# Bioaccumulation Model Calibration Update

CPG-EPA Meeting

June 5, 2018

623730

# Topics

- Review of bioaccumulation memo regarding $K_{OW}$ and $K_D$ per memo from EPA
- Calibration status
  - Review of calibrated parameter values
  - Comparison with priority calibration metrics
- Verification of model calibration
  - Dynamic model runs
  - Results for 3rd chemical (1,2,3,4,6,7,8-HpCDF)
  - Running model for individual samples
- Next Steps

# $K_{OW}$ and $K_D$

- Agree with findings of May 17 memo…
  - Unsure that attempting to fix highly uncertain $K_D$ value is advantageous.
  - Suggest that literature $K_D$ values can be useful in verifying $K_{OW}$
- Calculated $K_D$ at several $K_{OW}$ values for LPRSA modeled fish/crab:

| | $K_D$ values for TCDD at various $K_{OW}$ values | | | | |
|---|---|---|---|---|---|
| | $K_{OW}$ = 5.5 | $K_{OW}$ = 6 | $K_{OW}$ = 6.5 | $K_{OW}$ = 7 | $K_{OW}$ = 7.5 |
| Range (large) | 0.19-0.36 | 0.18-0.32 | 0.14-0.25 | 0.08-0.15 | 0.04-0.07 |
| Range (small) | 0.29-0.56 | 0.27-0.51 | 0.21-0.40 | 0.12-0.23 | 0.05-0.10 |
| Average | 0.33 | 0.30 | 0.24 | 0.14 | 0.06 |

- Suggests $K_{OW} \leq$ about 6.5 is more reasonable
  - Compare to range of literature values for $K_D$ of TCDD found by EPA
  - $K_D$ = 0.12 to 0.45 for rainbow trout

# Calibration Process

- Identify sensitive parameters according to sensitivity analysis and previous model knowledge.
- Modify parameters in sequence, looping back as needed.
- Focus on priority calibration targets, while also looking at overall model performance.

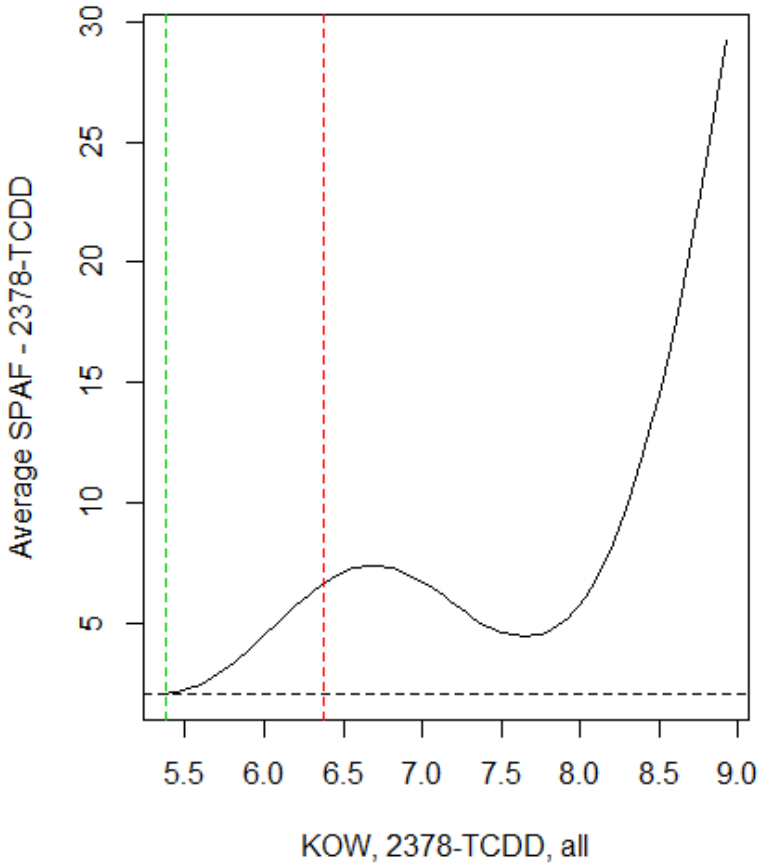
# Reminder about Calibration Targets

Predictions relative to empirical tissue data:

| Model Compartment | Count of Tissue Samples | | |
|---|---|---|---|
| | RM 0 – 6 | RM 6 – 14.7 | RM 14.7 – 17.4 |
| Benthic invertebrate DEPs | - | 13 | 1 |
| Benthic invertebrate C/Os | 5 | - | - |
| Small filter feeding fish | - | 3 | - |
| Small forage fish | 11 | 13 | 1 |
| Small American eel (< 50 cm) | 3 | 6 | 5 |
| Blue crab | 19 | 21 | 4 |
| Carp | na | 11 | 3 |
| Catfish | 6 | 27 | 12 |
| White perch | 9 | 8 | 3 |
| Large American eel (> 50 cm) | 3 | 6 | - |
| Bass | na | 4 | 2 |

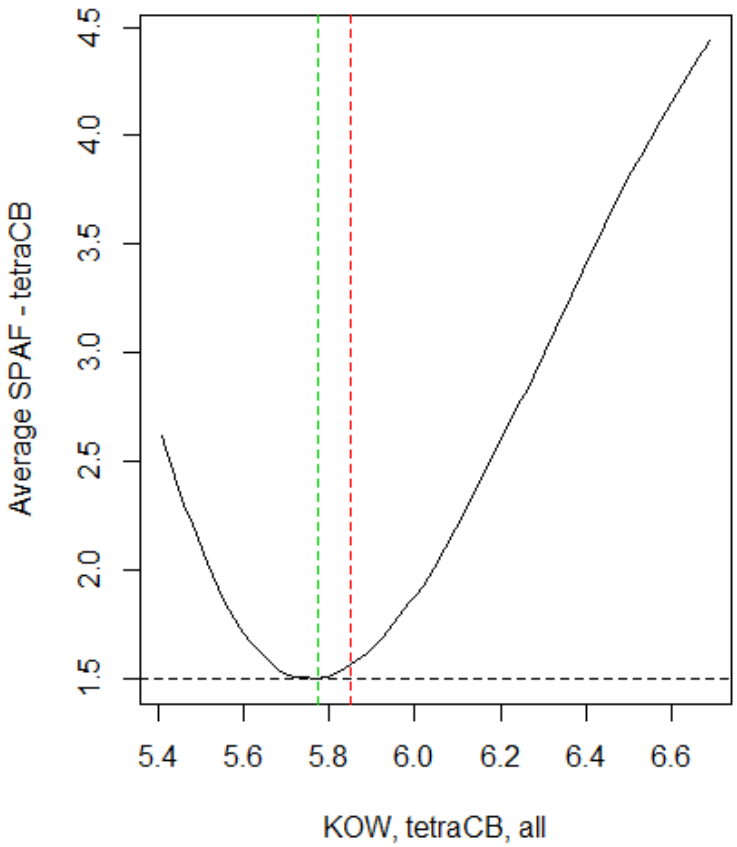
# 1 – $K_{OW}$ for 2,3,7,8-TCDD

- Distribution
  - Nominal value = 6.38
  - Range = 5.38 to 8.93
- Optimization plot indicates best calibration at low-end of range (e.g., $K_{OW}$ of 5.5).
- Alternative $K_{OW}$ around 7.5 less desirable than originally thought.



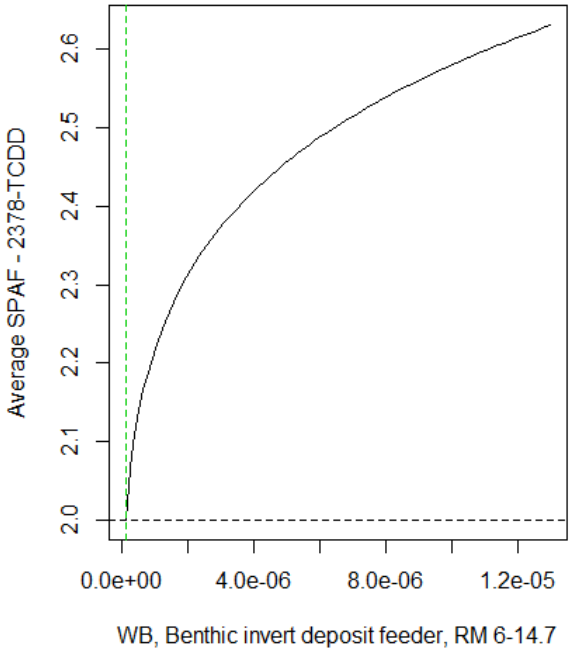
# 2 – $K_{OW}$ for TetraCB

- Distribution
  - Nominal value = 5.85
  - Range = 5.38 to 6.65
- Initial optimization indicated $K_{OW}$ of about 5.6.
- Revised optimization plot indicates best calibration at $K_{OW}$ of about 5.75



# 3 - Weight of Benthic Deposit Feeding Invertebrates (RM 6-14.7)

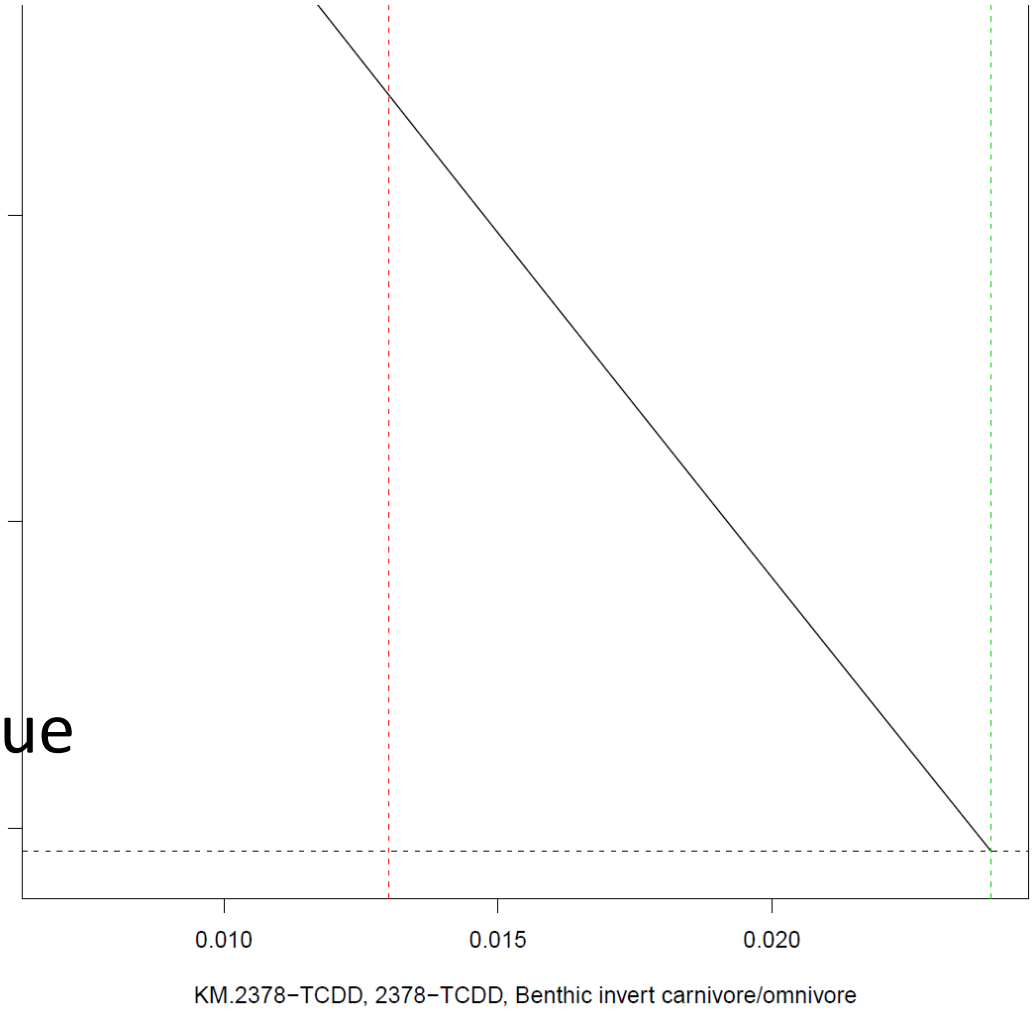
- Distribution
  - Nominal value = 36 mg ww
  - Range = 0.12 to 400 mg ww
- Optimization plot indicates lower values will result in improved SPAF.
- Selected calibrated value of 1 mg ww (1E-06 kg ww)
  - Better represents majority of species in this area.
  - Average skewed by several larger organisms.




| Taxon[a] | Percent of Biomass By Modeling Zone[b] | | | Body Weight (mg ww)[c] |
|---|---|---|---|---|
| | RM 0-6 | RM 6-14.7 | RM 14.7-Dam | |
| Arcteonais lomondi | | 6% | | 1.11 |
| Heteromastus filiformis | 2% | | | 3.31 |
| Ilyodrilus templetoni | | 10% | | 0.95 |
| Limnodrilus hoffmeisteri | 1% | 49% | 3% | 0.17 |
| Limnodrilus udekemianus | | 10% | 1% | 1.83 |
| Lumbriculidae | | 8% | 95% | 404 |
| Macoma balthica | 97% | 1% | | 151 |
| Quistadrilus multisetosus | | 9% | | 0.12 |
| Slavina appendiculata | | 5% | | 1.11 |

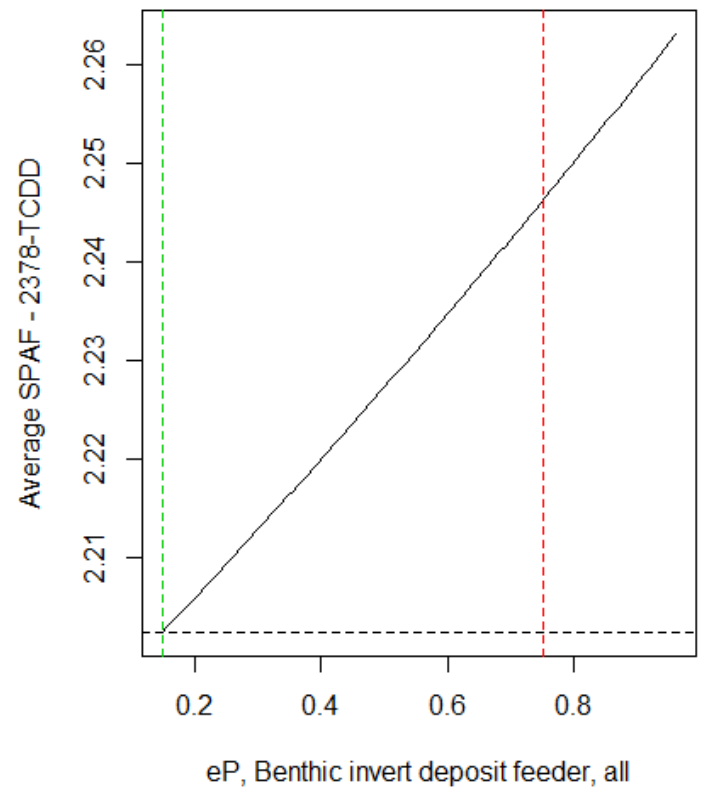
# 4 – Metabolic rate for invertebrates (2,3,7,8-TCDD)

- Distribution
  - Nominal value = 0.013
  - Range = 0.007 to 0.024
- Optimization indicates higher metabolic rate improves model performance.
- Selected calibrated value of 0.024 (max)



# 5 – Dietary AE of NLOC and NLOM for invertebrates (all types)

- Distribution
  - Nominal value = 0.75
  - Range = 0.15 to 0.96
- Optimization plot indicates lower values will result in improved SPAF (similar story with all related parameters).
- Selected value = 0.4 (based on previous conversations with Frank Gobas during 2015 calibration)



# 6 – Diet of Benthic Deposit Feeding Invertebrates (RM 6-14.7)

- Distribution:

| Prey Items | RM 0 to RM 6 | | RM 6 to RM 14.7 | | RM 14.7 to RM 17.4 | |
|---|---|---|---|---|---|---|
| | Nominal Value and Range (%) | Calibrated Value (%) | Nominal Value and Range (%) | Calibrated Value (%) | Nominal Value and Range (%) | Calibrated Value (%) |
| Sediment solids | 23 (0 – 40) | 23% | 89 (70 – 100) | **70%** | 84 (60 – 100) | **70%** |
| Particulates/detritus (near-bottom/fluff layer) | 43 (25 – 75) | 43% | 10 (0 – 30) | **26%** | 16 (0 – 40) | **30%** |
| Phytoplankton/algae | 17 (0 – 30) | 17% | 0.5 (0 – 5) | 2% | 0 (0 – 5) | 0% |
| Zooplankton | 17 (0 – 30) | 17% | 0.5 (0 – 5) | 2% | 0 (0 – 5) | 0% |

- Optimization results:
  - For RM 6-14.7 and RM 14.7 – Lower percentage of sediment and higher percentage of near-bottom particulates improves SPAFs.
  - For RM 0-6 – Less important to model performance; no changes to nominal values.

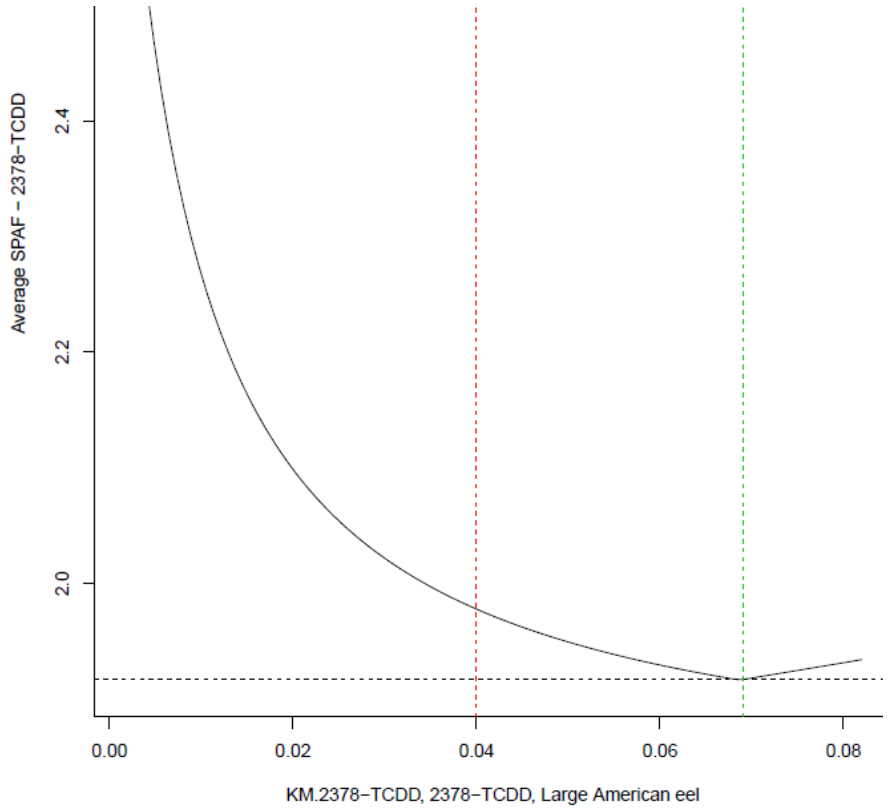
# 7 – Dissolved Oxygen Saturation (RM 6-14.7)

- RM 0-6 and RM 14.7-Dam:
  - Relatively small range for RM 0-6 and RM 14.7-Dam
  - No changes to nominal values.
- RM 6-14.7 –
  - Optimization indicates that lower parameter values will improve SPAF.
  - Selected value of 80%.

| River Mile/ Modeling Area | DO Saturation (%) | |
|---|---|---|
| | Measured | Interpolated |
| RM 0-1 | 69% | - |
| RM 1-2 | 66% | - |
| RM 2-3 | - | 65% |
| RM 3-4 | - | 64% |
| RM 4-5 | 63% | - |
| RM 5-6 | 64% | - |
| RM 6-7 | - | 71% |
| RM 7-8 | - | 77% |
| RM 8-9 | 84% | - |
| RM 9-10 | 83% | - |
| RM 10-11 | - | 86% |
| RM 11-12 | - | 89% |
| RM 12-13 | 92% | - |
| RM 13-14 | - | 95% |
| RM 14-15 | 97% | - |
| RM 15-16 | - | 97% |
| RM 16-17.5 | - | 97% |
| **Values by Modeling Area for Use in the Bioaccumulation Model:** | | |
| RM 0 to RM 6 | 65% (64 – 69%) | |
| RM 6 to RM 14.7 | **85% (71 – 97%)** | |
| RM 14.7 to RM 17.4 | 95% (92 – 97%) | |

# 8 – Metabolic rate for American eel (2,3,7,8-TCDD)

- Distribution:
  - Nominal value = 0.04
  - Range = 0.0016 to 0.082
- Optimization indicates improved model performance with higher values.
- Selected value of 0.06



# 9 – Lipid fraction for Benthic Invertebrate C/O for RM 0 – 6

- Distribution:
  - Nominal value = 1.6%
  - Range = 0.59% to 1.7%
- Optimization indicates improved model performance with lower values.
- Selected value of 0.6%

# 10 – Metabolic rate for carp (2,3,7,8-TCDD)

- Distribution:
  - Nominal value = 0.014
  - Range = 0.0016 to 0.056
- Optimization indicates improved model performance with value lower than nominal value.
- Selected value of 0.007 (half of nominal value)

# 11 – Diet for white perch (all areas)

- Distribution for percent of invertebrates in diet:

| Diet component | Nominal Value | Range |
|---|---|---|
| Invertebrates | 75% | 0 – 100% |
| Small fish | 15% | 0 – 90% |

- Optimization indicates improved SPAF with lower percentage of invertebrates and higher percentage of fish in diet.
- Selected values:
  - 40% invertebrates
  - 50% small fish

# 12 – Inputs from CFT model

- Modified inputs from CFT model
- Selected inputs to modify based on:
  - Sensitivity analysis
  - Contribution of inputs to predicted tissue concentrations
  - Model performance

| Parameter | 2,3,7,8-TCDD | | | TetraCB | | |
|---|---|---|---|---|---|---|
| | RM 0-6 | RM 6-14.7 | RM 14.7-DD | RM 0-6 | RM 6-14.7 | RM 14.7-DD |
| Sediment | ↑ | | | ↑ | | |
| Porewater | | | | | | |
| Bioavailable water | ↑ | | | ↑ | | |
| Fluff layer (near-bottom part.) | ↑ | | ↑ | ↑ | | |
| Water-column particulates | | | | | | |
| Algal carbon | | | | | | |

# 13 – Water Temperature

- Distributions by area:

| Area | RM 0 – 6 | RM 6 – 14.7 | RM 14.7 – Dam |
|---|---|---|---|
| Nominal value | 12.7 | 13.0 | 13.4 |
| Range of values | 8 to 17 | 9 to 18 | 8 to 17 |

- Optimization indicated:
  - Higher temperature (i.e., higher bioaccumulation) better for RM 0-6 (both chemicals) and RM 14.7-Dam (TCDD)
  - Lower temperature (i.e., lower bioaccumulation) better for RM 6-14.7 (both chemicals) and RM 14.7-Dam (tetraCB)

- No change to parameter values

# Calibration 1: Parameter values

| Parameter | Nom-inal | Range | Select-ed | Selected Value Min----------(Nominal)----------Max |
|---|---|---|---|---|
| 1: $K_{OW}$ for 2,3,7,8-TCDD | 6.38 | 5.38 - 8.93 | 5.5 | 5.38----------(6.38)----------8.93 |
| 2: $K_{OW}$ for TetraCB | 5.85 | 5.38 - 6.65 | 5.75 | 5.38----------(5.85)----------6.65 |
| 3: Weight of DEP (RM 6-14.7) | 36 mg | 0.12-400 mg | 1 mg | 0.12----------(36)----------400 |
| 4: KM for inverts (2,3,7,8-TCDD) | 0.013 | 0.007-0.024 | 0.024 (max) | 0.007-------(0.013)----------0.024 |
| 5: Invert dietary AE of NLOC/NLOM | 0.75 | 0.15-0.96 | 0.4 | 0.15----------(0.75)-------0.9 |
| 6: % of sed in DEP diet (RM 6-14.7 and 14.7-Dam) | 89% | 70-100% | 70% (min) | 70%----------(89%)---------100% |
| 7: DO Saturation (RM 6-14.7) | 85% | 71-97% | 80% | 71%----------(85%) ----------97% |

# continued…

| Parameter | Nom-inal | Range | Select-ed | Selected Value Min----------(Nominal)----------Max |
|---|---|---|---|---|
| 8: $K_M$ for eel (2,3,7,8-TCDD) | 0.04 | 0.0016-0.082 | 0.06 | 0.0016----------(0.04)----★----0.082 |
| 9: Lipid fraction for C/O (RM 0-6) | 1.6% | 0.59-1.7% | 0.6% (min) | ★59%----------(1.6%)--1.7% |
| 10: $K_M$ for carp (2,3,7,8-TCDD) | 0.014 | 0.0016-0.057 | 0.007 | 0.0016★----(0.014)---------0.057 |
| 11: % of inverts in WP diet | 75% | 0-100% | 40% | 0%----------★-------(75%)----100% |
| 12: Sediment (RM 0-6); both chemicals | | | max | ----------(N)----------★ |
| 12: Fluff (RM 0-6); both chemicals | | | max | ----------(N)----------★ |
| 12: Water (RM 0-6); both chemicals | | | max | ----------(N)----------★ |
| 12: Fluff layer (RM 14.7-D); TCDD only | | | max | ----------(N)----------★ |

# Calibration 1: Model performance

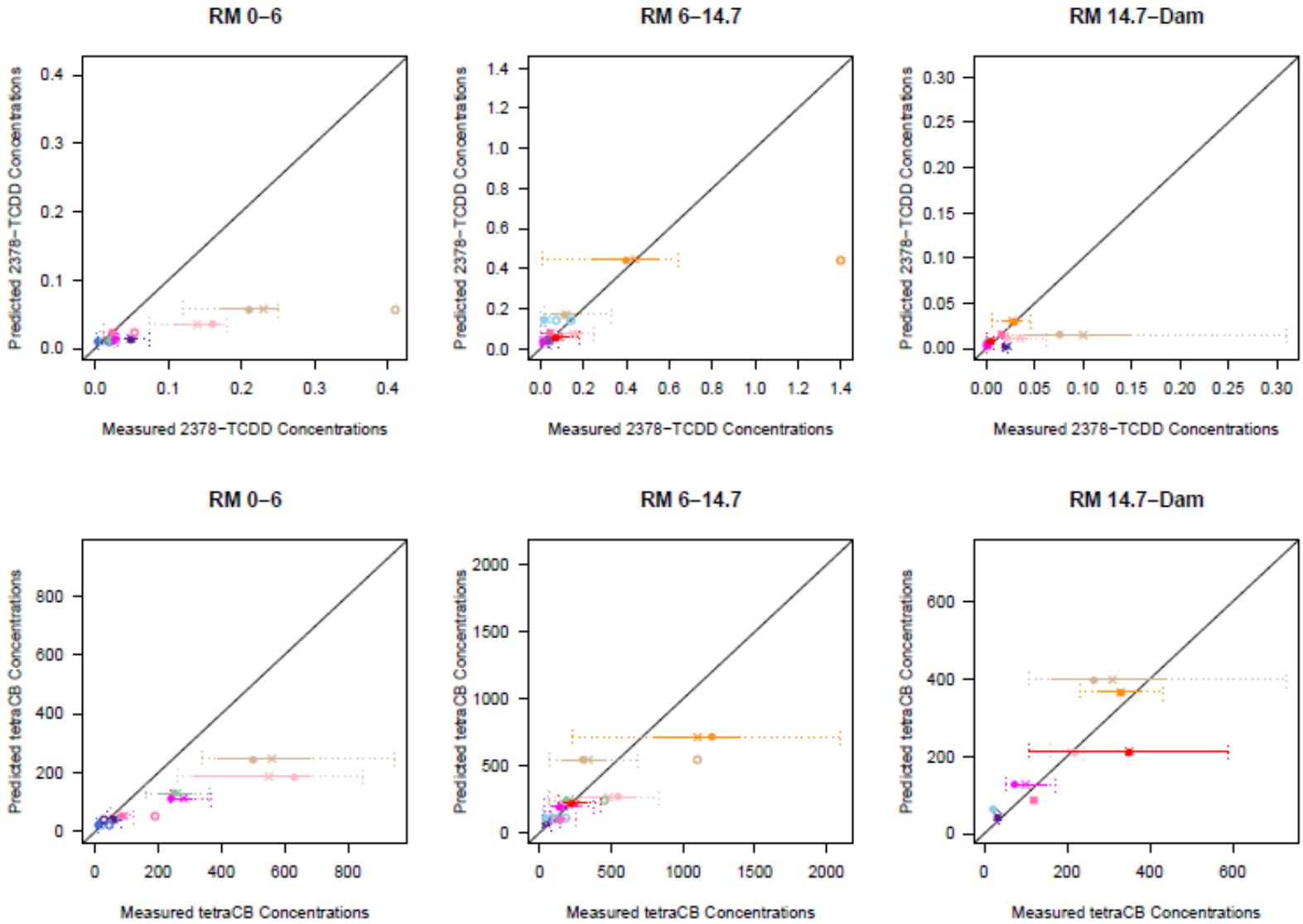
## Uncalibrated Model Results

| | 2378-TCDD | | | TetraCB | | |
|---|---|---|---|---|---|---|
| **Species** | **RM 0-6** | **RM 6-14.7** | **RM 14.7-Dam** | **RM 0-6** | **RM 6-14.7** | **RM 14.7-Dam** |
| Phytoplankton | | | | | | |
| Zooplankton | | | | | | |
| Benthic invert deposit feeder | | 50.6 | | | 6.0 | |
| Benthic invert filter feeder | | | | | | |
| Benthic invert detritivore | | | | | | |
| Benthic invert carnivore/omnivore | 19.2 | | | 3.2 | | |
| Small filter feeding fish | | 2.8 | | | -1.0 | |
| Small forage fish | 4.3 | 17.8 | -2.1 | -1.2 | 1.4 | -1.4 |
| Small American eel | 2.0 | 22.6 | 4.1 | -1.8 | 2.3 | 1.5 |
| Blue crab | 2.1 | 12.9 | -6.5 | 1.1 | 3.5 | 1.7 |
| Carp | | 1.1 | -5.3 | | -1.2 | 1.2 |
| Catfish | -1.8 | 5.5 | -17.6 | -1.6 | 2.8 | 1.4 |
| White perch | -1.0 | 4.8 | -6.0 | -2.2 | 1.1 | -1.2 |
| Large American eel | 3.0 | 8.3 | | -1.4 | 2.1 | |
| Bass | | 7.9 | 1.3 | | 1.9 | -1.5 |
| Average (all) | **2.4** | **9.3** | **6.1** | **1.6** | **1.9** | **1.4** |
| Average (priority) | **8.4** | | | **2.0** | | |

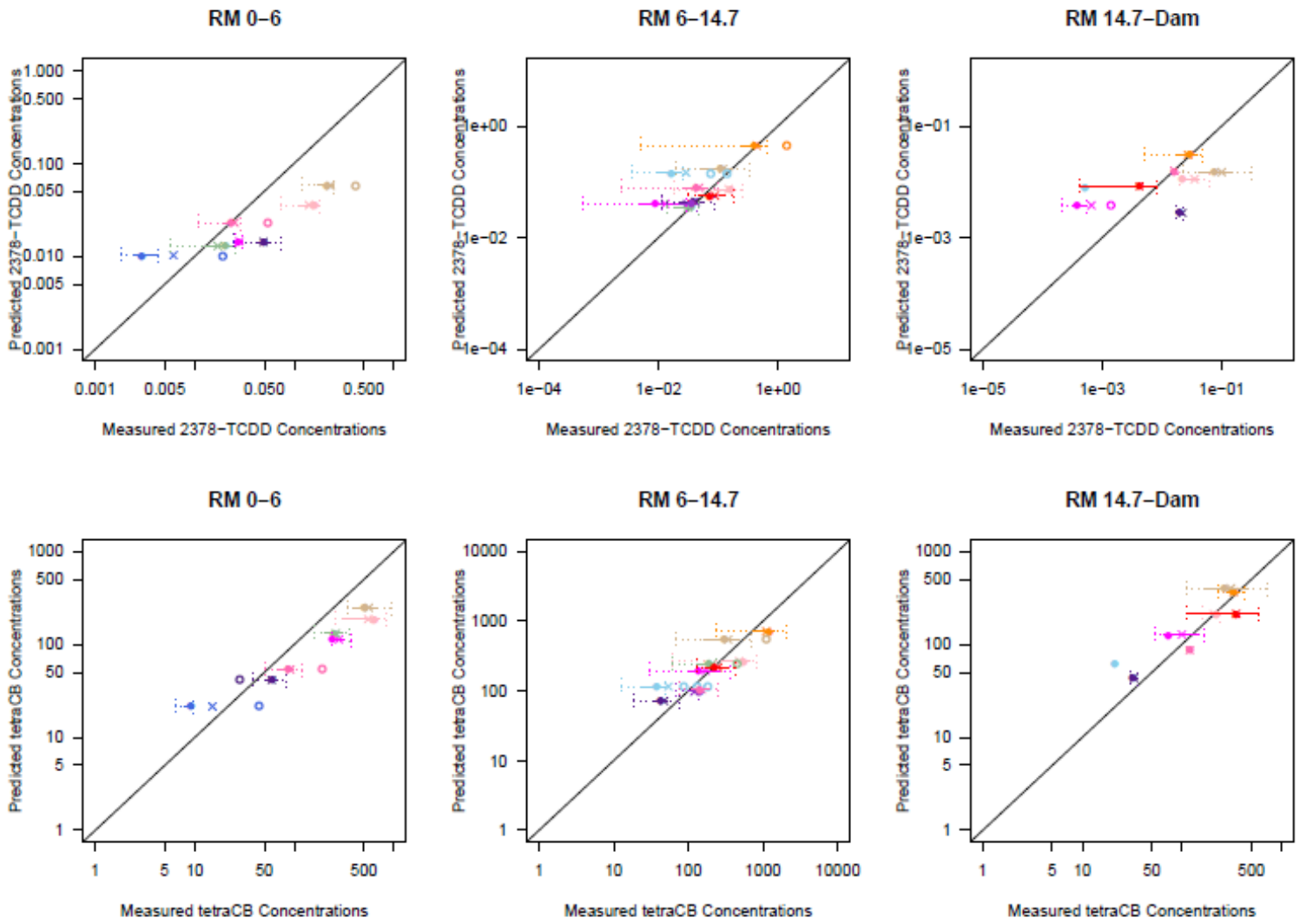
## Calibration 1 Model Results

| | 2378-TCDD | | | TetraCB | | |
|---|---|---|---|---|---|---|
| **Species** | **RM 0-6** | **RM 6-14.7** | **RM 14.7-Dam** | **RM 0-6** | **RM 6-14.7** | **RM 14.7-Dam** |
| Phytoplankton | | | | | | |
| Zooplankton | | | | | | |
| Benthic invert deposit feeder | | 5.0 | | | 2.1 | |
| Benthic invert filter feeder | | | | | | |
| Benthic invert detritivore | | | | | | |
| Benthic invert carnivore/omnivore | 1.7 | | | 1.4 | | |
| Small filter feeding fish | | 1.4 | | | -1.2 | |
| Small forage fish | -1.1 | 1.6 | -1.0 | -1.7 | -1.4 | -1.4 |
| Small American eel | -1.9 | 3.1 | 5.7 | -2.5 | 1.1 | 1.3 |
| Blue crab | -3.4 | 1.0 | -7.9 | -1.4 | 1.5 | 1.3 |
| Carp | | 1.0 | 1.1 | | -1.5 | 1.1 |
| Catfish | -4.0 | 1.4 | -6.7 | -2.3 | 1.6 | 1.3 |
| White perch | -4.0 | -2.0 | -3.1 | -2.9 | -1.8 | -1.0 |
| Large American eel | -1.3 | 1.1 | | -2.0 | 1.2 | |
| Bass | | -1.6 | 2.0 | | -1.2 | -1.6 |
| Average (all) | **2.6** | **1.6** | **3.9** | **2.1** | **1.4** | **1.3** |
| Average (priority) | **2.0** | | | **1.6** | | |

# Calibration 1: Model performance



# Calibration 1: Model performance



# Calibration 2

- Consider alternative solution
- Start with addressing over-prediction in RM 6-14.7 modeling area for uncalibrated model.
  - Minimize key inputs from CFT model
  - Then look at results and proceed from there
- Results in model with higher $K_{OW}$

# Calibration 2: Parameter values

| Parameter | Nom-inal | Range | Select-ed | Selected Value Min----------(Nominal)----------Max |
|---|---|---|---|---|
| Sediment (RM 6-14.7); 2,3,7,8-TCDD | | | min | ★----------✖(  )---------- |
| Fluff (RM 6-14.7); 2,3,7,8-TCDD | | | min | ★----------✖(  )---------- |
| Water (RM 6-14.7) ; 2,3,7,8-TCDD | | | min | ★----------(✖)---------- |
| Weight of DEP (RM 6-14.7) | 36 mg | 0.12-400 mg | 0.12 mg (min) | ★12-✖----(36)----------400 |
| Invert dietary AE of NLOC & NLOM | 0.75 | 0.15-0.96 | 0.4 | 0.15--------★-------(0.75)-------0.96 ✖ |
| % of sed in DEP diet (RM 6-14.7) | 89% | 70-100% | 70% | ★✖%----------(89%)---------100% |
| DO Saturation (RM 6-14.7) | 85% | 71-97% | 80% | 71%--------★--(85%) ----------97% ✖ |
| $K_{OW}$ for 2,3,7,8-TCDD | 6.38 | 5.38 - 8.93 | 5.9 | 5.3✖--★--(6.38)----------8.93 |

# continued…

| Parameter | Nom-inal | Range | Select-ed | Selected Value Min----------(Nominal)----------Max |
|---|---|---|---|---|
| $K_M$ for inverts (2,3,7,8-TCDD) | 0.013 | 0.007-0.024 | 0.02 | 0.007-------(0.013)-------★---0.02✖ |
| $K_M$ for eel (2,3,7,8-TCDD) | 0.04 | 0.0016-0.082 | 0.08 | 0.0016----------(0.04)----✖---0.082★ |
| Fluff layer (RM 14.7-Dam); TCDD only | | | max | ----------(N)----------★✖ |
| $K_{OW}$ for TetraCB | 5.85 | 5.38 - 6.65 | 5.85 | 5.38-------✖--(5.85★)----------6.65 |
| Sediment (RM 0-6); both chemicals | | | max | ----------(N)----------★✖ |
| Fluff (RM 0-6); both chemicals | | | max | ----------(N)----------★✖ |
| Water (RM 0-6); both chemicals | | | max | ----------(N)----------★✖ |

# Calibration 2: Model performance

## Uncalibrated Model Results

| | 2378-TCDD | | | TetraCB | | |
|---|---|---|---|---|---|---|
| **Species** | **RM 0-6** | **RM 6-14.7** | **RM 14.7-Dam** | **RM 0-6** | **RM 6-14.7** | **RM 14.7-Dam** |
| Phytoplankton | | | | | | |
| Zooplankton | | | | | | |
| Benthic invert deposit feeder | | 50.6 | | | 6.0 | |
| Benthic invert filter feeder | | | | | | |
| Benthic invert detritivore | | | | | | |
| Benthic invert carnivore/omnivore | 19.2 | | | 3.2 | | |
| Small filter feeding fish | | 2.8 | | | -1.0 | |
| Small forage fish | 4.3 | 17.8 | -2.1 | -1.2 | 1.4 | -1.4 |
| Small American eel | 2.0 | 22.6 | 4.1 | -1.8 | 2.3 | 1.5 |
| Blue crab | 2.1 | 12.9 | -6.5 | 1.1 | 3.5 | 1.7 |
| Carp | | 1.1 | -5.3 | | -1.2 | 1.2 |
| Catfish | -1.8 | 5.5 | -17.6 | -1.6 | 2.8 | 1.4 |
| White perch | -1.0 | 4.8 | -6.0 | -2.2 | 1.1 | -1.2 |
| Large American eel | 3.0 | 8.3 | | -1.4 | 2.1 | |
| Bass | | 7.9 | 1.3 | | 1.9 | -1.5 |
| Average (all) | **2.4** | **9.3** | **6.1** | **1.6** | **1.9** | **1.4** |
| Average (priority) | **8.4** | | | **2.0** | | |

## Calibration 2 Model Results

| | 2378-TCDD | | | TetraCB | | |
|---|---|---|---|---|---|---|
| **Species** | **RM 0-6** | **RM 6-14.7** | **RM 14.7-Dam** | **RM 0-6** | **RM 6-14.7** | **RM 14.7-Dam** |
| Phytoplankton | | | | | | |
| Zooplankton | | | | | | |
| Benthic invert deposit feeder | | 6.4 | | | 1.8 | |
| Benthic invert filter feeder | | | | | | |
| Benthic invert detritivore | | | | | | |
| Benthic invert carnivore/omnivore | 6.4 | | | 2.9 | | |
| Small filter feeding fish | | 2.1 | | | -1.1 | |
| Small forage fish | 2.1 | 2.5 | 1.6 | -1.3 | -1.2 | -1.2 |
| Small American eel | -1.5 | 2.8 | 6.0 | -2.0 | 1.3 | 1.5 |
| Blue crab | -1.4 | 1.8 | -4.2 | -1.1 | 1.7 | 1.6 |
| Carp | | -1.7 | -1.3 | | -1.4 | 1.2 |
| Catfish | -2.6 | 1.6 | -5.1 | -1.8 | 1.9 | 1.6 |
| White perch | -2.0 | -1.3 | -2.3 | -2.6 | -1.8 | -1.1 |
| Large American eel | -1.0 | 1.0 | | -1.6 | 1.3 | |
| Bass | | 1.2 | 3.7 | | 1.1 | -1.3 |
| **Average (all)** | **1.8** | **1.8** | **3.5** | **1.7** | **1.4** | **1.3** |
| **Average (priority)** | **1.7** | | | **1.5** | | |

# Calibration 1 vs. 2 Performance

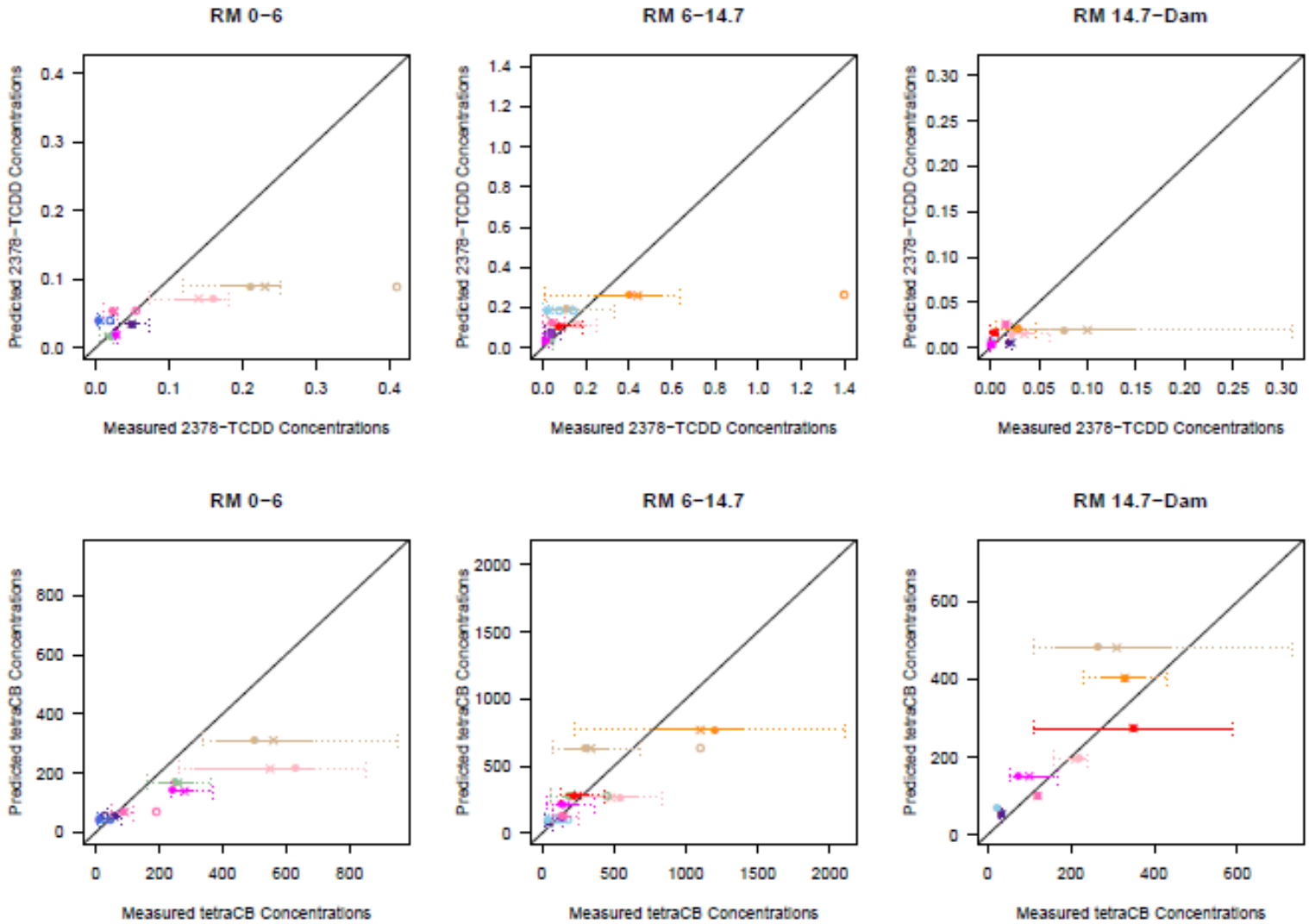
## Calibration 1 Model Results

| | 2378-TCDD | | | TetraCB | | |
|---|---|---|---|---|---|---|
| **Species** | **RM 0-6** | **RM 6-14.7** | **RM 14.7-Dam** | **RM 0-6** | **RM 6-14.7** | **RM 14.7-Dam** |
| Phytoplankton | | | | | | |
| Zooplankton | | | | | | |
| Benthic invert deposit feeder | | 5.0 | | | 2.1 | |
| Benthic invert filter feeder | | | | | | |
| Benthic invert detritivore | | | | | | |
| Benthic invert carnivore/omnivore | 1.7 | | | 1.4 | | |
| Small filter feeding fish | | 1.4 | | | -1.2 | |
| Small forage fish | -1.1 | 1.6 | -1.0 | -1.7 | -1.4 | -1.4 |
| Small American eel | -1.9 | 3.1 | 5.7 | -2.5 | 1.1 | 1.3 |
| Blue crab | -3.4 | 1.0 | -7.9 | -1.4 | 1.5 | 1.3 |
| Carp | | 1.0 | 1.1 | | -1.5 | 1.1 |
| Catfish | -4.0 | 1.4 | -6.7 | -2.3 | 1.6 | 1.3 |
| White perch | -4.0 | -2.0 | -3.1 | -2.9 | -1.8 | -1.0 |
| Large American eel | -1.3 | 1.1 | | -2.0 | 1.2 | |
| Bass | | -1.6 | 2.0 | | -1.2 | -1.6 |
| Average (all) | **2.6** | **1.6** | **3.9** | **2.1** | **1.4** | **1.3** |
| Average (priority) | **2.0** | | | **1.6** | | |

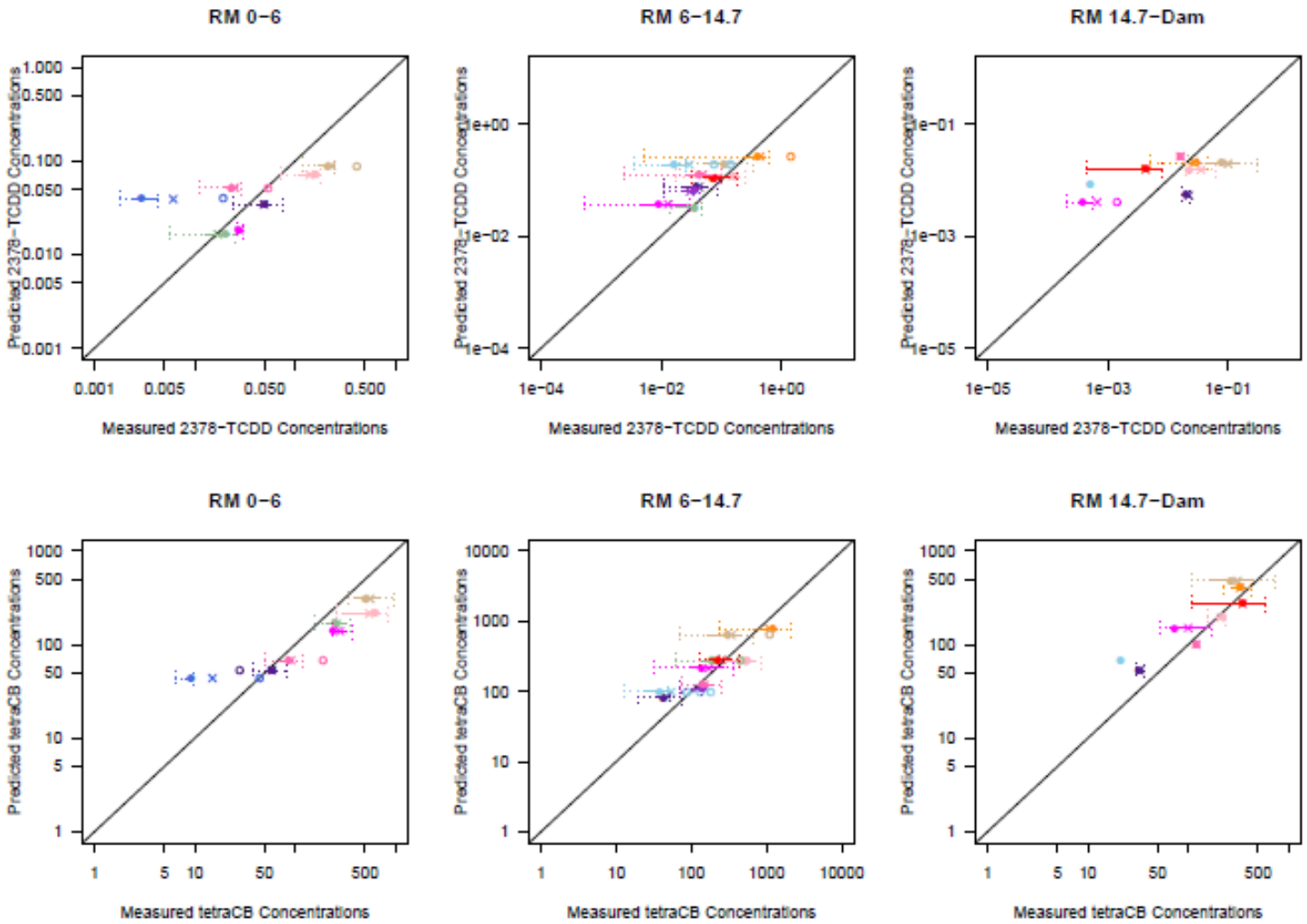
## Calibration 2 Model Results

| | 2378-TCDD | | | TetraCB | | |
|---|---|---|---|---|---|---|
| **Species** | **RM 0-6** | **RM 6-14.7** | **RM 14.7-Dam** | **RM 0-6** | **RM 6-14.7** | **RM 14.7-Dam** |
| Phytoplankton | | | | | | |
| Zooplankton | | | | | | |
| Benthic invert deposit feeder | | 6.4 | | | 1.8 | |
| Benthic invert filter feeder | | | | | | |
| Benthic invert detritivore | | | | | | |
| Benthic invert carnivore/omnivore | 6.4 | | | 2.9 | | |
| Small filter feeding fish | | 2.1 | | | -1.1 | |
| Small forage fish | 2.1 | 2.5 | 1.6 | -1.3 | -1.2 | -1.2 |
| Small American eel | -1.5 | 2.8 | 6.0 | -2.0 | 1.3 | 1.5 |
| Blue crab | -1.4 | 1.8 | -4.2 | -1.1 | 1.7 | 1.6 |
| Carp | | -1.7 | -1.3 | | -1.4 | 1.2 |
| Catfish | -2.6 | 1.6 | -5.1 | -1.8 | 1.9 | 1.6 |
| White perch | -2.0 | -1.3 | -2.3 | -2.6 | -1.8 | -1.1 |
| Large American eel | -1.0 | 1.0 | | -1.6 | 1.3 | |
| Bass | | 1.2 | 3.7 | | 1.1 | -1.3 |
| **Average (all)** | **1.8** | **1.8** | **3.5** | **1.7** | **1.4** | **1.3** |
| **Average (priority)** | **1.7** | | | **1.5** | | |

# Calibration 2: Model performance



# Calibration 2: Model performance

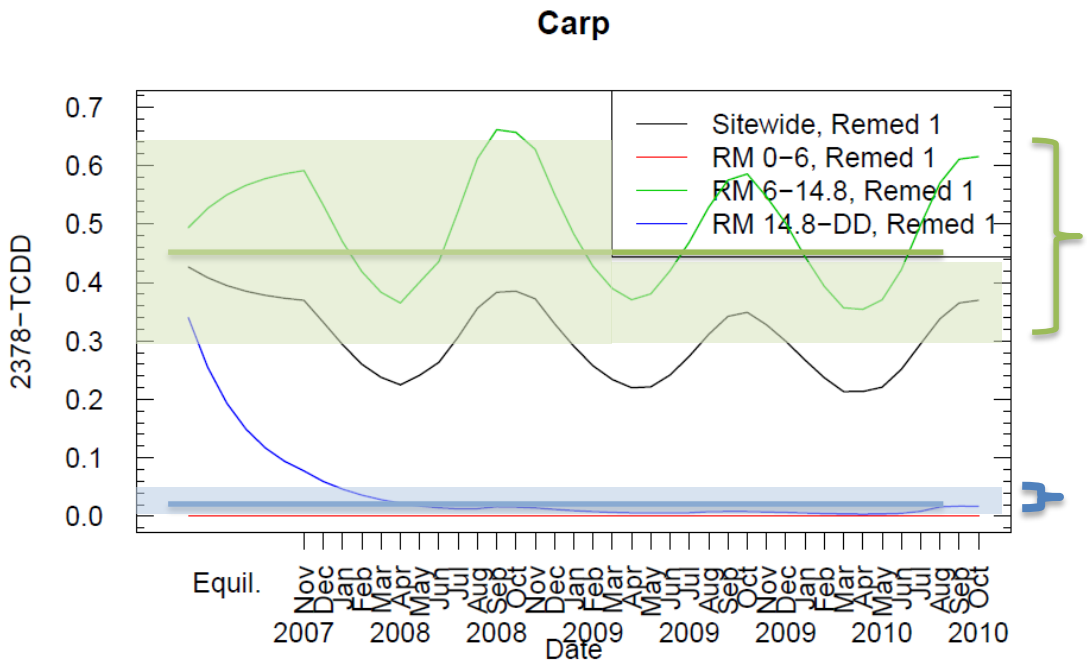


# Model Verification

- 3rd chemical (1,2,3,4,6,7,8-HpCDF):
  - Currently working to finish parameterization
  - Will require some chemical-specific calibration
- Individual samples:
  - Initial results appears promising
  - Will look at data representativeness
- Dynamic model:
  - early runs look promising

# Example of Dynamic Model Verification

- Calibration period (~3 years)
- Comparison of results produced by dynamic model with steady state model and empirical data.
- Example is for Calibration 1 – carp & 2,3,7,8-TCDD.




Empirical data

RM 6-14.7:
0.029 to 0.64, outlier of 1.4 (n=10)

RM 14.7-Dam:
0.0052 to 0.046 (n=2)

# Example of Model Evaluation for Individual Samples

- Preliminary model runs for calibration 1
- Carp & 2,3,7,8-TCDD
- Average SPAF:
  - RM 6-14.7 = 2.6
  - RM 14.7-Dam = 6.2

| Composite ID | SPAF | Over / Under Prediction? |
|---|---|---|
| **Modeling area: RM 6-14.7** | | |
| LPR3-CCWB-Ind005 | 2.3 | - |
| LPR3-CCWB-Ind002 | 1.8 | - |
| LPR4-CCWB-Ind175 | 1.4 | - |
| LPR4-CCWB-Ind186 | 1.3 | + |
| LPR5-CCWB-Ind011 | 1.1 | - |
| LPR5-CCWB-Ind160 | 4.3 | - |
| LPR6-CCWB-Ind028 | 1.9 | + |
| LPR6-CCWB-Ind021 | 3.6 | - |
| LPR7-CCWB-Ind042 | 1.6 | + |
| LPR7-CCWB-Ind069 | 7.0 | - |
| **Modeling area: RM 14.7-Dam** | | |
| LPR8-CCWB-Ind139 | 1.2 | - |
| LPR8-CCWB-Ind147 | 11.2 | - |

# Next Steps

- Continue refining calibration
- Continue work on model verification steps:
  - Dynamic model
  - Model performance for individual samples
  - Model performance for 1,2,3,4,6,7,8-HpCDF
- Work on updating model documentation