00
86	1.4343	2.64E+00
87	1.4747	2.59E+00
88	1.5152	2.53E+00
89	1.5556	2.47E+00
90	1.596	2.41E+00
91	1.6364	2.34E+00
92	1.6768	2.27E+00
93	1.7172	2.20E+00
94	1.7576	2.12E+00
95	1.798	2.05E+00
96	1.8384	1.97E+00
97	1.8788	1.88E+00
98	1.9192	1.80E+00
99	1.9596	1.72E+00
100	2	1.63E+00

	X	Y
69	0.74747	3.20E+00
70	0.78788	3.18E+00
71	0.82828	3.16E+00
72	0.86869	3.14E+00
73	0.90909	3.11E+00
74	0.94949	3.09E+00
75	0.9899	3.06E+00
76	1.0303	3.03E+00
77	1.0707	3.00E+00
78	1.1111	2.96E+00
79	1.1515	2.93E+00
80	1.1919	2.89E+00
81	1.2323	2.85E+00
82	1.2727	2.81E+00
83	1.3131	2.76E+00
84	1.3535	2.71E+00
85	1.3939	2.67E+00
86	1.4343	2.62E+00
87	1.4747	2.56E+00
88	1.5152	2.51E+00
89	1.5556	2.45E+00
90	1.596	2.39E+00
91	1.6364	2.33E+00
92	1.6768	2.27E+00
93	1.7172	2.21E+00
94	1.7576	2.14E+00
95	1.798	2.07E+00
96	1.8384	2.00E+00
97	1.8788	1.93E+00
98	1.9192	1.85E+00
99	1.9596	1.77E+00
100	2	1.70E+00

	X	Y
69	0.74747	3.29E+00
70	0.78788	3.29E+00
71	0.82828	3.29E+00
72	0.86869	3.26E+00
73	0.90909	3.21E+00
74	0.94949	3.16E+00
75	0.9899	3.11E+00
76	1.0303	3.06E+00
77	1.0707	3.01E+00
78	1.1111	2.96E+00
79	1.1515	2.91E+00
80	1.1919	2.86E+00
81	1.2323	2.82E+00
82	1.2727	2.77E+00
83	1.3131	2.72E+00
84	1.3535	2.67E+00
85	1.3939	2.62E+00
86	1.4343	2.57E+00
87	1.4747	2.52E+00
88	1.5152	2.47E+00
89	1.5556	2.42E+00
90	1.596	2.37E+00
91	1.6364	2.32E+00
92	1.6768	2.27E+00
93	1.7172	2.22E+00
94	1.7576	2.18E+00
95	1.798	2.13E+00
96	1.8384	2.08E+00
97	1.8788	2.03E+00
98	1.9192	1.98E+00
99	1.9596	1.93E+00
100	2	1.88E+00

Table E2.D-3. TRAP Model Output for Barium Data for the Bird Growth Endpoint (Johnson et al. 1960)

Chemical:	Barium
Study Authors:	Johnson et al. 1960
Receptor Group:	Bird
Effect Description:	Growth

Input Data:

Dose	Effect	SE
0.000001	435	not reported
27.91667	436	not reported
55.83333	410	not reported
111.6667	448	not reported
223.3333	428	not reported
446.6667	357	not reported
893.3333	218	not reported

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?
Use Only for Exploratory Data Analysis!
Maximum Iterations Reached Without Convergence
X50 at Maximum or Minimum Limit
Steepness At Maximum Or Minimum Limit
Error Estimates Cannot Be Determined
Large Standard Error for X50
Large Standard Error for Steepness
Large Standard Error for Y0
Inadequate Number of Partial Effects
Insufficient Data to Plot
Insufficient Data to Analyze

Model Parameters

Logistic Equation:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	2.9342	2.9492	2.66E-02	2.8755	3.023
S	1.6072	1.37E+00	0.24739	0.67944	2.0532
Y0	4.31E+02	4.34E+02	7.956	412.24	456.42

Threshold Sigmoid:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	2.9342	2.9533	2.40E-02	2.8867	3.0199
S	1.6072	1.36E+00	0.19522	0.82246	1.9065
Y0	4.31E+02	4.33E+02	6.7433	413.83	451.28

Piecewise Linear:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	2.9342	2.956	3.15E-02	2.8686	3.0434
S	1.6072	1.0703	0.15278	0.64617	1.4945
Y0	4.31E+02	4.31E+02	6.2418	414.07	448.73

Xp Estimates

6590.66

#REF!

Logistic Equation:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	889.7	750.77	1054.3	2.66E-02	2.9492
20	4.96E+02	3.72E+02	6.62E+02	4.51E-02	2.6956
10	3.53E+02	2.27E+02	5.48E+02	6.90E-02	2.5472
5	2.57E+02	1.42E+02	4.65E+02	9.25E-02	2.4105
0					

Threshold Sigmoid:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	898.07	770.44	1046.9	2.40E-02	2.9533
20	483	3.83E+02	609.85	3.65E-02	2.6839
10	3.53E+02	2.51E+02	4.97E+02	5.33E-02	2.5482
5	283.26	1.86E+02	4.32E+02	6.60E-02	2.4522
0	166.12	8.88E+01	3.11E+02	9.79E-02	2.22E+00

Piecewise Linear:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	903.64	738.98	1105	3.15E-02	2.956
20	473.93	391.73	573.37	2.98E-02	2.6757
10	382.19	296.79	492.18	3.96E-02	2.5823
5	343.22	257.19	458.02	4.51E-02	2.5356
0	308.22	222.51	426.95	5.10E-02	2.4889

Model Fit Summary

Dataset

Logistic Equation:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	4.35E+02	4.34E+02
2	1.45E+00	4.36E+02	4.34E+02
3	1.75E+00	4.10E+02	4.34E+02
4	2.05E+00	4.48E+02	4.31E+02
5	2.35E+00	428	418.59
6	2.65E+00	357	363.5
7	2.951	218	216.11

Threshold Sigmoid:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	4.35E+02	4.33E+02
2	1.45E+00	4.36E+02	4.33E+02
3	1.75E+00	4.10E+02	4.33E+02
4	2.05E+00	4.48E+02	4.33E+02
5	2.35E+00	428	425.9
6	2.65E+00	357	358.26
7	2.951	218	217.63

Piecewise Linear:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	4.35E+02	4.31E+02
2	1.45E+00	4.36E+02	4.31E+02
3	1.75E+00	4.10E+02	4.31E+02
4	2.05E+00	4.48E+02	4.31E+02
5	2.35E+00	428	431.4
6	2.65E+00	357	357
7	2.951	218	218

Analysis of Variance

Logistic Equation: R-squared: 0.975

	DF	SS	MS	F	Sig
Total (adj)	6	40021	6670.2		
Regression	2	39038	19519	79.429	0.0006
Error	4	982.97	245.74		

Threshold Sigmoid: R-squared: 0.981

	DF	SS	MS	F	Sig
Total (adj)	6	40021	6670.2		
Regression	2	39250	19625	101.79	0.0004
Error	4	771.23	192.81		

Piecewise Linear: R-squared: 0.981

	DF	SS	MS	F	Sig
Total (adj)	6	40021	6670.2		
Regression	2	39242	19621	100.72	0.0004
Error	4	779.2	194.8		

Prediction Line

	X	Y		X	Y		X	Y
1	-1	4.34E+02	1	-1	4.33E+02	1	-1	4.31E+02
2	-9.55E-01	4.34E+02	2	-9.55E-01	4.33E+02	2	-9.55E-01	4.31E+02
3	-9.09E-01	4.34E+02	3	-9.09E-01	4.33E+02	3	-9.09E-01	4.31E+02
4	-8.64E-01	4.34E+02	4	-8.64E-01	4.33E+02	4	-8.64E-01	4.31E+02
5	-8.18E-01	4.34E+02	5	-8.18E-01	4.33E+02	5	-8.18E-01	4.31E+02
6	-7.73E-01	4.34E+02	6	-7.73E-01	4.33E+02	6	-7.73E-01	4.31E+02
7	-7.27E-01	4.34E+02	7	-7.27E-01	4.33E+02	7	-7.27E-01	4.31E+02
8	-6.82E-01	4.34E+02	8	-6.82E-01	4.33E+02	8	-6.82E-01	4.31E+02
9	-6.36E-01	4.34E+02	9	-6.36E-01	4.33E+02	9	-6.36E-01	4.31E+02
10	-5.91E-01	4.34E+02	10	-5.91E-01	4.33E+02	10	-5.91E-01	4.31E+02
11	-5.45E-01	4.34E+02	11	-5.45E-01	4.33E+02	11	-5.45E-01	4.31E+02
12	-5.00E-01	4.34E+02	12	-5.00E-01	4.33E+02	12	-5.00E-01	4.31E+02
13	-4.55E-01	4.34E+02	13	-4.55E-01	4.33E+02	13	-4.55E-01	4.31E+02
14	-0.40909	4.34E+02	14	-0.40909	4.33E+02	14	-0.40909	4.31E+02
15	-0.36364	4.34E+02	15	-0.36364	4.33E+02	15	-0.36364	4.31E+02
16	-0.31818	4.34E+02	16	-0.31818	4.33E+02	16	-0.31818	4.31E+02
17	-0.27273	4.34E+02	17	-0.27273	4.33E+02	17	-0.27273	4.31E+02
18	-0.22727	4.34E+02	18	-0.22727	4.33E+02	18	-0.22727	4.31E+02
19	-0.18182	4.34E+02	19	-0.18182	4.33E+02	19	-0.18182	4.31E+02
20	-0.13636	4.34E+02	20	-0.13636	4.33E+02	20	-0.13636	4.31E+02
21	-9.09E-02	4.34E+02	21	-9.09E-02	4.33E+02	21	-9.09E-02	4.31E+02
22	-4.55E-02	4.34E+02	22	-4.55E-02	4.33E+02	22	-4.55E-02	4.31E+02
23	0.00E+00	4.34E+02	23	0.00E+00	4.33E+02	23	0.00E+00	4.31E+02
24	4.55E-02	4.34E+02	24	4.55E-02	4.33E+02	24	4.55E-02	4.31E+02
25	9.09E-02	4.34E+02	25	9.09E-02	4.33E+02	25	9.09E-02	4.31E+02
26	1.36E-01	4.34E+02	26	1.36E-01	4.33E+02	26	1.36E-01	4.31E+02
27	1.82E-01	4.34E+02	27	1.82E-01	4.33E+02	27	1.82E-01	4.31E+02
28	2.27E-01	4.34E+02	28	2.27E-01	4.33E+02	28	2.27E-01	4.31E+02
29	2.73E-01	4.34E+02	29	2.73E-01	4.33E+02	29	2.73E-01	4.31E+02
30	3.18E-01	4.34E+02	30	3.18E-01	4.33E+02	30	3.18E-01	4.31E+02
31	0.36364	4.34E+02	31	0.36364	4.33E+02	31	0.36364	4.31E+02
32	0.40909	4.34E+02	32	0.40909	4.33E+02	32	0.40909	4.31E+02
33	0.45455	4.34E+02	33	0.45455	4.33E+02	33	0.45455	4.31E+02
34	0.5	4.34E+02	34	0.5	4.33E+02	34	0.5	4.31E+02
35	0.54545	4.34E+02	35	0.54545	4.33E+02	35	0.54545	4.31E+02
36	0.59091	4.34E+02	36	0.59091	4.33E+02	36	0.59091	4.31E+02
37	0.63636	4.34E+02	37	0.63636	4.33E+02	37	0.63636	4.31E+02
38	0.68182	4.34E+02	38	0.68182	4.33E+02	38	0.68182	4.31E+02
39	0.72727	4.34E+02	39	0.72727	4.33E+02	39	0.72727	4.31E+02
40	0.77273	4.34E+02	40	0.77273	4.33E+02	40	0.77273	4.31E+02
41	0.81818	4.34E+02	41	0.81818	4.33E+02	41	0.81818	4.31E+02
42	0.86364	4.34E+02	42	0.86364	4.33E+02	42	0.86364	4.31E+02
43	0.90909	4.34E+02	43	0.90909	4.33E+02	43	0.90909	4.31E+02
44	0.95455	4.34E+02	44	0.95455	4.33E+02	44	0.95455	4.31E+02
45	1	4.34E+02	45	1	4.33E+02	45	1	4.31E+02
46	1.0455	4.34E+02	46	1.0455	4.33E+02	46	1.0455	4.31E+02
47	1.0909	4.34E+02	47	1.0909	4.33E+02	47	1.0909	4.31E+02
48	1.1364	4.34E+02	48	1.1364	4.33E+02	48	1.1364	4.31E+02
49	1.1818	4.34E+02	49	1.1818	4.33E+02	49	1.1818	4.31E+02
50	1.2273	4.34E+02	50	1.2273	4.33E+02	50	1.2273	4.31E+02
51	1.2727	4.34E+02	51	1.2727	4.33E+02	51	1.2727	4.31E+02
52	1.3182	4.34E+02	52	1.3182	4.33E+02	52	1.3182	4.31E+02
53	1.3636	4.34E+02	53	1.3636	4.33E+02	53	1.3636	4.31E+02
54	1.4091	4.34E+02	54	1.4091	4.33E+02	54	1.4091	4.31E+02
55	1.4545	4.34E+02	55	1.4545	4.33E+02	55	1.4545	4.31E+02
56	1.5	4.34E+02	56	1.5	4.33E+02	56	1.5	4.31E+02
57	1.5455	4.34E+02	57	1.5455	4.33E+02	57	1.5455	4.31E+02
58	1.5909	4.34E+02	58	1.5909	4.33E+02	58	1.5909	4.31E+02
59	1.6364	4.34E+02	59	1.6364	4.33E+02	59	1.6364	4.31E+02
60	1.6818	4.34E+02	60	1.6818	4.33E+02	60	1.6818	4.31E+02
61	1.7273	4.34E+02	61	1.7273	4.33E+02	61	1.7273	4.31E+02
62	1.7727	4.34E+02	62	1.7727	4.33E+02	62	1.7727	4.31E+02
63	1.8182	4.33E+02	63	1.8182	4.33E+02	63	1.8182	4.31E+02
64	1.8636	4.33E+02	64	1.8636	4.33E+02	64	1.8636	4.31E+02
65	1.9091	4.33E+02	65	1.9091	4.33E+02	65	1.9091	4.31E+02
66	1.9545	4.32E+02	66	1.9545	4.33E+02	66	1.9545	4.31E+02
67	2	4.32E+02	67	2	4.33E+02	67	2	4.31E+02
68	2.0455	4.31E+02	68	2.0455	4.33E+02	68	2.0455	4.31E+02
69	2.0909	4.30E+02	69	2.0909	4.33E+02	69	2.0909	4.31E+02
70	2.1364	4.29E+02	70	2.1364	4.33E+02	70	2.1364	4.31E+02
71	2.1818	4.28E+02	71	2.1818	4.33E+02	71	2.1818	4.31E+02
72	2.2273	4.26E+02	72	2.2273	4.33E+02	72	2.2273	4.31E+02
73	2.2727	4.24E+02	73	2.2727	4.31E+02	73	2.2727	4.31E+02
74	2.3182	4.21E+02	74	2.3182	4.29E+02	74	2.3182	4.31E+02
75	2.3636	4.17E+02	75	2.3636	4.24E+02	75	2.3636	4.31E+02

Prediction Line

	X	Y
76	2.4091	4.13E+02
77	2.4545	4.07E+02
78	2.5	4.00E+02
79	2.5455	3.91E+02
80	2.5909	3.81E+02
81	2.6364	3.68E+02
82	2.6818	3.53E+02
83	2.7273	3.35E+02
84	2.7727	3.14E+02
85	2.8182	2.92E+02
86	2.8636	2.67E+02
87	2.9091	2.41E+02
88	2.9545	2.14E+02
89	3	1.87E+02
90	3.0455	1.61E+02
91	3.0909	1.37E+02
92	3.1364	1.15E+02
93	3.1818	9.52E+01
94	3.2273	7.80E+01
95	3.2727	6.33E+01
96	3.3182	5.10E+01
97	3.3636	4.09E+01
98	3.4091	3.25E+01
99	3.4545	2.58E+01
100	3.5	2.04E+01

	X	Y
76	2.4091	4.18E+02
77	2.4545	4.10E+02
78	2.5	4.01E+02
79	2.5455	3.90E+02
80	2.5909	3.77E+02
81	2.6364	3.63E+02
82	2.6818	3.47E+02
83	2.7273	3.29E+02
84	2.7727	3.10E+02
85	2.8182	2.89E+02
86	2.8636	2.66E+02
87	2.9091	2.42E+02
88	2.9545	2.16E+02
89	3	1.90E+02
90	3.0455	1.65E+02
91	3.0909	1.43E+02
92	3.1364	1.22E+02
93	3.1818	1.02E+02
94	3.2273	8.48E+01
95	3.2727	6.88E+01
96	3.3182	5.45E+01
97	3.3636	4.19E+01
98	3.4091	3.09E+01
99	3.4545	2.16E+01
100	3.5	1.40E+01

	X	Y
76	2.4091	4.31E+02
77	2.4545	4.31E+02
78	2.5	4.26E+02
79	2.5455	4.05E+02
80	2.5909	3.84E+02
81	2.6364	3.63E+02
82	2.6818	3.42E+02
83	2.7273	3.21E+02
84	2.7727	3.00E+02
85	2.8182	2.79E+02
86	2.8636	2.58E+02
87	2.9091	2.37E+02
88	2.9545	2.16E+02
89	3	1.95E+02
90	3.0455	1.74E+02
91	3.0909	1.53E+02
92	3.1364	1.32E+02
93	3.1818	1.11E+02
94	3.2273	9.04E+01
95	3.2727	6.94E+01
96	3.3182	4.85E+01
97	3.3636	2.75E+01
98	3.4091	6.48E+00
99	3.4545	0.00E+00
100	3.5	0.00E+00

Table E2.D-4a. TRAP Model Output for Cadmium Data for the Bird Growth Endpoint (Bokori et al. 1995)

Chemical:	Cadmium
Study Authors:	Bokori et al. 1995
Receptor Group:	Bird
Effect Description:	Growth

Input Data:

Dose	Response	SE
1.00E-06	1.469	5.00E-02
4.7361	1.03	4.30E-02
18.944	0.476	1.70E-02
37.889	0.353	1.70E-02

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined	yes	yes	yes
Large Standard Error for X50			
Large Standard Error for Steepness			
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

Logistic Equation:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.026	0.96423			
S	0.56968	5.20E-01			
Y0	1.47E+00	1.49E+00			

Threshold Sigmoid:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.026	0.96588			
S	0.56968	5.51E-01			
Y0	1.47E+00	1.48E+00			

Piecewise Linear:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.026	0.96385			
S	0.56968	0.45768			
Y0	1.47E+00	1.47E+00			

Xp Estimates

Logistic Equation:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	9.2095	0.13027	651.09	0.14555	0.96423
20	1.99E+00	4.17E-04	9.48E+03	0.28952	2.98E-01
10	8.10E-01	1.18E-05	5.55E+04	0.38058	-9.13E-02
5	3.55E-01	4.28E-07	2.94E+05	0.46582	-0.4502
0					

Threshold Sigmoid:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	9.2444	0.12738	670.89	0.14645	0.96588
20	1.9911	2.92E-04	13557	0.30167	2.99E-01
10	9.18E-01	6.35E-06	1.33E+05	0.40614	-3.70E-02
5	0.53137	2.51E-07	1.12E+06	0.4978	-0.27461
0	1.42E-01	7.54E-14	2.67E+11	0.96603	-8.48E-01

Piecewise Linear:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	9.2012	2.19E-02	3874.7	0.20654	0.96385
20	2.034	1.61E-05	2.57E+05	0.40155	0.30836
10	1.2299	1.32E-06	1.15E+06	0.46981	8.99E-02
5	0.95635	3.75E-07	2.44E+06	0.50419	-1.94E-02
0	0.74365	1.06E-07	5.20E+06	0.53869	-0.12863

Model Fit Summary

Dataset

Logistic Equation:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.47E+00	1.49E+00
2	6.75E-01	1.03E+00	9.60E-01
3	1.28E+00	4.76E-01	5.09E-01
4	1.58E+00	3.53E-01	3.24E-01
5			
6			

Threshold Sigmoid:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.47E+00	1.48E+00
2	6.75E-01	1.03E+00	9.61E-01
3	1.28E+00	4.76E-01	5.09E-01
4	1.58E+00	3.53E-01	3.25E-01
5			
6			

Piecewise Linear:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.47E+00	1.47E+00
2	6.75E-01	1.03E+00	9.28E-01
3	1.28E+00	4.76E-01	5.24E-01
4	1.58E+00	3.53E-01	3.21E-01
5			
6			

Analysis of Variance

Logistic Equation:

R-squared: 0.996

	DF	SS	MS	F	Sig
Total (adj)	3	2548.9	849.64		
Regression	2	2539.4	1269.7	133.21	0.0612
Error	1	9.5315	9.5315		

Threshold Sigmoid:

R-squared: 0.996

	DF	SS	MS	F	Sig
Total (adj)	3	2548.9	849.64		
Regression	2	2539.8	1269.9	139.78	0.0597
Error	1	9.0852	9.0852		

Piecewise Linear:

R-squared: 0.993

	DF	SS	MS	F	Sig
Total (adj)	3	2548.9	849.64		
Regression	2	2532	1266	74.815	0.0815
Error	1	16.922	16.922		

Prediction Line

	X	Y
1	-2.5	1.49E+00
2	-2.45E+00	1.49E+00
3	-2.41E+00	1.49E+00
4	-2.36E+00	1.49E+00
5	-2.32E+00	1.49E+00
6	-2.27E+00	1.48E+00
7	-2.23E+00	1.48E+00
8	-2.18E+00	1.48E+00
9	-2.14E+00	1.48E+00
10	-2.09E+00	1.48E+00
11	-2.05E+00	1.48E+00
12	-2.00E+00	1.48E+00
13	-1.95E+00	1.48E+00
14	-1.9091	1.48E+00
15	-1.8636	1.48E+00
16	-1.8182	1.48E+00
17	-1.7727	1.48E+00
18	-1.7273	1.48E+00
19	-1.6818	1.48E+00
20	-1.6364	1.48E+00
21	-1.59E+00	1.48E+00
22	-1.55E+00	1.48E+00
23	-1.50E+00	1.48E+00
24	-1.45E+00	1.48E+00
25	-1.41E+00	1.48E+00
26	-1.36E+00	1.48E+00
27	-1.32E+00	1.47E+00
28	-1.27E+00	1.47E+00
29	-1.23E+00	1.47E+00
30	-1.18E+00	1.47E+00
31	-1.1364	1.47E+00
32	-1.0909	1.47E+00
33	-1.0455	1.46E+00
34	-1	1.46E+00
35	-0.95455	1.46E+00
36	-0.90909	1.46E+00
37	-0.86364	1.45E+00
38	-0.81818	1.45E+00
39	-0.77273	1.45E+00
40	-0.72727	1.44E+00
41	-0.68182	1.44E+00
42	-0.63636	1.44E+00
43	-0.59091	1.43E+00
44	-0.54545	1.43E+00
45	-0.5	1.42E+00
46	-0.45455	1.41E+00
47	-0.40909	1.41E+00
48	-0.36364	1.40E+00
49	-0.31818	1.39E+00
50	-0.27273	1.38E+00
51	-0.22727	1.37E+00
52	-0.18182	1.36E+00
53	-0.13636	1.35E+00
54	-9.09E-02	1.34E+00
55	-4.55E-02	1.32E+00
56	0	1.31E+00
57	4.55E-02	1.30E+00
58	9.09E-02	1.28E+00
59	0.13636	1.26E+00
60	0.18182	1.24E+00
61	0.22727	1.22E+00
62	0.27273	1.20E+00
63	0.31818	1.18E+00
64	0.36364	1.16E+00
65	0.40909	1.13E+00
66	0.45455	1.10E+00
67	0.5	1.08E+00
68	0.54545	1.05E+00
69	0.59091	1.02E+00

	X	Y
1	-2.5	1.48E+00
2	-2.45E+00	1.48E+00
3	-2.41E+00	1.48E+00
4	-2.36E+00	1.48E+00
5	-2.32E+00	1.48E+00
6	-2.27E+00	1.48E+00
7	-2.23E+00	1.48E+00
8	-2.18E+00	1.48E+00
9	-2.14E+00	1.48E+00
10	-2.09E+00	1.48E+00
11	-2.05E+00	1.48E+00
12	-2.00E+00	1.48E+00
13	-1.95E+00	1.48E+00
14	-1.9091	1.48E+00
15	-1.8636	1.48E+00
16	-1.8182	1.48E+00
17	-1.7727	1.48E+00
18	-1.7273	1.48E+00
19	-1.6818	1.48E+00
20	-1.6364	1.48E+00
21	-1.59E+00	1.48E+00
22	-1.55E+00	1.48E+00
23	-1.50E+00	1.48E+00
24	-1.45E+00	1.48E+00
25	-1.41E+00	1.48E+00
26	-1.36E+00	1.48E+00
27	-1.32E+00	1.48E+00
28	-1.27E+00	1.48E+00
29	-1.23E+00	1.48E+00
30	-1.18E+00	1.48E+00
31	-1.1364	1.48E+00
32	-1.0909	1.48E+00
33	-1.0455	1.48E+00
34	-1	1.48E+00
35	-0.95455	1.48E+00
36	-0.90909	1.48E+00
37	-0.86364	1.48E+00
38	-0.81818	1.48E+00
39	-0.77273	1.48E+00
40	-0.72727	1.48E+00
41	-0.68182	1.48E+00
42	-0.63636	1.47E+00
43	-0.59091	1.47E+00
44	-0.54545	1.46E+00
45	-0.5	1.46E+00
46	-0.45455	1.45E+00
47	-0.40909	1.44E+00
48	-0.36364	1.43E+00
49	-0.31818	1.42E+00
50	-0.27273	1.41E+00
51	-0.22727	1.40E+00
52	-0.18182	1.38E+00
53	-0.13636	1.37E+00
54	-9.09E-02	1.35E+00
55	-4.55E-02	1.34E+00
56	0	1.32E+00
57	4.55E-02	1.30E+00
58	9.09E-02	1.29E+00
59	0.13636	1.27E+00
60	0.18182	1.24E+00
61	0.22727	1.22E+00
62	0.27273	1.20E+00
63	0.31818	1.18E+00
64	0.36364	1.15E+00
65	0.40909	1.13E+00
66	0.45455	1.10E+00
67	0.5	1.07E+00
68	0.54545	1.05E+00
69	0.59091	1.02E+00

	X	Y
1	-2.5	1.47E+00
2	-2.45E+00	1.47E+00
3	-2.41E+00	1.47E+00
4	-2.36E+00	1.47E+00
5	-2.32E+00	1.47E+00
6	-2.27E+00	1.47E+00
7	-2.23E+00	1.47E+00
8	-2.18E+00	1.47E+00
9	-2.14E+00	1.47E+00
10	-2.09E+00	1.47E+00
11	-2.05E+00	1.47E+00
12	-2.00E+00	1.47E+00
13	-1.95E+00	1.47E+00
14	-1.9091	1.47E+00
15	-1.8636	1.47E+00
16	-1.8182	1.47E+00
17	-1.7727	1.47E+00
18	-1.7273	1.47E+00
19	-1.6818	1.47E+00
20	-1.6364	1.47E+00
21	-1.59E+00	1.47E+00
22	-1.55E+00	1.47E+00
23	-1.50E+00	1.47E+00
24	-1.45E+00	1.47E+00
25	-1.41E+00	1.47E+00
26	-1.36E+00	1.47E+00
27	-1.32E+00	1.47E+00
28	-1.27E+00	1.47E+00
29	-1.23E+00	1.47E+00
30	-1.18E+00	1.47E+00
31	-1.1364	1.47E+00
32	-1.0909	1.47E+00
33	-1.0455	1.47E+00
34	-1	1.47E+00
35	-0.95455	1.47E+00
36	-0.90909	1.47E+00
37	-0.86364	1.47E+00
38	-0.81818	1.47E+00
39	-0.77273	1.47E+00
40	-0.72727	1.47E+00
41	-0.68182	1.47E+00
42	-0.63636	1.47E+00
43	-0.59091	1.47E+00
44	-0.54545	1.47E+00
45	-0.5	1.47E+00
46	-0.45455	1.47E+00
47	-0.40909	1.47E+00
48	-0.36364	1.47E+00
49	-0.31818	1.47E+00
50	-0.27273	1.47E+00
51	-0.22727	1.47E+00
52	-0.18182	1.47E+00
53	-0.13636	1.47E+00
54	-9.09E-02	1.44E+00
55	-4.55E-02	1.41E+00
56	0	1.38E+00
57	4.55E-02	1.35E+00
58	9.09E-02	1.32E+00
59	0.13636	1.29E+00
60	0.18182	1.26E+00
61	0.22727	1.23E+00
62	0.27273	1.20E+00
63	0.31818	1.17E+00
64	0.36364	1.14E+00
65	0.40909	1.11E+00
66	0.45455	1.08E+00
67	0.5	1.05E+00
68	0.54545	1.02E+00
69	0.59091	9.85E-01

Prediction Line

	X	Y
70	0.63636	9.88E-01
71	0.68182	9.56E-01
72	0.72727	9.23E-01
73	0.77273	8.90E-01
74	0.81818	8.55E-01
75	0.86364	8.21E-01
76	0.90909	7.86E-01
77	0.95455	7.51E-01
78	1	7.16E-01
79	1.0455	6.81E-01
80	1.0909	6.46E-01
81	1.1364	6.12E-01
82	1.1818	5.78E-01
83	1.2273	5.45E-01
84	1.2727	5.13E-01
85	1.3182	4.81E-01
86	1.3636	4.51E-01
87	1.4091	4.22E-01
88	1.4545	3.94E-01
89	1.5	3.67E-01
90	1.5455	3.42E-01
91	1.5909	3.17E-01
92	1.6364	2.94E-01
93	1.6818	2.73E-01
94	1.7273	2.52E-01
95	1.7727	2.33E-01
96	1.8182	2.15E-01
97	1.8636	1.98E-01
98	1.9091	1.82E-01
99	1.9545	1.68E-01
100	2	1.54E-01

	X	Y
70	0.63636	9.87E-01
71	0.68182	9.56E-01
72	0.72727	9.24E-01
73	0.77273	8.92E-01
74	0.81818	8.58E-01
75	0.86364	8.23E-01
76	0.90909	7.88E-01
77	0.95455	7.51E-01
78	1	7.14E-01
79	1.0455	6.78E-01
80	1.0909	6.43E-01
81	1.1364	6.09E-01
82	1.1818	5.76E-01
83	1.2273	5.44E-01
84	1.2727	5.12E-01
85	1.3182	4.82E-01
86	1.3636	4.52E-01
87	1.4091	4.24E-01
88	1.4545	3.96E-01
89	1.5	3.69E-01
90	1.5455	3.44E-01
91	1.5909	3.19E-01
92	1.6364	2.95E-01
93	1.6818	2.72E-01
94	1.7273	2.50E-01
95	1.7727	2.29E-01
96	1.8182	2.09E-01
97	1.8636	1.89E-01
98	1.9091	1.71E-01
99	1.9545	1.54E-01
100	2	1.37E-01

	X	Y
70	0.63636	9.55E-01
71	0.68182	9.24E-01
72	0.72727	8.94E-01
73	0.77273	8.63E-01
74	0.81818	8.32E-01
75	0.86364	8.02E-01
76	0.90909	7.71E-01
77	0.95455	7.41E-01
78	1	7.10E-01
79	1.0455	6.80E-01
80	1.0909	6.49E-01
81	1.1364	6.19E-01
82	1.1818	5.88E-01
83	1.2273	5.57E-01
84	1.2727	5.27E-01
85	1.3182	4.96E-01
86	1.3636	4.66E-01
87	1.4091	4.35E-01
88	1.4545	4.05E-01
89	1.5	3.74E-01
90	1.5455	3.43E-01
91	1.5909	3.13E-01
92	1.6364	2.82E-01
93	1.6818	2.52E-01
94	1.7273	2.21E-01
95	1.7727	1.91E-01
96	1.8182	1.60E-01
97	1.8636	1.30E-01
98	1.9091	9.90E-02
99	1.9545	6.84E-02
100	2	3.79E-02

Table E2.D-4b. TRAP Model Output for Cadmium Data for the Bird Reproduction Endpoint (Leach et al. 1979)

Chemical:	Cadmium
Study Authors:	Leach et al. 1979
Receptor Group:	Bird
Effect Description:	Reproduction

Input Data:

Dose	Response	SE
0.0055	64.3	not reported
0.2393	69.5	not reported
0.9408	59.9	not reported
3.7469	48.3	not reported

Modeling Parameters			
Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered			
Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined	yes	yes	yes
Large Standard Error for X50			
Large Standard Error for Steepness			
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL		Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL		Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
X50	0.92368	0.93309				X50	0.92368	1.0222				X50	0.92368	0.94956			
S	0.6145	6.55E-01				S	0.6145	5.64E-01				S	0.6145	0.65994			
Y0	6.69E+01	6.67E+01				Y0	6.69E+01	6.66E+01				Y0	6.69E+01	6.46E+01			

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp	p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp	p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	8.5722	5.33E-04	1.38E+05	0.33107	0.93309	50	10.525	1.24E-03	89163	3.09E-01	1.0222	50	8.9035				0.94956
20	2.54E+00	2.80E-03	2.29E+03	0.23267	0.40416	20	2.3442	1.01E-02	545.42	1.86E-01	0.36999	20	3.1259				0.49497
10	1.24E+00	1.61E-06	9.60E+05	0.46336	9.48E-02	10	1.10E+00	1.03E-04	1.17E+04	0.31697	4.13E-02	10	2.2052				0.34344
5	6.45E-01	8.44E-10	4.93E+08	0.69912	-0.19035	5	6.44E-01	2.13E-06	1.94E+05	0.43128	-0.19119	5	1.8522				0.26768
0						0	1.77E-01	1.08E-10	2.89E+08	0.72505	-7.52E-01	0	1.5557				0.19191

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var
1	-2.26E+00	6.43E+01	6.67E+01	1	-2.26E+00	6.43E+01	6.66E+01	1	-2.26E+00	6.43E+01	6.46E+01
2	-6.21E-01	6.95E+01	6.56E+01	2	-6.21E-01	6.95E+01	6.64E+01	2	-6.21E-01	6.95E+01	6.46E+01
3	-2.65E-02	5.99E+01	6.17E+01	3	-2.65E-02	5.99E+01	6.10E+01	3	-2.65E-02	5.99E+01	6.46E+01
4	5.74E-01	4.83E+01	4.80E+01	4	5.74E-01	4.83E+01	4.80E+01	4	0.57367	48.3	48.3
5				5				5			
6				6				6			

Analysis of Variance

R-squared:	0.9	R-squared:	0.934

R-squared: 0.811

	DF	SS	MS	F	Sig		DF	SS	MS	F	Sig		DF	SS	MS	F	Sig
Total (adj)	3	244.64	81.547			Total (adj)	3	244.64	81.547			Total (adj)	3	244.64	81.547		
Regression	2	220.24	110.12	4.5141	0.3158	Regression	2	228.49	114.25	7.0742	0.2569	Regression	2	198.45	99.227	2.1484	0.4345
Error	1	24.395	24.395			Error	1	16.15	16.15			Error	1	46.187	46.187		

Prediction Line

	X	Y
1	-2	6.67E+01
2	-1.97E+00	6.67E+01
3	-1.94E+00	6.67E+01
4	-1.91E+00	6.67E+01
5	-1.88E+00	6.67E+01
6	-1.85E+00	6.67E+01
7	-1.82E+00	6.67E+01
8	-1.79E+00	6.67E+01
9	-1.76E+00	6.66E+01
10	-1.73E+00	6.66E+01
11	-1.70E+00	6.66E+01
12	-1.67E+00	6.66E+01
13	-1.64E+00	6.66E+01
14	-1.6061	6.66E+01
15	-1.5758	6.66E+01
16	-1.5455	6.66E+01
17	-1.5152	6.66E+01
18	-1.4848	6.66E+01
19	-1.4545	6.66E+01
20	-1.4242	6.66E+01
21	-1.39E+00	6.66E+01
22	-1.36E+00	6.65E+01
23	-1.33E+00	6.65E+01
24	-1.30E+00	6.65E+01
25	-1.27E+00	6.65E+01
26	-1.24E+00	6.65E+01
27	-1.21E+00	6.65E+01
28	-1.18E+00	6.64E+01
29	-1.15E+00	6.64E+01
30	-1.12E+00	6.64E+01
31	-1.0909	6.64E+01
32	-1.06E+00	6.63E+01
33	-1.03E+00	6.63E+01
34	-1	6.63E+01
35	-9.70E-01	6.63E+01
36	-9.39E-01	6.62E+01
37	-9.09E-01	6.62E+01
38	-8.79E-01	6.61E+01
39	-8.48E-01	6.61E+01
40	-8.18E-01	6.60E+01
41	-7.88E-01	6.60E+01
42	-7.58E-01	6.59E+01
43	-7.27E-01	6.59E+01
44	-6.97E-01	6.58E+01
45	-6.67E-01	6.57E+01
46	-6.36E-01	6.56E+01
47	-6.06E-01	6.55E+01
48	-5.76E-01	6.55E+01
49	-5.45E-01	6.53E+01
50	-5.15E-01	6.52E+01
51	-0.48485	6.51E+01
52	-0.45455	6.50E+01
53	-0.42424	6.49E+01
54	-0.39394	6.47E+01
55	-0.36364	6.45E+01
56	-0.33333	6.44E+01
57	-0.30303	6.42E+01
58	-0.27273	6.40E+01
59	-0.24242	6.38E+01
60	-0.21212	6.35E+01
61	-0.18182	6.33E+01
62	-0.15152	6.30E+01
63	-0.12121	6.27E+01
64	-9.09E-02	6.24E+01
65	-6.06E-02	6.21E+01
66	-3.03E-02	6.18E+01
67	0	6.14E+01
68	3.03E-02	6.10E+01
69	6.06E-02	6.06E+01

	X	Y
1	-2	6.66E+01
2	-1.97E+00	6.66E+01
3	-1.94E+00	6.66E+01
4	-1.91E+00	6.66E+01
5	-1.88E+00	6.66E+01
6	-1.85E+00	6.66E+01
7	-1.82E+00	6.66E+01
8	-1.79E+00	6.66E+01
9	-1.76E+00	6.66E+01
10	-1.73E+00	6.66E+01
11	-1.70E+00	6.66E+01
12	-1.67E+00	6.66E+01
13	-1.64E+00	6.66E+01
14	-1.6061	6.66E+01
15	-1.5758	6.66E+01
16	-1.5455	6.66E+01
17	-1.5152	6.66E+01
18	-1.4848	6.66E+01
19	-1.4545	6.66E+01
20	-1.4242	6.66E+01
21	-1.39E+00	6.66E+01
22	-1.36E+00	6.66E+01
23	-1.33E+00	6.66E+01
24	-1.30E+00	6.66E+01
25	-1.27E+00	6.66E+01
26	-1.24E+00	6.66E+01
27	-1.21E+00	6.66E+01
28	-1.18E+00	6.66E+01
29	-1.15E+00	6.66E+01
30	-1.12E+00	6.66E+01
31	-1.0909	6.66E+01
32	-1.06E+00	6.66E+01
33	-1.03E+00	6.66E+01
34	-1	6.66E+01
35	-9.70E-01	6.66E+01
36	-9.39E-01	6.66E+01
37	-9.09E-01	6.66E+01
38	-8.79E-01	6.66E+01
39	-8.48E-01	6.66E+01
40	-8.18E-01	6.66E+01
41	-7.88E-01	6.66E+01
42	-7.58E-01	6.66E+01
43	-7.27E-01	6.66E+01
44	-6.97E-01	6.66E+01
45	-6.67E-01	6.65E+01
46	-6.36E-01	6.64E+01
47	-6.06E-01	6.64E+01
48	-5.76E-01	6.63E+01
49	-5.45E-01	6.61E+01
50	-5.15E-01	6.60E+01
51	-0.48485	6.58E+01
52	-0.45455	6.56E+01
53	-0.42424	6.54E+01
54	-0.39394	6.52E+01
55	-0.36364	6.50E+01
56	-0.33333	6.47E+01
57	-0.30303	6.45E+01
58	-0.27273	6.42E+01
59	-0.24242	6.38E+01
60	-0.21212	6.35E+01
61	-0.18182	6.31E+01
62	-0.15152	6.28E+01
63	-0.12121	6.24E+01
64	-9.09E-02	6.20E+01
65	-6.06E-02	6.15E+01
66	-3.03E-02	6.11E+01
67	0	6.06E+01
68	3.03E-02	6.01E+01
69	6.06E-02	5.96E+01

	X	Y
1	-2	6.46E+01
2	-1.97E+00	6.46E+01
3	-1.94E+00	6.46E+01
4	-1.91E+00	6.46E+01
5	-1.88E+00	6.46E+01
6	-1.85E+00	6.46E+01
7	-1.82E+00	6.46E+01
8	-1.79E+00	6.46E+01
9	-1.76E+00	6.46E+01
10	-1.73E+00	6.46E+01
11	-1.70E+00	6.46E+01
12	-1.67E+00	6.46E+01
13	-1.64E+00	6.46E+01
14	-1.6061	6.46E+01
15	-1.5758	6.46E+01
16	-1.5455	6.46E+01
17	-1.5152	6.46E+01
18	-1.4848	6.46E+01
19	-1.4545	6.46E+01
20	-1.4242	6.46E+01
21	-1.39E+00	6.46E+01
22	-1.36E+00	6.46E+01
23	-1.33E+00	6.46E+01
24	-1.30E+00	6.46E+01
25	-1.27E+00	6.46E+01
26	-1.24E+00	6.46E+01
27	-1.21E+00	6.46E+01
28	-1.18E+00	6.46E+01
29	-1.15E+00	6.46E+01
30	-1.12E+00	6.46E+01
31	-1.0909	6.46E+01
32	-1.06E+00	6.46E+01
33	-1.03E+00	6.46E+01
34	-1	6.46E+01
35	-9.70E-01	6.46E+01
36	-9.39E-01	6.46E+01
37	-9.09E-01	6.46E+01
38	-8.79E-01	6.46E+01
39	-8.48E-01	6.46E+01
40	-8.18E-01	6.46E+01
41	-7.88E-01	6.46E+01
42	-7.58E-01	6.46E+01
43	-7.27E-01	6.46E+01
44	-6.97E-01	6.46E+01
45	-6.67E-01	6.46E+01
46	-6.36E-01	6.46E+01
47	-6.06E-01	6.46E+01
48	-5.76E-01	6.46E+01
49	-5.45E-01	6.46E+01
50	-5.15E-01	6.46E+01
51	-0.48485	6.46E+01
52	-0.45455	6.46E+01
53	-0.42424	6.46E+01
54	-0.39394	6.46E+01
55	-0.36364	6.46E+01
56	-0.33333	6.46E+01
57	-0.30303	6.46E+01
58	-0.27273	6.46E+01
59	-0.24242	6.46E+01
60	-0.21212	6.46E+01
61	-0.18182	6.46E+01
62	-0.15152	6.46E+01
63	-0.12121	6.46E+01
64	-9.09E-02	6.46E+01
65	-6.06E-02	6.46E+01
66	-3.03E-02	6.46E+01
67	0	6.46E+01
68	3.03E-02	6.46E+01
69	6.06E-02	6.46E+01

Prediction Line

	X	Y
70	9.09E-02	6.01E+01
71	0.12121	5.96E+01
72	0.15152	5.91E+01
73	0.18182	5.85E+01
74	0.21212	5.79E+01
75	0.24242	5.73E+01
76	0.27273	5.67E+01
77	0.30303	5.60E+01
78	0.33333	5.52E+01
79	0.36364	5.45E+01
80	0.39394	5.36E+01
81	0.42424	5.28E+01
82	0.45455	5.19E+01
83	0.48485	5.10E+01
84	0.51515	5.00E+01
85	0.54545	4.90E+01
86	0.57576	4.79E+01
87	0.60606	4.68E+01
88	0.63636	4.57E+01
89	0.66667	4.45E+01
90	0.69697	4.34E+01
91	0.72727	4.21E+01
92	0.75758	4.09E+01
93	0.78788	3.96E+01
94	0.81818	3.83E+01
95	0.84848	3.70E+01
96	0.87879	3.57E+01
97	0.90909	3.44E+01
98	0.93939	3.31E+01
99	0.9697	3.18E+01
100	1	3.04E+01

	X	Y
70	9.09E-02	5.91E+01
71	0.12121	5.85E+01
72	0.15152	5.79E+01
73	0.18182	5.74E+01
74	0.21212	5.68E+01
75	0.24242	5.61E+01
76	0.27273	5.55E+01
77	0.30303	5.48E+01
78	0.33333	5.41E+01
79	0.36364	5.34E+01
80	0.39394	5.27E+01
81	0.42424	5.20E+01
82	0.45455	5.12E+01
83	0.48485	5.04E+01
84	0.51515	4.96E+01
85	0.54545	4.88E+01
86	0.57576	4.79E+01
87	0.60606	4.71E+01
88	0.63636	4.62E+01
89	0.66667	4.53E+01
90	0.69697	4.44E+01
91	0.72727	4.34E+01
92	0.75758	4.25E+01
93	0.78788	4.15E+01
94	0.81818	4.05E+01
95	0.84848	3.95E+01
96	0.87879	3.85E+01
97	0.90909	3.74E+01
98	0.93939	3.63E+01
99	0.9697	3.52E+01
100	1	3.41E+01

	X	Y
70	9.09E-02	6.46E+01
71	0.12121	6.46E+01
72	0.15152	6.46E+01
73	0.18182	6.46E+01
74	0.21212	6.37E+01
75	0.24242	6.24E+01
76	0.27273	6.11E+01
77	0.30303	5.98E+01
78	0.33333	5.85E+01
79	0.36364	5.73E+01
80	0.39394	5.60E+01
81	0.42424	5.47E+01
82	0.45455	5.34E+01
83	0.48485	5.21E+01
84	0.51515	5.08E+01
85	0.54545	4.95E+01
86	0.57576	4.82E+01
87	0.60606	4.69E+01
88	0.63636	4.56E+01
89	0.66667	4.43E+01
90	0.69697	4.30E+01
91	0.72727	4.18E+01
92	0.75758	4.05E+01
93	0.78788	3.92E+01
94	0.81818	3.79E+01
95	0.84848	3.66E+01
96	0.87879	3.53E+01
97	0.90909	3.40E+01
98	0.93939	3.27E+01
99	0.9697	3.14E+01
100	1	3.01E+01

Table E2.D-4c. TRAP Model Output for Cadmium Data for the Bird Survival Endpoint (Pooling Group C: Bokori et al. 1995a; Olgun 2015)

Chemical:	Cadmium
Study Authors:	Pooling group C
Receptor Group:	Bird
Effect Description:	Survival

Input Data:

Dose	Effect Relative to Control
1.00E-06	100
9.3623	77.778
18.725	55.556
37.449	44.444
4.21E-02	100
0.70027	100
1.3584	100
2.6747	106.67
5.307	106.7
10.572	46.7

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?
Use Only for Exploratory Data Analysis!
Maximum Iterations Reached Without Convergence
X50 at Maximum or Minimum Limit
Steepness At Maximum Or Minimum Limit
Error Estimates Cannot Be Determined
Large Standard Error for X50
Large Standard Error for Steepness
Large Standard Error for Y0
Inadequate Number of Partial Effects
Insufficient Data to Plot
Insufficient Data to Analyze

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL		Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL		Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.3404	1.3276	0.12523	1.0314	1.6237	LogX50	1.3404	1.3431	0.1223	1.0539	1.6323	LogX50	1.3404	1.3501	0.11178	1.0858	1.6144
S	1.0536	6.96E-01	0.27924	3.53E-02	1.3558	S	1.0536	7.77E-01	0.28693	9.89E-02	1.4559	S	1.0536	0.64819	0.18422	0.21258	1.0838
Y0	1.02E+02	1.04E+02	7.5804	86.267	122.12	Y0	1.02E+02	1.02E+02	6.7468	86.286	118.19	Y0	1.02E+02	1.01E+02	5.2929	88.818	113.85

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp	p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp	p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	21.26	10.751	42.043	0.12523	1.3276	50	22.034	11.322	42.884	0.1223	1.3431	50	22.392	12.184	41.152	0.11178	1.3501
20	6.75E+00	2.04E+00	2.24E+01	0.22005	0.82929	20	7.4186	2.69E+00	20.495	0.18664	0.87032	20	7.7136	3.992	14.905	0.12098	0.88726
10	3.45E+00	5.93E-01	2.01E+01	0.32354	0.53782	10	4.29E+00	9.78E-01	1.88E+01	0.27131	0.63204	10	5.4073	2.3663	12.357	0.15179	0.73298
5	1.86E+00	1.84E-01	1.88E+01	0.42515	0.26925	5	2.9077	4.42E-01	1.91E+01	0.34603	0.46355	5	4.5274	1.8004	11.385	0.16936	0.65585
0						0	1.1397	4.76E-02	2.73E+01	0.58317	5.68E-02	0	3.7906	1.3631	10.541	0.18785	0.57871

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	1.04E+02	1	-6.00E+00	1.00E+02	1.02E+02	1	-6.00E+00	1.00E+02	1.01E+02
2	9.71E-01	7.78E+01	1.04E+02	2	-1.38E+00	1.00E+02	1.02E+02	2	-1.38E+00	1.00E+02	1.01E+02
3	1.27E+00	5.56E+01	1.03E+02	3	-1.55E-01	1.00E+02	1.02E+02	3	-1.55E-01	1.00E+02	1.01E+02
4	1.57E+00	4.44E+01	1.01E+02	4	1.33E-01	1.00E+02	1.02E+02	4	1.33E-01	1.00E+02	1.01E+02
5	-1.38E+00	1.00E+02	9.63E+01	5	4.27E-01	1.07E+02	9.80E+01	5	4.27E-01	1.07E+02	1.01E+02
6	-1.55E-01	1.00E+02	8.78E+01	6	7.25E-01	1.07E+02	8.85E+01	6	7.25E-01	1.07E+02	9.17E+01
7	1.33E-01	100	75.985	7	9.71E-01	77.778	76.396	7	9.71E-01	77.778	75.541
8	4.27E-01	106.67	72.864	8	1.02E+00	46.667	73.327	8	1.02E+00	46.667	72.073
9	0.72487	106.67	56.085	9	1.2724	55.556	56.584	9	1.2724	55.556	55.768
10	1.0242	46.667	34.941	10	1.5734	44.444	34.451	10	1.5734	44.444	35.996

Analysis of Variance

R-squared:	0.781	R-squared:	0.788	R-squared:	0.833

	DF	SS	MS	F	Sig		DF	SS	MS	F	Sig		DF	SS	MS	F	Sig
Total (adj)	9	5857.3	650.81			Total (adj)	9	5857.3	650.81			Total (adj)	9	5857.3	650.81		
Regression	2	4572	2286	12.451	0.0049	Regression	2	4617.4	2308.7	13.035	0.0044	Regression	2	4876.8	2438.4	17.408	0.0019
Error	7	1285.2	183.61			Error	7	1239.9	177.12			Error	7	980.51	140.07		

Prediction Line

	X	Y
1	-2.5	1.04E+02
2	-2.45E+00	1.04E+02
3	-2.41E+00	1.04E+02
4	-2.36E+00	1.04E+02
5	-2.32E+00	1.04E+02
6	-2.27E+00	1.04E+02
7	-2.23E+00	1.04E+02
8	-2.18E+00	1.04E+02
9	-2.14E+00	1.04E+02
10	-2.09E+00	1.04E+02
11	-2.05E+00	1.04E+02
12	-2.00E+00	1.04E+02
13	-1.95E+00	1.04E+02
14	-1.9091	1.04E+02
15	-1.8636	1.04E+02
16	-1.8182	1.04E+02
17	-1.7727	1.04E+02
18	-1.7273	1.04E+02
19	-1.6818	1.04E+02
20	-1.6364	1.04E+02
21	-1.59E+00	1.04E+02
22	-1.55E+00	1.04E+02
23	-1.50E+00	1.04E+02
24	-1.45E+00	1.04E+02
25	-1.41E+00	1.04E+02
26	-1.36E+00	1.04E+02
27	-1.32E+00	1.04E+02
28	-1.27E+00	1.04E+02
29	-1.23E+00	1.04E+02
30	-1.18E+00	1.04E+02
31	-1.1364	1.04E+02
32	-1.0909	1.04E+02
33	-1.0455	1.04E+02
34	-1	1.04E+02
35	-0.95455	1.04E+02
36	-0.90909	1.04E+02
37	-0.86364	1.04E+02
38	-0.81818	1.04E+02
39	-0.77273	1.04E+02
40	-0.72727	1.04E+02
41	-6.82E-01	1.04E+02
42	-6.36E-01	1.04E+02
43	-5.91E-01	1.04E+02
44	-5.45E-01	1.04E+02
45	-5.00E-01	1.04E+02
46	-4.55E-01	1.03E+02
47	-0.40909	1.03E+02
48	-0.36364	1.03E+02
49	-0.31818	1.03E+02
50	-0.27273	1.03E+02
51	-0.22727	1.03E+02
52	-0.18182	1.03E+02
53	-0.13636	1.02E+02
54	-9.09E-02	1.02E+02
55	-4.55E-02	1.02E+02
56	0	1.02E+02
57	4.55E-02	1.01E+02
58	9.09E-02	1.01E+02
59	0.13636	1.01E+02
60	0.18182	1.00E+02
61	0.22727	9.95E+01
62	0.27273	9.89E+01
63	0.31818	9.83E+01
64	0.36364	9.75E+01
65	0.40909	9.67E+01
66	0.45455	9.58E+01
67	0.5	9.47E+01
68	0.54545	9.36E+01
69	0.59091	9.23E+01
70	0.63636	9.09E+01
71	0.68182	8.94E+01
72	0.72727	8.77E+01
73	0.77273	8.59E+01
74	0.81818	8.39E+01
75	0.86364	8.17E+01
76	0.90909	7.94E+01

	X	Y
1	-2.5	1.02E+02
2	-2.45E+00	1.02E+02
3	-2.41E+00	1.02E+02
4	-2.36E+00	1.02E+02
5	-2.32E+00	1.02E+02
6	-2.27E+00	1.02E+02
7	-2.23E+00	1.02E+02
8	-2.18E+00	1.02E+02
9	-2.14E+00	1.02E+02
10	-2.09E+00	1.02E+02
11	-2.05E+00	1.02E+02
12	-2.00E+00	1.02E+02
13	-1.95E+00	1.02E+02
14	-1.9091	1.02E+02
15	-1.8636	1.02E+02
16	-1.8182	1.02E+02
17	-1.7727	1.02E+02
18	-1.7273	1.02E+02
19	-1.6818	1.02E+02
20	-1.6364	1.02E+02
21	-1.59E+00	1.02E+02
22	-1.55E+00	1.02E+02
23	-1.50E+00	1.02E+02
24	-1.45E+00	1.02E+02
25	-1.41E+00	1.02E+02
26	-1.36E+00	1.02E+02
27	-1.32E+00	1.02E+02
28	-1.27E+00	1.02E+02
29	-1.23E+00	1.02E+02
30	-1.18E+00	1.02E+02
31	-1.1364	1.02E+02
32	-1.0909	1.02E+02
33	-1.0455	1.02E+02
34	-1	1.02E+02
35	-0.95455	1.02E+02
36	-0.90909	1.02E+02
37	-0.86364	1.02E+02
38	-0.81818	1.02E+02
39	-0.77273	1.02E+02
40	-0.72727	1.02E+02
41	-6.82E-01	1.02E+02
42	-6.36E-01	1.02E+02
43	-5.91E-01	1.02E+02
44	-5.45E-01	1.02E+02
45	-5.00E-01	1.02E+02
46	-4.55E-01	1.02E+02
47	-0.40909	1.02E+02
48	-0.36364	1.02E+02
49	-0.31818	1.02E+02
50	-0.27273	1.02E+02
51	-0.22727	1.02E+02
52	-0.18182	1.02E+02
53	-0.13636	1.02E+02
54	-9.09E-02	1.02E+02
55	-4.55E-02	1.02E+02
56	0	1.02E+02
57	4.55E-02	1.02E+02
58	9.09E-02	1.02E+02
59	0.13636	1.02E+02
60	0.18182	1.02E+02
61	0.22727	1.01E+02
62	0.27273	1.01E+02
63	0.31818	1.00E+02
64	0.36364	9.93E+01
65	0.40909	9.84E+01
66	0.45455	9.74E+01
67	0.5	9.62E+01
68	0.54545	9.49E+01
69	0.59091	9.34E+01
70	0.63636	9.19E+01
71	0.68182	9.02E+01
72	0.72727	8.84E+01
73	0.77273	8.64E+01
74	0.81818	8.43E+01
75	0.86364	8.21E+01
76	0.90909	7.98E+01

	X	Y
1	-2.5	1.01E+02
2	-2.45E+00	1.01E+02
3	-2.41E+00	1.01E+02
4	-2.36E+00	1.01E+02
5	-2.32E+00	1.01E+02
6	-2.27E+00	1.01E+02
7	-2.23E+00	1.01E+02
8	-2.18E+00	1.01E+02
9	-2.14E+00	1.01E+02
10	-2.09E+00	1.01E+02
11	-2.05E+00	1.01E+02
12	-2.00E+00	1.01E+02
13	-1.95E+00	1.01E+02
14	-1.9091	1.01E+02
15	-1.8636	1.01E+02
16	-1.8182	1.01E+02
17	-1.7727	1.01E+02
18	-1.7273	1.01E+02
19	-1.6818	1.01E+02
20	-1.6364	1.01E+02
21	-1.59E+00	1.01E+02
22	-1.55E+00	1.01E+02
23	-1.50E+00	1.01E+02
24	-1.45E+00	1.01E+02
25	-1.41E+00	1.01E+02
26	-1.36E+00	1.01E+02
27	-1.32E+00	1.01E+02
28	-1.27E+00	1.01E+02
29	-1.23E+00	1.01E+02
30	-1.18E+00	1.01E+02
31	-1.1364	1.01E+02
32	-1.0909	1.01E+02
33	-1.0455	1.01E+02
34	-1	1.01E+02
35	-0.95455	1.01E+02
36	-0.90909	1.01E+02
37	-0.86364	1.01E+02
38	-0.81818	1.01E+02
39	-0.77273	1.01E+02
40	-0.72727	1.01E+02
41	-6.82E-01	1.01E+02
42	-6.36E-01	1.01E+02
43	-5.91E-01	1.01E+02
44	-5.45E-01	1.01E+02
45	-5.00E-01	1.01E+02
46	-4.55E-01	1.01E+02
47	-0.40909	1.01E+02
48	-0.36364	1.01E+02
49	-0.31818	1.01E+02
50	-0.27273	1.01E+02
51	-0.22727	1.01E+02
52	-0.18182	1.01E+02
53	-0.13636	1.01E+02
54	-9.09E-02	1.01E+02
55	-4.55E-02	1.01E+02
56	0	1.01E+02
57	4.55E-02	1.01E+02
58	9.09E-02	1.01E+02
59	0.13636	1.01E+02
60	0.18182	1.01E+02
61	0.22727	1.01E+02
62	0.27273	1.01E+02
63	0.31818	1.01E+02
64	0.36364	1.01E+02
65	0.40909	1.01E+02
66	0.45455	1.01E+02
67	0.5	1.01E+02
68	0.54545	1.01E+02
69	0.59091	1.01E+02
70	0.63636	9.75E+01
71	0.68182	9.46E+01
72	0.72727	9.16E+01
73	0.77273	8.86E+01
74	0.81818	8.56E+01
75	0.86364	8.26E+01
76	0.90909	7.96E+01

Prediction Line

	X	Y
77	0.95455	7.69E+01
78	1	7.43E+01
79	1.0455	7.16E+01
80	1.0909	6.87E+01
81	1.1364	6.56E+01
82	1.1818	6.25E+01
83	1.2273	5.93E+01
84	1.2727	5.61E+01
85	1.3182	5.28E+01
86	1.3636	4.95E+01
87	1.4091	4.62E+01
88	1.4545	4.30E+01
89	1.5	3.98E+01
90	1.5455	3.68E+01
91	1.5909	3.38E+01
92	1.6364	3.10E+01
93	1.6818	2.83E+01
94	1.7273	2.58E+01
95	1.7727	2.34E+01
96	1.8182	2.12E+01
97	1.8636	1.91E+01
98	1.9091	1.72E+01
99	1.9545	1.55E+01
100	2	1.39E+01

	X	Y
77	0.95455	7.73E+01
78	1	7.48E+01
79	1.0455	7.20E+01
80	1.0909	6.92E+01
81	1.1364	6.62E+01
82	1.1818	6.31E+01
83	1.2273	5.99E+01
84	1.2727	5.66E+01
85	1.3182	5.31E+01
86	1.3636	4.95E+01
87	1.4091	4.60E+01
88	1.4545	4.26E+01
89	1.5	3.94E+01
90	1.5455	3.63E+01
91	1.5909	3.33E+01
92	1.6364	3.05E+01
93	1.6818	2.77E+01
94	1.7273	2.51E+01
95	1.7727	2.27E+01
96	1.8182	2.03E+01
97	1.8636	1.81E+01
98	1.9091	1.60E+01
99	1.9545	1.41E+01
100	2	1.22E+01

	X	Y
77	0.95455	7.66E+01
78	1	7.37E+01
79	1.0455	7.07E+01
80	1.0909	6.77E+01
81	1.1364	6.47E+01
82	1.1818	6.17E+01
83	1.2273	5.87E+01
84	1.2727	5.57E+01
85	1.3182	5.28E+01
86	1.3636	4.98E+01
87	1.4091	4.68E+01
88	1.4545	4.38E+01
89	1.5	4.08E+01
90	1.5455	3.78E+01
91	1.5909	3.48E+01
92	1.6364	3.19E+01
93	1.6818	2.89E+01
94	1.7273	2.59E+01
95	1.7727	2.29E+01
96	1.8182	1.99E+01
97	1.8636	1.69E+01
98	1.9091	1.39E+01
99	1.9545	1.10E+01
100	2	7.98E+00

Table E2.D-4d. TRAP Model Output for Cadmium Data for the Mammal Growth Endpoint (Wilson et al. 1941)

Chemical:	Cadmium
Study Authors:	Wilson et al. 1941
Receptor Group:	Mammal
Effect Description:	Growth

Input Data:

Dose	Response	SE
1.00E-06	0.2	not reported
3.5124	0.16	not reported
7.0248	0.14	not reported
14.163	0.12	not reported
28.326	0.07	not reported
56.652	0.05	not reported

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?
Use Only for Exploratory Data Analysis!
Maximum Iterations Reached Without Convergence
X50 at Maximum or Minimum Limit
Steepness At Maximum Or Minimum Limit
Error Estimates Cannot Be Determined
Large Standard Error for X50
Large Standard Error for Steepness
Large Standard Error for Y0
Inadequate Number of Partial Effects
Insufficient Data to Plot
Insufficient Data to Analyze

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.2363	1.251	5.48E-02	1.0766	1.4254
S	0.53259	5.55E-01	6.44E-02	3.50E-01	0.7597
Y0	2.00E-01	1.99E-01	7.41E-03	1.75E-01	0.22211

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.2363	1.25	5.36E-02	1.0795	1.4204
S	0.53259	5.85E-01	6.45E-02	0.37972	0.79017
Y0	2.00E-01	1.99E-01	7.26E-03	1.76E-01	0.22173

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.2363	1.2331	6.71E-02	1.0195	1.4467
S	0.53259	0.47995	5.48E-02	0.30545	0.65445
Y0	2.00E-01	2.00E-01	9.52E-03	0.16969	0.23031

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	17.823	11.928	26.633	5.48E-02	1.251
20	4.23E+00	2.00E+00	8.95E+00	0.10228	0.62619
10	1.82E+00	6.52E-01	5.10E+00	0.14038	0.2607
5	8.39E-01	2.29E-01	3.08E+00	0.17724	-7.61E-02
0					

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	17.781	12.008	26.329	5.36E-02	1.25
20	4.1842	2.02E+00	8.6834	9.96E-02	0.62162
10	2.02E+00	7.33E-01	5.56E+00	0.13826	0.30493
5	1.205	3.38E-01	4.30E+00	0.17352	8.10E-02
0	0.34705	3.65E-02	3.30E+00	0.30735	-4.60E-01

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	17.104	10.46	27.969	6.71E-02	1.2331
20	4.0554	1.8526	8.8778	1.07E-01	0.60804
10	2.5101	0.9932	6.3436	0.12652	0.39968
5	1.9747	0.72456	5.382	0.13682	0.29551
0	1.5536	0.52765	4.5742	0.14737	0.19133

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	2.00E-01	1.99E-01
2	5.46E-01	1.60E-01	1.64E-01
3	8.47E-01	1.40E-01	1.41E-01
4	1.15E+00	1.20E-01	1.10E-01
5	1.45E+00	7.00E-02	7.75E-02
6	1.7532	5.00E-02	4.91E-02

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	2.00E-01	1.99E-01
2	5.46E-01	1.60E-01	1.64E-01
3	8.47E-01	1.40E-01	1.41E-01
4	1.15E+00	1.20E-01	1.10E-01
5	1.45E+00	7.00E-02	7.72E-02
6	1.7532	5.00E-02	4.94E-02

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	2.00E-01	2.00E-01
2	5.46E-01	1.60E-01	1.66E-01
3	8.47E-01	1.40E-01	1.37E-01
4	1.15E+00	1.20E-01	1.08E-01
5	1.45E+00	7.00E-02	7.90E-02
6	1.7532	5.00E-02	5.01E-02

Analysis of Variance

R-squared 0.989

	DF	SS	MS	F	Sig
Total (adj)	5	1.57E-02	3.15E-03		
Regression	2	1.56E-02	7.78E-03	134.67	0.0012
Error	3	1.73E-04	5.78E-05		

R-squared 0.99

	DF	SS	MS	F	Sig
Total (adj)	5	1.57E-02	3.15E-03		
Regression	2	1.56E-02	7.78E-03	142.45	0.0011
Error	3	1.64E-04	5.47E-05		

R-squared 0.983

	DF	SS	MS	F	Sig
Total (adj)	5	1.57E-02	3.15E-03		
Regression	2	1.55E-02	7.73E-03	85.251	0.0023
Error	3	2.72E-04	9.07E-05		

Prediction Line

	X	Y		X	Y		X	Y
1	-2	1.98E-01	1	-2	1.99E-01	1	-2	2.00E-01
2	-1.96E+00	1.98E-01	2	-1.96E+00	1.99E-01	2	-1.96E+00	2.00E-01
3	-1.92E+00	1.98E-01	3	-1.92E+00	1.99E-01	3	-1.92E+00	2.00E-01
4	-1.88E+00	1.98E-01	4	-1.88E+00	1.99E-01	4	-1.88E+00	2.00E-01
5	-1.84E+00	1.98E-01	5	-1.84E+00	1.99E-01	5	-1.84E+00	2.00E-01
6	-1.80E+00	1.98E-01	6	-1.80E+00	1.99E-01	6	-1.80E+00	2.00E-01
7	-1.76E+00	1.98E-01	7	-1.76E+00	1.99E-01	7	-1.76E+00	2.00E-01
8	-1.72E+00	1.98E-01	8	-1.72E+00	1.99E-01	8	-1.72E+00	2.00E-01
9	-1.68E+00	1.98E-01	9	-1.68E+00	1.99E-01	9	-1.68E+00	2.00E-01
10	-1.64E+00	1.98E-01	10	-1.64E+00	1.99E-01	10	-1.64E+00	2.00E-01
11	-1.60E+00	1.98E-01	11	-1.60E+00	1.99E-01	11	-1.60E+00	2.00E-01
12	-1.56E+00	1.98E-01	12	-1.56E+00	1.99E-01	12	-1.56E+00	2.00E-01
13	-1.52E+00	1.98E-01	13	-1.52E+00	1.99E-01	13	-1.52E+00	2.00E-01
14	-1.4747	1.98E-01	14	-1.4747	1.99E-01	14	-1.4747	2.00E-01
15	-1.4343	1.98E-01	15	-1.4343	1.99E-01	15	-1.4343	2.00E-01
16	-1.3939	1.98E-01	16	-1.3939	1.99E-01	16	-1.3939	2.00E-01
17	-1.3535	1.98E-01	17	-1.3535	1.99E-01	17	-1.3535	2.00E-01
18	-1.3131	1.98E-01	18	-1.3131	1.99E-01	18	-1.3131	2.00E-01
19	-1.2727	1.98E-01	19	-1.2727	1.99E-01	19	-1.2727	2.00E-01
20	-1.2323	1.98E-01	20	-1.2323	1.99E-01	20	-1.2323	2.00E-01
21	-1.19E+00	1.98E-01	21	-1.19E+00	1.99E-01	21	-1.19E+00	2.00E-01
22	-1.15E+00	1.98E-01	22	-1.15E+00	1.99E-01	22	-1.15E+00	2.00E-01
23	-1.11E+00	1.97E-01	23	-1.11E+00	1.99E-01	23	-1.11E+00	2.00E-01
24	-1.07E+00	1.97E-01	24	-1.07E+00	1.99E-01	24	-1.07E+00	2.00E-01
25	-1.03E+00	1.97E-01	25	-1.03E+00	1.99E-01	25	-1.03E+00	2.00E-01
26	-9.90E-01	1.97E-01	26	-9.90E-01	1.99E-01	26	-9.90E-01	2.00E-01
27	-9.49E-01	1.97E-01	27	-9.49E-01	1.99E-01	27	-9.49E-01	2.00E-01
28	-9.09E-01	1.97E-01	28	-9.09E-01	1.99E-01	28	-9.09E-01	2.00E-01
29	-8.69E-01	1.97E-01	29	-8.69E-01	1.99E-01	29	-8.69E-01	2.00E-01
30	-8.28E-01	1.97E-01	30	-8.28E-01	1.99E-01	30	-8.28E-01	2.00E-01
31	-0.78788	1.96E-01	31	-0.78788	1.99E-01	31	-0.78788	2.00E-01
32	-0.74747	1.96E-01	32	-0.74747	1.99E-01	32	-0.74747	2.00E-01
33	-0.70707	1.96E-01	33	-0.70707	1.99E-01	33	-0.70707	2.00E-01
34	-0.66667	1.96E-01	34	-0.66667	1.99E-01	34	-0.66667	2.00E-01
35	-0.62626	1.96E-01	35	-0.62626	1.99E-01	35	-0.62626	2.00E-01
36	-0.58586	1.95E-01	36	-0.58586	1.99E-01	36	-0.58586	2.00E-01
37	-0.54545	1.95E-01	37	-0.54545	1.99E-01	37	-0.54545	2.00E-01
38	-0.50505	1.95E-01	38	-0.50505	1.99E-01	38	-0.50505	2.00E-01
39	-0.46465	1.94E-01	39	-0.46465	1.99E-01	39	-0.46465	2.00E-01
40	-0.42424	1.94E-01	40	-0.42424	1.99E-01	40	-0.42424	2.00E-01
41	-0.38384	1.93E-01	41	-0.38384	1.98E-01	41	-0.38384	2.00E-01
42	-0.34343	1.93E-01	42	-0.34343	1.98E-01	42	-0.34343	2.00E-01
43	-0.30303	1.92E-01	43	-0.30303	1.98E-01	43	-0.30303	2.00E-01
44	-0.26263	1.92E-01	44	-0.26263	1.97E-01	44	-0.26263	2.00E-01
45	-0.22222	1.91E-01	45	-0.22222	1.97E-01	45	-0.22222	2.00E-01
46	-0.18182	1.91E-01	46	-0.18182	1.96E-01	46	-0.18182	2.00E-01
47	-0.14141	1.90E-01	47	-0.14141	1.95E-01	47	-0.14141	2.00E-01
48	-0.10101	1.89E-01	48	-0.10101	1.94E-01	48	-0.10101	2.00E-01
49	-6.06E-02	1.88E-01	49	-6.06E-02	1.93E-01	49	-6.06E-02	2.00E-01
50	-2.02E-02	1.87E-01	50	-2.02E-02	1.92E-01	50	-2.02E-02	2.00E-01
51	2.02E-02	1.86E-01	51	2.02E-02	1.91E-01	51	2.02E-02	2.00E-01
52	6.06E-02	1.85E-01	52	6.06E-02	1.89E-01	52	6.06E-02	2.00E-01
53	0.10101	1.84E-01	53	0.10101	1.88E-01	53	0.10101	2.00E-01
54	0.14141	1.83E-01	54	0.14141	1.86E-01	54	0.14141	2.00E-01
55	0.18182	1.82E-01	55	0.18182	1.85E-01	55	0.18182	2.00E-01
56	0.22222	1.80E-01	56	0.22222	1.83E-01	56	0.22222	1.97E-01
57	0.26263	1.79E-01	57	0.26263	1.81E-01	57	0.26263	1.93E-01
58	0.30303	1.77E-01	58	0.30303	1.79E-01	58	0.30303	1.89E-01
59	0.34343	1.75E-01	59	0.34343	1.77E-01	59	0.34343	1.85E-01
60	0.38384	1.73E-01	60	0.38384	1.74E-01	60	0.38384	1.82E-01
61	0.42424	1.71E-01	61	0.42424	1.72E-01	61	0.42424	1.78E-01
62	0.46465	1.69E-01	62	0.46465	1.70E-01	62	0.46465	1.74E-01
63	0.50505	1.67E-01	63	0.50505	1.67E-01	63	0.50505	1.70E-01
64	0.54545	1.64E-01	64	0.54545	1.64E-01	64	0.54545	1.66E-01
65	0.58586	1.62E-01	65	0.58586	1.61E-01	65	0.58586	1.62E-01
66	0.62626	1.59E-01	66	0.62626	1.59E-01	66	0.62626	1.58E-01
67	0.66667	1.56E-01	67	0.66667	1.56E-01	67	0.66667	1.54E-01
68	0.70707	1.53E-01	68	0.70707	1.52E-01	68	0.70707	1.50E-01
69	0.74747	1.50E-01	69	0.74747	1.49E-01	69	0.74747	1.47E-01

Prediction Line

	X	Y
70	0.78788	1.46E-01
71	0.82828	1.43E-01
72	0.86869	1.39E-01
73	0.90909	1.35E-01
74	0.94949	1.31E-01
75	0.9899	1.27E-01
76	1.0303	1.23E-01
77	1.0707	1.19E-01
78	1.1111	1.15E-01
79	1.1515	1.10E-01
80	1.1919	1.06E-01
81	1.2323	1.01E-01
82	1.2727	9.69E-02
83	1.3131	9.24E-02
84	1.3535	8.80E-02
85	1.3939	8.37E-02
86	1.4343	7.94E-02
87	1.4747	7.51E-02
88	1.5152	7.10E-02
89	1.5556	6.69E-02
90	1.596	6.30E-02
91	1.6364	5.92E-02
92	1.6768	5.56E-02
93	1.7172	5.21E-02
94	1.7576	4.87E-02
95	1.798	4.55E-02
96	1.8384	4.24E-02
97	1.8788	3.95E-02
98	1.9192	3.67E-02
99	1.9596	3.41E-02
100	2	3.17E-02

	X	Y
70	0.78788	1.46E-01
71	0.82828	1.42E-01
72	0.86869	1.39E-01
73	0.90909	1.35E-01
74	0.94949	1.31E-01
75	0.9899	1.27E-01
76	1.0303	1.23E-01
77	1.0707	1.19E-01
78	1.1111	1.15E-01
79	1.1515	1.10E-01
80	1.1919	1.06E-01
81	1.2323	1.01E-01
82	1.2727	9.67E-02
83	1.3131	9.21E-02
84	1.3535	8.76E-02
85	1.3939	8.33E-02
86	1.4343	7.90E-02
87	1.4747	7.49E-02
88	1.5152	7.09E-02
89	1.5556	6.70E-02
90	1.596	6.32E-02
91	1.6364	5.95E-02
92	1.6768	5.59E-02
93	1.7172	5.24E-02
94	1.7576	4.91E-02
95	1.798	4.58E-02
96	1.8384	4.27E-02
97	1.8788	3.97E-02
98	1.9192	3.68E-02
99	1.9596	3.40E-02
100	2	3.13E-02

	X	Y
70	0.78788	1.43E-01
71	0.82828	1.39E-01
72	0.86869	1.35E-01
73	0.90909	1.31E-01
74	0.94949	1.27E-01
75	0.9899	1.23E-01
76	1.0303	1.19E-01
77	1.0707	1.16E-01
78	1.1111	1.12E-01
79	1.1515	1.08E-01
80	1.1919	1.04E-01
81	1.2323	1.00E-01
82	1.2727	9.62E-02
83	1.3131	9.23E-02
84	1.3535	8.84E-02
85	1.3939	8.46E-02
86	1.4343	8.07E-02
87	1.4747	7.68E-02
88	1.5152	7.29E-02
89	1.5556	6.90E-02
90	1.596	6.52E-02
91	1.6364	6.13E-02
92	1.6768	5.74E-02
93	1.7172	5.35E-02
94	1.7576	4.97E-02
95	1.798	4.58E-02
96	1.8384	4.19E-02
97	1.8788	3.80E-02
98	1.9192	3.41E-02
99	1.9596	3.03E-02
100	2	2.64E-02

Table E2.D-4e. TRAP Model Output for Cadmium Data for the Mammal Reproduction Endpoint (Sutou et al. 1980)

Chemical:	Cadmium
Study Authors:	Sutou et al. 1980
Receptor Group:	Mammal
Effect Description:	Reproduction

Input Data:

Dose	Response	SE
0.00	14.2	2
0.10	13.9	1.7
1.00	13.1	2.3
10.00	7.2	2.4

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm
Error Messages Encountered			
Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined	yes	yes	yes
Large Standard Error for X50			
Large Standard Error for Steepness			
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

Logistic Equation:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.1393	1.0183			
S	0.48025	6.26E-01			
Y0	1.41E+01	1.41E+01			

Threshold Sigmoid:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.1393	1.0215			
S	0.48025	6.23E-01			
Y0	1.41E+01	1.40E+01			

Piecewise Linear:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.1393	1.0317			
S	0.48025	0.42065			
Y0	1.41E+01	1.40E+01			

Xp Estimates

Logistic Equation:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	10.43	5.2665	20.657	2.34E-02	1.0183
20	2.91E+00	5.80E-01	1.46E+01	5.52E-02	0.46456
10	1.38E+00	1.17E-01	1.64E+01	8.45E-02	0.14065
5	6.95E-01	2.59E-02	1.86E+01	0.1124	-1.58E-01
0					

Threshold Sigmoid:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	10.509	3.9407	28.024	3.35E-02	1.0215
20	2.7027	5.14E-01	14.198	5.67E-02	0.4318
10	1.36E+00	1.25E-01	1.48E+01	8.16E-02	0.13457
5	0.84024	4.47E-02	1.58E+01	0.10031	-7.56E-02
0	0.26121	3.55E-03	1.92E+01	0.14689	-5.83E-01

Piecewise Linear:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	10.757	2.5205	45.912	4.96E-02	1.0317
20	2.0822	0.65954	6.5739	3.93E-02	0.31853
10	1.2045	0.30525	4.7529	4.69E-02	8.08E-02
5	0.9161	0.19973	4.2019	5.21E-02	-3.81E-02
0	0.69675	0.12846	3.779	5.78E-02	-0.15692

Model Fit Summary

Dataset

Logistic Equation:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.42E+01	1.41E+01
2	-1.00E+00	1.39E+01	1.40E+01
3	0.00E+00	1.31E+01	1.31E+01
4	1.00E+00	7.20E+00	7.20E+00
5			
6			

Threshold Sigmoid:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.42E+01	1.40E+01
2	-1.00E+00	1.39E+01	1.40E+01
3	0.00E+00	1.31E+01	1.31E+01
4	1.00E+00	7.20E+00	7.20E+00
5			
6			

Piecewise Linear:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.42E+01	1.40E+01
2	-1.00E+00	1.39E+01	1.40E+01
3	0.00E+00	1.31E+01	1.31E+01
4	1.00E+00	7.20E+00	7.20E+00
5			
6			

Analysis of Variance

Logistic Equation: R-squared 1

	DF	SS	MS	F	Sig
Total (adj)	3	1.90E+02	6.33E+01		
Regression	2	1.90E+02	9.50E+01	14168	0.0059
Error	1	6.71E-03	6.71E-03		

Threshold Sigmoid: R-squared 1

	DF	SS	MS	F	Sig
Total (adj)	3	1.90E+02	6.33E+01		
Regression	2	1.90E+02	9.50E+01	7273.2	0.0083
Error	1	1.31E-02	1.31E-02		

Piecewise Linear: R-squared 1

	DF	SS	MS	F	Sig
Total (adj)	3	1.90E+02	6.33E+01		
Regression	2	1.90E+02	9.50E+01	7273.2	0.0083
Error	1	1.31E-02	1.31E-02		

Prediction Line

	X	Y
1	-3	1.41E+01
2	-2.95E+00	1.41E+01
3	-2.91E+00	1.41E+01
4	-2.86E+00	1.41E+01
5	-2.82E+00	1.41E+01
6	-2.77E+00	1.41E+01
7	-2.73E+00	1.41E+01
8	-2.68E+00	1.41E+01
9	-2.64E+00	1.41E+01
10	-2.59E+00	1.41E+01
11	-2.55E+00	1.41E+01
12	-2.50E+00	1.41E+01
13	-2.45E+00	1.41E+01
14	-2.4091	1.41E+01
15	-2.3636	1.41E+01
16	-2.3182	1.41E+01
17	-2.2727	1.41E+01
18	-2.2273	1.41E+01
19	-2.1818	1.41E+01
20	-2.1364	1.41E+01
21	-2.09E+00	1.41E+01
22	-2.05E+00	1.41E+01
23	-2.00E+00	1.41E+01
24	-1.95E+00	1.41E+01
25	-1.91E+00	1.41E+01
26	-1.86E+00	1.41E+01
27	-1.82E+00	1.41E+01
28	-1.77E+00	1.41E+01
29	-1.73E+00	1.41E+01
30	-1.68E+00	1.41E+01
31	-1.6364	1.41E+01
32	-1.5909	1.41E+01
33	-1.5455	1.41E+01
34	-1.5	1.41E+01
35	-1.4545	1.41E+01
36	-1.4091	1.41E+01
37	-1.36E+00	1.41E+01
38	-1.32E+00	1.40E+01
39	-1.27E+00	1.40E+01
40	-1.23E+00	1.40E+01
41	-1.18E+00	1.40E+01
42	-1.14E+00	1.40E+01
43	-1.09E+00	1.40E+01
44	-1.05E+00	1.40E+01
45	-1	1.40E+01
46	-0.95455	1.40E+01
47	-0.90909	1.40E+01
48	-0.86364	1.40E+01
49	-0.81818	1.39E+01
50	-0.77273	1.39E+01
51	-0.72727	1.39E+01
52	-0.68182	1.39E+01
53	-0.63636	1.39E+01
54	-0.59091	1.38E+01
55	-0.54545	1.38E+01
56	-0.5	1.38E+01
57	-0.45455	1.37E+01
58	-0.40909	1.37E+01
59	-0.36364	1.37E+01
60	-0.31818	1.36E+01
61	-0.27273	1.36E+01
62	-0.22727	1.35E+01
63	-0.18182	1.34E+01
64	-0.13636	1.33E+01
65	-9.09E-02	1.33E+01
66	-4.55E-02	1.32E+01
67	0	1.31E+01
68	4.55E-02	1.30E+01
69	9.09E-02	1.28E+01

	X	Y
1	-3	1.40E+01
2	-2.95E+00	1.40E+01
3	-2.91E+00	1.40E+01
4	-2.86E+00	1.40E+01
5	-2.82E+00	1.40E+01
6	-2.77E+00	1.40E+01
7	-2.73E+00	1.40E+01
8	-2.68E+00	1.40E+01
9	-2.64E+00	1.40E+01
10	-2.59E+00	1.40E+01
11	-2.55E+00	1.40E+01
12	-2.50E+00	1.40E+01
13	-2.45E+00	1.40E+01
14	-2.4091	1.40E+01
15	-2.3636	1.40E+01
16	-2.3182	1.40E+01
17	-2.2727	1.40E+01
18	-2.2273	1.40E+01
19	-2.1818	1.40E+01
20	-2.1364	1.40E+01
21	-2.09E+00	1.40E+01
22	-2.05E+00	1.40E+01
23	-2.00E+00	1.40E+01
24	-1.95E+00	1.40E+01
25	-1.91E+00	1.40E+01
26	-1.86E+00	1.40E+01
27	-1.82E+00	1.40E+01
28	-1.77E+00	1.40E+01
29	-1.73E+00	1.40E+01
30	-1.68E+00	1.40E+01
31	-1.6364	1.40E+01
32	-1.5909	1.40E+01
33	-1.5455	1.40E+01
34	-1.5	1.40E+01
35	-1.4545	1.40E+01
36	-1.4091	1.40E+01
37	-1.36E+00	1.40E+01
38	-1.32E+00	1.40E+01
39	-1.27E+00	1.40E+01
40	-1.23E+00	1.40E+01
41	-1.18E+00	1.40E+01
42	-1.14E+00	1.40E+01
43	-1.09E+00	1.40E+01
44	-1.05E+00	1.40E+01
45	-1	1.40E+01
46	-0.95455	1.40E+01
47	-0.90909	1.40E+01
48	-0.86364	1.40E+01
49	-0.81818	1.40E+01
50	-0.77273	1.40E+01
51	-0.72727	1.40E+01
52	-0.68182	1.40E+01
53	-0.63636	1.40E+01
54	-0.59091	1.40E+01
55	-0.54545	1.40E+01
56	-0.5	1.40E+01
57	-0.45455	1.40E+01
58	-0.40909	1.39E+01
59	-0.36364	1.39E+01
60	-0.31818	1.38E+01
61	-0.27273	1.38E+01
62	-0.22727	1.37E+01
63	-0.18182	1.36E+01
64	-0.13636	1.35E+01
65	-9.09E-02	1.34E+01
66	-4.55E-02	1.32E+01
67	0	1.31E+01
68	4.55E-02	1.30E+01
69	9.09E-02	1.28E+01

	X	Y
1	-3	1.40E+01
2	-2.95E+00	1.40E+01
3	-2.91E+00	1.40E+01
4	-2.86E+00	1.40E+01
5	-2.82E+00	1.40E+01
6	-2.77E+00	1.40E+01
7	-2.73E+00	1.40E+01
8	-2.68E+00	1.40E+01
9	-2.64E+00	1.40E+01
10	-2.59E+00	1.40E+01
11	-2.55E+00	1.40E+01
12	-2.50E+00	1.40E+01
13	-2.45E+00	1.40E+01
14	-2.4091	1.40E+01
15	-2.3636	1.40E+01
16	-2.3182	1.40E+01
17	-2.2727	1.40E+01
18	-2.2273	1.40E+01
19	-2.1818	1.40E+01
20	-2.1364	1.40E+01
21	-2.09E+00	1.40E+01
22	-2.05E+00	1.40E+01
23	-2.00E+00	1.40E+01
24	-1.95E+00	1.40E+01
25	-1.91E+00	1.40E+01
26	-1.86E+00	1.40E+01
27	-1.82E+00	1.40E+01
28	-1.77E+00	1.40E+01
29	-1.73E+00	1.40E+01
30	-1.68E+00	1.40E+01
31	-1.6364	1.40E+01
32	-1.5909	1.40E+01
33	-1.5455	1.40E+01
34	-1.5	1.40E+01
35	-1.4545	1.40E+01
36	-1.4091	1.40E+01
37	-1.36E+00	1.40E+01
38	-1.32E+00	1.40E+01
39	-1.27E+00	1.40E+01
40	-1.23E+00	1.40E+01
41	-1.18E+00	1.40E+01
42	-1.14E+00	1.40E+01
43	-1.09E+00	1.40E+01
44	-1.05E+00	1.40E+01
45	-1	1.40E+01
46	-0.95455	1.40E+01
47	-0.90909	1.40E+01
48	-0.86364	1.40E+01
49	-0.81818	1.40E+01
50	-0.77273	1.40E+01
51	-0.72727	1.40E+01
52	-0.68182	1.40E+01
53	-0.63636	1.40E+01
54	-0.59091	1.40E+01
55	-0.54545	1.40E+01
56	-0.5	1.40E+01
57	-0.45455	1.40E+01
58	-0.40909	1.40E+01
59	-0.36364	1.40E+01
60	-0.31818	1.40E+01
61	-0.27273	1.40E+01
62	-0.22727	1.40E+01
63	-0.18182	1.40E+01
64	-0.13636	1.39E+01
65	-9.09E-02	1.36E+01
66	-4.55E-02	1.34E+01
67	0	1.31E+01
68	4.55E-02	1.28E+01
69	9.09E-02	1.26E+01

Prediction Line

	X	Y
70	0.13636	1.27E+01
71	0.18182	1.25E+01
72	0.22727	1.24E+01
73	0.27273	1.22E+01
74	0.31818	1.20E+01
75	0.36364	1.18E+01
76	0.40909	1.16E+01
77	0.45455	1.13E+01
78	0.5	1.11E+01
79	0.54545	1.08E+01
80	0.59091	1.05E+01
81	0.63636	1.02E+01
82	0.68182	9.85E+00
83	0.72727	9.50E+00
84	0.77273	9.14E+00
85	0.81818	8.77E+00
86	0.86364	8.39E+00
87	0.90909	8.00E+00
88	0.95455	7.60E+00
89	1	7.20E+00
90	1.0455	6.80E+00
91	1.0909	6.41E+00
92	1.1364	6.01E+00
93	1.1818	5.62E+00
94	1.2273	5.24E+00
95	1.2727	4.87E+00
96	1.3182	4.52E+00
97	1.3636	4.18E+00
98	1.4091	3.85E+00
99	1.4545	3.54E+00
100	1.5	3.25E+00

	X	Y
70	0.13636	1.26E+01
71	0.18182	1.24E+01
72	0.22727	1.22E+01
73	0.27273	1.20E+01
74	0.31818	1.18E+01
75	0.36364	1.16E+01
76	0.40909	1.13E+01
77	0.45455	1.11E+01
78	0.5	1.08E+01
79	0.54545	1.06E+01
80	0.59091	1.03E+01
81	0.63636	9.98E+00
82	0.68182	9.67E+00
83	0.72727	9.35E+00
84	0.77273	9.02E+00
85	0.81818	8.68E+00
86	0.86364	8.33E+00
87	0.90909	7.96E+00
88	0.95455	7.59E+00
89	1	7.20E+00
90	1.0455	6.81E+00
91	1.0909	6.42E+00
92	1.1364	6.05E+00
93	1.1818	5.68E+00
94	1.2273	5.33E+00
95	1.2727	4.99E+00
96	1.3182	4.66E+00
97	1.3636	4.34E+00
98	1.4091	4.03E+00
99	1.4545	3.74E+00
100	1.5	3.45E+00

	X	Y
70	0.13636	1.23E+01
71	0.18182	1.20E+01
72	0.22727	1.18E+01
73	0.27273	1.15E+01
74	0.31818	1.12E+01
75	0.36364	1.10E+01
76	0.40909	1.07E+01
77	0.45455	1.04E+01
78	0.5	1.02E+01
79	0.54545	9.88E+00
80	0.59091	9.61E+00
81	0.63636	9.35E+00
82	0.68182	9.08E+00
83	0.72727	8.81E+00
84	0.77273	8.54E+00
85	0.81818	8.27E+00
86	0.86364	8.00E+00
87	0.90909	7.74E+00
88	0.95455	7.47E+00
89	1	7.20E+00
90	1.0455	6.93E+00
91	1.0909	6.66E+00
92	1.1364	6.40E+00
93	1.1818	6.13E+00
94	1.2273	5.86E+00
95	1.2727	5.59E+00
96	1.3182	5.32E+00
97	1.3636	5.05E+00
98	1.4091	4.79E+00
99	1.4545	4.52E+00
100	1.5	4.25E+00

Table E2.D-4f. TRAP Model Output for Cadmium Data for the Mammal Survival Endpoint (Swiergosz et al. 1998)

Chemical:	Cadmium
Study Authors:	Swiergosz et al. 1998
Receptor Group:	Mammal
Effect Description:	Survival

Input Data:

Dose	# of Org w/o response	Total # of Org	Survival
6.18E-02	12.9	15	0.86
3.4331	9	15	0.60
9.155	6.9	15	0.46

Modeling Parameters

Analysis Type:	Tolerance Distribution	Tolerance Distribution	Tolerance Distribution
Model Shape:	Gaussian Distribution	Triangular Distribution	Rectangular Distribution
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined			
Large Standard Error for X50	yes	yes	yes
Large Standard Error for Steepness	yes	yes	yes
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.0471	1.032	0.39269	0.15705	1.907
S	1.1009	1.01E+00	1.4931	0.70581	1.7727
Y0	0.86	0.87155	0.14146	0.52151	0.99341

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.0471	1.0424	0.4341	7.52E-02	2.0096
S	1.1009	9.31E-01	1.2563	0.65022	1.6331
Y0	0.86	0.86007	9.31E-02	0.57398	0.98335

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.0471	1.0528	0.50126	-6.41E-02	2.1697
S	1.1009	0.75527	0.97661	0.52772	1.3255
Y0	0.86	0.86001	8.96E-02	0.58744	0.9812

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	10.765	1.44E+00	8.07E+01	0.39269	1.032
20	1.52	3.63E-03	6.36E+02	1.1203	0.18185
10	0.54633	2.19E-05	1.37E+04	1.7571	-0.26255
5	0.23467	1.42E-07	3.87E+05	2.2915	-0.62953
0					

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	11.026	1.19E+00	1.02E+02	0.4341	1.0424
20	1.6018	1.23E-02	2.09E+02	0.89792	0.2046
10	6.06E-01	1.30E-04	2819.9	1.4448	-0.21766
5	0.30462	2.84E-06	32725	1.84	-0.51624
0	5.79E-02	5.52E-12	6.08E+08	2.8034	-1.24E+00

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	11.293	8.63E-01	1.48E+02	0.50126	1.0528
20	1.853	3.69E-02	93.002	0.70784	0.26789
10	1.0145	2.50E-03	411.79	1.0208	6.25E-03
5	0.75064	5.43E-04	1038.2	1.1826	-0.12457
0	0.55541	1.02E-04	3.03E+03	1.3461	-0.25538

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var
1	-1.21E+00	0.86	0.86
2	5.36E-01	0.6	0.60001
3	9.62E-01	0.46	0.46001
4			
5			
6			

	Exposure	Effects Var	Est Effects Var
1	-1.21E+00	0.86	0.86
2	5.36E-01	0.6	0.6
3	9.62E-01	0.46	0.46
4			
5			
6			

	Exposure	Effects Var	Est Effects Var
1	-1.21E+00	0.86	0.86001
2	5.36E-01	0.6	0.6
3	9.62E-01	0.46	0.46
4			
5			
6			

Analysis of Variance

R-squared:

	DF	SS	MS	F	Sig
Total (adj)					
Regression					
Error					

R-squared:

	DF	SS	MS	F	Sig
Total (adj)					
Regression					
Error					

R-squared:

	DF	SS	MS	F	Sig
Total (adj)					
Regression					
Error					

Prediction Line

	X	Y		X	Y		X	Y
1	-1	0.85226	1	-1	0.85541	1	-1	0.86001
2	-9.75E-01	0.85109	2	-9.75E-01	0.85437	2	-9.75E-01	0.86001
3	-9.49E-01	0.84985	3	-9.49E-01	0.85322	3	-9.49E-01	0.86001
4	-9.24E-01	0.84855	4	-9.24E-01	0.85197	4	-9.24E-01	0.86001
5	-8.99E-01	0.84718	5	-8.99E-01	0.85061	5	-8.99E-01	0.86001
6	-8.74E-01	0.84575	6	-8.74E-01	0.84914	6	-8.74E-01	0.86001
7	-8.48E-01	0.84425	7	-8.48E-01	0.84757	7	-8.48E-01	0.86001
8	-8.23E-01	0.84268	8	-8.23E-01	0.84589	8	-8.23E-01	0.86001
9	-7.98E-01	0.84103	9	-7.98E-01	0.84411	9	-7.98E-01	0.86001
10	-7.73E-01	0.83931	10	-7.73E-01	0.84222	10	-7.73E-01	0.86001
11	-7.47E-01	0.8375	11	-7.47E-01	0.84023	11	-7.47E-01	0.86001
12	-7.22E-01	0.83562	12	-7.22E-01	0.83813	12	-7.22E-01	0.86001
13	-6.97E-01	0.83366	13	-6.97E-01	0.83593	13	-6.97E-01	0.86001
14	-0.67172	0.8316	14	-0.67172	0.83362	14	-0.67172	0.86001
15	-0.64646	0.82946	15	-0.64646	0.8312	15	-0.64646	0.86001
16	-0.62121	0.82723	16	-0.62121	0.82868	16	-0.62121	0.86001
17	-0.59596	0.82491	17	-0.59596	0.82605	17	-0.59596	0.86001
18	-0.57071	0.82249	18	-0.57071	0.82332	18	-0.57071	0.86001
19	-0.54545	0.81997	19	-0.54545	0.82048	19	-0.54545	0.86001
20	-0.5202	0.81735	20	-0.5202	0.81754	20	-0.5202	0.86001
21	-0.49495	0.81463	21	-0.49495	0.81449	21	-0.49495	0.86001
22	-0.4697	0.81181	22	-0.4697	0.81133	22	-0.4697	0.86001
23	-0.44444	0.80887	23	-0.44444	0.80807	23	-0.44444	0.86001
24	-0.41919	0.80583	24	-0.41919	0.80471	24	-0.41919	0.86001
25	-0.39394	0.80268	25	-0.39394	0.80124	25	-0.39394	0.86001
26	-0.36869	0.79941	26	-0.36869	0.79766	26	-0.36869	0.86001
27	-0.34343	0.79603	27	-0.34343	0.79398	27	-0.34343	0.86001
28	-0.31818	0.79253	28	-0.31818	0.79019	28	-0.31818	0.86001
29	-0.29293	0.78892	29	-0.29293	0.7863	29	-0.29293	0.86001
30	-0.26768	0.78518	30	-0.26768	0.7823	30	-0.26768	0.86001
31	-0.24242	0.78132	31	-0.24242	0.7782	31	-0.24242	0.85575
32	-0.21717	0.77734	32	-0.21717	0.77399	32	-0.21717	0.84745
33	-0.19192	0.77323	33	-0.19192	0.76967	33	-0.19192	0.83915
34	-0.16667	0.76899	34	-0.16667	0.76525	34	-0.16667	0.83085
35	-0.14141	0.76463	35	-0.14141	0.76072	35	-0.14141	0.82255
36	-0.11616	0.76014	36	-0.11616	0.75609	36	-0.11616	0.81425
37	-9.09E-02	0.75552	37	-9.09E-02	0.75135	37	-9.09E-02	0.80595
38	-6.57E-02	0.75077	38	-6.57E-02	0.74651	38	-6.57E-02	0.79765
39	-4.04E-02	0.74589	39	-4.04E-02	0.74156	39	-4.04E-02	0.78935
40	-1.52E-02	0.74087	40	-1.52E-02	0.73651	40	-1.52E-02	0.78105
41	1.01E-02	0.73573	41	1.01E-02	0.73135	41	1.01E-02	0.77275
42	3.54E-02	0.73045	42	3.54E-02	0.72608	42	3.54E-02	0.76445
43	6.06E-02	0.72505	43	6.06E-02	0.72071	43	6.06E-02	0.75615
44	8.59E-02	0.71951	44	8.59E-02	0.71524	44	8.59E-02	0.74785
45	0.11111	0.71384	45	0.11111	0.70965	45	0.11111	0.73955
46	0.13636	0.70803	46	0.13636	0.70397	46	0.13636	0.73125
47	0.16162	0.7021	47	0.16162	0.69817	47	0.16162	0.72295
48	0.18687	0.69604	48	0.18687	0.69227	48	0.18687	0.71465
49	0.21212	0.68985	49	0.21212	0.68627	49	0.21212	0.70635
50	0.23737	0.68354	50	0.23737	0.68016	50	0.23737	0.69805
51	0.26263	0.6771	51	0.26263	0.67395	51	0.26263	0.68975
52	0.28788	0.67053	52	0.28788	0.66762	52	0.28788	0.68145
53	0.31313	0.66385	53	0.31313	0.6612	53	0.31313	0.67315
54	0.33838	0.65704	54	0.33838	0.65467	54	0.33838	0.66485
55	0.36364	0.65012	55	0.36364	0.64803	55	0.36364	0.65655
56	0.38889	0.64308	56	0.38889	0.64129	56	0.38889	0.64825
57	0.41414	0.63592	57	0.41414	0.63444	57	0.41414	0.63995
58	0.43939	0.62866	58	0.43939	0.62748	58	0.43939	0.63165
59	0.46465	0.62129	59	0.46465	0.62042	59	0.46465	0.62335
60	0.4899	0.61382	60	0.4899	0.61326	60	0.4899	0.61505
61	0.51515	0.60624	61	0.51515	0.60599	61	0.51515	0.60675
62	0.5404	0.59857	62	0.5404	0.59861	62	0.5404	0.59845
63	0.56566	0.5908	63	0.56566	0.59113	63	0.56566	0.59016
64	0.59091	0.58294	64	0.59091	0.58354	64	0.59091	0.58186
65	0.61616	0.575	65	0.61616	0.57585	65	0.61616	0.57356
66	0.64141	0.56698	66	0.64141	0.56805	66	0.64141	0.56526
67	0.66667	0.55887	67	0.66667	0.56015	67	0.66667	0.55696
68	0.69192	0.5507	68	0.69192	0.55214	68	0.69192	0.54866
69	0.71717	0.54245	69	0.71717	0.54403	69	0.71717	0.54036

Prediction Line

	X	Y
70	0.74242	0.53414
71	0.76768	0.52577
72	0.79293	0.51734
73	0.81818	0.50887
74	0.84343	0.50035
75	0.86869	0.49179
76	0.89394	0.48319
77	0.91919	0.47457
78	0.94444	0.46592
79	0.9697	0.45725
80	0.99495	0.44857
81	1.0202	0.43988
82	1.0455	0.43119
83	1.0707	0.4225
84	1.096	0.41383
85	1.1212	0.40516
86	1.1465	0.39651
87	1.1717	0.38789
88	1.197	0.3793
89	1.2222	0.37074
90	1.2475	0.36222
91	1.2727	0.35375
92	1.298	0.34533
93	1.3232	0.33696
94	1.3485	0.32865
95	1.3737	0.32041
96	1.399	0.31224
97	1.4242	0.30414
98	1.4495	0.29612
99	1.4747	0.28818
100	1.5	0.28033

	X	Y
70	0.74242	0.5358
71	0.76768	0.52748
72	0.79293	0.51905
73	0.81818	0.51051
74	0.84343	0.50187
75	0.86869	0.49312
76	0.89394	0.48427
77	0.91919	0.47531
78	0.94444	0.46624
79	0.9697	0.45707
80	0.99495	0.4478
81	1.0202	0.43841
82	1.0455	0.42893
83	1.0707	0.41947
84	1.096	0.41011
85	1.1212	0.40086
86	1.1465	0.39172
87	1.1717	0.38268
88	1.197	0.37374
89	1.2222	0.36491
90	1.2475	0.35619
91	1.2727	0.34757
92	1.298	0.33906
93	1.3232	0.33066
94	1.3485	0.32236
95	1.3737	0.31416
96	1.399	0.30607
97	1.4242	0.29809
98	1.4495	0.29021
99	1.4747	0.28244
100	1.5	0.27477

	X	Y
70	0.74242	0.53206
71	0.76768	0.52376
72	0.79293	0.51546
73	0.81818	0.50716
74	0.84343	0.49886
75	0.86869	0.49056
76	0.89394	0.48226
77	0.91919	0.47396
78	0.94444	0.46566
79	0.9697	0.45736
80	0.99495	0.44906
81	1.0202	0.44076
82	1.0455	0.43246
83	1.0707	0.42416
84	1.096	0.41586
85	1.1212	0.40756
86	1.1465	0.39926
87	1.1717	0.39096
88	1.197	0.38266
89	1.2222	0.37436
90	1.2475	0.36606
91	1.2727	0.35776
92	1.298	0.34946
93	1.3232	0.34116
94	1.3485	0.33286
95	1.3737	0.32456
96	1.399	0.31626
97	1.4242	0.30796
98	1.4495	0.29966
99	1.4747	0.29136
100	1.5	0.28306

Table E2.D-5a. TRAP Model Output for Copper Data for the Bird Growth Endpoint (Pooling Group D: Poupoulis and Jensen 1976; Wang et al. 1987)

Chemical:	Copper
Study Authors:	Pooling group D
Receptor Group:	Bird
Effect Description:	Growth

Input Data:

Dose	Effect Relative to Control
2.23E-01	100
14.182	97.39
28.14	102.61
56.057	83.936
111.89	48.594
0.22333	100
2.81E+01	97.727
56.057	82.727
83.973	45.227
1.12E+02	46.136
0.22333	100
28.14	99.044
56.057	93.499
111.89	50.287
0.64189	100
64.831	82.947
0.64189	100
64.831	76.34

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?
Use Only for Exploratory Data Analysis!
Maximum Iterations Reached Without Convergence
X50 at Maximum or Minimum Limit
Steepness At Maximum Or Minimum Limit
Error Estimates Cannot Be Determined
Large Standard Error for X50
Large Standard Error for Steepness
Large Standard Error for Y0
Inadequate Number of Partial Effects
Insufficient Data to Plot
Insufficient Data to Analyze

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.9506	2.0127	2.01E-02	1.9698	2.0555
S	2.0271	1.53E+00	0.2195	1.0636	1.9993
Y0	9.93E+01	1.01E+02	2.2542	96.089	105.7

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.9506	2.0187	2.02E-02	1.9755	2.0618
S	2.0271	1.61E+00	0.22216	1.1389	2.0859
Y0	9.93E+01	1.00E+02	2.1279	95.425	104.5

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.9506	2.0158	2.07E-02	1.9717	2.0598
S	2.0271	1.3468	0.14404	1.0398	1.6538
Y0	9.93E+01	9.96E+01	1.8164	95.77	103.51

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	102.96	93.287	113.63	2.01E-02	2.0127
20	6.11E+01	5.19E+01	7.21E+01	3.35E-02	1.7864
10	4.51E+01	3.52E+01	5.77E+01	5.02E-02	1.654
5	3.40E+01	2.45E+01	4.72E+01	6.66E-02	1.532
0					

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	104.39	94.523	115.28	2.02E-02	2.0187
20	61.76	5.30E+01	71.979	3.12E-02	1.7907
10	4.74E+01	3.78E+01	5.94E+01	4.59E-02	1.6758
5	39.317	2.95E+01	5.25E+01	5.88E-02	1.5946
0	25.03	1.48E+01	4.23E+01	0.1069	1.40E+00

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	103.7	93.697	114.77	2.07E-02	2.0158
20	62.091	56.363	68.4	1.97E-02	1.793
10	52.333	46.275	59.184	2.51E-02	1.7188
5	48.045	41.835	55.177	2.82E-02	1.6817
0	44.109	37.786	51.49	3.15E-02	1.6445

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var
1	-6.51E-01	1.00E+02	1.01E+02
2	-6.51E-01	1.00E+02	1.01E+02
3	-6.51E-01	1.00E+02	1.01E+02
4	-1.93E-01	1.00E+02	1.01E+02
5	-1.93E-01	1.00E+02	1.01E+02
6	1.15E+00	9.74E+01	1.00E+02
7	1.45E+00	1.03E+02	9.78E+01
8	1.45E+00	9.90E+01	9.78E+01
9	1.45E+00	9.77E+01	9.78E+01
10	1.75E+00	93.499	84.189
11	1.75E+00	83.936	84.189
12	1.75E+00	8.27E+01	8.42E+01
13	1.81E+00	8.29E+01	7.81E+01
14	1.81E+00	76.34	78.082
15	1.92E+00	45.227	63.798
16	2.05E+00	50.287	44.887
17	2.05E+00	48.594	44.887
18	2.05E+00	46.136	44.887
19			
20			

	Exposure	Effects Var	Est Effects Var
1	-6.51E-01	1.00E+02	1.00E+02
2	-6.51E-01	1.00E+02	1.00E+02
3	-6.51E-01	1.00E+02	1.00E+02
4	-1.93E-01	1.00E+02	1.00E+02
5	-1.93E-01	1.00E+02	1.00E+02
6	1.15E+00	9.74E+01	1.00E+02
7	1.45E+00	1.03E+02	9.96E+01
8	1.45E+00	9.90E+01	9.96E+01
9	1.45E+00	9.77E+01	9.96E+01
10	1.75E+00	93.499	84.027
11	1.75E+00	83.936	84.027
12	1.75E+00	8.27E+01	8.40E+01
13	1.81E+00	8.29E+01	7.78E+01
14	1.81E+00	76.34	77.762
15	1.92E+00	45.227	64.052
16	2.05E+00	50.287	45.241
17	2.05E+00	48.594	45.241
18	2.05E+00	46.136	45.241
19			
20			

	Exposure	Effects Var	Est Effects Var
1	-6.51E-01	1.00E+02	9.96E+01
2	-6.51E-01	1.00E+02	9.96E+01
3	-6.51E-01	1.00E+02	9.96E+01
4	-1.93E-01	1.00E+02	9.96E+01
5	-1.93E-01	1.00E+02	9.96E+01
6	1.15E+00	9.74E+01	9.96E+01
7	1.45E+00	1.03E+02	9.96E+01
8	1.45E+00	9.90E+01	9.96E+01
9	1.45E+00	9.77E+01	9.96E+01
10	1.75E+00	93.499	85.671
11	1.75E+00	83.936	85.671
12	1.75E+00	8.27E+01	8.57E+01
13	1.81E+00	8.29E+01	7.72E+01
14	1.81E+00	76.34	77.196
15	1.92E+00	45.227	62.118
16	2.05E+00	50.287	45.39
17	2.05E+00	48.594	45.39
18	2.05E+00	46.136	45.39
19			
20			

Analysis of Variance

R-squared 0.93

	DF	SS	MS	F	Sig
Total (adj)	17	7697.4	452.79		
Regression	2	7154.8	3577.4	98.886	0
Error	15	542.66	36.177		

R-squared 0.931

	DF	SS	MS	F	Sig
Total (adj)	17	7697.4	452.79		
Regression	2	7165.7	3582.9	101.08	0
Error	15	531.69	35.446		

R-squared 0.942

	DF	SS	MS	F	Sig
Total (adj)	17	7697.4	452.79		
Regression	2	7252	3626	122.11	0
Error	15	445.4	29.694		

Prediction Line

	X	Y
1	-0.5	1.01E+02
2	-4.70E-01	1.01E+02
3	-4.39E-01	1.01E+02
4	-4.09E-01	1.01E+02
5	-3.79E-01	1.01E+02
6	-3.48E-01	1.01E+02
7	-3.18E-01	1.01E+02
8	-2.88E-01	1.01E+02
9	-2.58E-01	1.01E+02
10	-2.27E-01	1.01E+02
11	-1.97E-01	1.01E+02
12	-1.67E-01	1.01E+02
13	-1.36E-01	1.01E+02
14	-0.10606	1.01E+02
15	-7.58E-02	1.01E+02
16	-4.55E-02	1.01E+02
17	-1.52E-02	1.01E+02
18	1.52E-02	1.01E+02
19	4.55E-02	1.01E+02
20	7.58E-02	1.01E+02
21	1.06E-01	1.01E+02
22	1.36E-01	1.01E+02
23	1.67E-01	1.01E+02
24	1.97E-01	1.01E+02
25	2.27E-01	1.01E+02
26	2.58E-01	1.01E+02
27	2.88E-01	1.01E+02
28	3.18E-01	1.01E+02
29	3.48E-01	1.01E+02
30	3.79E-01	1.01E+02
31	0.40909	1.01E+02
32	4.39E-01	1.01E+02
33	4.70E-01	1.01E+02
34	0.5	1.01E+02
35	5.30E-01	1.01E+02

	X	Y
1	-0.5	1.00E+02
2	-4.70E-01	1.00E+02
3	-4.39E-01	1.00E+02
4	-4.09E-01	1.00E+02
5	-3.79E-01	1.00E+02
6	-3.48E-01	1.00E+02
7	-3.18E-01	1.00E+02
8	-2.88E-01	1.00E+02
9	-2.58E-01	1.00E+02
10	-2.27E-01	1.00E+02
11	-1.97E-01	1.00E+02
12	-1.67E-01	1.00E+02
13	-1.36E-01	1.00E+02
14	-0.10606	1.00E+02
15	-7.58E-02	1.00E+02
16	-4.55E-02	1.00E+02
17	-1.52E-02	1.00E+02
18	1.52E-02	1.00E+02
19	4.55E-02	1.00E+02
20	7.58E-02	1.00E+02
21	1.06E-01	1.00E+02
22	1.36E-01	1.00E+02
23	1.67E-01	1.00E+02
24	1.97E-01	1.00E+02
25	2.27E-01	1.00E+02
26	2.58E-01	1.00E+02
27	2.88E-01	1.00E+02
28	3.18E-01	1.00E+02
29	3.48E-01	1.00E+02
30	3.79E-01	1.00E+02
31	0.40909	1.00E+02
32	4.39E-01	1.00E+02
33	4.70E-01	1.00E+02
34	0.5	1.00E+02
35	5.30E-01	1.00E+02

	X	Y
1	-0.5	9.96E+01
2	-4.70E-01	9.96E+01
3	-4.39E-01	9.96E+01
4	-4.09E-01	9.96E+01
5	-3.79E-01	9.96E+01
6	-3.48E-01	9.96E+01
7	-3.18E-01	9.96E+01
8	-2.88E-01	9.96E+01
9	-2.58E-01	9.96E+01
10	-2.27E-01	9.96E+01
11	-1.97E-01	9.96E+01
12	-1.67E-01	9.96E+01
13	-1.36E-01	9.96E+01
14	-0.10606	9.96E+01
15	-7.58E-02	9.96E+01
16	-4.55E-02	9.96E+01
17	-1.52E-02	9.96E+01
18	1.52E-02	9.96E+01
19	4.55E-02	9.96E+01
20	7.58E-02	9.96E+01
21	1.06E-01	9.96E+01
22	1.36E-01	9.96E+01
23	1.67E-01	9.96E+01
24	1.97E-01	9.96E+01
25	2.27E-01	9.96E+01
26	2.58E-01	9.96E+01
27	2.88E-01	9.96E+01
28	3.18E-01	9.96E+01
29	3.48E-01	9.96E+01
30	3.79E-01	9.96E+01
31	0.40909	9.96E+01
32	4.39E-01	9.96E+01
33	4.70E-01	9.96E+01
34	0.5	9.96E+01
35	5.30E-01	9.96E+01

Prediction Line

	X	Y		X	Y		X	Y
36	5.61E-01	1.01E+02	36	5.61E-01	1.00E+02	36	5.61E-01	9.96E+01
37	0.59091	1.01E+02	37	0.59091	1.00E+02	37	0.59091	9.96E+01
38	0.62121	1.01E+02	38	0.62121	1.00E+02	38	0.62121	9.96E+01
39	0.65152	1.01E+02	39	0.65152	1.00E+02	39	0.65152	9.96E+01
40	0.68182	1.01E+02	40	0.68182	1.00E+02	40	0.68182	9.96E+01
41	0.71212	1.01E+02	41	0.71212	1.00E+02	41	0.71212	9.96E+01
42	0.74242	1.01E+02	42	0.74242	1.00E+02	42	0.74242	9.96E+01
43	0.77273	1.01E+02	43	0.77273	1.00E+02	43	0.77273	9.96E+01
44	0.80303	1.01E+02	44	0.80303	1.00E+02	44	0.80303	9.96E+01
45	0.83333	1.01E+02	45	0.83333	1.00E+02	45	0.83333	9.96E+01
46	0.86364	1.01E+02	46	0.86364	1.00E+02	46	0.86364	9.96E+01
47	0.89394	1.01E+02	47	0.89394	1.00E+02	47	0.89394	9.96E+01
48	0.92424	1.01E+02	48	0.92424	1.00E+02	48	0.92424	9.96E+01
49	0.95455	1.01E+02	49	0.95455	1.00E+02	49	0.95455	9.96E+01
50	0.98485	1.01E+02	50	0.98485	1.00E+02	50	0.98485	9.96E+01
51	1.0152	1.01E+02	51	1.0152	1.00E+02	51	1.0152	9.96E+01
52	1.0455	1.01E+02	52	1.0455	1.00E+02	52	1.0455	9.96E+01
53	1.0758	1.01E+02	53	1.0758	1.00E+02	53	1.0758	9.96E+01
54	1.1061	1.01E+02	54	1.1061	1.00E+02	54	1.1061	9.96E+01
55	1.1364	1.00E+02	55	1.1364	1.00E+02	55	1.1364	9.96E+01
56	1.1667	1.00E+02	56	1.1667	1.00E+02	56	1.1667	9.96E+01
57	1.197	1.00E+02	57	1.197	1.00E+02	57	1.197	9.96E+01
58	1.2273	1.00E+02	58	1.2273	1.00E+02	58	1.2273	9.96E+01
59	1.2576	9.99E+01	59	1.2576	1.00E+02	59	1.2576	9.96E+01
60	1.2879	9.97E+01	60	1.2879	1.00E+02	60	1.2879	9.96E+01
61	1.3182	9.95E+01	61	1.3182	1.00E+02	61	1.3182	9.96E+01
62	1.3485	9.92E+01	62	1.3485	1.00E+02	62	1.3485	9.96E+01
63	1.3788	9.89E+01	63	1.3788	1.00E+02	63	1.3788	9.96E+01
64	1.4091	9.85E+01	64	1.4091	9.99E+01	64	1.4091	9.96E+01
65	1.4394	9.80E+01	65	1.4394	9.97E+01	65	1.4394	9.96E+01
66	1.4697	9.74E+01	66	1.4697	9.93E+01	66	1.4697	9.96E+01
67	1.5	9.67E+01	67	1.5	9.86E+01	67	1.5	9.96E+01
68	1.5303	9.59E+01	68	1.5303	9.77E+01	68	1.5303	9.96E+01
69	1.5606	9.49E+01	69	1.5606	9.65E+01	69	1.5606	9.96E+01
70	1.5909	9.38E+01	70	1.5909	9.51E+01	70	1.5909	9.96E+01
71	1.6212	9.25E+01	71	1.6212	9.35E+01	71	1.6212	9.96E+01
72	1.6515	9.09E+01	72	1.6515	9.16E+01	72	1.6515	9.87E+01
73	1.6818	8.91E+01	73	1.6818	8.95E+01	73	1.6818	9.46E+01
74	1.7121	8.71E+01	74	1.7121	8.72E+01	74	1.7121	9.06E+01
75	1.7424	8.47E+01	75	1.7424	8.46E+01	75	1.7424	8.65E+01
76	1.7727	8.20E+01	76	1.7727	8.18E+01	76	1.7727	8.24E+01
77	1.803	7.90E+01	77	1.803	7.87E+01	77	1.803	7.84E+01
78	1.8333	7.57E+01	78	1.8333	7.54E+01	78	1.8333	7.43E+01
79	1.8636	7.20E+01	79	1.8636	7.18E+01	79	1.8636	7.02E+01
80	1.8939	6.80E+01	80	1.8939	6.81E+01	80	1.8939	6.62E+01
81	1.9242	6.38E+01	81	1.9242	6.40E+01	81	1.9242	6.21E+01
82	1.9545	5.93E+01	82	1.9545	5.98E+01	82	1.9545	5.80E+01
83	1.9848	5.47E+01	83	1.9848	5.53E+01	83	1.9848	5.40E+01
84	2.0152	5.01E+01	84	2.0152	5.05E+01	84	2.0152	4.99E+01
85	2.0455	4.54E+01	85	2.0455	4.58E+01	85	2.0455	4.58E+01
86	2.0758	4.08E+01	86	2.0758	4.12E+01	86	2.0758	4.18E+01
87	2.1061	3.64E+01	87	2.1061	3.69E+01	87	2.1061	3.77E+01
88	2.1364	3.22E+01	88	2.1364	3.28E+01	88	2.1364	3.36E+01
89	2.1667	2.83E+01	89	2.1667	2.90E+01	89	2.1667	2.96E+01
90	2.197	2.47E+01	90	2.197	2.54E+01	90	2.197	2.55E+01
91	2.2273	2.14E+01	91	2.2273	2.20E+01	91	2.2273	2.14E+01
92	2.2576	1.84E+01	92	2.2576	1.89E+01	92	2.2576	1.74E+01
93	2.2879	1.58E+01	93	2.2879	1.60E+01	93	2.2879	1.33E+01
94	2.3182	1.35E+01	94	2.3182	1.34E+01	94	2.3182	9.24E+00
95	2.3485	1.14E+01	95	2.3485	1.10E+01	95	2.3485	5.17E+00
96	2.3788	9.68E+00	96	2.3788	8.79E+00	96	2.3788	1.11E+00
97	2.4091	8.18E+00	97	2.4091	6.86E+00	97	2.4091	0.00E+00
98	2.4394	6.89E+00	98	2.4394	5.17E+00	98	2.4394	0.00E+00
99	2.4697	5.79E+00	99	2.4697	3.72E+00	99	2.4697	0.00E+00
100	2.5	4.85E+00	100	2.5	2.51E+00	100	2.5	0.00E+00

Table E2.D-5b. TRAP Model Output for Copper Data for the Bird Reproduction Endpoint (Pooling Group A: Chiou et al. 1997; Harms and Buresh 1986; Pearce et al. 1983; Stevenson and Jackson 1980a; Stevenson and Jackson 1980b)

Chemical:	Copper
Study Authors:	Pooling group A
Receptor Group:	Bird
Effect Description:	Reproduction

Input Data:

Dose	Effect Relative to Control
1.8506	100
13.3653	103
27.7587	99
40.9870	51
51.9534	34
0.3785	100
31.9197	32
0.3154	100
15.7706	111
31.5412	89
63.0824	22
126.1648	11
0.4731	100
32.0143	78
63.5555	22
126.6379	9
0.4794	100
16.2500	100
32.0206	78
63.5618	22
126.6442	11

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered			
Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined			
Large Standard Error for X50			
Large Standard Error for Steepness			
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.6786	1.6234	2.97E-02	1.5609	1.6859
S	1.6525	1.88E+00	0.37164	1.0972	2.6588
Y0	1.01E+02	1.03E+02	4.7041	93.319	113.08

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.6786	1.624	2.89E-02	1.5633	1.6846
S	1.6525	2.09E+00	0.42271	1.2053	2.9814
Y0	1.01E+02	1.02E+02	4.5689	92.49	111.69

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.6786	1.6294	2.48E-02	1.5774	1.6814
S	1.6525	1.7466	0.28011	1.1581	2.3351
Y0	1.01E+02	1.02E+02	4.2851	92.747	110.75

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	42.017	36.386	48.518	2.97E-02	1.6234
20	2.75E+01	2.16E+01	3.49E+01	4.93E-02	1.4389
10	2.14E+01	1.54E+01	2.97E+01	6.76E-02	1.3309
5	1.70E+01	1.13E+01	2.58E+01	8.58E-02	1.2315
0					

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	42.07	36.586	48.375	2.89E-02	1.624
20	28.08	2.23E+01	35.363	4.77E-02	1.4484
10	2.29E+01	1.68E+01	3.12E+01	6.42E-02	1.3599
5	19.83	1.38E+01	2.86E+01	7.55E-02	1.2973
0	14.005	9.12E+00	2.15E+01	8.86E-02	1.15E+00

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	42.602	37.793	48.023	2.48E-02	1.6294
20	28.686	23.842	34.514	3.82E-02	1.4577
10	25.143	20.163	31.353	4.56E-02	1.4004
5	23.539	18.522	29.915	4.96E-02	1.3718
0	22.037	17.006	28.558	5.36E-02	1.3432

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var	Exposure	Effects Var	Est Effects Var	Exposure	Effects Var	Est Effects Var
1	-5.01E-01	1.00E+02	1.03E+02	-5.01E-01	1.00E+02	1.02E+02	-5.01E-01	1.00E+02	1.02E+02
2	-4.22E-01	1.00E+02	1.03E+02	-4.22E-01	1.00E+02	1.02E+02	-4.22E-01	1.00E+02	1.02E+02
3	-3.25E-01	1.00E+02	1.03E+02	-3.25E-01	1.00E+02	1.02E+02	-3.25E-01	1.00E+02	1.02E+02
4	-3.19E-01	1.00E+02	1.03E+02	-3.19E-01	1.00E+02	1.02E+02	-3.19E-01	1.00E+02	1.02E+02
5	2.67E-01	1.00E+02	1.03E+02	2.67E-01	1.00E+02	1.02E+02	2.67E-01	1.00E+02	1.02E+02
6	1.13E+00	1.03E+02	1.01E+02	1.13E+00	1.03E+02	1.02E+02	1.13E+00	1.03E+02	1.02E+02
7	1.20E+00	1.11E+02	9.91E+01	1.20E+00	1.11E+02	1.01E+02	1.20E+00	1.11E+02	1.02E+02
8	1.21E+00	1.00E+02	9.88E+01	1.21E+00	1.00E+02	1.01E+02	1.21E+00	1.00E+02	1.02E+02
9	1.44E+00	9.90E+01	8.20E+01	1.44E+00	9.90E+01	8.23E+01	1.44E+00	9.90E+01	8.39E+01
10	1.50E+00	8.90E+01	7.41E+01	1.50E+00	8.90E+01	7.43E+01	1.50E+00	8.90E+01	7.41E+01
11	1.50E+00	3.20E+01	7.33E+01	1.50E+00	3.20E+01	7.35E+01	1.50E+00	3.20E+01	7.32E+01
12	1.51E+00	7.80E+01	7.31E+01	1.51E+00	7.80E+01	7.32E+01	1.51E+00	7.80E+01	7.29E+01
13	1.51E+00	78	73.082	1.51E+00	78	73.234	1.51E+00	78	72.912
14	1.61E+00	5.10E+01	5.37E+01	1.61E+00	5.10E+01	5.34E+01	1.61E+00	5.10E+01	5.39E+01
15	1.72E+00	3.40E+01	3.44E+01	1.72E+00	3.40E+01	3.33E+01	1.72E+00	3.40E+01	3.56E+01
16	1.80E+00	2.20E+01	2.17E+01	1.80E+00	2.20E+01	2.04E+01	1.80E+00	2.20E+01	2.06E+01
17	1.80E+00	2.20E+01	2.12E+01	1.80E+00	2.20E+01	1.99E+01	1.80E+00	2.20E+01	2.00E+01
18	1.80E+00	2.20E+01	2.12E+01	1.80E+00	2.20E+01	1.99E+01	1.80E+00	2.20E+01	2.00E+01
19	2.10E+00	1.10E+01	2.78E+00	2.10E+00	1.10E+01	1.19E-04	2.10E+00	1.10E+01	0.00E+00
20	2.10E+00	9.00E+00	2.75E+00	2.10E+00	9.00E+00	0.00E+00	2.10E+00	9.00E+00	0.00E+00
21	2.10E+00	1.10E+01	2.75E+00	2.10E+00	1.10E+01	0.00E+00	2.10E+00	1.10E+01	0.00E+00
22									
23									

Analysis of Variance

R-squared: 0.911 | R-squared: 0.909 | R-squared: 0.911

	DF	SS	MS	F	Sig
Total (adj)	20	29739	1486.9		
Regression	2	27093	13546	92.146	0
Error	18	2646.1	147.01		

	DF	SS	MS	F	Sig
Total (adj)	20	29739	1486.9		
Regression	2	27026	13513	89.654	0
Error	18	2713	150.72		

	DF	SS	MS	F	Sig
Total (adj)	20	29739	1486.9		
Regression	2	27094	13547	92.221	0
Error	18	2644.2	146.9		

Prediction Line

	X	Y	X	Y	X	Y
1	-0.5	1.03E+02	-0.5	1.02E+02	-0.5	1.02E+02
2	-4.70E-01	1.03E+02	-4.70E-01	1.02E+02	-4.70E-01	1.02E+02
3	-4.39E-01	1.03E+02	-4.39E-01	1.02E+02	-4.39E-01	1.02E+02
4	-4.09E-01	1.03E+02	-4.09E-01	1.02E+02	-4.09E-01	1.02E+02
5	-3.79E-01	1.03E+02	-3.79E-01	1.02E+02	-3.79E-01	1.02E+02
6	-3.48E-01	1.03E+02	-3.48E-01	1.02E+02	-3.48E-01	1.02E+02
7	-3.18E-01	1.03E+02	-3.18E-01	1.02E+02	-3.18E-01	1.02E+02
8	-2.88E-01	1.03E+02	-2.88E-01	1.02E+02	-2.88E-01	1.02E+02
9	-2.58E-01	1.03E+02	-2.58E-01	1.02E+02	-2.58E-01	1.02E+02
10	-2.27E-01	1.03E+02	-2.27E-01	1.02E+02	-2.27E-01	1.02E+02
11	-1.97E-01	1.03E+02	-1.97E-01	1.02E+02	-1.97E-01	1.02E+02
12	-1.67E-01	1.03E+02	-1.67E-01	1.02E+02	-1.67E-01	1.02E+02
13	-1.36E-01	1.03E+02	-1.36E-01	1.02E+02	-1.36E-01	1.02E+02
14	-0.10606	1.03E+02	-0.10606	1.02E+02	-0.10606	1.02E+02
15	-7.58E-02	1.03E+02	-7.58E-02	1.02E+02	-7.58E-02	1.02E+02
16	-4.55E-02	1.03E+02	-4.55E-02	1.02E+02	-4.55E-02	1.02E+02
17	-1.52E-02	1.03E+02	-1.52E-02	1.02E+02	-1.52E-02	1.02E+02
18	1.52E-02	1.03E+02	1.52E-02	1.02E+02	1.52E-02	1.02E+02
19	4.55E-02	1.03E+02	4.55E-02	1.02E+02	4.55E-02	1.02E+02
20	7.58E-02	1.03E+02	7.58E-02	1.02E+02	7.58E-02	1.02E+02
21	1.06E-01	1.03E+02	1.06E-01	1.02E+02	1.06E-01	1.02E+02
22	1.36E-01	1.03E+02	1.36E-01	1.02E+02	1.36E-01	1.02E+02
23	1.67E-01	1.03E+02	1.67E-01	1.02E+02	1.67E-01	1.02E+02
24	1.97E-01	1.03E+02	1.97E-01	1.02E+02	1.97E-01	1.02E+02
25	2.27E-01	1.03E+02	2.27E-01	1.02E+02	2.27E-01	1.02E+02
26	2.58E-01	1.03E+02	2.58E-01	1.02E+02	2.58E-01	1.02E+02
27	2.88E-01	1.03E+02	2.88E-01	1.02E+02	2.88E-01	1.02E+02
28	3.18E-01	1.03E+02	3.18E-01	1.02E+02	3.18E-01	1.02E+02
29	3.48E-01	1.03E+02	3.48E-01	1.02E+02	3.48E-01	1.02E+02
30	3.79E-01	1.03E+02	3.79E-01	1.02E+02	3.79E-01	1.02E+02
31	0.40909	1.03E+02	0.40909	1.02E+02	0.40909	1.02E+02

Prediction Line

	X	Y		X	Y		X	Y
32	0.43939	1.03E+02	32	0.43939	1.02E+02	32	0.43939	1.02E+02
33	0.4697	1.03E+02	33	0.4697	1.02E+02	33	0.4697	1.02E+02
34	0.5	1.03E+02	34	0.5	1.02E+02	34	0.5	1.02E+02
35	0.5303	1.03E+02	35	0.5303	1.02E+02	35	0.5303	1.02E+02
36	0.56061	1.03E+02	36	0.56061	1.02E+02	36	0.56061	1.02E+02
37	0.59091	1.03E+02	37	0.59091	1.02E+02	37	0.59091	1.02E+02
38	0.62121	1.03E+02	38	0.62121	1.02E+02	38	0.62121	1.02E+02
39	0.65152	1.03E+02	39	0.65152	1.02E+02	39	0.65152	1.02E+02
40	0.68182	1.03E+02	40	0.68182	1.02E+02	40	0.68182	1.02E+02
41	0.71212	1.03E+02	41	0.71212	1.02E+02	41	0.71212	1.02E+02
42	0.74242	1.03E+02	42	0.74242	1.02E+02	42	0.74242	1.02E+02
43	0.77273	1.03E+02	43	0.77273	1.02E+02	43	0.77273	1.02E+02
44	0.80303	1.03E+02	44	0.80303	1.02E+02	44	0.80303	1.02E+02
45	0.83333	1.03E+02	45	0.83333	1.02E+02	45	0.83333	1.02E+02
46	0.86364	1.03E+02	46	0.86364	1.02E+02	46	0.86364	1.02E+02
47	0.89394	1.03E+02	47	0.89394	1.02E+02	47	0.89394	1.02E+02
48	0.92424	1.03E+02	48	0.92424	1.02E+02	48	0.92424	1.02E+02
49	0.95455	1.03E+02	49	0.95455	1.02E+02	49	0.95455	1.02E+02
50	0.98485	1.02E+02	50	0.98485	1.02E+02	50	0.98485	1.02E+02
51	1.0152	1.02E+02	51	1.0152	1.02E+02	51	1.0152	1.02E+02
52	1.0455	1.02E+02	52	1.0455	1.02E+02	52	1.0455	1.02E+02
53	1.0758	1.02E+02	53	1.0758	1.02E+02	53	1.0758	1.02E+02
54	1.1061	1.01E+02	54	1.1061	1.02E+02	54	1.1061	1.02E+02
55	1.1364	1.01E+02	55	1.1364	1.02E+02	55	1.1364	1.02E+02
56	1.1667	1.00E+02	56	1.1667	1.02E+02	56	1.1667	1.02E+02
57	1.197	9.92E+01	57	1.197	1.02E+02	57	1.197	1.02E+02
58	1.2273	9.82E+01	58	1.2273	1.01E+02	58	1.2273	1.02E+02
59	1.2576	9.70E+01	59	1.2576	9.93E+01	59	1.2576	1.02E+02
60	1.2879	9.55E+01	60	1.2879	9.76E+01	60	1.2879	1.02E+02
61	1.3182	9.37E+01	61	1.3182	9.55E+01	61	1.3182	1.02E+02
62	1.3485	9.16E+01	62	1.3485	9.29E+01	62	1.3485	1.01E+02
63	1.3788	8.90E+01	63	1.3788	9.00E+01	63	1.3788	9.54E+01
64	1.4091	8.60E+01	64	1.4091	8.66E+01	64	1.4091	9.00E+01
65	1.4394	8.25E+01	65	1.4394	8.29E+01	65	1.4394	8.46E+01
66	1.4697	7.85E+01	66	1.4697	7.87E+01	66	1.4697	7.93E+01
67	1.5	7.39E+01	67	1.5	7.41E+01	67	1.5	7.39E+01
68	1.5303	6.89E+01	68	1.5303	6.91E+01	68	1.5303	6.85E+01
69	1.5606	6.36E+01	69	1.5606	6.37E+01	69	1.5606	6.31E+01
70	1.5909	5.79E+01	70	1.5909	5.79E+01	70	1.5909	5.77E+01
71	1.6212	5.20E+01	71	1.6212	5.16E+01	71	1.6212	5.23E+01
72	1.6515	4.62E+01	72	1.6515	4.53E+01	72	1.6515	4.70E+01
73	1.6818	4.05E+01	73	1.6818	3.94E+01	73	1.6818	4.16E+01
74	1.7121	3.50E+01	74	1.7121	3.39E+01	74	1.7121	3.62E+01
75	1.7424	3.00E+01	75	1.7424	2.89E+01	75	1.7424	3.08E+01
76	1.7727	2.54E+01	76	1.7727	2.42E+01	76	1.7727	2.54E+01
77	1.803	2.13E+01	77	1.803	1.99E+01	77	1.803	2.00E+01
78	1.8333	1.77E+01	78	1.8333	1.61E+01	78	1.8333	1.46E+01
79	1.8636	1.46E+01	79	1.8636	1.27E+01	79	1.8636	9.25E+00
80	1.8939	1.20E+01	80	1.8939	9.65E+00	80	1.8939	3.87E+00
81	1.9242	9.75E+00	81	1.9242	7.04E+00	81	1.9242	0.00E+00
82	1.9545	7.92E+00	82	1.9545	4.84E+00	82	1.9545	0.00E+00
83	1.9848	6.41E+00	83	1.9848	3.05E+00	83	1.9848	0.00E+00
84	2.0152	5.17E+00	84	2.0152	1.67E+00	84	2.0152	0.00E+00
85	2.0455	4.16E+00	85	2.0455	7.07E-01	85	2.0455	0.00E+00
86	2.0758	3.34E+00	86	2.0758	1.50E-01	86	2.0758	0.00E+00
87	2.1061	2.68E+00	87	2.1061	0.00E+00	87	2.1061	0.00E+00
88	2.1364	2.14E+00	88	2.1364	0.00E+00	88	2.1364	0.00E+00
89	2.1667	1.71E+00	89	2.1667	0.00E+00	89	2.1667	0.00E+00
90	2.197	1.37E+00	90	2.197	0.00E+00	90	2.197	0.00E+00
91	2.2273	1.09E+00	91	2.2273	0.00E+00	91	2.2273	0.00E+00
92	2.2576	8.73E-01	92	2.2576	0.00E+00	92	2.2576	0.00E+00
93	2.2879	6.97E-01	93	2.2879	0.00E+00	93	2.2879	0.00E+00
94	2.3182	5.56E-01	94	2.3182	0.00E+00	94	2.3182	0.00E+00
95	2.3485	4.43E-01	95	2.3485	0.00E+00	95	2.3485	0.00E+00
96	2.3788	3.53E-01	96	2.3788	0.00E+00	96	2.3788	0.00E+00
97	2.4091	2.81E-01	97	2.4091	0.00E+00	97	2.4091	0.00E+00
98	2.4394	2.24E-01	98	2.4394	0.00E+00	98	2.4394	0.00E+00
99	2.4697	1.79E-01	99	2.4697	0.00E+00	99	2.4697	0.00E+00
100	2.5	1.42E-01	100	2.5	0.00E+00	100	2.5	0.00E+00

Table E2.D-5c. TRAP Model Output for Copper Data for the Bird Survival Endpoint (Mehring et al. 1960)

Chemical:	Copper
Study Authors:	Mehring et al. 1960
Receptor Group:	Bird
Effect Description:	Survival

Input Data:

Dose	# of Org w/o response	Total # of Org	Survival
1.926585	39	40	0.975
29.86207	18	20	0.9
42.23668	19	20	0.95
55.50048	17	20	0.85
87.43733	12	20	0.6

Modeling Parameters

Analysis Type:	Tolerance Distribution	Tolerance Distribution	Tolerance Distribution
Model Shape:	Gaussian Distribution	Triangular Distribution	Rectangular Distribution
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined			
Large Standard Error for X50			
Large Standard Error for Steepness			yes
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

Gaussian Distribution:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
X50	1.9864	2.0245	9.67E-02	1.8089	2.24
S	0.17442	2.39E-01	0.11223	0.16732	0.42025
Y0	0.94167	0.96229	2.79E-02	0.86119	0.99629

Triangular Distribution:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
X50	1.9864	2.002	7.67E-02	1.831	2.1729
S	0.17442	1.84E-01	8.02E-02	0.12852	0.3228
Y0	0.94167	0.95152	2.72E-02	0.86507	0.98984

Rectangular Distribution:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
X50	1.9864	2.0404	0.13385	1.7421	2.3386
S	0.17442	0.21652	0.11753	0.15129	0.37998
Y0	0.94167	0.95	2.44E-02	0.8769	0.98621

Xp Estimates

Gaussian Distribution:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	105.8	64.407	173.78	9.67E-02	2.0245
20	66.517	47.49	93.166	6.25E-02	1.8229
10	52.189	31.004	87.852	9.04E-02	1.7176
5	42.715	19.697	92.633	0.12391	1.6306
0					

Triangular Distribution:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	100.45	67.764	148.9	7.67E-02	2.002
20	68.605	51.541	91.318	5.27E-02	1.8364
10	5.66E+01	37.197	86.156	7.18E-02	1.7529
5	49.417	27.707	88.139	9.19E-02	1.6939
0	35.596	10.549	120.11	0.14776	1.5514

Rectangular Distribution:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	109.74	55.224	218.07	0.13385	2.0404
20	65.365	48.689	87.752	5.32E-02	1.8153
10	54.997	37.163	81.39	6.66E-02	1.7403
5	50.447	30.83	82.546	8.05E-02	1.7028
0	46.274	24.932	85.884	9.67E-02	1.6653

Model Fit Summary

Dataset

Gaussian Distribution:

	Exposure	Effects Var	Est Effects Var
1	2.85E-01	0.975	0.96229
2	1.48E+00	0.9	0.95181
3	1.63E+00	0.95	0.91618
4	1.74E+00	0.85	0.84587
5	1.94E+00	0.6	0.61129
6			

Triangular Distribution:

	Exposure	Effects Var	Est Effects Var
1	2.85E-01	0.975	0.95152
2	1.48E+00	0.9	0.95152
3	1.63E+00	0.95	0.93858
4	1.74E+00	0.85	0.86432
5	1.94E+00	0.6	0.59454
6			

Rectangular Distribution:

	Exposure	Effects Var	Est Effects Var
1	2.85E-01	0.975	0.95
2	1.48E+00	0.9	0.95
3	1.63E+00	0.95	0.95
4	1.74E+00	0.85	0.85
5	1.94E+00	0.6	0.6
6			

Analysis of Variance

Gaussian Distribution:

R-squared:

	DF	SS	MS	F	Sig
Total (adj)					
Regression					
Error					

Triangular Distribution:

R-squared:

	DF	SS	MS	F	Sig
Total (adj)					
Regression					
Error					

Rectangular Distribution:

R-squared:

	DF	SS	MS	F	Sig
Total (adj)					
Regression					
Error					

Prediction Line

	X	Y
1	0.2	0.96229
2	2.20E-01	0.96229
3	2.40E-01	0.96229
4	2.61E-01	0.96229
5	2.81E-01	0.96229
6	3.01E-01	0.96229
7	3.21E-01	0.96229
8	3.41E-01	0.96229
9	3.62E-01	0.96229
10	3.82E-01	0.96229
11	4.02E-01	0.96229
12	4.22E-01	0.96229
13	4.42E-01	0.96229
14	0.46263	0.96229
15	0.48283	0.96229
16	0.50303	0.96229
17	0.52323	0.96229
18	0.54343	0.96229
19	0.56364	0.96229
20	0.58384	0.96229
21	0.60404	0.96229
22	0.62424	0.96229
23	0.64444	0.96229
24	0.66465	0.96229
25	0.68485	0.96229
26	0.70505	0.96229
27	0.72525	0.96229
28	0.74545	0.96229
29	0.76566	0.96229
30	0.78586	0.96229
31	0.80606	0.96229
32	0.82626	0.96229
33	0.84646	0.96229
34	0.86667	0.96229
35	0.88687	0.96229
36	0.90707	0.96229
37	0.92727	0.96229
38	0.94747	0.96229
39	0.96768	0.96229
40	0.98788	0.96229
41	1.0081	0.96228
42	1.0283	0.96228
43	1.0485	0.96227
44	1.0687	0.96226
45	1.0889	0.96225
46	1.1091	0.96223
47	1.1293	0.9622
48	1.1495	0.96217
49	1.1697	0.96212
50	1.1899	0.96206
51	1.2101	0.96197
52	1.2303	0.96186
53	1.2505	0.9617
54	1.2707	0.9615
55	1.2909	0.96124
56	1.3111	0.9609
57	1.3313	0.96047
58	1.3515	0.95991
59	1.3717	0.95921
60	1.3919	0.95832
61	1.4121	0.95722
62	1.4323	0.95584
63	1.4525	0.95415
64	1.4727	0.95209
65	1.4929	0.94957
66	1.5131	0.94655
67	1.5333	0.94292
68	1.5535	0.93861
69	1.5737	0.93352
70	1.5939	0.92756

	X	Y
1	0.2	0.95152
2	2.20E-01	0.95152
3	2.40E-01	0.95152
4	2.61E-01	0.95152
5	2.81E-01	0.95152
6	3.01E-01	0.95152
7	3.21E-01	0.95152
8	3.41E-01	0.95152
9	3.62E-01	0.95152
10	3.82E-01	0.95152
11	4.02E-01	0.95152
12	4.22E-01	0.95152
13	4.42E-01	0.95152
14	0.46263	0.95152
15	0.48283	0.95152
16	0.50303	0.95152
17	0.52323	0.95152
18	0.54343	0.95152
19	0.56364	0.95152
20	0.58384	0.95152
21	0.60404	0.95152
22	0.62424	0.95152
23	0.64444	0.95152
24	0.66465	0.95152
25	0.68485	0.95152
26	0.70505	0.95152
27	0.72525	0.95152
28	0.74545	0.95152
29	0.76566	0.95152
30	0.78586	0.95152
31	0.80606	0.95152
32	0.82626	0.95152
33	0.84646	0.95152
34	0.86667	0.95152
35	0.88687	0.95152
36	0.90707	0.95152
37	0.92727	0.95152
38	0.94747	0.95152
39	0.96768	0.95152
40	0.98788	0.95152
41	1.0081	0.95152
42	1.0283	0.95152
43	1.0485	0.95152
44	1.0687	0.95152
45	1.0889	0.95152
46	1.1091	0.95152
47	1.1293	0.95152
48	1.1495	0.95152
49	1.1697	0.95152
50	1.1899	0.95152
51	1.2101	0.95152
52	1.2303	0.95152
53	1.2505	0.95152
54	1.2707	0.95152
55	1.2909	0.95152
56	1.3111	0.95152
57	1.3313	0.95152
58	1.3515	0.95152
59	1.3717	0.95152
60	1.3919	0.95152
61	1.4121	0.95152
62	1.4323	0.95152
63	1.4525	0.95152
64	1.4727	0.95152
65	1.4929	0.95152
66	1.5131	0.95152
67	1.5333	0.95152
68	1.5535	0.95151
69	1.5737	0.95035
70	1.5939	0.94728

	X	Y
1	0.2	0.95
2	2.20E-01	0.95
3	2.40E-01	0.95
4	2.61E-01	0.95
5	2.81E-01	0.95
6	3.01E-01	0.95
7	3.21E-01	0.95
8	3.41E-01	0.95
9	3.62E-01	0.95
10	3.82E-01	0.95
11	4.02E-01	0.95
12	4.22E-01	0.95
13	4.42E-01	0.95
14	0.46263	0.95
15	0.48283	0.95
16	0.50303	0.95
17	0.52323	0.95
18	0.54343	0.95
19	0.56364	0.95
20	0.58384	0.95
21	0.60404	0.95
22	0.62424	0.95
23	0.64444	0.95
24	0.66465	0.95
25	0.68485	0.95
26	0.70505	0.95
27	0.72525	0.95
28	0.74545	0.95
29	0.76566	0.95
30	0.78586	0.95
31	0.80606	0.95
32	0.82626	0.95
33	0.84646	0.95
34	0.86667	0.95
35	0.88687	0.95
36	0.90707	0.95
37	0.92727	0.95
38	0.94747	0.95
39	0.96768	0.95
40	0.98788	0.95
41	1.0081	0.95
42	1.0283	0.95
43	1.0485	0.95
44	1.0687	0.95
45	1.0889	0.95
46	1.1091	0.95
47	1.1293	0.95
48	1.1495	0.95
49	1.1697	0.95
50	1.1899	0.95
51	1.2101	0.95
52	1.2303	0.95
53	1.2505	0.95
54	1.2707	0.95
55	1.2909	0.95
56	1.3111	0.95
57	1.3313	0.95
58	1.3515	0.95
59	1.3717	0.95
60	1.3919	0.95
61	1.4121	0.95
62	1.4323	0.95
63	1.4525	0.95
64	1.4727	0.95
65	1.4929	0.95
66	1.5131	0.95
67	1.5333	0.95
68	1.5535	0.95
69	1.5737	0.95
70	1.5939	0.95

Prediction Line

	X	Y
71	1.6141	0.92062
72	1.6343	0.91261
73	1.6545	0.90341
74	1.6747	0.89293
75	1.6949	0.88108
76	1.7152	0.86778
77	1.7354	0.85294
78	1.7556	0.83651
79	1.7758	0.81845
80	1.796	0.79874
81	1.8162	0.77738
82	1.8364	0.75439
83	1.8566	0.72983
84	1.8768	0.70377
85	1.897	0.67632
86	1.9172	0.64761
87	1.9374	0.61779
88	1.9576	0.58705
89	1.9778	0.55557
90	1.998	0.52358
91	2.0182	0.49128
92	2.0384	0.45891
93	2.0586	0.4267
94	2.0788	0.39487
95	2.099	0.36364
96	2.1192	0.33323
97	2.1394	0.30381
98	2.1596	0.27556
99	2.1798	0.24862
100	2.2	0.22312

	X	Y
71	1.6141	0.94229
72	1.6343	0.93539
73	1.6545	0.92658
74	1.6747	0.91586
75	1.6949	0.90323
76	1.7152	0.88868
77	1.7354	0.87222
78	1.7556	0.85384
79	1.7758	0.83356
80	1.796	0.81136
81	1.8162	0.78725
82	1.8364	0.76122
83	1.8566	0.73328
84	1.8768	0.70343
85	1.897	0.67167
86	1.9172	0.63799
87	1.9374	0.6024
88	1.9576	0.5649
89	1.9778	0.52549
90	1.998	0.48416
91	2.0182	0.44215
92	2.0384	0.40199
93	2.0586	0.36373
94	2.0788	0.32739
95	2.099	0.29296
96	2.1192	0.26045
97	2.1394	0.22984
98	2.1596	0.20115
99	2.1798	0.17438
100	2.2	0.14951

	X	Y
71	1.6141	0.95
72	1.6343	0.95
73	1.6545	0.95
74	1.6747	0.93808
75	1.6949	0.9125
76	1.7152	0.88691
77	1.7354	0.86133
78	1.7556	0.83574
79	1.7758	0.81016
80	1.796	0.78457
81	1.8162	0.75899
82	1.8364	0.7334
83	1.8566	0.70782
84	1.8768	0.68223
85	1.897	0.65665
86	1.9172	0.63106
87	1.9374	0.60548
88	1.9576	0.57989
89	1.9778	0.5543
90	1.998	0.52872
91	2.0182	0.50313
92	2.0384	0.47755
93	2.0586	0.45196
94	2.0788	0.42638
95	2.099	0.40079
96	2.1192	0.37521
97	2.1394	0.34962
98	2.1596	0.32404
99	2.1798	0.29845
100	2.2	0.27287

Table E2.D-5d. TRAP Model Output for Copper Data for the Mammal Growth Endpoint (Allcroft et al. 1961)

Chemical:	Copper
Study Authors:	Allcroft et al. 1961
Receptor Group:	Mammal
Effect Description:	Growth

Input Data:

Dose	Response	SE
0.24667	1.24	not reported
9.3	1.18	not reported
17.267	0.36	not reported
36.667	9.00E-02	not reported

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined	yes	yes	yes
Large Standard Error for X50			
Large Standard Error for Steepness			
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

Logistic Equation:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.2662	1.1714			
S	2.5514	3.36E+00			
Y0	1.21E+00	1.25E+00			

Threshold Sigmoid:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.2662	1.1682			
S	2.5514	3.45E+00			
Y0	1.21E+00	1.24E+00			

Piecewise Linear:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.2662	1.152			
S	2.5514	2.4608			
Y0	1.21E+00	1.24E+00			

Xp Estimates

Logistic Equation:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	14.84	4.8885	45.051	3.80E-02	1.1714
20	1.17E+01	1.22E+00	1.12E+02	7.73E-02	1.0684
10	1.02E+01	5.08E-01	2.04E+02	0.10246	1.0081
5	8.97E+00	2.25E-01	3.58E+02	0.12602	0.95256
0					

Threshold Sigmoid:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	14.73	5.2827	41.073	3.51E-02	1.1682
20	11.525	1.79E+00	74.202	6.37E-02	1.0617
10	1.02E+01	9.68E-01	1.07E+02	8.04E-02	1.0079
5	9.332	6.16E-01	1.41E+02	9.29E-02	0.96997
0	7.556	1.66E-01	3.45E+02	0.13058	8.78E-01

Piecewise Linear:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	14.191	6.5055	30.955	2.67E-02	1.152
20	10.717	4.0273	28.522	3.35E-02	1.0301
10	9.7602	3.2043	29.729	3.81E-02	0.98946
5	9.314	2.8372	30.577	4.06E-02	0.96914
0	8.8883	2.5027	31.567	4.33E-02	0.94882

Model Fit Summary

Dataset

Logistic Equation:

	Exposure	Effects Var	Est Effects Var
1	-6.08E-01	1.24E+00	1.25E+00
2	9.68E-01	1.18E+00	1.17E+00
3	1.24E+00	3.60E-01	3.65E-01
4	1.56E+00	9.00E-02	6.29E-03
5			
6			

Threshold Sigmoid:

	Exposure	Effects Var	Est Effects Var
1	-6.08E-01	1.24E+00	1.24E+00
2	9.68E-01	1.18E+00	1.18E+00
3	1.24E+00	3.60E-01	3.60E-01
4	1.56E+00	9.00E-02	0.00E+00
5			
6			

Piecewise Linear:

	Exposure	Effects Var	Est Effects Var
1	-6.08E-01	1.24E+00	1.24E+00
2	9.68E-01	1.18E+00	1.18E+00
3	1.24E+00	3.60E-01	3.60E-01
4	1.56E+00	9.00E-02	0.00E+00
5			
6			

Analysis of Variance

Logistic Equation: R-squared 0.993

	DF	SS	MS	F	Sig
Total (adj)	3	1.0085	0.33616		
Regression	2	1.0013	0.50066	69.903	0.0843
Error	1	7.16E-03	7.16E-03		

Threshold Sigmoid: R-squared 0.992

	DF	SS	MS	F	Sig
Total (adj)	3	1.0085	0.33616		
Regression	2	1.0004	0.50019	61.752	0.0896
Error	1	8.10E-03	8.10E-03		

Piecewise Linear: R-squared 0.992

	DF	SS	MS	F	Sig
Total (adj)	3	1.0085	0.33616		
Regression	2	1.0004	0.50019	61.752	0.0896
Error	1	8.10E-03	8.10E-03		

Prediction Line

	X	Y
1	-0.5	1.25E+00
2	-4.75E-01	1.25E+00
3	-4.49E-01	1.25E+00
4	-4.24E-01	1.25E+00
5	-3.99E-01	1.25E+00
6	-3.74E-01	1.25E+00
7	-3.48E-01	1.25E+00
8	-3.23E-01	1.25E+00
9	-2.98E-01	1.25E+00
10	-2.73E-01	1.25E+00
11	-2.47E-01	1.25E+00
12	-2.22E-01	1.25E+00
13	-1.97E-01	1.25E+00
14	-0.17172	1.25E+00
15	-0.14646	1.25E+00
16	-0.12121	1.25E+00
17	-9.60E-02	1.25E+00
18	-7.07E-02	1.25E+00
19	-4.55E-02	1.25E+00
20	-2.02E-02	1.25E+00
21	5.05E-03	1.25E+00
22	3.03E-02	1.25E+00
23	5.56E-02	1.25E+00
24	8.08E-02	1.25E+00
25	1.06E-01	1.25E+00
26	1.31E-01	1.25E+00
27	1.57E-01	1.25E+00
28	1.82E-01	1.25E+00
29	2.07E-01	1.25E+00
30	2.32E-01	1.25E+00
31	0.25758	1.25E+00
32	0.28283	1.25E+00
33	0.30808	1.25E+00
34	0.33333	1.25E+00
35	0.35859	1.25E+00
36	0.38384	1.25E+00
37	0.40909	1.25E+00
38	0.43434	1.25E+00
39	0.4596	1.25E+00
40	0.48485	1.25E+00
41	0.5101	1.25E+00
42	0.53535	1.25E+00
43	0.56061	1.25E+00
44	0.58586	1.25E+00
45	0.61111	1.25E+00
46	0.63636	1.25E+00
47	0.66162	1.25E+00
48	0.68687	1.25E+00
49	0.71212	1.24E+00
50	0.73737	1.24E+00
51	0.76263	1.24E+00
52	0.78788	1.24E+00
53	0.81313	1.24E+00
54	0.83838	1.23E+00
55	0.86364	1.23E+00
56	0.88889	1.22E+00
57	0.91414	1.21E+00
58	0.93939	1.19E+00
59	0.96465	1.17E+00
60	0.9899	1.15E+00
61	1.0152	1.11E+00
62	1.0404	1.06E+00
63	1.0657	1.01E+00
64	1.0909	9.32E-01
65	1.1162	8.46E-01
66	1.1414	7.48E-01
67	1.1667	6.44E-01
68	1.1919	5.38E-01
69	1.2172	4.38E-01

	X	Y
1	-0.5	1.24E+00
2	-4.75E-01	1.24E+00
3	-4.49E-01	1.24E+00
4	-4.24E-01	1.24E+00
5	-3.99E-01	1.24E+00
6	-3.74E-01	1.24E+00
7	-3.48E-01	1.24E+00
8	-3.23E-01	1.24E+00
9	-2.98E-01	1.24E+00
10	-2.73E-01	1.24E+00
11	-2.47E-01	1.24E+00
12	-2.22E-01	1.24E+00
13	-1.97E-01	1.24E+00
14	-0.17172	1.24E+00
15	-0.14646	1.24E+00
16	-0.12121	1.24E+00
17	-9.60E-02	1.24E+00
18	-7.07E-02	1.24E+00
19	-4.55E-02	1.24E+00
20	-2.02E-02	1.24E+00
21	5.05E-03	1.24E+00
22	3.03E-02	1.24E+00
23	5.56E-02	1.24E+00
24	8.08E-02	1.24E+00
25	1.06E-01	1.24E+00
26	1.31E-01	1.24E+00
27	1.57E-01	1.24E+00
28	1.82E-01	1.24E+00
29	2.07E-01	1.24E+00
30	2.32E-01	1.24E+00
31	0.25758	1.24E+00
32	0.28283	1.24E+00
33	0.30808	1.24E+00
34	0.33333	1.24E+00
35	0.35859	1.24E+00
36	0.38384	1.24E+00
37	0.40909	1.24E+00
38	0.43434	1.24E+00
39	0.4596	1.24E+00
40	0.48485	1.24E+00
41	0.5101	1.24E+00
42	0.53535	1.24E+00
43	0.56061	1.24E+00
44	0.58586	1.24E+00
45	0.61111	1.24E+00
46	0.63636	1.24E+00
47	0.66162	1.24E+00
48	0.68687	1.24E+00
49	0.71212	1.24E+00
50	0.73737	1.24E+00
51	0.76263	1.24E+00
52	0.78788	1.24E+00
53	0.81313	1.24E+00
54	0.83838	1.24E+00
55	0.86364	1.24E+00
56	0.88889	1.24E+00
57	0.91414	1.23E+00
58	0.93939	1.21E+00
59	0.96465	1.19E+00
60	0.9899	1.15E+00
61	1.0152	1.10E+00
62	1.0404	1.05E+00
63	1.0657	9.81E-01
64	1.0909	9.07E-01
65	1.1162	8.23E-01
66	1.1414	7.29E-01
67	1.1667	6.27E-01
68	1.1919	5.23E-01
69	1.2172	4.28E-01

	X	Y
1	-0.5	1.24E+00
2	-4.75E-01	1.24E+00
3	-4.49E-01	1.24E+00
4	-4.24E-01	1.24E+00
5	-3.99E-01	1.24E+00
6	-3.74E-01	1.24E+00
7	-3.48E-01	1.24E+00
8	-3.23E-01	1.24E+00
9	-2.98E-01	1.24E+00
10	-2.73E-01	1.24E+00
11	-2.47E-01	1.24E+00
12	-2.22E-01	1.24E+00
13	-1.97E-01	1.24E+00
14	-0.17172	1.24E+00
15	-0.14646	1.24E+00
16	-0.12121	1.24E+00
17	-9.60E-02	1.24E+00
18	-7.07E-02	1.24E+00
19	-4.55E-02	1.24E+00
20	-2.02E-02	1.24E+00
21	5.05E-03	1.24E+00
22	3.03E-02	1.24E+00
23	5.56E-02	1.24E+00
24	8.08E-02	1.24E+00
25	1.06E-01	1.24E+00
26	1.31E-01	1.24E+00
27	1.57E-01	1.24E+00
28	1.82E-01	1.24E+00
29	2.07E-01	1.24E+00
30	2.32E-01	1.24E+00
31	0.25758	1.24E+00
32	0.28283	1.24E+00
33	0.30808	1.24E+00
34	0.33333	1.24E+00
35	0.35859	1.24E+00
36	0.38384	1.24E+00
37	0.40909	1.24E+00
38	0.43434	1.24E+00
39	0.4596	1.24E+00
40	0.48485	1.24E+00
41	0.5101	1.24E+00
42	0.53535	1.24E+00
43	0.56061	1.24E+00
44	0.58586	1.24E+00
45	0.61111	1.24E+00
46	0.63636	1.24E+00
47	0.66162	1.24E+00
48	0.68687	1.24E+00
49	0.71212	1.24E+00
50	0.73737	1.24E+00
51	0.76263	1.24E+00
52	0.78788	1.24E+00
53	0.81313	1.24E+00
54	0.83838	1.24E+00
55	0.86364	1.24E+00
56	0.88889	1.24E+00
57	0.91414	1.24E+00
58	0.93939	1.24E+00
59	0.96465	1.19E+00
60	0.9899	1.11E+00
61	1.0152	1.04E+00
62	1.0404	9.61E-01
63	1.0657	8.83E-01
64	1.0909	8.06E-01
65	1.1162	7.29E-01
66	1.1414	6.52E-01
67	1.1667	5.75E-01
68	1.1919	4.98E-01
69	1.2172	4.21E-01

Prediction Line

	X	Y
70	1.2424	3.47E-01
71	1.2677	2.68E-01
72	1.2929	2.04E-01
73	1.3182	1.52E-01
74	1.3434	1.12E-01
75	1.3687	8.21E-02
76	1.3939	5.95E-02
77	1.4192	4.30E-02
78	1.4444	3.09E-02
79	1.4697	2.22E-02
80	1.4949	1.59E-02
81	1.5202	1.13E-02
82	1.5455	8.09E-03
83	1.5707	5.77E-03
84	1.596	4.12E-03
85	1.6212	2.93E-03
86	1.6465	2.09E-03
87	1.6717	1.49E-03
88	1.697	1.06E-03
89	1.7222	7.55E-04
90	1.7475	5.38E-04
91	1.7727	3.83E-04
92	1.798	2.73E-04
93	1.8232	1.94E-04
94	1.8485	1.38E-04
95	1.8737	9.84E-05
96	1.899	7.01E-05
97	1.9242	4.99E-05
98	1.9495	3.55E-05
99	1.9747	2.53E-05
100	2	1.80E-05

	X	Y
70	1.2424	3.43E-01
71	1.2677	2.68E-01
72	1.2929	2.01E-01
73	1.3182	1.44E-01
74	1.3434	9.70E-02
75	1.3687	5.90E-02
76	1.3939	3.04E-02
77	1.4192	1.12E-02
78	1.4444	1.38E-03
79	1.4697	0.00E+00
80	1.4949	0.00E+00
81	1.5202	0.00E+00
82	1.5455	0.00E+00
83	1.5707	0.00E+00
84	1.596	0.00E+00
85	1.6212	0.00E+00
86	1.6465	0.00E+00
87	1.6717	0.00E+00
88	1.697	0.00E+00
89	1.7222	0.00E+00
90	1.7475	0.00E+00
91	1.7727	0.00E+00
92	1.798	0.00E+00
93	1.8232	0.00E+00
94	1.8485	0.00E+00
95	1.8737	0.00E+00
96	1.899	0.00E+00
97	1.9242	0.00E+00
98	1.9495	0.00E+00
99	1.9747	0.00E+00
100	2	0.00E+00

	X	Y
70	1.2424	3.44E-01
71	1.2677	2.67E-01
72	1.2929	1.90E-01
73	1.3182	1.13E-01
74	1.3434	3.59E-02
75	1.3687	0.00E+00
76	1.3939	0.00E+00
77	1.4192	0.00E+00
78	1.4444	0.00E+00
79	1.4697	0.00E+00
80	1.4949	0.00E+00
81	1.5202	0.00E+00
82	1.5455	0.00E+00
83	1.5707	0.00E+00
84	1.596	0.00E+00
85	1.6212	0.00E+00
86	1.6465	0.00E+00
87	1.6717	0.00E+00
88	1.697	0.00E+00
89	1.7222	0.00E+00
90	1.7475	0.00E+00
91	1.7727	0.00E+00
92	1.798	0.00E+00
93	1.8232	0.00E+00
94	1.8485	0.00E+00
95	1.8737	0.00E+00
96	1.899	0.00E+00
97	1.9242	0.00E+00
98	1.9495	0.00E+00
99	1.9747	0.00E+00
100	2	0.00E+00

Table E2.D-6a. TRAP Model Output for Iron Data for the Bird Survival Endpoint (Pooling Group A: Pescatore and Harter-Dennis 1989; Wallner-Pendleton et al. 1986)

Chemical:	Iron
Study Authors:	Pooled dataset A
Receptor Group:	Bird
Effect Description:	Survival

Input Data:

Dose	Effect Relative to Control
0.000001	100
708.9038	93.40
945.2051	83.90
1181.5064	73.50
1417.8077	48.90
2835.6153	8.30
0.000001	100.00
6.6952	100.00
66.9520	100.00
669.5203	100.00
2008.5608	80

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?
Use Only for Exploratory Data Analysis!
Maximum Iterations Reached Without Convergence
X50 at Maximum or Minimum Limit
Steepness At Maximum Or Minimum Limit
Error Estimates Cannot Be Determined
Large Standard Error for X50
Large Standard Error for Steepness
Large Standard Error for Y0
Inadequate Number of Partial Effects
Insufficient Data to Plot
Insufficient Data to Analyze

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	3.2429	3.2813	7.07E-02	3.1182	3.4444
S	1.91E+00	1.42E+00	5.56E-01	1.37E-01	2.70E+00
Y0	1.00E+02	1.00E+02	7.3059	83.419	117.11

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	3.2429	3.2886	7.15E-02	3.1236	3.4535
S	1.91E+00	1.49E+00	5.48E-01	2.26E-01	2.76E+00
Y0	1.00E+02	9.95E+01	7.3997	82.437	116.56

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	3.2429	3.268	6.51E-02	3.12E+00	3.418
S	1.9071	1.2445	0.40992	0.29927	2.1898
Y0	1.00E+02	9.89E+01	6.1466	84.726	113.07

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	1911.1	1312.7	2782.4	7.07E-02	3.2813
20	1.09E+03	5.98E+02	1.98E+03	1.13E-01	3.0372
10	7.84E+02	3.34E+02	1.84E+03	1.60E-01	2.8944
5	5.79E+02	1.92E+02	1.75E+03	2.08E-01	2.7628
0					

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	1943.4	1329.3	2841.2	7.15E-02	3.2886
20	1101.4	6.23E+02	1946.9	0.10729	3.042
10	8.27E+02	3.75E+02	1.83E+03	0.14912	2.9177
5	675.73	2.50E+02	1.83E+03	0.18731	2.8298
0	414.57	6.81E+01	2.52E+03	0.34004	2.62E+00

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	1853.4	1311.9	2618.4	6.51E-02	3.268
20	1063.9	673.68	1680.2	8.61E-02	3.0269
10	884.21	503.28	1553.5	0.10614	2.9466
5	806.09	432.79	1501.4	0.11713	2.9064
0	734.86	3.71E+02	1454.2	0.12855	2.8662

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	1.00E+02
2	-6.00E+00	1.00E+02	1.00E+02
3	8.26E-01	1.00E+02	1.00E+02
4	1.83E+00	1.00E+02	1.00E+02
5	2.83E+00	1.00E+02	9.33E+01
6	2.85E+00	9.34E+01	9.23E+01
7	2.98E+00	8.39E+01	8.53E+01
8	3.07E+00	7.35E+01	7.68E+01
9	3.15E+00	4.89E+01	6.78E+01
10	3.30E+00	8.00E+01	4.71E+01
11	3.45E+00	8.3	2.75E+01
12			

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	9.95E+01
2	-6.00E+00	1.00E+02	9.95E+01
3	8.26E-01	1.00E+02	9.95E+01
4	1.83E+00	1.00E+02	9.95E+01
5	2.83E+00	1.00E+02	9.47E+01
6	2.85E+00	9.34E+01	9.35E+01
7	2.98E+00	8.39E+01	8.53E+01
8	3.07E+00	7.35E+01	7.66E+01
9	3.15E+00	4.89E+01	6.80E+01
10	3.30E+00	8.00E+01	4.76E+01
11	3.45E+00	8.3	28.392
12			

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	9.89E+01
2	-6.00E+00	1.00E+02	9.89E+01
3	8.26E-01	1.00E+02	9.89E+01
4	1.83E+00	1.00E+02	9.89E+01
5	2.83E+00	1.00E+02	9.89E+01
6	2.85E+00	9.34E+01	9.89E+01
7	2.98E+00	8.39E+01	8.54E+01
8	3.07E+00	7.35E+01	7.35E+01
9	3.15E+00	4.89E+01	6.38E+01
10	3.30E+00	8.00E+01	4.52E+01
11	3.45E+00	8.3	26.718
12			

Analysis of Variance

R-squared: 0.776

	DF	SS	MS	F	Sig
Total (adj)	10	8339.3	833.93		
Regression	2	6468.7	3234.4	13.833	0.0025
Error	8	1870.6	233.82		

R-squared: 0.778

	DF	SS	MS	F	Sig
Total (adj)	10	8339.3	833.93		
Regression	2	6483.8	3241.9	13.978	0.0025
Error	8	1855.5	231.94		

R-squared: 0.783

	DF	SS	MS	F	Sig
Total (adj)	10	8339.3	833.93		
Regression	2	6525.8	3262.9	14.394	0.0022
Error	8	1813.5	226.68		

Prediction Line

	X	Y		X	Y		X	Y
1	-0.5	1.00E+02	1	-0.5	9.95E+01	1	-0.5	9.89E+01
2	-4.55E-01	1.00E+02	2	-4.55E-01	9.95E+01	2	-4.55E-01	9.89E+01
3	-4.09E-01	1.00E+02	3	-4.09E-01	9.95E+01	3	-4.09E-01	9.89E+01
4	-3.64E-01	1.00E+02	4	-3.64E-01	9.95E+01	4	-3.64E-01	9.89E+01
5	-3.18E-01	1.00E+02	5	-3.18E-01	9.95E+01	5	-3.18E-01	9.89E+01
6	-2.73E-01	1.00E+02	6	-2.73E-01	9.95E+01	6	-2.73E-01	9.89E+01
7	-2.27E-01	1.00E+02	7	-2.27E-01	9.95E+01	7	-2.27E-01	9.89E+01
8	-1.82E-01	1.00E+02	8	-1.82E-01	9.95E+01	8	-1.82E-01	9.89E+01
9	-1.36E-01	1.00E+02	9	-1.36E-01	9.95E+01	9	-1.36E-01	9.89E+01
10	-9.09E-02	1.00E+02	10	-9.09E-02	9.95E+01	10	-9.09E-02	9.89E+01
11	-4.55E-02	1.00E+02	11	-4.55E-02	9.95E+01	11	-4.55E-02	9.89E+01
12	0.00E+00	1.00E+02	12	0.00E+00	9.95E+01	12	0.00E+00	9.89E+01
13	4.55E-02	1.00E+02	13	4.55E-02	9.95E+01	13	4.55E-02	9.89E+01
14	9.09E-02	1.00E+02	14	9.09E-02	9.95E+01	14	9.09E-02	9.89E+01
15	0.13636	1.00E+02	15	0.13636	9.95E+01	15	0.13636	9.89E+01
16	0.18182	1.00E+02	16	0.18182	9.95E+01	16	0.18182	9.89E+01
17	0.22727	1.00E+02	17	0.22727	9.95E+01	17	0.22727	9.89E+01
18	0.27273	1.00E+02	18	0.27273	9.95E+01	18	0.27273	9.89E+01
19	0.31818	1.00E+02	19	0.31818	9.95E+01	19	0.31818	9.89E+01
20	0.36364	1.00E+02	20	0.36364	9.95E+01	20	0.36364	9.89E+01
21	4.09E-01	1.00E+02	21	4.09E-01	9.95E+01	21	4.09E-01	9.89E+01
22	4.55E-01	1.00E+02	22	4.55E-01	9.95E+01	22	4.55E-01	9.89E+01
23	5.00E-01	1.00E+02	23	5.00E-01	9.95E+01	23	5.00E-01	9.89E+01
24	5.45E-01	1.00E+02	24	5.45E-01	9.95E+01	24	5.45E-01	9.89E+01
25	5.91E-01	1.00E+02	25	5.91E-01	9.95E+01	25	5.91E-01	9.89E+01
26	6.36E-01	1.00E+02	26	6.36E-01	9.95E+01	26	6.36E-01	9.89E+01
27	6.82E-01	1.00E+02	27	6.82E-01	9.95E+01	27	6.82E-01	9.89E+01
28	7.27E-01	1.00E+02	28	7.27E-01	9.95E+01	28	7.27E-01	9.89E+01
29	7.73E-01	1.00E+02	29	7.73E-01	9.95E+01	29	7.73E-01	9.89E+01
30	8.18E-01	1.00E+02	30	8.18E-01	9.95E+01	30	8.18E-01	9.89E+01
31	0.86364	1.00E+02	31	0.86364	9.95E+01	31	0.86364	9.89E+01
32	0.90909	1.00E+02	32	0.90909	9.95E+01	32	0.90909	9.89E+01
33	0.95455	1.00E+02	33	0.95455	9.95E+01	33	0.95455	9.89E+01
34	1	1.00E+02	34	1	9.95E+01	34	1	9.89E+01
35	1.0455	1.00E+02	35	1.0455	9.95E+01	35	1.0455	9.89E+01
36	1.0909	1.00E+02	36	1.0909	9.95E+01	36	1.0909	9.89E+01
37	1.1364	1.00E+02	37	1.1364	9.95E+01	37	1.1364	9.89E+01
38	1.1818	1.00E+02	38	1.1818	9.95E+01	38	1.1818	9.89E+01
39	1.2273	1.00E+02	39	1.2273	9.95E+01	39	1.2273	9.89E+01
40	1.2727	1.00E+02	40	1.2727	9.95E+01	40	1.2727	9.89E+01
41	1.3182	1.00E+02	41	1.3182	9.95E+01	41	1.3182	9.89E+01
42	1.3636	1.00E+02	42	1.3636	9.95E+01	42	1.3636	9.89E+01
43	1.41E+00	1.00E+02	43	1.41E+00	9.95E+01	43	1.41E+00	9.89E+01
44	1.45E+00	1.00E+02	44	1.45E+00	9.95E+01	44	1.45E+00	9.89E+01
45	1.5	1.00E+02	45	1.5	9.95E+01	45	1.5	9.89E+01
46	1.55E+00	1.00E+02	46	1.55E+00	9.95E+01	46	1.55E+00	9.89E+01
47	1.59E+00	1.00E+02	47	1.59E+00	9.95E+01	47	1.59E+00	9.89E+01
48	1.6364	1.00E+02	48	1.6364	9.95E+01	48	1.6364	9.89E+01
49	1.6818	1.00E+02	49	1.6818	9.95E+01	49	1.6818	9.89E+01
50	1.7273	1.00E+02	50	1.7273	9.95E+01	50	1.7273	9.89E+01
51	1.7727	1.00E+02	51	1.7727	9.95E+01	51	1.7727	9.89E+01
52	1.8182	1.00E+02	52	1.8182	9.95E+01	52	1.8182	9.89E+01
53	1.8636	1.00E+02	53	1.8636	9.95E+01	53	1.8636	9.89E+01
54	1.9091	1.00E+02	54	1.9091	9.95E+01	54	1.9091	9.89E+01
55	1.9545	1.00E+02	55	1.9545	9.95E+01	55	1.9545	9.89E+01
56	2	1.00E+02	56	2	9.95E+01	56	2	9.89E+01
57	2.0455	1.00E+02	57	2.0455	9.95E+01	57	2.0455	9.89E+01
58	2.0909	1.00E+02	58	2.0909	9.95E+01	58	2.0909	9.89E+01
59	2.1364	1.00E+02	59	2.1364	9.95E+01	59	2.1364	9.89E+01
60	2.1818	1.00E+02	60	2.1818	9.95E+01	60	2.1818	9.89E+01
61	2.2273	1.00E+02	61	2.2273	9.95E+01	61	2.2273	9.89E+01
62	2.2727	9.99E+01	62	2.2727	9.95E+01	62	2.2727	9.89E+01
63	2.3182	9.98E+01	63	2.3182	9.95E+01	63	2.3182	9.89E+01
64	2.3636	9.97E+01	64	2.3636	9.95E+01	64	2.3636	9.89E+01
65	2.4091	9.96E+01	65	2.4091	9.95E+01	65	2.4091	9.89E+01
66	2.4545	9.94E+01	66	2.4545	9.95E+01	66	2.4545	9.89E+01
67	2.5	9.91E+01	67	2.5	9.95E+01	67	2.5	9.89E+01

Prediction Line

	X	Y		X	Y		X	Y
68	2.5455	9.88E+01	68	2.5455	9.95E+01	68	2.5455	9.89E+01
69	2.5909	9.83E+01	69	2.5909	9.95E+01	69	2.5909	9.89E+01
70	2.6364	9.78E+01	70	2.6364	9.95E+01	70	2.6364	9.89E+01
71	2.6818	9.70E+01	71	2.6818	9.90E+01	71	2.6818	9.89E+01
72	2.7273	9.61E+01	72	2.7273	9.82E+01	72	2.7273	9.89E+01
73	2.7727	9.50E+01	73	2.7727	9.68E+01	73	2.7727	9.89E+01
74	2.8182	9.35E+01	74	2.8182	9.51E+01	74	2.8182	9.89E+01
75	2.8636	9.17E+01	75	2.8636	9.28E+01	75	2.8636	9.89E+01
76	2.91E+00	8.95E+01	76	2.91E+00	9.01E+01	76	2.91E+00	9.36E+01
77	2.95E+00	8.67E+01	77	2.95E+00	8.70E+01	77	2.95E+00	8.80E+01
78	3	8.34E+01	78	3	8.33E+01	78	3	8.24E+01
79	3.05E+00	7.95E+01	79	3.05E+00	7.93E+01	79	3.05E+00	7.68E+01
80	3.09E+00	7.49E+01	80	3.09E+00	7.47E+01	80	3.09E+00	7.12E+01
81	3.1364	6.97E+01	81	3.1364	6.98E+01	81	3.1364	6.56E+01
82	3.1818	6.39E+01	82	3.1818	6.43E+01	82	3.1818	6.01E+01
83	3.2273	5.78E+01	83	3.2273	5.84E+01	83	3.2273	5.45E+01
84	3.2727	5.14E+01	84	3.2727	5.21E+01	84	3.2727	4.89E+01
85	3.3182	4.49E+01	85	3.3182	4.55E+01	85	3.3182	4.33E+01
86	3.3636	3.86E+01	86	3.3636	3.92E+01	86	3.3636	3.77E+01
87	3.4091	3.27E+01	87	3.4091	3.35E+01	87	3.4091	3.21E+01
88	3.4545	2.73E+01	88	3.4545	2.82E+01	88	3.4545	2.65E+01
89	3.5	2.25E+01	89	3.5	2.33E+01	89	3.5	2.09E+01
90	3.5455	1.83E+01	90	3.5455	1.89E+01	90	3.5455	1.53E+01
91	3.5909	1.47E+01	91	3.5909	1.50E+01	91	3.5909	9.70E+00
92	3.6364	1.18E+01	92	3.6364	1.15E+01	92	3.6364	4.11E+00
93	3.6818	9.35E+00	93	3.6818	8.52E+00	93	3.6818	0.00E+00
94	3.7273	7.38E+00	94	3.7273	5.96E+00	94	3.7273	0.00E+00
95	3.7727	5.80E+00	95	3.7727	3.86E+00	95	3.7727	0.00E+00
96	3.8182	4.54E+00	96	3.8182	2.21E+00	96	3.8182	0.00E+00
97	3.8636	3.54E+00	97	3.8636	1.02E+00	97	3.8636	0.00E+00
98	3.9091	2.76E+00	98	3.9091	2.81E-01	98	3.9091	0.00E+00
99	3.9545	2.14E+00	99	3.9545	2.74E-03	99	3.9545	0.00E+00
100	4	1.66E+00	100	4	0.00E+00	100	4	0.00E+00

Table E2.D-6b. TRAP Model Output for Iron Data for the Mammal Survival Endpoint (Whittaker et al. 1996)

Chemical:	Iron
Study Authors:	Whittaker et al. 1996
Receptor Group:	Mammal
Effect Description:	Survival

Input Data:

Dose	# of Org w/o response	Total # of Org	Survival
3.728024	11	11	1
37.28024	10	10	1
372.8024	8	10	0.80
2130.3	13	18	0.722

Modeling Parameters			
Analysis Type:	Tolerance Distribution	Tolerance Distribution	Tolerance Distribution
Model Shape:	Gaussian Distribution	Triangular Distribution	Rectangular Distribution
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered			
Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			yes
X50 at Maximum or Minimum Limit			yes
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined			
Large Standard Error for X50	yes	yes	yes
Large Standard Error for Steepness	yes		yes
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

Gaussian Distribution:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	3.7022	3.9108	0.60679	2.5588	5.2628
S	1.0497	1.15E+00	0.73843	0.8061	2.0247
Y0	1	0.9999	1.76E-02	0.69134	1

Triangular Distribution:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	3.7022	3.9243	0.5432	2.714	5.1347
S	1.0497	1.12E+00	0.45239	0.78017	1.9595
Y0	1	0.9999	3.01E-03	0.71505	1

Rectangular Distribution:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	3.7022	4.2022	1.3617	1.1682	7.2363
S	1.0497	1.4316	1.5229	1.0003	2.5123
Y0	1	0.9999	2.18E-03	0.83872	1

Xp Estimates

Gaussian Distribution:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	8143.1	3.62E+02	1.83E+05	0.60679	3.9108
20	870.6	1.55E+02	4.90E+03	0.32074	2.9398
10	270.57	1.34E+01	5.45E+03	0.52116	2.4323
5	103.07	9.22E-01	1.15E+04	0.75503	2.0131
0					

Triangular Distribution:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	8401.4	5.18E+02	1.36E+05	0.5432	3.9243
20	830.04	1.74E+02	3.95E+03	0.28744	2.9191
10	2.59E+02	40.226	1661.1	0.31825	2.4125
5	113.29	8.7573	1465.7	0.40662	2.0542
0	15.464	4.76E-02	5022.3	0.7026	1.19E+00

Rectangular Distribution:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	15930	1.47E+01	1.72E+07	1.3617	4.2022
20	518.21	34.396	7807.5	0.49032	2.7145
10	165.42	0.8146	33593	0.90312	2.2186
5	93.465	8.48E-02	1.03E+05	1.1454	1.9706
0	52.807	7.05E-03	3.96E+05	1.3955	1.7227

Model Fit Summary

Dataset

Gaussian Distribution:

	Exposure	Effects Var	Est Effects Var
1	5.71E-01	1	0.998
2	1.57E+00	1	0.97861
3	2.57E+00	0.8	0.87708
4	3.33E+00	0.72222	0.6931
5			
6			

Triangular Distribution:

	Exposure	Effects Var	Est Effects Var
1	5.71E-01	1	0.9999
2	1.57E+00	1	0.99014
3	2.57E+00	0.8	0.87223
4	3.33E+00	0.72222	0.6941
5			
6			

Rectangular Distribution:

	Exposure	Effects Var	Est Effects Var
1	5.71E-01	1	0.9999
2	1.57E+00	1	0.9999
3	2.57E+00	0.8	0.82878
4	3.33E+00	0.72222	0.67616
5			
6			

Analysis of Variance

Gaussian Distribution:

R-squared:

	DF	SS	MS	F	Sig
Total (adj)					
Regression					
Error					

Triangular Distribution:

R-squared:

	DF	SS	MS	F	Sig
Total (adj)					
Regression					
Error					

Rectangular Distribution:

R-squared:

	DF	SS	MS	F	Sig
Total (adj)					
Regression					
Error					

Prediction Line

	X	Y
1	0	0.99955
2	3.54E-02	0.99951
3	7.07E-02	0.99946
4	1.06E-01	0.99941
5	1.41E-01	0.99936
6	1.77E-01	0.9993
7	2.12E-01	0.99923
8	2.47E-01	0.99915
9	2.83E-01	0.99907
10	3.18E-01	0.99898
11	3.54E-01	0.99888
12	3.89E-01	0.99877
13	4.24E-01	0.99865
14	0.4596	0.99851
15	0.49495	0.99837
16	0.5303	0.99821
17	0.56566	0.99803
18	0.60101	0.99784
19	0.63636	0.99763
20	0.67172	0.9974
21	0.70707	0.99716
22	0.74242	0.99689
23	0.77778	0.99659
24	0.81313	0.99627
25	0.84848	0.99593
26	0.88384	0.99555
27	0.91919	0.99514
28	0.95455	0.9947
29	0.9899	0.99423
30	1.0253	0.99371
31	1.0606	0.99315
32	1.096	0.99255
33	1.1313	0.99191
34	1.1667	0.99121
35	1.202	0.99046
36	1.2374	0.98966
37	1.2727	0.98879
38	1.3081	0.98787
39	1.3434	0.98687
40	1.3788	0.98581
41	1.4141	0.98467
42	1.4495	0.98346
43	1.4848	0.98216
44	1.5202	0.98078
45	1.5556	0.9793
46	1.5909	0.97773
47	1.6263	0.97606
48	1.6616	0.97429
49	1.697	0.97241
50	1.7323	0.97041
51	1.7677	0.96829
52	1.803	0.96605
53	1.8384	0.96369
54	1.8737	0.96118
55	1.9091	0.95854
56	1.9444	0.95576
57	1.9798	0.95282
58	2.0152	0.94973
59	2.0505	0.94648
60	2.0859	0.94307
61	2.1212	0.93948
62	2.1566	0.93572
63	2.1919	0.93179
64	2.2273	0.92767
65	2.2626	0.92336
66	2.298	0.91885
67	2.3333	0.91415
68	2.3687	0.90925
69	2.404	0.90415

	X	Y
1	0	0.9999
2	3.54E-02	0.9999
3	7.07E-02	0.9999
4	1.06E-01	0.9999
5	1.41E-01	0.9999
6	1.77E-01	0.9999
7	2.12E-01	0.9999
8	2.47E-01	0.9999
9	2.83E-01	0.9999
10	3.18E-01	0.9999
11	3.54E-01	0.9999
12	3.89E-01	0.9999
13	4.24E-01	0.9999
14	0.4596	0.9999
15	0.49495	0.9999
16	0.5303	0.9999
17	0.56566	0.9999
18	0.60101	0.9999
19	0.63636	0.9999
20	0.67172	0.9999
21	0.70707	0.9999
22	0.74242	0.9999
23	0.77778	0.9999
24	0.81313	0.9999
25	0.84848	0.9999
26	0.88384	0.9999
27	0.91919	0.9999
28	0.95455	0.9999
29	0.9899	0.9999
30	1.0253	0.9999
31	1.0606	0.9999
32	1.096	0.9999
33	1.1313	0.9999
34	1.1667	0.9999
35	1.202	0.99989
36	1.2374	0.99975
37	1.2727	0.99944
38	1.3081	0.99896
39	1.3434	0.99831
40	1.3788	0.9975
41	1.4141	0.99652
42	1.4495	0.99538
43	1.4848	0.99406
44	1.5202	0.99258
45	1.5556	0.99094
46	1.5909	0.98912
47	1.6263	0.98714
48	1.6616	0.98499
49	1.697	0.98268
50	1.7323	0.9802
51	1.7677	0.97755
52	1.803	0.97473
53	1.8384	0.97175
54	1.8737	0.9686
55	1.9091	0.96528
56	1.9444	0.96179
57	1.9798	0.95814
58	2.0152	0.95432
59	2.0505	0.95034
60	2.0859	0.94618
61	2.1212	0.94186
62	2.1566	0.93738
63	2.1919	0.93272
64	2.2273	0.9279
65	2.2626	0.92291
66	2.298	0.91776
67	2.3333	0.91244
68	2.3687	0.90695
69	2.404	0.90129

	X	Y
1	0	0.9999
2	3.54E-02	0.9999
3	7.07E-02	0.9999
4	1.06E-01	0.9999
5	1.41E-01	0.9999
6	1.77E-01	0.9999
7	2.12E-01	0.9999
8	2.47E-01	0.9999
9	2.83E-01	0.9999
10	3.18E-01	0.9999
11	3.54E-01	0.9999
12	3.89E-01	0.9999
13	4.24E-01	0.9999
14	0.4596	0.9999
15	0.49495	0.9999
16	0.5303	0.9999
17	0.56566	0.9999
18	0.60101	0.9999
19	0.63636	0.9999
20	0.67172	0.9999
21	0.70707	0.9999
22	0.74242	0.9999
23	0.77778	0.9999
24	0.81313	0.9999
25	0.84848	0.9999
26	0.88384	0.9999
27	0.91919	0.9999
28	0.95455	0.9999
29	0.9899	0.9999
30	1.0253	0.9999
31	1.0606	0.9999
32	1.096	0.9999
33	1.1313	0.9999
34	1.1667	0.9999
35	1.202	0.9999
36	1.2374	0.9999
37	1.2727	0.9999
38	1.3081	0.9999
39	1.3434	0.9999
40	1.3788	0.9999
41	1.4141	0.9999
42	1.4495	0.9999
43	1.4848	0.9999
44	1.5202	0.9999
45	1.5556	0.9999
46	1.5909	0.9999
47	1.6263	0.9999
48	1.6616	0.9999
49	1.697	0.9999
50	1.7323	0.99796
51	1.7677	0.99083
52	1.803	0.9837
53	1.8384	0.97658
54	1.8737	0.96945
55	1.9091	0.96232
56	1.9444	0.95519
57	1.9798	0.94807
58	2.0152	0.94094
59	2.0505	0.93381
60	2.0859	0.92668
61	2.1212	0.91955
62	2.1566	0.91243
63	2.1919	0.9053
64	2.2273	0.89817
65	2.2626	0.89104
66	2.298	0.88392
67	2.3333	0.87679
68	2.3687	0.86966
69	2.404	0.86253

Prediction Line

	X	Y
70	2.4394	0.89883
71	2.4747	0.89331
72	2.5101	0.88757
73	2.5455	0.88161
74	2.5808	0.87543
75	2.6162	0.86903
76	2.6515	0.8624
77	2.6869	0.85556
78	2.7222	0.84848
79	2.7576	0.84118
80	2.7929	0.83365
81	2.8283	0.82589
82	2.8636	0.81791
83	2.899	0.8097
84	2.9343	0.80127
85	2.9697	0.79261
86	3.0051	0.78374
87	3.0404	0.77465
88	3.0758	0.76535
89	3.1111	0.75584
90	3.1465	0.74613
91	3.1818	0.73621
92	3.2172	0.72611
93	3.2525	0.71581
94	3.2879	0.70534
95	3.3232	0.69468
96	3.3586	0.68387
97	3.3939	0.67289
98	3.4293	0.66176
99	3.4646	0.65048
100	3.5	0.63908

	X	Y
70	2.4394	0.89547
71	2.4747	0.88948
72	2.5101	0.88332
73	2.5455	0.877
74	2.5808	0.8705
75	2.6162	0.86385
76	2.6515	0.85702
77	2.6869	0.85003
78	2.7222	0.84287
79	2.7576	0.83554
80	2.7929	0.82805
81	2.8283	0.82039
82	2.8636	0.81256
83	2.899	0.80456
84	2.9343	0.7964
85	2.9697	0.78807
86	3.0051	0.77958
87	3.0404	0.77091
88	3.0758	0.76208
89	3.1111	0.75308
90	3.1465	0.74392
91	3.1818	0.73459
92	3.2172	0.72509
93	3.2525	0.71542
94	3.2879	0.70559
95	3.3232	0.69559
96	3.3586	0.68543
97	3.3939	0.67509
98	3.4293	0.66459
99	3.4646	0.65392
100	3.5	0.64309

	X	Y
70	2.4394	0.85541
71	2.4747	0.84828
72	2.5101	0.84115
73	2.5455	0.83402
74	2.5808	0.8269
75	2.6162	0.81977
76	2.6515	0.81264
77	2.6869	0.80551
78	2.7222	0.79838
79	2.7576	0.79126
80	2.7929	0.78413
81	2.8283	0.777
82	2.8636	0.76987
83	2.899	0.76275
84	2.9343	0.75562
85	2.9697	0.74849
86	3.0051	0.74136
87	3.0404	0.73424
88	3.0758	0.72711
89	3.1111	0.71998
90	3.1465	0.71285
91	3.1818	0.70573
92	3.2172	0.6986
93	3.2525	0.69147
94	3.2879	0.68434
95	3.3232	0.67721
96	3.3586	0.67009
97	3.3939	0.66296
98	3.4293	0.65583
99	3.4646	0.6487
100	3.5	0.64158

Table E2.D-7a. TRAP Model Output for Lead Data for the Bird Survival Endpoint (Pooling Group F: Anders et al. 1982; Barthalmus et al. 1977)

Chemical:	Lead
Study Authors:	Pooling group F
Receptor Group:	Bird
Effect Description:	Survival

Input Data:

Dose	Effect Relative to Control
1.00E-06	100
6.25	100
12.5	80
25	50
1.00E-06	100
6.250	83.3

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?
Use Only for Exploratory Data Analysis!
Maximum Iterations Reached Without Convergence
X50 at Maximum or Minimum Limit
Steepness At Maximum Or Minimum Limit
Error Estimates Cannot Be Determined
Large Standard Error for X50
Large Standard Error for Steepness
Large Standard Error for Y0
Inadequate Number of Partial Effects
Insufficient Data to Plot
Insufficient Data to Analyze

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.4136	1.4049	6.66E-02	1.1931	1.6167
S	0.9957	1.07E+00	0.3437	-2.70E-02	2.1607
Y0	1.00E+02	9.96E+01	4.6939	84.612	114.49

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.4136	1.4101	7.20E-02	1.1809	1.6393
S	0.9957	1.04E+00	0.29366	0.10577	1.9749
Y0	1.00E+02	9.96E+01	5.0005	83.666	115.49

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.4136	1.4188	9.20E-02	1.126	1.7117
S	0.9957	1.0399	0.41101	-0.2681	2.3479
Y0	1.00E+02	9.58E+01	4.1667	82.573	109.09

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	25.403	15.599	41.369	6.66E-02	1.4049
20	1.20E+01	5.63E+00	2.57E+01	0.1035	1.08
10	7.76E+00	2.46E+00	2.45E+01	0.15666	0.88999
5	5.19E+00	1.12E+00	2.41E+01	0.20958	0.71489
0					

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	25.71	15.168	43.578	7.20E-02	1.4101
20	11.397	5.50E+00	23.629	9.95E-02	1.0568
10	7.56E+00	2.70E+00	2.12E+01	0.14076	0.87873
5	5.6601	1.60E+00	2.01E+01	0.17284	0.75283
0	2.811	4.37E-01	1.81E+01	0.25411	4.49E-01

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	26.233	13.366	51.487	9.20E-02	1.4188
20	13.501	7.4009	24.628	8.20E-02	1.1304
10	10.819	4.8598	24.087	0.10922	1.0342
5	9.6853	3.88E+00	24.196	0.12494	0.98611
0	8.6703	3.07E+00	24.45	0.14148	0.93803

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	9.96E+01
2	7.96E-01	1.00E+02	9.96E+01
3	1.10E+00	8.00E+01	9.27E+01
4	1.40E+00	5.00E+01	9.27E+01
5	-6.00E+00	100	78.467
6	0.79588	83.333	50.512

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	9.96E+01
2	-6.00E+00	1.00E+02	9.96E+01
3	7.96E-01	1.00E+02	9.31E+01
4	7.96E-01	8.33E+01	9.31E+01
5	1.10E+00	80	76.949
6	1.3979	50	51.041

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	9.58E+01
2	-6.00E+00	1.00E+02	9.58E+01
3	7.96E-01	1.00E+02	9.58E+01
4	7.96E-01	8.33E+01	9.58E+01
5	1.10E+00	80	80
6	1.3979	50	50

Analysis of Variance

R-squared: 0.925

	DF	SS	MS	F	Sig
Total (adj)	5	1925.9	385.19		
Regression	2	1782	891.02	18.579	0.0204
Error	3	143.88	47.959		

R-squared: 0.92

	DF	SS	MS	F	Sig
Total (adj)	5	1925.9	385.19		
Regression	2	1772.2	886.12	17.297	0.0225
Error	3	153.69	51.23		

R-squared: 0.892

	DF	SS	MS	F	Sig
Total (adj)	5	1925.9	385.19		
Regression	2	1717.6	858.8	12.367	0.0356
Error	3	208.33	69.444		

Prediction Line

	X	Y		X	Y		X	Y
1	-2.5	9.96E+01	1	-2.5	9.96E+01	1	-2.5	9.58E+01
2	-2.45E+00	9.96E+01	2	-2.45E+00	9.96E+01	2	-2.45E+00	9.58E+01
3	-2.41E+00	9.96E+01	3	-2.41E+00	9.96E+01	3	-2.41E+00	9.58E+01
4	-2.36E+00	9.96E+01	4	-2.36E+00	9.96E+01	4	-2.36E+00	9.58E+01
5	-2.32E+00	9.96E+01	5	-2.32E+00	9.96E+01	5	-2.32E+00	9.58E+01
6	-2.27E+00	9.96E+01	6	-2.27E+00	9.96E+01	6	-2.27E+00	9.58E+01
7	-2.23E+00	9.96E+01	7	-2.23E+00	9.96E+01	7	-2.23E+00	9.58E+01
8	-2.18E+00	9.96E+01	8	-2.18E+00	9.96E+01	8	-2.18E+00	9.58E+01
9	-2.14E+00	9.96E+01	9	-2.14E+00	9.96E+01	9	-2.14E+00	9.58E+01
10	-2.09E+00	9.96E+01	10	-2.09E+00	9.96E+01	10	-2.09E+00	9.58E+01
11	-2.05E+00	9.96E+01	11	-2.05E+00	9.96E+01	11	-2.05E+00	9.58E+01
12	-2.00E+00	9.96E+01	12	-2.00E+00	9.96E+01	12	-2.00E+00	9.58E+01
13	-1.95E+00	9.96E+01	13	-1.95E+00	9.96E+01	13	-1.95E+00	9.58E+01
14	-1.9091	9.96E+01	14	-1.9091	9.96E+01	14	-1.9091	9.58E+01
15	-1.8636	9.96E+01	15	-1.8636	9.96E+01	15	-1.8636	9.58E+01
16	-1.8182	9.96E+01	16	-1.8182	9.96E+01	16	-1.8182	9.58E+01
17	-1.7727	9.96E+01	17	-1.7727	9.96E+01	17	-1.7727	9.58E+01
18	-1.7273	9.96E+01	18	-1.7273	9.96E+01	18	-1.7273	9.58E+01
19	-1.6818	9.96E+01	19	-1.6818	9.96E+01	19	-1.6818	9.58E+01
20	-1.6364	9.96E+01	20	-1.6364	9.96E+01	20	-1.6364	9.58E+01
21	-1.59E+00	9.96E+01	21	-1.59E+00	9.96E+01	21	-1.59E+00	9.58E+01
22	-1.55E+00	9.96E+01	22	-1.55E+00	9.96E+01	22	-1.55E+00	9.58E+01
23	-1.50E+00	9.96E+01	23	-1.50E+00	9.96E+01	23	-1.50E+00	9.58E+01
24	-1.45E+00	9.95E+01	24	-1.45E+00	9.96E+01	24	-1.45E+00	9.58E+01
25	-1.41E+00	9.95E+01	25	-1.41E+00	9.96E+01	25	-1.41E+00	9.58E+01
26	-1.36E+00	9.95E+01	26	-1.36E+00	9.96E+01	26	-1.36E+00	9.58E+01
27	-1.32E+00	9.95E+01	27	-1.32E+00	9.96E+01	27	-1.32E+00	9.58E+01
28	-1.27E+00	9.95E+01	28	-1.27E+00	9.96E+01	28	-1.27E+00	9.58E+01
29	-1.23E+00	9.95E+01	29	-1.23E+00	9.96E+01	29	-1.23E+00	9.58E+01
30	-1.18E+00	9.95E+01	30	-1.18E+00	9.96E+01	30	-1.18E+00	9.58E+01
31	-1.1364	9.95E+01	31	-1.1364	9.96E+01	31	-1.1364	9.58E+01
32	-1.0909	9.95E+01	32	-1.0909	9.96E+01	32	-1.0909	9.58E+01
33	-1.0455	9.95E+01	33	-1.0455	9.96E+01	33	-1.0455	9.58E+01
34	-1	9.95E+01	34	-1	9.96E+01	34	-1	9.58E+01
35	-0.95455	9.95E+01	35	-0.95455	9.96E+01	35	-0.95455	9.58E+01
36	-0.90909	9.95E+01	36	-0.90909	9.96E+01	36	-0.90909	9.58E+01
37	-0.86364	9.95E+01	37	-0.86364	9.96E+01	37	-0.86364	9.58E+01
38	-0.81818	9.95E+01	38	-0.81818	9.96E+01	38	-0.81818	9.58E+01
39	-0.77273	9.95E+01	39	-0.77273	9.96E+01	39	-0.77273	9.58E+01
40	-0.72727	9.95E+01	40	-0.72727	9.96E+01	40	-0.72727	9.58E+01
41	-0.68182	9.95E+01	41	-0.68182	9.96E+01	41	-0.68182	9.58E+01
42	-0.63636	9.95E+01	42	-0.63636	9.96E+01	42	-0.63636	9.58E+01
43	-0.59091	9.95E+01	43	-0.59091	9.96E+01	43	-0.59091	9.58E+01
44	-0.54545	9.95E+01	44	-0.54545	9.96E+01	44	-0.54545	9.58E+01
45	-0.5	9.95E+01	45	-0.5	9.96E+01	45	-0.5	9.58E+01
46	-0.45455	9.95E+01	46	-0.45455	9.96E+01	46	-0.45455	9.58E+01
47	-0.40909	9.95E+01	47	-0.40909	9.96E+01	47	-0.40909	9.58E+01
48	-0.36364	9.95E+01	48	-0.36364	9.96E+01	48	-0.36364	9.58E+01
49	-0.31818	9.95E+01	49	-0.31818	9.96E+01	49	-0.31818	9.58E+01
50	-0.27273	9.95E+01	50	-0.27273	9.96E+01	50	-0.27273	9.58E+01
51	-0.22727	9.95E+01	51	-0.22727	9.96E+01	51	-0.22727	9.58E+01
52	-0.18182	9.94E+01	52	-0.18182	9.96E+01	52	-0.18182	9.58E+01
53	-0.13636	9.94E+01	53	-0.13636	9.96E+01	53	-0.13636	9.58E+01
54	-9.09E-02	9.94E+01	54	-9.09E-02	9.96E+01	54	-9.09E-02	9.58E+01
55	-4.55E-02	9.93E+01	55	-4.55E-02	9.96E+01	55	-4.55E-02	9.58E+01
56	0	9.93E+01	56	0	9.96E+01	56	0	9.58E+01
57	4.55E-02	9.93E+01	57	4.55E-02	9.96E+01	57	4.55E-02	9.58E+01
58	9.09E-02	9.92E+01	58	9.09E-02	9.96E+01	58	9.09E-02	9.58E+01
59	0.13636	9.91E+01	59	0.13636	9.96E+01	59	0.13636	9.58E+01
60	0.18182	9.90E+01	60	0.18182	9.96E+01	60	0.18182	9.58E+01
61	0.22727	9.89E+01	61	0.22727	9.96E+01	61	0.22727	9.58E+01
62	0.27273	9.88E+01	62	0.27273	9.96E+01	62	0.27273	9.58E+01
63	0.31818	9.86E+01	63	0.31818	9.96E+01	63	0.31818	9.58E+01
64	0.36364	9.84E+01	64	0.36364	9.96E+01	64	0.36364	9.58E+01
65	0.40909	9.81E+01	65	0.40909	9.96E+01	65	0.40909	9.58E+01
66	0.45455	9.79E+01	66	0.45455	9.96E+01	66	0.45455	9.58E+01
67	0.5	9.75E+01	67	0.5	9.94E+01	67	0.5	9.58E+01
68	0.54545	9.71E+01	68	0.54545	9.91E+01	68	0.54545	9.58E+01
69	0.59091	9.66E+01	69	0.59091	9.85E+01	69	0.59091	9.58E+01
70	0.63636	9.59E+01	70	0.63636	9.77E+01	70	0.63636	9.58E+01

Prediction Line

	X	Y
71	0.68182	9.52E+01
72	0.72727	9.43E+01
73	0.77273	9.33E+01
74	0.81818	9.20E+01
75	0.86364	9.06E+01
76	0.90909	8.88E+01
77	0.95455	8.68E+01
78	1	8.45E+01
79	1.0455	8.19E+01
80	1.0909	7.89E+01
81	1.1364	7.55E+01
82	1.1818	7.18E+01
83	1.2273	6.78E+01
84	1.2727	6.35E+01
85	1.3182	5.89E+01
86	1.3636	5.41E+01
87	1.4091	4.93E+01
88	1.4545	4.45E+01
89	1.5	3.98E+01
90	1.5455	3.53E+01
91	1.5909	3.10E+01
92	1.6364	2.70E+01
93	1.6818	2.34E+01
94	1.7273	2.01E+01
95	1.7727	1.71E+01
96	1.8182	1.46E+01
97	1.8636	1.23E+01
98	1.9091	1.04E+01
99	1.9545	8.70E+00
100	2	7.28E+00

	X	Y
71	0.68182	9.67E+01
72	0.72727	9.54E+01
73	0.77273	9.39E+01
74	0.81818	9.22E+01
75	0.86364	9.03E+01
76	0.90909	8.82E+01
77	0.95455	8.58E+01
78	1	8.32E+01
79	1.0455	8.04E+01
80	1.0909	7.74E+01
81	1.1364	7.41E+01
82	1.1818	7.06E+01
83	1.2273	6.69E+01
84	1.2727	6.30E+01
85	1.3182	5.89E+01
86	1.3636	5.45E+01
87	1.4091	4.99E+01
88	1.4545	4.53E+01
89	1.5	4.09E+01
90	1.5455	3.68E+01
91	1.5909	3.28E+01
92	1.6364	2.91E+01
93	1.6818	2.56E+01
94	1.7273	2.24E+01
95	1.7727	1.93E+01
96	1.8182	1.65E+01
97	1.8636	1.39E+01
98	1.9091	1.15E+01
99	1.9545	9.36E+00
100	2	7.43E+00

	X	Y
71	0.68182	9.58E+01
72	0.72727	9.58E+01
73	0.77273	9.58E+01
74	0.81818	9.58E+01
75	0.86364	9.58E+01
76	0.90909	9.58E+01
77	0.95455	9.42E+01
78	1	8.97E+01
79	1.0455	8.51E+01
80	1.0909	8.06E+01
81	1.1364	7.61E+01
82	1.1818	7.15E+01
83	1.2273	6.70E+01
84	1.2727	6.25E+01
85	1.3182	5.79E+01
86	1.3636	5.34E+01
87	1.4091	4.89E+01
88	1.4545	4.44E+01
89	1.5	3.98E+01
90	1.5455	3.53E+01
91	1.5909	3.08E+01
92	1.6364	2.62E+01
93	1.6818	2.17E+01
94	1.7273	1.72E+01
95	1.7727	1.26E+01
96	1.8182	8.12E+00
97	1.8636	3.59E+00
98	1.9091	0.00E+00
99	1.9545	0.00E+00
100	2	0.00E+00

Table E2.D-7b. TRAP Model Output for Lead Data for the Mammal Survival Endpoint (Lorenzo et al. 1978)

Chemical:	Lead
Study Authors:	Lorenzo et al. 1978
Receptor Group:	Mammal
Effect Description:	Survival

Input Data:

Dose	# of Org w/o response	Total # of Org	Survival
1.00E-06	65	78	0.84
2.2	64	78	0.83
10	39	78	0.5
19.9	11	78	0.15
39.9	0	78	0

Modeling Parameters

Analysis Type:	Tolerance Distribution	Tolerance Distribution	Tolerance Distribution
Model Shape:	Gaussian Distribution	Triangular Distribution	Rectangular Distribution
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?
Use Only for Exploratory Data Analysis!
Maximum Iterations Reached Without Convergence
X50 at Maximum or Minimum Limit
Steepness At Maximum Or Minimum Limit
Error Estimates Cannot Be Determined
Large Standard Error for X50
Large Standard Error for Steepness
Large Standard Error for Y0
Inadequate Number of Partial Effects
Insufficient Data to Plot
Insufficient Data to Analyze

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.0132	1.0683	3.40E-02	0.9997	1.1369
S	0.29483	2.20E-01	3.44E-02	0.16835	0.31567
Y0	0.82692	0.82602	3.04E-02	0.75704	0.88212

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.0132	1.064	3.63E-02	0.99045	1.1376
S	0.29483	2.23E-01	2.79E-02	0.17915	0.29497
Y0	0.82692	0.82676	3.03E-02	0.7581	0.88258

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.0132	1.072	3.87E-02	0.99241	1.1516
S	0.29483	0.19871	3.89E-02	0.14415	0.31965
Y0	0.82692	0.82692	3.03E-02	0.75826	0.88273

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	11.703	9.99E+00	1.37E+01	3.40E-02	1.0683
20	7.6476	5.91E+00	9.90E+00	5.44E-02	0.88353
10	6.1227	4.40E+00	8.52E+00	6.76E-02	0.78694
5	5.0954	3.42E+00	7.60E+00	7.90E-02	0.70718
0					

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	11.589	9.78E+00	1.37E+01	3.63E-02	1.064
20	7.3011	5.66E+00	9.41E+00	5.36E-02	0.86339
10	5.78E+00	4.2559	7.8621	6.35E-02	0.76226
5	4.9064	3.4633	6.9507	7.06E-02	0.69076
0	3.2971	2.0686	5.2553	8.83E-02	5.18E-01

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	11.804	9.83E+00	1.42E+01	3.87E-02	1.072
20	7.3368	5.1026	10.549	7.28E-02	0.86551
10	6.2614	4.0131	9.7693	8.54E-02	0.79667
5	5.7843	3.54E+00	9.4536	9.17E-02	0.76225
0	5.3436	3.11E+00	9.19E+00	9.82E-02	0.72784

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	0.83333	0.82602
2	3.42E-01	0.82051	0.82563
3	1.00E+00	0.5	0.51393
4	1.30E+00	0.14103	0.12135
5	1.60E+00	0	6.38E-03
6			

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	0.83333	0.82676
2	3.42E-01	0.82051	0.82676
3	1.00E+00	0.5	0.50469
4	1.30E+00	0.14103	0.1343
5	1.60E+00	0	1.94E-04
6			

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	0.83333	0.82692
2	3.42E-01	0.82051	0.82692
3	1.00E+00	0.5	0.5
4	1.30E+00	0.14103	0.14103
5	1.60E+00	0	8.27E-05
6			

Analysis of Variance

R-squared:

	DF	SS	MS	F	Sig
Total (adj)					
Regression					
Error					

R-squared:

	DF	SS	MS	F	Sig
Total (adj)					
Regression					
Error					

R-squared:

	DF	SS	MS	F	Sig
Total (adj)					
Regression					
Error					

Prediction Line

	X	Y		X	Y		X	Y
1	-2.5	0.82602	1	-2.5	0.82676	1	-2.5	0.82692
2	-2.45E+00	0.82602	2	-2.45E+00	0.82676	2	-2.45E+00	0.82692
3	-2.41E+00	0.82602	3	-2.41E+00	0.82676	3	-2.41E+00	0.82692
4	-2.36E+00	0.82602	4	-2.36E+00	0.82676	4	-2.36E+00	0.82692
5	-2.32E+00	0.82602	5	-2.32E+00	0.82676	5	-2.32E+00	0.82692
6	-2.27E+00	0.82602	6	-2.27E+00	0.82676	6	-2.27E+00	0.82692
7	-2.23E+00	0.82602	7	-2.23E+00	0.82676	7	-2.23E+00	0.82692
8	-2.18E+00	0.82602	8	-2.18E+00	0.82676	8	-2.18E+00	0.82692
9	-2.14E+00	0.82602	9	-2.14E+00	0.82676	9	-2.14E+00	0.82692
10	-2.09E+00	0.82602	10	-2.09E+00	0.82676	10	-2.09E+00	0.82692
11	-2.05E+00	0.82602	11	-2.05E+00	0.82676	11	-2.05E+00	0.82692
12	-2.00E+00	0.82602	12	-2.00E+00	0.82676	12	-2.00E+00	0.82692
13	-1.95E+00	0.82602	13	-1.95E+00	0.82676	13	-1.95E+00	0.82692
14	-1.9091	0.82602	14	-1.9091	0.82676	14	-1.9091	0.82692
15	-1.8636	0.82602	15	-1.8636	0.82676	15	-1.8636	0.82692
16	-1.8182	0.82602	16	-1.8182	0.82676	16	-1.8182	0.82692
17	-1.7727	0.82602	17	-1.7727	0.82676	17	-1.7727	0.82692
18	-1.7273	0.82602	18	-1.7273	0.82676	18	-1.7273	0.82692
19	-1.6818	0.82602	19	-1.6818	0.82676	19	-1.6818	0.82692
20	-1.6364	0.82602	20	-1.6364	0.82676	20	-1.6364	0.82692
21	-1.5909	0.82602	21	-1.5909	0.82676	21	-1.5909	0.82692
22	-1.5455	0.82602	22	-1.5455	0.82676	22	-1.5455	0.82692
23	-1.5	0.82602	23	-1.5	0.82676	23	-1.5	0.82692
24	-1.4545	0.82602	24	-1.4545	0.82676	24	-1.4545	0.82692
25	-1.4091	0.82602	25	-1.4091	0.82676	25	-1.4091	0.82692
26	-1.3636	0.82602	26	-1.3636	0.82676	26	-1.3636	0.82692
27	-1.3182	0.82602	27	-1.3182	0.82676	27	-1.3182	0.82692
28	-1.2727	0.82602	28	-1.2727	0.82676	28	-1.2727	0.82692
29	-1.2273	0.82602	29	-1.2273	0.82676	29	-1.2273	0.82692
30	-1.1818	0.82602	30	-1.1818	0.82676	30	-1.1818	0.82692
31	-1.1364	0.82602	31	-1.1364	0.82676	31	-1.1364	0.82692
32	-1.09E+00	0.82602	32	-1.09E+00	0.82676	32	-1.09E+00	0.82692
33	-1.05E+00	0.82602	33	-1.05E+00	0.82676	33	-1.05E+00	0.82692
34	-1	0.82602	34	-1	0.82676	34	-1	0.82692
35	-9.55E-01	0.82602	35	-9.55E-01	0.82676	35	-9.55E-01	0.82692
36	-9.09E-01	0.82602	36	-9.09E-01	0.82676	36	-9.09E-01	0.82692
37	-0.86364	0.82602	37	-0.86364	0.82676	37	-0.86364	0.82692
38	-0.81818	0.82602	38	-0.81818	0.82676	38	-0.81818	0.82692
39	-0.77273	0.82602	39	-0.77273	0.82676	39	-0.77273	0.82692
40	-0.72727	0.82602	40	-0.72727	0.82676	40	-0.72727	0.82692
41	-0.68182	0.82602	41	-0.68182	0.82676	41	-0.68182	0.82692
42	-0.63636	0.82602	42	-0.63636	0.82676	42	-0.63636	0.82692
43	-0.59091	0.82602	43	-0.59091	0.82676	43	-0.59091	0.82692
44	-0.54545	0.82602	44	-0.54545	0.82676	44	-0.54545	0.82692
45	-0.5	0.82602	45	-0.5	0.82676	45	-0.5	0.82692
46	-0.45455	0.82602	46	-0.45455	0.82676	46	-0.45455	0.82692
47	-0.40909	0.82602	47	-0.40909	0.82676	47	-0.40909	0.82692
48	-0.36364	0.82602	48	-0.36364	0.82676	48	-0.36364	0.82692
49	-0.31818	0.82602	49	-0.31818	0.82676	49	-0.31818	0.82692
50	-0.27273	0.82602	50	-0.27273	0.82676	50	-0.27273	0.82692
51	-0.22727	0.82602	51	-0.22727	0.82676	51	-0.22727	0.82692
52	-0.18182	0.82602	52	-0.18182	0.82676	52	-0.18182	0.82692
53	-0.13636	0.82602	53	-0.13636	0.82676	53	-0.13636	0.82692
54	-9.09E-02	0.82602	54	-9.09E-02	0.82676	54	-9.09E-02	0.82692
55	-4.55E-02	0.82602	55	-4.55E-02	0.82676	55	-4.55E-02	0.82692
56	0	0.82602	56	0	0.82676	56	0	0.82692
57	4.55E-02	0.82602	57	4.55E-02	0.82676	57	4.55E-02	0.82692
58	9.09E-02	0.82602	58	9.09E-02	0.82676	58	9.09E-02	0.82692
59	0.13636	0.82601	59	0.13636	0.82676	59	0.13636	0.82692
60	0.18182	0.826	60	0.18182	0.82676	60	0.18182	0.82692
61	0.22727	0.82597	61	0.22727	0.82676	61	0.22727	0.82692
62	0.27273	0.8259	62	0.27273	0.82676	62	0.27273	0.82692
63	0.31818	0.82576	63	0.31818	0.82676	63	0.31818	0.82692
64	0.36364	0.82547	64	0.36364	0.82676	64	0.36364	0.82692
65	0.40909	0.82491	65	0.40909	0.82676	65	0.40909	0.82692
66	0.45455	0.82388	66	0.45455	0.82676	66	0.45455	0.82692
67	0.5	0.82204	67	0.5	0.82676	67	0.5	0.82692
68	0.54545	0.8189	68	0.54545	0.82572	68	0.54545	0.82692
69	0.59091	0.81377	69	0.59091	0.81941	69	0.59091	0.82692

Prediction Line

	X	Y
70	0.63636	0.80573
71	0.68182	0.79367
72	0.72727	0.77632
73	0.77273	0.75243
74	0.81818	0.72088
75	0.86364	0.68098
76	0.90909	0.63261
77	0.95455	0.57644
78	1	0.51393
79	1.0455	0.44728
80	1.0909	0.37918
81	1.1364	0.31251
82	1.1818	0.24998
83	1.2273	0.19377
84	1.2727	0.14536
85	1.3182	0.10541
86	1.3636	7.38E-02
87	1.4091	4.99E-02
88	1.4545	3.25E-02
89	1.5	2.04E-02
90	1.5455	1.24E-02
91	1.5909	7.22E-03
92	1.6364	4.08E-03
93	1.6818	2.23E-03
94	1.7273	1.19E-03
95	1.7727	6.33E-04
96	1.8182	3.45E-04
97	1.8636	2.03E-04
98	1.9091	1.36E-04
99	1.9545	1.05E-04
100	2	9.17E-05

	X	Y
70	0.63636	0.80737
71	0.68182	0.7896
72	0.72727	0.76609
73	0.77273	0.73685
74	0.81818	0.70188
75	0.86364	0.66118
76	0.90909	0.61475
77	0.95455	0.56259
78	1	0.50469
79	1.0455	0.44107
80	1.0909	0.37371
81	1.1364	0.31114
82	1.1818	0.25429
83	1.2273	0.20317
84	1.2727	0.15779
85	1.3182	0.11814
86	1.3636	8.42E-02
87	1.4091	5.60E-02
88	1.4545	3.36E-02
89	1.5	1.68E-02
90	1.5455	5.85E-03
91	1.5909	5.84E-04
92	1.6364	8.27E-05
93	1.6818	8.27E-05
94	1.7273	8.27E-05
95	1.7727	8.27E-05
96	1.8182	8.27E-05
97	1.8636	8.27E-05
98	1.9091	8.27E-05
99	1.9545	8.27E-05
100	2	8.27E-05

	X	Y
70	0.63636	0.82692
71	0.68182	0.82692
72	0.72727	0.82692
73	0.77273	0.77299
74	0.81818	0.7184
75	0.86364	0.6638
76	0.90909	0.6092
77	0.95455	0.5546
78	1	0.5
79	1.0455	0.4454
80	1.0909	0.3908
81	1.1364	0.3362
82	1.1818	0.2816
83	1.2273	0.22701
84	1.2727	0.17241
85	1.3182	0.11781
86	1.3636	6.32E-02
87	1.4091	8.61E-03
88	1.4545	8.27E-05
89	1.5	8.27E-05
90	1.5455	8.27E-05
91	1.5909	8.27E-05
92	1.6364	8.27E-05
93	1.6818	8.27E-05
94	1.7273	8.27E-05
95	1.7727	8.27E-05
96	1.8182	8.27E-05
97	1.8636	8.27E-05
98	1.9091	8.27E-05
99	1.9545	8.27E-05
100	2	8.27E-05

Table E2.D-8a. TRAP Model Output for Methylmercury Data for the Bird Growth Endpoint (Scott et al. 1975)

Chemical:	Mercury
Study Authors:	Scott et al. 1975
Receptor Group:	Bird
Effect Description:	Growth

Input Data:

Dose	Effect	SE
1.00E-06	1.664	not reported
0.70071	1.462	not reported
1.4014	1.139	not reported

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined	yes	yes	yes
Large Standard Error for X50			
Large Standard Error for Steepness			
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL		Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL		Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	0.34009	0.34009				LogX50	0.34009	0.3518				LogX50	0.34009	0.43269			
S	1.0006	1.00E+00				S	1.0006	1.00E+00				S	1.0006	0.64482			
Y0	1.66E+00	1.66E+00				Y0	1.66E+00	1.66E+00				Y0	1.66E+00	1.66E+00			

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp	p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp	p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	2.1882	Infinity	0	0.12997	0.34009	50	2.248	Infinity	0	0.12997	0.3518	50	2.7083	Infinity	0	0.12997	0.43269
20	9.86E-01	Infinity	0.00E+00	0.12997	-6.29E-03	20	0.96602	Infinity	0	0.12997	-1.50E-02	20	0.92778	Infinity	0	0.12997	-3.26E-02
10	6.18E-01	Infinity	0.00E+00	0.12997	-0.20891	10	6.31E-01	Infinity	0.00E+00	0.12997	-0.19989	10	0.64918	Infinity	0	0.12997	-0.18764
5	4.02E-01	Infinity	0.00E+00	0.12997	-0.39561	5	0.46707	Infinity	0.00E+00	0.12997	-0.33062	5	0.54303	Infinity	0	0.12997	-0.26518
0						0	0.22583	Infinity	0.00E+00	0.12997	-6.46E-01	0	0.45423	Infinity	0	0.12997	-0.34272

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.66E+00	1.66E+00	1	-6.00E+00	1.66E+00	1.66E+00	1	-6.00E+00	1.66E+00	1.66E+00
2	-1.54E-01	1.46E+00	1.46E+00	2	-1.54E-01	1.46E+00	1.46E+00	2	-1.54E-01	1.46E+00	1.46E+00
3	1.47E-01	1.14E+00	1.14E+00	3	1.47E-01	1.14E+00	1.14E+00	3	1.47E-01	1.14E+00	1.14E+00
4				4				4			
5				5				5			
6				6				6			

Analysis of Variance

R-squared	0.902	R-squared	0.902	R-squared	0.902

	DF	SS	MS	F	Sig		DF	SS	MS	F	Sig		DF	SS	MS	F	Sig
Total (adj)	5	4.2398	0.84796			Total (adj)	5	4.2398	0.84796			Total (adj)	5	4.2398	0.84796		
Regression	2	3.8229	1.9115	13.756	0.0308	Regression	2	3.8229	1.9115	13.756	0.0308	Regression	2	3.8229	1.9115	13.756	0.0308
Error	3	0.41686	0.13895			Error	3	0.41686	0.13895			Error	3	0.41686	0.13895		

Prediction Line

	X	Y		X	Y		X	Y
1	-4	1.66E+00	1	-4	1.66E+00	1	-4	1.66E+00
2	-3.95E+00	1.66E+00	2	-3.95E+00	1.66E+00	2	-3.95E+00	1.66E+00
3	-3.91E+00	1.66E+00	3	-3.91E+00	1.66E+00	3	-3.91E+00	1.66E+00
4	-3.86E+00	1.66E+00	4	-3.86E+00	1.66E+00	4	-3.86E+00	1.66E+00
5	-3.82E+00	1.66E+00	5	-3.82E+00	1.66E+00	5	-3.82E+00	1.66E+00
6	-3.77E+00	1.66E+00	6	-3.77E+00	1.66E+00	6	-3.77E+00	1.66E+00
7	-3.73E+00	1.66E+00	7	-3.73E+00	1.66E+00	7	-3.73E+00	1.66E+00
8	-3.68E+00	1.66E+00	8	-3.68E+00	1.66E+00	8	-3.68E+00	1.66E+00
9	-3.64E+00	1.66E+00	9	-3.64E+00	1.66E+00	9	-3.64E+00	1.66E+00
10	-3.59E+00	1.66E+00	10	-3.59E+00	1.66E+00	10	-3.59E+00	1.66E+00
11	-3.55E+00	1.66E+00	11	-3.55E+00	1.66E+00	11	-3.55E+00	1.66E+00
12	-3.50E+00	1.66E+00	12	-3.50E+00	1.66E+00	12	-3.50E+00	1.66E+00
13	-3.45E+00	1.66E+00	13	-3.45E+00	1.66E+00	13	-3.45E+00	1.66E+00
14	-3.4091	1.66E+00	14	-3.4091	1.66E+00	14	-3.4091	1.66E+00
15	-3.3636	1.66E+00	15	-3.3636	1.66E+00	15	-3.3636	1.66E+00
16	-3.3182	1.66E+00	16	-3.3182	1.66E+00	16	-3.3182	1.66E+00
17	-3.2727	1.66E+00	17	-3.2727	1.66E+00	17	-3.2727	1.66E+00
18	-3.2273	1.66E+00	18	-3.2273	1.66E+00	18	-3.2273	1.66E+00
19	-3.1818	1.66E+00	19	-3.1818	1.66E+00	19	-3.1818	1.66E+00
20	-3.1364	1.66E+00	20	-3.1364	1.66E+00	20	-3.1364	1.66E+00
21	-3.09E+00	1.66E+00	21	-3.09E+00	1.66E+00	21	-3.09E+00	1.66E+00
22	-3.05E+00	1.66E+00	22	-3.05E+00	1.66E+00	22	-3.05E+00	1.66E+00
23	-3.00E+00	1.66E+00	23	-3.00E+00	1.66E+00	23	-3.00E+00	1.66E+00
24	-2.95E+00	1.66E+00	24	-2.95E+00	1.66E+00	24	-2.95E+00	1.66E+00
25	-2.91E+00	1.66E+00	25	-2.91E+00	1.66E+00	25	-2.91E+00	1.66E+00
26	-2.86E+00	1.66E+00	26	-2.86E+00	1.66E+00	26	-2.86E+00	1.66E+00
27	-2.82E+00	1.66E+00	27	-2.82E+00	1.66E+00	27	-2.82E+00	1.66E+00
28	-2.77E+00	1.66E+00	28	-2.77E+00	1.66E+00	28	-2.77E+00	1.66E+00
29	-2.73E+00	1.66E+00	29	-2.73E+00	1.66E+00	29	-2.73E+00	1.66E+00
30	-2.68E+00	1.66E+00	30	-2.68E+00	1.66E+00	30	-2.68E+00	1.66E+00
31	-2.6364	1.66E+00	31	-2.6364	1.66E+00	31	-2.6364	1.66E+00
32	-2.5909	1.66E+00	32	-2.5909	1.66E+00	32	-2.5909	1.66E+00
33	-2.5455	1.66E+00	33	-2.5455	1.66E+00	33	-2.5455	1.66E+00
34	-2.5	1.66E+00	34	-2.5	1.66E+00	34	-2.5	1.66E+00
35	-2.4545	1.66E+00	35	-2.4545	1.66E+00	35	-2.4545	1.66E+00
36	-2.4091	1.66E+00	36	-2.4091	1.66E+00	36	-2.4091	1.66E+00
37	-2.3636	1.66E+00	37	-2.3636	1.66E+00	37	-2.3636	1.66E+00
38	-2.3182	1.66E+00	38	-2.3182	1.66E+00	38	-2.3182	1.66E+00
39	-2.2727	1.66E+00	39	-2.2727	1.66E+00	39	-2.2727	1.66E+00
40	-2.2273	1.66E+00	40	-2.2273	1.66E+00	40	-2.2273	1.66E+00
41	-2.1818	1.66E+00	41	-2.1818	1.66E+00	41	-2.1818	1.66E+00
42	-2.1364	1.66E+00	42	-2.1364	1.66E+00	42	-2.1364	1.66E+00
43	-2.0909	1.66E+00	43	-2.0909	1.66E+00	43	-2.0909	1.66E+00
44	-2.0455	1.66E+00	44	-2.0455	1.66E+00	44	-2.0455	1.66E+00
45	-2	1.66E+00	45	-2	1.66E+00	45	-2	1.66E+00
46	-1.9545	1.66E+00	46	-1.9545	1.66E+00	46	-1.9545	1.66E+00
47	-1.9091	1.66E+00	47	-1.9091	1.66E+00	47	-1.9091	1.66E+00
48	-1.8636	1.66E+00	48	-1.8636	1.66E+00	48	-1.8636	1.66E+00
49	-1.8182	1.66E+00	49	-1.8182	1.66E+00	49	-1.8182	1.66E+00
50	-1.7727	1.66E+00	50	-1.7727	1.66E+00	50	-1.7727	1.66E+00
51	-1.7273	1.66E+00	51	-1.7273	1.66E+00	51	-1.7273	1.66E+00
52	-1.6818	1.66E+00	52	-1.6818	1.66E+00	52	-1.6818	1.66E+00
53	-1.6364	1.66E+00	53	-1.6364	1.66E+00	53	-1.6364	1.66E+00
54	-1.5909	1.66E+00	54	-1.5909	1.66E+00	54	-1.5909	1.66E+00
55	-1.5455	1.66E+00	55	-1.5455	1.66E+00	55	-1.5455	1.66E+00
56	-1.5	1.66E+00	56	-1.5	1.66E+00	56	-1.5	1.66E+00
57	-1.4545	1.66E+00	57	-1.4545	1.66E+00	57	-1.4545	1.66E+00
58	-1.4091	1.66E+00	58	-1.4091	1.66E+00	58	-1.4091	1.66E+00
59	-1.3636	1.66E+00	59	-1.3636	1.66E+00	59	-1.3636	1.66E+00
60	-1.3182	1.66E+00	60	-1.3182	1.66E+00	60	-1.3182	1.66E+00
61	-1.2727	1.66E+00	61	-1.2727	1.66E+00	61	-1.2727	1.66E+00
62	-1.2273	1.66E+00	62	-1.2273	1.66E+00	62	-1.2273	1.66E+00
63	-1.1818	1.66E+00	63	-1.1818	1.66E+00	63	-1.1818	1.66E+00
64	-1.1364	1.66E+00	64	-1.1364	1.66E+00	64	-1.1364	1.66E+00
65	-1.0909	1.66E+00	65	-1.0909	1.66E+00	65	-1.0909	1.66E+00
66	-1.0455	1.66E+00	66	-1.0455	1.66E+00	66	-1.0455	1.66E+00
67	-1	1.66E+00	67	-1	1.66E+00	67	-1	1.66E+00
68	-0.95455	1.65E+00	68	-0.95455	1.66E+00	68	-0.95455	1.66E+00
69	-0.90909	1.65E+00	69	-0.90909	1.66E+00	69	-0.90909	1.66E+00

Prediction Line

	X	Y
70	-0.86364	1.65E+00
71	-0.81818	1.65E+00
72	-0.77273	1.64E+00
73	-0.72727	1.64E+00
74	-0.68182	1.64E+00
75	-0.63636	1.63E+00
76	-0.59091	1.62E+00
77	-0.54545	1.62E+00
78	-0.5	1.61E+00
79	-0.45455	1.60E+00
80	-0.40909	1.59E+00
81	-0.36364	1.57E+00
82	-0.31818	1.55E+00
83	-0.27273	1.53E+00
84	-0.22727	1.51E+00
85	-0.18182	1.48E+00
86	-0.13636	1.45E+00
87	-9.09E-02	1.41E+00
88	-4.55E-02	1.37E+00
89	0	1.32E+00
90	4.55E-02	1.27E+00
91	9.09E-02	1.22E+00
92	0.13636	1.15E+00
93	0.18182	1.09E+00
94	0.22727	1.02E+00
95	0.27273	9.43E-01
96	0.31818	8.68E-01
97	0.36364	7.93E-01
98	0.40909	7.18E-01
99	0.45455	6.45E-01
100	0.5	5.74E-01

	X	Y
70	-0.86364	1.66E+00
71	-0.81818	1.66E+00
72	-0.77273	1.66E+00
73	-0.72727	1.66E+00
74	-0.68182	1.66E+00
75	-0.63636	1.66E+00
76	-0.59091	1.66E+00
77	-0.54545	1.66E+00
78	-0.5	1.65E+00
79	-0.45455	1.63E+00
80	-0.40909	1.62E+00
81	-0.36364	1.60E+00
82	-0.31818	1.57E+00
83	-0.27273	1.55E+00
84	-0.22727	1.52E+00
85	-0.18182	1.48E+00
86	-0.13636	1.45E+00
87	-9.09E-02	1.41E+00
88	-4.55E-02	1.36E+00
89	0	1.32E+00
90	4.55E-02	1.26E+00
91	9.09E-02	1.21E+00
92	0.13636	1.15E+00
93	0.18182	1.09E+00
94	0.22727	1.03E+00
95	0.27273	9.59E-01
96	0.31818	8.87E-01
97	0.36364	8.12E-01
98	0.40909	7.39E-01
99	0.45455	6.70E-01
100	0.5	6.03E-01

	X	Y
70	-0.86364	1.66E+00
71	-0.81818	1.66E+00
72	-0.77273	1.66E+00
73	-0.72727	1.66E+00
74	-0.68182	1.66E+00
75	-0.63636	1.66E+00
76	-0.59091	1.66E+00
77	-0.54545	1.66E+00
78	-0.5	1.66E+00
79	-0.45455	1.66E+00
80	-0.40909	1.66E+00
81	-0.36364	1.66E+00
82	-0.31818	1.64E+00
83	-0.27273	1.59E+00
84	-0.22727	1.54E+00
85	-0.18182	1.49E+00
86	-0.13636	1.44E+00
87	-9.09E-02	1.39E+00
88	-4.55E-02	1.35E+00
89	0	1.30E+00
90	4.55E-02	1.25E+00
91	9.09E-02	1.20E+00
92	0.13636	1.15E+00
93	0.18182	1.10E+00
94	0.22727	1.05E+00
95	0.27273	1.00E+00
96	0.31818	9.55E-01
97	0.36364	9.06E-01
98	0.40909	8.57E-01
99	0.45455	8.09E-01
100	0.5	7.60E-01

Table E2.D-8b. TRAP Model Output for Methylmercury Data for the Bird Reproduction Endpoint (Varian-Ramos et al. 2014)

Chemical:	Mercury
Study Authors:	Varian-Ramos et al. 2014
Receptor Group:	Bird
Effect Description:	Reproduction

Input Data:

Dose	Effect	SE
1.00E-06	13	not reported
5.12E-02	9	not reported
0.10241	6	not reported
0.20482	7	not reported
0.40964	8	not reported

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence	yes	yes	yes
X50 at Maximum or Minimum Limit	yes	yes	yes
Steepness At Maximum Or Minimum Limit	yes	yes	yes
Error Estimates Cannot Be Determined			
Large Standard Error for X50	yes	yes	yes
Large Standard Error for Steepness	yes	yes	yes
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

Logistic Equation:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	-1.0377	-0.53774	0.48603	-2.629	1.5535
S	0.80148	2.67E-01	0.26351	-0.86665	1.401
Y0	1.30E+01	1.30E+01	2.1094	3.9495	22.102

Threshold Sigmoid:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	-1.0377	-0.53774	0.50271	-2.7007	1.6252
S	0.80148	2.67E-01	0.26691	-0.88127	1.4156
Y0	1.30E+01	1.30E+01	1.996	4.437	21.613

Piecewise Linear:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	-1.0377	-0.53774	0.49315	-2.6596	1.5841
S	0.80148	0.26716	0.23761	-0.75519	1.2895
Y0	1.30E+01	1.30E+01	2.05	4.2024	21.843

Xp Estimates

Logistic Equation:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	0.28991	2.35E-03	35.768	0.48603	-0.53774
20	1.46E-02	7.61E-08	2.81E+03	1.2279	-1.835
10	2.55E-03	1.13E-11	5.75E+05	1.9415	-2.5938
5	5.09E-04	2.82E-15	9.21E+07	2.6164	-3.293
0					

Threshold Sigmoid:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	0.28991	1.99E-03	42.192	0.50271	-0.53774
20	1.22E-02	2.21E-08	6726.5	1.3344	-1.9135
10	2.47E-03	1.78E-12	3.43E+06	2.1247	-2.6069
5	8.00E-04	8.91E-16	7.18E+08	2.7781	-3.0971
0	5.24E-05	1.30E-25	2.12E+16	4.7892	-4.28E+00

Piecewise Linear:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	0.28991	2.19E-03	38.38	0.49315	-0.53774
20	2.18E-02	2.68E-06	177.84	0.9089	-1.6607
10	9.23E-03	5.75E-08	1481	1.2098	-2.035
5	6.00E-03	7.96E-09	4516.3	1.3659	-2.2221
0	3.90E-03	1.08E-09	14077	1.5241	-2.4093

Model Fit Summary

Dataset

Logistic Equation:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.30E+01	1.30E+01
2	-1.29E+00	9.00E+00	9.00E+00
3	-9.90E-01	6.00E+00	8.06E+00
4	-6.89E-01	7.00E+00	7.04E+00
5	-3.88E-01	8	5.9914
6			

Threshold Sigmoid:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.30E+01	1.30E+01
2	-1.29E+00	9.00E+00	8.87E+00
3	-9.90E-01	6.00E+00	7.99E+00
4	-6.89E-01	7.00E+00	7.03E+00
5	-3.88E-01	8	6.0005
6			

Piecewise Linear:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.30E+01	1.30E+01
2	-1.29E+00	9.00E+00	9.13E+00
3	-9.90E-01	6.00E+00	8.08E+00
4	-6.89E-01	7.00E+00	7.04E+00
5	-3.88E-01	8	5.989
6			

Analysis of Variance

Logistic Equation: R-squared 0.717

	DF	SS	MS	F	Sig
Total (adj)	4	29.2	7.3		
Regression	2	20.939	10.469	2.5346	0.2829
Error	2	8.2612	4.1306		

Threshold Sigmoid: R-squared 0.727

	DF	SS	MS	F	Sig
Total (adj)	4	29.2	7.3		
Regression	2	21.223	10.611	2.6605	0.2732
Error	2	7.9771	3.9885		

Piecewise Linear: R-squared 0.712

	DF	SS	MS	F	Sig
Total (adj)	4	29.2	7.3		
Regression	2	20.795	10.398	2.4742	0.2878
Error	2	8.4048	4.2024		

Prediction Line

	X	Y
1	-4.5	1.28E+01
2	-4.45E+00	1.28E+01
3	-4.40E+00	1.28E+01
4	-4.35E+00	1.28E+01
5	-4.30E+00	1.28E+01
6	-4.25E+00	1.28E+01
7	-4.20E+00	1.28E+01
8	-4.15E+00	1.28E+01
9	-4.10E+00	1.27E+01
10	-4.05E+00	1.27E+01
11	-3.99E+00	1.27E+01
12	-3.94E+00	1.27E+01
13	-3.89E+00	1.27E+01
14	-3.8434	1.27E+01
15	-3.7929	1.26E+01
16	-3.7424	1.26E+01
17	-3.6919	1.26E+01
18	-3.6414	1.26E+01
19	-3.5909	1.25E+01
20	-3.5404	1.25E+01
21	-3.49E+00	1.25E+01
22	-3.44E+00	1.25E+01
23	-3.39E+00	1.24E+01
24	-3.34E+00	1.24E+01
25	-3.29E+00	1.24E+01
26	-3.24E+00	1.23E+01
27	-3.19E+00	1.23E+01
28	-3.14E+00	1.23E+01
29	-3.09E+00	1.22E+01
30	-3.04E+00	1.22E+01
31	-2.9848	1.21E+01
32	-2.9343	1.21E+01
33	-2.8838	1.20E+01
34	-2.8333	1.20E+01
35	-2.7828	1.19E+01
36	-2.7323	1.19E+01
37	-2.6818	1.18E+01
38	-2.6313	1.18E+01
39	-2.5808	1.17E+01
40	-2.5303	1.16E+01
41	-2.4798	1.16E+01
42	-2.4293	1.15E+01
43	-2.3788	1.14E+01
44	-2.3283	1.14E+01
45	-2.2778	1.13E+01
46	-2.2273	1.12E+01
47	-2.1768	1.11E+01
48	-2.1263	1.10E+01
49	-2.0758	1.09E+01
50	-2.0253	1.08E+01
51	-1.9747	1.07E+01
52	-1.9242	1.06E+01
53	-1.8737	1.05E+01
54	-1.8232	1.04E+01
55	-1.7727	1.03E+01
56	-1.7222	1.02E+01
57	-1.6717	1.00E+01
58	-1.6212	9.91E+00
59	-1.5707	9.78E+00
60	-1.5202	9.65E+00
61	-1.4697	9.51E+00
62	-1.4192	9.37E+00
63	-1.3687	9.23E+00
64	-1.3182	9.08E+00
65	-1.2677	8.93E+00
66	-1.2172	8.78E+00
67	-1.1667	8.62E+00
68	-1.1162	8.46E+00
69	-1.0657	8.30E+00

	X	Y
1	-4.5	1.30E+01
2	-4.45E+00	1.30E+01
3	-4.40E+00	1.30E+01
4	-4.35E+00	1.30E+01
5	-4.30E+00	1.30E+01
6	-4.25E+00	1.30E+01
7	-4.20E+00	1.30E+01
8	-4.15E+00	1.30E+01
9	-4.10E+00	1.30E+01
10	-4.05E+00	1.30E+01
11	-3.99E+00	1.30E+01
12	-3.94E+00	1.30E+01
13	-3.89E+00	1.30E+01
14	-3.8434	1.29E+01
15	-3.7929	1.29E+01
16	-3.7424	1.29E+01
17	-3.6919	1.29E+01
18	-3.6414	1.28E+01
19	-3.5909	1.28E+01
20	-3.5404	1.28E+01
21	-3.49E+00	1.27E+01
22	-3.44E+00	1.27E+01
23	-3.39E+00	1.27E+01
24	-3.34E+00	1.26E+01
25	-3.29E+00	1.26E+01
26	-3.24E+00	1.25E+01
27	-3.19E+00	1.25E+01
28	-3.14E+00	1.24E+01
29	-3.09E+00	1.24E+01
30	-3.04E+00	1.23E+01
31	-2.9848	1.22E+01
32	-2.9343	1.22E+01
33	-2.8838	1.21E+01
34	-2.8333	1.21E+01
35	-2.7828	1.20E+01
36	-2.7323	1.19E+01
37	-2.6818	1.18E+01
38	-2.6313	1.18E+01
39	-2.5808	1.17E+01
40	-2.5303	1.16E+01
41	-2.4798	1.15E+01
42	-2.4293	1.14E+01
43	-2.3788	1.13E+01
44	-2.3283	1.13E+01
45	-2.2778	1.12E+01
46	-2.2273	1.11E+01
47	-2.1768	1.10E+01
48	-2.1263	1.09E+01
49	-2.0758	1.08E+01
50	-2.0253	1.07E+01
51	-1.9747	1.06E+01
52	-1.9242	1.04E+01
53	-1.8737	1.03E+01
54	-1.8232	1.02E+01
55	-1.7727	1.01E+01
56	-1.7222	9.98E+00
57	-1.6717	9.86E+00
58	-1.6212	9.74E+00
59	-1.5707	9.61E+00
60	-1.5202	9.48E+00
61	-1.4697	9.35E+00
62	-1.4192	9.22E+00
63	-1.3687	9.08E+00
64	-1.3182	8.95E+00
65	-1.2677	8.80E+00
66	-1.2172	8.66E+00
67	-1.1667	8.52E+00
68	-1.1162	8.37E+00
69	-1.0657	8.22E+00

	X	Y
1	-4.5	1.30E+01
2	-4.45E+00	1.30E+01
3	-4.40E+00	1.30E+01
4	-4.35E+00	1.30E+01
5	-4.30E+00	1.30E+01
6	-4.25E+00	1.30E+01
7	-4.20E+00	1.30E+01
8	-4.15E+00	1.30E+01
9	-4.10E+00	1.30E+01
10	-4.05E+00	1.30E+01
11	-3.99E+00	1.30E+01
12	-3.94E+00	1.30E+01
13	-3.89E+00	1.30E+01
14	-3.8434	1.30E+01
15	-3.7929	1.30E+01
16	-3.7424	1.30E+01
17	-3.6919	1.30E+01
18	-3.6414	1.30E+01
19	-3.5909	1.30E+01
20	-3.5404	1.30E+01
21	-3.49E+00	1.30E+01
22	-3.44E+00	1.30E+01
23	-3.39E+00	1.30E+01
24	-3.34E+00	1.30E+01
25	-3.29E+00	1.30E+01
26	-3.24E+00	1.30E+01
27	-3.19E+00	1.30E+01
28	-3.14E+00	1.30E+01
29	-3.09E+00	1.30E+01
30	-3.04E+00	1.30E+01
31	-2.9848	1.30E+01
32	-2.9343	1.30E+01
33	-2.8838	1.30E+01
34	-2.8333	1.30E+01
35	-2.7828	1.30E+01
36	-2.7323	1.30E+01
37	-2.6818	1.30E+01
38	-2.6313	1.30E+01
39	-2.5808	1.30E+01
40	-2.5303	1.30E+01
41	-2.4798	1.30E+01
42	-2.4293	1.30E+01
43	-2.3788	1.29E+01
44	-2.3283	1.27E+01
45	-2.2778	1.26E+01
46	-2.2273	1.24E+01
47	-2.1768	1.22E+01
48	-2.1263	1.20E+01
49	-2.0758	1.19E+01
50	-2.0253	1.17E+01
51	-1.9747	1.15E+01
52	-1.9242	1.13E+01
53	-1.8737	1.12E+01
54	-1.8232	1.10E+01
55	-1.7727	1.08E+01
56	-1.7222	1.06E+01
57	-1.6717	1.05E+01
58	-1.6212	1.03E+01
59	-1.5707	1.01E+01
60	-1.5202	9.93E+00
61	-1.4697	9.75E+00
62	-1.4192	9.58E+00
63	-1.3687	9.40E+00
64	-1.3182	9.23E+00
65	-1.2677	9.05E+00
66	-1.2172	8.88E+00
67	-1.1667	8.70E+00
68	-1.1162	8.52E+00
69	-1.0657	8.35E+00

Prediction Line

	X	Y
70	-1.0152	8.14E+00
71	-0.96465	7.97E+00
72	-0.91414	7.81E+00
73	-0.86364	7.64E+00
74	-0.81313	7.46E+00
75	-0.76263	7.29E+00
76	-0.71212	7.12E+00
77	-0.66162	6.94E+00
78	-0.61111	6.77E+00
79	-0.56061	6.59E+00
80	-0.5101	6.42E+00
81	-0.4596	6.24E+00
82	-0.40909	6.07E+00
83	-0.35859	5.89E+00
84	-0.30808	5.72E+00
85	-0.25758	5.55E+00
86	-0.20707	5.37E+00
87	-0.15657	5.20E+00
88	-0.10606	5.04E+00
89	-5.56E-02	4.87E+00
90	-5.05E-03	4.71E+00
91	4.55E-02	4.55E+00
92	9.60E-02	4.39E+00
93	0.14646	4.23E+00
94	0.19697	4.08E+00
95	0.24747	3.93E+00
96	0.29798	3.78E+00
97	0.34848	3.64E+00
98	0.39899	3.50E+00
99	0.44949	3.36E+00
100	0.5	3.23E+00

	X	Y
70	-1.0152	8.07E+00
71	-0.96465	7.91E+00
72	-0.91414	7.76E+00
73	-0.86364	7.60E+00
74	-0.81313	7.44E+00
75	-0.76263	7.27E+00
76	-0.71212	7.11E+00
77	-0.66162	6.94E+00
78	-0.61111	6.77E+00
79	-0.56061	6.59E+00
80	-0.5101	6.42E+00
81	-0.4596	6.24E+00
82	-0.40909	6.07E+00
83	-0.35859	5.90E+00
84	-0.30808	5.74E+00
85	-0.25758	5.57E+00
86	-0.20707	5.41E+00
87	-0.15657	5.25E+00
88	-0.10606	5.10E+00
89	-5.56E-02	4.94E+00
90	-5.05E-03	4.79E+00
91	4.55E-02	4.64E+00
92	9.60E-02	4.49E+00
93	0.14646	4.35E+00
94	0.19697	4.21E+00
95	0.24747	4.07E+00
96	0.29798	3.93E+00
97	0.34848	3.79E+00
98	0.39899	3.66E+00
99	0.44949	3.53E+00
100	0.5	3.40E+00

	X	Y
70	-1.0152	8.17E+00
71	-0.96465	8.00E+00
72	-0.91414	7.82E+00
73	-0.86364	7.65E+00
74	-0.81313	7.47E+00
75	-0.76263	7.29E+00
76	-0.71212	7.12E+00
77	-0.66162	6.94E+00
78	-0.61111	6.77E+00
79	-0.56061	6.59E+00
80	-0.5101	6.42E+00
81	-0.4596	6.24E+00
82	-0.40909	6.06E+00
83	-0.35859	5.89E+00
84	-0.30808	5.71E+00
85	-0.25758	5.54E+00
86	-0.20707	5.36E+00
87	-0.15657	5.19E+00
88	-0.10606	5.01E+00
89	-5.56E-02	4.83E+00
90	-5.05E-03	4.66E+00
91	4.55E-02	4.48E+00
92	9.60E-02	4.31E+00
93	0.14646	4.13E+00
94	0.19697	3.96E+00
95	0.24747	3.78E+00
96	0.29798	3.60E+00
97	0.34848	3.43E+00
98	0.39899	3.25E+00
99	0.44949	3.08E+00
100	0.5	2.90E+00

Table E2.D-8c. TRAP Model Output for Methylmercury Data for the Bird Reproduction Endpoint (Albers et al. 2007)

Chemical:	Mercury
Study Authors:	Albers et al. 2007
Receptor Group:	Bird
Effect Description:	Reproduction

Input Data:

Dose	Effect	SE
1.67E-03	2.25	0.45
7.87E-02	1.89	0.45
0.21367	1.3	0.34
0.33517	1.5	0.34
0.48075	0.14	0.14
0.620	0.0	0.0

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered			
Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence	yes		
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit	yes		
Error Estimates Cannot Be Determined			
Large Standard Error for X50			
Large Standard Error for Steepness	yes	yes	
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL		Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL		Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	-0.691	-0.41055	5.84E-02	-0.59648	-0.22462	LogX50	-0.691	-0.46109	8.21E-02	-0.72232	-0.19986	LogX50	-0.691	-0.50849	8.57E-02	-0.78114	-0.23584
S	1.4481	4.34E+00	3.0405	-5.3318	14.021	S	1.4481	2.47E+00	1.4431	-2.1224	7.0626	S	1.4481	1.5956	0.63395	-0.42188	3.6131
Y0	2.25E+00	1.84E+00	0.23982	1.0792	2.6056	Y0	2.25E+00	1.97E+00	0.30184	1.0045	2.9257	Y0	2.25E+00	2.07E+00	0.30059	1.1134	3.0266

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp	p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp	p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	0.38855	0.25323	0.59618	5.84E-02	-0.41055	50	0.34587	0.18953	0.63115	8.21E-02	-0.46109	50	0.31011	0.16552	0.58098	8.57E-02	-0.50849
20	3.23E-01	1.77E-01	5.92E-01	8.25E-02	-0.49033	20	0.24553	8.76E-02	0.68799	0.14061	-0.60989	20	0.20114	7.12E-02	0.56808	0.14169	-0.6965
10	2.90E-01	1.32E-01	6.41E-01	0.10802	-0.53699	10	2.07E-01	4.92E-02	8.67E-01	0.19572	-0.68488	10	0.17411	5.25E-02	0.57786	0.16371	-0.75917
5	2.63E-01	9.83E-02	7.04E-01	0.13433	-0.57999	5	0.18285	2.87E-02	1.16E+00	0.2527	-0.73791	5	0.16199	4.49E-02	0.58405	0.17501	-0.79051
0						0	0.13616	9.69E-03	1.91E+00	0.36061	-8.66E-01	0	0.15071	3.84E-02	0.59094	0.18646	-0.82184

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var
1	-2.78E+00	2.25E+00	1.84E+00	1	-2.78E+00	2.25E+00	1.97E+00	1	-2.78E+00	2.25E+00	2.07E+00
2	-1.10E+00	1.89E+00	1.84E+00	2	-1.10E+00	1.89E+00	1.97E+00	2	-1.10E+00	1.89E+00	2.07E+00
3	-6.70E-01	1.30E+00	1.82E+00	3	-6.70E-01	1.30E+00	1.74E+00	3	-6.70E-01	1.30E+00	1.57E+00
4	-4.75E-01	1.50E+00	1.39E+00	4	-4.75E-01	1.50E+00	1.05E+00	4	-4.75E-01	1.50E+00	9.24E-01
5	-3.18E-01	0.14	0.30769	5	-3.18E-01	0.14	0.41097	5	-3.18E-01	0.14	0.40608
6	-0.20757	0	5.26E-02	6	-0.20757	0	0.13726	6	-0.20757	0	4.11E-02

Analysis of Variance

R-squared:	0.886	0.865	0.872

	DF	SS	MS	F	Sig		DF	SS	MS	F	Sig		DF	SS	MS	F	Sig
Total (adj)	5	4.2398	0.84796			Total (adj)	5	4.2398	0.84796			Total (adj)	5	4.2398	0.84796		
Regression	2	3.755	1.8775	11.617	0.0387	Regression	2	3.6664	1.8332	9.5915	0.0497	Regression	2	3.6977	1.8488	10.231	0.0457
Error	3	0.48485	0.16162			Error	3	0.57339	0.19113			Error	3	0.54214	0.18071		

Prediction Line

	X	Y		X	Y		X	Y
1	-2.5	1.84E+00	1	-2.5	1.97E+00	1	-2.5	2.07E+00
2	-2.47E+00	1.84E+00	2	-2.47E+00	1.97E+00	2	-2.47E+00	2.07E+00
3	-2.44E+00	1.84E+00	3	-2.44E+00	1.97E+00	3	-2.44E+00	2.07E+00
4	-2.41E+00	1.84E+00	4	-2.41E+00	1.97E+00	4	-2.41E+00	2.07E+00
5	-2.38E+00	1.84E+00	5	-2.38E+00	1.97E+00	5	-2.38E+00	2.07E+00
6	-2.35E+00	1.84E+00	6	-2.35E+00	1.97E+00	6	-2.35E+00	2.07E+00
7	-2.32E+00	1.84E+00	7	-2.32E+00	1.97E+00	7	-2.32E+00	2.07E+00
8	-2.29E+00	1.84E+00	8	-2.29E+00	1.97E+00	8	-2.29E+00	2.07E+00
9	-2.26E+00	1.84E+00	9	-2.26E+00	1.97E+00	9	-2.26E+00	2.07E+00
10	-2.23E+00	1.84E+00	10	-2.23E+00	1.97E+00	10	-2.23E+00	2.07E+00
11	-2.20E+00	1.84E+00	11	-2.20E+00	1.97E+00	11	-2.20E+00	2.07E+00
12	-2.17E+00	1.84E+00	12	-2.17E+00	1.97E+00	12	-2.17E+00	2.07E+00
13	-2.14E+00	1.84E+00	13	-2.14E+00	1.97E+00	13	-2.14E+00	2.07E+00
14	-2.1061	1.84E+00	14	-2.1061	1.97E+00	14	-2.1061	2.07E+00
15	-2.0758	1.84E+00	15	-2.0758	1.97E+00	15	-2.0758	2.07E+00
16	-2.0455	1.84E+00	16	-2.0455	1.97E+00	16	-2.0455	2.07E+00
17	-2.0152	1.84E+00	17	-2.0152	1.97E+00	17	-2.0152	2.07E+00
18	-1.9848	1.84E+00	18	-1.9848	1.97E+00	18	-1.9848	2.07E+00
19	-1.9545	1.84E+00	19	-1.9545	1.97E+00	19	-1.9545	2.07E+00
20	-1.9242	1.84E+00	20	-1.9242	1.97E+00	20	-1.9242	2.07E+00
21	-1.89E+00	1.84E+00	21	-1.89E+00	1.97E+00	21	-1.89E+00	2.07E+00
22	-1.86E+00	1.84E+00	22	-1.86E+00	1.97E+00	22	-1.86E+00	2.07E+00
23	-1.83E+00	1.84E+00	23	-1.83E+00	1.97E+00	23	-1.83E+00	2.07E+00
24	-1.80E+00	1.84E+00	24	-1.80E+00	1.97E+00	24	-1.80E+00	2.07E+00
25	-1.77E+00	1.84E+00	25	-1.77E+00	1.97E+00	25	-1.77E+00	2.07E+00
26	-1.74E+00	1.84E+00	26	-1.74E+00	1.97E+00	26	-1.74E+00	2.07E+00
27	-1.71E+00	1.84E+00	27	-1.71E+00	1.97E+00	27	-1.71E+00	2.07E+00
28	-1.68E+00	1.84E+00	28	-1.68E+00	1.97E+00	28	-1.68E+00	2.07E+00
29	-1.65E+00	1.84E+00	29	-1.65E+00	1.97E+00	29	-1.65E+00	2.07E+00
30	-1.62E+00	1.84E+00	30	-1.62E+00	1.97E+00	30	-1.62E+00	2.07E+00
31	-1.5909	1.84E+00	31	-1.5909	1.97E+00	31	-1.5909	2.07E+00
32	-1.5606	1.84E+00	32	-1.5606	1.97E+00	32	-1.5606	2.07E+00
33	-1.5303	1.84E+00	33	-1.5303	1.97E+00	33	-1.5303	2.07E+00
34	-1.5	1.84E+00	34	-1.5	1.97E+00	34	-1.5	2.07E+00
35	-1.4697	1.84E+00	35	-1.4697	1.97E+00	35	-1.4697	2.07E+00
36	-1.4394	1.84E+00	36	-1.4394	1.97E+00	36	-1.4394	2.07E+00
37	-1.4091	1.84E+00	37	-1.4091	1.97E+00	37	-1.4091	2.07E+00
38	-1.3788	1.84E+00	38	-1.3788	1.97E+00	38	-1.3788	2.07E+00
39	-1.3485	1.84E+00	39	-1.3485	1.97E+00	39	-1.3485	2.07E+00
40	-1.3182	1.84E+00	40	-1.3182	1.97E+00	40	-1.3182	2.07E+00
41	-1.2879	1.84E+00	41	-1.2879	1.97E+00	41	-1.2879	2.07E+00
42	-1.2576	1.84E+00	42	-1.2576	1.97E+00	42	-1.2576	2.07E+00
43	-1.2273	1.84E+00	43	-1.2273	1.97E+00	43	-1.2273	2.07E+00
44	-1.197	1.84E+00	44	-1.197	1.97E+00	44	-1.197	2.07E+00
45	-1.1667	1.84E+00	45	-1.1667	1.97E+00	45	-1.1667	2.07E+00
46	-1.1364	1.84E+00	46	-1.1364	1.97E+00	46	-1.1364	2.07E+00
47	-1.1061	1.84E+00	47	-1.1061	1.97E+00	47	-1.1061	2.07E+00
48	-1.0758	1.84E+00	48	-1.0758	1.97E+00	48	-1.0758	2.07E+00
49	-1.0455	1.84E+00	49	-1.0455	1.97E+00	49	-1.0455	2.07E+00
50	-1.0152	1.84E+00	50	-1.0152	1.97E+00	50	-1.0152	2.07E+00
51	-0.98485	1.84E+00	51	-0.98485	1.97E+00	51	-0.98485	2.07E+00
52	-0.95455	1.84E+00	52	-0.95455	1.97E+00	52	-0.95455	2.07E+00
53	-0.92424	1.84E+00	53	-0.92424	1.97E+00	53	-0.92424	2.07E+00
54	-0.89394	1.84E+00	54	-0.89394	1.97E+00	54	-0.89394	2.07E+00
55	-0.86364	1.84E+00	55	-0.86364	1.97E+00	55	-0.86364	2.07E+00
56	-0.83333	1.84E+00	56	-0.83333	1.96E+00	56	-0.83333	2.07E+00
57	-0.80303	1.84E+00	57	-0.80303	1.94E+00	57	-0.80303	2.01E+00
58	-0.77273	1.84E+00	58	-0.77273	1.91E+00	58	-0.77273	1.91E+00
59	-0.74242	1.84E+00	59	-0.74242	1.87E+00	59	-0.74242	1.81E+00
60	-0.71212	1.83E+00	60	-0.71212	1.82E+00	60	-0.71212	1.71E+00
61	-0.68182	1.83E+00	61	-0.68182	1.76E+00	61	-0.68182	1.61E+00
62	-0.65152	1.81E+00	62	-0.65152	1.69E+00	62	-0.65152	1.51E+00
63	-0.62121	1.80E+00	63	-0.62121	1.61E+00	63	-0.62121	1.41E+00
64	-0.59091	1.77E+00	64	-0.59091	1.51E+00	64	-0.59091	1.31E+00
65	-0.56061	1.72E+00	65	-0.56061	1.41E+00	65	-0.56061	1.21E+00
66	-0.5303	1.64E+00	66	-0.5303	1.29E+00	66	-0.5303	1.11E+00
67	-0.5	1.52E+00	67	-0.5	1.16E+00	67	-0.5	1.01E+00
68	-0.4697	1.36E+00	68	-0.4697	1.02E+00	68	-0.4697	9.07E-01
69	-0.43939	1.15E+00	69	-0.43939	8.80E-01	69	-0.43939	8.07E-01
70	-0.40909	9.10E-01	70	-0.40909	7.46E-01	70	-0.40909	7.07E-01
71	-0.37879	6.73E-01	71	-0.37879	6.24E-01	71	-0.37879	6.07E-01
72	-0.34848	4.68E-01	72	-0.34848	5.12E-01	72	-0.34848	5.07E-01

Prediction Line

	X	Y
73	-0.31818	3.08E-01
74	-0.28788	1.95E-01
75	-0.25758	1.21E-01
76	-0.22727	7.32E-02
77	-0.19697	4.40E-02
78	-0.16667	2.62E-02
79	-0.13636	1.56E-02
80	-0.10606	9.23E-03
81	-7.58E-02	5.46E-03
82	-4.55E-02	3.23E-03
83	-1.52E-02	1.91E-03
84	1.52E-02	1.13E-03
85	4.55E-02	6.66E-04
86	7.58E-02	3.94E-04
87	0.10606	2.33E-04
88	0.13636	1.37E-04
89	0.16667	8.11E-05
90	0.19697	4.79E-05
91	0.22727	2.83E-05
92	0.25758	1.67E-05
93	0.28788	9.87E-06
94	0.31818	5.83E-06
95	0.34848	3.44E-06
96	0.37879	2.03E-06
97	0.40909	1.20E-06
98	0.43939	7.09E-07
99	0.4697	4.19E-07
100	0.5	2.47E-07

	X	Y
73	-0.31818	4.11E-01
74	-0.28788	3.22E-01
75	-0.25758	2.43E-01
76	-0.22727	1.75E-01
77	-0.19697	1.19E-01
78	-0.16667	7.31E-02
79	-0.13636	3.85E-02
80	-0.10606	1.49E-02
81	-7.58E-02	2.28E-03
82	-4.55E-02	0.00E+00
83	-1.52E-02	0.00E+00
84	1.52E-02	0.00E+00
85	4.55E-02	0.00E+00
86	7.58E-02	0.00E+00
87	0.10606	0.00E+00
88	0.13636	0.00E+00
89	0.16667	0.00E+00
90	0.19697	0.00E+00
91	0.22727	0.00E+00
92	0.25758	0.00E+00
93	0.28788	0.00E+00
94	0.31818	0.00E+00
95	0.34848	0.00E+00
96	0.37879	0.00E+00
97	0.40909	0.00E+00
98	0.43939	0.00E+00
99	0.4697	0.00E+00
100	0.5	0.00E+00

	X	Y
73	-0.31818	4.06E-01
74	-0.28788	3.06E-01
75	-0.25758	2.06E-01
76	-0.22727	1.06E-01
77	-0.19697	6.06E-03
78	-0.16667	0.00E+00
79	-0.13636	0.00E+00
80	-0.10606	0.00E+00
81	-7.58E-02	0.00E+00
82	-4.55E-02	0.00E+00
83	-1.52E-02	0.00E+00
84	1.52E-02	0.00E+00
85	4.55E-02	0.00E+00
86	7.58E-02	0.00E+00
87	0.10606	0.00E+00
88	0.13636	0.00E+00
89	0.16667	0.00E+00
90	0.19697	0.00E+00
91	0.22727	0.00E+00
92	0.25758	0.00E+00
93	0.28788	0.00E+00
94	0.31818	0.00E+00
95	0.34848	0.00E+00
96	0.37879	0.00E+00
97	0.40909	0.00E+00
98	0.43939	0.00E+00
99	0.4697	0.00E+00
100	0.5	0.00E+00

Table E2.D-8d. TRAP Model Output for Methylmercury Data for the Mammal Survival Endpoint (Pooling Group E: Mitsumori et al. 1983; Verschuuren et al. 1976b)

Chemical:	Mercury
Study Authors:	Pooling group E
Receptor Group:	Mammal
Effect Description:	Survival

Input Data:

Dose	Effect Relative to Control
1.00E-06	100
2.62E-02	100
0.13096	107.95
0.65479	28.409
1.00E-06	100
2.59E-02	108.33
0.12929	108.33
0.64647	33.333
1.00E-06	100
8.10E-03	78.947
4.05E-02	84.211
0.2025	73.684
0.000001	100.0
7.08E-03	94.444
3.54E-02	66.667
0.1769	66.667

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered			
Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			yes
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined			
Large Standard Error for X50			
Large Standard Error for Steepness			
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	-0.36035	-0.34511	9.07E-02	-5.41E-01	-0.14907
S	1.2775	1.24E+00	0.44876	0.27104	2.21
Y0	9.43E+01	9.50E+01	4.5166	85.213	104.73

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	-0.36035	-0.34567	8.51E-02	-5.30E-01	-0.16184
S	1.2775	1.35E+00	0.41605	0.44656	2.2442
Y0	9.43E+01	9.44E+01	4.3065	85.122	103.73

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	-0.36035	-0.37893	7.33E-02	-0.5372	-0.22066
S	1.2775	0.98137	0.2036	0.54153	1.4212
Y0	9.43E+01	9.44E+01	3.9775	85.794	102.98

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	0.45174	2.88E-01	0.70947	9.07E-02	-0.34511
20	2.37E-01	1.14E-01	4.95E-01	0.14772	-0.62448
10	1.63E-01	6.08E-02	4.37E-01	0.19809	-0.78791
5	1.15E-01	3.36E-02	3.96E-01	0.24795	-0.93849
0					

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	0.45116	2.95E-01	0.68891	8.51E-02	-0.34567
20	0.24051	1.31E-01	0.43999	0.12142	-0.61886
10	1.75E-01	8.14E-02	3.77E-01	0.15404	-0.75655
5	1.40E-01	5.68E-02	3.45E-01	0.1814	-0.85391
0	8.15E-02	1.69E-02	3.94E-01	0.31672	-1.09E+00

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	0.4179	0.29027	0.60164	7.33E-02	-0.37893
20	0.20672	0.14224	0.30042	7.52E-02	-0.68463
10	0.16348	0.10617	0.25173	8.68E-02	-0.78652
5	0.14539	9.12E-02	0.23187	9.38E-02	-0.83747
0	0.12929	7.80E-02	0.21423	0.10151	-0.88842

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	9.50E+01	1	-6.00E+00	1.00E+02	9.44E+01	1	-6.00E+00	1.00E+02	9.44E+01
2	-6.00E+00	1.00E+02	9.50E+01	2	-6.00E+00	1.00E+02	9.44E+01	2	-6.00E+00	1.00E+02	9.44E+01
3	-6.00E+00	1.00E+02	9.50E+01	3	-6.00E+00	1.00E+02	9.44E+01	3	-6.00E+00	1.00E+02	9.44E+01
4	-6.00E+00	1.00E+02	9.50E+01	4	-6.00E+00	1.00E+02	9.44E+01	4	-6.00E+00	1.00E+02	9.44E+01
5	-2.15E+00	94.4	94.958	5	-2.15E+00	94.4	94.426	5	-2.15E+00	94.4	94.387
6	-2.09E+00	78.9	94.954	6	-2.09E+00	78.9	94.426	6	-2.09E+00	78.9	94.387
7	-1.59E+00	108.3	94.771	7	-1.59E+00	108.3	94.426	7	-1.59E+00	108.3	94.387
8	-1.58E+00	100	94.765	8	-1.58E+00	100	94.426	8	-1.58E+00	100	94.387
9	-1.45E+00	66.7	94.579	9	-1.45E+00	66.7	94.426	9	-1.45E+00	66.7	94.387
10	-1.39E+00	84.2	94.448	10	-1.39E+00	84.2	94.426	10	-1.39E+00	84.2	94.387
11	-8.88E-01	108.3	88.967	11	-8.88E-01	108.3	90.989	11	-8.88E-01	108.3	94.387
12	-8.83E-01	108	88.81	12	-8.83E-01	108	90.796	12	-8.83E-01	108	93.873
13	-7.52E-01	66.7	83.851	13	-7.52E-01	66.7	84.738	13	-7.52E-01	66.7	81.775
14	-6.94E-01	73.7	80.658	14	-6.94E-01	73.7	81.067	14	-6.94E-01	73.7	76.339
15	-1.89E-01	33.3	30.007	15	-1.89E-01	33.3	29.452	15	-1.89E-01	33.3	29.642
16	-0.1839	28.4	29.444	16	-0.1839	28.4	28.898	16	-0.1839	28.4	29.128

Analysis of Variance

R-squared	0.733	R-squared	0.743	R-squared	0.779

	DF	SS	MS	F	Sig		DF	SS	MS	F	Sig		DF	SS	MS	F	Sig
Total (adj)	15	9534.7	635.65			Total (adj)	15	9534.7	635.65			Total (adj)	15	9534.7	635.65		
Regression	2	6986.3	3493.1	17.819	0.0002	Regression	2	7082.2	3541.1	18.77	0.0001	Regression	2	7432.2	3716.1	22.976	0.0001
Error	13	2548.5	196.04			Error	13	2452.5	188.66			Error	13	2102.6	161.74		

Prediction Line

	X	Y		X	Y		X	Y
1	-4	9.50E+01	1	-4	9.44E+01	1	-4	9.44E+01
2	-3.95E+00	9.50E+01	2	-3.95E+00	9.44E+01	2	-3.95E+00	9.44E+01
3	-3.91E+00	9.50E+01	3	-3.91E+00	9.44E+01	3	-3.91E+00	9.44E+01
4	-3.86E+00	9.50E+01	4	-3.86E+00	9.44E+01	4	-3.86E+00	9.44E+01
5	-3.82E+00	9.50E+01	5	-3.82E+00	9.44E+01	5	-3.82E+00	9.44E+01
6	-3.77E+00	9.50E+01	6	-3.77E+00	9.44E+01	6	-3.77E+00	9.44E+01
7	-3.73E+00	9.50E+01	7	-3.73E+00	9.44E+01	7	-3.73E+00	9.44E+01
8	-3.68E+00	9.50E+01	8	-3.68E+00	9.44E+01	8	-3.68E+00	9.44E+01
9	-3.64E+00	9.50E+01	9	-3.64E+00	9.44E+01	9	-3.64E+00	9.44E+01
10	-3.59E+00	9.50E+01	10	-3.59E+00	9.44E+01	10	-3.59E+00	9.44E+01
11	-3.55E+00	9.50E+01	11	-3.55E+00	9.44E+01	11	-3.55E+00	9.44E+01
12	-3.50E+00	9.50E+01	12	-3.50E+00	9.44E+01	12	-3.50E+00	9.44E+01
13	-3.45E+00	9.50E+01	13	-3.45E+00	9.44E+01	13	-3.45E+00	9.44E+01
14	-3.41E+00	9.50E+01	14	-3.41E+00	9.44E+01	14	-3.4091	9.44E+01
15	-3.36E+00	9.50E+01	15	-3.36E+00	9.44E+01	15	-3.3636	9.44E+01
16	-3.3182	9.50E+01	16	-3.3182	9.44E+01	16	-3.3182	9.44E+01
17	-3.2727	9.50E+01	17	-3.2727	9.44E+01	17	-3.2727	9.44E+01
18	-3.2273	9.50E+01	18	-3.2273	9.44E+01	18	-3.2273	9.44E+01
19	-3.1818	9.50E+01	19	-3.1818	9.44E+01	19	-3.1818	9.44E+01
20	-3.1364	9.50E+01	20	-3.1364	9.44E+01	20	-3.1364	9.44E+01
21	-3.09E+00	9.50E+01	21	-3.09E+00	9.44E+01	21	-3.09E+00	9.44E+01
22	-3.05E+00	9.50E+01	22	-3.05E+00	9.44E+01	22	-3.05E+00	9.44E+01
23	-3.00E+00	9.50E+01	23	-3.00E+00	9.44E+01	23	-3.00E+00	9.44E+01
24	-2.95E+00	9.50E+01	24	-2.95E+00	9.44E+01	24	-2.95E+00	9.44E+01
25	-2.91E+00	9.50E+01	25	-2.91E+00	9.44E+01	25	-2.91E+00	9.44E+01
26	-2.86E+00	9.50E+01	26	-2.86E+00	9.44E+01	26	-2.86E+00	9.44E+01
27	-2.82E+00	9.50E+01	27	-2.82E+00	9.44E+01	27	-2.82E+00	9.44E+01
28	-2.77E+00	9.50E+01	28	-2.77E+00	9.44E+01	28	-2.77E+00	9.44E+01
29	-2.73E+00	9.50E+01	29	-2.73E+00	9.44E+01	29	-2.73E+00	9.44E+01
30	-2.68E+00	9.50E+01	30	-2.68E+00	9.44E+01	30	-2.68E+00	9.44E+01
31	-2.6364	9.50E+01	31	-2.6364	9.44E+01	31	-2.6364	9.44E+01
32	-2.5909	9.50E+01	32	-2.5909	9.44E+01	32	-2.5909	9.44E+01
33	-2.5455	9.50E+01	33	-2.5455	9.44E+01	33	-2.5455	9.44E+01
34	-2.5	9.50E+01	34	-2.5	9.44E+01	34	-2.5	9.44E+01
35	-2.4545	9.50E+01	35	-2.4545	9.44E+01	35	-2.4545	9.44E+01
36	-2.4091	9.50E+01	36	-2.4091	9.44E+01	36	-2.4091	9.44E+01
37	-2.3636	9.50E+01	37	-2.3636	9.44E+01	37	-2.3636	9.44E+01
38	-2.3182	9.50E+01	38	-2.3182	9.44E+01	38	-2.3182	9.44E+01

Prediction Line

	X	Y		X	Y		X	Y
39	-2.2727	9.50E+01	39	-2.2727	9.44E+01	39	-2.2727	9.44E+01
40	-2.2273	9.50E+01	40	-2.2273	9.44E+01	40	-2.2273	9.44E+01
41	-2.1818	9.50E+01	41	-2.1818	9.44E+01	41	-2.1818	9.44E+01
42	-2.1364	9.50E+01	42	-2.1364	9.44E+01	42	-2.1364	9.44E+01
43	-2.0909	9.50E+01	43	-2.0909	9.44E+01	43	-2.0909	9.44E+01
44	-2.0455	9.49E+01	44	-2.0455	9.44E+01	44	-2.0455	9.44E+01
45	-2	9.49E+01	45	-2	9.44E+01	45	-2	9.44E+01
46	-1.9545	9.49E+01	46	-1.9545	9.44E+01	46	-1.9545	9.44E+01
47	-1.9091	9.49E+01	47	-1.9091	9.44E+01	47	-1.9091	9.44E+01
48	-1.8636	9.49E+01	48	-1.8636	9.44E+01	48	-1.8636	9.44E+01
49	-1.8182	9.49E+01	49	-1.8182	9.44E+01	49	-1.8182	9.44E+01
50	-1.7727	9.49E+01	50	-1.7727	9.44E+01	50	-1.7727	9.44E+01
51	-1.7273	9.49E+01	51	-1.7273	9.44E+01	51	-1.7273	9.44E+01
52	-1.6818	9.48E+01	52	-1.6818	9.44E+01	52	-1.6818	9.44E+01
53	-1.6364	9.48E+01	53	-1.6364	9.44E+01	53	-1.6364	9.44E+01
54	-1.5909	9.48E+01	54	-1.5909	9.44E+01	54	-1.5909	9.44E+01
55	-1.5455	9.47E+01	55	-1.5455	9.44E+01	55	-1.5455	9.44E+01
56	-1.5	9.47E+01	56	-1.5	9.44E+01	56	-1.5	9.44E+01
57	-1.4545	9.46E+01	57	-1.4545	9.44E+01	57	-1.4545	9.44E+01
58	-1.4091	9.45E+01	58	-1.4091	9.44E+01	58	-1.4091	9.44E+01
59	-1.3636	9.44E+01	59	-1.3636	9.44E+01	59	-1.3636	9.44E+01
60	-1.3182	9.42E+01	60	-1.3182	9.44E+01	60	-1.3182	9.44E+01
61	-1.2727	9.40E+01	61	-1.2727	9.44E+01	61	-1.2727	9.44E+01
62	-1.2273	9.38E+01	62	-1.2273	9.44E+01	62	-1.2273	9.44E+01
63	-1.1818	9.35E+01	63	-1.1818	9.44E+01	63	-1.1818	9.44E+01
64	-1.1364	9.31E+01	64	-1.1364	9.44E+01	64	-1.1364	9.44E+01
65	-1.0909	9.27E+01	65	-1.0909	9.44E+01	65	-1.0909	9.44E+01
66	-1.0455	9.21E+01	66	-1.0455	9.43E+01	66	-1.0455	9.44E+01
67	-1	9.14E+01	67	-1	9.38E+01	67	-1	9.44E+01
68	-0.95455	9.06E+01	68	-0.95455	9.29E+01	68	-0.95455	9.44E+01
69	-0.90909	8.95E+01	69	-0.90909	9.17E+01	69	-0.90909	9.44E+01
70	-0.86364	8.82E+01	70	-0.86364	9.01E+01	70	-0.86364	9.21E+01
71	-0.81818	8.67E+01	71	-0.81818	8.82E+01	71	-0.81818	8.79E+01
72	-0.77273	8.48E+01	72	-0.77273	8.59E+01	72	-0.77273	8.37E+01
73	-0.72727	8.26E+01	73	-0.72727	8.32E+01	73	-0.72727	7.95E+01
74	-0.68182	7.99E+01	74	-0.68182	8.03E+01	74	-0.68182	7.53E+01
75	-0.63636	7.69E+01	75	-0.63636	7.69E+01	75	-0.63636	7.10E+01
76	-0.59091	7.33E+01	76	-0.59091	7.32E+01	76	-0.59091	6.68E+01
77	-0.54545	6.93E+01	77	-0.54545	6.92E+01	77	-0.54545	6.26E+01
78	-0.5	6.49E+01	78	-0.5	6.48E+01	78	-0.5	5.84E+01
79	-0.45455	6.01E+01	79	-0.45455	6.00E+01	79	-0.45455	5.42E+01
80	-0.40909	5.50E+01	80	-0.40909	5.49E+01	80	-0.40909	5.00E+01
81	-0.36364	4.97E+01	81	-0.36364	4.95E+01	81	-0.36364	4.58E+01
82	-0.31818	4.43E+01	82	-0.31818	4.38E+01	82	-0.31818	4.16E+01
83	-0.27273	3.90E+01	83	-0.27273	3.84E+01	83	-0.27273	3.74E+01
84	-0.22727	3.40E+01	84	-0.22727	3.34E+01	84	-0.22727	3.31E+01
85	-0.18182	2.92E+01	85	-0.18182	2.87E+01	85	-0.18182	2.89E+01
86	-0.13636	2.49E+01	86	-0.13636	2.44E+01	86	-0.13636	2.47E+01
87	-9.09E-02	2.10E+01	87	-9.09E-02	2.04E+01	87	-9.09E-02	2.05E+01
88	-4.55E-02	1.75E+01	88	-4.55E-02	1.68E+01	88	-4.55E-02	1.63E+01
89	0	1.45E+01	89	0	1.35E+01	89	0	1.21E+01
90	4.55E-02	1.20E+01	90	4.55E-02	1.06E+01	90	4.55E-02	7.88E+00
91	9.09E-02	9.79E+00	91	9.09E-02	8.04E+00	91	9.09E-02	3.67E+00
92	0.13636	7.98E+00	92	0.13636	5.83E+00	92	0.13636	0.00E+00
93	0.18182	6.48E+00	93	0.18182	3.98E+00	93	0.18182	0.00E+00
94	0.22727	5.24E+00	94	0.22727	2.48E+00	94	0.22727	0.00E+00
95	0.27273	4.23E+00	95	0.27273	1.33E+00	95	0.27273	0.00E+00
96	0.31818	3.41E+00	96	0.31818	5.39E-01	96	0.31818	0.00E+00
97	0.36364	2.74E+00	97	0.36364	9.87E-02	97	0.36364	0.00E+00
98	0.40909	2.20E+00	98	0.40909	0.00E+00	98	0.40909	0.00E+00
99	0.45455	1.76E+00	99	0.45455	0.00E+00	99	0.45455	0.00E+00
100	0.5	1.41E+00	100	0.5	0.00E+00	100	0.5	0.00E+00

Table E2.D-9a. TRAP Model Output for Molybdenum Data for the Bird Growth Endpoint (Pooling Group A: Davies et al. 1960)

Chemical:	Molybdenum
Study Authors:	Pooling group A
Receptor Group:	Bird
Effect Description:	Growth

Input Data:

Dose	Effect Relative to Control
0.000001	100
55.85317	88.920
83.77976	77.841
111.7063	73.864
139.6329	74.716
167.5595	65.341
0.000001	100
223.4127	64.452
446.8254	34.219
670.2381	21.262
893.6508	15.615

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?
Use Only for Exploratory Data Analysis!
Maximum Iterations Reached Without Convergence
X50 at Maximum or Minimum Limit
Steepness At Maximum Or Minimum Limit
Error Estimates Cannot Be Determined
Large Standard Error for X50
Large Standard Error for Steepness
Large Standard Error for Y0
Inadequate Number of Partial Effects
Insufficient Data to Plot
Insufficient Data to Analyze

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	2.4294	2.4557	3.01E-02	2.3862	2.5251
S	0.75981	7.83E-01	6.14E-02	0.64146	0.92459
Y0	1.00E+02	9.87E+01	2.4568	93.04	104.37

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	2.4294	2.4528	3.09E-02	2.3815	2.524
S	0.75981	8.18E-01	6.17E-02	0.6755	0.96001
Y0	1.00E+02	9.88E+01	2.54	92.945	104.66

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	2.4294	2.4342	3.82E-02	2.346	2.5224
S	0.75981	0.63458	4.73E-02	0.52549	0.74368
Y0	1.00E+02	1.00E+02	3.4606	92.02	107.98

Xp Estimates

1504.991

#REF!

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	285.54	243.34	335.07	3.01E-02	2.4557
20	1.03E+02	7.91E+01	1.34E+02	4.99E-02	2.0131
10	5.68E+01	3.97E+01	8.12E+01	6.74E-02	1.7542
5	3.28E+01	2.09E+01	5.14E+01	8.46E-02	1.5156
0					

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	283.63	240.72	334.19	3.09E-02	2.4528
20	100.76	7.70E+01	131.85	5.06E-02	2.0033
10	5.98E+01	4.15E+01	8.63E+01	6.90E-02	1.7768
5	41.362	2.60E+01	6.57E+01	8.71E-02	1.6166
0	16.978	7.05E+00	4.09E+01	0.16558	1.23E+00

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	271.76	221.81	332.96	3.82E-02	2.4342
20	91.505	68.022	123.09	5.59E-02	1.9614
10	63.659	45.081	89.893	6.50E-02	1.8039
5	53.097	36.643	76.939	6.99E-02	1.7251
0	44.287	29.761	65.902	7.49E-02	1.6463

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	9.87E+01
2	-6.00E+00	1.00E+02	9.87E+01
3	1.75E+00	8.89E+01	8.90E+01
4	1.92E+00	7.78E+01	8.30E+01
5	2.05E+00	73.864	77.175
6	2.15E+00	74.716	71.634
7	2.22E+00	65.341	66.5
8	2.35E+00	64.452	57.513
9	2.65E+00	34.219	34.771
10	2.83E+00	21.262	23.546
11	2.9512	15.615	17.254

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	9.88E+01
2	-6.00E+00	1.00E+02	9.88E+01
3	1.75E+00	8.89E+01	9.00E+01
4	1.92E+00	7.78E+01	8.29E+01
5	2.05E+00	73.864	76.688
6	2.15E+00	74.716	71.139
7	2.22E+00	65.341	66.144
8	2.35E+00	64.452	57.421
9	2.65E+00	34.219	34.741
10	2.83E+00	21.262	23.834
11	2.9512	15.615	17.338

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	1.00E+02
2	-6.00E+00	1.00E+02	1.00E+02
3	1.75E+00	8.89E+01	9.36E+01
4	1.92E+00	7.78E+01	8.24E+01
5	2.05E+00	73.864	74.502
6	2.15E+00	74.716	68.353
7	2.22E+00	65.341	63.328
8	2.35E+00	64.452	55.399
9	2.65E+00	34.219	36.296
10	2.83E+00	21.262	25.122
11	2.9512	15.615	17.194

Analysis of Variance

R-squared: 0.987

	DF	SS	MS	F	Sig
Total (adj)	10	8659.7	865.97		
Regression	2	8551.1	4275.5	315.05	0
Error	8	108.57	13.571		

R-squared: 0.987

	DF	SS	MS	F	Sig
Total (adj)	10	8659.7	865.97		
Regression	2	8549.1	4274.6	309.39	0
Error	8	110.53	13.816		

R-squared: 0.978

	DF	SS	MS	F	Sig
Total (adj)	10	8659.7	865.97		
Regression	2	8468	4234	176.77	0
Error	8	191.62	23.952		

Prediction Line

	X	Y
1	-1	9.87E+01
2	-9.55E-01	9.87E+01
3	-9.09E-01	9.87E+01
4	-8.64E-01	9.87E+01
5	-8.18E-01	9.87E+01
6	-7.73E-01	9.87E+01
7	-7.27E-01	9.87E+01
8	-6.82E-01	9.87E+01
9	-6.36E-01	9.87E+01
10	-5.91E-01	9.87E+01
11	-5.45E-01	9.87E+01
12	-5.00E-01	9.87E+01
13	-4.55E-01	9.87E+01
14	-0.40909	9.87E+01
15	-0.36364	9.87E+01
16	-0.31818	9.87E+01
17	-0.27273	9.87E+01
18	-0.22727	9.87E+01
19	-0.18182	9.87E+01
20	-0.13636	9.87E+01
21	-9.09E-02	9.87E+01
22	-4.55E-02	9.87E+01
23	0.00E+00	9.87E+01
24	4.55E-02	9.87E+01
25	9.09E-02	9.86E+01
26	1.36E-01	9.86E+01
27	1.82E-01	9.86E+01
28	2.27E-01	9.86E+01
29	2.73E-01	9.86E+01
30	3.18E-01	9.86E+01
31	0.36364	9.86E+01
32	0.40909	9.85E+01
33	0.45455	9.85E+01
34	0.5	9.85E+01
35	0.54545	9.85E+01
36	0.59091	9.84E+01
37	0.63636	9.84E+01
38	0.68182	9.83E+01
39	0.72727	9.83E+01
40	0.77273	9.82E+01
41	0.81818	9.81E+01
42	0.86364	9.80E+01
43	0.90909	9.79E+01
44	0.95455	9.78E+01
45	1	9.77E+01
46	1.0455	9.75E+01
47	1.0909	9.74E+01
48	1.1364	9.71E+01
49	1.1818	9.69E+01
50	1.2273	9.66E+01
51	1.2727	9.63E+01
52	1.3182	9.60E+01
53	1.3636	9.56E+01
54	1.4091	9.51E+01
55	1.4545	9.46E+01
56	1.5	9.40E+01
57	1.5455	9.33E+01
58	1.5909	9.25E+01
59	1.6364	9.17E+01
60	1.6818	9.07E+01
61	1.7273	8.96E+01
62	1.7727	8.83E+01
63	1.8182	8.69E+01
64	1.8636	8.53E+01
65	1.9091	8.36E+01
66	1.9545	8.17E+01
67	2	7.96E+01

	X	Y
1	-1	9.88E+01
2	-9.55E-01	9.88E+01
3	-9.09E-01	9.88E+01
4	-8.64E-01	9.88E+01
5	-8.18E-01	9.88E+01
6	-7.73E-01	9.88E+01
7	-7.27E-01	9.88E+01
8	-6.82E-01	9.88E+01
9	-6.36E-01	9.88E+01
10	-5.91E-01	9.88E+01
11	-5.45E-01	9.88E+01
12	-5.00E-01	9.88E+01
13	-4.55E-01	9.88E+01
14	-0.40909	9.88E+01
15	-0.36364	9.88E+01
16	-0.31818	9.88E+01
17	-0.27273	9.88E+01
18	-0.22727	9.88E+01
19	-0.18182	9.88E+01
20	-0.13636	9.88E+01
21	-9.09E-02	9.88E+01
22	-4.55E-02	9.88E+01
23	0.00E+00	9.88E+01
24	4.55E-02	9.88E+01
25	9.09E-02	9.88E+01
26	1.36E-01	9.88E+01
27	1.82E-01	9.88E+01
28	2.27E-01	9.88E+01
29	2.73E-01	9.88E+01
30	3.18E-01	9.88E+01
31	0.36364	9.88E+01
32	0.40909	9.88E+01
33	0.45455	9.88E+01
34	0.5	9.88E+01
35	0.54545	9.88E+01
36	0.59091	9.88E+01
37	0.63636	9.88E+01
38	0.68182	9.88E+01
39	0.72727	9.88E+01
40	0.77273	9.88E+01
41	0.81818	9.88E+01
42	0.86364	9.88E+01
43	0.90909	9.88E+01
44	0.95455	9.88E+01
45	1	9.88E+01
46	1.0455	9.88E+01
47	1.0909	9.88E+01
48	1.1364	9.88E+01
49	1.1818	9.88E+01
50	1.2273	9.88E+01
51	1.2727	9.87E+01
52	1.3182	9.85E+01
53	1.3636	9.82E+01
54	1.4091	9.77E+01
55	1.4545	9.71E+01
56	1.5	9.64E+01
57	1.5455	9.55E+01
58	1.5909	9.45E+01
59	1.6364	9.33E+01
60	1.6818	9.21E+01
61	1.7273	9.06E+01
62	1.7727	8.91E+01
63	1.8182	8.74E+01
64	1.8636	8.55E+01
65	1.9091	8.36E+01
66	1.9545	8.15E+01
67	2	7.92E+01

	X	Y
1	-1	1.00E+02
2	-9.55E-01	1.00E+02
3	-9.09E-01	1.00E+02
4	-8.64E-01	1.00E+02
5	-8.18E-01	1.00E+02
6	-7.73E-01	1.00E+02
7	-7.27E-01	1.00E+02
8	-6.82E-01	1.00E+02
9	-6.36E-01	1.00E+02
10	-5.91E-01	1.00E+02
11	-5.45E-01	1.00E+02
12	-5.00E-01	1.00E+02
13	-4.55E-01	1.00E+02
14	-0.40909	1.00E+02
15	-0.36364	1.00E+02
16	-0.31818	1.00E+02
17	-0.27273	1.00E+02
18	-0.22727	1.00E+02
19	-0.18182	1.00E+02
20	-0.13636	1.00E+02
21	-9.09E-02	1.00E+02
22	-4.55E-02	1.00E+02
23	0.00E+00	1.00E+02
24	4.55E-02	1.00E+02
25	9.09E-02	1.00E+02
26	1.36E-01	1.00E+02
27	1.82E-01	1.00E+02
28	2.27E-01	1.00E+02
29	2.73E-01	1.00E+02
30	3.18E-01	1.00E+02
31	0.36364	1.00E+02
32	0.40909	1.00E+02
33	0.45455	1.00E+02
34	0.5	1.00E+02
35	0.54545	1.00E+02
36	0.59091	1.00E+02
37	0.63636	1.00E+02
38	0.68182	1.00E+02
39	0.72727	1.00E+02
40	0.77273	1.00E+02
41	0.81818	1.00E+02
42	0.86364	1.00E+02
43	0.90909	1.00E+02
44	0.95455	1.00E+02
45	1	1.00E+02
46	1.0455	1.00E+02
47	1.0909	1.00E+02
48	1.1364	1.00E+02
49	1.1818	1.00E+02
50	1.2273	1.00E+02
51	1.2727	1.00E+02
52	1.3182	1.00E+02
53	1.3636	1.00E+02
54	1.4091	1.00E+02
55	1.4545	1.00E+02
56	1.5	1.00E+02
57	1.5455	1.00E+02
58	1.5909	1.00E+02
59	1.6364	1.00E+02
60	1.6818	9.77E+01
61	1.7273	9.49E+01
62	1.7727	9.20E+01
63	1.8182	8.91E+01
64	1.8636	8.62E+01
65	1.9091	8.33E+01
66	1.9545	8.04E+01
67	2	7.76E+01

Prediction Line

	X	Y
68	2.0455	7.73E+01
69	2.0909	7.48E+01
70	2.1364	7.22E+01
71	2.1818	6.93E+01
72	2.2273	6.63E+01
73	2.2727	6.31E+01
74	2.3182	5.98E+01
75	2.3636	5.64E+01
76	2.4091	5.29E+01
77	2.4545	4.94E+01
78	2.5	4.59E+01
79	2.5455	4.25E+01
80	2.5909	3.91E+01
81	2.6364	3.57E+01
82	2.6818	3.26E+01
83	2.7273	2.95E+01
84	2.7727	2.67E+01
85	2.8182	2.40E+01
86	2.8636	2.15E+01
87	2.9091	1.92E+01
88	2.9545	1.71E+01
89	3	1.52E+01
90	3.0455	1.34E+01
91	3.0909	1.19E+01
92	3.1364	1.05E+01
93	3.1818	9.21E+00
94	3.2273	8.08E+00
95	3.2727	7.09E+00
96	3.3182	6.21E+00
97	3.3636	5.43E+00
98	3.4091	4.74E+00
99	3.4545	4.14E+00
100	3.5	3.61E+00

	X	Y
68	2.0455	7.68E+01
69	2.0909	7.43E+01
70	2.1364	7.17E+01
71	2.1818	6.89E+01
72	2.2273	6.59E+01
73	2.2727	6.29E+01
74	2.3182	5.97E+01
75	2.3636	5.63E+01
76	2.4091	5.29E+01
77	2.4545	4.93E+01
78	2.5	4.57E+01
79	2.5455	4.22E+01
80	2.5909	3.89E+01
81	2.6364	3.57E+01
82	2.6818	3.26E+01
83	2.7273	2.97E+01
84	2.7727	2.69E+01
85	2.8182	2.43E+01
86	2.8636	2.18E+01
87	2.9091	1.94E+01
88	2.9545	1.72E+01
89	3	1.51E+01
90	3.0455	1.31E+01
91	3.0909	1.13E+01
92	3.1364	9.61E+00
93	3.1818	8.06E+00
94	3.2273	6.64E+00
95	3.2727	5.36E+00
96	3.3182	4.22E+00
97	3.3636	3.22E+00
98	3.4091	2.35E+00
99	3.4545	1.61E+00
100	3.5	1.02E+00

	X	Y
68	2.0455	7.47E+01
69	2.0909	7.18E+01
70	2.1364	6.89E+01
71	2.1818	6.60E+01
72	2.2273	6.31E+01
73	2.2727	6.02E+01
74	2.3182	5.74E+01
75	2.3636	5.45E+01
76	2.4091	5.16E+01
77	2.4545	4.87E+01
78	2.5	4.58E+01
79	2.5455	4.29E+01
80	2.5909	4.01E+01
81	2.6364	3.72E+01
82	2.6818	3.43E+01
83	2.7273	3.14E+01
84	2.7727	2.85E+01
85	2.8182	2.56E+01
86	2.8636	2.27E+01
87	2.9091	1.99E+01
88	2.9545	1.70E+01
89	3	1.41E+01
90	3.0455	1.12E+01
91	3.0909	8.33E+00
92	3.1364	5.44E+00
93	3.1818	2.56E+00
94	3.2273	0.00E+00
95	3.2727	0.00E+00
96	3.3182	0.00E+00
97	3.3636	0.00E+00
98	3.4091	0.00E+00
99	3.4545	0.00E+00
100	3.5	0.00E+00

Table E2.D-9b. TRAP Model Output for Molybdenum Data for the Bird Reproduction Endpoint (Lepore and Miller 1965)

Chemical:	Molybdenum
Study Authors:	Lepore and Miller 1965
Receptor Group:	Bird
Effect Description:	Reproduction

Input Data:

Dose	Effect	SE
0.000001	15.6	not reported
31.53449	13.3	not reported
63.06898	8	not reported
126.138	2.8	not reported

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			yes
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined	yes	yes	yes
Large Standard Error for X50			
Large Standard Error for Steepness			
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.8174	1.8126			
S	1.3598	1.35E+00			
Y0	1.56E+01	1.56E+01			

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.8174	1.8122			
S	1.3598	1.42E+00			
Y0	1.56E+01	1.56E+01			

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.8174	1.8132			
S	1.3598	1.118			
Y0	1.56E+01	1.56E+01			

Xp Estimates

483.784

#REF!

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	64.954	52.497	80.368	7.28E-03	1.8126
20	3.60E+01	2.48E+01	5.22E+01	1.27E-02	1.556
10	2.55E+01	1.54E+01	4.21E+01	1.72E-02	1.4059
5	1.85E+01	9.85E+00	3.48E+01	2.16E-02	1.2676
0					

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	64.892	53.582	78.589	6.55E-03	1.8122
20	35.733	2.55E+01	49.983	1.15E-02	1.5531
10	2.65E+01	1.66E+01	4.22E+01	1.59E-02	1.4225
5	21.386	1.18E+01	3.86E+01	2.02E-02	1.3301
0	12.799	4.80E+00	3.41E+01	3.35E-02	1.11E+00

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	65.042	61.725	68.538	1.79E-03	1.8132
20	35.063	32.398	37.947	2.70E-03	1.5448
10	28.536	26.033	31.281	3.14E-03	1.4554
5	25.744	23.327	28.411	3.37E-03	1.4107
0	23.225	20.9	25.808	3.61E-03	1.366

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.56E+01	1.56E+01
2	1.50E+00	1.33E+01	1.32E+01
3	1.80E+00	8.00E+00	8.09E+00
4	2.10E+00	2.80E+00	2.72E+00
5			
6			

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.56E+01	1.56E+01
2	1.50E+00	1.33E+01	1.32E+01
3	1.80E+00	8.00E+00	8.09E+00
4	2.10E+00	2.80E+00	2.73E+00
5			
6			

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.56E+01	1.56E+01
2	1.50E+00	1.33E+01	1.33E+01
3	1.80E+00	8.00E+00	8.03E+00
4	2.10E+00	2.80E+00	2.78E+00
5			
6			

Analysis of Variance

R-squared: 1

	DF	SS	MS	F	Sig
Total (adj)	3	98.068	32.689		
Regression	2	98.044	49.022	2127.2	0.0153
Error	1	2.30E-02	2.30E-02		

R-squared: 1

	DF	SS	MS	F	Sig
Total (adj)	3	98.068	32.689		
Regression	2	98.047	49.023	2383.9	0.0145
Error	1	2.06E-02	2.06E-02		

R-squared: 1

	DF	SS	MS	F	Sig
Total (adj)	3	98.068	32.689		
Regression	2	98.066	49.033	29419	0.0041
Error	1	1.67E-03	1.67E-03		

Prediction Line

	X	Y		X	Y		X	Y
1	-2	1.56E+01	1	-2	1.56E+01	1	-2	1.56E+01
2	-1.95E+00	1.56E+01	2	-1.95E+00	1.56E+01	2	-1.95E+00	1.56E+01
3	-1.91E+00	1.56E+01	3	-1.91E+00	1.56E+01	3	-1.91E+00	1.56E+01
4	-1.86E+00	1.56E+01	4	-1.86E+00	1.56E+01	4	-1.86E+00	1.56E+01
5	-1.82E+00	1.56E+01	5	-1.82E+00	1.56E+01	5	-1.82E+00	1.56E+01
6	-1.77E+00	1.56E+01	6	-1.77E+00	1.56E+01	6	-1.77E+00	1.56E+01
7	-1.73E+00	1.56E+01	7	-1.73E+00	1.56E+01	7	-1.73E+00	1.56E+01
8	-1.68E+00	1.56E+01	8	-1.68E+00	1.56E+01	8	-1.68E+00	1.56E+01
9	-1.64E+00	1.56E+01	9	-1.64E+00	1.56E+01	9	-1.64E+00	1.56E+01
10	-1.59E+00	1.56E+01	10	-1.59E+00	1.56E+01	10	-1.59E+00	1.56E+01
11	-1.55E+00	1.56E+01	11	-1.55E+00	1.56E+01	11	-1.55E+00	1.56E+01
12	-1.50E+00	1.56E+01	12	-1.50E+00	1.56E+01	12	-1.50E+00	1.56E+01
13	-1.45E+00	1.56E+01	13	-1.45E+00	1.56E+01	13	-1.45E+00	1.56E+01
14	-1.4091	1.56E+01	14	-1.4091	1.56E+01	14	-1.4091	1.56E+01
15	-1.3636	1.56E+01	15	-1.3636	1.56E+01	15	-1.3636	1.56E+01
16	-1.3182	1.56E+01	16	-1.3182	1.56E+01	16	-1.3182	1.56E+01
17	-1.2727	1.56E+01	17	-1.2727	1.56E+01	17	-1.2727	1.56E+01
18	-1.2273	1.56E+01	18	-1.2273	1.56E+01	18	-1.2273	1.56E+01
19	-1.1818	1.56E+01	19	-1.1818	1.56E+01	19	-1.1818	1.56E+01
20	-1.1364	1.56E+01	20	-1.1364	1.56E+01	20	-1.1364	1.56E+01
21	-1.09E+00	1.56E+01	21	-1.09E+00	1.56E+01	21	-1.09E+00	1.56E+01
22	-1.05E+00	1.56E+01	22	-1.05E+00	1.56E+01	22	-1.05E+00	1.56E+01
23	-1.00E+00	1.56E+01	23	-1.00E+00	1.56E+01	23	-1.00E+00	1.56E+01
24	-9.55E-01	1.56E+01	24	-9.55E-01	1.56E+01	24	-9.55E-01	1.56E+01
25	-9.09E-01	1.56E+01	25	-9.09E-01	1.56E+01	25	-9.09E-01	1.56E+01
26	-8.64E-01	1.56E+01	26	-8.64E-01	1.56E+01	26	-8.64E-01	1.56E+01
27	-8.18E-01	1.56E+01	27	-8.18E-01	1.56E+01	27	-8.18E-01	1.56E+01
28	-7.73E-01	1.56E+01	28	-7.73E-01	1.56E+01	28	-7.73E-01	1.56E+01
29	-7.27E-01	1.56E+01	29	-7.27E-01	1.56E+01	29	-7.27E-01	1.56E+01
30	-6.82E-01	1.56E+01	30	-6.82E-01	1.56E+01	30	-6.82E-01	1.56E+01
31	-0.63636	1.56E+01	31	-0.63636	1.56E+01	31	-0.63636	1.56E+01
32	-0.59091	1.56E+01	32	-0.59091	1.56E+01	32	-0.59091	1.56E+01
33	-0.54545	1.56E+01	33	-0.54545	1.56E+01	33	-0.54545	1.56E+01
34	-0.5	1.56E+01	34	-0.5	1.56E+01	34	-0.5	1.56E+01
35	-0.45455	1.56E+01	35	-0.45455	1.56E+01	35	-0.45455	1.56E+01
36	-0.40909	1.56E+01	36	-0.40909	1.56E+01	36	-0.40909	1.56E+01
37	-0.36364	1.56E+01	37	-0.36364	1.56E+01	37	-0.36364	1.56E+01
38	-0.31818	1.56E+01	38	-0.31818	1.56E+01	38	-0.31818	1.56E+01
39	-0.27273	1.56E+01	39	-0.27273	1.56E+01	39	-0.27273	1.56E+01
40	-0.22727	1.56E+01	40	-0.22727	1.56E+01	40	-0.22727	1.56E+01
41	-0.18182	1.56E+01	41	-0.18182	1.56E+01	41	-0.18182	1.56E+01
42	-0.13636	1.56E+01	42	-0.13636	1.56E+01	42	-0.13636	1.56E+01
43	-9.09E-02	1.56E+01	43	-9.09E-02	1.56E+01	43	-9.09E-02	1.56E+01
44	-4.55E-02	1.56E+01	44	-4.55E-02	1.56E+01	44	-4.55E-02	1.56E+01
45	0	1.56E+01	45	0	1.56E+01	45	0	1.56E+01
46	4.55E-02	1.56E+01	46	4.55E-02	1.56E+01	46	4.55E-02	1.56E+01
47	9.09E-02	1.56E+01	47	9.09E-02	1.56E+01	47	9.09E-02	1.56E+01
48	0.13636	1.56E+01	48	0.13636	1.56E+01	48	0.13636	1.56E+01
49	0.18182	1.56E+01	49	0.18182	1.56E+01	49	0.18182	1.56E+01
50	0.22727	1.56E+01	50	0.22727	1.56E+01	50	0.22727	1.56E+01
51	0.27273	1.56E+01	51	0.27273	1.56E+01	51	0.27273	1.56E+01
52	0.31818	1.56E+01	52	0.31818	1.56E+01	52	0.31818	1.56E+01
53	0.36364	1.56E+01	53	0.36364	1.56E+01	53	0.36364	1.56E+01
54	0.40909	1.56E+01	54	0.40909	1.56E+01	54	0.40909	1.56E+01
55	0.45455	1.56E+01	55	0.45455	1.56E+01	55	0.45455	1.56E+01
56	0.5	1.56E+01	56	0.5	1.56E+01	56	0.5	1.56E+01
57	0.54545	1.56E+01	57	0.54545	1.56E+01	57	0.54545	1.56E+01
58	0.59091	1.56E+01	58	0.59091	1.56E+01	58	0.59091	1.56E+01
59	0.63636	1.56E+01	59	0.63636	1.56E+01	59	0.63636	1.56E+01
60	0.68182	1.56E+01	60	0.68182	1.56E+01	60	0.68182	1.56E+01
61	0.72727	1.56E+01	61	0.72727	1.56E+01	61	0.72727	1.56E+01
62	0.77273	1.56E+01	62	0.77273	1.56E+01	62	0.77273	1.56E+01
63	0.81818	1.56E+01	63	0.81818	1.56E+01	63	0.81818	1.56E+01
64	0.86364	1.55E+01	64	0.86364	1.56E+01	64	0.86364	1.56E+01
65	0.90909	1.55E+01	65	0.90909	1.56E+01	65	0.90909	1.56E+01
66	0.95455	1.55E+01	66	0.95455	1.56E+01	66	0.95455	1.56E+01
67	1	1.54E+01	67	1	1.56E+01	67	1	1.56E+01
68	1.0455	1.54E+01	68	1.0455	1.56E+01	68	1.0455	1.56E+01
69	1.0909	1.53E+01	69	1.0909	1.56E+01	69	1.0909	1.56E+01

Prediction Line

	X	Y
70	1.1364	1.52E+01
71	1.1818	1.51E+01
72	1.2273	1.50E+01
73	1.2727	1.48E+01
74	1.3182	1.46E+01
75	1.3636	1.44E+01
76	1.4091	1.41E+01
77	1.4545	1.37E+01
78	1.5	1.32E+01
79	1.5455	1.27E+01
80	1.5909	1.20E+01
81	1.6364	1.13E+01
82	1.6818	1.05E+01
83	1.7273	9.59E+00
84	1.7727	8.66E+00
85	1.8182	7.70E+00
86	1.8636	6.75E+00
87	1.9091	5.83E+00
88	1.9545	4.96E+00
89	2	4.17E+00
90	2.0455	3.46E+00
91	2.0909	2.84E+00
92	2.1364	2.32E+00
93	2.1818	1.87E+00
94	2.2273	1.50E+00
95	2.2727	1.20E+00
96	2.3182	9.56E-01
97	2.3636	7.58E-01
98	2.4091	5.99E-01
99	2.4545	4.73E-01
100	2.5	3.72E-01

	X	Y
70	1.1364	1.56E+01
71	1.1818	1.55E+01
72	1.2273	1.54E+01
73	1.2727	1.52E+01
74	1.3182	1.49E+01
75	1.3636	1.46E+01
76	1.4091	1.42E+01
77	1.4545	1.37E+01
78	1.5	1.32E+01
79	1.5455	1.26E+01
80	1.5909	1.20E+01
81	1.6364	1.12E+01
82	1.6818	1.04E+01
83	1.7273	9.59E+00
84	1.7727	8.67E+00
85	1.8182	7.68E+00
86	1.8636	6.72E+00
87	1.9091	5.82E+00
88	1.9545	4.98E+00
89	2	4.21E+00
90	2.0455	3.50E+00
91	2.0909	2.86E+00
92	2.1364	2.28E+00
93	2.1818	1.77E+00
94	2.2273	1.32E+00
95	2.2727	9.40E-01
96	2.3182	6.23E-01
97	2.3636	3.71E-01
98	2.4091	1.84E-01
99	2.4545	6.17E-02
100	2.5	4.66E-03

	X	Y
70	1.1364	1.56E+01
71	1.1818	1.56E+01
72	1.2273	1.56E+01
73	1.2727	1.56E+01
74	1.3182	1.56E+01
75	1.3636	1.56E+01
76	1.4091	1.48E+01
77	1.4545	1.41E+01
78	1.5	1.33E+01
79	1.5455	1.25E+01
80	1.5909	1.17E+01
81	1.6364	1.09E+01
82	1.6818	1.01E+01
83	1.7273	9.30E+00
84	1.7727	8.51E+00
85	1.8182	7.71E+00
86	1.8636	6.92E+00
87	1.9091	6.13E+00
88	1.9545	5.33E+00
89	2	4.54E+00
90	2.0455	3.75E+00
91	2.0909	2.96E+00
92	2.1364	2.16E+00
93	2.1818	1.37E+00
94	2.2273	5.78E-01
95	2.2727	0.00E+00
96	2.3182	0.00E+00
97	2.3636	0.00E+00
98	2.4091	0.00E+00
99	2.4545	0.00E+00
100	2.5	0.00E+00

Table E2.D-9c. TRAP Model Output for Molybdenum Data for the Bird Suvival Endpoint (Davies et al. 1960)

Chemical:	Molybdenum
Study Authors:	Davies et al. 1960
Receptor Group:	Bird
Effect Description:	Survival

Input Data:

Dose	# of Org w/o response	Total # of Org	Survival
0.000001	19	19	1
223.4127	17.86	19	0.94
446.8254	17.86	19	0.94
670.2381	12.73	19	0.67
893.6508	7.41	19	0.39

Modeling Parameters

Analysis Type:	Tolerance Distribution	Tolerance Distribution	Tolerance Distribution
Model Shape:	Gaussian Distribution	Triangular Distribution	Rectangular Distribution
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm
Error Messages Encountered			
Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined			
Large Standard Error for X50			
Large Standard Error for Steepness			yes
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

Gaussian Distribution:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	2.9099	2.9093	3.44E-02	2.8374	2.9812
S	0.1263	1.50E-01	5.29E-02	0.10511	0.26401
Y0	0.96	0.97147	2.67E-02	0.86046	0.99901

Triangular Distribution:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	2.9099	2.9103	3.59E-02	2.8343	2.9863
S	0.1263	1.46E-01	4.48E-02	0.10207	0.25636
Y0	0.96	0.97067	2.72E-02	0.85846	0.99893

Rectangular Distribution:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	2.9099	2.911	3.77E-02	2.8278	2.9942
S	0.1263	0.12364	6.87E-02	8.64E-02	0.21699
Y0	0.96	0.96	2.60E-02	0.87173	0.99407

Xp Estimates

Gaussian Distribution:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	811.44	6.88E+02	9.58E+02	3.44E-02	2.9093
20	606.24	4.79E+02	7.68E+02	4.68E-02	2.7826
10	520.55	3.66E+02	7.40E+02	6.55E-02	2.7165
5	458.99	2.84E+02	7.42E+02	8.28E-02	2.6618
0					

Triangular Distribution:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	813.35	6.83E+02	9.69E+02	3.59E-02	2.9103
20	600.85	4.83E+02	7.48E+02	4.26E-02	2.7788
10	5.16E+02	375.33	708.85	5.76E-02	2.7125
5	463.04	305.13	702.67	7.04E-02	2.6656
0	356.83	158.94	801.11	0.10534	2.55E+00

Rectangular Distribution:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	814.68	6.73E+02	9.87E+02	3.77E-02	2.911
20	606.03	417.77	879.12	6.79E-02	2.7825
10	549.11	326.81	922.63	8.91E-02	2.7397
5	522.69	2.85E+02	958.19	0.10018	2.7182
0	497.54	2.46E+02	1.01E+03	0.1114	2.6968

Model Fit Summary

Dataset

Gaussian Distribution:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1	0.97147
2	2.35E+00	0.94	0.97137
3	2.65E+00	0.94	0.93019
4	2.83E+00	0.67	0.68928
5	2.95E+00	0.39	0.3792
6			

Triangular Distribution:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1	0.97067
2	2.35E+00	0.94	0.97067
3	2.65E+00	0.94	0.93451
4	2.83E+00	0.67	0.68659
5	2.95E+00	0.39	0.38081
6			

Rectangular Distribution:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1	0.96
2	2.35E+00	0.94	0.96
3	2.65E+00	0.94	0.96
4	2.83E+00	0.67	0.67
5	2.95E+00	0.39	0.39
6			

Analysis of Variance

Gaussian Distribution:

R-squared:

	DF	SS	MS	F	Sig
Total (adj)					
Regression					
Error					

Triangular Distribution:

R-squared:

	DF	SS	MS	F	Sig
Total (adj)					
Regression					
Error					

Rectangular Distribution:

R-squared:

	DF	SS	MS	F	Sig
Total (adj)					
Regression					
Error					

Prediction Line

	X	Y
1	-1	0.97147
2	-9.55E-01	0.97147
3	-9.09E-01	0.97147
4	-8.64E-01	0.97147
5	-8.18E-01	0.97147
6	-7.73E-01	0.97147
7	-7.27E-01	0.97147
8	-6.82E-01	0.97147
9	-6.36E-01	0.97147
10	-5.91E-01	0.97147
11	-5.45E-01	0.97147
12	-5.00E-01	0.97147
13	-4.55E-01	0.97147
14	-0.40909	0.97147
15	-0.36364	0.97147
16	-0.31818	0.97147
17	-0.27273	0.97147
18	-0.22727	0.97147
19	-0.18182	0.97147
20	-0.13636	0.97147
21	-9.09E-02	0.97147
22	-4.55E-02	0.97147
23	0	0.97147
24	4.55E-02	0.97147
25	9.09E-02	0.97147
26	0.13636	0.97147
27	0.18182	0.97147
28	0.22727	0.97147
29	0.27273	0.97147
30	0.31818	0.97147
31	0.36364	0.97147
32	0.40909	0.97147
33	0.45455	0.97147
34	0.5	0.97147
35	0.54545	0.97147
36	0.59091	0.97147
37	0.63636	0.97147
38	0.68182	0.97147
39	0.72727	0.97147
40	0.77273	0.97147
41	0.81818	0.97147
42	0.86364	0.97147
43	0.90909	0.97147
44	0.95455	0.97147
45	1	0.97147
46	1.0455	0.97147
47	1.0909	0.97147
48	1.1364	0.97147
49	1.1818	0.97147
50	1.2273	0.97147
51	1.2727	0.97147
52	1.3182	0.97147
53	1.3636	0.97147
54	1.4091	0.97147
55	1.4545	0.97147
56	1.5	0.97147
57	1.5455	0.97147
58	1.5909	0.97147
59	1.6364	0.97147
60	1.6818	0.97147
61	1.7273	0.97147
62	1.7727	0.97147
63	1.8182	0.97147
64	1.8636	0.97147
65	1.9091	0.97147
66	1.9545	0.97147
67	2	0.97147
68	2.0455	0.97147
69	2.0909	0.97147

	X	Y
1	-1	0.97067
2	-9.55E-01	0.97067
3	-9.09E-01	0.97067
4	-8.64E-01	0.97067
5	-8.18E-01	0.97067
6	-7.73E-01	0.97067
7	-7.27E-01	0.97067
8	-6.82E-01	0.97067
9	-6.36E-01	0.97067
10	-5.91E-01	0.97067
11	-5.45E-01	0.97067
12	-5.00E-01	0.97067
13	-4.55E-01	0.97067
14	-0.40909	0.97067
15	-0.36364	0.97067
16	-0.31818	0.97067
17	-0.27273	0.97067
18	-0.22727	0.97067
19	-0.18182	0.97067
20	-0.13636	0.97067
21	-9.09E-02	0.97067
22	-4.55E-02	0.97067
23	0	0.97067
24	4.55E-02	0.97067
25	9.09E-02	0.97067
26	0.13636	0.97067
27	0.18182	0.97067
28	0.22727	0.97067
29	0.27273	0.97067
30	0.31818	0.97067
31	0.36364	0.97067
32	0.40909	0.97067
33	0.45455	0.97067
34	0.5	0.97067
35	0.54545	0.97067
36	0.59091	0.97067
37	0.63636	0.97067
38	0.68182	0.97067
39	0.72727	0.97067
40	0.77273	0.97067
41	0.81818	0.97067
42	0.86364	0.97067
43	0.90909	0.97067
44	0.95455	0.97067
45	1	0.97067
46	1.0455	0.97067
47	1.0909	0.97067
48	1.1364	0.97067
49	1.1818	0.97067
50	1.2273	0.97067
51	1.2727	0.97067
52	1.3182	0.97067
53	1.3636	0.97067
54	1.4091	0.97067
55	1.4545	0.97067
56	1.5	0.97067
57	1.5455	0.97067
58	1.5909	0.97067
59	1.6364	0.97067
60	1.6818	0.97067
61	1.7273	0.97067
62	1.7727	0.97067
63	1.8182	0.97067
64	1.8636	0.97067
65	1.9091	0.97067
66	1.9545	0.97067
67	2	0.97067
68	2.0455	0.97067
69	2.0909	0.97067

	X	Y
1	-1	0.96
2	-9.55E-01	0.96
3	-9.09E-01	0.96
4	-8.64E-01	0.96
5	-8.18E-01	0.96
6	-7.73E-01	0.96
7	-7.27E-01	0.96
8	-6.82E-01	0.96
9	-6.36E-01	0.96
10	-5.91E-01	0.96
11	-5.45E-01	0.96
12	-5.00E-01	0.96
13	-4.55E-01	0.96
14	-0.40909	0.96
15	-0.36364	0.96
16	-0.31818	0.96
17	-0.27273	0.96
18	-0.22727	0.96
19	-0.18182	0.96
20	-0.13636	0.96
21	-9.09E-02	0.96
22	-4.55E-02	0.96
23	0	0.96
24	4.55E-02	0.96
25	9.09E-02	0.96
26	0.13636	0.96
27	0.18182	0.96
28	0.22727	0.96
29	0.27273	0.96
30	0.31818	0.96
31	0.36364	0.96
32	0.40909	0.96
33	0.45455	0.96
34	0.5	0.96
35	0.54545	0.96
36	0.59091	0.96
37	0.63636	0.96
38	0.68182	0.96
39	0.72727	0.96
40	0.77273	0.96
41	0.81818	0.96
42	0.86364	0.96
43	0.90909	0.96
44	0.95455	0.96
45	1	0.96
46	1.0455	0.96
47	1.0909	0.96
48	1.1364	0.96
49	1.1818	0.96
50	1.2273	0.96
51	1.2727	0.96
52	1.3182	0.96
53	1.3636	0.96
54	1.4091	0.96
55	1.4545	0.96
56	1.5	0.96
57	1.5455	0.96
58	1.5909	0.96
59	1.6364	0.96
60	1.6818	0.96
61	1.7273	0.96
62	1.7727	0.96
63	1.8182	0.96
64	1.8636	0.96
65	1.9091	0.96
66	1.9545	0.96
67	2	0.96
68	2.0455	0.96
69	2.0909	0.96

Prediction Line

	X	Y
70	2.1364	0.97147
71	2.1818	0.97147
72	2.2273	0.97147
73	2.2727	0.97146
74	2.3182	0.97143
75	2.3636	0.97133
76	2.4091	0.97104
77	2.4545	0.97025
78	2.5	0.9683
79	2.5455	0.96389
80	2.5909	0.95479
81	2.6364	0.93762
82	2.6818	0.90805
83	2.7273	0.86151
84	2.7727	0.79462
85	2.8182	0.70681
86	2.8636	0.60152
87	2.9091	0.48621
88	2.9545	0.37086
89	3	0.26547
90	3.0455	0.17751
91	3.0909	0.11047
92	3.1364	6.38E-02
93	3.1818	3.41E-02
94	3.2273	1.69E-02
95	3.2727	7.72E-03
96	3.3182	3.29E-03
97	3.3636	1.32E-03
98	3.4091	5.30E-04
99	3.4545	2.38E-04
100	3.5	1.39E-04

	X	Y
70	2.1364	0.97067
71	2.1818	0.97067
72	2.2273	0.97067
73	2.2727	0.97067
74	2.3182	0.97067
75	2.3636	0.97067
76	2.4091	0.97067
77	2.4545	0.97067
78	2.5	0.97067
79	2.5455	0.97067
80	2.5909	0.96507
81	2.6364	0.94399
82	2.6818	0.90725
83	2.7273	0.85484
84	2.7727	0.78678
85	2.8182	0.70305
86	2.8636	0.60366
87	2.9091	0.4886
88	2.9545	0.37274
89	3	0.27253
90	3.0455	0.18798
91	3.0909	0.1191
92	3.1364	6.59E-02
93	3.1818	2.83E-02
94	3.2273	6.41E-03
95	3.2727	9.71E-05
96	3.3182	9.71E-05
97	3.3636	9.71E-05
98	3.4091	9.71E-05
99	3.4545	9.71E-05
100	3.5	9.71E-05

	X	Y
70	2.1364	0.96
71	2.1818	0.96
72	2.2273	0.96
73	2.2727	0.96
74	2.3182	0.96
75	2.3636	0.96
76	2.4091	0.96
77	2.4545	0.96
78	2.5	0.96
79	2.5455	0.96
80	2.5909	0.96
81	2.6364	0.96
82	2.6818	0.96
83	2.7273	0.89177
84	2.7727	0.7899
85	2.8182	0.68803
86	2.8636	0.58617
87	2.9091	0.4843
88	2.9545	0.38243
89	3	0.28056
90	3.0455	0.17869
91	3.0909	7.68E-02
92	3.1364	9.60E-05
93	3.1818	9.60E-05
94	3.2273	9.60E-05
95	3.2727	9.60E-05
96	3.3182	9.60E-05
97	3.3636	9.60E-05
98	3.4091	9.60E-05
99	3.4545	9.60E-05
100	3.5	9.60E-05

Table E2.D-9d. TRAP Model Output for Molybdenum Data for the Mammal Reproduction Endpoint (Fungwe et al. 1990)

Chemical:	Molybdenum
Study Authors:	Fungwe et al. 1990
Receptor Group:	Mammal
Effect Description:	Reproduction

Input Data:

Dose	Effect	SE
1.00E-06	50.4	4.1
1.4273	47.5	2.7
2.6427	33.9	5.3
13.231	33.5	4.6
27.823	33.9	5.3

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered			
Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			yes
X50 at Maximum or Minimum Limit			yes
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined			
Large Standard Error for X50	yes	yes	yes
Large Standard Error for Steepness	yes	yes	
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL		Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL		Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	1.3648	1.8132	0.61174	-0.81894	4.4453	LogX50	1.3648	1.8206	0.60763	-0.79383	4.435	LogX50	1.3648	1.8648	0.66755	-1.0074	4.737
S	0.43823	2.95E-01	0.21404	-0.62617	1.2157	S	0.43823	3.14E-01	0.19655	-0.53169	1.1597	S	0.43823	0.2309	0.10544	-0.22277	0.68457
Y0	5.04E+01	5.12E+01	6.024	25.273	77.112	Y0	5.04E+01	5.09E+01	5.8755	25.572	76.132	Y0	5.04E+01	5.08E+01	5.4823	27.23	74.407

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp	p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp	p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	65.039	0.15173	27880	0.61174	1.8132	50	66.159	0.16076	27228	0.60763	1.8206	50	73.245	9.83E-02	54576	0.66755	1.8648
20	4.34E+00	5.94E-03	3.17E+03	0.66564	0.63747	20	4.468	1.32E-02	1511.2	0.58782	0.65011	20	3.6773	4.87E-02	277.8	0.43652	0.56552
10	8.91E-01	2.08E-05	3.82E+04	1.0766	-5.03E-02	10	1.15E+00	2.28E-04	5.79E+03	0.86052	6.02E-02	10	1.3566	8.52E-03	216.12	0.51184	0.13244
5	2.07E-01	7.04E-08	6.09E+05	1.5034	-0.68399	5	0.43959	9.13E-06	2.12E+04	1.0883	-0.35695	5	0.82394	2.85E-03	237.9	0.57186	-8.41E-02
0						0	4.33E-02	2.59E-09	7.22E+05	1.6787	-1.36E+00	0	0.50044	8.69E-04	288.3	0.64158	-0.30065

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var
1	-6.00E+00	5.04E+01	5.12E+01	1	-6.00E+00	5.04E+01	5.09E+01	1	-6.00E+00	5.04E+01	5.08E+01
2	1.55E-01	4.75E+01	4.48E+01	2	1.55E-01	4.75E+01	4.51E+01	2	1.55E-01	4.75E+01	4.55E+01
3	4.22E-01	3.39E+01	4.29E+01	3	4.22E-01	3.39E+01	4.29E+01	3	4.22E-01	3.39E+01	4.23E+01
4	1.12E+00	3.35E+01	3.55E+01	4	1.12E+00	3.35E+01	3.54E+01	4	1.12E+00	3.35E+01	3.41E+01
5	1.44E+00	33.9	31.075	5	1.44E+00	33.9	31.078	5	1.44E+00	33.9	30.342
6				6				6			

Analysis of Variance

R-squared	0.999	R-squared	0.999	R-squared	0.999

	DF	SS	MS	F	Sig		DF	SS	MS	F	Sig		DF	SS	MS	F	Sig
Total (adj)	4	5502.7	1375.7			Total (adj)	4	5502.7	1375.7			Total (adj)	4	5502.7	1375.7		
Regression	2	5498.4	2749.2	1266.3	0.0008	Regression	2	5498.6	2749.3	1333.4	0.0007	Regression	2	5499.1	2749.6	1537.8	0.0006
Error	2	4.342	2.171			Error	2	4.1236	2.0618			Error	2	3.576	1.788		

Prediction Line

	X	Y
1	-2.5	5.09E+01
2	-2.45E+00	5.09E+01
3	-2.41E+00	5.08E+01
4	-2.36E+00	5.08E+01
5	-2.32E+00	5.08E+01
6	-2.27E+00	5.08E+01
7	-2.23E+00	5.08E+01
8	-2.18E+00	5.07E+01
9	-2.14E+00	5.07E+01
10	-2.09E+00	5.07E+01
11	-2.05E+00	5.07E+01
12	-2.00E+00	5.06E+01
13	-1.95E+00	5.06E+01
14	-1.9091	5.06E+01
15	-1.8636	5.05E+01
16	-1.8182	5.05E+01
17	-1.7727	5.05E+01
18	-1.7273	5.04E+01
19	-1.6818	5.04E+01
20	-1.6364	5.03E+01
21	-1.59E+00	5.03E+01
22	-1.55E+00	5.02E+01
23	-1.50E+00	5.02E+01
24	-1.45E+00	5.01E+01
25	-1.41E+00	5.01E+01
26	-1.36E+00	5.00E+01
27	-1.32E+00	4.99E+01
28	-1.27E+00	4.99E+01
29	-1.23E+00	4.98E+01
30	-1.18E+00	4.97E+01
31	-1.1364	4.97E+01
32	-1.0909	4.96E+01
33	-1.0455	4.95E+01
34	-1	4.94E+01
35	-0.95455	4.93E+01
36	-0.90909	4.92E+01
37	-0.86364	4.91E+01
38	-0.81818	4.90E+01
39	-0.77273	4.89E+01
40	-0.72727	4.88E+01
41	-0.68182	4.86E+01
42	-0.63636	4.85E+01
43	-0.59091	4.84E+01
44	-0.54545	4.82E+01
45	-0.5	4.81E+01
46	-0.45455	4.79E+01
47	-0.40909	4.77E+01
48	-0.36364	4.75E+01
49	-0.31818	4.74E+01
50	-0.27273	4.72E+01
51	-0.22727	4.70E+01
52	-0.18182	4.67E+01
53	-0.13636	4.65E+01
54	-9.09E-02	4.63E+01
55	-4.55E-02	4.60E+01
56	0	4.58E+01
57	4.55E-02	4.55E+01
58	9.09E-02	4.53E+01
59	0.13636	4.50E+01
60	0.18182	4.47E+01
61	0.22727	4.44E+01
62	0.27273	4.40E+01
63	0.31818	4.37E+01
64	0.36364	4.33E+01
65	0.40909	4.30E+01
66	0.45455	4.26E+01
67	0.5	4.22E+01
68	0.54545	4.18E+01
69	0.59091	4.14E+01

	X	Y
1	-2.5	5.09E+01
2	-2.45E+00	5.09E+01
3	-2.41E+00	5.09E+01
4	-2.36E+00	5.09E+01
5	-2.32E+00	5.09E+01
6	-2.27E+00	5.09E+01
7	-2.23E+00	5.09E+01
8	-2.18E+00	5.09E+01
9	-2.14E+00	5.09E+01
10	-2.09E+00	5.09E+01
11	-2.05E+00	5.09E+01
12	-2.00E+00	5.09E+01
13	-1.95E+00	5.09E+01
14	-1.9091	5.09E+01
15	-1.8636	5.09E+01
16	-1.8182	5.09E+01
17	-1.7727	5.09E+01
18	-1.7273	5.09E+01
19	-1.6818	5.09E+01
20	-1.6364	5.09E+01
21	-1.59E+00	5.09E+01
22	-1.55E+00	5.09E+01
23	-1.50E+00	5.09E+01
24	-1.45E+00	5.09E+01
25	-1.41E+00	5.09E+01
26	-1.36E+00	5.09E+01
27	-1.32E+00	5.08E+01
28	-1.27E+00	5.08E+01
29	-1.23E+00	5.08E+01
30	-1.18E+00	5.08E+01
31	-1.1364	5.07E+01
32	-1.0909	5.07E+01
33	-1.0455	5.06E+01
34	-1	5.05E+01
35	-0.95455	5.04E+01
36	-0.90909	5.03E+01
37	-0.86364	5.02E+01
38	-0.81818	5.01E+01
39	-0.77273	5.00E+01
40	-0.72727	4.98E+01
41	-0.68182	4.97E+01
42	-0.63636	4.95E+01
43	-0.59091	4.94E+01
44	-0.54545	4.92E+01
45	-0.5	4.90E+01
46	-0.45455	4.88E+01
47	-0.40909	4.86E+01
48	-0.36364	4.83E+01
49	-0.31818	4.81E+01
50	-0.27273	4.79E+01
51	-0.22727	4.76E+01
52	-0.18182	4.73E+01
53	-0.13636	4.71E+01
54	-9.09E-02	4.68E+01
55	-4.55E-02	4.65E+01
56	0	4.62E+01
57	4.55E-02	4.59E+01
58	9.09E-02	4.55E+01
59	0.13636	4.52E+01
60	0.18182	4.49E+01
61	0.22727	4.45E+01
62	0.27273	4.41E+01
63	0.31818	4.38E+01
64	0.36364	4.34E+01
65	0.40909	4.30E+01
66	0.45455	4.26E+01
67	0.5	4.21E+01
68	0.54545	4.17E+01
69	0.59091	4.13E+01

	X	Y
1	-2.5	5.08E+01
2	-2.45E+00	5.08E+01
3	-2.41E+00	5.08E+01
4	-2.36E+00	5.08E+01
5	-2.32E+00	5.08E+01
6	-2.27E+00	5.08E+01
7	-2.23E+00	5.08E+01
8	-2.18E+00	5.08E+01
9	-2.14E+00	5.08E+01
10	-2.09E+00	5.08E+01
11	-2.05E+00	5.08E+01
12	-2.00E+00	5.08E+01
13	-1.95E+00	5.08E+01
14	-1.9091	5.08E+01
15	-1.8636	5.08E+01
16	-1.8182	5.08E+01
17	-1.7727	5.08E+01
18	-1.7273	5.08E+01
19	-1.6818	5.08E+01
20	-1.6364	5.08E+01
21	-1.59E+00	5.08E+01
22	-1.55E+00	5.08E+01
23	-1.50E+00	5.08E+01
24	-1.45E+00	5.08E+01
25	-1.41E+00	5.08E+01
26	-1.36E+00	5.08E+01
27	-1.32E+00	5.08E+01
28	-1.27E+00	5.08E+01
29	-1.23E+00	5.08E+01
30	-1.18E+00	5.08E+01
31	-1.1364	5.08E+01
32	-1.0909	5.08E+01
33	-1.0455	5.08E+01
34	-1	5.08E+01
35	-0.95455	5.08E+01
36	-0.90909	5.08E+01
37	-0.86364	5.08E+01
38	-0.81818	5.08E+01
39	-0.77273	5.08E+01
40	-0.72727	5.08E+01
41	-0.68182	5.08E+01
42	-0.63636	5.08E+01
43	-0.59091	5.08E+01
44	-0.54545	5.08E+01
45	-0.5	5.08E+01
46	-0.45455	5.08E+01
47	-0.40909	5.08E+01
48	-0.36364	5.08E+01
49	-0.31818	5.08E+01
50	-0.27273	5.05E+01
51	-0.22727	5.00E+01
52	-0.18182	4.94E+01
53	-0.13636	4.89E+01
54	-9.09E-02	4.84E+01
55	-4.55E-02	4.78E+01
56	0	4.73E+01
57	4.55E-02	4.68E+01
58	9.09E-02	4.62E+01
59	0.13636	4.57E+01
60	0.18182	4.52E+01
61	0.22727	4.46E+01
62	0.27273	4.41E+01
63	0.31818	4.36E+01
64	0.36364	4.30E+01
65	0.40909	4.25E+01
66	0.45455	4.20E+01
67	0.5	4.14E+01
68	0.54545	4.09E+01
69	0.59091	4.04E+01

Prediction Line

	X	Y
70	0.63636	4.10E+01
71	0.68182	4.05E+01
72	0.72727	4.01E+01
73	0.77273	3.96E+01
74	0.81818	3.91E+01
75	0.86364	3.86E+01
76	0.90909	3.81E+01
77	0.95455	3.75E+01
78	1	3.70E+01
79	1.0455	3.65E+01
80	1.0909	3.59E+01
81	1.1364	3.53E+01
82	1.1818	3.47E+01
83	1.2273	3.41E+01
84	1.2727	3.35E+01
85	1.3182	3.29E+01
86	1.3636	3.22E+01
87	1.4091	3.16E+01
88	1.4545	3.09E+01
89	1.5	3.03E+01
90	1.5455	2.96E+01
91	1.5909	2.89E+01
92	1.6364	2.83E+01
93	1.6818	2.76E+01
94	1.7273	2.69E+01
95	1.7727	2.62E+01
96	1.8182	2.55E+01
97	1.8636	2.48E+01
98	1.9091	2.42E+01
99	1.9545	2.35E+01
100	2	2.28E+01

	X	Y
70	0.63636	4.08E+01
71	0.68182	4.04E+01
72	0.72727	3.99E+01
73	0.77273	3.94E+01
74	0.81818	3.89E+01
75	0.86364	3.84E+01
76	0.90909	3.79E+01
77	0.95455	3.74E+01
78	1	3.68E+01
79	1.0455	3.63E+01
80	1.0909	3.57E+01
81	1.1364	3.52E+01
82	1.1818	3.46E+01
83	1.2273	3.40E+01
84	1.2727	3.34E+01
85	1.3182	3.28E+01
86	1.3636	3.22E+01
87	1.4091	3.16E+01
88	1.4545	3.09E+01
89	1.5	3.03E+01
90	1.5455	2.96E+01
91	1.5909	2.90E+01
92	1.6364	2.83E+01
93	1.6818	2.76E+01
94	1.7273	2.69E+01
95	1.7727	2.62E+01
96	1.8182	2.55E+01
97	1.8636	2.47E+01
98	1.9091	2.40E+01
99	1.9545	2.33E+01
100	2	2.26E+01

	X	Y
70	0.63636	3.98E+01
71	0.68182	3.93E+01
72	0.72727	3.88E+01
73	0.77273	3.82E+01
74	0.81818	3.77E+01
75	0.86364	3.72E+01
76	0.90909	3.66E+01
77	0.95455	3.61E+01
78	1	3.56E+01
79	1.0455	3.50E+01
80	1.0909	3.45E+01
81	1.1364	3.40E+01
82	1.1818	3.34E+01
83	1.2273	3.29E+01
84	1.2727	3.24E+01
85	1.3182	3.18E+01
86	1.3636	3.13E+01
87	1.4091	3.08E+01
88	1.4545	3.02E+01
89	1.5	2.97E+01
90	1.5455	2.92E+01
91	1.5909	2.86E+01
92	1.6364	2.81E+01
93	1.6818	2.76E+01
94	1.7273	2.70E+01
95	1.7727	2.65E+01
96	1.8182	2.60E+01
97	1.8636	2.54E+01
98	1.9091	2.49E+01
99	1.9545	2.44E+01
100	2	2.38E+01

Table E2.D-10a. TRAP Model Output for Selenium Data for the Bird Growth Endpoint (Pooling Group A: El-Begearmi and Combs 1982; Jensen 1986; Dafalla and Adam 1986)

Chemical:	Selenium
Study Authors:	Pooling group A
Receptor Group:	Bird
Effect Description:	Growth

Input Data:

Dose	Effect Relative to Control
1.00E-06	100
2.7239	35.613
5.4479	19.104
8.1718	17.453
1.00E-06	100
2.724	33.4
5.4479	31.924
8.1718	19.345
1.12E-02	100
2.23E-02	102.65
0.039	103.2
0.12283	95.265
0.5695	76.705
1.00E-06	100
0.25936	70

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?
Use Only for Exploratory Data Analysis!
Maximum Iterations Reached Without Convergence
X50 at Maximum or Minimum Limit
Steepness At Maximum Or Minimum Limit
Error Estimates Cannot Be Determined
Large Standard Error for X50
Large Standard Error for Steepness
Large Standard Error for Y0
Inadequate Number of Partial Effects
Insufficient Data to Plot
Insufficient Data to Analyze

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	0.18426	1.43E-01	6.84E-02	-5.89E-03	0.29198
S	0.56175	4.98E-01	5.51E-02	0.37822	0.61811
Y0	1.01E+02	1.02E+02	2.6067	96.329	107.69

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	0.18426	0.14871	6.15E-02	1.46E-02	0.2828
S	0.56175	5.24E-01	5.02E-02	0.41421	0.63302
Y0	1.01E+02	1.01E+02	2.3271	95.972	106.11

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	0.18426	0.11983	5.14E-02	7.87E-03	0.23179
S	0.56175	0.4085	2.87E-02	0.34589	0.4711
Y0	1.01E+02	1.01E+02	2.1713	96.248	105.71

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	1.3901	0.98652	1.9588	6.84E-02	1.43E-01
20	2.80E-01	1.48E-01	5.29E-01	0.12685	-0.55266
10	1.10E-01	4.72E-02	2.55E-01	0.16808	-0.95962
5	4.63E-02	1.63E-02	1.31E-01	0.20745	-1.3346
0					

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	1.4083	1.0342	1.9178	6.15E-02	0.14871
20	0.27975	1.60E-01	0.48955	0.11154	-0.55323
10	1.24E-01	5.95E-02	2.58E-01	0.14623	-0.90701
5	6.96E-02	2.87E-02	1.69E-01	0.1767	-1.1572
0	1.73E-02	3.12E-03	9.64E-02	0.34205	-1.76E+00

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	1.3178	1.0183	1.7053	5.14E-02	0.11983
20	0.2429	0.15903	0.371	8.44E-02	-0.61457
10	0.13824	8.41E-02	0.22721	9.90E-02	-0.85937
5	1.04E-01	6.11E-02	0.17807	0.10664	-0.98177
0	7.87E-02	4.43E-02	0.13965	0.11438	-1.1042

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	1.02E+02	1	-6.00E+00	1.00E+02	1.01E+02	1	-6.00E+00	1.00E+02	1.01E+02
2	-6.00E+00	1.00E+02	1.02E+02	2	-6.00E+00	1.00E+02	1.01E+02	2	-6.00E+00	1.00E+02	1.01E+02
3	-6.00E+00	1.00E+02	1.02E+02	3	-6.00E+00	1.00E+02	1.01E+02	3	-6.00E+00	1.00E+02	1.01E+02
4	-1.95E+00	1.00E+02	1.00E+02	4	-1.95E+00	1.00E+02	1.01E+02	4	-1.95E+00	1.00E+02	1.01E+02
5	-1.65E+00	1.03E+02	9.92E+01	5	-1.65E+00	1.03E+02	1.01E+02	5	-1.65E+00	1.03E+02	1.01E+02
6	-1.41E+00	1.03E+02	9.76E+01	6	-1.41E+00	1.03E+02	9.93E+01	6	-1.41E+00	1.03E+02	1.01E+02
7	-9.11E-01	9.53E+01	9.09E+01	7	-9.11E-01	9.53E+01	9.10E+01	7	-9.11E-01	9.53E+01	9.30E+01
8	-5.86E-01	7.00E+01	8.27E+01	8	-5.86E-01	7.00E+01	8.19E+01	8	-5.86E-01	7.00E+01	7.96E+01
9	-2.45E-01	7.67E+01	6.98E+01	9	-2.45E-01	7.67E+01	6.92E+01	9	-2.45E-01	7.67E+01	6.55E+01
10	4.35E-01	35.613	36.563	10	4.35E-01	35.613	36.501	10	4.35E-01	35.613	37.481
11	4.35E-01	3.34E+01	3.66E+01	11	4.35E-01	3.34E+01	3.65E+01	11	4.35E-01	3.34E+01	3.75E+01
12	7.36E-01	3.19E+01	2.39E+01	12	7.36E-01	3.19E+01	2.42E+01	12	7.36E-01	3.19E+01	2.51E+01
13	7.36E-01	19.104	23.94	13	7.36E-01	19.104	24.218	13	7.36E-01	19.104	25.063
14	9.12E-01	19.345	18.114	14	9.12E-01	19.345	18.198	14	9.12E-01	19.345	17.8
15	0.91232	17.453	18.114	15	0.91232	17.453	18.198	15	0.91232	17.453	17.8

Analysis of Variance

R-squared: 0.979

	DF	SS	MS	F	Sig
Total (adj)	14	18205	1300.4		
Regression	2	17821	8910.7	278.63	0
Error	12	383.77	31.981		

R-squared: 0.981

	DF	SS	MS	F	Sig
Total (adj)	14	18205	1300.4		
Regression	2	17868	8934	318	0
Error	12	337.13	28.094		

R-squared: 0.981

	DF	SS	MS	F	Sig
Total (adj)	14	18205	1300.4		
Regression	2	17866	8932.9	315.79	0
Error	12	339.45	28.288		

Prediction Line

	X	Y		X	Y		X	Y
1	-3	1.02E+02	1	-3	1.01E+02	1	-3	1.01E+02
2	-2.95E+00	1.02E+02	2	-2.95E+00	1.01E+02	2	-2.95E+00	1.01E+02
3	-2.91E+00	1.02E+02	3	-2.91E+00	1.01E+02	3	-2.91E+00	1.01E+02
4	-2.86E+00	1.02E+02	4	-2.86E+00	1.01E+02	4	-2.86E+00	1.01E+02
5	-2.82E+00	1.02E+02	5	-2.82E+00	1.01E+02	5	-2.82E+00	1.01E+02
6	-2.77E+00	1.02E+02	6	-2.77E+00	1.01E+02	6	-2.77E+00	1.01E+02
7	-2.73E+00	1.02E+02	7	-2.73E+00	1.01E+02	7	-2.73E+00	1.01E+02
8	-2.68E+00	1.02E+02	8	-2.68E+00	1.01E+02	8	-2.68E+00	1.01E+02
9	-2.64E+00	1.02E+02	9	-2.64E+00	1.01E+02	9	-2.64E+00	1.01E+02
10	-2.59E+00	1.02E+02	10	-2.59E+00	1.01E+02	10	-2.59E+00	1.01E+02
11	-2.55E+00	1.02E+02	11	-2.55E+00	1.01E+02	11	-2.55E+00	1.01E+02
12	-2.50E+00	1.01E+02	12	-2.50E+00	1.01E+02	12	-2.50E+00	1.01E+02
13	-2.45E+00	1.01E+02	13	-2.45E+00	1.01E+02	13	-2.45E+00	1.01E+02
14	-2.4091	1.01E+02	14	-2.4091	1.01E+02	14	-2.4091	1.01E+02
15	-2.3636	1.01E+02	15	-2.3636	1.01E+02	15	-2.3636	1.01E+02
16	-2.3182	1.01E+02	16	-2.3182	1.01E+02	16	-2.3182	1.01E+02
17	-2.2727	1.01E+02	17	-2.2727	1.01E+02	17	-2.2727	1.01E+02
18	-2.2273	1.01E+02	18	-2.2273	1.01E+02	18	-2.2273	1.01E+02
19	-2.1818	1.01E+02	19	-2.1818	1.01E+02	19	-2.1818	1.01E+02
20	-2.1364	1.01E+02	20	-2.1364	1.01E+02	20	-2.1364	1.01E+02
21	-2.09E+00	1.01E+02	21	-2.09E+00	1.01E+02	21	-2.09E+00	1.01E+02
22	-2.05E+00	1.01E+02	22	-2.05E+00	1.01E+02	22	-2.05E+00	1.01E+02
23	-2.00E+00	1.01E+02	23	-2.00E+00	1.01E+02	23	-2.00E+00	1.01E+02
24	-1.95E+00	1.00E+02	24	-1.95E+00	1.01E+02	24	-1.95E+00	1.01E+02
25	-1.91E+00	1.00E+02	25	-1.91E+00	1.01E+02	25	-1.91E+00	1.01E+02
26	-1.86E+00	1.00E+02	26	-1.86E+00	1.01E+02	26	-1.86E+00	1.01E+02
27	-1.82E+00	1.00E+02	27	-1.82E+00	1.01E+02	27	-1.82E+00	1.01E+02
28	-1.77E+00	9.98E+01	28	-1.77E+00	1.01E+02	28	-1.77E+00	1.01E+02
29	-1.73E+00	9.96E+01	29	-1.73E+00	1.01E+02	29	-1.73E+00	1.01E+02
30	-1.68E+00	9.94E+01	30	-1.68E+00	1.01E+02	30	-1.68E+00	1.01E+02
31	-1.6364	9.91E+01	31	-1.6364	1.01E+02	31	-1.6364	1.01E+02
32	-1.5909	9.89E+01	32	-1.5909	1.01E+02	32	-1.5909	1.01E+02
33	-1.5455	9.86E+01	33	-1.5455	1.00E+02	33	-1.5455	1.01E+02
34	-1.5	9.83E+01	34	-1.5	1.00E+02	34	-1.5	1.01E+02
35	-1.4545	9.79E+01	35	-1.4545	9.97E+01	35	-1.4545	1.01E+02
36	-1.4091	9.76E+01	36	-1.4091	9.93E+01	36	-1.4091	1.01E+02
37	-1.3636	9.72E+01	37	-1.3636	9.89E+01	37	-1.3636	1.01E+02
38	-1.3182	9.67E+01	38	-1.3182	9.83E+01	38	-1.3182	1.01E+02
39	-1.2727	9.63E+01	39	-1.2727	9.77E+01	39	-1.2727	1.01E+02

Prediction Line

	X	Y
40	-1.2273	9.58E+01
41	-1.1818	9.52E+01
42	-1.1364	9.46E+01
43	-1.0909	9.40E+01
44	-1.0455	9.33E+01
45	-1	9.25E+01
46	-0.95455	9.17E+01
47	-0.90909	9.08E+01
48	-0.86364	8.99E+01
49	-0.81818	8.89E+01
50	-0.77273	8.78E+01
51	-0.72727	8.67E+01
52	-0.68182	8.55E+01
53	-0.63636	8.42E+01
54	-0.59091	8.28E+01
55	-5.45E-01	8.14E+01
56	-5.00E-01	7.98E+01
57	-4.55E-01	7.82E+01
58	-4.09E-01	7.65E+01
59	-3.64E-01	7.48E+01
60	-3.18E-01	7.29E+01
61	-0.27273	7.10E+01
62	-0.22727	6.90E+01
63	-0.18182	6.70E+01
64	-0.13636	6.48E+01
65	-9.09E-02	6.27E+01
66	-4.55E-02	6.05E+01
67	0	5.82E+01
68	4.55E-02	5.59E+01
69	9.09E-02	5.37E+01
70	0.13636	5.13E+01
71	0.18182	4.90E+01
72	0.22727	4.67E+01
73	0.27273	4.45E+01
74	0.31818	4.22E+01
75	0.36364	4.00E+01
76	0.40909	3.78E+01
77	0.45455	3.57E+01
78	0.5	3.36E+01
79	0.54545	3.16E+01
80	0.59091	2.96E+01
81	0.63636	2.78E+01
82	0.68182	2.60E+01
83	0.72727	2.43E+01
84	0.77273	2.26E+01
85	0.81818	2.11E+01
86	0.86364	1.96E+01
87	0.90909	1.82E+01
88	0.95455	1.69E+01
89	1	1.57E+01
90	1.0455	1.45E+01
91	1.0909	1.34E+01
92	1.1364	1.24E+01
93	1.1818	1.14E+01
94	1.2273	1.05E+01
95	1.2727	9.72E+00
96	1.3182	8.95E+00
97	1.3636	8.24E+00
98	1.4091	7.58E+00
99	1.4545	6.97E+00
100	1.5	6.40E+00

	X	Y
40	-1.2273	9.71E+01
41	-1.1818	9.64E+01
42	-1.1364	9.56E+01
43	-1.0909	9.48E+01
44	-1.0455	9.39E+01
45	-1	9.30E+01
46	-0.95455	9.20E+01
47	-0.90909	9.10E+01
48	-0.86364	8.99E+01
49	-0.81818	8.87E+01
50	-0.77273	8.75E+01
51	-0.72727	8.62E+01
52	-0.68182	8.49E+01
53	-0.63636	8.35E+01
54	-0.59091	8.21E+01
55	-5.45E-01	8.06E+01
56	-5.00E-01	7.90E+01
57	-4.55E-01	7.74E+01
58	-4.09E-01	7.57E+01
59	-3.64E-01	7.40E+01
60	-3.18E-01	7.22E+01
61	-0.27273	7.04E+01
62	-0.22727	6.85E+01
63	-0.18182	6.65E+01
64	-0.13636	6.45E+01
65	-9.09E-02	6.24E+01
66	-4.55E-02	6.03E+01
67	0	5.81E+01
68	4.55E-02	5.58E+01
69	9.09E-02	5.35E+01
70	0.13636	5.12E+01
71	0.18182	4.88E+01
72	0.22727	4.65E+01
73	0.27273	4.42E+01
74	0.31818	4.20E+01
75	0.36364	3.98E+01
76	0.40909	3.77E+01
77	0.45455	3.56E+01
78	0.5	3.36E+01
79	0.54545	3.17E+01
80	0.59091	2.98E+01
81	0.63636	2.80E+01
82	0.68182	2.63E+01
83	0.72727	2.45E+01
84	0.77273	2.29E+01
85	0.81818	2.13E+01
86	0.86364	1.98E+01
87	0.90909	1.83E+01
88	0.95455	1.69E+01
89	1	1.55E+01
90	1.0455	1.42E+01
91	1.0909	1.30E+01
92	1.1364	1.18E+01
93	1.1818	1.06E+01
94	1.2273	9.57E+00
95	1.2727	8.55E+00
96	1.3182	7.59E+00
97	1.3636	6.69E+00
98	1.4091	5.84E+00
99	1.4545	5.05E+00
100	1.5	4.32E+00

	X	Y
40	-1.2273	1.01E+02
41	-1.1818	1.01E+02
42	-1.1364	1.01E+02
43	-1.0909	1.00E+02
44	-1.0455	9.86E+01
45	-1	9.67E+01
46	-0.95455	9.48E+01
47	-0.90909	9.29E+01
48	-0.86364	9.11E+01
49	-0.81818	8.92E+01
50	-0.77273	8.73E+01
51	-0.72727	8.54E+01
52	-0.68182	8.36E+01
53	-0.63636	8.17E+01
54	-0.59091	7.98E+01
55	-5.45E-01	7.79E+01
56	-5.00E-01	7.61E+01
57	-4.55E-01	7.42E+01
58	-4.09E-01	7.23E+01
59	-3.64E-01	7.04E+01
60	-3.18E-01	6.86E+01
61	-0.27273	6.67E+01
62	-0.22727	6.48E+01
63	-0.18182	6.29E+01
64	-0.13636	6.11E+01
65	-9.09E-02	5.92E+01
66	-4.55E-02	5.73E+01
67	0	5.54E+01
68	4.55E-02	5.36E+01
69	9.09E-02	5.17E+01
70	0.13636	4.98E+01
71	0.18182	4.79E+01
72	0.22727	4.61E+01
73	0.27273	4.42E+01
74	0.31818	4.23E+01
75	0.36364	4.04E+01
76	0.40909	3.86E+01
77	0.45455	3.67E+01
78	0.5	3.48E+01
79	0.54545	3.29E+01
80	0.59091	3.11E+01
81	0.63636	2.92E+01
82	0.68182	2.73E+01
83	0.72727	2.54E+01
84	0.77273	2.36E+01
85	0.81818	2.17E+01
86	0.86364	1.98E+01
87	0.90909	1.79E+01
88	0.95455	1.61E+01
89	1	1.42E+01
90	1.0455	1.23E+01
91	1.0909	1.04E+01
92	1.1364	8.56E+00
93	1.1818	6.68E+00
94	1.2273	4.81E+00
95	1.2727	2.93E+00
96	1.3182	1.06E+00
97	1.3636	0.00E+00
98	1.4091	0.00E+00
99	1.4545	0.00E+00
100	1.5	0.00E+00

Table E2.D-10b. TRAP Model Output for Selenium Data for the Bird Reproduction Endpoint (Ort and Latshaw 1978)

Chemical:	Selenium
Study Authors:	Ort and Latshaw 1978
Receptor Group:	Bird
Effect Description:	Reproduction

Input Data:

Dose	Effect	SE
9.35E-03	92	3.2
0.39909	84.2	4.2
0.55498	66.8	8.7
0.71087	65.4	6

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered			
Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined	yes	yes	yes
Large Standard Error for X50			
Large Standard Error for Steepness			
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	-3.56E-02	5.96E-04			
S	1.5277	1.37E+00			
Y0	9.20E+01	9.22E+01			

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	-3.56E-02	1.08E-02			
S	1.5277	1.37E+00			
Y0	9.20E+01	9.21E+01			

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	-3.56E-02	7.88E-02			
S	1.5277	0.85643			
Y0	9.20E+01	9.20E+01			

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	1.0014	6.03E-02	16.636	9.61E-02	5.96E-04
20	5.60E-01	1.15E-01	2.72E+00	5.40E-02	-0.25173
10	3.99E-01	2.25E-02	7.05E+00	9.82E-02	-0.39933
5	2.92E-01	3.57E-03	2.38E+01	0.15051	-0.53534
0					

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	1.0251	6.88E-02	15.266	9.23E-02	1.08E-02
20	0.55286	1.39E-01	2.2002	4.72E-02	-0.25738
10	4.05E-01	4.67E-02	3.51E+00	7.38E-02	-0.39254
5	0.32501	1.67E-02	6.34E+00	0.10153	-0.4881
0	0.19106	1.12E-03	3.26E+01	0.1757	-7.19E-01

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	1.1991	5.78E-02	24.863	0.10363	7.88E-02
20	0.53524	0.1783	1.6068	3.76E-02	-0.27145
10	0.40906	0.11519	1.4526	4.33E-02	-0.38822
5	0.3576	7.65E-02	1.6716	5.27E-02	-0.4466
0	0.31262	4.77E-02	2.0478	6.42E-02	-0.50498

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var
1	-2.03E+00	9.20E+01	9.22E+01
2	-3.99E-01	8.42E+01	8.29E+01
3	-2.56E-01	6.68E+01	7.41E+01
4	-1.48E-01	6.54E+01	6.39E+01
5			
6			

	Exposure	Effects Var	Est Effects Var
1	-2.03E+00	9.20E+01	9.21E+01
2	-3.99E-01	8.42E+01	8.32E+01
3	-2.56E-01	6.68E+01	7.35E+01
4	-1.48E-01	6.54E+01	6.39E+01
5			
6			

	Exposure	Effects Var	Est Effects Var
1	-2.03E+00	9.20E+01	9.20E+01
2	-3.99E-01	8.42E+01	8.36E+01
3	-2.56E-01	6.68E+01	7.24E+01
4	-1.48E-01	6.54E+01	6.39E+01
5			
6			

Analysis of Variance

R-squared: 1

	DF	SS	MS	F	Sig
Total (adj)	3	18445	6148.4		
Regression	2	18444	9222.2	10867	0.0068
Error	1	0.84862	0.84862		

R-squared: 1

	DF	SS	MS	F	Sig
Total (adj)	3	18445	6148.4		
Regression	2	18445	9222.3	12924	0.0062
Error	1	0.71358	0.71358		

R-squared: 1

	DF	SS	MS	F	Sig
Total (adj)	3	18445	6148.4		
Regression	2	18445	9222.4	18844	0.0052
Error	1	0.48941	0.48941		

Prediction Line

	X	Y		X	Y		X	Y
1	-2	9.22E+01	1	-2	9.21E+01	1	-2	9.20E+01
2	-1.98E+00	9.22E+01	2	-1.98E+00	9.21E+01	2	-1.98E+00	9.20E+01
3	-1.96E+00	9.22E+01	3	-1.96E+00	9.21E+01	3	-1.96E+00	9.20E+01
4	-1.93E+00	9.22E+01	4	-1.93E+00	9.21E+01	4	-1.93E+00	9.20E+01
5	-1.91E+00	9.22E+01	5	-1.91E+00	9.21E+01	5	-1.91E+00	9.20E+01
6	-1.89E+00	9.22E+01	6	-1.89E+00	9.21E+01	6	-1.89E+00	9.20E+01
7	-1.87E+00	9.22E+01	7	-1.87E+00	9.21E+01	7	-1.87E+00	9.20E+01
8	-1.84E+00	9.22E+01	8	-1.84E+00	9.21E+01	8	-1.84E+00	9.20E+01
9	-1.82E+00	9.22E+01	9	-1.82E+00	9.21E+01	9	-1.82E+00	9.20E+01
10	-1.80E+00	9.22E+01	10	-1.80E+00	9.21E+01	10	-1.80E+00	9.20E+01
11	-1.78E+00	9.22E+01	11	-1.78E+00	9.21E+01	11	-1.78E+00	9.20E+01
12	-1.76E+00	9.22E+01	12	-1.76E+00	9.21E+01	12	-1.76E+00	9.20E+01
13	-1.73E+00	9.22E+01	13	-1.73E+00	9.21E+01	13	-1.73E+00	9.20E+01
14	-1.7111	9.22E+01	14	-1.7111	9.21E+01	14	-1.7111	9.20E+01
15	-1.6889	9.22E+01	15	-1.6889	9.21E+01	15	-1.6889	9.20E+01
16	-1.6667	9.22E+01	16	-1.6667	9.21E+01	16	-1.6667	9.20E+01
17	-1.6444	9.22E+01	17	-1.6444	9.21E+01	17	-1.6444	9.20E+01
18	-1.6222	9.22E+01	18	-1.6222	9.21E+01	18	-1.6222	9.20E+01
19	-1.6	9.22E+01	19	-1.6	9.21E+01	19	-1.6	9.20E+01
20	-1.5778	9.21E+01	20	-1.5778	9.21E+01	20	-1.5778	9.20E+01
21	-1.56E+00	9.21E+01	21	-1.56E+00	9.21E+01	21	-1.56E+00	9.20E+01
22	-1.53E+00	9.21E+01	22	-1.53E+00	9.21E+01	22	-1.53E+00	9.20E+01
23	-1.51E+00	9.21E+01	23	-1.51E+00	9.21E+01	23	-1.51E+00	9.20E+01
24	-1.49E+00	9.21E+01	24	-1.49E+00	9.21E+01	24	-1.49E+00	9.20E+01
25	-1.47E+00	9.21E+01	25	-1.47E+00	9.21E+01	25	-1.47E+00	9.20E+01
26	-1.44E+00	9.21E+01	26	-1.44E+00	9.21E+01	26	-1.44E+00	9.20E+01
27	-1.42E+00	9.21E+01	27	-1.42E+00	9.21E+01	27	-1.42E+00	9.20E+01
28	-1.40E+00	9.21E+01	28	-1.40E+00	9.21E+01	28	-1.40E+00	9.20E+01
29	-1.38E+00	9.21E+01	29	-1.38E+00	9.21E+01	29	-1.38E+00	9.20E+01
30	-1.36E+00	9.21E+01	30	-1.36E+00	9.21E+01	30	-1.36E+00	9.20E+01
31	-1.3333	9.21E+01	31	-1.3333	9.21E+01	31	-1.3333	9.20E+01
32	-1.3111	9.21E+01	32	-1.3111	9.21E+01	32	-1.3111	9.20E+01
33	-1.2889	9.21E+01	33	-1.2889	9.21E+01	33	-1.2889	9.20E+01
34	-1.2667	9.21E+01	34	-1.2667	9.21E+01	34	-1.2667	9.20E+01
35	-1.2444	9.21E+01	35	-1.2444	9.21E+01	35	-1.2444	9.20E+01
36	-1.2222	9.21E+01	36	-1.2222	9.21E+01	36	-1.2222	9.20E+01
37	-1.2	9.20E+01	37	-1.2	9.21E+01	37	-1.2	9.20E+01
38	-1.1778	9.20E+01	38	-1.1778	9.21E+01	38	-1.1778	9.20E+01
39	-1.1556	9.20E+01	39	-1.1556	9.21E+01	39	-1.1556	9.20E+01
40	-1.1333	9.20E+01	40	-1.1333	9.21E+01	40	-1.1333	9.20E+01
41	-1.1111	9.20E+01	41	-1.1111	9.21E+01	41	-1.1111	9.20E+01
42	-1.0889	9.19E+01	42	-1.0889	9.21E+01	42	-1.0889	9.20E+01
43	-1.0667	9.19E+01	43	-1.0667	9.21E+01	43	-1.0667	9.20E+01
44	-1.0444	9.19E+01	44	-1.0444	9.21E+01	44	-1.0444	9.20E+01
45	-1.0222	9.18E+01	45	-1.0222	9.21E+01	45	-1.0222	9.20E+01
46	-1	9.18E+01	46	-1	9.21E+01	46	-1	9.20E+01
47	-0.97778	9.17E+01	47	-0.97778	9.21E+01	47	-0.97778	9.20E+01
48	-0.95556	9.17E+01	48	-0.95556	9.21E+01	48	-0.95556	9.20E+01
49	-0.93333	9.16E+01	49	-0.93333	9.21E+01	49	-0.93333	9.20E+01
50	-0.91111	9.16E+01	50	-0.91111	9.21E+01	50	-0.91111	9.20E+01
51	-0.88889	9.15E+01	51	-0.88889	9.21E+01	51	-0.88889	9.20E+01
52	-0.86667	9.14E+01	52	-0.86667	9.21E+01	52	-0.86667	9.20E+01
53	-0.84444	9.13E+01	53	-0.84444	9.21E+01	53	-0.84444	9.20E+01
54	-0.82222	9.12E+01	54	-0.82222	9.21E+01	54	-0.82222	9.20E+01
55	-0.8	9.10E+01	55	-0.8	9.21E+01	55	-0.8	9.20E+01
56	-0.77778	9.09E+01	56	-0.77778	9.21E+01	56	-0.77778	9.20E+01
57	-0.75556	9.07E+01	57	-0.75556	9.21E+01	57	-0.75556	9.20E+01
58	-0.73333	9.06E+01	58	-0.73333	9.21E+01	58	-0.73333	9.20E+01
59	-0.71111	9.04E+01	59	-0.71111	9.21E+01	59	-0.71111	9.20E+01
60	-0.68889	9.01E+01	60	-0.68889	9.20E+01	60	-0.68889	9.20E+01
61	-0.66667	8.99E+01	61	-0.66667	9.18E+01	61	-0.66667	9.20E+01
62	-0.64444	8.96E+01	62	-0.64444	9.16E+01	62	-0.64444	9.20E+01
63	-0.62222	8.93E+01	63	-0.62222	9.13E+01	63	-0.62222	9.20E+01
64	-0.6	8.89E+01	64	-0.6	9.09E+01	64	-0.6	9.20E+01
65	-0.57778	8.85E+01	65	-0.57778	9.04E+01	65	-0.57778	9.20E+01
66	-0.55556	8.80E+01	66	-0.55556	8.98E+01	66	-0.55556	9.20E+01
67	-0.53333	8.75E+01	67	-0.53333	8.91E+01	67	-0.53333	9.20E+01
68	-0.51111	8.69E+01	68	-0.51111	8.83E+01	68	-0.51111	9.20E+01
69	-0.48889	8.63E+01	69	-0.48889	8.75E+01	69	-0.48889	9.07E+01
70	-0.46667	8.56E+01	70	-0.46667	8.66E+01	70	-0.46667	8.90E+01
71	-0.44444	8.48E+01	71	-0.44444	8.56E+01	71	-0.44444	8.72E+01

Prediction Line

	X	Y
72	-0.42222	8.39E+01
73	-0.4	8.30E+01
74	-0.37778	8.19E+01
75	-0.35556	8.08E+01
76	-0.33333	7.95E+01
77	-0.31111	7.81E+01
78	-0.28889	7.66E+01
79	-0.26667	7.49E+01
80	-0.24444	7.31E+01
81	-0.22222	7.12E+01
82	-0.2	6.92E+01
83	-0.17778	6.70E+01
84	-0.15556	6.47E+01
85	-0.13333	6.23E+01
86	-0.11111	5.98E+01
87	-8.89E-02	5.72E+01
88	-6.67E-02	5.45E+01
89	-4.44E-02	5.18E+01
90	-2.22E-02	4.90E+01
91	0	4.62E+01
92	2.22E-02	4.33E+01
93	4.44E-02	4.06E+01
94	6.67E-02	3.78E+01
95	8.89E-02	3.51E+01
96	0.11111	3.25E+01
97	0.13333	3.00E+01
98	0.15556	2.76E+01
99	0.17778	2.53E+01
100	0.2	2.31E+01

	X	Y
72	-0.42222	8.45E+01
73	-0.4	8.33E+01
74	-0.37778	8.20E+01
75	-0.35556	8.07E+01
76	-0.33333	7.92E+01
77	-0.31111	7.77E+01
78	-0.28889	7.61E+01
79	-0.26667	7.44E+01
80	-0.24444	7.26E+01
81	-0.22222	7.07E+01
82	-0.2	6.88E+01
83	-0.17778	6.68E+01
84	-0.15556	6.46E+01
85	-0.13333	6.24E+01
86	-0.11111	6.01E+01
87	-8.89E-02	5.78E+01
88	-6.67E-02	5.53E+01
89	-4.44E-02	5.27E+01
90	-2.22E-02	5.01E+01
91	0	4.74E+01
92	2.22E-02	4.46E+01
93	4.44E-02	4.19E+01
94	6.67E-02	3.93E+01
95	8.89E-02	3.67E+01
96	0.11111	3.42E+01
97	0.13333	3.19E+01
98	0.15556	2.96E+01
99	0.17778	2.74E+01
100	0.2	2.53E+01

	X	Y
72	-0.42222	8.55E+01
73	-0.4	8.37E+01
74	-0.37778	8.20E+01
75	-0.35556	8.02E+01
76	-0.33333	7.85E+01
77	-0.31111	7.67E+01
78	-0.28889	7.50E+01
79	-0.26667	7.32E+01
80	-0.24444	7.15E+01
81	-0.22222	6.97E+01
82	-0.2	6.80E+01
83	-0.17778	6.62E+01
84	-0.15556	6.45E+01
85	-0.13333	6.27E+01
86	-0.11111	6.10E+01
87	-8.89E-02	5.92E+01
88	-6.67E-02	5.75E+01
89	-4.44E-02	5.57E+01
90	-2.22E-02	5.40E+01
91	0	5.22E+01
92	2.22E-02	5.05E+01
93	4.44E-02	4.87E+01
94	6.67E-02	4.70E+01
95	8.89E-02	4.52E+01
96	0.11111	4.35E+01
97	0.13333	4.17E+01
98	0.15556	4.00E+01
99	0.17778	3.82E+01
100	0.2	3.65E+01

Table E2.D-10c. TRAP Model Output for Selenium Data for the Mammal Growth Endpoint (Mahan and Moxon 1984)

Chemical:	Selenium
Study Authors:	Mahan and Moxon 1984
Receptor Group:	Mammal
Effect Description:	Growth

Input Data:

Dose	Effect	SE
0	18.7	0.55
0.10189	18.6	0.55
0.20377	17.4	0.55
0.30566	16	0.55
0.40755	15.1	0.55
0.61132	11.2	0.55
0.815	9.1	0.55
1.630	5.7	0.55

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?
Use Only for Exploratory Data Analysis!
Maximum Iterations Reached Without Convergence
X50 at Maximum or Minimum Limit
Steepness At Maximum Or Minimum Limit
Error Estimates Cannot Be Determined
Large Standard Error for X50
Large Standard Error for Steepness
Large Standard Error for Y0
Inadequate Number of Partial Effects
Insufficient Data to Plot
Insufficient Data to Analyze

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	-5.00E-02	-0.10206	3.94E-02	-0.21147	7.35E-03
S	0.9935	8.34E-01	0.10988	0.52883	1.139
Y0	1.86E+01	1.98E+01	0.95574	17.17	22.477

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	-5.00E-02	-8.04E-02	4.04E-02	-0.19256	3.18E-02
S	0.9935	9.29E-01	0.1308	0.56628	1.2926
Y0	1.86E+01	1.92E+01	0.98312	16.422	21.881

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	-5.00E-02	-3.73E-02	3.20E-02	-0.12613	5.16E-02
S	0.9935	0.83144	7.79E-02	0.61504	1.0478
Y0	1.86E+01	1.80E+01	0.53069	16.527	19.473

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	0.79057	0.61451	1.0171	3.94E-02	-0.10206
20	3.04E-01	1.78E-01	5.17E-01	8.32E-02	-0.51766
10	1.73E-01	8.40E-02	3.58E-01	0.11337	-0.76077
5	1.04E-01	4.18E-02	2.57E-01	0.14188	-0.98478
0					

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	0.83107	0.64185	1.0761	4.04E-02	-8.04E-02
20	0.33434	1.91E-01	0.58433	8.73E-02	-0.47582
10	2.11E-01	9.57E-02	4.67E-01	0.12394	-0.67513
5	0.15274	5.62E-02	4.15E-01	0.15631	-0.81606
0	6.98E-02	1.38E-02	3.53E-01	0.25353	-1.16E+00

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	0.91776	0.74794	1.1261	3.20E-02	-3.73E-02
20	0.39986	0.3091	0.51727	4.03E-02	-0.39809
10	0.30313	0.22266	0.4127	4.83E-02	-0.51837
5	0.26394	0.18843	0.3697	5.27E-02	-0.5785
0	0.22981	0.15925	0.33162	5.74E-02	-0.63864

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var
1	-9.92E-01	1.86E+01	1.89E+01
2	-6.91E-01	1.74E+01	1.74E+01
3	-5.15E-01	1.60E+01	1.58E+01
4	-3.90E-01	1.51E+01	1.43E+01
5	-2.14E-01	11.2	11.737
6	-8.88E-02	9.1	9.6923
7	2.12E-01	5.7	5.1448
8			

	Exposure	Effects Var	Est Effects Var
1	-9.92E-01	1.86E+01	1.89E+01
2	-6.91E-01	1.74E+01	1.74E+01
3	-5.15E-01	1.60E+01	1.57E+01
4	-3.90E-01	1.51E+01	1.43E+01
5	-2.14E-01	11.2	11.803
6	-8.88E-02	9.1	9.7253
7	2.12E-01	5.7	5.0757
8			

	Exposure	Effects Var	Est Effects Var
1	-9.92E-01	1.86E+01	1.80E+01
2	-6.91E-01	1.74E+01	1.80E+01
3	-5.15E-01	1.60E+01	1.61E+01
4	-3.90E-01	1.51E+01	1.43E+01
5	-2.14E-01	11.2	11.641
6	-8.88E-02	9.1	9.771
7	2.12E-01	5.7	5.2658
8			

Analysis of Variance

R-squared 0.996

	DF	SS	MS	F	Sig
Total (adj)	6	1276	212.66		
Regression	2	1270.6	635.29	472.16	0
Error	4	5.382	1.3455		

R-squared 0.995

	DF	SS	MS	F	Sig
Total (adj)	6	1276	212.66		
Regression	2	1269.5	634.73	389.9	0
Error	4	6.5118	1.6279		

R-squared 0.994

	DF	SS	MS	F	Sig
Total (adj)	6	1276	212.66		
Regression	2	1268.5	634.26	340.63	0
Error	4	7.4482	1.862		

Prediction Line

	X	Y		X	Y		X	Y
1	-1	1.89E+01	1	-1	1.89E+01	1	-1	1.80E+01
2	-9.86E-01	1.88E+01	2	-9.86E-01	1.89E+01	2	-9.86E-01	1.80E+01
3	-9.72E-01	1.88E+01	3	-9.72E-01	1.89E+01	3	-9.72E-01	1.80E+01
4	-9.58E-01	1.87E+01	4	-9.58E-01	1.88E+01	4	-9.58E-01	1.80E+01
5	-9.43E-01	1.87E+01	5	-9.43E-01	1.88E+01	5	-9.43E-01	1.80E+01
6	-9.29E-01	1.86E+01	6	-9.29E-01	1.87E+01	6	-9.29E-01	1.80E+01
7	-9.15E-01	1.86E+01	7	-9.15E-01	1.87E+01	7	-9.15E-01	1.80E+01
8	-9.01E-01	1.85E+01	8	-9.01E-01	1.86E+01	8	-9.01E-01	1.80E+01
9	-8.87E-01	1.85E+01	9	-8.87E-01	1.86E+01	9	-8.87E-01	1.80E+01
10	-8.73E-01	1.84E+01	10	-8.73E-01	1.85E+01	10	-8.73E-01	1.80E+01
11	-8.59E-01	1.84E+01	11	-8.59E-01	1.84E+01	11	-8.59E-01	1.80E+01
12	-8.44E-01	1.83E+01	12	-8.44E-01	1.83E+01	12	-8.44E-01	1.80E+01
13	-8.30E-01	1.82E+01	13	-8.30E-01	1.83E+01	13	-8.30E-01	1.80E+01
14	-0.81616	1.81E+01	14	-0.81616	1.82E+01	14	-0.81616	1.80E+01
15	-0.80202	1.81E+01	15	-0.80202	1.81E+01	15	-0.80202	1.80E+01
16	-0.78788	1.80E+01	16	-0.78788	1.80E+01	16	-0.78788	1.80E+01
17	-0.77374	1.79E+01	17	-0.77374	1.79E+01	17	-0.77374	1.80E+01
18	-0.7596	1.78E+01	18	-0.7596	1.79E+01	18	-0.7596	1.80E+01
19	-0.74545	1.77E+01	19	-0.74545	1.78E+01	19	-0.74545	1.80E+01
20	-0.73131	1.77E+01	20	-0.73131	1.77E+01	20	-0.73131	1.80E+01
21	-7.17E-01	1.76E+01	21	-7.17E-01	1.76E+01	21	-7.17E-01	1.80E+01
22	-7.03E-01	1.75E+01	22	-7.03E-01	1.75E+01	22	-7.03E-01	1.80E+01
23	-6.89E-01	1.74E+01	23	-6.89E-01	1.73E+01	23	-6.89E-01	1.80E+01
24	-6.75E-01	1.73E+01	24	-6.75E-01	1.72E+01	24	-6.75E-01	1.80E+01
25	-6.61E-01	1.72E+01	25	-6.61E-01	1.71E+01	25	-6.61E-01	1.80E+01
26	-6.46E-01	1.71E+01	26	-6.46E-01	1.70E+01	26	-6.46E-01	1.80E+01
27	-6.32E-01	1.69E+01	27	-6.32E-01	1.69E+01	27	-6.32E-01	1.79E+01
28	-6.18E-01	1.68E+01	28	-6.18E-01	1.68E+01	28	-6.18E-01	1.77E+01
29	-6.04E-01	1.67E+01	29	-6.04E-01	1.66E+01	29	-6.04E-01	1.75E+01
30	-5.90E-01	1.66E+01	30	-5.90E-01	1.65E+01	30	-5.90E-01	1.73E+01
31	-0.57576	1.64E+01	31	-0.57576	1.64E+01	31	-0.57576	1.71E+01
32	-0.56162	1.63E+01	32	-0.56162	1.62E+01	32	-0.56162	1.68E+01
33	-0.54747	1.62E+01	33	-0.54747	1.61E+01	33	-0.54747	1.66E+01
34	-0.53333	1.60E+01	34	-0.53333	1.59E+01	34	-0.53333	1.64E+01
35	-0.51919	1.59E+01	35	-0.51919	1.58E+01	35	-0.51919	1.62E+01
36	-0.50505	1.57E+01	36	-0.50505	1.56E+01	36	-0.50505	1.60E+01
37	-0.49091	1.56E+01	37	-0.49091	1.55E+01	37	-0.49091	1.58E+01
38	-0.47677	1.54E+01	38	-0.47677	1.53E+01	38	-0.47677	1.56E+01
39	-0.46263	1.52E+01	39	-0.46263	1.52E+01	39	-0.46263	1.54E+01
40	-0.44848	1.51E+01	40	-0.44848	1.50E+01	40	-0.44848	1.52E+01
41	-0.43434	1.49E+01	41	-0.43434	1.48E+01	41	-0.43434	1.49E+01
42	-0.4202	1.47E+01	42	-0.4202	1.47E+01	42	-0.4202	1.47E+01
43	-0.40606	1.45E+01	43	-0.40606	1.45E+01	43	-0.40606	1.45E+01
44	-0.39192	1.44E+01	44	-0.39192	1.43E+01	44	-0.39192	1.43E+01
45	-0.37778	1.42E+01	45	-0.37778	1.41E+01	45	-0.37778	1.41E+01
46	-0.36364	1.40E+01	46	-0.36364	1.40E+01	46	-0.36364	1.39E+01
47	-0.34949	1.38E+01	47	-0.34949	1.38E+01	47	-0.34949	1.37E+01
48	-0.33535	1.36E+01	48	-0.33535	1.36E+01	48	-0.33535	1.35E+01
49	-0.32121	1.34E+01	49	-0.32121	1.34E+01	49	-0.32121	1.32E+01
50	-0.30707	1.32E+01	50	-0.30707	1.32E+01	50	-0.30707	1.30E+01
51	-0.29293	1.30E+01	51	-0.29293	1.30E+01	51	-0.29293	1.28E+01
52	-0.27879	1.28E+01	52	-0.27879	1.28E+01	52	-0.27879	1.26E+01
53	-0.26465	1.25E+01	53	-0.26465	1.26E+01	53	-0.26465	1.24E+01
54	-0.25051	1.23E+01	54	-0.25051	1.24E+01	54	-0.25051	1.22E+01
55	-0.23636	1.21E+01	55	-0.23636	1.22E+01	55	-0.23636	1.20E+01
56	-0.22222	1.19E+01	56	-0.22222	1.19E+01	56	-0.22222	1.18E+01
57	-0.20808	1.16E+01	57	-0.20808	1.17E+01	57	-0.20808	1.16E+01
58	-0.19394	1.14E+01	58	-0.19394	1.15E+01	58	-0.19394	1.13E+01
59	-0.1798	1.12E+01	59	-0.1798	1.13E+01	59	-0.1798	1.11E+01
60	-0.16566	1.10E+01	60	-0.16566	1.10E+01	60	-0.16566	1.09E+01
61	-0.15152	1.07E+01	61	-0.15152	1.08E+01	61	-0.15152	1.07E+01

Prediction Line

	X	Y
62	-0.13737	1.05E+01
63	-0.12323	1.03E+01
64	-0.10909	1.00E+01
65	-9.49E-02	9.79E+00
66	-8.08E-02	9.56E+00
67	-6.67E-02	9.33E+00
68	-5.25E-02	9.09E+00
69	-3.84E-02	8.86E+00
70	-2.42E-02	8.63E+00
71	-1.01E-02	8.40E+00
72	4.04E-03	8.18E+00
73	1.82E-02	7.95E+00
74	3.23E-02	7.73E+00
75	4.65E-02	7.51E+00
76	6.06E-02	7.29E+00
77	7.47E-02	7.07E+00
78	8.89E-02	6.86E+00
79	0.10303	6.65E+00
80	0.11717	6.44E+00
81	0.13131	6.24E+00
82	0.14545	6.04E+00
83	0.1596	5.84E+00
84	0.17374	5.65E+00
85	0.18788	5.46E+00
86	0.20202	5.28E+00
87	0.21616	5.10E+00
88	0.2303	4.92E+00
89	0.24444	4.75E+00
90	0.25859	4.58E+00
91	0.27273	4.41E+00
92	0.28687	4.25E+00
93	0.30101	4.10E+00
94	0.31515	3.95E+00
95	0.32929	3.80E+00
96	0.34343	3.66E+00
97	0.35758	3.52E+00
98	0.37172	3.38E+00
99	0.38586	3.25E+00
100	0.4	3.13E+00

	X	Y
62	-0.13737	1.06E+01
63	-0.12323	1.03E+01
64	-0.10909	1.01E+01
65	-9.49E-02	9.83E+00
66	-8.08E-02	9.58E+00
67	-6.67E-02	9.33E+00
68	-5.25E-02	9.09E+00
69	-3.84E-02	8.84E+00
70	-2.42E-02	8.60E+00
71	-1.01E-02	8.37E+00
72	4.04E-03	8.13E+00
73	1.82E-02	7.90E+00
74	3.23E-02	7.68E+00
75	4.65E-02	7.45E+00
76	6.06E-02	7.23E+00
77	7.47E-02	7.01E+00
78	8.89E-02	6.80E+00
79	0.10303	6.59E+00
80	0.11717	6.38E+00
81	0.13131	6.18E+00
82	0.14545	5.98E+00
83	0.1596	5.78E+00
84	0.17374	5.59E+00
85	0.18788	5.40E+00
86	0.20202	5.21E+00
87	0.21616	5.03E+00
88	0.2303	4.84E+00
89	0.24444	4.67E+00
90	0.25859	4.49E+00
91	0.27273	4.32E+00
92	0.28687	4.15E+00
93	0.30101	3.99E+00
94	0.31515	3.83E+00
95	0.32929	3.67E+00
96	0.34343	3.52E+00
97	0.35758	3.37E+00
98	0.37172	3.22E+00
99	0.38586	3.08E+00
100	0.4	2.93E+00

	X	Y
62	-0.13737	1.05E+01
63	-0.12323	1.03E+01
64	-0.10909	1.01E+01
65	-9.49E-02	9.86E+00
66	-8.08E-02	9.65E+00
67	-6.67E-02	9.44E+00
68	-5.25E-02	9.23E+00
69	-3.84E-02	9.02E+00
70	-2.42E-02	8.81E+00
71	-1.01E-02	8.59E+00
72	4.04E-03	8.38E+00
73	1.82E-02	8.17E+00
74	3.23E-02	7.96E+00
75	4.65E-02	7.75E+00
76	6.06E-02	7.54E+00
77	7.47E-02	7.32E+00
78	8.89E-02	7.11E+00
79	0.10303	6.90E+00
80	0.11717	6.69E+00
81	0.13131	6.48E+00
82	0.14545	6.27E+00
83	0.1596	6.05E+00
84	0.17374	5.84E+00
85	0.18788	5.63E+00
86	0.20202	5.42E+00
87	0.21616	5.21E+00
88	0.2303	5.00E+00
89	0.24444	4.78E+00
90	0.25859	4.57E+00
91	0.27273	4.36E+00
92	0.28687	4.15E+00
93	0.30101	3.94E+00
94	0.31515	3.73E+00
95	0.32929	3.51E+00
96	0.34343	3.30E+00
97	0.35758	3.09E+00
98	0.37172	2.88E+00
99	0.38586	2.67E+00
100	0.4	2.46E+00

Table E2.D-11a. TRAP Model Output for Thallium Data for the Mammal Growth Endpoint (Pooling Group A: Downs et al. 1960)

Chemical:	Thallium
Study Authors:	Pooling group A
Receptor Group:	Mammal
Effect Description:	Growth

Input Data:	**Dose**	**Effect Relative to Control**
	0.000001	100
	1.736765899	82.35
	3.039340323	44.12
	0.000001	100
	2.027991685	95
	3.548985449	75

Modeling Parameters			
Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered			
Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence	yes	yes	yes
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit	yes	yes	yes
Error Estimates Cannot Be Determined			
Large Standard Error for X50			
Large Standard Error for Steepness	yes	yes	yes
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	0.47876	0.58601	1.11E-01	0.23166	0.94035
S	5.6669	1.89E+00	2.03E+00	-4.5638	8.3417
Y0	9.25E+01	9.76E+01	12.998	56.211	138.94

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	0.47876	0.61471	0.14331	0.15865	1.0708
S	5.6669	1.89E+00	1.9384	-4.28	8.0579
Y0	9.25E+01	9.49E+01	13.109	53.173	136.61

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	0.47876	0.58837	0.18261	7.22E-03	1.1695
S	5.6669	1.889	4.2998	-11.795	15.573
Y0	9.25E+01	9.52E+01	9.7352	64.232	126.2

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	3.8548	1.7048	8.7167	1.11E-01	0.58601
20	2.53E+00	7.77E-01	8.22E+00	1.61E-01	0.40253
10	1.97E+00	2.85E-01	1.37E+01	2.64E-01	0.29521
5	1.57E+00	1.08E-01	2.29E+01	3.66E-01	0.19631
0					

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	4.1183	1.441	11.77	0.14331	0.61471
20	2.6311	8.75E-01	7.9147	0.15029	0.42014
10	2.10E+00	3.83E-01	1.15E+01	0.23204	0.32207
5	1.7895	2.03E-01	1.58E+01	0.29693	0.25273
0	1.2171	4.14E-02	3.58E+01	0.46127	8.53E-02

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	3.8759	1.0168	14.775	0.18261	0.58837
20	2.6888	0.55115	13.117	0.21627	0.42955
10	2.3802	0.21101	26.849	0.33066	0.37661
5	2.2395	0.12924	38.805	0.38924	0.35014
0	2.107	7.89E-02	56.269	0.44827	0.32367

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	9.76E+01
2	2.40E-01	8.24E+01	9.76E+01
3	4.83E-01	4.41E+01	9.09E+01
4	-6.00E+00	1.00E+02	8.70E+01
5	3.07E-01	9.50E+01	6.69E+01
6	5.50E-01	7.50E+01	5.54E+01
7			
8			
9			
10			
11			
12			

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	9.49E+01
2	-6.00E+00	1.00E+02	9.49E+01
3	2.40E-01	8.24E+01	9.09E+01
4	3.07E-01	9.50E+01	8.66E+01
5	4.83E-01	4.41E+01	6.81E+01
6	5.50E-01	7.50E+01	5.83E+01
7			
8			
9			
10			
11			
12			

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	9.52E+01
2	-6.00E+00	1.00E+02	9.52E+01
3	2.40E-01	8.24E+01	9.52E+01
4	3.07E-01	9.50E+01	9.52E+01
5	4.83E-01	4.41E+01	6.66E+01
6	5.50E-01	7.50E+01	5.45E+01
7			
8			
9			
10			
11			
12			

Analysis of Variance

R-squared: 0.541

	DF	SS	MS	F	Sig
Total (adj)	5	2297.7	459.54		
Regression	2	1243.6	621.82	1.7698	0.3107
Error	3	1054	351.35		

R-squared 0.543

	DF	SS	MS	F	Sig
Total (adj)	5	2297.7	459.54		
Regression	2	1246.5	623.25	1.7787	0.3094
Error	3	1051.2	350.39		

R-squared 0.505

	DF	SS	MS	F	Sig
Total (adj)	5	2297.7	459.54		
Regression	2	1160.4	580.2	1.5305	0.3482
Error	3	1137.3	379.1		

Prediction Line

	X	Y		X	Y		X	Y
1	-3.5	9.76E+01	1	-3.5	9.49E+01	1	-3.5	9.52E+01
2	-3.45E+00	9.76E+01	2	-3.45E+00	9.49E+01	2	-3.45E+00	9.52E+01
3	-3.41E+00	9.76E+01	3	-3.41E+00	9.49E+01	3	-3.41E+00	9.52E+01
4	-3.36E+00	9.76E+01	4	-3.36E+00	9.49E+01	4	-3.36E+00	9.52E+01
5	-3.32E+00	9.76E+01	5	-3.32E+00	9.49E+01	5	-3.32E+00	9.52E+01
6	-3.27E+00	9.76E+01	6	-3.27E+00	9.49E+01	6	-3.27E+00	9.52E+01
7	-3.23E+00	9.76E+01	7	-3.23E+00	9.49E+01	7	-3.23E+00	9.52E+01
8	-3.18E+00	9.76E+01	8	-3.18E+00	9.49E+01	8	-3.18E+00	9.52E+01
9	-3.14E+00	9.76E+01	9	-3.14E+00	9.49E+01	9	-3.14E+00	9.52E+01
10	-3.09E+00	9.76E+01	10	-3.09E+00	9.49E+01	10	-3.09E+00	9.52E+01
11	-3.05E+00	9.76E+01	11	-3.05E+00	9.49E+01	11	-3.05E+00	9.52E+01
12	-3.00E+00	9.76E+01	12	-3.00E+00	9.49E+01	12	-3.00E+00	9.52E+01
13	-2.95E+00	9.76E+01	13	-2.95E+00	9.49E+01	13	-2.95E+00	9.52E+01
14	-2.91E+00	9.76E+01	14	-2.91E+00	9.49E+01	14	-2.91E+00	9.52E+01
15	-2.8636	9.76E+01	15	-2.8636	9.49E+01	15	-2.8636	9.52E+01
16	-2.8182	9.76E+01	16	-2.8182	9.49E+01	16	-2.8182	9.52E+01
17	-2.7727	9.76E+01	17	-2.7727	9.49E+01	17	-2.7727	9.52E+01
18	-2.7273	9.76E+01	18	-2.7273	9.49E+01	18	-2.7273	9.52E+01
19	-2.6818	9.76E+01	19	-2.6818	9.49E+01	19	-2.6818	9.52E+01
20	-2.6364	9.76E+01	20	-2.6364	9.49E+01	20	-2.6364	9.52E+01
21	-2.59E+00	9.76E+01	21	-2.59E+00	9.49E+01	21	-2.59E+00	9.52E+01
22	-2.55E+00	9.76E+01	22	-2.55E+00	9.49E+01	22	-2.55E+00	9.52E+01
23	-2.50E+00	9.76E+01	23	-2.50E+00	9.49E+01	23	-2.50E+00	9.52E+01
24	-2.45E+00	9.76E+01	24	-2.45E+00	9.49E+01	24	-2.45E+00	9.52E+01
25	-2.41E+00	9.76E+01	25	-2.41E+00	9.49E+01	25	-2.41E+00	9.52E+01
26	-2.36E+00	9.76E+01	26	-2.36E+00	9.49E+01	26	-2.36E+00	9.52E+01
27	-2.32E+00	9.76E+01	27	-2.32E+00	9.49E+01	27	-2.32E+00	9.52E+01
28	-2.27E+00	9.76E+01	28	-2.27E+00	9.49E+01	28	-2.27E+00	9.52E+01
29	-2.23E+00	9.76E+01	29	-2.23E+00	9.49E+01	29	-2.23E+00	9.52E+01
30	-2.18E+00	9.76E+01	30	-2.18E+00	9.49E+01	30	-2.18E+00	9.52E+01
31	-2.1364	9.76E+01	31	-2.1364	9.49E+01	31	-2.1364	9.52E+01
32	-2.0909	9.76E+01	32	-2.0909	9.49E+01	32	-2.0909	9.52E+01
33	-2.0455	9.76E+01	33	-2.0455	9.49E+01	33	-2.0455	9.52E+01
34	-2	9.76E+01	34	-2	9.49E+01	34	-2	9.52E+01
35	-1.9545	9.76E+01	35	-1.9545	9.49E+01	35	-1.9545	9.52E+01
36	-1.9091	9.76E+01	36	-1.9091	9.49E+01	36	-1.9091	9.52E+01
37	-1.8636	9.76E+01	37	-1.8636	9.49E+01	37	-1.8636	9.52E+01
38	-1.8182	9.76E+01	38	-1.8182	9.49E+01	38	-1.8182	9.52E+01
39	-1.7727	9.76E+01	39	-1.7727	9.49E+01	39	-1.7727	9.52E+01
40	-1.7273	9.76E+01	40	-1.7273	9.49E+01	40	-1.7273	9.52E+01
41	-1.6818	9.76E+01	41	-1.6818	9.49E+01	41	-1.6818	9.52E+01
42	-1.6364	9.76E+01	42	-1.6364	9.49E+01	42	-1.6364	9.52E+01
43	-1.59E+00	9.76E+01	43	-1.59E+00	9.49E+01	43	-1.59E+00	9.52E+01
44	-1.55E+00	9.76E+01	44	-1.55E+00	9.49E+01	44	-1.55E+00	9.52E+01
45	-1.5	9.76E+01	45	-1.5	9.49E+01	45	-1.5	9.52E+01
46	-1.45E+00	9.76E+01	46	-1.45E+00	9.49E+01	46	-1.45E+00	9.52E+01
47	-1.41E+00	9.76E+01	47	-1.41E+00	9.49E+01	47	-1.41E+00	9.52E+01
48	-1.3636	9.76E+01	48	-1.3636	9.49E+01	48	-1.3636	9.52E+01
49	-1.3182	9.76E+01	49	-1.3182	9.49E+01	49	-1.3182	9.52E+01
50	-1.2727	9.76E+01	50	-1.2727	9.49E+01	50	-1.2727	9.52E+01
51	-1.2273	9.76E+01	51	-1.2273	9.49E+01	51	-1.2273	9.52E+01
52	-1.1818	9.76E+01	52	-1.1818	9.49E+01	52	-1.1818	9.52E+01
53	-1.1364	9.76E+01	53	-1.1364	9.49E+01	53	-1.1364	9.52E+01
54	-1.0909	9.76E+01	54	-1.0909	9.49E+01	54	-1.0909	9.52E+01
55	-1.0455	9.76E+01	55	-1.0455	9.49E+01	55	-1.0455	9.52E+01
56	-1	9.76E+01	56	-1	9.49E+01	56	-1	9.52E+01
57	-0.95455	9.76E+01	57	-0.95455	9.49E+01	57	-0.95455	9.52E+01
58	-0.90909	9.76E+01	58	-0.90909	9.49E+01	58	-0.90909	9.52E+01
59	-0.86364	9.76E+01	59	-0.86364	9.49E+01	59	-0.86364	9.52E+01
60	-0.81818	9.76E+01	60	-0.81818	9.49E+01	60	-0.81818	9.52E+01

Prediction Line

	X	Y
61	-0.77273	9.76E+01
62	-0.72727	9.76E+01
63	-0.68182	9.76E+01
64	-0.63636	9.76E+01
65	-0.59091	9.76E+01
66	-0.54545	9.76E+01
67	-0.5	9.76E+01
68	-0.45455	9.75E+01
69	-0.40909	9.75E+01
70	-0.36364	9.75E+01
71	-0.31818	9.75E+01
72	-0.27273	9.74E+01
73	-0.22727	9.74E+01
74	-0.18182	9.73E+01
75	-0.13636	9.72E+01
76	-9.09E-02	9.70E+01
77	-4.55E-02	9.68E+01
78	0	9.64E+01
79	4.55E-02	9.60E+01
80	9.09E-02	9.53E+01
81	0.13636	9.44E+01
82	0.18182	9.32E+01
83	0.22727	9.15E+01
84	0.27273	8.92E+01
85	0.31818	8.62E+01
86	0.36364	8.23E+01
87	0.40909	7.73E+01
88	0.45455	7.12E+01
89	0.5	6.41E+01
90	0.54545	5.62E+01
91	0.59091	4.79E+01
92	0.63636	3.96E+01
93	0.68182	3.19E+01
94	0.72727	2.50E+01
95	0.77273	1.91E+01
96	0.81818	1.44E+01
97	0.86364	1.07E+01
98	0.90909	7.81E+00
99	0.95455	5.68E+00
100	1	4.09E+00

	X	Y
61	-0.77273	9.49E+01
62	-0.72727	9.49E+01
63	-0.68182	9.49E+01
64	-0.63636	9.49E+01
65	-0.59091	9.49E+01
66	-0.54545	9.49E+01
67	-0.5	9.49E+01
68	-0.45455	9.49E+01
69	-0.40909	9.49E+01
70	-0.36364	9.49E+01
71	-0.31818	9.49E+01
72	-0.27273	9.49E+01
73	-0.22727	9.49E+01
74	-0.18182	9.49E+01
75	-0.13636	9.49E+01
76	-9.09E-02	9.49E+01
77	-4.55E-02	9.49E+01
78	0	9.49E+01
79	4.55E-02	9.49E+01
80	9.09E-02	9.49E+01
81	0.13636	9.45E+01
82	0.18182	9.33E+01
83	0.22727	9.15E+01
84	0.27273	8.89E+01
85	0.31818	8.57E+01
86	0.36364	8.18E+01
87	0.40909	7.71E+01
88	0.45455	7.18E+01
89	0.5	6.58E+01
90	0.54545	5.90E+01
91	0.59091	5.16E+01
92	0.63636	4.36E+01
93	0.68182	3.62E+01
94	0.72727	2.94E+01
95	0.77273	2.33E+01
96	0.81818	1.80E+01
97	0.86364	1.33E+01
98	0.90909	9.35E+00
99	0.95455	6.08E+00
100	1	3.52E+00

	X	Y
61	-0.77273	9.52E+01
62	-0.72727	9.52E+01
63	-0.68182	9.52E+01
64	-0.63636	9.52E+01
65	-0.59091	9.52E+01
66	-0.54545	9.52E+01
67	-0.5	9.52E+01
68	-0.45455	9.52E+01
69	-0.40909	9.52E+01
70	-0.36364	9.52E+01
71	-0.31818	9.52E+01
72	-0.27273	9.52E+01
73	-0.22727	9.52E+01
74	-0.18182	9.52E+01
75	-0.13636	9.52E+01
76	-9.09E-02	9.52E+01
77	-4.55E-02	9.52E+01
78	0	9.52E+01
79	4.55E-02	9.52E+01
80	9.09E-02	9.52E+01
81	0.13636	9.52E+01
82	0.18182	9.52E+01
83	0.22727	9.52E+01
84	0.27273	9.52E+01
85	0.31818	9.52E+01
86	0.36364	8.80E+01
87	0.40909	7.99E+01
88	0.45455	7.17E+01
89	0.5	6.35E+01
90	0.54545	5.53E+01
91	0.59091	4.72E+01
92	0.63636	3.90E+01
93	0.68182	3.08E+01
94	0.72727	2.26E+01
95	0.77273	1.45E+01
96	0.81818	6.27E+00
97	0.86364	0.00E+00
98	0.90909	0.00E+00
99	0.95455	0.00E+00
100	1	0.00E+00

Table E2.D-11b. TRAP Model Output for Thallium Data for the Mammal Survival Endpoint (Pooling Group B: Downs et al. 1960)

Chemical:	Thallium
Study Authors:	Pooling group B
Receptor Group:	Mammal
Effect Description:	Survival

Input Data:

Dose	Effect Relative to Control
0.000001	100
1.736765899	125
3.039340323	25
4.341914747	0
0.000001	100
2.027991685	60
3.548985449	60
5.069979213	0

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			yes
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined			
Large Standard Error for X50			
Large Standard Error for Steepness	yes	yes	
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

Logistic Equation:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	0.42985	0.44207	8.21E-02	0.23112	0.65302
S	3.6162	2.53E+00	1.52E+00	-1.3874	6.4472
Y0	1.13E+02	1.05E+02	17.49	59.831	149.75

Threshold Sigmoid:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	0.42985	0.44655	7.64E-02	0.25006	0.64304
S	3.6162	2.78E+00	1.4885	-1.0509	6.6015
Y0	1.13E+02	1.04E+02	17.256	59.64	148.36

Piecewise Linear:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	0.42985	0.45412	6.09E-02	0.29765	0.61059
S	3.6162	2.3323	0.95554	-0.12395	4.7886
Y0	1.13E+02	1.02E+02	15.564	62.192	142.21

Xp Estimates

Logistic Equation:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	2.7674	1.7026	4.498	8.21E-02	0.44207
20	2.02E+00	8.87E-01	4.60E+00	1.39E-01	0.30507
10	1.68E+00	5.73E-01	4.92E+00	1.82E-01	0.22494
5	1.42E+00	3.78E-01	5.30E+00	2.23E-01	0.1511
0					

Threshold Sigmoid:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	2.7961	1.7785	4.3959	7.64E-02	0.44655
20	2.0612	9.67E-01	4.3922	0.12782	0.31412
10	1.77E+00	6.55E-01	4.77E+00	0.16765	0.24738
5	1.5855	4.76E-01	5.28E+00	0.20312	0.20018
0	1.2197	2.61E-01	5.69E+00	0.26019	8.62E-02

Piecewise Linear:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	2.8452	1.9845	4.0793	6.09E-02	0.45412
20	2.1159	1.1958	3.7441	9.64E-02	0.32549
10	1.917	0.99182	3.7051	0.11133	0.28262
5	1.8246	0.90184	3.6917	0.11906	0.26118
0	1.7368	0.81937	3.6813	0.12692	0.23974

Model Fit Summary

Dataset

Logistic Equation:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	1.05E+02
2	-6.00E+00	1.00E+02	1.05E+02
3	2.40E-01	1.25E+02	9.28E+01
4	3.07E-01	6.00E+01	8.35E+01
5	4.83E-01	2.50E+01	4.18E+01
6	5.50E-01	6.00E+01	2.63E+01
7	6.38E-01	0.00E+00	1.27E+01
8	7.05E-01	0.00E+00	6.85E+00
9			
10			
11			
12			

Threshold Sigmoid:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	1.04E+02
2	-6.00E+00	1.00E+02	1.04E+02
3	2.40E-01	1.25E+02	9.46E+01
4	3.07E-01	6.00E+01	8.45E+01
5	4.83E-01	2.50E+01	4.21E+01
6	5.50E-01	6.00E+01	2.64E+01
7	6.38E-01	0.00E+00	1.15E+01
8	7.05E-01	0.00E+00	4.16E+00
9			
10			
11			
12			

Piecewise Linear:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.00E+02	1.02E+02
2	-6.00E+00	1.00E+02	1.02E+02
3	2.40E-01	1.25E+02	1.02E+02
4	3.07E-01	6.00E+01	8.62E+01
5	4.83E-01	2.50E+01	4.43E+01
6	5.50E-01	6.00E+01	2.82E+01
7	6.38E-01	0.00E+00	7.35E+00
8	7.05E-01	0.00E+00	0.00E+00
9			
10			
11			
12			

Analysis of Variance

R-squared: 0.794

	DF	SS	MS	F	Sig
Total (adj)	7	15837	2262.5		
Regression	2	12579	6289.4	9.6503	0.0192
Error	5	3258.7	651.73		

R-squared 0.803

	DF	SS	MS	F	Sig
Total (adj)	7	15837	2262.5		
Regression	2	12712	6355.9	10.167	0.0173
Error	5	3125.8	625.15		

R-squared 0.833

	DF	SS	MS	F	Sig
Total (adj)	7	15837	2262.5		
Regression	2	13189	6594.4	12.449	0.0114
Error	5	2648.6	529.72		

Prediction Line

	X	Y		X	Y		X	Y
1	-3	1.05E+02	1	-3	1.04E+02	1	-3	1.02E+02
2	-2.96E+00	1.05E+02	2	-2.96E+00	1.04E+02	2	-2.96E+00	1.02E+02
3	-2.92E+00	1.05E+02	3	-2.92E+00	1.04E+02	3	-2.92E+00	1.02E+02
4	-2.88E+00	1.05E+02	4	-2.88E+00	1.04E+02	4	-2.88E+00	1.02E+02
5	-2.84E+00	1.05E+02	5	-2.84E+00	1.04E+02	5	-2.84E+00	1.02E+02
6	-2.80E+00	1.05E+02	6	-2.80E+00	1.04E+02	6	-2.80E+00	1.02E+02
7	-2.76E+00	1.05E+02	7	-2.76E+00	1.04E+02	7	-2.76E+00	1.02E+02
8	-2.72E+00	1.05E+02	8	-2.72E+00	1.04E+02	8	-2.72E+00	1.02E+02
9	-2.68E+00	1.05E+02	9	-2.68E+00	1.04E+02	9	-2.68E+00	1.02E+02
10	-2.64E+00	1.05E+02	10	-2.64E+00	1.04E+02	10	-2.64E+00	1.02E+02
11	-2.60E+00	1.05E+02	11	-2.60E+00	1.04E+02	11	-2.60E+00	1.02E+02
12	-2.56E+00	1.05E+02	12	-2.56E+00	1.04E+02	12	-2.56E+00	1.02E+02
13	-2.52E+00	1.05E+02	13	-2.52E+00	1.04E+02	13	-2.52E+00	1.02E+02
14	-2.47E+00	1.05E+02	14	-2.47E+00	1.04E+02	14	-2.47E+00	1.02E+02
15	-2.4343	1.05E+02	15	-2.4343	1.04E+02	15	-2.4343	1.02E+02
16	-2.3939	1.05E+02	16	-2.3939	1.04E+02	16	-2.3939	1.02E+02
17	-2.3535	1.05E+02	17	-2.3535	1.04E+02	17	-2.3535	1.02E+02
18	-2.3131	1.05E+02	18	-2.3131	1.04E+02	18	-2.3131	1.02E+02
19	-2.2727	1.05E+02	19	-2.2727	1.04E+02	19	-2.2727	1.02E+02
20	-2.2323	1.05E+02	20	-2.2323	1.04E+02	20	-2.2323	1.02E+02
21	-2.19E+00	1.05E+02	21	-2.19E+00	1.04E+02	21	-2.19E+00	1.02E+02
22	-2.15E+00	1.05E+02	22	-2.15E+00	1.04E+02	22	-2.15E+00	1.02E+02
23	-2.11E+00	1.05E+02	23	-2.11E+00	1.04E+02	23	-2.11E+00	1.02E+02
24	-2.07E+00	1.05E+02	24	-2.07E+00	1.04E+02	24	-2.07E+00	1.02E+02
25	-2.03E+00	1.05E+02	25	-2.03E+00	1.04E+02	25	-2.03E+00	1.02E+02
26	-1.99E+00	1.05E+02	26	-1.99E+00	1.04E+02	26	-1.99E+00	1.02E+02
27	-1.95E+00	1.05E+02	27	-1.95E+00	1.04E+02	27	-1.95E+00	1.02E+02
28	-1.91E+00	1.05E+02	28	-1.91E+00	1.04E+02	28	-1.91E+00	1.02E+02
29	-1.87E+00	1.05E+02	29	-1.87E+00	1.04E+02	29	-1.87E+00	1.02E+02
30	-1.83E+00	1.05E+02	30	-1.83E+00	1.04E+02	30	-1.83E+00	1.02E+02
31	-1.7879	1.05E+02	31	-1.7879	1.04E+02	31	-1.7879	1.02E+02
32	-1.7475	1.05E+02	32	-1.7475	1.04E+02	32	-1.7475	1.02E+02
33	-1.7071	1.05E+02	33	-1.7071	1.04E+02	33	-1.7071	1.02E+02
34	-1.6667	1.05E+02	34	-1.6667	1.04E+02	34	-1.6667	1.02E+02
35	-1.6263	1.05E+02	35	-1.6263	1.04E+02	35	-1.6263	1.02E+02
36	-1.5859	1.05E+02	36	-1.5859	1.04E+02	36	-1.5859	1.02E+02
37	-1.5455	1.05E+02	37	-1.5455	1.04E+02	37	-1.5455	1.02E+02
38	-1.5051	1.05E+02	38	-1.5051	1.04E+02	38	-1.5051	1.02E+02
39	-1.4646	1.05E+02	39	-1.4646	1.04E+02	39	-1.4646	1.02E+02
40	-1.4242	1.05E+02	40	-1.4242	1.04E+02	40	-1.4242	1.02E+02
41	-1.3838	1.05E+02	41	-1.3838	1.04E+02	41	-1.3838	1.02E+02
42	-1.3434	1.05E+02	42	-1.3434	1.04E+02	42	-1.3434	1.02E+02
43	-1.30E+00	1.05E+02	43	-1.30E+00	1.04E+02	43	-1.30E+00	1.02E+02
44	-1.26E+00	1.05E+02	44	-1.26E+00	1.04E+02	44	-1.26E+00	1.02E+02
45	-1.2222	1.05E+02	45	-1.2222	1.04E+02	45	-1.2222	1.02E+02
46	-1.18E+00	1.05E+02	46	-1.18E+00	1.04E+02	46	-1.18E+00	1.02E+02
47	-1.14E+00	1.05E+02	47	-1.14E+00	1.04E+02	47	-1.14E+00	1.02E+02
48	-1.101	1.05E+02	48	-1.101	1.04E+02	48	-1.101	1.02E+02
49	-1.0606	1.05E+02	49	-1.0606	1.04E+02	49	-1.0606	1.02E+02
50	-1.0202	1.05E+02	50	-1.0202	1.04E+02	50	-1.0202	1.02E+02
51	-0.9798	1.05E+02	51	-0.9798	1.04E+02	51	-0.9798	1.02E+02
52	-0.93939	1.05E+02	52	-0.93939	1.04E+02	52	-0.93939	1.02E+02
53	-0.89899	1.05E+02	53	-0.89899	1.04E+02	53	-0.89899	1.02E+02
54	-0.85859	1.05E+02	54	-0.85859	1.04E+02	54	-0.85859	1.02E+02
55	-0.81818	1.05E+02	55	-0.81818	1.04E+02	55	-0.81818	1.02E+02
56	-0.77778	1.05E+02	56	-0.77778	1.04E+02	56	-0.77778	1.02E+02
57	-0.73737	1.05E+02	57	-0.73737	1.04E+02	57	-0.73737	1.02E+02
58	-0.69697	1.05E+02	58	-0.69697	1.04E+02	58	-0.69697	1.02E+02
59	-0.65657	1.05E+02	59	-0.65657	1.04E+02	59	-0.65657	1.02E+02
60	-0.61616	1.05E+02	60	-0.61616	1.04E+02	60	-0.61616	1.02E+02
61	-0.57576	1.05E+02	61	-0.57576	1.04E+02	61	-0.57576	1.02E+02

Prediction Line

	X	Y
62	-0.53535	1.05E+02
63	-0.49495	1.05E+02
64	-0.45455	1.05E+02
65	-0.41414	1.05E+02
66	-0.37374	1.05E+02
67	-0.33333	1.05E+02
68	-0.29293	1.05E+02
69	-0.25253	1.05E+02
70	-0.21212	1.05E+02
71	-0.17172	1.05E+02
72	-0.13131	1.04E+02
73	-9.09E-02	1.04E+02
74	-5.05E-02	1.04E+02
75	-1.01E-02	1.04E+02
76	3.03E-02	1.03E+02
77	7.07E-02	1.02E+02
78	0.11111	1.01E+02
79	0.15152	9.95E+01
80	0.19192	9.71E+01
81	0.23232	9.36E+01
82	0.27273	8.88E+01
83	0.31313	8.24E+01
84	0.35354	7.44E+01
85	0.39394	6.49E+01
86	0.43434	5.44E+01
87	0.47475	4.38E+01
88	0.51515	3.39E+01
89	0.55556	2.52E+01
90	0.59596	1.82E+01
91	0.63636	1.29E+01
92	0.67677	8.92E+00
93	0.71717	6.10E+00
94	0.75758	4.13E+00
95	0.79798	2.78E+00
96	0.83838	1.87E+00
97	0.87879	1.25E+00
98	0.91919	8.32E-01
99	0.9596	5.54E-01
100	1	3.69E-01

	X	Y
62	-0.53535	1.04E+02
63	-0.49495	1.04E+02
64	-0.45455	1.04E+02
65	-0.41414	1.04E+02
66	-0.37374	1.04E+02
67	-0.33333	1.04E+02
68	-0.29293	1.04E+02
69	-0.25253	1.04E+02
70	-0.21212	1.04E+02
71	-0.17172	1.04E+02
72	-0.13131	1.04E+02
73	-9.09E-02	1.04E+02
74	-5.05E-02	1.04E+02
75	-1.01E-02	1.04E+02
76	3.03E-02	1.04E+02
77	7.07E-02	1.04E+02
78	0.11111	1.04E+02
79	0.15152	1.02E+02
80	0.19192	9.95E+01
81	0.23232	9.55E+01
82	0.27273	9.01E+01
83	0.31313	8.34E+01
84	0.35354	7.54E+01
85	0.39394	6.61E+01
86	0.43434	5.55E+01
87	0.47475	4.42E+01
88	0.51515	3.41E+01
89	0.55556	2.53E+01
90	0.59596	1.78E+01
91	0.63636	1.16E+01
92	0.67677	6.78E+00
93	0.71717	3.22E+00
94	0.75758	9.73E-01
95	0.79798	3.17E-02
96	0.83838	0.00E+00
97	0.87879	0.00E+00
98	0.91919	0.00E+00
99	0.9596	0.00E+00
100	1	0.00E+00

	X	Y
62	-0.53535	1.02E+02
63	-0.49495	1.02E+02
64	-0.45455	1.02E+02
65	-0.41414	1.02E+02
66	-0.37374	1.02E+02
67	-0.33333	1.02E+02
68	-0.29293	1.02E+02
69	-0.25253	1.02E+02
70	-0.21212	1.02E+02
71	-0.17172	1.02E+02
72	-0.13131	1.02E+02
73	-9.09E-02	1.02E+02
74	-5.05E-02	1.02E+02
75	-1.01E-02	1.02E+02
76	3.03E-02	1.02E+02
77	7.07E-02	1.02E+02
78	0.11111	1.02E+02
79	0.15152	1.02E+02
80	0.19192	1.02E+02
81	0.23232	1.02E+02
82	0.27273	9.43E+01
83	0.31313	8.47E+01
84	0.35354	7.51E+01
85	0.39394	6.54E+01
86	0.43434	5.58E+01
87	0.47475	4.62E+01
88	0.51515	3.66E+01
89	0.55556	2.69E+01
90	0.59596	1.73E+01
91	0.63636	7.66E+00
92	0.67677	0.00E+00
93	0.71717	0.00E+00
94	0.75758	0.00E+00
95	0.79798	0.00E+00
96	0.83838	0.00E+00
97	0.87879	0.00E+00
98	0.91919	0.00E+00
99	0.9596	0.00E+00
100	1	0.00E+00

Table E2.D-12a. TRAP Model Output for Vanadium Data for the Bird Growth Endpoint (Berg and Lawrence 1971)

Chemical:	Vanadium
Study Authors:	Berg and Lawrence 1971
Receptor Group:	Bird
Effect Description:	Growth

Input Data:

Dose	Effect	Standard Error
0.000001	126	not reported
1.160299	102	not reported
2.320598	68	not reported

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined	yes	yes	yes
Large Standard Error for X50			
Large Standard Error for Steepness			
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

Logistic Equation:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	0.40278	0.40278			
S	1.0695	1.07E+00			
Y0	1.26E+02	1.26E+02			

Threshold Sigmoid:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	0.40278	0.40122			
S	1.0695	1.14E+00			
Y0	1.26E+02	1.26E+02			

Piecewise Linear:

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	0.40278	0.40987			
S	1.0695	0.89639			
Y0	1.26E+02	1.26E+02			

Xp Estimates

Logistic Equation:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	2.528	Infinity	0	0	0.40278
20	1.20E+00	Infinity	0.00E+00	0	7.87E-02
10	7.75E-01	Infinity	0.00E+00	0	-0.11081
5	5.18E-01	Infinity	0.00E+00	0	-0.28547
0					

Threshold Sigmoid:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	2.519	Infinity	0	0	0.40122
20	1.1967	Infinity	0	0	7.80E-02
10	8.22E-01	Infinity	0.00E+00	0	-8.49E-02
5	0.63076	Infinity	0.00E+00	0	-0.20014
0	0.33247	Infinity	0.00E+00	0	-4.78E-01

Piecewise Linear:

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	2.5696	Infinity	0	0	0.40987
20	1.189	Infinity	0	0	7.52E-02
10	0.91968	Infinity	0	0	-3.64E-02
5	0.80883	Infinity	0	0	-9.21E-02
0	0.71134	Infinity	0	0	-0.14792

Model Fit Summary

Dataset

Logistic Equation:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.26E+02	1.26E+02
2	6.46E-02	1.02E+02	1.02E+02
3	3.66E-01	6.80E+01	6.80E+01
4			
5			
6			

Threshold Sigmoid:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.26E+02	1.26E+02
2	6.46E-02	1.02E+02	1.02E+02
3	3.66E-01	6.80E+01	6.80E+01
4			
5			
6			

Piecewise Linear:

	Exposure	Effects Var	Est Effects Var
1	-6.00E+00	1.26E+02	1.26E+02
2	6.46E-02	1.02E+02	1.02E+02
3	3.66E-01	6.80E+01	6.80E+01
4			
5			
6			

Analysis of Variance

Logistic Equation: R-squared 0

	DF	SS	MS	F	Sig
Total (adj)	0	0	0		
Regression	0	0	0	0	0
Error	0	0	0		

Threshold Sigmoid: R-squared 0

	DF	SS	MS	F	Sig
Total (adj)	0	0	0		
Regression	0	0	0	0	0
Error	0	0	0		

Piecewise Linear: R-squared 0

	DF	SS	MS	F	Sig
Total (adj)	0	0	0		
Regression	0	0	0	0	0
Error	0	0	0		

Prediction Line

	X	Y		X	Y		X	Y
1	-3.5	1.26E+02	1	-3.5	1.26E+02	1	-3.5	1.26E+02
2	-3.45E+00	1.26E+02	2	-3.45E+00	1.26E+02	2	-3.45E+00	1.26E+02
3	-3.41E+00	1.26E+02	3	-3.41E+00	1.26E+02	3	-3.41E+00	1.26E+02
4	-3.36E+00	1.26E+02	4	-3.36E+00	1.26E+02	4	-3.36E+00	1.26E+02
5	-3.32E+00	1.26E+02	5	-3.32E+00	1.26E+02	5	-3.32E+00	1.26E+02
6	-3.27E+00	1.26E+02	6	-3.27E+00	1.26E+02	6	-3.27E+00	1.26E+02
7	-3.23E+00	1.26E+02	7	-3.23E+00	1.26E+02	7	-3.23E+00	1.26E+02
8	-3.18E+00	1.26E+02	8	-3.18E+00	1.26E+02	8	-3.18E+00	1.26E+02
9	-3.14E+00	1.26E+02	9	-3.14E+00	1.26E+02	9	-3.14E+00	1.26E+02
10	-3.09E+00	1.26E+02	10	-3.09E+00	1.26E+02	10	-3.09E+00	1.26E+02
11	-3.05E+00	1.26E+02	11	-3.05E+00	1.26E+02	11	-3.05E+00	1.26E+02
12	-3.00E+00	1.26E+02	12	-3.00E+00	1.26E+02	12	-3.00E+00	1.26E+02
13	-2.95E+00	1.26E+02	13	-2.95E+00	1.26E+02	13	-2.95E+00	1.26E+02
14	-2.9091	1.26E+02	14	-2.9091	1.26E+02	14	-2.9091	1.26E+02
15	-2.8636	1.26E+02	15	-2.8636	1.26E+02	15	-2.8636	1.26E+02
16	-2.8182	1.26E+02	16	-2.8182	1.26E+02	16	-2.8182	1.26E+02
17	-2.7727	1.26E+02	17	-2.7727	1.26E+02	17	-2.7727	1.26E+02
18	-2.7273	1.26E+02	18	-2.7273	1.26E+02	18	-2.7273	1.26E+02
19	-2.6818	1.26E+02	19	-2.6818	1.26E+02	19	-2.6818	1.26E+02
20	-2.6364	1.26E+02	20	-2.6364	1.26E+02	20	-2.6364	1.26E+02
21	-2.59E+00	1.26E+02	21	-2.59E+00	1.26E+02	21	-2.59E+00	1.26E+02
22	-2.55E+00	1.26E+02	22	-2.55E+00	1.26E+02	22	-2.55E+00	1.26E+02
23	-2.50E+00	1.26E+02	23	-2.50E+00	1.26E+02	23	-2.50E+00	1.26E+02
24	-2.45E+00	1.26E+02	24	-2.45E+00	1.26E+02	24	-2.45E+00	1.26E+02
25	-2.41E+00	1.26E+02	25	-2.41E+00	1.26E+02	25	-2.41E+00	1.26E+02
26	-2.36E+00	1.26E+02	26	-2.36E+00	1.26E+02	26	-2.36E+00	1.26E+02
27	-2.32E+00	1.26E+02	27	-2.32E+00	1.26E+02	27	-2.32E+00	1.26E+02
28	-2.27E+00	1.26E+02	28	-2.27E+00	1.26E+02	28	-2.27E+00	1.26E+02
29	-2.23E+00	1.26E+02	29	-2.23E+00	1.26E+02	29	-2.23E+00	1.26E+02
30	-2.18E+00	1.26E+02	30	-2.18E+00	1.26E+02	30	-2.18E+00	1.26E+02
31	-2.1364	1.26E+02	31	-2.1364	1.26E+02	31	-2.1364	1.26E+02
32	-2.0909	1.26E+02	32	-2.0909	1.26E+02	32	-2.0909	1.26E+02
33	-2.0455	1.26E+02	33	-2.0455	1.26E+02	33	-2.0455	1.26E+02
34	-2	1.26E+02	34	-2	1.26E+02	34	-2	1.26E+02
35	-1.9545	1.26E+02	35	-1.9545	1.26E+02	35	-1.9545	1.26E+02
36	-1.9091	1.26E+02	36	-1.9091	1.26E+02	36	-1.9091	1.26E+02
37	-1.8636	1.26E+02	37	-1.8636	1.26E+02	37	-1.8636	1.26E+02
38	-1.8182	1.26E+02	38	-1.8182	1.26E+02	38	-1.8182	1.26E+02
39	-1.7727	1.26E+02	39	-1.7727	1.26E+02	39	-1.7727	1.26E+02
40	-1.7273	1.26E+02	40	-1.7273	1.26E+02	40	-1.7273	1.26E+02
41	-1.6818	1.26E+02	41	-1.6818	1.26E+02	41	-1.6818	1.26E+02
42	-1.6364	1.26E+02	42	-1.6364	1.26E+02	42	-1.6364	1.26E+02
43	-1.5909	1.26E+02	43	-1.5909	1.26E+02	43	-1.5909	1.26E+02
44	-1.5455	1.26E+02	44	-1.5455	1.26E+02	44	-1.5455	1.26E+02
45	-1.5	1.26E+02	45	-1.5	1.26E+02	45	-1.5	1.26E+02
46	-1.4545	1.26E+02	46	-1.4545	1.26E+02	46	-1.4545	1.26E+02
47	-1.4091	1.26E+02	47	-1.4091	1.26E+02	47	-1.4091	1.26E+02
48	-1.3636	1.26E+02	48	-1.3636	1.26E+02	48	-1.3636	1.26E+02
49	-1.3182	1.26E+02	49	-1.3182	1.26E+02	49	-1.3182	1.26E+02
50	-1.2727	1.26E+02	50	-1.2727	1.26E+02	50	-1.2727	1.26E+02
51	-1.2273	1.26E+02	51	-1.2273	1.26E+02	51	-1.2273	1.26E+02
52	-1.1818	1.26E+02	52	-1.1818	1.26E+02	52	-1.1818	1.26E+02
53	-1.1364	1.26E+02	53	-1.1364	1.26E+02	53	-1.1364	1.26E+02
54	-1.0909	1.26E+02	54	-1.0909	1.26E+02	54	-1.0909	1.26E+02
55	-1.0455	1.26E+02	55	-1.0455	1.26E+02	55	-1.0455	1.26E+02
56	-1	1.26E+02	56	-1	1.26E+02	56	-1	1.26E+02
57	-0.95455	1.26E+02	57	-0.95455	1.26E+02	57	-0.95455	1.26E+02
58	-0.90909	1.26E+02	58	-0.90909	1.26E+02	58	-0.90909	1.26E+02
59	-0.86364	1.25E+02	59	-0.86364	1.26E+02	59	-0.86364	1.26E+02
60	-0.81818	1.25E+02	60	-0.81818	1.26E+02	60	-0.81818	1.26E+02
61	-0.77273	1.25E+02	61	-0.77273	1.26E+02	61	-0.77273	1.26E+02
62	-0.72727	1.25E+02	62	-0.72727	1.26E+02	62	-0.72727	1.26E+02
63	-0.68182	1.25E+02	63	-0.68182	1.26E+02	63	-0.68182	1.26E+02
64	-0.63636	1.25E+02	64	-0.63636	1.26E+02	64	-0.63636	1.26E+02
65	-0.59091	1.24E+02	65	-0.59091	1.26E+02	65	-0.59091	1.26E+02
66	-0.54545	1.24E+02	66	-0.54545	1.26E+02	66	-0.54545	1.26E+02
67	-0.5	1.23E+02	67	-0.5	1.26E+02	67	-0.5	1.26E+02
68	-0.45455	1.23E+02	68	-0.45455	1.26E+02	68	-0.45455	1.26E+02
69	-0.40909	1.22E+02	69	-0.40909	1.26E+02	69	-0.40909	1.26E+02

Prediction Line

	X	Y
70	-0.36364	1.21E+02
71	-0.31818	1.20E+02
72	-0.27273	1.19E+02
73	-0.22727	1.18E+02
74	-0.18182	1.16E+02
75	-0.13636	1.15E+02
76	-9.09E-02	1.12E+02
77	-4.55E-02	1.10E+02
78	0	1.07E+02
79	4.55E-02	1.04E+02
80	9.09E-02	9.97E+01
81	0.13636	9.55E+01
82	0.18182	9.07E+01
83	0.22727	8.56E+01
84	0.27273	8.01E+01
85	0.31818	7.43E+01
86	0.36364	6.83E+01
87	0.40909	6.22E+01
88	0.45455	5.61E+01
89	0.5	5.01E+01
90	0.54545	4.43E+01
91	0.59091	3.89E+01
92	0.63636	3.39E+01
93	0.68182	2.93E+01
94	0.72727	2.52E+01
95	0.77273	2.15E+01
96	0.81818	1.82E+01
97	0.86364	1.54E+01
98	0.90909	1.30E+01
99	0.95455	1.09E+01
100	1	9.08E+00

	X	Y
70	-0.36364	1.25E+02
71	-0.31818	1.24E+02
72	-0.27273	1.23E+02
73	-0.22727	1.21E+02
74	-0.18182	1.19E+02
75	-0.13636	1.16E+02
76	-9.09E-02	1.14E+02
77	-4.55E-02	1.11E+02
78	0	1.07E+02
79	4.55E-02	1.04E+02
80	9.09E-02	9.96E+01
81	0.13636	9.52E+01
82	0.18182	9.05E+01
83	0.22727	8.55E+01
84	0.27273	8.01E+01
85	0.31818	7.43E+01
86	0.36364	6.83E+01
87	0.40909	6.19E+01
88	0.45455	5.56E+01
89	0.5	4.96E+01
90	0.54545	4.40E+01
91	0.59091	3.88E+01
92	0.63636	3.38E+01
93	0.68182	2.92E+01
94	0.72727	2.49E+01
95	0.77273	2.10E+01
96	0.81818	1.74E+01
97	0.86364	1.42E+01
98	0.90909	1.12E+01
99	0.95455	8.66E+00
100	1	6.42E+00

	X	Y
70	-0.36364	1.26E+02
71	-0.31818	1.26E+02
72	-0.27273	1.26E+02
73	-0.22727	1.26E+02
74	-0.18182	1.26E+02
75	-0.13636	1.25E+02
76	-9.09E-02	1.20E+02
77	-4.55E-02	1.14E+02
78	0	1.09E+02
79	4.55E-02	1.04E+02
80	9.09E-02	9.90E+01
81	0.13636	9.39E+01
82	0.18182	8.88E+01
83	0.22727	8.36E+01
84	0.27273	7.85E+01
85	0.31818	7.34E+01
86	0.36364	6.82E+01
87	0.40909	6.31E+01
88	0.45455	5.80E+01
89	0.5	5.28E+01
90	0.54545	4.77E+01
91	0.59091	4.26E+01
92	0.63636	3.74E+01
93	0.68182	3.23E+01
94	0.72727	2.72E+01
95	0.77273	2.20E+01
96	0.81818	1.69E+01
97	0.86364	1.17E+01
98	0.90909	6.62E+00
99	0.95455	1.48E+00
100	1	0.00E+00

Table E2.D-12b. TRAP Model Output for Vanadium Data for the Bird Survival Endpoint (Blalock and Hill 1987)

Chemical:	Vanadium
Study Authors:	Blalock and Hill 1987
Receptor Group:	Bird
Effect Description:	Survival

Input Data:

Dose	# of Org w/o response	Total # of Org	Survival
1.00E-06	38	40	0.95
1.1171	40	40	1.00
2.2341	33	40	0.83
4.4683	6	40	0.15

Modeling Parameters

Analysis Type:	Tolerance Distribution	Tolerance Distribution	Tolerance Distribution
Model Shape:	Gaussian Distribution	Triangular Distribution	Rectangular Distribution
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?			
Use Only for Exploratory Data Analysis!			
Maximum Iterations Reached Without Convergence			
X50 at Maximum or Minimum Limit			
Steepness At Maximum Or Minimum Limit			
Error Estimates Cannot Be Determined			
Large Standard Error for X50			
Large Standard Error for Steepness			
Large Standard Error for Y0			
Inadequate Number of Partial Effects			
Insufficient Data to Plot			
Insufficient Data to Analyze			

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL		Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL		Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
LogX50	0.48866	0.5004	2.69E-02	0.44547	0.55532	LogX50	0.48866	0.49959	2.63E-02	0.4456	0.55359	LogX50	0.48866	0.4996	1.88E-02	0.46174	0.53746
S	0.19364	1.46E-01	2.58E-02	0.10847	0.22176	S	0.19364	1.38E-01	2.39E-02	0.10331	0.20773	S	0.19364	0.12551	1.55E-02	0.10118	0.16535
Y0	0.975	0.97473	1.79E-02	0.91019	0.99707	Y0	0.975	0.975	1.75E-02	0.91259	0.99696	Y0	0.975	0.975	1.75E-02	0.91259	0.99696

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp	p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp	p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	3.1652	2.79E+00	3.59E+00	2.69E-02	0.5004	50	3.1593	2.79E+00	3.58E+00	2.63E-02	0.49959	50	3.1594	2.90E+00	3.45E+00	1.88E-02	0.4996
20	2.3867	2.00E+00	2.84E+00	3.63E-02	0.3778	20	2.3734	2.00E+00	2.82E+00	3.55E-02	0.37538	20	2.3397	2.0704	2.6441	2.58E-02	0.36917
10	2.0593	1.64E+00	2.58E+00	4.47E-02	0.31372	10	2.05E+00	1.6478	2.5623	4.35E-02	0.31277	10	2.1168	1.8342	2.4431	2.98E-02	0.32569
5	1.823	1.38E+00	2.40E+00	5.25E-02	0.26079	5	1.8557	1.4254	2.4158	5.00E-02	0.2685	5	2.0135	1.72E+00	2.3514	3.19E-02	0.30395
0						0	1.4509	0.96065	2.1913	6.80E-02	1.62E-01	0	1.9152	1.62E+00	2.27E+00	3.41E-02	0.28221

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var		Exposure	Effects Var	Est Effects Var
1	-6.00E+00	0.95	0.97473	1	-6.00E+00	0.95	0.975	1	-6.00E+00	0.95	0.975
2	4.81E-02	1	0.9738	2	4.81E-02	1	0.975	2	4.81E-02	1	0.975
3	3.49E-01	0.825	0.82902	3	3.49E-01	0.825	0.825	3	3.49E-01	0.825	0.825
4	6.50E-01	0.15	0.14823	4	6.50E-01	0.15	0.15	4	6.50E-01	0.15	0.15
5				5				5			
6				6				6			

Analysis of Variance

R-squared: | R-squared: | R-squared:

	DF	SS	MS	F	Sig		DF	SS	MS	F	Sig		DF	SS	MS	F	Sig
Total (adj)						Total (adj)						Total (adj)					
Regression						Regression						Regression					
Error						Error						Error					

Prediction Line

	X	Y		X	Y		X	Y
1	-3.5	0.97473	1	-3.5	0.975	1	-3.5	0.975
2	-3.45E+00	0.97473	2	-3.45E+00	0.975	2	-3.45E+00	0.975
3	-3.41E+00	0.97473	3	-3.41E+00	0.975	3	-3.41E+00	0.975
4	-3.36E+00	0.97473	4	-3.36E+00	0.975	4	-3.36E+00	0.975
5	-3.32E+00	0.97473	5	-3.32E+00	0.975	5	-3.32E+00	0.975
6	-3.27E+00	0.97473	6	-3.27E+00	0.975	6	-3.27E+00	0.975
7	-3.23E+00	0.97473	7	-3.23E+00	0.975	7	-3.23E+00	0.975
8	-3.18E+00	0.97473	8	-3.18E+00	0.975	8	-3.18E+00	0.975
9	-3.14E+00	0.97473	9	-3.14E+00	0.975	9	-3.14E+00	0.975
10	-3.09E+00	0.97473	10	-3.09E+00	0.975	10	-3.09E+00	0.975
11	-3.05E+00	0.97473	11	-3.05E+00	0.975	11	-3.05E+00	0.975
12	-3.00E+00	0.97473	12	-3.00E+00	0.975	12	-3.00E+00	0.975
13	-2.95E+00	0.97473	13	-2.95E+00	0.975	13	-2.95E+00	0.975
14	-2.9091	0.97473	14	-2.9091	0.975	14	-2.9091	0.975
15	-2.8636	0.97473	15	-2.8636	0.975	15	-2.8636	0.975
16	-2.8182	0.97473	16	-2.8182	0.975	16	-2.8182	0.975
17	-2.7727	0.97473	17	-2.7727	0.975	17	-2.7727	0.975
18	-2.7273	0.97473	18	-2.7273	0.975	18	-2.7273	0.975
19	-2.6818	0.97473	19	-2.6818	0.975	19	-2.6818	0.975
20	-2.6364	0.97473	20	-2.6364	0.975	20	-2.6364	0.975
21	-2.5909	0.97473	21	-2.5909	0.975	21	-2.5909	0.975
22	-2.5455	0.97473	22	-2.5455	0.975	22	-2.5455	0.975
23	-2.5	0.97473	23	-2.5	0.975	23	-2.5	0.975
24	-2.4545	0.97473	24	-2.4545	0.975	24	-2.4545	0.975
25	-2.4091	0.97473	25	-2.4091	0.975	25	-2.4091	0.975
26	-2.3636	0.97473	26	-2.3636	0.975	26	-2.3636	0.975
27	-2.3182	0.97473	27	-2.3182	0.975	27	-2.3182	0.975
28	-2.2727	0.97473	28	-2.2727	0.975	28	-2.2727	0.975
29	-2.2273	0.97473	29	-2.2273	0.975	29	-2.2273	0.975
30	-2.1818	0.97473	30	-2.1818	0.975	30	-2.1818	0.975
31	-2.1364	0.97473	31	-2.1364	0.975	31	-2.1364	0.975
32	-2.0909	0.97473	32	-2.0909	0.975	32	-2.0909	0.975
33	-2.0455	0.97473	33	-2.0455	0.975	33	-2.0455	0.975
34	-2	0.97473	34	-2	0.975	34	-2	0.975
35	-1.9545	0.97473	35	-1.9545	0.975	35	-1.9545	0.975
36	-1.9091	0.97473	36	-1.9091	0.975	36	-1.9091	0.975
37	-1.8636	0.97473	37	-1.8636	0.975	37	-1.8636	0.975
38	-1.8182	0.97473	38	-1.8182	0.975	38	-1.8182	0.975
39	-1.7727	0.97473	39	-1.7727	0.975	39	-1.7727	0.975
40	-1.7273	0.97473	40	-1.7273	0.975	40	-1.7273	0.975
41	-1.6818	0.97473	41	-1.6818	0.975	41	-1.6818	0.975
42	-1.6364	0.97473	42	-1.6364	0.975	42	-1.6364	0.975
43	-1.5909	0.97473	43	-1.5909	0.975	43	-1.5909	0.975
44	-1.5455	0.97473	44	-1.5455	0.975	44	-1.5455	0.975
45	-1.5	0.97473	45	-1.5	0.975	45	-1.5	0.975
46	-1.4545	0.97473	46	-1.4545	0.975	46	-1.4545	0.975
47	-1.4091	0.97473	47	-1.4091	0.975	47	-1.4091	0.975
48	-1.3636	0.97473	48	-1.3636	0.975	48	-1.3636	0.975
49	-1.3182	0.97473	49	-1.3182	0.975	49	-1.3182	0.975
50	-1.2727	0.97473	50	-1.2727	0.975	50	-1.2727	0.975
51	-1.2273	0.97473	51	-1.2273	0.975	51	-1.2273	0.975
52	-1.1818	0.97473	52	-1.1818	0.975	52	-1.1818	0.975
53	-1.1364	0.97473	53	-1.1364	0.975	53	-1.1364	0.975
54	-1.0909	0.97473	54	-1.0909	0.975	54	-1.0909	0.975
55	-1.0455	0.97473	55	-1.0455	0.975	55	-1.0455	0.975
56	-1	0.97473	56	-1	0.975	56	-1	0.975
57	-0.95455	0.97473	57	-0.95455	0.975	57	-0.95455	0.975
58	-0.90909	0.97473	58	-0.90909	0.975	58	-0.90909	0.975
59	-0.86364	0.97473	59	-0.86364	0.975	59	-0.86364	0.975
60	-0.81818	0.97473	60	-0.81818	0.975	60	-0.81818	0.975
61	-0.77273	0.97473	61	-0.77273	0.975	61	-0.77273	0.975
62	-0.72727	0.97473	62	-0.72727	0.975	62	-0.72727	0.975
63	-0.68182	0.97473	63	-0.68182	0.975	63	-0.68182	0.975
64	-0.63636	0.97473	64	-0.63636	0.975	64	-0.63636	0.975
65	-0.59091	0.97473	65	-0.59091	0.975	65	-0.59091	0.975
66	-0.54545	0.97473	66	-0.54545	0.975	66	-0.54545	0.975
67	-0.5	0.97473	67	-0.5	0.975	67	-0.5	0.975
68	-0.45455	0.97473	68	-0.45455	0.975	68	-0.45455	0.975
69	-0.40909	0.97473	69	-0.40909	0.975	69	-0.40909	0.975

Prediction Line

	X	Y	X	Y	X	Y
70	-0.36364	0.97473	-0.36364	0.975	-0.36364	0.975
71	-0.31818	0.97473	-0.31818	0.975	-0.31818	0.975
72	-0.27273	0.97473	-0.27273	0.975	-0.27273	0.975
73	-0.22727	0.97473	-0.22727	0.975	-0.22727	0.975
74	-0.18182	0.97473	-0.18182	0.975	-0.18182	0.975
75	-0.13636	0.97472	-0.13636	0.975	-0.13636	0.975
76	-9.09E-02	0.9747	-9.09E-02	0.975	-9.09E-02	0.975
77	-4.55E-02	0.97464	-4.55E-02	0.975	-4.55E-02	0.975
78	0	0.97444	0	0.975	0	0.975
79	4.55E-02	0.97386	4.55E-02	0.975	4.55E-02	0.975
80	9.09E-02	0.97232	9.09E-02	0.975	9.09E-02	0.975
81	0.13636	0.96866	0.13636	0.975	0.13636	0.975
82	0.18182	0.96072	0.18182	0.97326	0.18182	0.975
83	0.22727	0.9451	0.22727	0.95661	0.22727	0.975
84	0.27273	0.91719	0.27273	0.92233	0.27273	0.975
85	0.31818	0.87192	0.31818	0.87041	0.31818	0.89435
86	0.36364	0.80524	0.36364	0.80085	0.36364	0.79242
87	0.40909	0.71607	0.40909	0.71366	0.40909	0.6905
88	0.45455	0.60781	0.45455	0.60883	0.45455	0.58858
89	0.5	0.48847	0.5	0.48637	0.5	0.48665
90	0.54545	0.36904	0.54545	0.36423	0.54545	0.38473
91	0.59091	0.2605	0.59091	0.25972	0.59091	0.28281
92	0.63636	0.17096	0.63636	0.17284	0.63636	0.18089
93	0.68182	0.10388	0.68182	0.10361	0.68182	7.90E-02
94	0.72727	5.83E-02	0.72727	5.20E-02	0.72727	9.75E-05
95	0.77273	3.01E-02	0.77273	1.80E-02	0.77273	9.75E-05
96	0.81818	1.43E-02	0.81818	1.70E-03	0.81818	9.75E-05
97	0.86364	6.26E-03	0.86364	9.75E-05	0.86364	9.75E-05
98	0.90909	2.54E-03	0.90909	9.75E-05	0.90909	9.75E-05
99	0.95455	9.86E-04	0.95455	9.75E-05	0.95455	9.75E-05
100	1	3.92E-04	1	9.75E-05	1	9.75E-05

Table E2.D-13. TRAP Model Output for Zinc Data for the Bird Reproduction Endpoint (Gibson et al. 1986)

Chemical:	Zinc
Study Authors:	Gibson et al. 1986
Receptor Group:	Bird
Effect Description:	Reproduction

Input Data:

Dose	Response	SE
2.097289	6.4	not reported
63.78227	5.8	not reported
125.4673	2.6	not reported
187.1522	0.6	not reported
248.8372	0.5	not reported
310.522	0.3	not reported

Modeling Parameters

Analysis Type:	Nonlinear Regression	Nonlinear Regression	Nonlinear Regression
Model Shape:	Logistic Equation	Threshold Sigmoid	Piecewise Linear
# of Parameters:	Three	Three	Three
Exposure Variable Transform:	Logarithm	Logarithm	Logarithm

Error Messages Encountered

Inadequate Partial Effects - Proceed Anyway?
Use Only for Exploratory Data Analysis!
Maximum Iterations Reached Without Convergence
X50 at Maximum or Minimum Limit
Steepness At Maximum Or Minimum Limit
Error Estimates Cannot Be Determined
Large Standard Error for X50
Large Standard Error for Steepness
Large Standard Error for Y0
Inadequate Number of Partial Effects
Insufficient Data to Plot
Insufficient Data to Analyze

Model Parameters

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
X50	2.0633	2.0534	1.68E-02	2.0001	2.1067
S	1.9608	2.23E+00	0.24912	1.4415	3.0272
Y0	6.4	6.4134	0.18207	5.834	6.9928

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
X50	2.0633	2.0517	2.42E-02	1.9746	2.1288
S	1.9608	2.23E+00	0.30068	1.2682	3.182
Y0	6.4	6.418	0.27815	5.5328	7.3032

	Initial Guess	Final Estimate	Standard Error	95% LCL	95% UCL
X50	2.0633	2.0405	2.33E-02	1.9662	2.1147
S	1.9608	1.7342	0.18274	1.1526	2.3157
Y0	6.4	6.4	0.33815	5.3238	7.4762

Xp Estimates

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	113.08	100.01	127.86	1.68E-02	2.0534
20	79.12	63.459	98.644	3.01E-02	1.8983
10	64.202	48.117	85.664	3.94E-02	1.8075
5	52.96	37.203	75.39	4.82E-02	1.7239
0					

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	112.65	94.326	134.53	2.42E-02	2.0517
20	77.011	56.532	104.91	4.22E-02	1.8866
10	6.36E+01	43.293	93.366	5.24E-02	1.8033
5	55.518	36.423	84.624	5.75E-02	1.7444
0	40.024	23.31	68.723	7.38E-02	1.6023

p	Xp	95% LCL	95% UCL	Xp Std Err	Log Xp
50	109.76	92.515	130.23	2.33E-02	2.0405
20	73.699	57.135	95.064	3.47E-02	1.8675
10	64.535	48.248	86.32	3.97E-02	1.8098
5	60.39	44.301	82.321	4.23E-02	1.781
0	56.511	40.661	78.539	4.49E-02	1.7521

Model Fit Summary

Dataset

	Exposure	Effects Var	Est Effects Var
1	3.22E-01	6.4	6.4134
2	1.80E+00	5.8	5.7866
3	2.10E+00	2.6	2.5686
4	2.27E+00	0.6	0.79498
5	2.40E+00	0.5	0.28691
6	2.4921	0.3	0.12468

	Exposure	Effects Var	Est Effects Var
1	3.22E-01	6.4	6.418
2	1.80E+00	5.8	5.7672
3	2.10E+00	2.6	2.5755
4	2.27E+00	0.6	0.83283
5	2.40E+00	0.5	0.17594
6	2.4921	0.3	1.30E-03

	Exposure	Effects Var	Est Effects Var
1	3.22E-01	6.4	6.4
2	1.80E+00	5.8	5.8166
3	2.10E+00	2.6	2.5554
4	2.27E+00	0.6	0.628
5	2.40E+00	0.5	0
6	2.4921	0.3	0

Analysis of Variance

R-squared: 0.997

	DF	SS	MS	F	Sig
Total (adj)	5	38.32	7.664		
Regression	2	38.204	19.102	496.11	0.0002
Error	3	0.11551	3.85E-02		

R-squared: 0.993

	DF	SS	MS	F	Sig
Total (adj)	5	38.32	7.664		
Regression	2	38.07	19.035	228.01	0.0005
Error	3	0.25045	8.35E-02		

R-squared: 0.991

	DF	SS	MS	F	Sig
Total (adj)	5	38.32	7.664		
Regression	2	37.977	18.988	166.06	0.0008
Error	3	0.34304	0.11435		

Prediction Line

	X	Y		X	Y		X	Y
1	0	6.4134	1	0	6.418	1	0	6.4
2	3.03E-02	6.4134	2	3.03E-02	6.418	2	3.03E-02	6.4
3	6.06E-02	6.4134	3	6.06E-02	6.418	3	6.06E-02	6.4
4	9.09E-02	6.4134	4	9.09E-02	6.418	4	9.09E-02	6.4
5	1.21E-01	6.4134	5	1.21E-01	6.418	5	1.21E-01	6.4
6	1.52E-01	6.4134	6	1.52E-01	6.418	6	1.52E-01	6.4
7	1.82E-01	6.4134	7	1.82E-01	6.418	7	1.82E-01	6.4
8	2.12E-01	6.4134	8	2.12E-01	6.418	8	2.12E-01	6.4
9	2.42E-01	6.4134	9	2.42E-01	6.418	9	2.42E-01	6.4
10	2.73E-01	6.4134	10	2.73E-01	6.418	10	2.73E-01	6.4
11	3.03E-01	6.4134	11	3.03E-01	6.418	11	3.03E-01	6.4
12	3.33E-01	6.4134	12	3.33E-01	6.418	12	3.33E-01	6.4
13	3.64E-01	6.4134	13	3.64E-01	6.418	13	3.64E-01	6.4
14	0.39394	6.4134	14	0.39394	6.418	14	0.39394	6.4
15	0.42424	6.4134	15	0.42424	6.418	15	0.42424	6.4
16	0.45455	6.4134	16	0.45455	6.418	16	0.45455	6.4
17	0.48485	6.4134	17	0.48485	6.418	17	0.48485	6.4
18	0.51515	6.4134	18	0.51515	6.418	18	0.51515	6.4
19	0.54545	6.4134	19	0.54545	6.418	19	0.54545	6.4
20	0.57576	6.4134	20	0.57576	6.418	20	0.57576	6.4
21	0.60606	6.4134	21	0.60606	6.418	21	0.60606	6.4
22	0.63636	6.4134	22	0.63636	6.418	22	0.63636	6.4
23	0.66667	6.4134	23	0.66667	6.418	23	0.66667	6.4
24	0.69697	6.4134	24	0.69697	6.418	24	0.69697	6.4
25	0.72727	6.4134	25	0.72727	6.418	25	0.72727	6.4
26	0.75758	6.4134	26	0.75758	6.418	26	0.75758	6.4
27	0.78788	6.4133	27	0.78788	6.418	27	0.78788	6.4
28	0.81818	6.4133	28	0.81818	6.418	28	0.81818	6.4
29	0.84848	6.4133	29	0.84848	6.418	29	0.84848	6.4
30	0.87879	6.4132	30	0.87879	6.418	30	0.87879	6.4
31	0.90909	6.4132	31	0.90909	6.418	31	0.90909	6.4
32	0.93939	6.4131	32	0.93939	6.418	32	0.93939	6.4
33	0.9697	6.413	33	0.9697	6.418	33	0.9697	6.4
34	1	6.4129	34	1	6.418	34	1	6.4
35	1.0303	6.4127	35	1.0303	6.418	35	1.0303	6.4
36	1.0606	6.4125	36	1.0606	6.418	36	1.0606	6.4
37	1.0909	6.4122	37	1.0909	6.418	37	1.0909	6.4
38	1.1212	6.4119	38	1.1212	6.418	38	1.1212	6.4
39	1.1515	6.4114	39	1.1515	6.418	39	1.1515	6.4
40	1.1818	6.4108	40	1.1818	6.418	40	1.1818	6.4
41	1.2121	6.4099	41	1.2121	6.418	41	1.2121	6.4
42	1.2424	6.4089	42	1.2424	6.418	42	1.2424	6.4
43	1.2727	6.4074	43	1.2727	6.418	43	1.2727	6.4
44	1.303	6.4056	44	1.303	6.418	44	1.303	6.4
45	1.3333	6.4032	45	1.3333	6.418	45	1.3333	6.4
46	1.3636	6.4	46	1.3636	6.418	46	1.3636	6.4
47	1.3939	6.3958	47	1.3939	6.418	47	1.3939	6.4
48	1.4242	6.3903	48	1.4242	6.418	48	1.4242	6.4
49	1.4545	6.3832	49	1.4545	6.418	49	1.4545	6.4
50	1.4848	6.3738	50	1.4848	6.418	50	1.4848	6.4
51	1.5152	6.3616	51	1.5152	6.418	51	1.5152	6.4
52	1.5455	6.3457	52	1.5455	6.418	52	1.5455	6.4
53	1.5758	6.3249	53	1.5758	6.418	53	1.5758	6.4
54	1.6061	6.2978	54	1.6061	6.4178	54	1.6061	6.4
55	1.6364	6.2627	55	1.6364	6.3996	55	1.6364	6.4
56	1.6667	6.2173	56	1.6667	6.3522	56	1.6667	6.4
57	1.697	6.1587	57	1.697	6.2757	57	1.697	6.4
58	1.7273	6.0836	58	1.7273	6.1699	58	1.7273	6.4
59	1.7576	5.9878	59	1.7576	6.035	59	1.7576	6.3396
60	1.7879	5.8667	60	1.7879	5.8709	60	1.7879	6.0032
61	1.8182	5.7151	61	1.8182	5.6777	61	1.8182	5.6669
62	1.8485	5.5279	62	1.8485	5.4552	62	1.8485	5.3306
63	1.8788	5.3002	63	1.8788	5.2036	63	1.8788	4.9943
64	1.9091	5.0288	64	1.9091	4.9228	64	1.9091	4.658
65	1.9394	4.7123	65	1.9394	4.6128	65	1.9394	4.3216
66	1.9697	4.3531	66	1.9697	4.2736	66	1.9697	3.9853
67	2	3.9577	67	2	3.9053	67	2	3.649
68	2.0303	3.5365	68	2.0303	3.5077	68	2.0303	3.3127
69	2.0606	3.1034	69	2.0606	3.0835	69	2.0606	2.9764
70	2.0909	2.6741	70	2.0909	2.6739	70	2.0909	2.64
71	2.1212	2.2636	71	2.1212	2.2935	71	2.1212	2.3037

Prediction Line

	X	Y
72	2.1515	1.8844
73	2.1818	1.545
74	2.2121	1.2499
75	2.2424	0.99955
76	2.2727	0.79167
77	2.303	0.62206
78	2.3333	0.48565
79	2.3636	0.37721
80	2.3939	0.29178
81	2.4242	0.22499
82	2.4545	0.17305
83	2.4848	0.13284
84	2.5152	0.10182
85	2.5455	7.80E-02
86	2.5758	5.96E-02
87	2.6061	4.56E-02
88	2.6364	3.48E-02
89	2.6667	2.66E-02
90	2.697	2.03E-02
91	2.7273	1.55E-02
92	2.7576	1.18E-02
93	2.7879	9.03E-03
94	2.8182	6.89E-03
95	2.8485	5.26E-03
96	2.8788	4.01E-03
97	2.9091	3.06E-03
98	2.9394	2.33E-03
99	2.9697	1.78E-03
100	3	1.36E-03

	X	Y
72	2.1515	1.9422
73	2.1818	1.6201
74	2.2121	1.3272
75	2.2424	1.0635
76	2.2727	0.82897
77	2.303	0.62361
78	2.3333	0.44743
79	2.3636	0.30043
80	2.3939	0.1826
81	2.4242	9.40E-02
82	2.4545	3.45E-02
83	2.4848	4.22E-03
84	2.5152	0
85	2.5455	0
86	2.5758	0
87	2.6061	0
88	2.6364	0
89	2.6667	0
90	2.697	0
91	2.7273	0
92	2.7576	0
93	2.7879	0
94	2.8182	0
95	2.8485	0
96	2.8788	0
97	2.9091	0
98	2.9394	0
99	2.9697	0
100	3	0

	X	Y
72	2.1515	1.9674
73	2.1818	1.6311
74	2.2121	1.2947
75	2.2424	0.95842
76	2.2727	0.6221
77	2.303	0.28578
78	2.3333	0
79	2.3636	0
80	2.3939	0
81	2.4242	0
82	2.4545	0
83	2.4848	0
84	2.5152	0
85	2.5455	0
86	2.5758	0
87	2.6061	0
88	2.6364	0
89	2.6667	0
90	2.697	0
91	2.7273	0
92	2.7576	0
93	2.7879	0
94	2.8182	0
95	2.8485	0
96	2.8788	0
97	2.9091	0
98	2.9394	0
99	2.9697	0
100	3	0

ANNEX E

ECO-SSL TRV DERIVATION PLOTS COMPARED TO SELECTED TRVS

ACRONYMS AND ABBREVIATIONS

BERA	baseline ecological risk assessment
Eco-SSL	ecological soil screening level
EPA	U.S. Environmental Protection Agency
LOAEL	lowest-observed-adverse-effect level
NOAEL	no-observed-adverse-effect level
TRV	toxicity reference value
UCR	Upper Columbia River

UNITS OF MEASURE

mg Cr III/kg bw/day	milligram(s) of chromium (III) per kilogram of body weight per day
mg Se/kg bw/day	milligram(s) of selenium per kilogram of body weight per day
mg V/kg bw/day	milligram(s) of vanadium per kilogram of body weight per day

The purpose of this annex is to show the bird and mammal toxicity reference values (TRVs) derived for the Upper Columbia River (UCR) baseline ecological risk assessment (BERA) for the terrestrial areas of the Site (hereinafter, the Upland BERA) compared to the bird and mammal TRVs derived by the U.S. Environmental Protection Agency (EPA) for use in calculating ecological soil screening levels (Eco-SSLs).

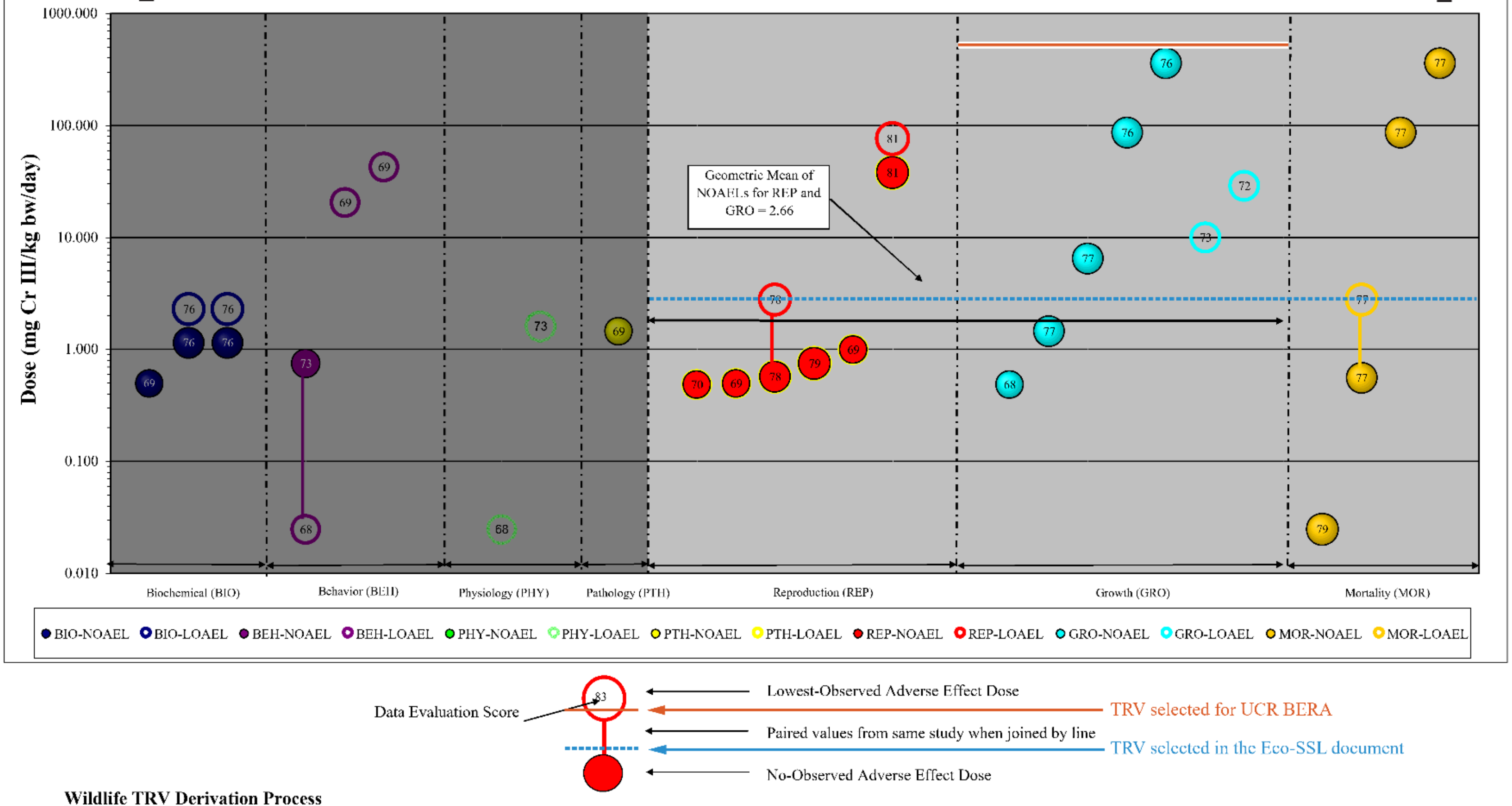
EPA's TRV derivation figures in this annex were extracted from Eco-SSL documents. Each figure shows the no-observed-adverse-effect levels (NOAELs) and the lowest-observed-adverse-effect levels (LOAELs) used in deriving the Eco-SSL wildlife TRV for a particular receptor and metal. The Eco-SSL TRV derivation process depended on the available data for a particular receptor and metal and is described below the figure. Only reproduction, growth, and/or survival data were used to derive the Eco-SSL TRVs, although the figures also show other endpoints, such as behavior and pathology.

The following modifications were overlaid on these figures for the purposes of this annex:

- The reproduction, growth, and survival TRVs derived for use in the Upland BERA were added in orange.
- The single TRV derived by EPA (representing reproduction, growth, and survival combined) was added in blue.
- The NOAELs/LOAELs for endpoints other than reproduction, growth, or survival are shaded because they were not used in TRV derivation.

Figure 5.1 Avian TRV Derivation for Trivalent Chromium

[Modified from Eco-SSL Document by adding TRV selected for UCR BERA in orange, adding TRV selected in the Eco-SSL document in blue, and shading out endpoints not used in TRV selection.]



Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

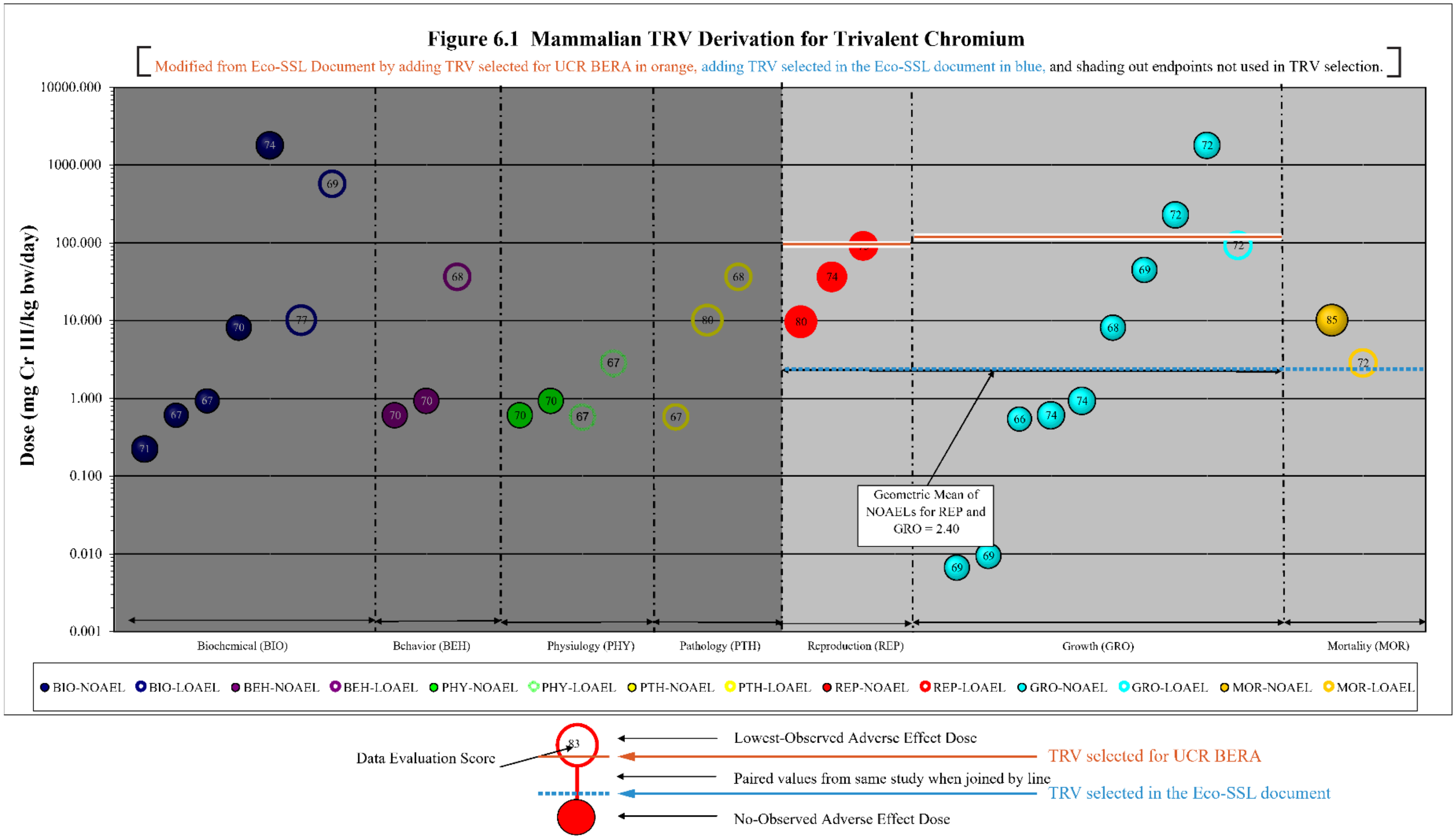
2) There are three NOAEL results available for calculation of a geometric mean.

4) The geometric mean is equal to 2.66 mg/kg bw/d and is higher than the lowest bounded LOAEL within the reproduction, growth, and survival effect groups.

5) The avian wildlife TRV for trivalent chromium is equal to 2.66 mg chromium/kg bw/day which is the geometric mean of NOAEL values for growth, and reproduction.

Note: Selected BERA wildlife TRVs for comparative purposes (in mg Cr III/kg bw/day): Growth = 510; Reproduction = none; Survival = none

Figure E2.E-1. Avian TRV Derivation for Chromium (III) as Presented in Figure 5.1 of EPA's Eco-SSL Document (USEPA 2008)



Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are three NOAEL results available for calculation of a geometric mean.

4) The geometric mean is equal to 2.40 mg/kg bw/d. There are no bounded LOAEL values for comparison.

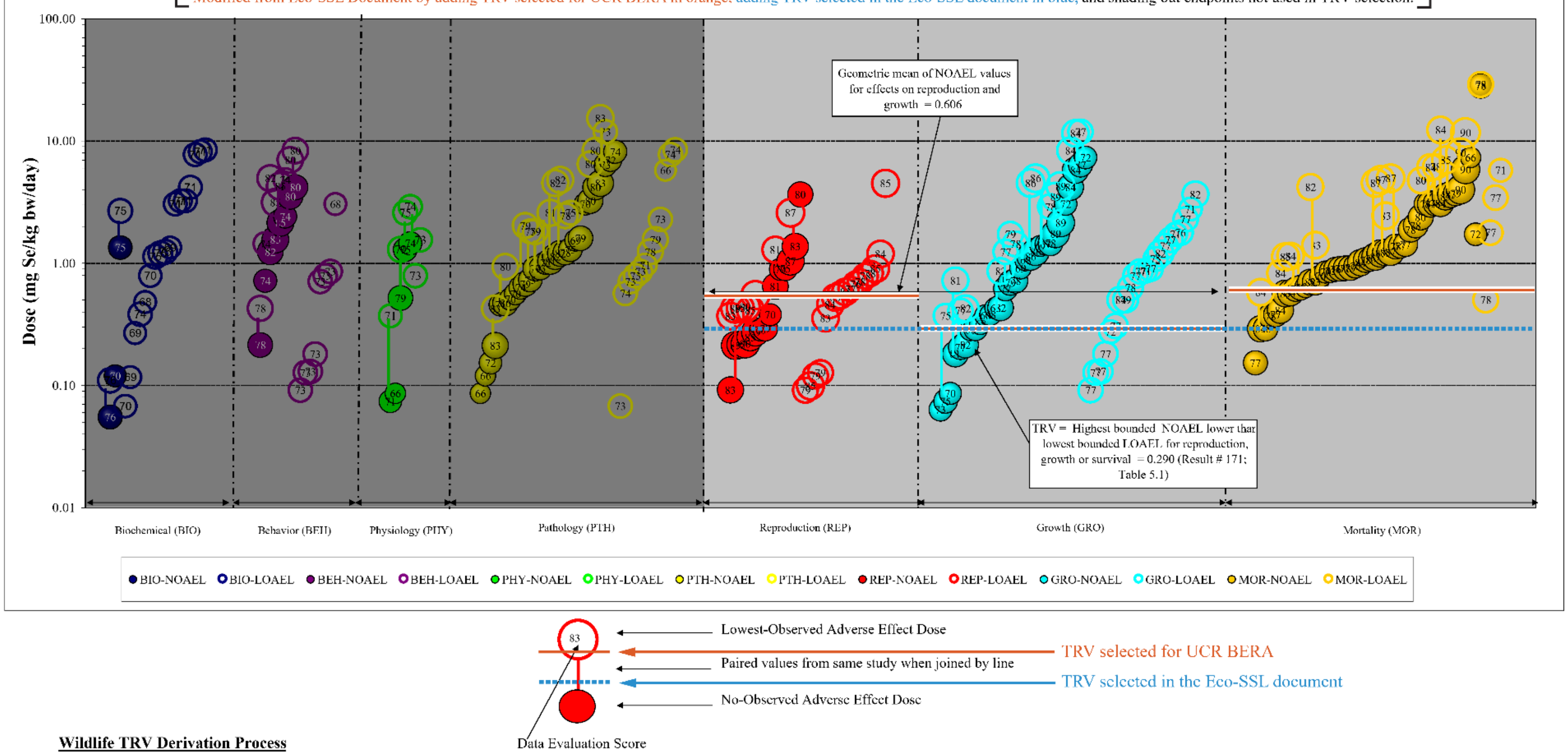
5) The mammalian wildlife TRV for trivalent chromium is equal to 2.40 mg chromium/kg bw/day which is the geometric mean NOAEL for effects on growth and reproduction.

Note: Selected BERA wildlife TRVs for comparative purposes (in mg Cr III/kg bw/day): Growth = 110; Reproduction = 91; Survival = none

Figure E2.E-2. Mammalian TRV Derivation for Chromium (III) as Presented in Figure 6.1 of EPA’s Eco-SSL Document (USEPA 2008)

Figure 5.1 Avian TRV Derivation for Selenium

[Modified from Eco-SSL Document by adding TRV selected for UCR BERA in orange, adding TRV selected in the Eco-SSL document in blue, and shading out endpoints not used in TRV selection.]



Geometric mean of NOAEL values for effects on reproduction and growth = 0.606

TRV = Highest bounded NOAEL lower than lowest bounded LOAEL for reproduction, growth or survival = 0.290 (Result # 171; Table 5.1)

Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are at least three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean.

3) The geometric mean is equal to 0.606 mg selenium/kg bw/d. However, this value is higher than the lowest bounded LOAEL for results within the reproduction, growth, and survival (MOR) effect groups.

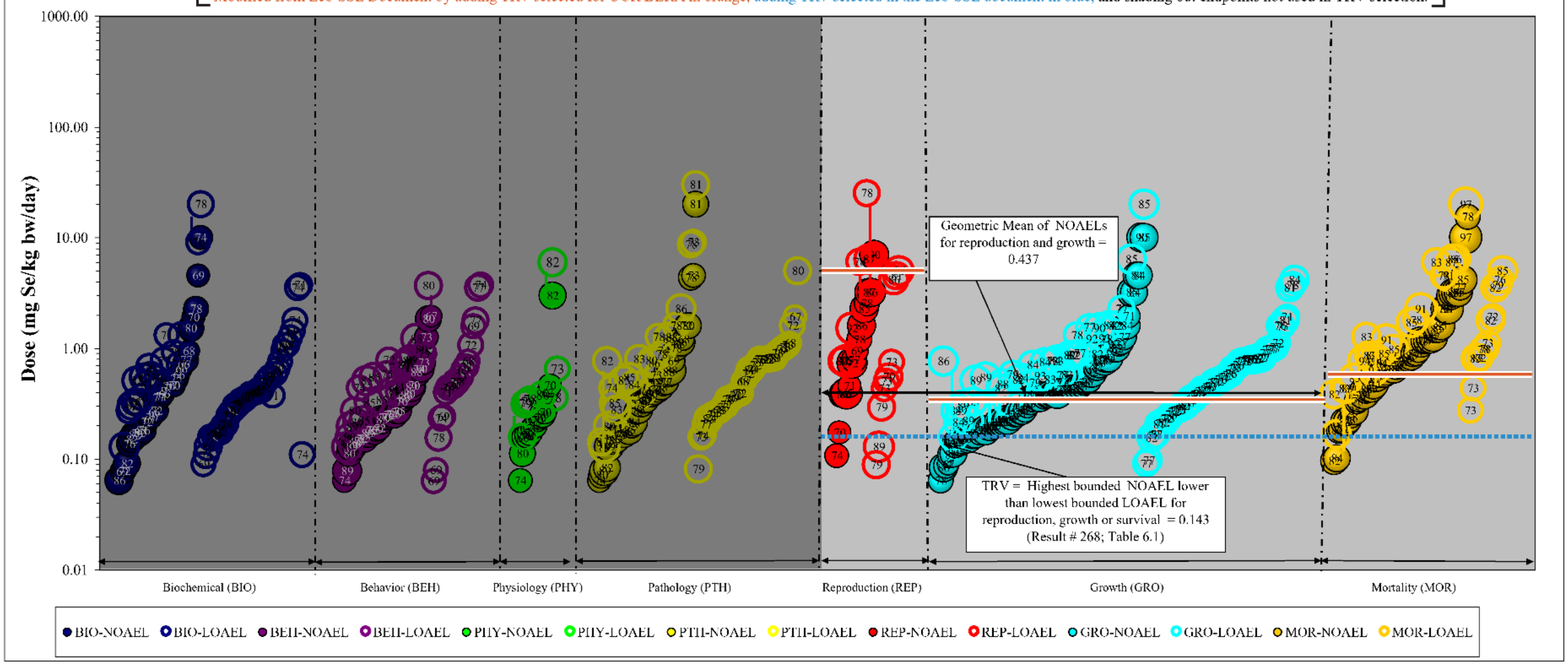
3) The avian wildlife TRV for selenium is equal to 0.290 mg selenium/kg bw/day which is the highest NOAEL value lower than the lowest bounded LOAEL value for effects on reproduction, growth or survival.

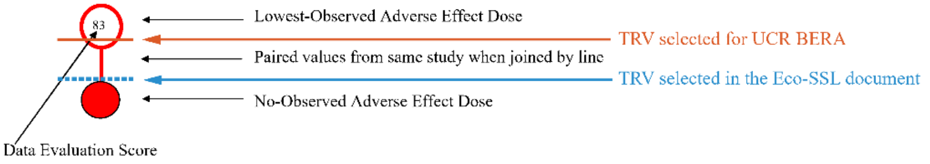
Note: Selected BERA wildlife TRVs for comparative purposes (in mg Se/kg bw/day): Growth = 0.29; Reproduction = 0.55; Survival = 0.59

Figure E2.E-3. Avian TRV Derivation for Selenium as Presented in Figure 5.1 of EPA's Eco-SSL Document (USEPA 2007b)

Figure 6.1 Mammalian TRV Derivation for Selenium

[Modified from Eco-SSL Document by adding TRV selected for UCR BERA in orange, adding TRV selected in the Eco-SSL document in blue, and shading out endpoints not used in TRV selection.]





Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean.

3) The geometric mean is equal to 0.437 mg selenium/kg bw/d. However, this value is higher than the lowest bounded LOAEL for results within the reproduction, growth, and survival (MOR) effect groups.

4) The mammalian wildlife TRV for selenium is equal to 0.143 mg selenium/kg bw/day which is the highest NOAEL value lower than the lowest LOAEL value for reproduction and growth.

Note: Selected BERA wildlife TRVs for comparative purposes (in mg Se/kg bw/day): Growth = 0.33; Reproduction = 5.0; Survival = 0.61

Figure E2.E-4. Mammalian TRV Derivation for Selenium as Presented in Figure 6.1 of EPA’s Eco-SSL Document (USEPA 2007b)

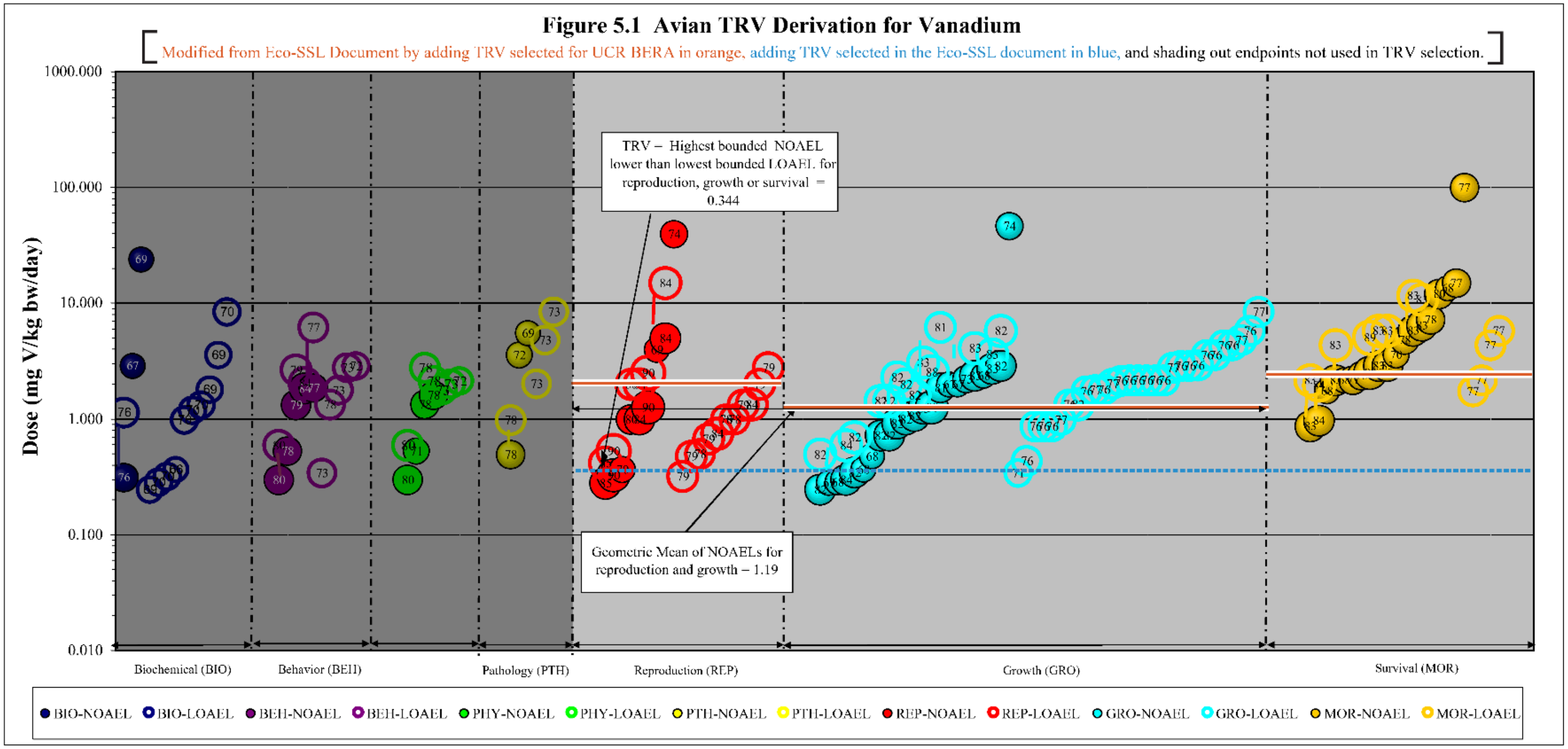
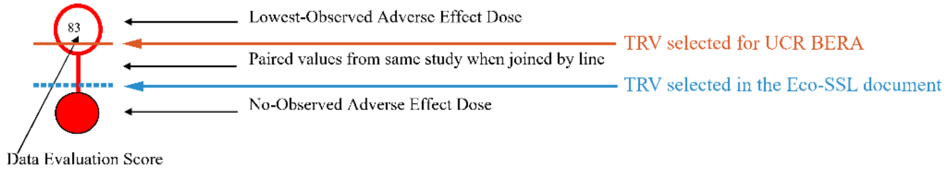


Figure 5.1 Avian TRV Derivation for Vanadium

[Modified from Eco-SSL Document by adding TRV selected for UCR BERA in orange, adding TRV selected in the Eco-SSL document in blue, and shading out endpoints not used in TRV selection.]

TRV – Highest bounded NOAEL lower than lowest bounded LOAEL for reproduction, growth or survival = 0.344

Geometric Mean of NOAELs for reproduction and growth = 1.19



Wildlife TRV Derivation Process

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean.

3) The geometric mean is equal to 1.19 mg vanadium /kg bw/d but is higher than the lowest bounded LOAEL for results within the reproduction, growth, and survival effect groups.

4) The avian wildlife TRV for vanadium is equal to 0.344 mg vanadium/kg bw/day which is the highest bounded LOAEL lower than the lowest bounded LOAEL for results within reproduction, growth and survival effect groups.

Note: Selected BERA wildlife TRVs for comparative purposes (in mg V/kg bw/day): Growth = 1.2; Reproduction = 2.1; Survival = 2.4

Figure E2.E-5. Avian TRV Derivation for Vanadium as Presented in Figure 6.1 of EPA's Eco-SSL Document (USEPA 2005c)

ATTACHMENT E3

UCR WILDLIFE BIOAVAILABILITY FACTORS

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MEMORANDUM

To: Teck American Incorporated

From: Berit Bergquist (Windward Environmental LLC) and Phyllis Fuchsman (Ramboll)

Subject: Wildlife Bioavailability Factors for the Upper Columbia River Upland BERA

Date: January 5, 2023

1 INTRODUCTION

This technical memorandum presents the rationale for deriving wildlife bioavailability factors for use in the baseline ecological risk assessment (BERA) for the upland habitat of the Upper Columbia River (UCR) Site, along with the uncertainty associated with the use of these factors. Bioavailability factors allow for a more realistic estimate of the absorption of metals from soil and food items ingested from the Site. The amount absorbed is expected to be less than the amount absorbed from exposures administered in toxicity tests (i.e., metal added to food, water, or administered *via* gavage) used to develop toxicity reference values (TRVs). Bioavailability factors are presented in this memorandum for metals for which bird and mammal hazard quotients (HQs) were calculated in the Upland BERA,[1] with a focus on the metal chemicals of potential concern (COPCs) with the greatest exceedances of screening-level TRVs: copper, lead, and zinc.

Section 2 of this memorandum presents background information about how bioavailability factors are used in the calculation of wildlife doses and how in vitro bioaccessibility (IVBA) assay results from UCR samples are used to estimate bioavailability. Section 3 presents a data usability evaluation for the available IVBA data, including the applicability of IVBA data to wildlife receptors. Section 4 addresses the methods for extrapolating the IVBA data to areas where these analyses have not been conducted, and for estimating bioavailability from the IVBA data. Section 5

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[1] HQs are calculated for aluminum, barium, cadmium, chromium, copper, iron, lead, mercury, molybdenum, selenium, thallium, vanadium, and zinc in the Upland BERA.

discusses bioavailability factors for wildlife food ingestion based on bioaccessibility data from the literature. A summary and list of references are presented in Sections 6 and 7, respectively.

2 BACKGROUND INFORMATION

The wildlife bioavailability factors to be used in the Upland BERA are modifiers defined as relative bioavailability (RBA) factors in the wildlife dose equation, used as follows:

$$Dietary\ dose = \frac{\left[\left(FIR \times C_{food} \times RBA_{food}\right) + \left(SIR \times C_s \times RBA_s\right)\right]}{BW\ x\ AUF}$$

Where:

Dietary dose =	Bioavailable COPC exposure per day via food, water, and soil (mg/kg bw/day)
FIR=	food ingestion rate (kg food dw/day)
C_{food} =	concentration in plant, invertebrate, or animal prey items (mg/kg food dw)
RBA_{food} =	bioavailability of the COPC in plant, invertebrate, or animal prey items relative to that in the applicable TRV study (fraction)
SIR =	incidental soil ingestion rate (kg soil dw/day)
C_s =	concentration in soil (mg/kg dw)
RBA_s =	bioavailability of the COPC in soil relative to that in the applicable TRV study (fraction)
BW =	species body weight (kg)
AUF =	area use factor (fraction)

The RBA factors account for the difference between the absolute bioavailability (ABA) of a metal in Site soil or food and the ABA of the metal in the TRV study to which the dietary dose is being compared. For example, for soil ingestion:

$$RBA_s = \frac{ABA\ for\ soil}{ABA\ for\ reference\ material\ in\ toxicity\ study}$$

ABA is defined as the fraction of an administered dose that crosses the gastrointestinal epithelium and reaches systemic circulation (USEPA 2017; NRC 2003; Health Canada 2017):

$$Absolute\ bioavailability\ (ABA) = \frac{Absorbed\ dose}{Administered\ dose}$$

It is not necessary to identify ABA for risk assessment purposes; indeed, ABA is not typically measured directly. However, RBA may be measured experimentally using an indicator of ABA (e.g., metal concentration in blood or organ tissue), with parallel in vivo exposures conducted for a contaminated soil of interest and a reference substance representative of TRV studies.

Site-specific data on the RBA of metals in the UCR are not available. However, data are available from IVBA analyses, which simulate the conditions in an organism's gut to provide an estimate of the fraction available for absorption from the gastrointestinal tract. IVBA analyses are operationally defined. The relationship between the bioaccessibility of a metal in a particular medium derived from in vitro analysis and the RBA of that metal in that medium can be estimated from in vivo validation studies, if data are available. Such relationships are available for lead for birds and mammals, but not for copper or zinc. Section 4 discusses the basis for interpreting IVBA data for metals lacking in vivo validation studies; to be conservative in these cases, it is assumed that the RBA is equivalent to that of the IVBA.

3 UCR IVBA DATA USABILITY ASSESSMENT

This section describes the data usability assessment conducted to establish an IVBA dataset suitable and of acceptable quality for use in the Upland BERA. This assessment is also discussed in Appendix A of the Upland BERA.

The data usability process for establishing the IVBA dataset included four steps:

1) A data inventory step, to identify all IVBA studies with data relevant for use in the Upland BERA
2) A data quality step, to determine whether data identified in Step 1 are of acceptable quality for use in the Upland BERA
3) A data suitability step, to assess the relevance of sampling methods relative to the objectives of the analyses
4) A data comparability step, to determine whether data collected from different studies or using different methods can be combined for specific evaluations.

The results of each of these steps are discussed in the following sections.

3.1 Data inventory

IVBA data were considered potentially relevant for the Upland BERA if they could be used in either of the following ways:

- To estimate RBA at the specific Upland BERA soil locations where IVBA was analyzed (herein referred to as the sample-specific IVBA dataset)
- To establish statistical relationships with other co-located parameters so that IVBA (and thus RBA) can be estimated for locations that have data for these parameters but not for IVBA (as described in Section 4).

For the second of these data uses, a larger IVBA dataset, including soil and sediment not in the Upland BERA soil dataset (herein referred to as the entire IVBA dataset), is used to allow for a more robust evaluation. Five UCR studies have involved the collection of IVBA data in soil or sediment: the beach sediment study conducted from 2009 to 2011 (TAI 2014), the upland soil study conducted by Teck American Incorporated (TAI) in 2014 (TAI 2015), the Bossburg Flat beach sediment and soil study conducted in 2015 (TAI 2016), and two residential soil studies conducted in 2014 and 2016 (CH2M HILL 2016; TAI 2017). The two residential soil studies are excluded from the IVBA dataset because 1) they are not included in the Upland BERA soil dataset (see Appendix A of the Upland BERA), and 2) data are not available for soil parameters that could be used to estimate IVBA for samples lacking IVBA data. Table 1 summarizes the sampling design for each of the three studies in the IVBA data inventory. The following subsections describe each of the three studies in more detail.

Table 1. Summary of sampling designs for IVBA dataset studies

Study	Media	Size Fraction Analyzed	Number of DUs with IVBA Data	Analytes[a]
Upland soil study	soil	< 149 µm	ADA – 22[b,c] RFDA – 3[b,c]	IVBA for all target analyte metals, grain size, TOC, pH
Bossburg Flat beach study	soil	< 150 µm	upland – 6[c]	Lead and arsenic IVBA, grain size, TOC, pH
	sediment	< 250 µm	beaches – 10[c]	
Beach sediment study	sediment	< 63 µm 63 to < 125 µm 125 to < 250 µm 250 µm to < 2 mm	33 beaches	Lead IVBA, grain size, TOC, pH

[a] TOC and pH were measured on the < 2-mm size fraction.

[b] Only a subset of soil samples from the 142 ADA DUs and the 16 RFDA DUs were analyzed for IVBA. None of the soil samples from the 13 WSDA DUs were analyzed for IVBA.

[c] A subset of DUs were sampled in triplicate for IVBA analysis as part of the upland soil study and the Bossburg Flat beach study.

ADA – aerial deposition area
DU – decision unit
IVBA – in vitro bioaccessibility
RFDA – relict floodplain deposition area
TOC – total organic carbon
UCR – Upper Columbia River
WSDA – windblown sediment deposition area

3.1.1 Upland soil study

For the upland soil study (TAI 2015), samples were collected from 171 decision units (DUs). Soil samples were collected from the aerial deposition area (ADA), windblown sediment deposition areas (WSDAs), and relict floodplain deposition areas (RFDAs). The samples were processed prior to analysis to represent both the < 149-µm fraction (for use in the human health risk assessment [HHRA]) and the < 2-mm fraction (for use in the Upland BERA).

A total of 142 locations, each location approximately 25 acres in size, were sampled in the ADA. Incremental composite sampling was used to collect 1 composite sample from each of the 142 upland soil locations (TAI 2015). A total of 16 composite samples were collected from the RFDAs, and a total of 13 composite samples were collected from the WSDAs. Maps with sampling locations for the TAI upland soil study are presented in the data summary report (TAI 2015).

IVBA analyses were conducted on 25 samples sieved to less than 149 µm, collected from DUs with lead concentrations greater than 100 mg/kg. This was slightly more than 20% of the samples with lead concentrations greater than 100 mg/kg. IVBA analyses were conducted on samples from 22 DUs in the ADA and 3 DUs in the RFDAs (Table 1). Triplicate samples were collected for IVBA analysis from one DU in the ADA and one DU in the RFDAs from separate increment locations in order to estimate the variance of the mean.[2] IVBA analyses were not conducted on any WSDA samples. Only ADA locations are included in the Upland BERA for the estimation of wildlife exposure to metals. However, IVBA data from the RFDA locations are used to develop regression relationships between IVBA and soil conventional parameters in order to estimate IVBA at locations without such data, as described in Section 4.

IVBA summary statistics for metals for which wildlife HQs were calculated in the Upland BERA are shown in Table 2. The IVBA results for copper, lead, and zinc are shown by area in Figure 1.

Table 2. Summary of UCR IVBA data

Metal[a]	Sample Type and Size Fraction	N[b]	IVBA (%)[c,d]			
			Min.	Max.	Mean	Median
ADA (soil)						
Aluminum	< 149 µm	24	9.40	30.6	19.7	19.7
Barium		24	45.8	76.6	62.2	62.4
Cadmium		24	68.0	91.9	81.7	82.7
Chromium		24	1.60	6.90	3.52	3.45
Copper		24	13.2	40.0	24.2	24.3
Iron		24	3.10	10.8	6.34	6.15
Lead		24	65.00	95.9	84.6	84.8
Mercury		16	2.80	9.50	6.87	7.10
Molybdenum		4	4.35	7.20	5.45	4.80
Selenium		2	11.8	21.7	16.8	16.8
Thallium		24	8.70	41.1	18.1	16.5
Vanadium		24	3.00	8.60	5.02	5.00
Zinc		24	19.4	52.2	39.7	43.3

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[2] The IVBA triplicate samples were not averaged in this evaluation unless otherwise noted.

Metal[a]	Sample Type and Size Fraction	N[b]	IVBA (%)[c,d]			
			Min.	Max.	Mean	Median
RFDA (soil)						
Aluminum	< 149 µm	5	14.7	17.6	16.6	17.5
Barium		5	26.4	40.9	32.2	29.4
Cadmium		5	36.8	43.4	39.3	37.7
Chromium		5	11.4	12.9	12.2	12.3
Copper		5	38.6	53.0	47.8	51.7
Iron		5	13.5	21.1	16.9	16.1
Lead		5	55.2	63.7	60.1	61.3
Mercury		1	0.90	0.90	0.90	0.90
Molybdenum		5	2.60	3.90	3.30	3.40
Selenium		1	13.0	13.0	13.0	13.0
Thallium		5	10.4	13.2	11.5	10.9
Vanadium		5	14.7	19.2	16.4	15.4
Zinc		5	42.7	53.0	46.5	43.7
Bossburg Flat Uplands (soil)						
Lead	< 150 µm	8	58.9	74.4	67.4	68.1
Bossburg Flat Beaches (sediment)						
Lead	< 250 µm	18	51.0	68.4	60.1	60.4
UCR Beaches (sediment)[e]						
Lead	< 63 µm	33	29.4	82.0	56.0	54.9
	63–< 125 µm	33	25.5	69.5	48.9	52.4
	125–< 250 µm	33	21.1	71.8	47.4	49.7
	250 µm–< 2 mm	33	18.1	69.3	39.3	36.4

[a] Only metals for which HQs are calculated in the Upland BERA are presented. Arsenic IVBA data are also available for the studies in this table, but arsenic is not an upland COPC.

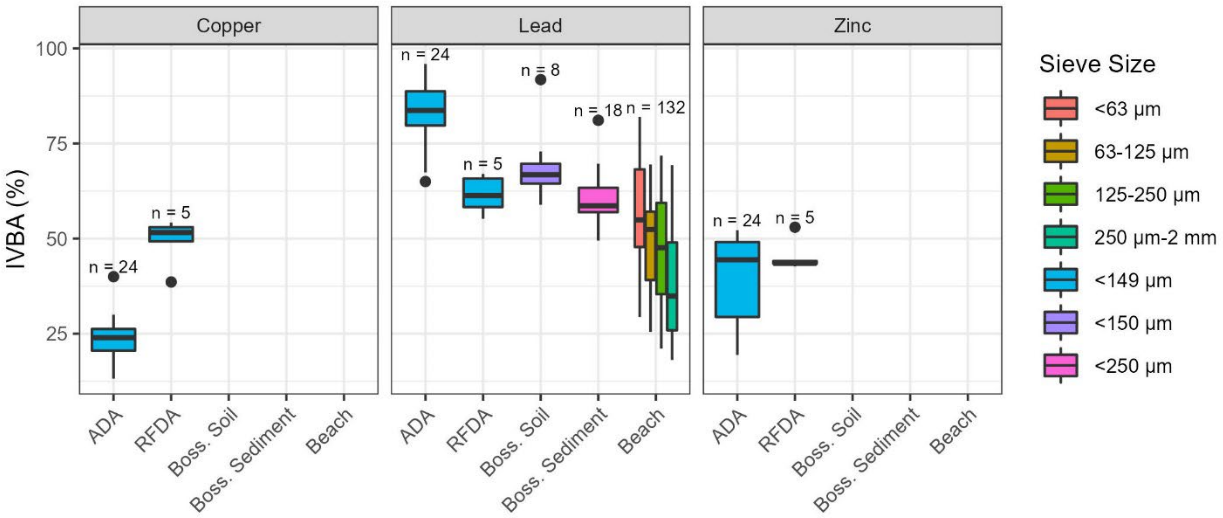
[b] %IVBA was not calculated for samples with non-detected or rejected values for either the IVBA metal concentration or the total metal concentration.

[c] %IVBA was calculated as the concentration of metal derived from the IVBA method divided by the total concentration of metal in the sample.

[d] Triplicate results were averaged before calculating statistics.

[e] Results from the reanalysis of samples from five beaches in 2013 (where samples were sieved to < 250 µm) indicated that IVBA values were higher than those from the same five beaches sampled in 2011 (when values for the three size factions < 250 µm were averaged on a weighted basis) (USEPA 2014). However, lead concentrations in the 2013 samples were lower than those in the 2011 samples, resulting in comparable HHRA RBA-adjusted lead concentrations (USEPA 2014).

ADA – aerial deposition area
BERA – baseline ecological risk assessment
COPC – chemical of potential concern
HHRA – human health risk assessment
HQ – hazard quotient
IVBA – in vitro bioaccessibility
RBA – relative bioavailability
RFDA – relict floodplain deposition area
UCR – Upper Columbia River



Box and whisker plots: Box encompasses the second and third quartiles of data, with inner horizontal line representing the median. Whiskers show minimum and maximum values excluding outliers. Outliers (data points beyond 1.5× the difference between the 25th and 75th percentiles) are plotted as individual points.

ADA – aerial deposition area
Boss. – Bossburg
IVBA – in vitro bioaccessibility
RFDA – relict floodplain deposition area

Figure 1. Bioaccessibility of copper, lead, and zinc in areas of the Site

3.1.2 Bossburg Flat beach study

Similar to the upland soil study, sampling was conducted within DUs using the incremental composite sampling method for the Bossburg Flat beach study. Six soil DUs were sampled in the upland area and 10 sediment DUs were sampled in the beach area. All DU samples were analyzed for lead and arsenic IVBA. Triplicate samples were collected for IVBA analysis from one soil DU and three sediment DUs from separate increment locations, in order to estimate the variance of the mean. Soil samples were sieved to the < 150-µm size fraction, and sediment samples were sieved to the < 250-µm size fraction. Only lead results are presented in Table 2 and Figure 1, because arsenic HQs are not calculated for wildlife in the Upland BERA.

3.1.3 Beach sediment study

For the beach sediment study, 5 composite samples were collected from each of 33 beaches, and IVBA analysis was conducted on 1 composite sample randomly selected from each beach (TAI 2014). Each selected composite was sieved into four size fractions and analyzed for lead IVBA (Table 1).[3]

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[3] In 2013, lead IVBA analyses were re-run on archived samples from 5 of the 33 beaches (USEPA 2013). These samples were analyzed for the sediment fraction sieved to < 250 µm, as opposed to being analyzed for three separate size fractions (< 63 µm, 63 to < 125 µm, and 125 to < 250 µm).

3.2 Data quality

The data quality assessment included a review of the availability of a list of data documentation items considered important in order to ensure data usability (e.g., supporting documentation on sampling methods; information on analytical methods; description of data validation process). The full list of items evaluated and the results of the assessment are described in detail in Appendix A of the Upland BERA. None of the IVBA data sources are missing any data documentation items, and all three studies are acceptable for use in the Upland BERA.

3.3 Data suitability

IVBA data are used in the Upland BERA to estimate the bioavailability of metals in soils incidentally ingested by wildlife. IVBA data were generated for this Site using a method designed for HHRA purposes; therefore, this section evaluates the suitability and applicability of the IVBA data for use in the wildlife risk assessment.

In the proceedings of an industry-government workshop on the development of metal cleanup values, Sample et al. (2014) recommended the evaluation of metal bioaccessibility as one component of ecological exposure assessment refinements. Although IVBA methods are designed to address human exposure to metals, metal bioaccessibility data are useful for improving wildlife exposure estimates. Although not yet routine, bioaccessibility analyses have been used in ecological risk assessments at other sites, including the Coeur d'Alene Superfund site (USEPA 2001).

As shown in Table 1, IVBA analyses were conducted on the < 149-µm or < 150-µm size fractions, which are considered relevant for the HHRA, whereas the < 2-mm size fraction is considered relevant for the Upland BERA. However, metals in larger particles are often less bioaccessible than those in smaller particles, due to a lower surface-to-volume ratio (e.g., Walraven et al. 2015). This indicates that the use of the < 149-µm or < 150-µm size fractions as a surrogate for the < 2-mm size fraction would likely result in a high bias, and therefore conservatism, in the estimation of bioavailability in the size fraction ingested by wildlife. Therefore, data from the < 149-µm or < 150-µm size fractions are suitable for application to wildlife for a conservative estimate of bioavailability.

The remainder of this section covers three technical issues with applying IVBA data to wildlife exposure estimation. Section 3.3.1 considers the influence of digestive system characteristics, which differ among species. Section 3.3.2 evaluates validation studies comparing IVBA and RBA data in animals. Section 3.3.3 verifies the applicability of IVBA data to the specific TRVs selected for use in the Upland BERA.

3.3.1 Digestive physiology

The method used to measure metal bioaccessibility at the UCR Site (EPA Method 1340) uses a non-exhaustive extraction process to simulate the digestive system of a child ingesting soil on an empty stomach. The sample is extracted for 1 hour, with an extraction fluid consisting of 0.4 molar glycine at a pH of 1.5, and applied at a solution-to-soil ratio of 100:1. Extractant pH and extraction duration are of particular interest for comparisons among species.

Comparisons across IVBA methods indicate that extractant pH strongly affects IVBA outcomes for several metals, especially lead (Ng et al. 2015; Yan et al. 2016; ESG 2011), with lower pH resulting in higher estimated bioaccessibility. It is reasonable to expect that gut pH affects metal extraction during digestion in a similar manner. Among mammalian and avian species, differences in gastric pH tend to be associated with different feeding guilds (Beasley et al. 2015). Low gastric pH can serve as a barrier to infection, such that from an evolutionary perspective, scavengers and carnivores benefit more from low pH than do herbivores and insectivores (Beasley et al. 2015). Table 3 classifies the potential wildlife species assessed in the Upland BERA by feeding guild and provides gastric pH data for other representative species in each feeding guild. The gastric pH ranges summarized in Table 3 are all similar to or greater than the pH of 1.5 used in EPA Method 1340. Thus, with respect to pH, the IVBA results generated with this method of measuring metal bioaccessibility should be conservative (i.e., biased to overestimate) when applied to the wildlife species of interest. Indeed, the overestimation bias could be large for pH-sensitive metals like lead, considering that many wildlife species' stomach fluids are estimated to be orders of magnitude less acidic than the extractant used in EPA Method 1340.

Table 3. Gastric pH of representative mammalian and avian species

Feeding Guild[a]	Potential UCR Wildlife Receptors	Similar Species with Gastric pH Data[b]	pH Range[b]
Mammals			
Carnivores/piscivores	mink, river otter, gray wolf, short-tailed weasel	ferret, dog, cat	1.5–4.5
Invertivores	little brown bat, water shrew, pygmy shrew	common pipistrelle, echidna	5.1–6.8
Omnivores	muskrat, masked shrew, deer mouse	mouse, rat	3.8–4.4
Herbivores (hindgut fermenters)	meadow vole	hamster, guinea pig, gerbil, beaver, porcupine	1.7 (beaver) 4.3–4.9 (others)
Herbivores (ruminant)	white-tailed deer	brocket deer, pony, ox, guanaco	4.4–7.3
Birds			
Carnivores (including vertebrates/carrion prey)	bald eagle, American kestrel	bald eagle, various falcons	1.3–1.8
Piscivores/ aquatic invertivores	belted kingfisher, red-breasted merganser	great cormorant, various penguins	2.3–3.0
Invertivores/ omnivores (excluding vertebrate prey)	tree swallow, sage thrasher, American robin, black-capped chickadee, mallard	starling, chicken, mallard	2.0–3.7

Feeding Guild[a]	Potential UCR Wildlife Receptors	Similar Species with Gastric pH Data[b]	pH Range[b]
Invertivores with opportunistic vertebrate carrion consumption	Spotted sandpiper	oystercatcher, moorhen	1.2–1.4
Herbivores	tundra swan, California quail	Japanese quail,[c] pigeon[d]	2.0–4.8

[a] Feeding guilds are consistent with those presented in the BERA work plan and expanded problem formulation (TAI 2011; 2012).
[b] pH data are from Beasley et al. (2015) unless noted otherwise.
[c] Japanese quail data are from Beyer et al. (2016).
[d] Pigeon data are from Langlois (2003).
BERA – baseline ecological risk assessment
UCR – Upper Columbia River

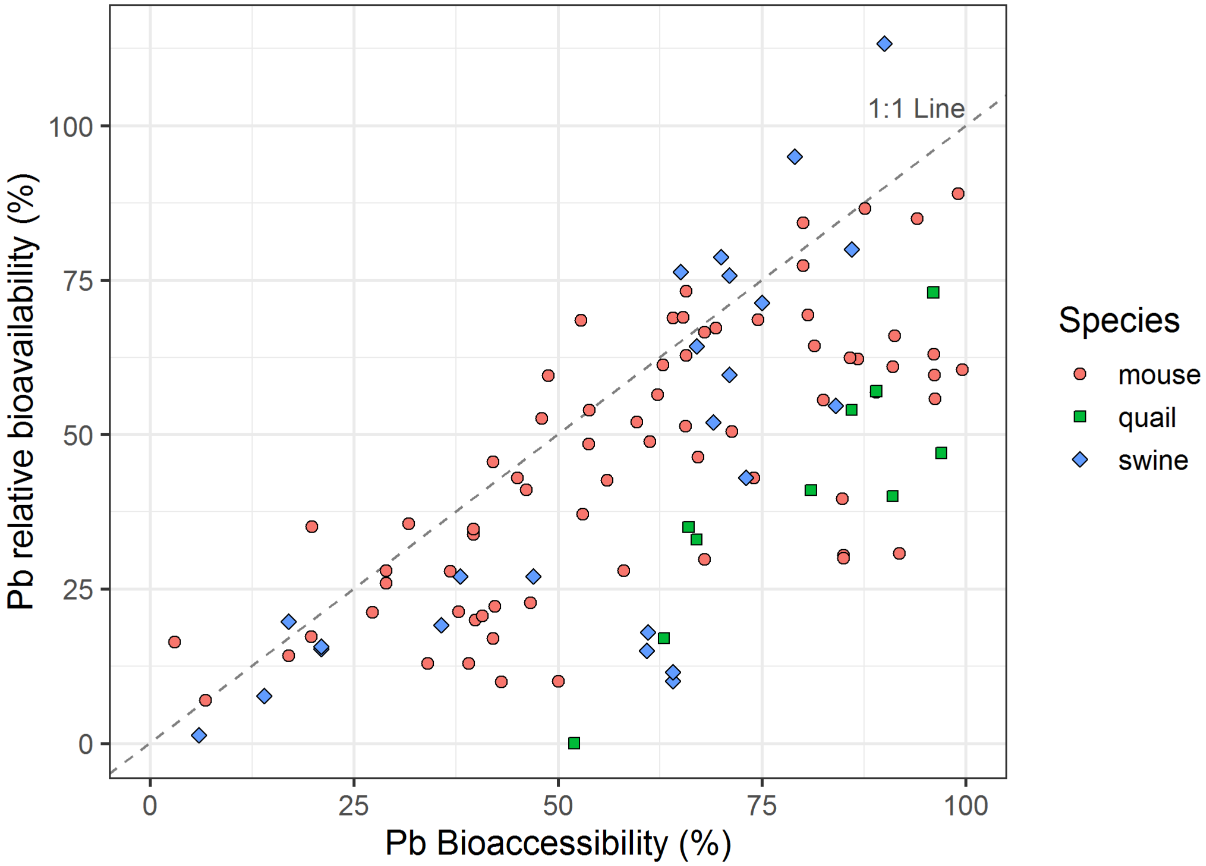
Although probably less influential than pH, gut passage time also varies substantially among species and could affect how well IVBA data represent metal bioaccessibility for a given species of interest. While this parameter does not contribute greatly to differences in results among various IVBA methods (Ng et al. 2015), significantly shorter or longer digestion times might affect bioaccessibility (i.e., the amount of metal solubilized from soil could increase with greater digestion time). Table 4 provides examples of food passage times through the guts of various species. Small birds and mammals have much shorter gut passage times than do humans, whereas ruminants (e.g., cows, bison) can have much longer gut passage times. The durations given in Table 4 represent the complete digestive process, whereas EPA Method 1340 specifically simulates the gastric (stomach) phase of digestion. Nevertheless, if the gastric phase is even roughly proportional across species, then the duration of extraction in EPA Method 1340 will be conservative with respect to small birds and mammals but not necessarily conservative with respect to ruminants. Additionally, ruminant digestion involves bacterial fermentation in a reducing environment, which could change metal speciation and possibly bioavailability compared to non-ruminant digestive conditions (Suedel et al. 2006). Thus, IVBA data might not be appropriately representative of ruminant digestion and will not be applied to ruminants in the Upland BERA.

Table 4. Examples of gut retention times for various species

Species	Gut Retention Time (hours)	Reference
Human	47	Hatton et al. (2015)
Swine	49	Hatton et al. (2015)
Rat	30	Hatton et al. (2015)
Songbirds	0.8–1.8	Karasov and Douglas (2013) and Levey and Karasov (1994)
Great mouse-eared bat	5	Hernout et al. (2015)
Brandt’s vole	5.5	Clauss et al. (2007)
Bison	79	Clauss et al. (2007)

3.3.2 In vivo validation of bioaccessibility analyses

Studies providing paired measurements of lead bioaccessibility and in vivo bioavailability for the same soils are available for swine, mice, and Japanese quail (Li et al. 2020 and references therein; Beyer et al. 2016). The validation studies relevant to this memorandum measured IVBA lead using EPA Method 1340 and directly measured lead bioavailability in animals. Bioavailability was measured based on lead concentrations in blood or organ tissues, and in vivo results were interpreted by comparing lead uptake from contaminated soils to the uptake of a soluble lead reference compound (generally lead acetate). Figure 2 compares the resulting IVBA and RBA data; results that plot to the right of the 1:1 line represent soils and species for which the measured IVBA result is greater than the RBA result, so the use of IVBA data tends to overestimate true exposure. EPA Method 1340 tends to overestimate in vivo RBA more strongly in quail than in mammalian species. No systematic difference between swine and mice overestimation bias is evident.



Data sources: Beyer et al. (2016) for Japanese quail, Li et al. (2020) for mammals

Figure 2. Comparison of in vitro bioaccessibility and in vivo relative bioavailability of lead in soils ingested by mice, swine, and Japanese quail

In addition to lead, EPA Method 1340 has been validated for assessing arsenic and cadmium bioaccessibility in soils (Li et al. 2020; USEPA 2017). For several other metals in soil (e.g., antimony,[4] cobalt, and nickel), more limited validation efforts have been documented using swine and rats and have shown qualitative agreement between approaches (i.e., consistently very low IVBA and RBA results) (Vasiluk et al. 2019; Suh et al. 2019; Denys et al. 2012). For zinc, data to compare IVBA and RBA measurements are only available for pure zinc minerals, rather than zinc-contaminated soils (Molina et al. 2013). Although EPA Method 1340 severely over-predicted RBA, it is unclear whether that result was primarily due to the IVBA method or the materials tested. Paired IVBA and RBA data for copper based on EPA Method 1340 are not available.

Overall, the successful validation of IVBA methods in laboratory animals implies the methods' applicability to wildlife and humans. The similarity of results between swine and mice suggests that applicability of the IVBA approach should not be unduly affected by specific digestive system characteristics, at least among non-ruminant mammals. Although avian validation data are limited, the available information suggests that the application of IVBA data from EPA Method 1340 to birds is conservative.

3.3.3 IVBA applicability relative to UCR site TRVs

Metal bioavailability for the reference dosing medium in a TRV study, while typically not measured, is expected to be high relative to many environmentally relevant forms, given that soluble forms of metals are generally used to deliver the dose via spiked food, gavage, or drinking water. In studies used to derive the UCR wildlife TRVs for copper, lead, and zinc, all forms were soluble or bioavailable (i.e., copper sulfate, lead nitrate, lead acetate, zinc carbonate, zinc chloride, zinc acetate, zinc sulfate, and zinc methionine), with the exceptions of copper oxide and zinc oxide (Table 5). Copper oxide had greater toxicity than did copper sulfate from other studies, which could reflect copper oxide's similar bioavailability to that of the more soluble sulfate form, or it could be a result of other aspects of the study design. Although zinc oxide is insoluble in water, it has been shown in some in vitro studies to have bioaccessibility similar to or higher than those of soluble forms of zinc when added to food (Etcheverry et al. 2012). Therefore, for this evaluation, the TRVs are derived for metal forms to which typical RBA derivations apply.

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[4] The antimony validation used a European IVBA method rather than EPA Method 1340.

Table 5. Exposure route and form of metal in studies used to derive UCR TRVs

Metal	Exposure Form and Route	Mammals			Birds		
		Survival	Growth	Reproduction	Survival	Growth	Reproduction
Copper	form	sulfate	sulfate	sulfate	oxide	sulfate	sulfate
	route	diet	diet	diet	diet	diet	diet
Lead	form	nitrate	nitrate	acetate	nitrate	acetate	acetate
	route[a]	gavage	gavage	gavage	gavage	diet	diet
Zinc	form	carbonate	multiple[b]	multiple[b]	carbonate	multiple[b]	acetate
	route[a]	diet	gavage and diet	gavage and diet	diet	diet	diet

Note: Details on studies used to derive TRVs are available from TAI (2019b).

[a] During gavage administration, food was available to the animals *ad libitum*.

[b] EPA's Eco-SSL is used as the zinc TRV for mammals/growth, mammals/reproduction, and birds/growth (USEPA 2007). The mammal and bird Eco-SSLs for zinc were derived as the geomean of NOAEL values for growth and reproduction from studies that used zinc in the forms of acetate, carbonate, chloride, methionine, oxide, or sulfate; a small number of studies did not specify the form of zinc.

Eco-SSL – ecological soil screening level

EPA – US Environmental Protection Agency

NOAEL – no-observable-adverse-effect level

TRV – toxicity reference value

UCR – Upper Columbia River

3.4 Data comparability

For developing regression relationships at locations with no IVBA data, IVBA data from all three studies were grouped to determine if there was a relationship that would support combining the data. As shown in Table 1, although the same IVBA method was used, data were collected from both soil and sediment and from different grain size fractions. As described in Section 5, the evaluation of data from all three groups showed that the relationships between lead/pH and zinc/total organic carbon (TOC) displayed a similar enough pattern to warrant combining the data across media types and grain sizes.

4 APPLICATION OF IVBA DATA TO SOIL INGESTION

To apply the Site-specific IVBA data to soil ingestion as a wildlife exposure pathway in the Upland BERA, it is necessary to determine 1) how to estimate metal bioaccessibility in samples with different characteristics than those that were analyzed for metal bioaccessibility, and 2) how to estimate RBA from measured or estimated IVBA results. These considerations are addressed in Sections 4.1 and 4.2.

4.1 Extrapolation of IVBA data to additional samples

Limitations in spatial coverage of the existing Site-specific IVBA data include the following:

- Bioaccessibility was analyzed in a subset of upland soil samples, with the expectation that the results would be extrapolated to the remaining upland locations.

- Bioaccessibility analyses included only arsenic and lead in soil and sediment samples collected for the Bossburg Flat beach study.
- No bioaccessibility analyses were performed for soils in the Washington State Department of Ecology's (Ecology's) upland soil study.

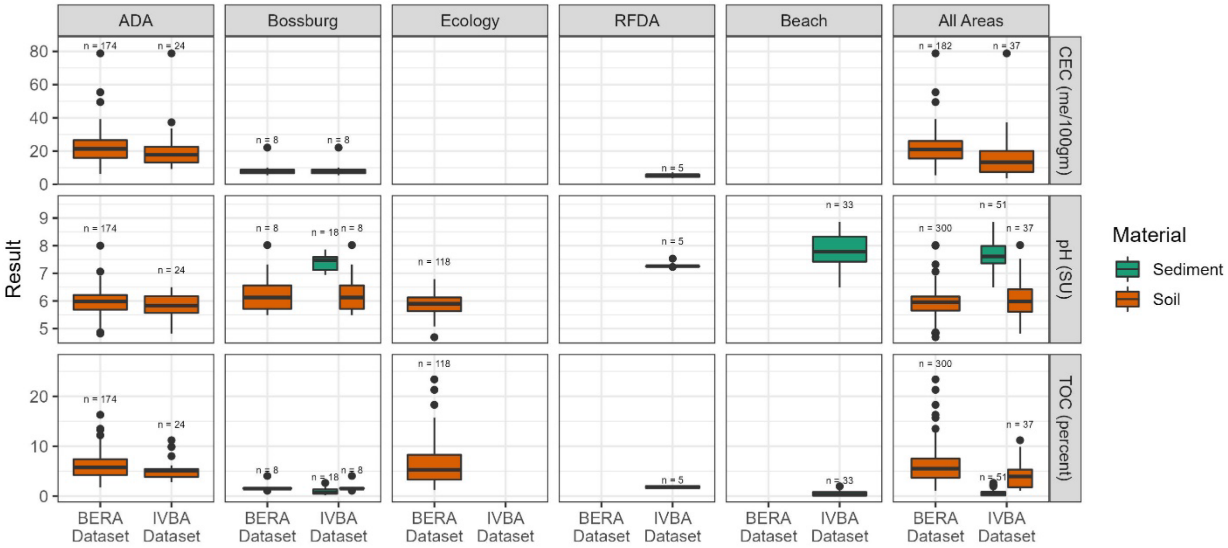
Therefore, it was necessary to examine factors potentially affecting metal bioaccessibility to determine the most appropriate approach for extrapolating the existing data to additional areas. This evaluation focused on copper, lead, and zinc, the Site-related metal COPCs with the greatest exceedances of screening-level TRVs (TAI 2019a, 2020). A simpler default approach—informed by the findings for copper, lead, and zinc—was identified for other metals, as discussed below. IVBA data for soil and sediment samples not included in the Upland BERA dataset (RFDA soil data from the TAI upland soil study, and sediment data from the beach sediment study and Bossburg Flat beach study) were also included in this evaluation to provide a more robust extrapolation approach for lead IVBA data. Copper and zinc IVBA data were not available for sediment samples.

Metal bioaccessibility in soil depends on the metal's physical/chemical form and the soil's capacity to bind the metal. Factors that could potentially affect metal speciation and binding include (Walraven et al. 2015; Grøn and Andersen 2003; Furman et al. 2007; Dehghani et al. 2018; Yan et al. 2019):

- Metal form in the source material as originally released to the environment
- Soil characteristics such as pH, redox state, TOC content, cation exchange capacity (CEC), and grain size distribution
- Total metal concentrations, which when low relate primarily to chemical form (i.e., proportion in natural background minerals versus anthropogenic contamination), and when high may relate to saturation of binding sites

Metal speciation has not been analyzed at the Site, but generalizations can be made regarding typical metal forms in slag and airborne particles from smelter operations. In slag, zinc tends to be concentrated in mineral phases like spinels and silicates, while elements that are chemically incompatible with these mineral structures (e.g., lead and copper) are typically incorporated into amorphous glasses and minor alloy phases (Piatak et al. 2004; Piatak and Seal 2010; Ettler 2001). In soils contaminated by airborne particulates, metals are commonly found in a small size fraction (< 10 µm) (Vespa et al. 2010; Batonneau et al. 2004). Depending on source and soil chemistry, zinc may be found in carbonates, hydroxides, iron oxides, or sulfides (Vespa et al. 2010; Roberts et al. 2002), while lead and copper may be found as various oxide, sulfide, sulfate, and alloy species (Spear et al. 1998; Burt et al. 2003). Slag fragments and dusts tend to be less soluble than airborne particles, and therefore metals in slag tend to be less bioavailable than those in airborne dusts (Spear et al. 1998; Ettler 2016). Thus, the origin of metal contamination (e.g., slag materials in relict floodplains versus airborne particulates in the ADA) is one of the factors considered in the assessment of bioaccessibility extrapolation approaches. However, because geochemical transformations of metals probably occur after their release into the environment, other above-listed factors also play an important role in determining bioaccessibility.

Sample characteristics that could influence metal bioaccessibility and have been measured at the Site include pH, TOC, CEC, grain size distribution, and total metal concentrations; results are shown by area in Figures 3 through 5.[5] Data for all samples that have IVBA data are compared to data for all samples in the Upland BERA dataset, which includes samples for which IVBA data are not available and need to be estimated.



Note: Upland soil study RFDA samples and beach sediment study samples are not included in the Upland BERA dataset.

ADA – aerial deposition area	RFDA – relict floodplain deposition area
BERA – baseline ecological risk assessment	SU – standard unit
CEC – cation exchange capacity	TOC – total organic carbon
Ecology – Washington State Department of Ecology	UCR – Upper Columbia River
IVBA – in vitro bioaccessibility	

Figure 3. Sample characteristics that may influence bioaccessibility in areas of the UCR Site

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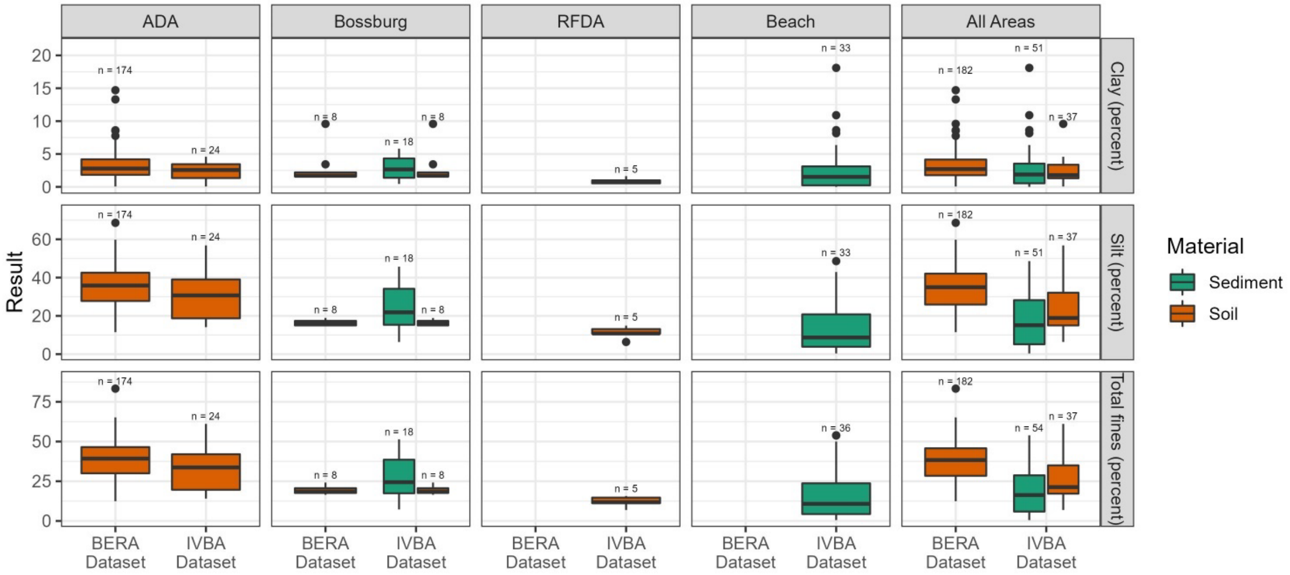
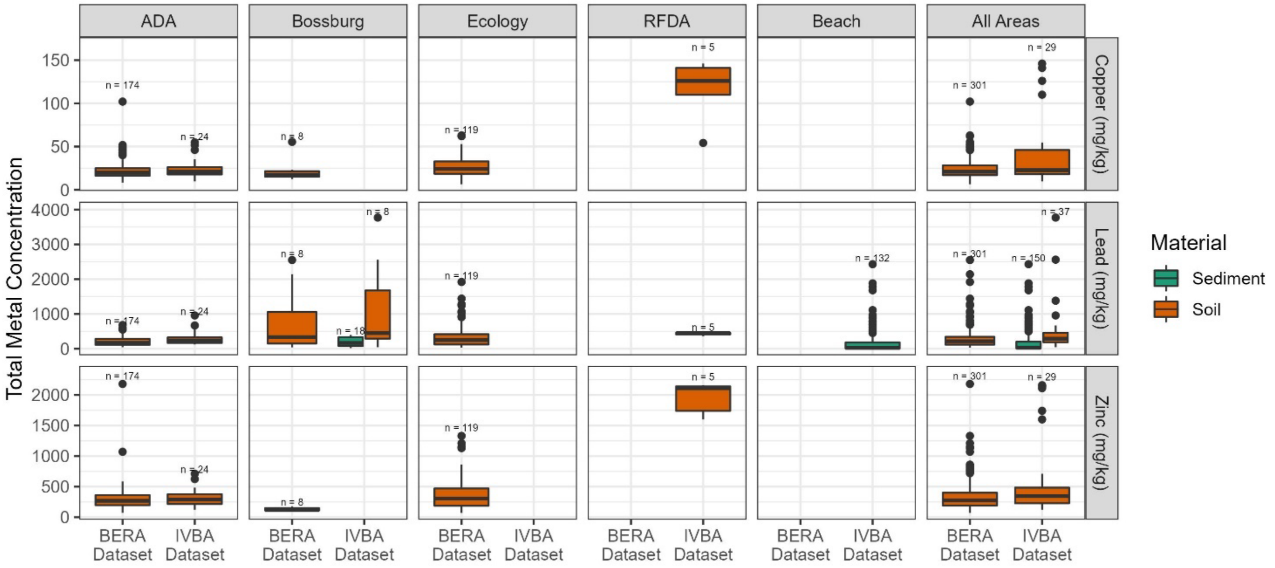
[5] CEC and grain size data are not available for Ecology's soil study, and CEC data are not available for the beach sediment study.



Note: Total fines = silt + clay; grain size data were not collected during Ecology's soil study

ADA – aerial deposition area	IVBA – in vitro bioaccessibility
BERA – baseline ecological risk assessment	RFDA – relict floodplain deposition area
Ecology – Washington State Department of Ecology	UCR – Upper Columbia River

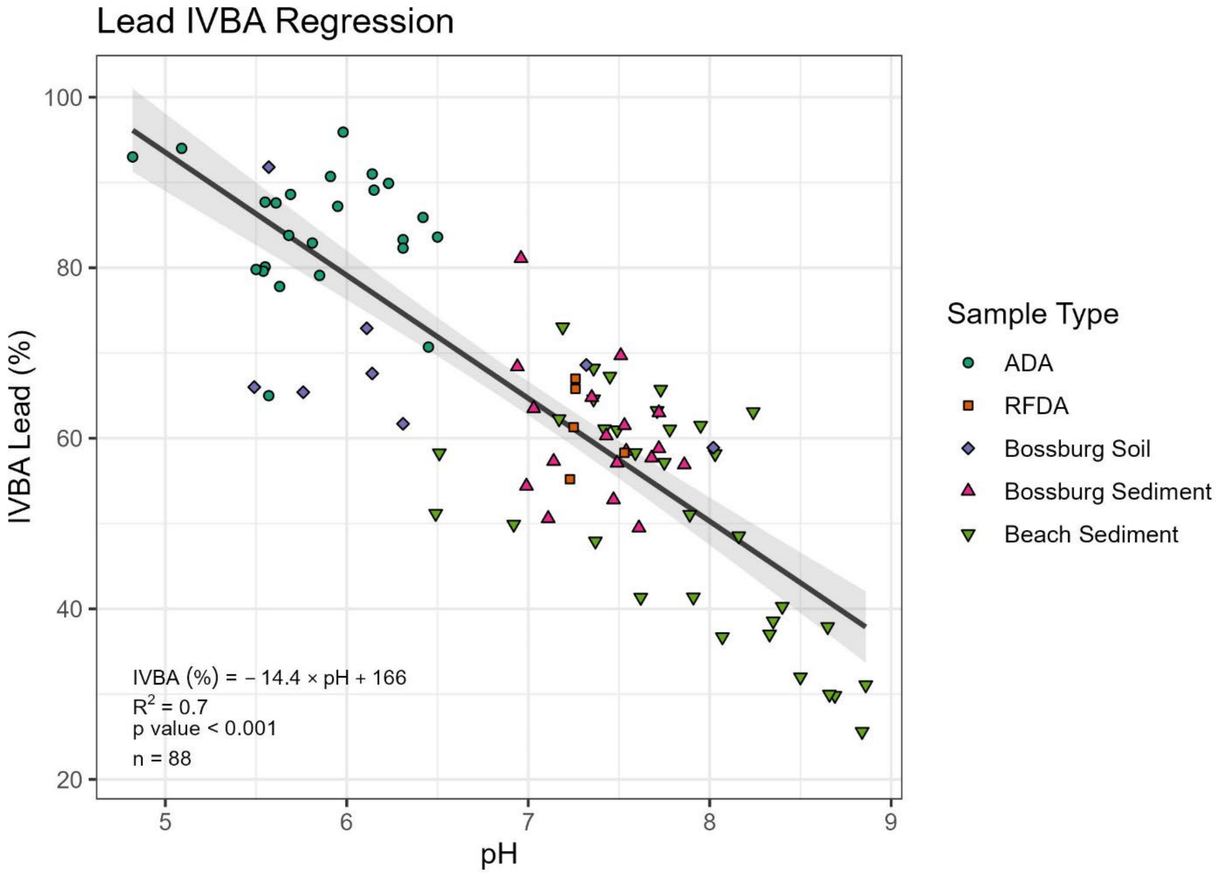
Figure 4. Grain size characteristics of samples from the UCR Site



ADA – aerial deposition area	IVBA – in vitro bioaccessibility
BERA – baseline ecological risk assessment	RFDA – relict floodplain deposition area
Ecology – Washington State Department of Ecology	UCR – Upper Columbia River

Figure 5. Total copper, lead, and zinc concentrations in samples from the UCR Site

Total metal concentration, pH, TOC, CEC, percent clay, and percent fines (silt + clay) were assessed to determine their usefulness as predictors of copper, lead, or zinc bioaccessibility. No relationship was observed for CEC, percent clay, or percent fines with lead or zinc bioaccessibility. A strong relationship was observed between pH and lead bioaccessibility, as shown in Figure 6; greater acidity evidently promotes greater lead bioaccessibility. This relationship bridges areas, source types, and media types, as a consistent linear relationship is evident across ADA and RFDA soils, as well as beach sediments and Bossburg soils and sediments. This finding is consistent with other published studies identifying pH as a key determinant of lead bioaccessibility (e.g., Yang et al. 2003; Dehghani et al. 2018).



Note: Beach area bioaccessibility values represent the average of results for the < 63-µm, 63- to < 125-µm, and 125- to < 250-µm size fractions.

ADA – aerial deposition area

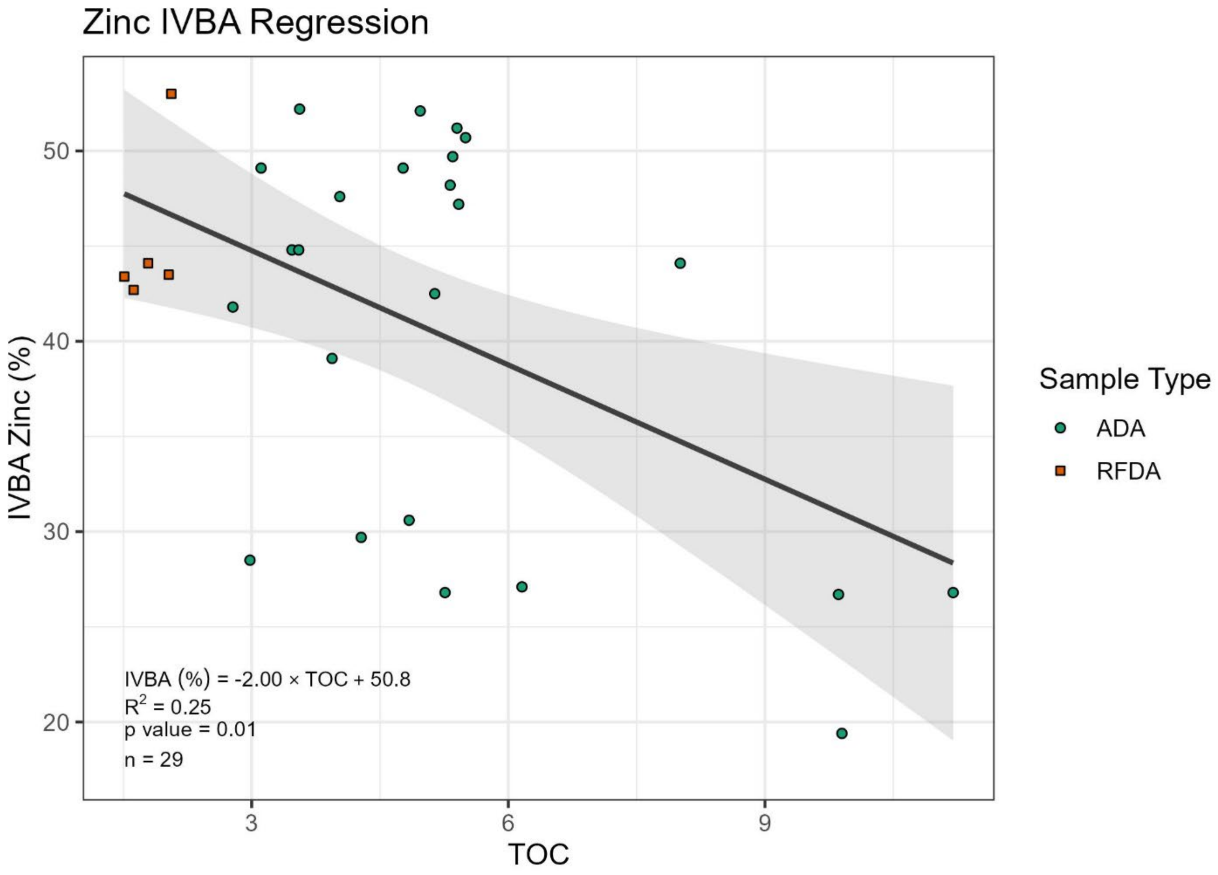
RFDA – relict floodplain deposition area

IVBA – in vitro bioaccessibility

UCR – Upper Columbia River

Figure 6. Lead bioaccessibility as a function of pH in samples from the UCR Site

For zinc, a more variable but still highly significant relationship was identified between soil TOC and percent bioaccessibility (Figure 7). This finding is based on data for ADA and RFDA soils; zinc bioaccessibility was not measured in soil or sediment collected during the Bossburg Flat beach study or the beach sediment study. At other sites, relationships between zinc bioaccessibility and soil characteristics vary among studies, but TOC has sometimes been identified as an important predictive variable (e.g., Dehghani et al. 2018), consistent with the UCR dataset.



ADA – aerial deposition area
IVBA – in vitro bioaccessibility
RFDA – relict floodplain deposition area
TOC – total organic carbon
UCR – Upper Columbia River

Figure 7. Zinc bioaccessibility as a function of TOC in soils from the UCR Site

Although copper bioaccessibility was found to be correlated to total copper concentrations, this relationship was not usable for Site-specific data extrapolation purposes. The range of total copper concentrations in the grain size fraction analyzed for bioaccessible metals was low (< 149-µm fraction, 7.28 to 146 mg/kg) compared to the range of copper concentrations in bulk soils (8.22 to 758 mg/kg). Applying the observed relationship from the < 149-µm fraction to bulk soils would result in predictions of more than 100% bioaccessibility, which would not be meaningful. In actuality, metals in larger particles are often less bioaccessible than those in smaller particles, due to a lower surface-to-volume ratio (e.g., Walraven et al. 2015); this pattern holds true on a Site-specific basis for lead in beach sediments.

Based on these findings, the approach to estimating lead and zinc bioaccessibility in the Upland BERA will be as follows. Measured bioaccessibility data will be used if available for a given ADA sample. In all other cases, the following equations from Figures 7 and 8 will be applied:

- Lead: %Bioaccessible = -14.4 × pH + 166
- Zinc: %Bioaccessible = -2.0 × %TOC + 50.8

Composite samples from soil DUs in the TAI upland soil study and the Bossburg Flat beach study, or from soil sampling locations in the Ecology upland soil study, will be used to calculate wildlife HQs in the Upland BERA.

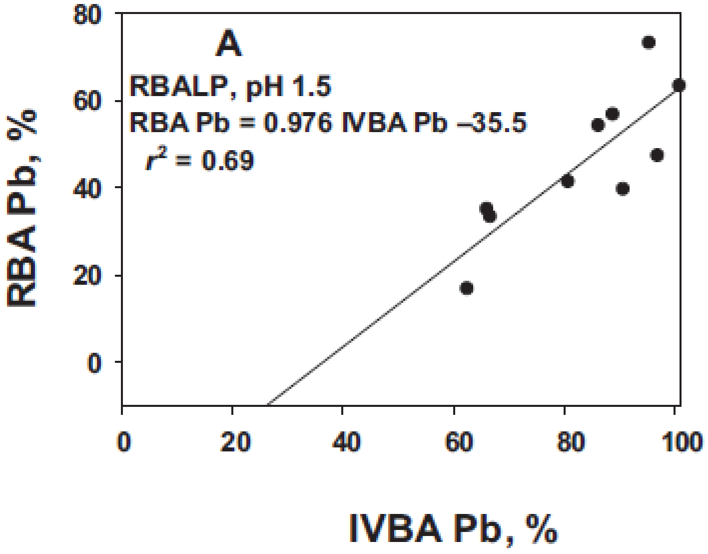
Whereas lead and zinc bioaccessibility will be estimated using regressions, the bioaccessibility of copper and other metals will be estimated according to the following approach:

- Measured IVBA data will be used, if available for a given metal and DU or sampling location.
- Mean percent bioaccessibility will be calculated for the ADA and will be used for other DUs or sampling locations where IVBA metals were not analyzed (i.e., ADA DUs that were not analyzed for IVBA, samples from the Bossburg Flat beach study, and samples from the Ecology upland soil study).

4.2 Estimation of relative bioavailability from bioaccessibility

For lead, the in vivo validation data described in Section 3 support regression equations to estimate RBA based on IVBA results. For birds, the applicable regression is as follows (Beyer et al. 2016; Figure 9):

Avian lead: %RBA = 0.976 × %Bioaccessible – 35.5



Note: From Beyer et al. (2016); regression model for in vitro method equivalent to EPA Method 1340.

EPA – US Environmental Protection Agency	RBA – relative bioavailability
IVBA – in vitro bioaccessibility	RBALP – relative bioaccessibility leaching procedure

Figure 9. Linear regression to predict relative bioavailability of lead in birds

To estimate lead RBA in mammals, two options are available, and the most appropriate option depends on how lead was administered in the applicable TRV study. EPA (2009) developed a regression to relate IVBA and RBA data for lead, based on validation data from swine. More recently, Li et al. (2020) identified an updated regression for the same purpose using a larger dataset representing both swine and mouse validation studies. Figure 10 shows the dataset compiled by Li et al. (2020) with regression lines from the analyses by EPA (2009, 2007) and Li et al. (2020). Symbols are used to differentiate between studies in which lead-contaminated soils were added to food and studies in which the test organisms were fasted and received lead-contaminated soils via gavage. Even though ABA is expected to be higher for fasted exposure (Wragg and Cave 2003), RBA tends to be higher for fed exposure (Figure 10). Apparently, the effect of food interactions (e.g., binding to phytate) on the ABA of lead is greater for the soluble lead salts used as reference compounds than it is for lead-contaminated soils.[6] The EPA regression line provides a good representation of the IVBA-RBA relationship for “fed” studies, whereas the Li et al. (2020) regression line is generally intermediate between the “fed” and “fasted” studies (Figure 10).

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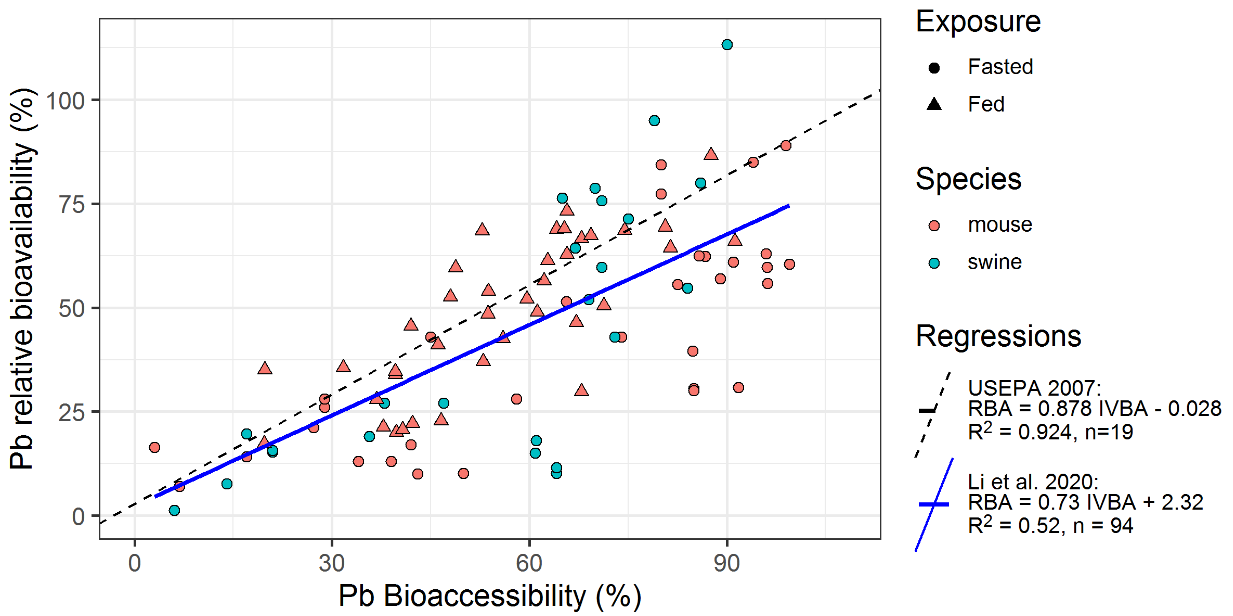
[6] See definition of RBA in Section 2. ABA of the reference compound is in the denominator, and if food binding causes a proportionally larger decrease in the denominator than in the numerator, then RBA increases.



Data source: Li et al. (2020); data for in vitro methods equivalent to EPA Method 1340.

EPA – US Environmental Protection Agency RBA – relative bioavailability

IVBA – in vitro bioaccessibility

Figure 10. Linear regression models to predict relative bioavailability of lead in mammals

As shown in Table 5, the Upland BERA TRVs for lead effects on reproduction, growth, and survival are all from studies in which lead was administered via gavage, although test organisms were not fasted. Given this method of exposure, the Li et al. (2020) regression is considered more applicable. Therefore, lead RBA will be estimated for mammals according to the following equation:

Mammalian lead: %RBA = 0.73 × %Bioaccessible + 2.32

For copper and zinc, comparable in vivo data are not available to quantify relationships between IVBA and RBA. Therefore, conservative assumptions are necessary and are informed by the validation for lead as well as the validations for other metals. For lead, assuming that RBA is equal to IVBA would overestimate the true RBA for most soils (see 1:1 line in Figure 2), when IVBA lead is measured with EPA Method 1340. The assumption of RBA and IVBA equivalence would also be conservative for arsenic and highly conservative for cadmium (as reviewed by Li et al. 2020), the other two metals for which extensive validation data are available. On this basis, RBA will be estimated for metals other than lead by setting RBA equal to the measured or estimated percent bioaccessibility for each DU or sampling location. Although this conservative assumption might overestimate metal exposure, the overestimation will be less extreme than if a default RBA of 100% were assumed.

The calculated RBA factors for use in the Upland BERA for soil are presented in Annex A of this memorandum.

5 APPLICATION OF LITERATURE BIOACCESSIBILITY DATA TO FOOD INGESTION

There are no UCR Site-specific wildlife food bioaccessibility data. The development of generic literature-based bioaccessibility estimates entails considerable uncertainty because of the paucity of literature data for metal bioaccessibility in dietary items relevant to UCR wildlife and the high variability in the bioaccessibility results when data are available. In addition, there are uncertainties associated with differences among extraction methodologies and a lack of validation studies specific to metals biologically incorporated into the diet. Therefore, it is recommended that the Upland BERA assume an RBA of 100% for food items in dietary exposures, unless new information becomes available that warrants a less conservative assumption.

The assumption of 100% bioavailability of metals in food items is particularly conservative for lead in plants and copper in terrestrial invertebrates, based on available literature. Uncertainties in the conservative assumption of 100% metal bioavailability will be addressed in the Upland BERA. The following bullets summarize the bioaccessibility results from the available literature:

- **Plants**: Brumbaugh et al. (2011) measured the bioaccessibility of lead and zinc in vegetation sampled near a mining haul road in Alaska for use in ecological risk assessment. Bioaccessibility of lead in leaves (willow, cranberry, birch, cottongrass stalk/blade) was between 3 and 41%, with a mean of 16%. Bioaccessibility of zinc in the same vegetation was between 50 and > 100%, with a mean of 92%.
- **Earthworms**: No earthworm bioaccessibility data were found for copper or zinc. Earthworms collected from a rifle/pistol range in Ontario contained 52 to 100% (average = 77%) bioaccessible lead (Kaufman et al. 2007).
- **Terrestrial invertebrates**: No appropriately conservative bioaccessibility data were found for lead or zinc.[7] However, appropriate data for copper bioaccessibility in terrestrial invertebrates are available from Hernout et al. (2015). Bioaccessibilities were 23% for Coleoptera (ground-dwelling beetles), 21% for Diptera (flies), and 50% for Lepidoptera (moths).

6 SUMMARY

Although IVBA data for UCR soil samples were generated using a method designed for the HHRA, it is also appropriate to use these data to decrease uncertainty in wildlife exposure assessment. With respect to extractant pH and extraction time in the IVBA method, the results are expected to be conservative when applied to the wildlife species of interest. In addition, the successful validation of IVBA methods in laboratory animals

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[7] Bioaccessibility studies using a gastro-intestinal extraction, rather than gastric only, were considered insufficiently conservative to use for lead and zinc, because the higher pH used in the intestinal phase decreases bioaccessibility (ESG 2011; Li et al. 2020). For copper, results of gastric and gastro-intestinal extractions are often similar (ESG 2011; Li et al. 2020).

implies their applicability to animals (i.e., wildlife, with the exception of ruminants) as well as humans. Although avian validation data are limited, the available information suggests that applying IVBA data from EPA Method 1340 to birds is conservative.

Limitations in spatial coverage of the existing Site-specific IVBA data necessitate extrapolating IVBA data to areas where data are not available. Factors potentially affecting metal bioaccessibility were evaluated to determine the most appropriate approach for extrapolating the existing data to additional areas. A summary of methods that will be used in the Upland BERA to estimate IVBA data for lead, zinc, and other metals where IVBA data are lacking is presented in Table 6.

Table 6. Summary of methods for estimating bioaccessibility

Chemical	IVBA Derivation Method	RBA Derivation Method
Lead	Use measured IVBA data if available. If not, use regression to estimate IVBA: IVBA = -14.4 × pH + 166.	bird RBA = 0.976 × IVBA - 35.5 mammal RBA = 0.73 × IVBA + 2.32
Zinc	Use measured IVBA data if available. If not, use regression to estimate IVBA: IVBA = -2.00 × TOC + 50.8.	equal to RBA
Aluminum	Use measured IVBA data if available. If not, use mean value from all ADA locations.	
Barium		
Cadmium		
Chromium		
Copper		
Iron		
Mercury		
Molybdenum		
Selenium		
Thallium		
Vanadium		

ADA – aerial deposition area
IVBA – in vitro bioaccessibility
RBA – relative bioavailability
TOC – total organic carbon

The RBA factors for soil will be estimated from in vivo validation studies for birds (Beyer et al. 2016) and mammals (Li et al. 2020) using equations shown in Table 6. Comparable in vivo data are not available for metals other than lead. Therefore, as a conservative assumption, the RBA for other metals will be estimated by setting it equal to the measured or estimated percent bioaccessibility for each DU or sampling location. The resulting RBA factors will be used in the dietary dose equation to adjust metals exposures occurring through soil ingestion.

Bioavailability factors will not be used in the dietary dose equation to adjust metals exposures occurring through food ingestion, because Site-specific bioaccessibility data are not available for metals in wildlife food. Instead, the default RBA for metals in wildlife food will be 100%. Uncertainty associated with this conservative assumption will be evaluated as part of the Upland BERA uncertainty analysis.

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ANNEX A

CALCULATED RBA FACTORS FOR USE IN THE UPPER COLUMBIA RIVER UPLAND BERA

Table E3.A-1. Calculated RBA Factors for Use in the Upper Columbia River Upland BERA

BERA Data Set Sample Location or 95 UCL	Conventional Parameters Used for Calculating Zinc and Lead RBA Factors		RBA Factors for Both Birds and Mammals (%)												RBA Factors for Birds Only (%)	RBA Factors for Mammals Only (%)
	pH	TOC (%)	Aluminum	Barium	Cadmium	Chromium	Copper	Iron	Mercury	Molybdenum	Selenium	Thallium	Vanadium	Zinc	Lead	Lead
TAI Upland Soil Study																
ADA-001*	5.95	5.32	9.40	62.2	87.1	1.60	22.4	3.20	6.85	5.18	16.8	15.3	4.20	48.2	49.6	66.0
ADA-002	6.75	1.98	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	46.8	31.6	52.5
ADA-004	5.98	3.55	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.7	42.5	60.6
ADA-005	6.68	1.75	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	47.3	32.6	53.3
ADA-006	5.89	3.37	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.1	43.7	61.6
ADA-008	6.01	5.73	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.3	42.0	60.3
ADA-010	6.43	7.22	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	36.4	36.1	55.9
ADA-015	5.55	5.37	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.1	48.5	65.2
ADA-016-A*	5.69	4.77	19.2	59.5	83.5	3.10	21.2	5.20	7.00	5.18	16.8	22.2	5.70	49.1	51.0	67.0
ADA-016-B*	5.68	3.11	17.4	55.3	75.8	3.40	17.9	4.40	6.10	4.90	16.8	19.7	5.00	49.1	46.3	63.5
ADA-016-C*	5.63	3.55	19.4	57.2	70.0	2.90	18.1	4.30	6.85	3.80	16.8	17.1	5.10	44.8	40.4	59.1
ADA-017	5.96	3.47	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.9	42.8	60.8
ADA-018	5.91	5.78	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.2	43.5	61.4
ADA-019	6.46	5.44	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.9	35.7	55.6
ADA-020-A	6.02	2.38	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	46.0	41.9	60.2
ADA-020-B	6.06	2.53	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.7	41.3	59.8
ADA-020-C	6.11	2.45	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.9	40.6	59.3
ADA-021	6.72	6.54	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.7	32.1	52.9
ADA-023-A	6.37	2.96	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.9	37.0	56.5
ADA-023-B	6.49	3.17	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.5	35.3	55.3
ADA-023-C	6.41	3.77	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.3	36.4	56.1
ADA-024	6.40	5.83	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.1	36.6	56.2
ADA-025	6.22	5.67	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.5	39.1	58.1
ADA-026	6.13	8.30	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	34.2	40.4	59.1
ADA-028	6.50	4.00	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	42.8	35.2	55.2
ADA-033	7.06	2.63	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.5	27.3	49.3
ADA-034	6.91	2.50	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.8	29.4	50.9
ADA-035*	6.50	5.26	21.5	62.8	84.6	4.00	24.1	8.00	6.85	5.18	16.8	14.7	5.60	26.8	46.1	63.3
ADA-039	6.10	2.43	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.9	40.8	59.4
ADA-042	5.64	3.19	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.4	47.2	64.2
ADA-043	6.35	7.42	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	36.0	37.3	56.7
ADA-044	5.93	8.17	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	34.5	43.2	61.2
ADA-045	6.13	7.92	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	35.0	40.4	59.1
ADA-046	5.89	4.27	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	42.3	43.7	61.6
ADA-047*	6.42	5.14	12.8	62.5	84.8	1.60	25.2	3.40	9.00	5.18	16.8	14.5	5.00	42.5	48.3	65.0
ADA-048*	6.31	11.2	20.1	58.4	84.7	4.90	24.9	8.00	6.70	7.20	21.7	41.1	8.60	26.8	44.8	62.4
ADA-049	6.07	3.82	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.2	41.2	59.7
ADA-050	6.11	8.38	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	34.0	40.6	59.3
ADA-051	6.12	5.22	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.4	40.5	59.2
ADA-052	6.40	7.47	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	35.9	36.6	56.2
ADA-053	5.83	9.10	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	32.6	44.6	62.2
ADA-054	5.92	10.1	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	30.6	43.3	61.3

Table E3.A-1. Calculated RBA Factors for Use in the Upper Columbia River Upland BERA

BERA Data Set Sample Location or 95 UCL	Conventional Parameters Used for Calculating Zinc and Lead RBA Factors		RBA Factors for Both Birds and Mammals (%)												RBA Factors for Birds Only (%)	RBA Factors for Mammals Only (%)
	pH	TOC (%)	Aluminum	Barium	Cadmium	Chromium	Copper	Iron	Mercury	Molybdenum	Selenium	Thallium	Vanadium	Zinc	Lead	Lead
TAI Upland Soil Study (continued)																
ADA-055-A	6.34	6.00	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.8	37.4	56.9
ADA-055-B	6.51	4.97	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.9	35.0	55.1
ADA-055-C	6.47	5.63	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.5	35.6	55.5
ADA-056	5.80	5.26	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.3	45.0	62.5
ADA-057*	6.45	4.28	10.1	59.9	82.3	1.90	16.5	3.10	8.00	5.18	16.8	9.30	3.50	29.7	33.5	53.9
ADA-058	6.01	5.87	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.1	42.0	60.3
ADA-059*	5.85	6.16	15.1	69.5	83.7	3.30	20.2	6.70	6.85	5.18	16.8	9.70	3.90	27.1	41.7	60.1
ADA-060-A	5.92	7.87	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	35.1	43.3	61.3
ADA-060-B	6.40	5.94	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.9	36.6	56.2
ADA-060-C	6.24	6.88	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.0	38.8	57.9
ADA-061*	5.57	9.90	15.1	54.3	82.5	1.80	13.2	3.70	6.85	5.18	16.8	8.70	3.50	19.4	27.9	49.8
ADA-062	6.08	7.94	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	34.9	41.1	59.6
ADA-063	5.62	7.18	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	36.4	47.5	64.4
ADA-064	5.49	6.95	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	36.9	49.4	65.8
ADA-065	6.11	2.84	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.1	40.6	59.3
ADA-066	5.98	4.83	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.1	42.5	60.6
ADA-067	6.08	4.43	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.9	41.1	59.6
ADA-070	6.03	7.24	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	36.3	41.8	60.1
ADA-071	5.82	5.23	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.3	44.7	62.3
ADA-073	5.18	6.71	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.4	53.7	69.0
ADA-076*	5.09	9.86	30.6	64.9	70.5	6.30	23.7	10.8	7.80	5.18	16.8	18.8	6.00	26.7	56.2	70.9
ADA-078	5.81	4.24	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	42.3	44.9	62.4
ADA-079	5.47	13.5	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	23.8	49.6	66.0
ADA-081*	5.55	4.84	24.5	60.9	82.6	2.80	20.4	5.80	6.85	5.18	16.8	15.0	4.30	30.6	42.7	60.8
ADA-082	5.98	7.59	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	35.6	42.5	60.6
ADA-084	6.31	10.1	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	30.6	37.8	57.2
ADA-085	6.56	11.5	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	27.8	34.3	54.5
ADA-088	6.18	7.68	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	35.4	39.7	58.5
ADA-089	6.15	6.17	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.5	40.1	58.9
ADA-090	5.81	8.28	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	34.2	44.9	62.4
ADA-091	6.08	5.96	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.9	41.1	59.6
ADA-092	5.98	10.1	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	30.6	42.5	60.6
ADA-093	5.80	5.83	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.1	45.0	62.5
ADA-094	5.78	4.92	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.0	45.3	62.7
ADA-095	6.30	10.3	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	30.2	38.0	57.3
ADA-096*	6.23	8.01	26.2	76.6	86.9	6.90	26.7	10.5	7.40	5.18	16.8	21.7	8.20	44.1	52.2	67.9
ADA-097	6.32	11.8	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	27.2	37.7	57.1
ADA-099	6.00	8.32	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	34.2	42.2	60.4
ADA-101	8.00	7.00	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	36.8	14.1	39.4
ADA-102	6.07	4.71	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.4	41.2	59.7
ADA-103	6.60	5.57	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.7	33.8	54.1
ADA-104	5.82	6.86	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.1	44.7	62.3
ADA-105	6.29	6.18	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.4	38.1	57.4

Table E3.A-1. Calculated RBA Factors for Use in the Upper Columbia River Upland BERA

BERA Data Set Sample Location or 95 UCL	Conventional Parameters Used for Calculating Zinc and Lead RBA Factors		RBA Factors for Both Birds and Mammals (%)												RBA Factors for Birds Only (%)	RBA Factors for Mammals Only (%)
	pH	TOC (%)	Aluminum	Barium	Cadmium	Chromium	Copper	Iron	Mercury	Molybdenum	Selenium	Thallium	Vanadium	Zinc	Lead	Lead
TAI Upland Soil Study (continued)																
ADA-106-A	5.88	7.40	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	36.0	43.9	61.7
ADA-106-B	5.37	5.87	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.1	51.0	67.1
ADA-106-C	5.62	7.07	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	36.7	47.5	64.4
ADA-107-A	6.16	7.35	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	36.1	39.9	58.7
ADA-107-B	6.34	5.33	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.1	37.4	56.9
ADA-107-C	6.01	5.25	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.3	42.0	60.3
ADA-108-A	6.20	7.09	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	36.6	39.4	58.3
ADA-108-B	6.23	6.50	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.8	39.0	58.0
ADA-108-C	6.31	8.16	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	34.5	37.8	57.2
ADA-109	6.11	9.78	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	31.2	40.6	59.3
ADA-110	6.02	4.77	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.3	41.9	60.2
ADA-111	6.24	4.84	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.1	38.8	57.9
ADA-112	5.77	9.12	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	32.6	45.4	62.8
ADA-113	5.90	7.68	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	35.4	43.6	61.5
ADA-114	4.95	8.89	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	33.0	56.9	71.5
ADA-115	6.11	6.50	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.8	40.6	59.3
ADA-116	5.70	4.22	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	42.4	46.4	63.6
ADA-117	5.66	3.86	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.1	47.0	64.0
ADA-118	6.31	5.70	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.4	37.8	57.2
ADA-119	6.31	6.49	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.8	37.8	57.2
ADA-121	6.28	6.36	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.1	38.3	57.5
ADA-122	6.06	6.71	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.4	41.3	59.8
ADA-124-A	4.86	4.45	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.9	58.2	72.4
ADA-124-B	5.17	5.01	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.8	53.9	69.2
ADA-124-C	5.22	3.31	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.2	53.2	68.6
ADA-125*	5.55	2.98	25.2	59.4	81.9	4.90	24.9	8.80	6.85	5.18	16.8	13.2	5.70	28.5	50.1	66.3
ADA-126*	6.15	4.03	19.3	68.1	82.3	3.70	40.0	7.50	8.30	5.18	16.8	20.5	5.00	47.6	51.5	67.4
ADA-127	6.44	4.87	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.1	36.0	55.8
ADA-128	6.32	2.80	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.2	37.7	57.1
ADA-131-A	5.60	7.29	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	36.2	47.8	64.6
ADA-131-B	5.17	5.85	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.1	53.9	69.2
ADA-131-C	5.69	7.25	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	36.3	46.5	63.7
ADA-132	4.86	4.14	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	42.5	58.2	72.4
ADA-133	5.76	4.61	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.6	45.6	63.0
ADA-135-A	6.06	2.57	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.7	41.3	59.8
ADA-135-B	5.89	2.28	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	46.2	43.7	61.6
ADA-135-C	5.99	2.40	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	46.0	42.3	60.5
ADA-136	6.09	3.58	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.6	40.9	59.5
ADA-139	6.00	4.72	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.4	42.2	60.4
ADA-140	5.64	2.73	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.3	47.2	64.2
ADA-141*	5.81	3.94	14.8	66.7	91.9	3.30	20.6	6.00	9.50	5.18	16.8	16.5	5.00	39.1	45.4	62.8
ADA-142*	6.14	3.56	21.6	68.7	82.8	3.30	27.1	6.90	5.40	5.18	16.8	23.0	4.40	52.2	53.3	68.7
ADA-143	5.78	2.58	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.6	45.3	62.7

Table E3.A-1. Calculated RBA Factors for Use in the Upper Columbia River Upland BERA

BERA Data Set Sample Location or 95 UCL	Conventional Parameters Used for Calculating Zinc and Lead RBA Factors		RBA Factors for Both Birds and Mammals (%)												RBA Factors for Birds Only (%)	RBA Factors for Mammals Only (%)
	pH	TOC (%)	Aluminum	Barium	Cadmium	Chromium	Copper	Iron	Mercury	Molybdenum	Selenium	Thallium	Vanadium	Zinc	Lead	Lead
TAI Upland Soil Study (continued)																
ADA-144*	5.54	4.97	28.4	54.2	69.3	2.10	23.8	4.30	4.10	5.18	11.8	26.8	5.10	52.1	42.2	60.4
ADA-145*	6.31	5.35	19.4	67.0	86.1	3.60	24.4	5.80	7.10	5.18	16.8	22.4	5.80	49.7	45.8	63.1
ADA-146	5.99	3.83	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.1	42.3	60.5
ADA-147	5.50	5.03	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.7	49.2	65.7
ADA-148	5.15	2.88	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.0	54.1	69.4
ADA-150*	5.50	2.78	19.9	45.8	68.0	3.90	26.1	5.60	5.70	5.18	16.8	14.0	4.10	41.8	42.4	60.6
ADA-151	5.05	3.44	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.9	55.5	70.4
ADA-152*	5.98	5.50	22.9	69.7	89.3	4.70	30.0	8.00	8.20	5.18	16.8	20.2	5.40	50.7	58.1	72.3
ADA-153	5.87	7.85	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	35.1	44.0	61.8
ADA-154-A	5.56	5.52	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.8	48.4	65.1
ADA-154-B	5.77	8.92	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	33.0	45.4	62.8
ADA-154-C	5.57	6.10	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.6	48.2	64.9
ADA-155	5.23	4.71	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.4	53.0	68.5
ADA-156	5.79	6.89	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.0	45.1	62.6
ADA-158-A	5.87	2.56	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.7	44.0	61.8
ADA-158-B	6.00	3.10	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.6	42.2	60.4
ADA-158-C	5.98	4.12	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	42.6	42.5	60.6
ADA-159-A	6.09	6.44	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.9	40.9	59.5
ADA-159-B	6.15	7.48	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	35.8	40.1	58.9
ADA-159-C	5.72	4.36	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	42.1	46.1	63.4
ADA-160*	5.61	3.47	24.4	52.4	74.8	3.80	23.4	6.30	6.85	5.18	16.8	16.4	4.30	44.8	50.0	66.3
ADA-161*	4.82	5.42	16.0	66.7	83.7	3.60	28.8	8.00	6.50	5.18	16.8	15.6	4.60	47.2	55.3	70.2
ADA-162*	5.91	5.40	18.0	60.9	81.4	2.30	26.7	4.40	2.80	4.80	16.8	20.3	3.00	51.2	53.0	68.5
ADA-164	6.24	6.44	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.9	38.8	57.9
ADA-165	5.82	4.59	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.6	44.7	62.3
ADA-168	6.13	3.41	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.0	40.4	59.1
ADA-169-A	5.96	7.39	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	36.0	42.8	60.8
ADA-169-B	5.78	8.90	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	33.0	45.3	62.7
ADA-169-C	6.44	9.14	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	32.5	36.0	55.8
ADA-170	5.46	9.20	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	32.4	49.8	66.1
ADA-171	5.80	6.15	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.5	45.0	62.5
ADA-172	5.16	16.3	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	18.2	54.0	69.3
ADA-173-A	5.43	6.08	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.6	50.2	66.4
ADA-173-B	5.86	5.69	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.4	44.2	61.9
ADA-173-C	5.58	7.87	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	35.1	48.1	64.8
ADA-174	5.25	9.32	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	32.2	52.7	68.3
ADA-175	5.13	6.04	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.7	54.4	69.6
ADA-176	5.56	5.91	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.0	48.4	65.1
ADA-177	4.84	13.3	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	24.2	58.5	72.6
ADA-178	5.52	7.60	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	35.6	48.9	65.5

Table E3.A-1. Calculated RBA Factors for Use in the Upper Columbia River Upland BERA

BERA Data Set Sample Location or 95 UCL	Conventional Parameters Used for Calculating Zinc and Lead RBA Factors		RBA Factors for Both Birds and Mammals (%)												RBA Factors for Birds Only (%)	RBA Factors for Mammals Only (%)
	pH	TOC (%)	Aluminum	Barium	Cadmium	Chromium	Copper	Iron	Mercury	Molybdenum	Selenium	Thallium	Vanadium	Zinc	Lead	Lead
TAI Upland Soil Study (continued)																
ADA-179	5.70	6.50	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.8	46.4	63.6
ADA-180	6.16	7.07	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	36.7	39.9	58.7
ADA-181	5.76	9.92	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	31.0	45.6	63.0
ADA-182	5.66	6.28	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.2	47.0	64.0
ADA-183	5.58	12.2	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	26.4	48.1	64.8
ADA-184	6.02	8.61	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	33.6	41.9	60.2
Ecology Upland Soil Study																
SA1-1C	5.83	9.54	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	31.7	44.6	62.2
SA1-2C	5.91	5.51	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.8	43.5	61.4
SA1-3C	5.90	5.85	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.1	43.6	61.5
SA1-3C2	5.69	3.93	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	42.9	46.5	63.7
SA1-4C	5.84	2.97	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.9	44.4	62.1
SA1-5C	5.87	8.47	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	33.9	44.0	61.8
SA1-6C	5.56	4.75	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.3	48.4	65.1
SA1-7C	5.90	4.96	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.9	43.6	61.5
SA1-8C	5.68	7.92	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	35.0	46.7	63.8
SA10-1C	6.14	8.80	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	33.2	40.2	59.0
SA10-2C	5.96	12.8	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	25.2	42.8	60.8
SA10-3C	6.02	6.66	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.5	41.9	60.2
SA10-3C2	6.08	4.13	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	42.5	41.1	59.6
SA10-4C	5.97	21.3	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	8.20	42.6	60.7
SA10-5C	6.41	9.37	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	32.1	36.4	56.1
SA10-6C	5.74	11.1	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	28.6	45.8	63.2
SA10-7C	6.12	8.72	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	33.4	40.5	59.2
SA10-8C	6.08	5.02	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.8	41.1	59.6
SA11-1C	6.09	1.98	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	46.8	40.9	59.5
SA11-2C	6.19	3.01	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.8	39.5	58.4
SA11-3C	6.52	5.68	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.4	34.9	55.0
SA11-4C	6.37	8.71	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	33.4	37.0	56.5
SA11-5C	5.41	5.13	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.5	50.5	66.6
SA11-6C	5.54	6.23	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.3	48.7	65.3
SA11-7C	5.16	23.4	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	4.00	54.0	69.3
SA11-8C	5.27	1.99	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	46.8	52.4	68.1
SA11-8C2	5.41	3.20	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.4	50.5	66.6
SA11-9C	5.90	8.29	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	34.2	43.6	61.5
SA12-1C	6.06	3.21	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.4	41.3	59.8
SA12-2C	5.08	4.47	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.9	55.1	70.1
SA12-3C	5.89	10.6	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	29.6	43.7	61.6
SA12-4C	6.75	5.55	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.7	31.6	52.5
SA12-6C	6.42	3.90	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.0	36.3	56.0
SA12-7C	6.13	1.38	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	48.0	40.4	59.1
SA12-7C2	6.25	3.29	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.2	38.7	57.8
SA12-8C	5.61	2.40	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	46.0	47.7	64.5

Table E3.A-1. Calculated RBA Factors for Use in the Upper Columbia River Upland BERA

BERA Data Set Sample Location or 95 UCL	Conventional Parameters Used for Calculating Zinc and Lead RBA Factors		RBA Factors for Both Birds and Mammals (%)												RBA Factors for Birds Only (%)	RBA Factors for Mammals Only (%)
	pH	TOC (%)	Aluminum	Barium	Cadmium	Chromium	Copper	Iron	Mercury	Molybdenum	Selenium	Thallium	Vanadium	Zinc	Lead	Lead
Ecology Upland Soil Study (continued)																
SA12-9C	6.24	2.97	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.9	38.8	57.9
SA13-1C	6.18	11.5	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	27.8	39.7	58.5
SA13-2C	6.68	12.6	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	25.6	32.6	53.3
SA13-3C	5.77	3.20	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.4	45.4	62.8
SA13-4C	5.95	5.64	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.5	42.9	61.0
SA13-5C	6.34	4.31	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	42.2	37.4	56.9
SA13-5C2	6.19	6.33	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.1	39.5	58.4
SA13-6C	5.73	2.77	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.3	46.0	63.3
SA13-7C	5.96	2.57	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.7	42.8	60.8
SA13-8C	5.29	3.69	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.4	52.2	67.9
SA2-1C	5.65	6.60	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.6	47.1	64.1
SA2-2C	5.73	2.37	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	46.1	46.0	63.3
SA2-3C	6.11	2.56	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.7	40.6	59.3
SA2-4C	5.22	3.13	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.5	53.2	68.6
SA2-4C2	5.27	3.28	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.2	52.4	68.1
SA2-5C	5.65	3.87	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.1	47.1	64.1
SA2-6C	5.85	3.63	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.5	44.3	62.0
SA2-7C	5.80	6.59	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.6	45.0	62.5
SA2-8C	6.26	2.14	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	46.5	38.5	57.7
SA3-1C	5.97	1.76	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	47.3	42.6	60.7
SA3-2C	5.58	1.98	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	46.8	48.1	64.8
SA3-3C	6.26	2.42	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	46.0	38.5	57.7
SA3-4C	5.87	2.42	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	46.0	44.0	61.8
SA3-5C	6.58	2.17	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	46.5	34.0	54.3
SA3-6C	5.63	6.97	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	36.9	47.4	64.3
SA3-6C2	6.41	15.7	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	19.4	36.4	56.1
SA3-7C	5.76	9.03	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	32.7	45.6	63.0
SA3-8C	5.94	4.02	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	42.8	43.0	61.1
SA4-1C	6.00	6.59	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.6	42.2	60.4
SA4-2C	6.59	8.72	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	33.4	33.9	54.2
SA4-3C	4.69	9.55	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	31.7	60.6	74.2
SA4-4C	5.40	11.4	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	28.0	50.6	66.7
SA4-5C	6.00	5.70	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.4	42.2	60.4
SA4-6C	5.77	12.2	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	26.4	45.4	62.8
SA4-6C2	5.80	10.2	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	30.4	45.0	62.5
SA4-7C	5.90	4.90	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.0	43.6	61.5
SA4-8C	5.63	5.14	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.5	47.4	64.3
SA5-1C	6.47	6.81	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.2	35.6	55.5
SA5-2C	6.15	5.96	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.9	40.1	58.9
SA5-3C	6.79	3.59	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.6	31.1	52.1
SA5-4C	6.12	4.69	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.4	40.5	59.2
SA5-4C2	6.16	5.46	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.9	39.9	58.7
SA5-5C	6.17	6.01	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.8	39.8	58.6

Table E3.A-1. Calculated RBA Factors for Use in the Upper Columbia River Upland BERA

BERA Data Set Sample Location or 95 UCL	Conventional Parameters Used for Calculating Zinc and Lead RBA Factors		RBA Factors for Both Birds and Mammals (%)												RBA Factors for Birds Only (%)	RBA Factors for Mammals Only (%)
	pH	TOC (%)	Aluminum	Barium	Cadmium	Chromium	Copper	Iron	Mercury	Molybdenum	Selenium	Thallium	Vanadium	Zinc	Lead	Lead
Ecology Upland Soil Study (continued)																
SA5-7C	6.19	5.54	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.7	39.5	58.4
SA5-8C	6.27	6.20	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.4	38.4	57.6
SA6-1C	5.91	6.74	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.3	43.5	61.4
SA6-2C	6.09	3.92	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.0	40.9	59.5
SA6-2C2	5.78	4.24	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	42.3	45.3	62.7
SA6-3C	5.46	8.08	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	34.6	49.8	66.1
SA6-4C	5.53	4.84	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.1	48.8	65.4
SA6-5C	6.02	2.56	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.7	41.9	60.2
SA6-6C	5.18	11.2	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	28.4	53.7	69.0
SA6-7C	5.30	7.92	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	35.0	52.0	67.8
SA6-8C	6.17	9.66	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	31.5	39.8	58.6
SA7-1C	5.65	6.63	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.5	47.1	64.1
SA7-2C	6.15	2.87	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.1	40.1	58.9
SA7-3C	5.48	8.81	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	33.2	49.5	65.9
SA7-4C	5.23	9.91	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	31.0	53.0	68.5
SA7-5C	5.12	8.07	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	34.7	54.6	69.7
SA7-5C2	5.43	6.12	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.6	50.2	66.4
SA7-6C	5.89	4.26	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	42.3	43.7	61.6
SA7-7C	5.46	5.19	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.4	49.8	66.1
SA7-8C	5.97	1.21	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	48.4	42.6	60.7
SA8-1C	5.66	3.85	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.1	47.0	64.0
SA8-2C	5.32	10.7	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	29.4	51.7	67.6
SA8-3C	5.70	1.85	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	47.1	46.4	63.6
SA8-3C2	5.59	1.27	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	48.3	48.0	64.7
SA8-4C	5.62	7.52	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	35.8	47.5	64.4
SA8-5C	5.43	18.3	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	14.2	50.2	66.4
SA8-6C	5.66	1.82	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	47.2	47.0	64.0
SA8-7C	5.56	8.30	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	34.2	48.4	65.1
SA8-8C	5.76	3.79	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.2	45.6	63.0
SA9-10C	6.03	9.18	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	32.4	41.8	60.1
SA9-10C2	6.11	6.56	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.7	40.6	59.3
SA9-1C	6.19	4.06	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	42.7	39.5	58.4
SA9-2C	6.10	3.80	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.2	40.8	59.4
SA9-3C	5.96	4.78	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	41.2	42.8	60.8
SA9-4C	6.13	3.32	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.2	40.4	59.1
SA9-5C	6.10	5.34	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.1	40.8	59.4
SA9-6C	6.44	8.40	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	34.0	36.0	55.8
SA9-7C	5.78	2.79	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	45.2	45.3	62.7
SA9-8C	5.97	12.4	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	26.0	42.6	60.7
SA9-9C	5.60	3.29	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	44.2	47.8	64.6
95 UCL for Subarea 1 [a]	5.80	5.99	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.8	45.0	62.6
95 UCL for Subarea 2 [a]	5.73	3.80	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	43.2	46.0	63.3
95 UCL for Subarea 3 [a]	6.00	5.16	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	40.5	42.2	60.4

Table E3.A-1. Calculated RBA Factors for Use in the Upper Columbia River Upland BERA

BERA Data Set Sample Location or 95 UCL	Conventional Parameters Used for Calculating Zinc and Lead RBA Factors		RBA Factors for Both Birds and Mammals (%)												RBA Factors for Birds Only (%)	RBA Factors for Mammals Only (%)
	pH	TOC (%)	Aluminum	Barium	Cadmium	Chromium	Copper	Iron	Mercury	Molybdenum	Selenium	Thallium	Vanadium	Zinc	Lead	Lead
Ecology Upland Soil Study (continued)																
95 UCL for Subarea 4 [a]	5.75	8.27	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	34.3	45.7	63.0
95 UCL for Subarea 5 [a]	6.29	5.44	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.9	38.1	57.3
95 UCL for Subarea 6 [a]	5.72	6.57	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.7	46.2	63.4
95 UCL for Subarea 7 [a]	5.60	5.90	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.0	47.8	64.7
95 UCL for Subarea 8 [a]	5.59	6.38	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	38.0	48.0	64.7
95 UCL for Subarea 9 [a]	6.04	5.81	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.2	41.7	60.0
95 UCL for Subarea 10 [a]	6.06	9.77	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	31.3	41.4	59.8
95 UCL for Subarea 11 [a]	5.79	6.76	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	37.3	45.2	62.7
95 UCL for Subarea 12 [a]	6.05	4.20	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	42.4	41.5	59.9
95 UCL for Subarea 13 [a]	6.01	5.85	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	39.1	42.0	60.3
Bossburg Flat Beach Study																
UDU-01-ICS**	6.11	1.51	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	47.8	35.7	55.5
UDU-02-ICS**	6.14	1.55	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	47.7	30.5	51.7
UDU-03-ICS**	6.31	1.08	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	48.6	24.7	47.4
UDU-04-ICS-A**	5.57	1.47	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	47.9	54.1	69.3
UDU-04-ICS-B**	5.49	1.75	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	47.3	28.9	50.5
UDU-04-ICS-C**	5.76	1.50	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	47.8	28.3	50.1
UDU-05-ICS**	7.32	1.51	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	47.8	31.5	52.4
UDU-06-ICS**	8.02	4.05	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	42.7	22.0	45.3
95 UCL for Bossburg soils [b]	6.34	1.80	19.6	61.8	81.3	3.49	23.8	6.20	6.85	5.18	16.8	18.2	5.04	47.2	37.4	56.9

Notes:

One asterisk next to the sampling location indicates that in vitro bioaccessibility (IVBA) data were collected at that location; two asterisks indicate that lead-only IVBA data were collected. Percent bioaccessibility could not be determined in some samples for mercury, molybdenum, or selenium because concentrations were below detection limits.

[a] Mean pH and total organic carbon (TOC) values for each subarea were used to calculate lead and zinc relative bioavailability (RBA) factors.

[b] Mean pH and TOC values for Bossburg decision units (DUs) were used to calculate lead and zinc RBA factors.

95 UCL - 95 percent upper confidence limit on the mean

APPENDIX F

HAZARD QUOTIENTS

UPPER COLUMBIA RIVER

FINAL
Appendix F
Hazard Quotients

December 2023

This appendix presents the derived hazard quotient (HQ) values, the potentially affected fraction (PAF) values calculated for plants and invertebrates, and the effective dose (EDx) values calculated for bird and mammal receptors used in the baseline ecological risk assessment (BERA) for the Terrestrial Study Area[1] of the Upper Columbia River site (hereinafter the site [2]). This appendix fully replaces the draft final version of Appendix F in the draft final Upland BERA prepared by Teck American Incorporated in 2023.

HQs, PAFs, and EDxs compare exposure estimates with benchmarks or toxicity reference values to indicate the potential for adverse effects at the organism level to ecological entities identified in the ecological assessment endpoints (e.g., plant or invertebrate communities, bird or mammalian wildlife populations) from exposure to chemicals of potential concern (COPCs) in soil. The COPCs for each ecological assessment endpoint (EAE) were identified in the U.S. Environmental Protection Agency (EPA)-approved final COPC Refinement (TAI 2020a, 2020b).

Four Excel tables listing HQs, PAF, and EDx values for each receptor group are included on the DVD attached to hard copies of the BERA or available electronically from the EPA.

- Table F-1 Terrestrial Plants
- Table F-2 Soil Invertebrates
- Table F-3 Birds
- Table F-4 Mammals

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[1] The term "Terrestrial Study Area" refers to the upland terrestrial habitat of the UCR site. Though it has yet to be fully defined, the upland area is commonly described as land above the elevations of historical Columbia River flood events and within the approximate footprint of metals deposition associated with historical smelter aerial emissions. For the purposes of the Upland BERA, the upland area is operationally defined as the spatial extent of the upland soil data set used for ecological risk analysis. The geographical extent of the Terrestrial Study Area is expected to be established by analyses presented in the Draft Final Upland Remedial Investigation (RI) Report, which is currently under U.S. Environmental Protection Agency review.

[2] As defined within the Settlement Agreement of June 2, 2006, the site consists of the areal extent of hazardous substances contamination within the United States in or adjacent to the Upper Columbia River, including the Franklin D. Roosevelt Lake, from the U.S.-Canada border to the Grand Coulee Dam, and all suitable areas in proximity to the contamination necessary for implementation of response actions.