UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION II
JACOB K. JAVITS FEDERAL BUILDING
NEW YORK, NEW YORK 10278-0012

MAR 0 8 1994

Dear Scientific and Technical Committee Member:

The U.S. Environmental Protection Agency has rescheduled the Scientific and Technical Committee (STC) meeting that was postponed due to inclement weather. The new date for the meeting is Thursday, March 24, 1994. The meeting will be held from 8:30 a.m. to 4:00 p.m. at the Holiday Inn Express, 946 New Loudon Road, Latham, New York. The telephone number of the Holiday Inn Express is (518) 783-6161. Please take note that the starting time has been moved up to 8:30 a.m.

The purpose of the meeting is to discuss the modeling that will be conducted as a part of the Reassessment. Presentations will be made by EPA's modeling contractors, and discussions will held to answer any questions that you may have. In addition, EPA hopes to get feedback from the committee on some of the assumptions that are being considered. An agenda is enclosed. Also enclosed is a copy of a memorandum prepared by Menzie-Cura, which outlines the bioaccumulation modeling that is currently planned. Copies of several memoranda prepared by Limno-Tech, outlining the fate and transport modeling were sent previously, but are still relevant for this meeting. Your familiarity with all of these documents will make for a more productive meeting.

If you have any questions regarding the meeting, please contact me at (212) 264-7508.

Sincerely yours,

Douglas J. Tomchuk

Douglas J. Tomchuk, Project Manager
Hudson River PCBs Site Reassessment

Enclosures

cc: Bill Ports, NYSDEC
John Haggard, GE
Bob Montione, NYSDOH
Diane Wehner, NOAA

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HUDSON RIVER PCBs SUPERFUND SITE
REASSESSMENT RI/FS
SCIENTIFIC AND TECHNICAL COMMITTEE
8:30 AM, THURSDAY, MARCH 24, 1994
LATHAM, NEW YORK

AGENDA

Welcome and Introduction (5 minutes)	Douglas Tomchuk, USEPA Project Manager
Fate and Transport Modeling Presentation (45 minutes)	Dr. Paul Rodgers, Limno-Tech Dr. Victor Bierman, Limno-Tech Dr. Jon Butcher, Cadmus
Introduction to Fate and Transport Modeling Discussion Topics (15 minutes)	" " "
Discussion on Fate and Transport Modeling (2 hours)	Moderated by: Dr. William Nicholson Mt. Sinai Medical Center
Lunch Break (1 hour)	
Bioaccumulation Modeling (45 minutes)	Dr. Jerry Cura, Menzie-Cura Dr. Jon Butcher
Introduction to Bioaccumulation Modeling Discussion Topics (15 minutes)	" " "
Discussion on Bioaccumulation (2.0 hours)	Moderated by: Dr. William Nicholson
Summary	Dr. William Nicholson

Observers will only be allowed to participate if the STC membership has a specific question of a particular observer.

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MEMORANDUM

File: 235

February 3, 1994

To: Hudson River Team
From: Charles Menzie/Jerry Cura/Trina von Stackelberg
Subject: Overview of Approach and Interim Status: Fish Models

The purpose of this memo is to outline our (MCA) approach concerning the structure of the food-chain models. We have been working primarily on supporting aspects of the work because the final structure of the models will depend, in part, on data that are currently being generated or have not yet been provided to MCA. However, our overall conceptual approach has been established and preliminary food chain models have been developed for a few of the selected fish species.

The model or models that are eventually used to estimate body burdens of PCBs in fish will be based on what works best either alone or in concert with another model. The eventual tool(s) will consist of either a statistical method (e.g., bi-variate regression model), steady-state food chain model, or a combination. The statistical approach is being explored by Cadmus with review and QA checks from MCA. The food chain models are being developed for the various fish species by MCA with review by Cadmus.

Ultimately, the bioaccumulation component will either be "hard wired" to the fate and transport model or will be operated separately using input from the fate and transport model. In either case, the model(s) will be used to estimate body burdens of PCBs associated with exposure pathways for these compounds from both sediment and water.

PCBs to be Modeled

This is a group decision which appears close to being made. Clearly, we will be modeling "total" PCBs. Which additional congener, homolog, or Aroclor groups get modeled has not been specified by the group. Our view is that for the purposes of human health and ecological risk assessment, the compounds that become bioaccumulated in fish should be the primary basis for selection of congeners or homologue groups to model beyond "total" PCBs. Source identification should be a secondary, albeit important, consideration.

Jones et al. (1989) identified a group of congeners comprised of 1 tri-chlorinated biphenyl, thirteen tetra-chlorinated biphenyl, and three penta-chlorinated biphenyl as valuable for monitoring PCBs in fish tissue in the upper Hudson. The literature for other aquatic systems suggests that congeners in the tetra through hepta groups tend to be most important within fish. If the fate and transport modeling needs to focus on a limited set of compounds, perhaps these should include: 1) total, 2) a homologue group reflecting the predominant (in fish) tetra-chlorobiphenyls, 3) a homologue group reflecting the predominant (in fish) penta-chlorobiphenyls, and 4) a homologue group reflecting the predominant (in fish) hexa-chlorobiphenyls. The later group (hexa) may be important based on work elsewhere. We suggest that data on PCBs in fish tissues (congener basis) recently generated and in the process of being generated should be consulted to identify the groups of PCB compounds that should be considered. There may be reasons for looking at other homologue groups or congeners from the standpoint of source identification and discrimination. Others within the team are in a better position to comment on this.

Oliver and Niimi (1988) conducted a similar study, albeit for Lake Ontario, and found that the tetra through hepta homologues were the primary contributors to PCB concentrations in fish on a lipid-normalized basis. Lake et. al (1990) also provides useful information on this topic.

We have been collecting and organizing our information on as detailed a level as is provided in the literature or in studies for the Hudson. When a final decision is made on the groups of compounds to be modelled, we will be in a position to accommodate that selection within the limits of available data. In summary, we think that selection of PCB groups to model should include total.

In addition to total, priority should be given to those congeners, groups of congeners, or homologues that are important in fish. A suggested prioritization scheme is as follows:

1. Highest priority: groups of PCB congeners that are important in fish and useful for source discrimination.

2. Moderate Priority: groups of PCB congeners that are important in fish but may not help discriminate among specific sources.

3. Lower to Moderate Priority: groups of PCBs that are not important in fish but useful for source identification.

Fish to be Modeled

Yellow Perch,
Largemouth Bass,
Pumpkinseed,
Brown Bullhead,
White Perch,
Spottail Shiner, and;
Striped Bass.

Conceptual Approach

The objective of the overall program is to identify the relative contribution of PCBs in Hudson River sediments and water to body burdens of selected fish species. Because exposure to PCBs may occur via water column and sediments, it is important to distinguish between these two media. Food is expected to be the primary route of exposure for fish but direct uptake from water may also be important depending on the specific organism under consideration.

Because of the important role of food as an exposure pathway, what and where a fish eats are viewed as key aspects of distinguishing between the relative contribution of the water column and sediments to a species' body burden of PCBs. Some species will feed predominantly on benthic invertebrates, others on water column invertebrates, and still others on forage fish (Figure 1).

"Predominantly" carries with it a certain degree of fuzziness. In fact, one of our top predators - the largemouth bass - will feed on all three components to varying degrees. In performing our analysis, we feel it important to acknowledge this uncertainty and to examine the implications of a species feeding in an opportunistic way.

As a result, we are focusing on a probabilistic approach (see sample output, attached) in which we specify distributions of key variables (i.e., compartment ingestion rates, etc.) to better account for the disparate eating patterns of the piscivorous and predatory fish.

The Food Chain Model

The statistical model(s) are not discussed herein. The discussion is focused only on the food chain model.

The food chain model will be used to identify a limited set of conversion factors for converting simultaneous water and sediment exposures to body burdens. The model will also be used to estimate uncertainty bounds around the estimates.

In its current form, the food chain model exists as a spreadsheet model and utilizes Excel™ and Crystal Ball™ Software for Windows. Excel is a standard spreadsheet and provides the basic computational framework. Crystal Ball is an add-in to Excel and permits uncertainties in exposure concentrations, food chain transfers, foraging behavior, and lipid content to be incorporated directly into the model and carried through to the final analysis. Calculations are made using Monte Carlo analyses.

A separate model is developed for each fish species depending on that species biology and available information on PCB bioaccumulation factors (BAFs). The models are steady state and do not incorporate uptake and depuration rates.

The common features of the models are as follows:

1. Two groups of invertebrates are described: a) invertebrates that live within and feed primarily on sedimentary material (primarily deposit feeders) and, b) invertebrates that feed primarily on organic

particulate matter transported in the water column (zooplankton, many epibenthic invertebrates, and some filter feeding invertebrates).

2. Invertebrates in group "a" are presumed to reflect localized sediment concentrations and to be in steady state with the sediments as described by lipid and organic carbon normalized BAF factors.

3. Invertebrates in group "b" are presumed to reflect PCB concentrations associated with particulate material in the water column on an organic carbon normalized basis. These invertebrates are presumed to be exposed to PCBs adsorbed onto or absorbed into organic particulate material in the form of detritus or algae. In a river system such as the the Hudson, we presume that both forms of organic material will be important in the diets of invertebrates. The invertebrates that feed in this manner are presumed to be in steady state with temporally averaged water column concentrations of PCBs on an organic solids basis as described by organic carbon normalized BAF factors.

4. In most cases, the models are designed to estimate body burdens in <u>adult</u> fish. These larger fish are the ones important for human health risk assessment. In addition, because the primary population-level risk of PCBs to fish is reproductive impairment, body burdens in adults can be used in the ecological evaluation. Because young fish of some species (e.g., Pumpkinseed sunfish) are important as forage fish, body burdens will be estimated for these juveniles. Fish fall into one of several types depending on their foraging strategy. The species-specific models incorporate such information and recognizes the variability that exists among and within species. The models currently incorporate reported ranges describing the fraction of the diet comprised of invertebrates in each of the two groups as well as forage fish. For example, in the current model for largemouth bass, adult fish feed primarily on other fish (50 - 90% of diet) but also feed on benthic and water column invertebrates.

5. The lipid normalized BAF factors between invertebrates and fish

and fish and fish are represented by ranges derived from the literature and from studies carried out in the Hudson. Values have been derived for total PCBs. Values are being derived for major homologue groups and specific congeners.

6. The models are driven by PCB concentrations normalized to organic carbon in sediments and particulate organic carbon in the water column. These selected source concentrations can be converted to other forms or can be supplemented (e.g., with dissolved PCBs in water column or sediment pore water) if this is determined to be important or the performance of the models.

Spatial Scales For Estimating Exposure to Fish

For most fish species, the zone of exposure is presumed to be the summer foraging areas. Fish obtain most of their PCB body burden via food (literature and other modeling values are typically in the range of 70 to 98%) and available information suggests that most of the feeding occurs during the warmer periods of the year. On a relative basis, little feeding occurs in the winter. Therefore, the summer foraging areas represent the most likely areas where exposure occurs. Most of the fish species tend to exhibit localized movements during the Summer. Thus, foraging areas and exposure zones can be highly localized for some species (as little as 100s of meters to a few kilometers). Notable exceptions are white perch and striped bass. We are still seeking input for other species on the spatial dimensions of Summer foraging areas.

The water column exposure regime is not expected to exhibit persistent small-scale spatial heterogeneity, although temporal variability could be large and spatial gradients will exist over small spatial scales at particular points in time. Within a segment of the river (i.e., over a longitudinal distance of a few to several miles), time-averaged concentrations within the water column are not expected to exhibit strong, persistent two-dimensional gradients. Therefore, the spatial scales for exposure to water concentrations should be established so that the "boxes" are: 1) large enough to include complete Summer foraging areas, 2) small enough to reflect predominant longitudinal gradients, and 3) manageable from a computational standpoint.

The sediment exposure regime in some reaches of the Hudson exhibits strong spatial gradients that reflect differences in sediment type as well as locations of "hot spots". Different fish species will also tend to forage over particular sediment types. These factors indicate that the sediment exposure fields for fish need to reflect major spatial variations in concentration and/or sediment type. To some extent, these are coincident within the river. The sediment-directed exposure zones or model "boxes" should be established so that they: 1) are larger than foraging areas, 2) reflect predominant sediment type and concentration patterns within the river, and 3) are manageable from a computational standpoint.

We have discussed the river segmentation with LTI and anticipate that, for the purpose of estimating exposure, the HUDTOX model will need to balance the above considerations within a manageable computational framework. MCA will need to work closely with LTI in identifying exposure zones to be modeled with HUDTOX. These zones will be based on information generated from the kriging and surficial geology (including side scan) studies.

Two species that pose a problem for defining exposure regimes are the striped bass and white perch. We are still working on an approach for these species.

Temporal Scales for Estimating Exposure to Fish

Exposure concentrations for water and sediments will be estimated as Summer averages (April through September). This averaging period is coincident with the time that fish are at their Summer foraging areas.

Information Sources and Selected Activities

Relate sediment concentrations to benthic invertebrates

This is being accomplished by relying on the following information:

1. Field data from Hudson study area: we will use co-located benthic invertebrate and sediment samples obtained during 1993 to quantify the relationships between invertebrate PCB and sediment PCB

levels; these data are not yet available;

2. Equilibrium partitioning (EP) method: we will estimate the EP for selected PCBs; this work is presently underway; when item "1" is completed we will compare the results;

3. Information from literature searches: there are a number of studies that relate sediment PCB and benthic invertebrate PCB concentrations; we view these data as supplementary to Item 1

Product: discussion of the relationships and suggested values for best estimate, range, or distribution. These will be lipid normalized (for organisms) and TOC normalized (for sediment).

Potential Problems: the values may vary for different taxa on a lipid normalized basis. We will need to cross this bridge when we get to it depending on what we learn from the Hudson sampling effort. It may or may not be important.

Relate water concentrations to planktonic and epibenthic or epiphytic invertebrates

This will be accomplished using one or more of the following:

1. Possible field data from Hudson study area: there may be some limited data. We will also look at the DHS data on artificial surfaces inasmuch as these expose invertebrates to water column concentrations; if there are no coincident water column data, we will not be able to make use of the artificial substrate data;

2. BCF limits: these provide theoretical limits on the relationship between zooplankton body burdens and dissolved water concentrations;

3. Relationship between Body Burdens and PCB concentrations in particulate phase: we will evaluate a simple empirical relationship between invertebrate body burdens and the concentrations of PCBs on suspended particulate matter;

4. Information from literature searches: there are a number of studies that relate PCB concentrations in water and planktonic invertebrate PCB concentrations.

Product: discussion of the relationships and suggested values for best estimate, range, or distribution. The relationships established will depend on whether they are related to the dissolved phase or the particulate phase.

Potential Problems: the values may vary for different taxa on a lipid normalized basis and there is considerable uncertainty in literature values due to the difficulty in measuring PCBs in water.

Relate food/water concentrations to forage fish

1. Field data from Hudson study area: data will be available for spottail shiner and pumpkinseed which serve as forage fish along with data for food (benthic invertebrates) and water; these data will be examined for possible relationships; data are not yet available;

2. Information from literature searches: there are data that relate body burdens in forage fish to benthic invertebrates and/or zooplankton;

4. FGETS Model: EPA Athens is assisting us by modifying the FGETS model to include a forage fish component; we plan to run this model under a variety of exposure scenarios to explore steady state conditions relating forage fish body burdens to water and their invertebrate food.

Product: discussion of the relationships and suggested values for best estimate, range, or distribution.

Potential Problems: the values may vary for different taxa on a lipid normalized basis. There is also uncertainty in literature values and regarding what the fish are feeding on. The FGETS and other bioacumulation models that attempt to model the rate of uptake and loss of PCBs from fish contain uncertainties in the parameterization of uptake and loss coefficients.

Relate fish body burdens to exposure in food and water

Information used will include:

1. Hudson River Data: there are and will be new data for PCB body burdens in several fish species; for example, largemouth bass feed on other species such as the pumpkinseed and spottail shiner and, therefore, synoptic data for these species will be crucial for determining statistical/empirical relationships;

2. Literature Values: there are a number of studies that relate body burdens in predatory fish to concentrations in their food;

3. FGETS Model: the FGETS model will be employed for a few of the selected fish species to explore the relationships between body burdens and exposure concentrations via the food web; the model requires a number of physiological parameters; these are included in the model for largemouth bass and brown bullhead; EPA is willing to help define parameters for some of the other species (Luis Suarez of EPA is assisting in modifying the model);

4. Statistical relationships: the statistical regression analyses being performed by Cadmus will help us understand the extent to which body burdens in fish may be related to sediment and/or water and may be used directly or in support of the food chain modeling approach.

Preliminary Models

For the purpose of illustration, we have set up models for largemouth bass and brown bullhead. Body burdens have been simulated for water and sediment concentrations. Examples of model output are attached to this memorandum. The models are preliminary in nature and will be modified when additional data are obtained for the river. However, in their current form, the models for these two species reflect our conceptual approach. In particular, the models directly incorporate uncertainties in foraging, BAF values, and other factors. The models could also incorporate uncertainties in exposure concentrations if this is desired.

References:

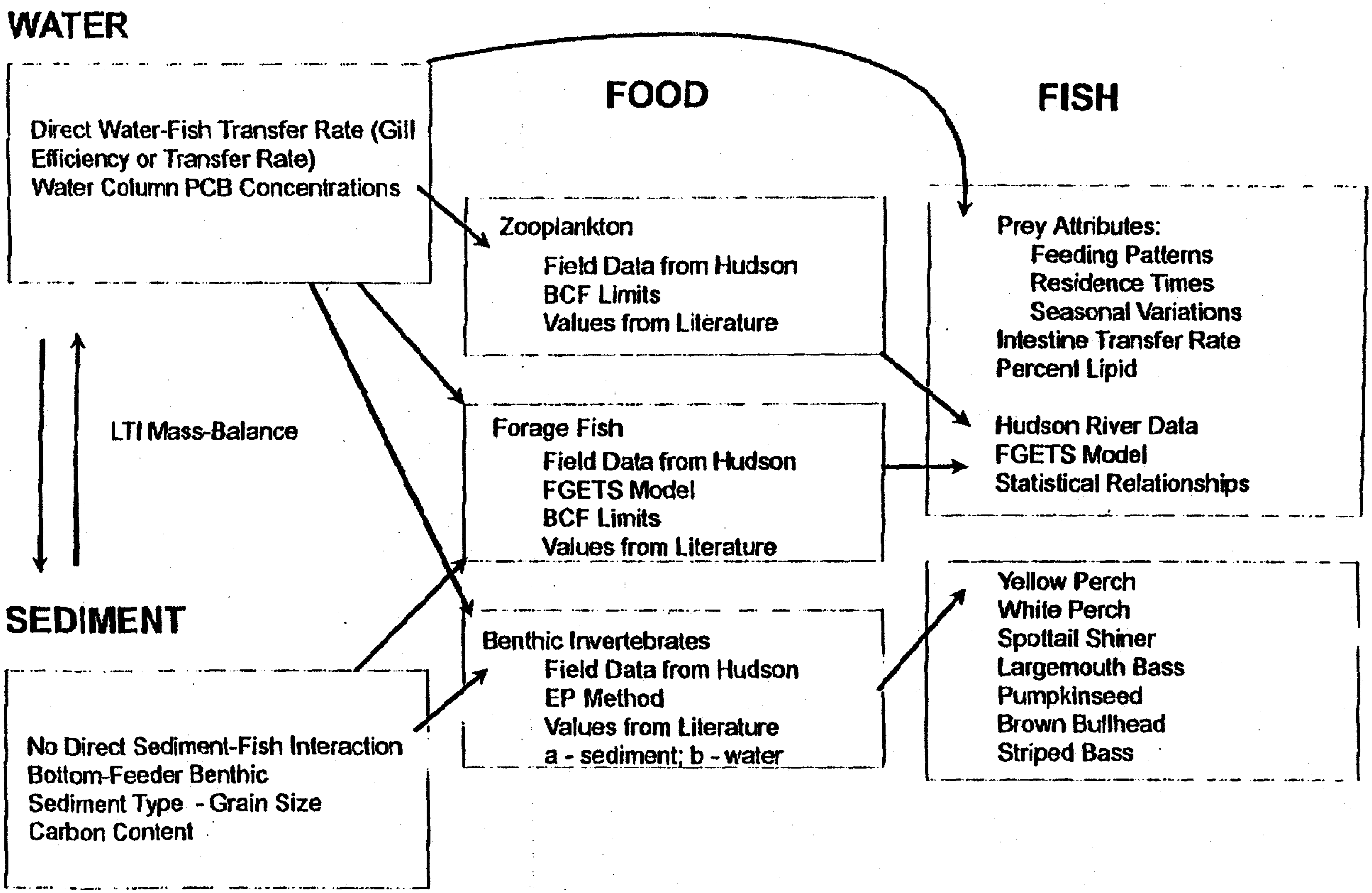
Jones, P.A., R.J. Sloan, and M.P. Brown. 1989. PCB congeners to monitor with caged juvenile fish in the upper Hudson River. Envir. Tox. and Chem. 8: 793-803.

Lake, J.L., N.I. Rubinstein, H. Lee II, C.A. Lake, J. Heltshe and S. Pavignano. 1990. Equilibrium partitioning and bioaccumulation of sediment-associated contaminants by infaunal organisms. Envir. Tox. and Chem. 9: 1095-1106.

Oliver, B.G., and A.J. Niimi. 1988. Trophodynamic analysis of polychlorinated biphenyl congeners and other chlorinated hydrocarbons in the Lake Ontario system. Environ. Sci Technol. 22(4):388-396.

Species	General Habitat Preferences	Feeding Preferences	General Tropic Status
Largemouth Bass	vegetated backwaters, shore areas and tributaries. Predominant species in Lake Champlain Canal, Seneca-Oswego Rivers and Erie Canal. Movement generally less than 5 miles (96% stay within 300 feet of nesting range). Upper levels: rarely found below 20 feet. Quiet, slow waters with soft bottoms.	50% - 90% of diet for bass over 50mm = fish. Will also eat crayfish, worms, mollusks, and larvae.	Piscivorous
White Perch	Mud, sand or clay substrate; light or no cover. Bottom-oriented. Accumulate during the day at 4.6 - 6 meter depths. Tend not to migrate from local geographic region.	70% of diet for perch over 10in = fish. Gut analysis: Oligochaete, Polychaete, Cirripedia, corophium, Leptoceriidae, Anchoa, Lepomis: < 1%; Copepoda, Cumacea: 2%; Ostracoda: 5%; Cyathura: 7%; Gammarus: 38%; Chrionomidae: 44%	Piscivorous
Brown Bullhead	Shallow, calm waters with abundant vegetation and sand or mud bottoms. Found at depths up to 40 feet.	Bottom feeder: offal, waste, small fish, mollusks, insects, leeches, earthworms, crayfish, other crustaceans and fish eggs.	Omnivorous includes plants and animals
Spottail Shiner	Clear water, found in depths up to 60 feet but prefer to congregate in larger numbers in shallow areas.	Seasonal. Spring--Terrestrial dipteria: 25%; Fish eggs: 72%; Hydracarina: 3%. Summer--Chironomid: 15%; Terrestrial dipteria: 60%; Fish eggs: 25%. Fall--Chironomid: 45%; Formicidae: 4%; Hydracarina: 9%; Terrestrial insects: 42%.	Invertebrate Feeder
Pumpkin-seed	Shallow areas with slow-moving water. Do not feed during the winter. Primarily bottom feeders - sometimes from water column.	Gut analysis: Cladocerans: 3%; Copepoda: 1%; Adult insects: 29%; Benthic (67%): Annelids: 7%; Insects (Chironomid): 60%	Invertebrate Feeder
Yellow Perch	Clear water, moderate vegetation, sand, gravel or mucky bottoms. Prefer slow-moving waters near the shore. Migrate from shallow to deep waters in the spring.	Gut analysis: Fish: 43%; Amphipoda: 23%; Chironomidae: 8%; Fish eggs: 2%.	Invertebrate Feeder and secondarily a piscivore

FIGURE 1
CONCEPTUAL SCHEMATIC OF FOOD-CHAIN MODEL



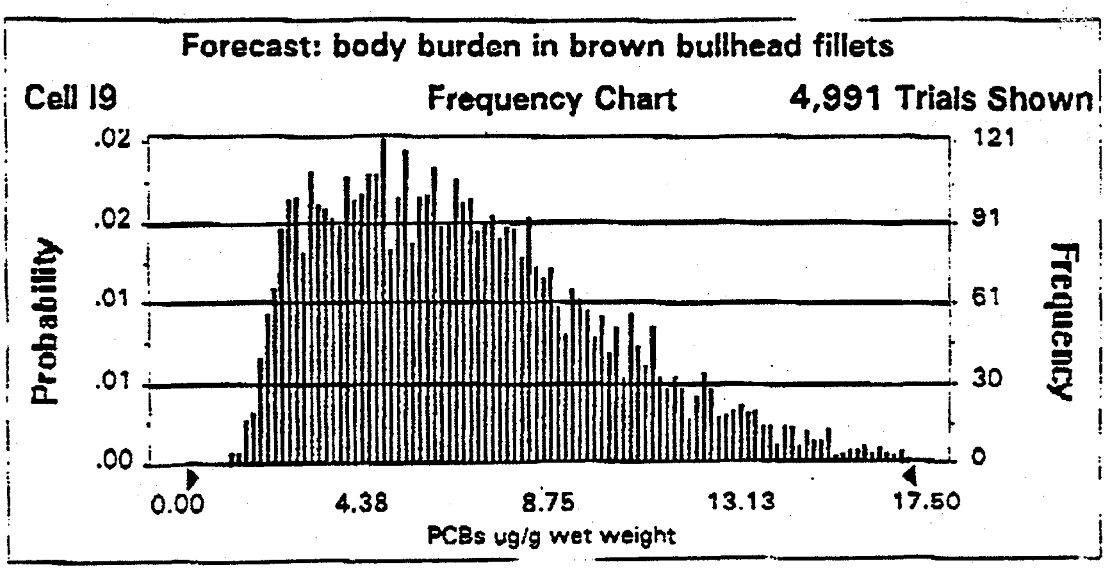
Report3

Brown Bullhead Simulation - Example Only
Water at 150 ug/gOC and Sediment at 50 ug/gOC

Forecast: body burden in brown bullhead fillets Cell: I9

Summary:
Display Range is from 0.00 to 17.50 PCBs ug/g wet weight
Entire Range is from 1.13 to 18.88 PCBs ug/g wet weight
After 5,000 Trials, the Std. Error of the Mean is 0.05

Statistics:	Display Range	Entire Range
Trials	4991	5000
Mean	6.78	6.80
Median	6.34	(unavailable)
Mode	3.94	(unavailable)
Standard Deviation	3.28	3.31
Variance	10.77	10.98
Skewness	0.66	(unavailable)
Kurtosis	2.90	(unavailable)
Coeff. of Variability	0.48	0.49
Range Minimum	0.00	1.13
Range Maximum	17.50	18.88
Range Width	17.50	17.75
Mean Std. Error	0.05	0.05



10.11686

Forecast: body burden in brown bullhead fillets (cont'd) Cell: I9

Percentiles for Entire Range (PCBs ug/g wet weight):

Percentile	body burden in brown bullhead fillets
0%	1.13
10%	2.83
25%	4.18
50%	6.35
75%	8.82
90%	11.41
100%	18.88

End of Forecast

Report3

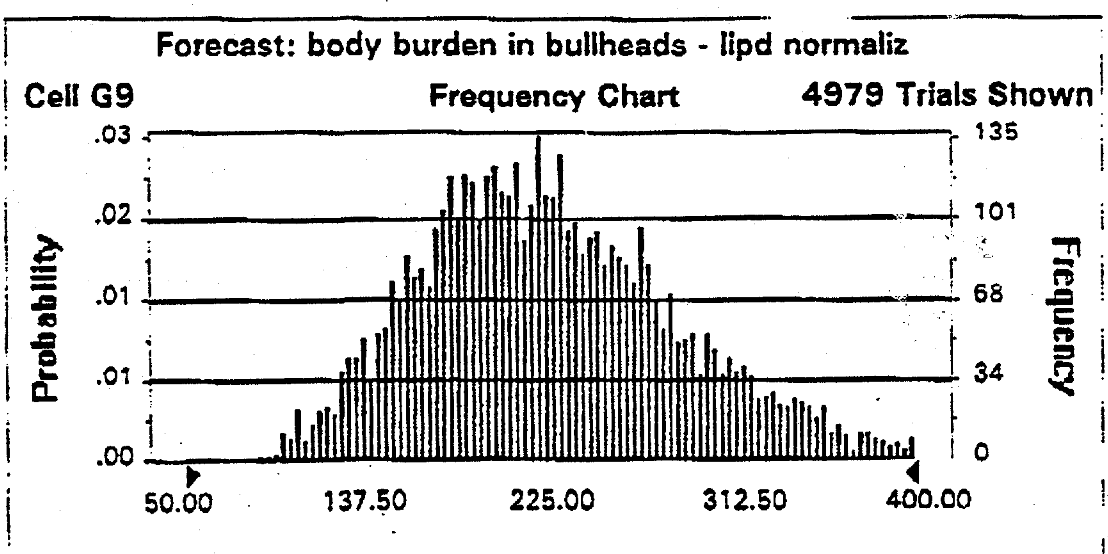
Forecast: body burden in bullheads - lipd normaliz

Cell: G9

Summary:

Display Range is from 50.00 to 400.00
Entire Range is from 88.44 to 447.19
After 5,000 Trials, the Std. Error of the Mean is 0.86

Statistics:	Display Range	Entire Range
Trials	4979	5000
Mean	224.40	225.22
Median	219.30	(unavailable)
Mode	219.75	(unavailable)
Standard Deviation	59.79	60.97
Variance	3574.51	3717.46
Skewness	0.38	(unavailable)
Kurtosis	2.73	(unavailable)
Coeff. of Variability	0.27	0.27
Range Minimum	50.00	88.44
Range Maximum	400.00	447.19
Range Width	350.00	358.75
Mean Std. Error	0.85	0.86



10.11688

Forecast: body burden in bullheads - lipd normaliz (cont'd) **Cell: G9**

Percentiles for Entire Range:

Percentile	body burden in bullheads - lipd normaliz
0%	88.44
10%	150.46
25%	180.36
50%	219.66
75%	264.69
90%	309.48
100%	447.19

End of Forecast

Report3

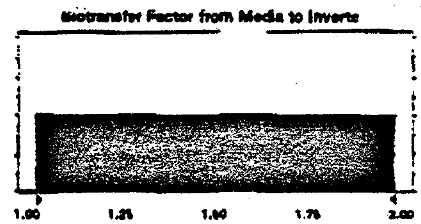
Assumptions

Assumption: Biotransfer Factor from Media to Inverte **Cell: C6**

Uniform distribution with parameters:

Minimum	1.00
Maximum	2.00

Selected range is from 1.00 to 6.50
Mean value in simulation was 1.49



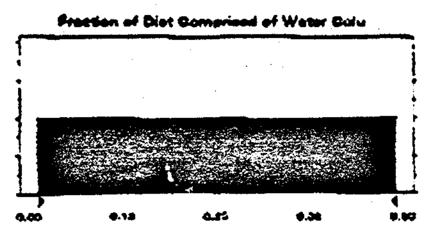
Assumption: Fraction of Diet Comprised of Water Colu **Cell: F6**

Note: most of diet (75% on average) comes from sediment

Uniform distribution with parameters:

Minimum	0.00
Maximum	0.50

Selected range is from 0.00 to 0.50
Mean value in simulation was 0.25

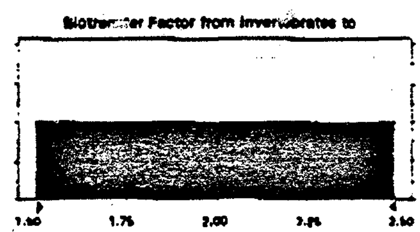


Assumption: Biotransfer Factor from Invertebrates to Bullheads **Cell: E6**

Uniform distribution with parameters:

Minimum	1.50
Maximum	2.50

Selected range is from 1.50 to 2.50
Mean value in simulation was 2.00



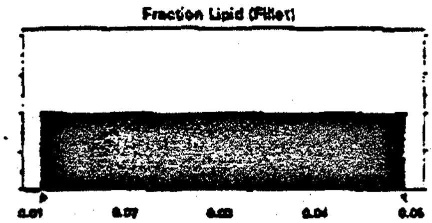
10.11690

Report3

Assumption: Fraction Lipid (Fillet) **Cell: H9**

Uniform distribution with parameters:

Minimum	0.01
Maximum	0.05



Selected range is from 0.01 to 0.05
Mean value in simulation was 0.03

End of Assumptions

10.11691

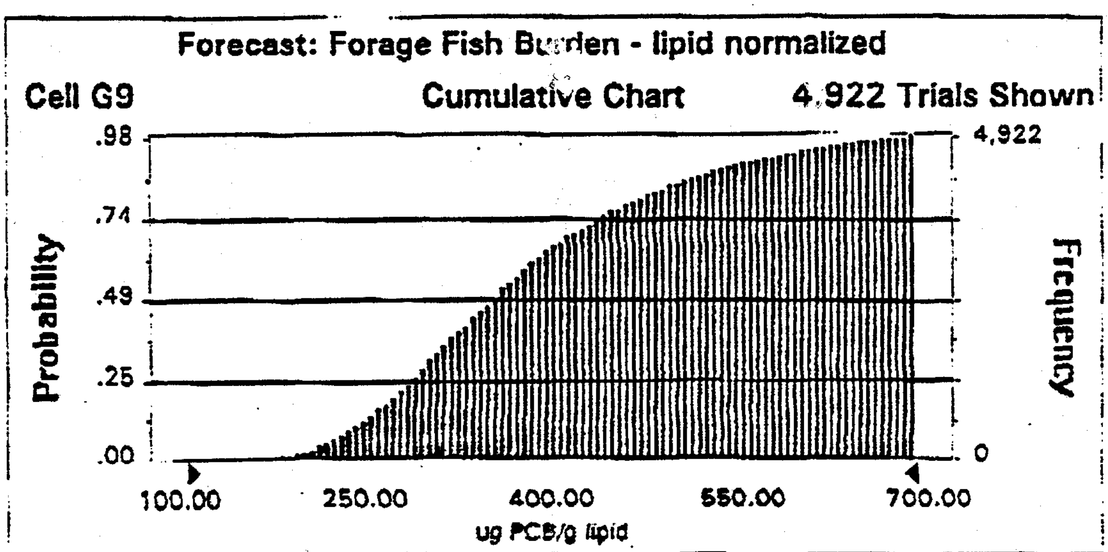
Report1

Largemouth Bass Simulation - Example Only
Simulation started on 2/2/94 at 8:34:19
Simulation stopped on 2/2/94 at 8:53:43

Forecast: Forage Fish Burden - lipid normalized **Cell: G9**

Summary:
Display Range is from 100.00 to 700.00 ug PCB/g lipid
Entire Range is from 142.88 to 862.61 ug PCB/g lipid
After 5,000 Trials, the Std. Error of the Mean is 1.72

Statistics:	Display Range	Entire Range
Trials	4922	5000
Mean	375.42	381.20
Median	357.65	(unavailable)
Mode	363.00	(unavailable)
Standard Deviation	113.46	121.66
Variance	12,872.07	14,801.01
Skewness	0.64	(unavailable)
Kurtosis	2.81	(unavailable)
Coeff. of Variability	0.30	0.32
Range Minimum	100.00	142.88
Range Maximum	700.00	862.61
Range Width	600.00	719.73
Mean Std. Error	1.62	1.72



10.11692

Forecast: Forage Fish Burden - lipid normalized (cont'd) **Cell: G9**

Percentiles for Entire Range (ug PCB/g lipid):

Percentile	Forage Fish Burden - lipid normalized
0%	142.88
10%	243.04
25%	291.37
50%	359.89
75%	451.86
90%	553.78
100%	862.61

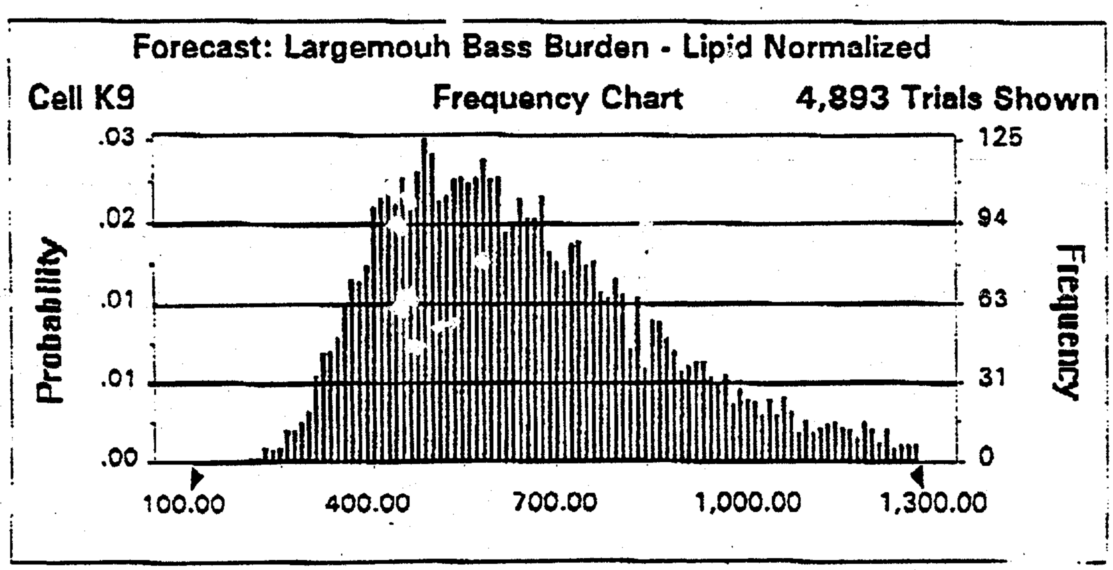
End of Forecast

Report1

Forecast: Largemouh Bass Burden - Lipid Normalized Cell: K9

Summary:
Display Range is from 100.00 to 1,300.00
Entire Range is from 197.88 to 2,019.56
After 5,000 Trials, the Std. Error of the Mean is 3.45

Statistics:	Display Range	Entire Range
Trials	4893	5000
Mean	645.18	662.38
Median	610.56	(unavailable)
Mode	474.00	(unavailable)
Standard Deviation	216.09	244.29
Variance	46,696.70	59,678.68
Skewness	0.64	(unavailable)
Kurtosis	2.93	(unavailable)
Coeff. of Variability	0.33	0.37
Range Minimum	100.00	197.88
Range Maximum	1,300.00	2,019.56
Range Width	1,200.00	1,821.68
Mean Std. Error	3.09	3.45



Report1

Forecast: Largemouh Bass Burden - Lipid Normalized (cont'd) Cell: K9

Percentiles for Entire Range:

Percentile	rgemouh Bass Burden - Lipid Normalized
0%	197.88
10%	395.36
25%	482.34
50%	617.32
75%	793.11
90%	988.38
100%	2,019.56

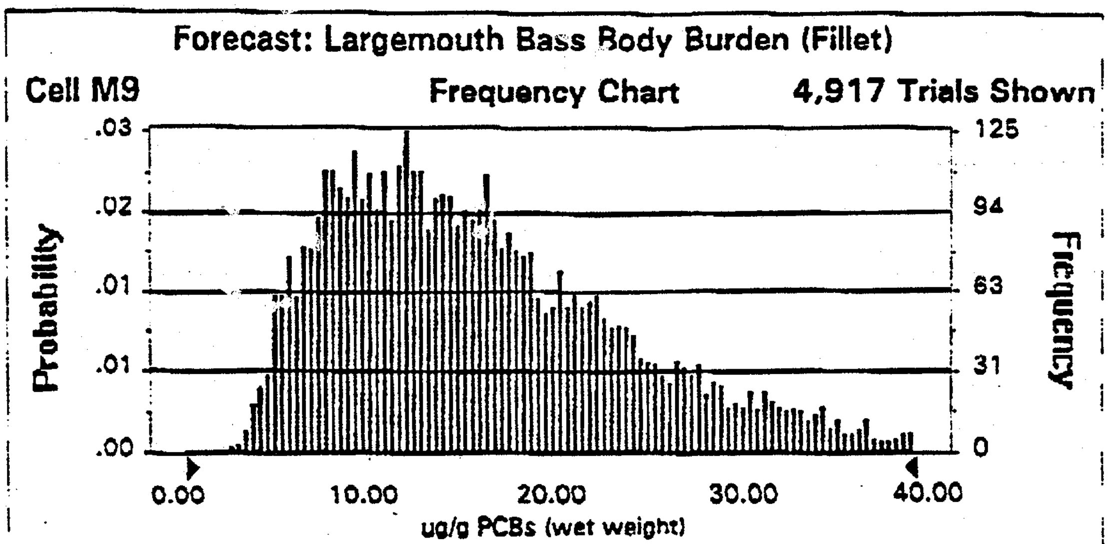
End of Forecast

Report1

Forecast: Largemouth Bass Body Burden (Fillet) Cell: M9

Summary:
Display Range is from 0.00 to 40.00 ug/g PCBs (wet weight)
Entire Range is from 2.44 to 76.51 ug/g PCBs (wet weight)
After 5,000 Trials, the Std. Error of the Mean is 0.12

Statistics:	Display Range	Entire Range
Trials	4917	5000
Mean	16.08	16.59
Median	14.73	(unavailable)
Mode	7.93	(unavailable)
Standard Deviation	7.77	8.69
Variance	60.42	75.50
Skewness	0.73	(unavailable)
Kurtosis	2.96	(unavailable)
Coeff. of Variability	0.48	0.52
Range Minimum	0.00	2.44
Range Maximum	40.00	76.51
Range Width	40.00	74.07
Mean Std. Error	0.11	0.12



10.11696

Report1

Forecast: Largemouth Bass Body Burden (Fillet) (cont'd) Cell: M9

Percentiles for Entire Range (ug/g PCBs (wet weight)):

Percentile	Largemouth Bass Body Burden (Fillet)
0%	2.44
10%	7.17
25%	10.08
50%	14.91
75%	21.32
90%	28.41
100%	76.51

End of Forecast

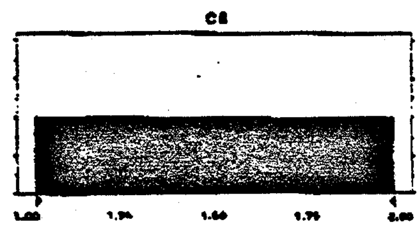
Assumptions

Assumption: Normalized biotransfer between media and invertebrates **Cell: C6**

Uniform distribution with parameters:

Minimum	1.00
Maximum	2.00

Mean value in simulation was 1.50

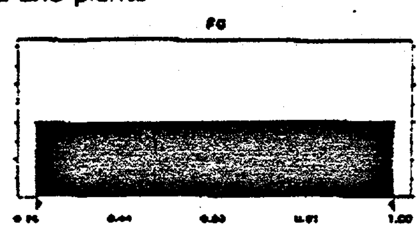


Fraction of forage fish diet comprised by water column invertebrates
This also includes invertebrates that are epibenthic on sediments and plants

Uniform distribution with parameters:

Minimum	0.25
Maximum	1.00

Selected range is from 0.25 to 1.00
Mean value in simulation was 0.63

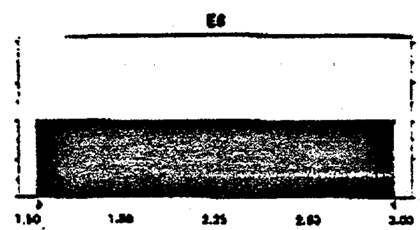


Cell: E6

Uniform distribution with parameters:

Minimum	1.50
Maximum	3.00

Selected range is from 1.50 to 3.00
Mean value in simulation was 2.25

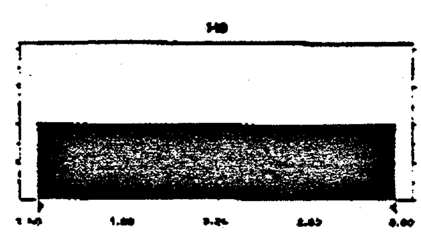


Normalized biotransfer between invertebrates and fish **Cell: H9**

Uniform distribution with parameters:

Minimum	1.50
Maximum	3.00

Selected range is from 1.50 to 3.00
Mean value in simulation was 2.26



Report1

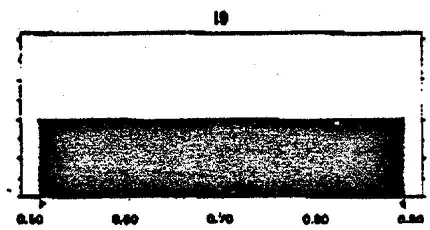
Fraction of largemouth bass diet comprised of fish

Cell: I9

Uniform distribution with parameters:

Minimum	0.50
Maximum	0.90

Selected range is from 0.50 to 0.90
Mean value in simulation was 0.70



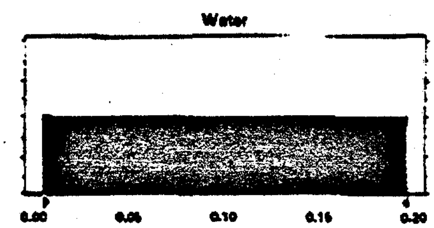
Fraction of invertebrate component of largemouth bass diet that consists of water column invertebrates

Cell: J6

Uniform distribution with parameters:

Minimum	0.00
Maximum	0.20

Selected range is from 0.00 to 0.20
Mean value in simulation was 0.10



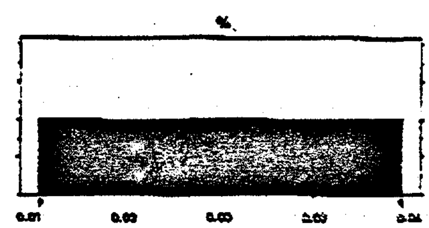
Percent lipid content of largemoth bass fillets

Cell: L9

Uniform distribution with parameters:

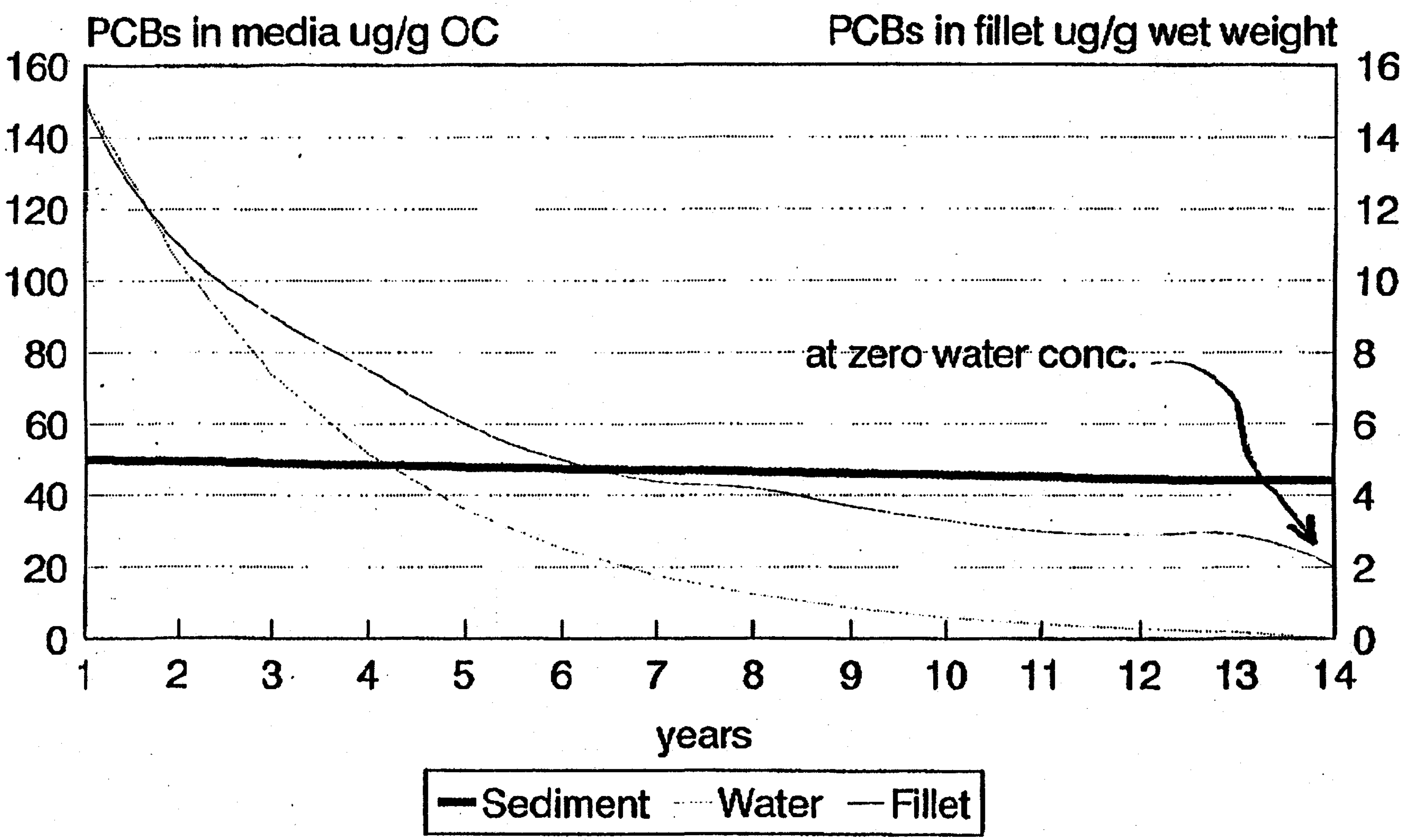
Minimum	0.01
Maximum	0.04

Selected range is from 0.01 to 0.04
Mean value in simulation was 0.03



End of Assumptions

10.11699


PCBs in media ug/g OC
PCBs in fillet ug/g wet weight
160
140
120
100
80
60
40
20
0
16
14
12
10
8
6
4
2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14
years
at zero water conc.
Sediment
Water
Fillet