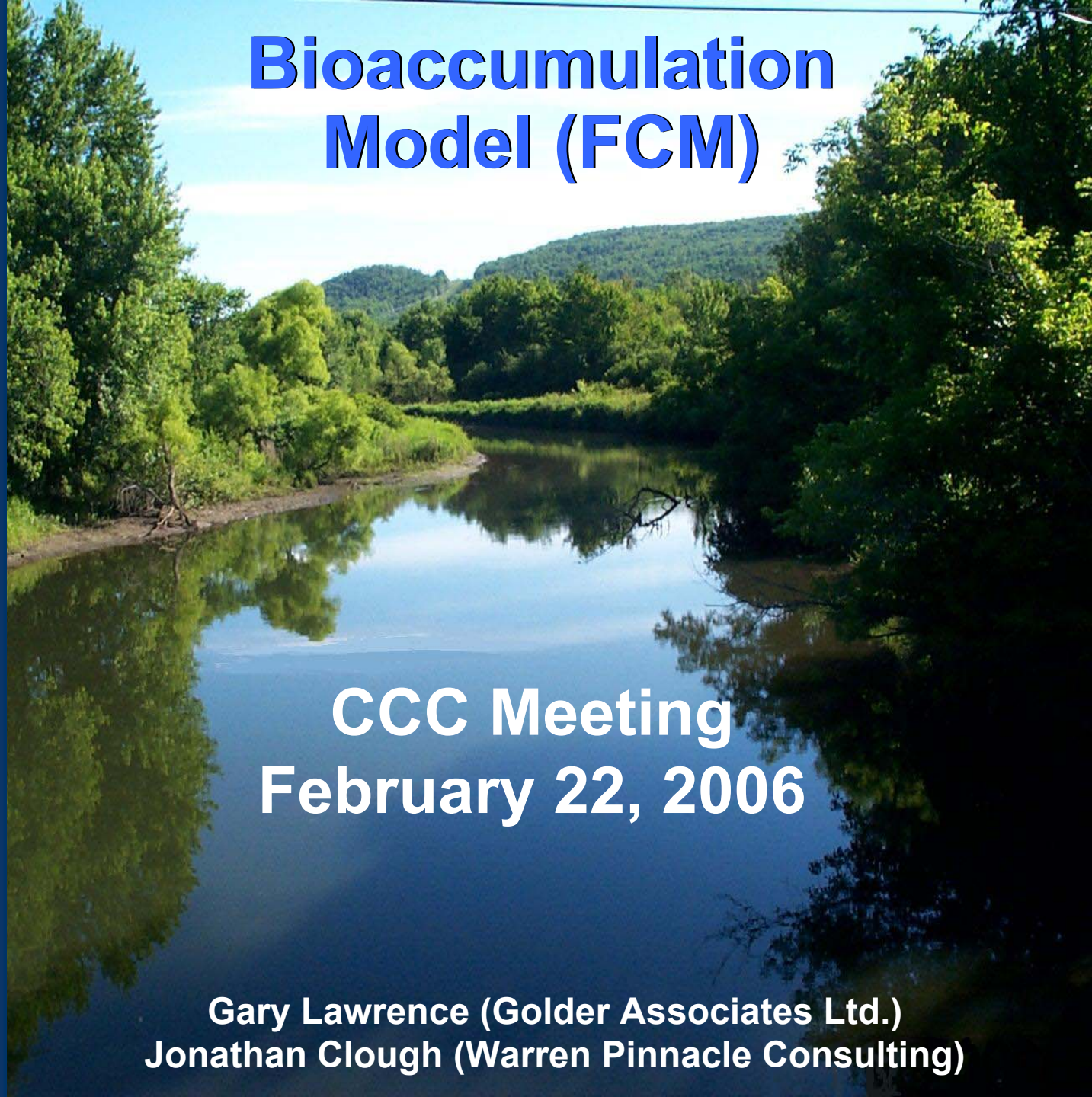
Bioaccumulation Model (FCM)



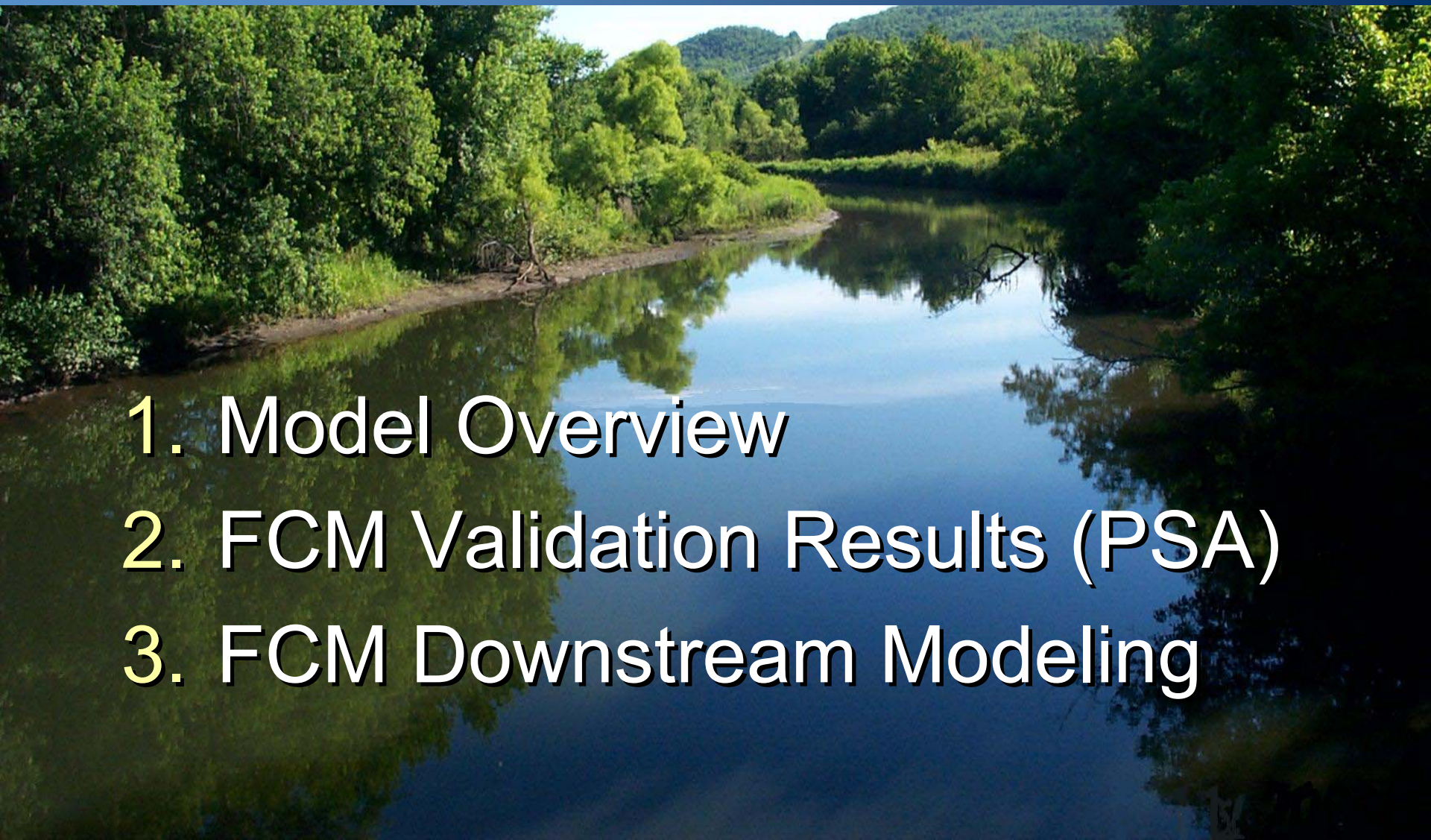
General Electric
Housatonic River
Site, Rest of River

Great Barrington,
MA

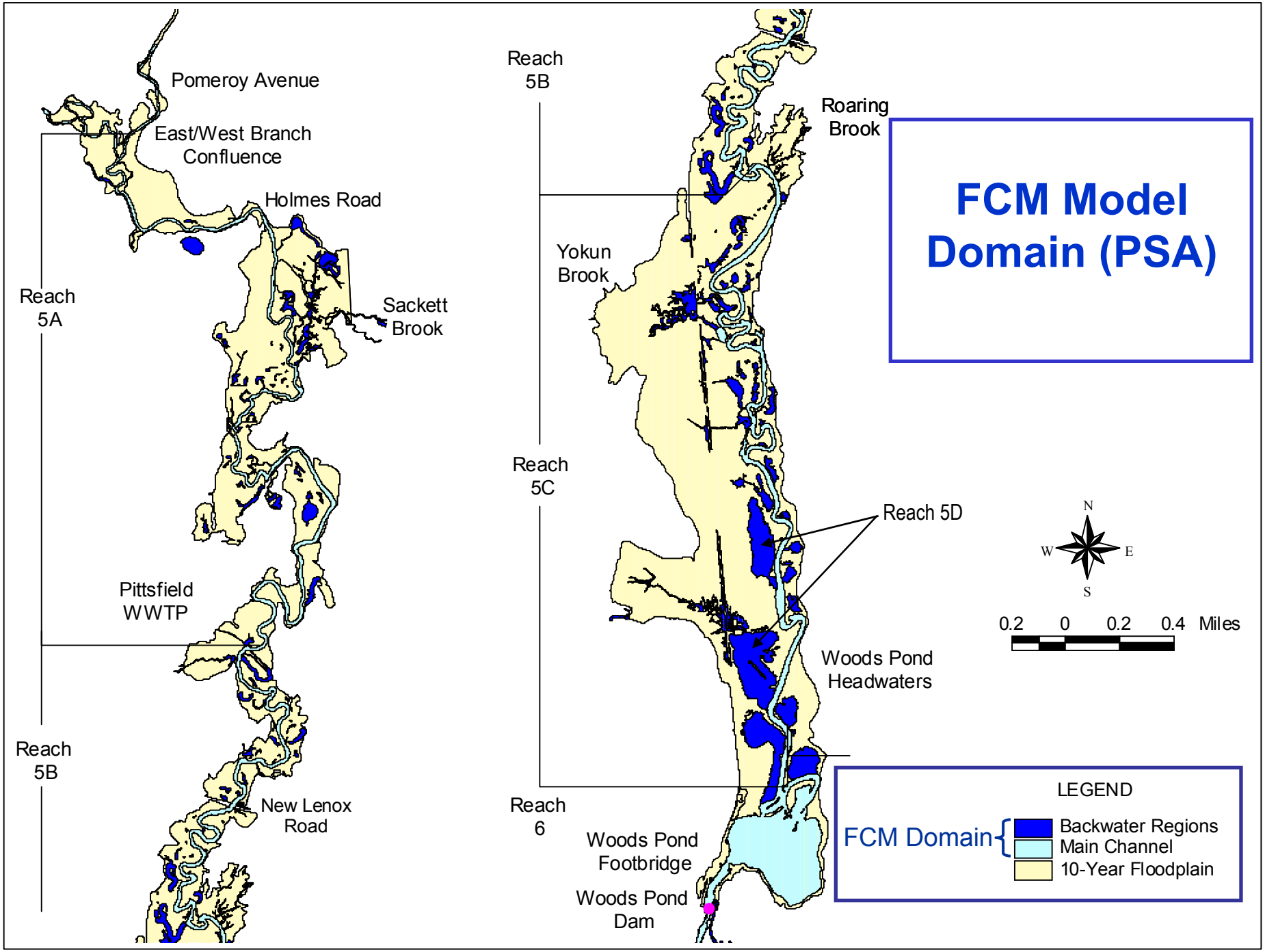
CCC Meeting
February 22, 2006

Gary Lawrence (Golder Associates Ltd.)
Jonathan Clough (Warren Pinnacle Consulting)

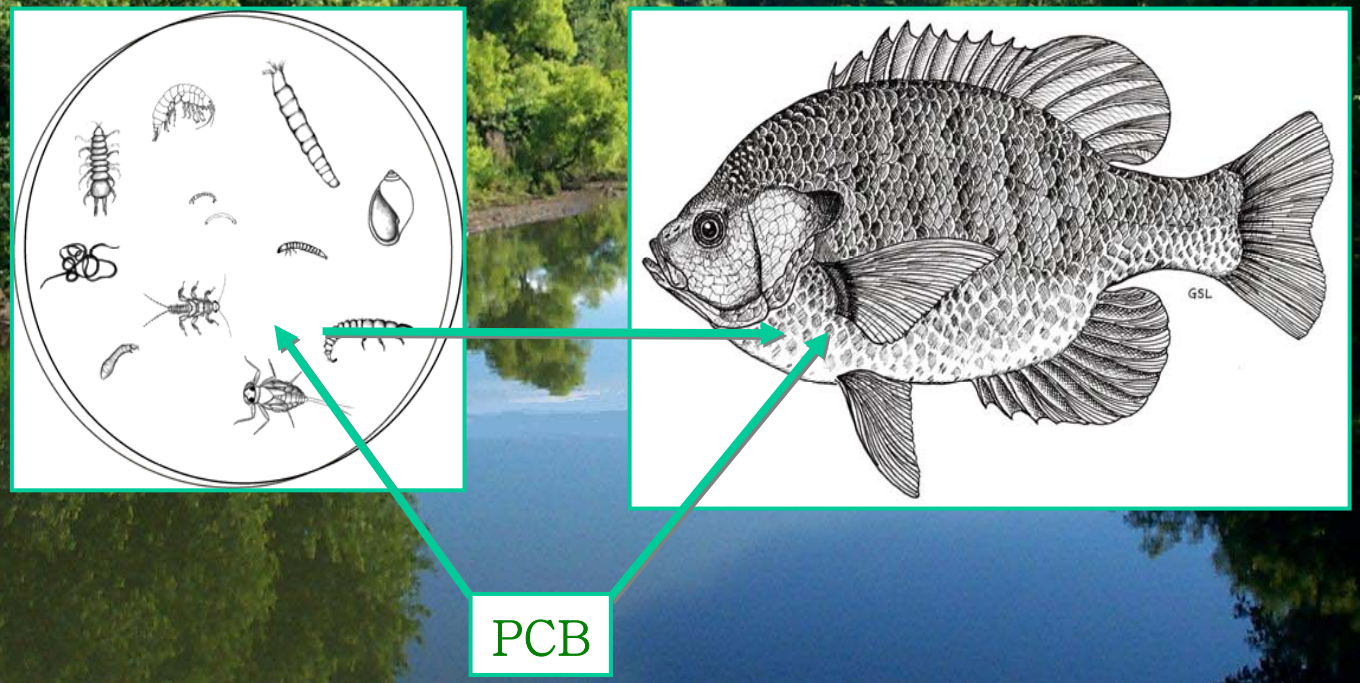
Outline



1. Model Overview
2. FCM Validation Results (PSA)
3. FCM Downstream Modeling

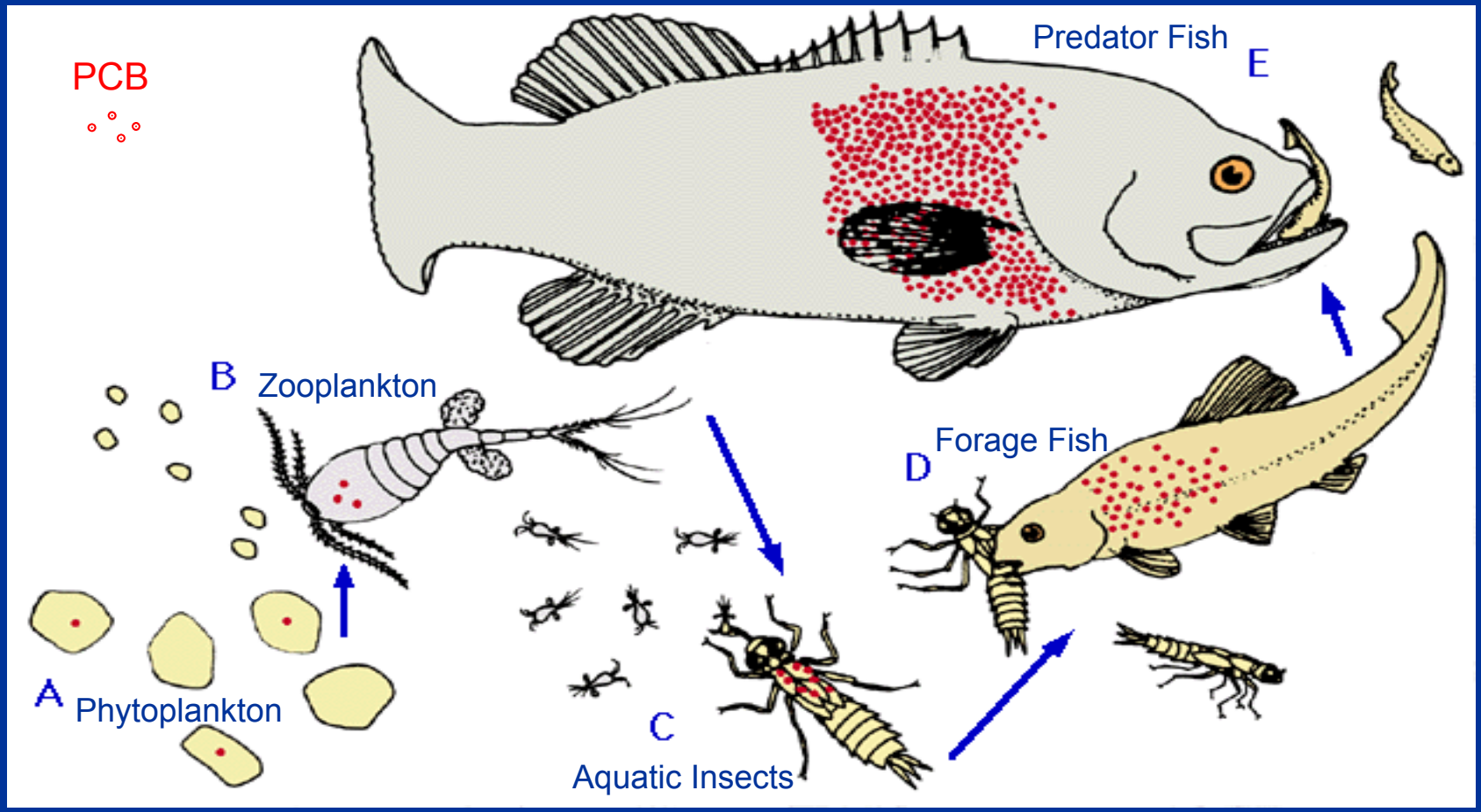

FCM Model Domain (PSA)
Pomeroy Avenue
East/West Branch Confluence
Holmes Road
Sackett Brook
Reach 5A
Pittsfield WWTP
Reach 5B
New Lenox Road
Reach 5B
Roaring Brook
Yokun Brook
Reach 5C
Reach 5D
Woods Pond Headwaters
Reach 6
Woods Pond Footbridge
Woods Pond Dam
N
W
E
S
0.2 0 0.2 0.4 Miles
LEGEND
FCM Domain
Backwater Regions
Main Channel
10-Year Floodplain

Bioaccumulation



- Bioaccumulation = the process by which living things accumulate contaminants from their environment
- Occurs by feeding and by contact with water and solids

Biomagnification



- Biomagnification: concentration in the food chain
  - PCBs both bioaccumulate and biomagnify

Model Linkages

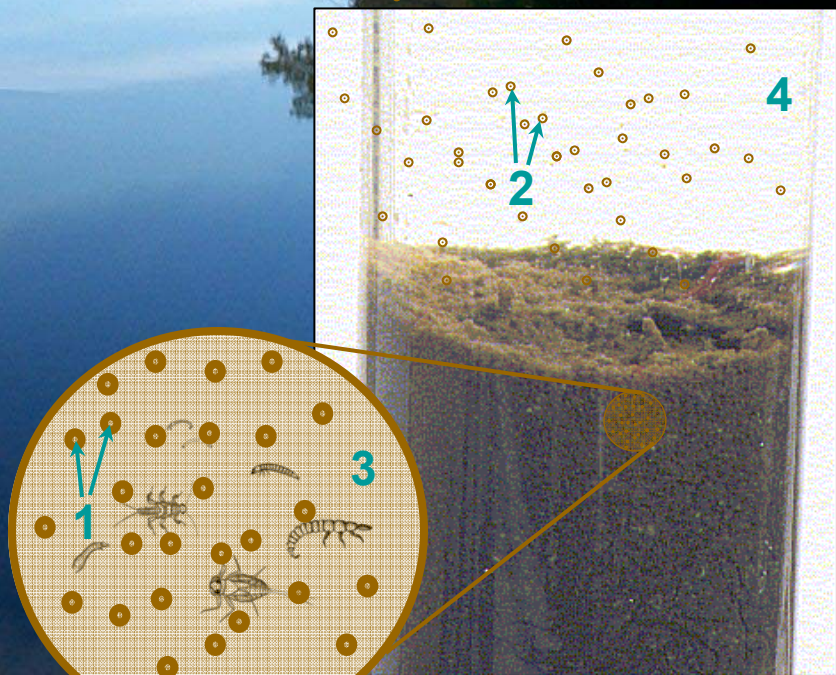
PCB Exposure Inputs (EFDC)

Temperature (HSPF)

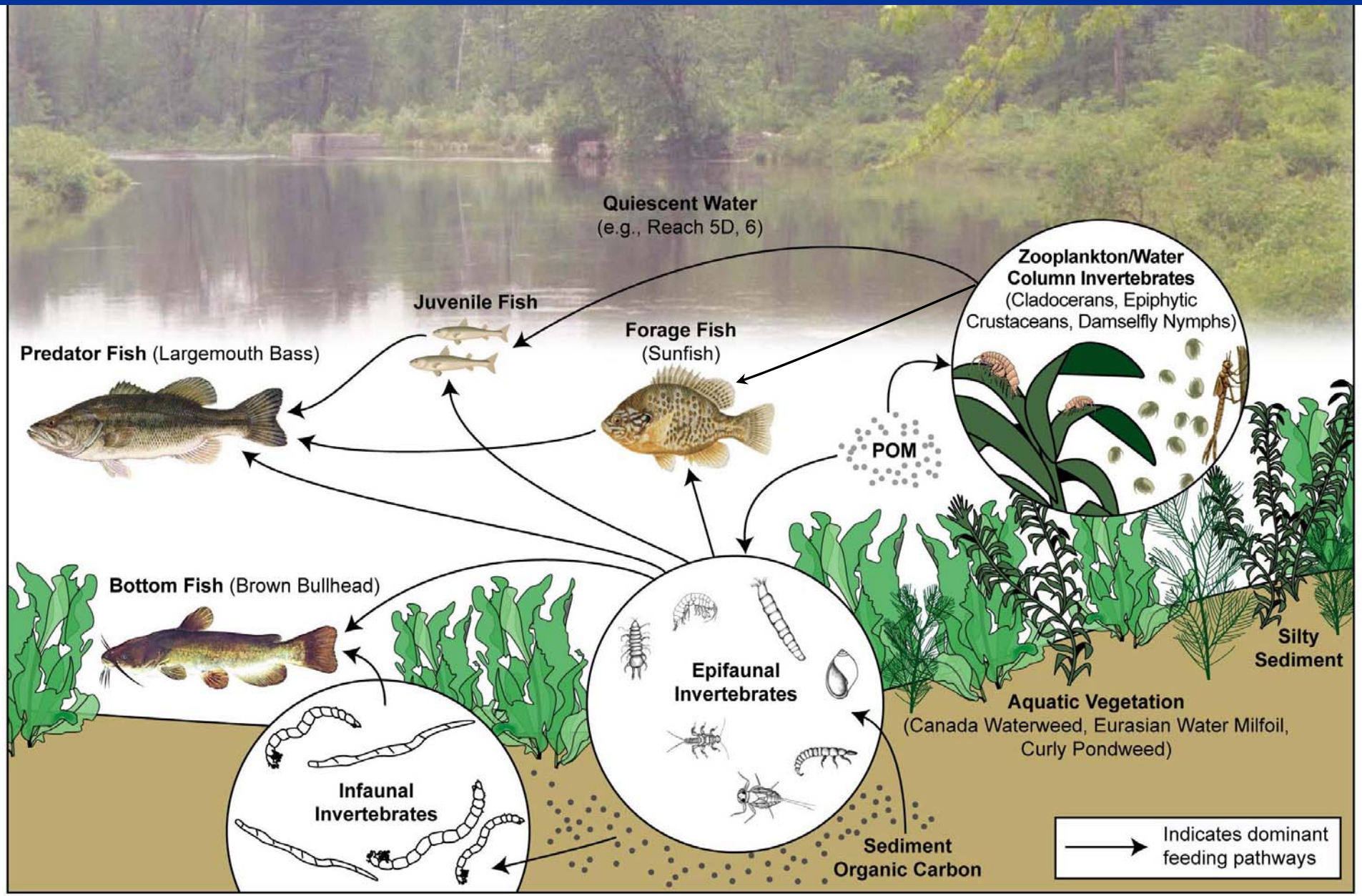
Bioaccumulation Model (FCM)

Exposure Inputs from EFDC:

1. PCB in bed sediment organic carbon
2. PCB in water column organic matter (POM)
3. Dissolved PCB in sediment pore water
4. Dissolved PCB in water column

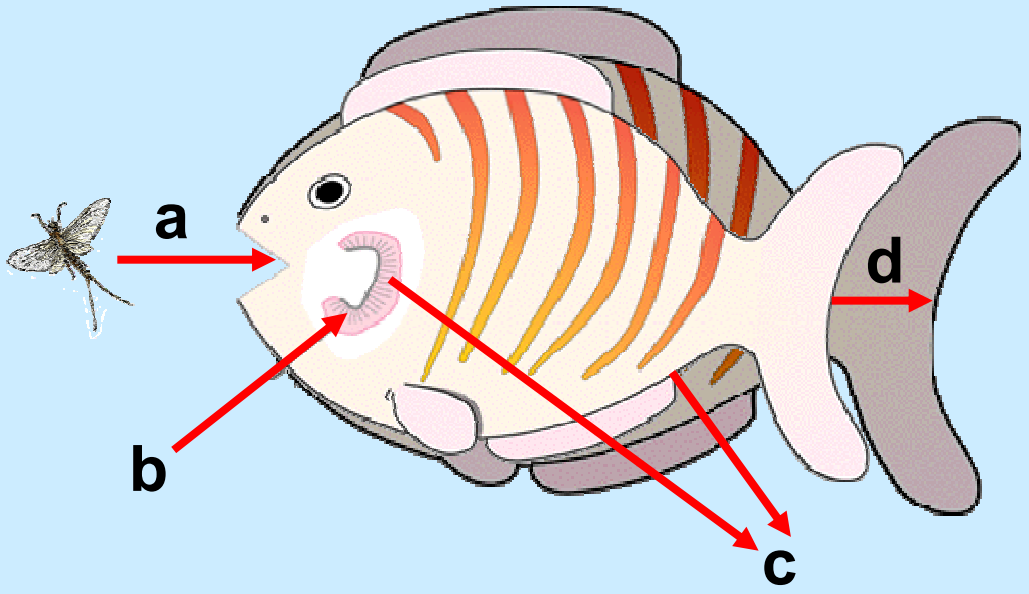


Conceptual Model



Bioaccumulation Processes

$$\frac{dv_i}{dt} = \underbrace{K_{ui}c}_{b} + \underbrace{\alpha_c \sum_{j=1}^{n} C_{ij}v_j}_{a} - \underbrace{(K_i + G_i)v_i}_{c\ \&\ d}$$

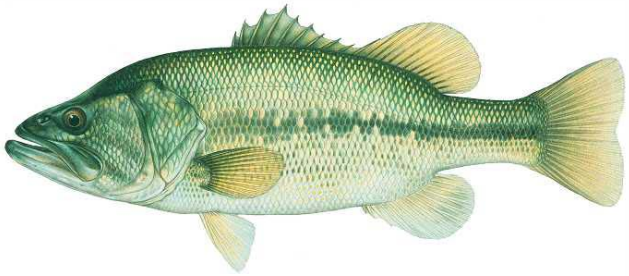


- **PCB Uptake:**
  - a. Dietary uptake
  - b. Respiration
- **PCB Elimination**
  - c. Depuration (loss by gill elimination and fecal egestion)
  - d. Growth dilution


FCM Validation
Results - PSA

FCM Representative Fish

Predators

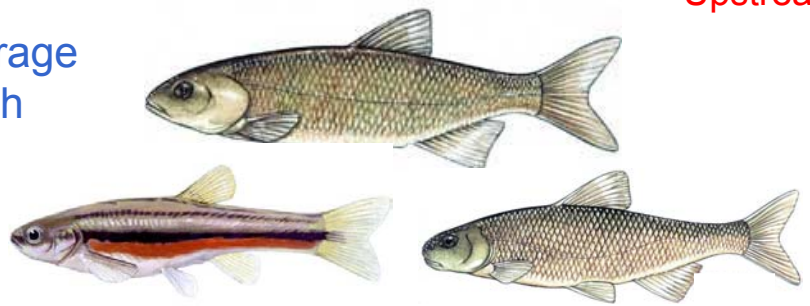


Bass

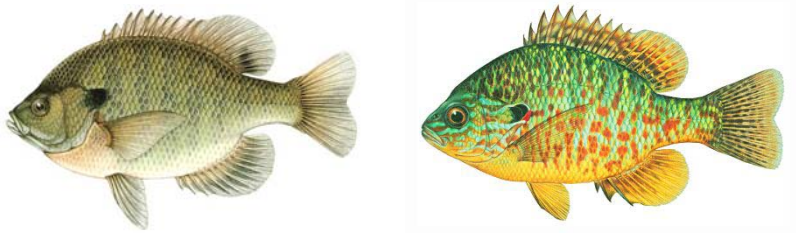
Upstream

Downstream

Forage Fish

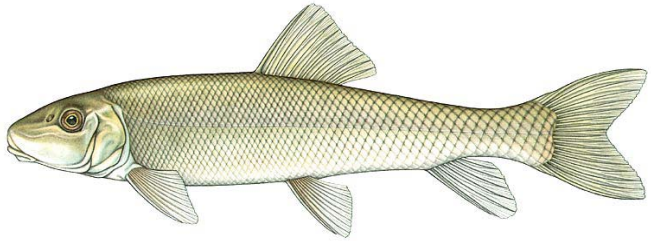


Cyprinid Minnows

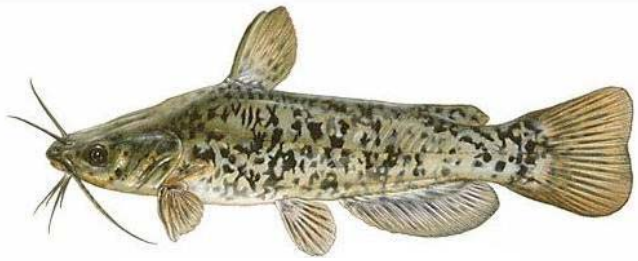


Sunfish

Bottom Fish

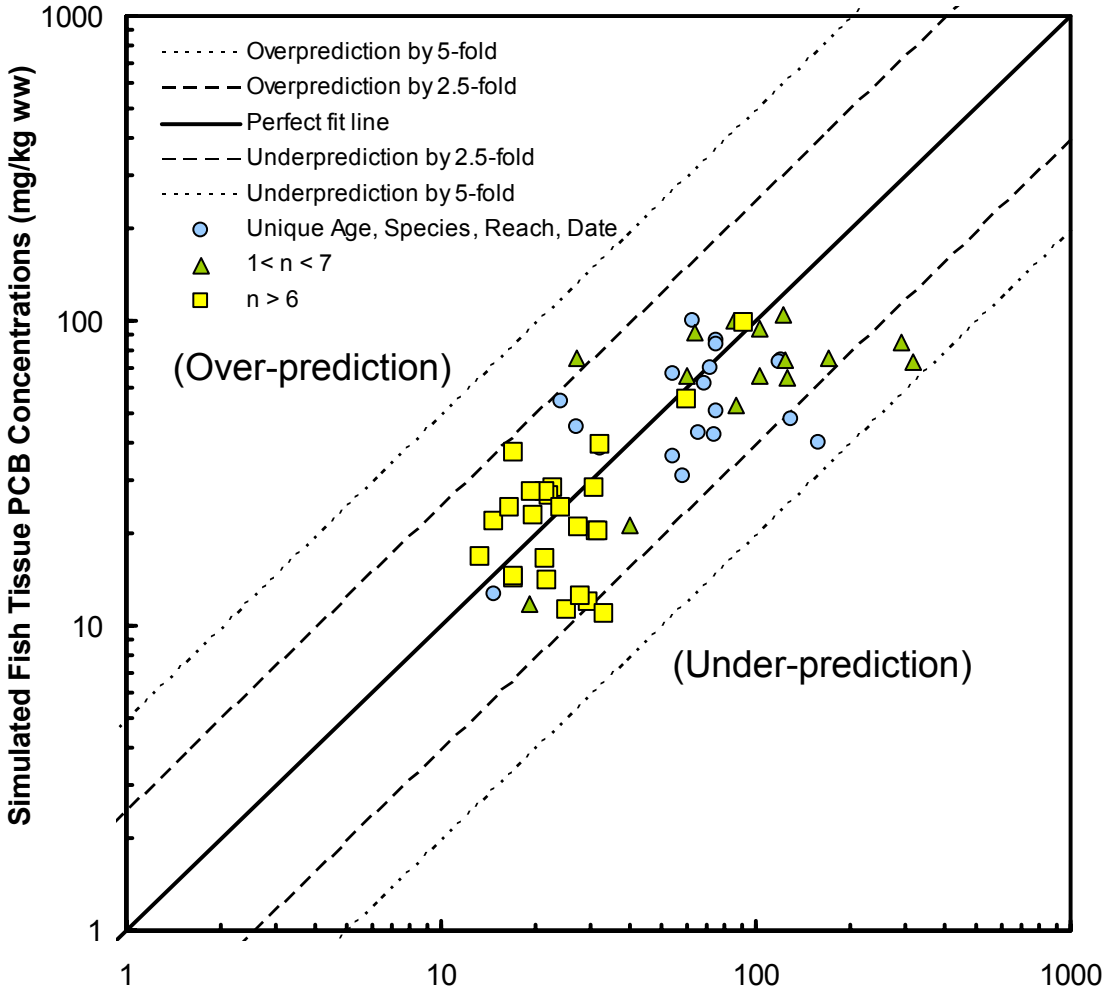


White Sucker



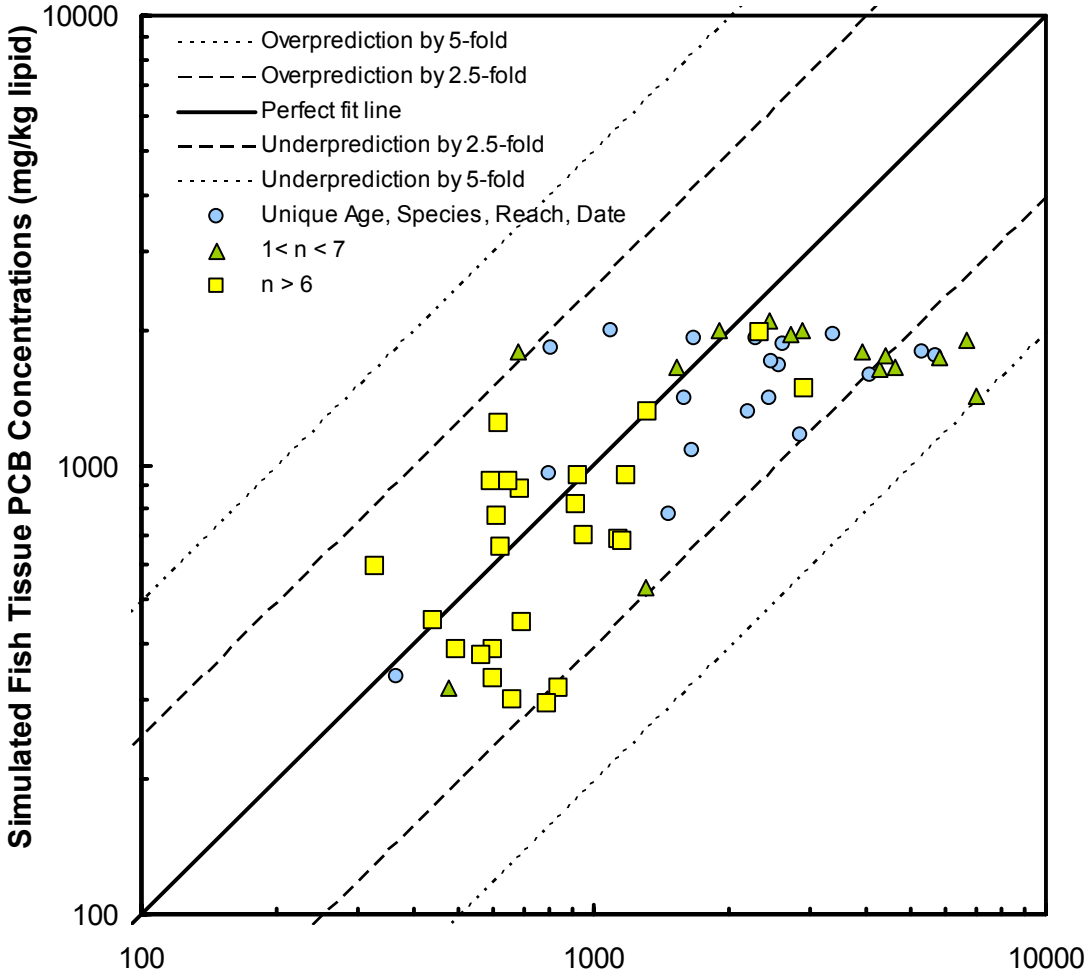
Bullhead

Validation – FCM Representative Species

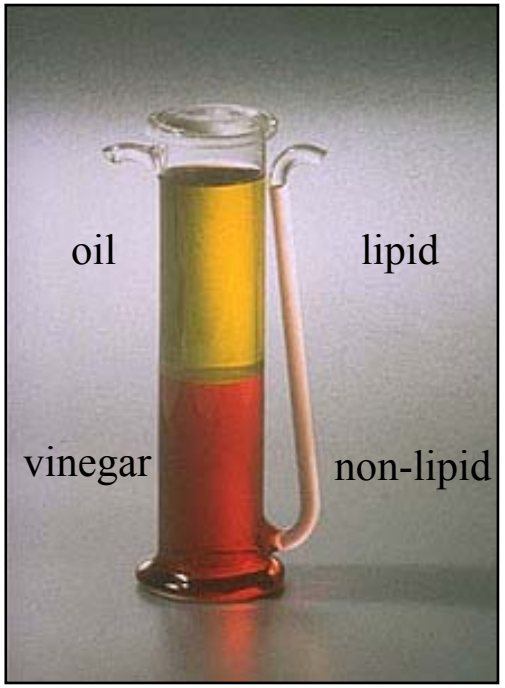


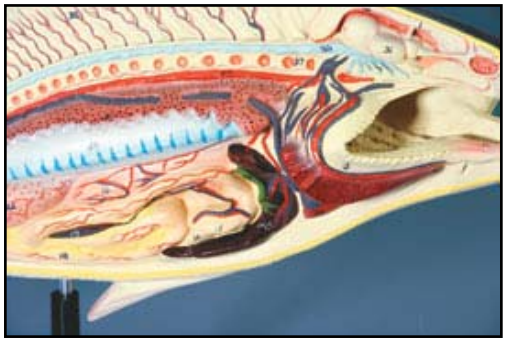
**Validation Data Set, Measured PCB Concentrations (mg/kg ww)
Expressed as Averages for each Combination of
FCM Species, Age, Reach, and Date Collected**

Validation – By Sample Size (Lipid-normalized tPCB)

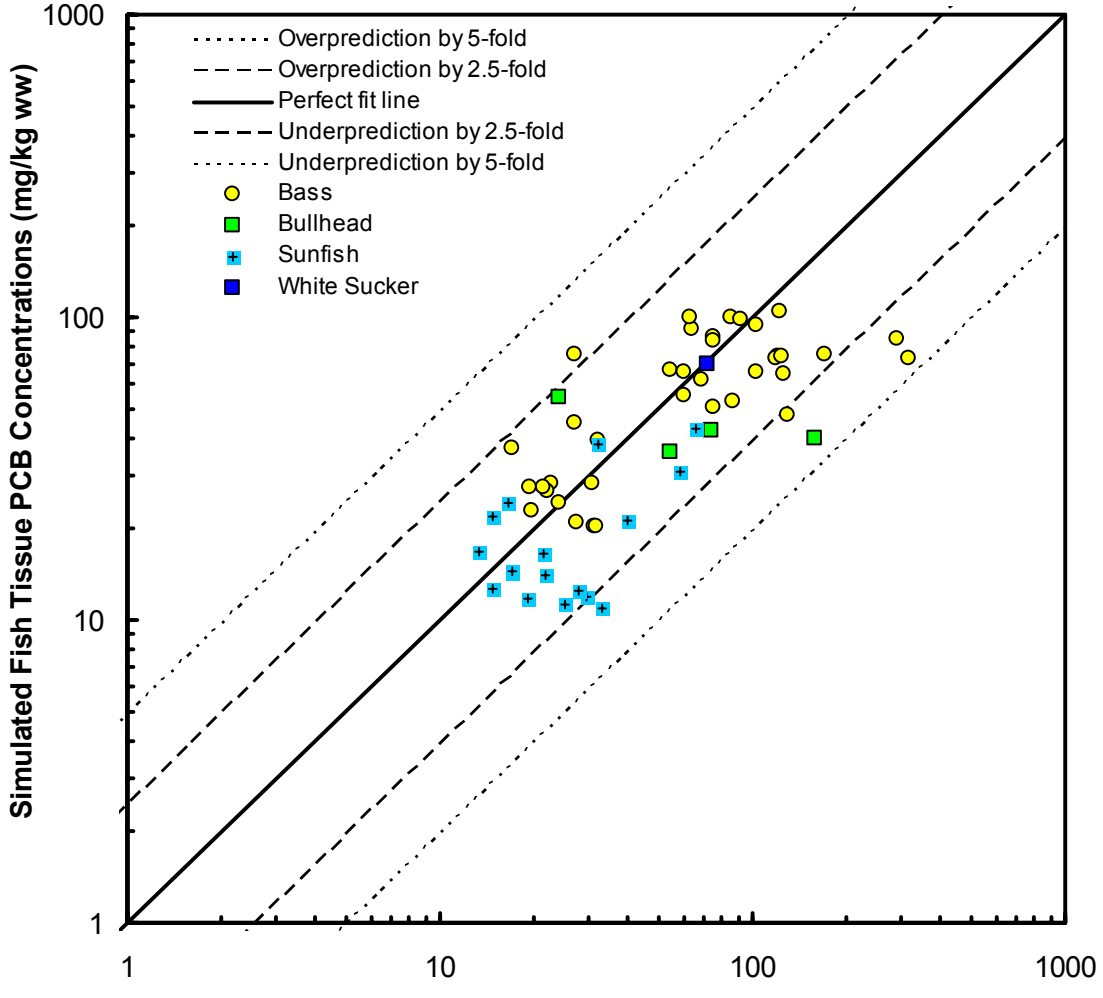


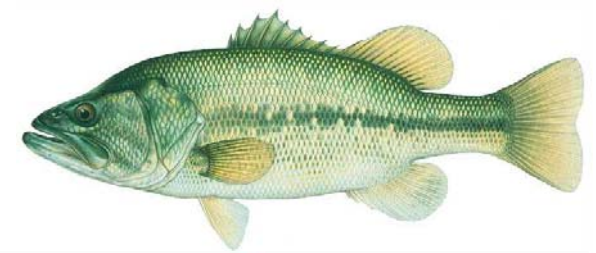
Validation Data Set, Measured PCB Concentrations (mg/kg lipid)
Expressed as Averages for each Combination of
FCM Species, Age, Reach, and Date Collected

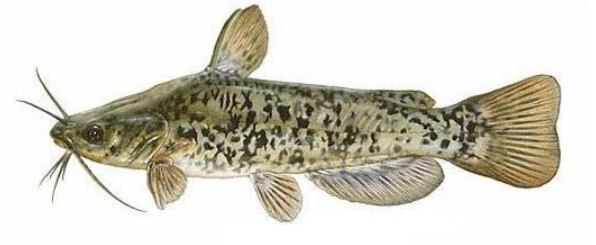


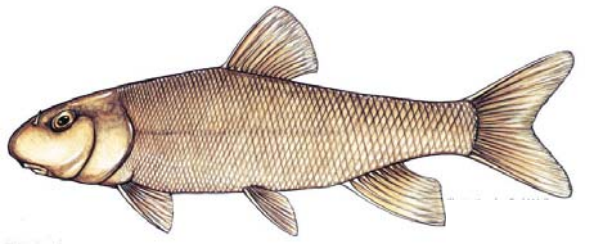


Validation – By Species



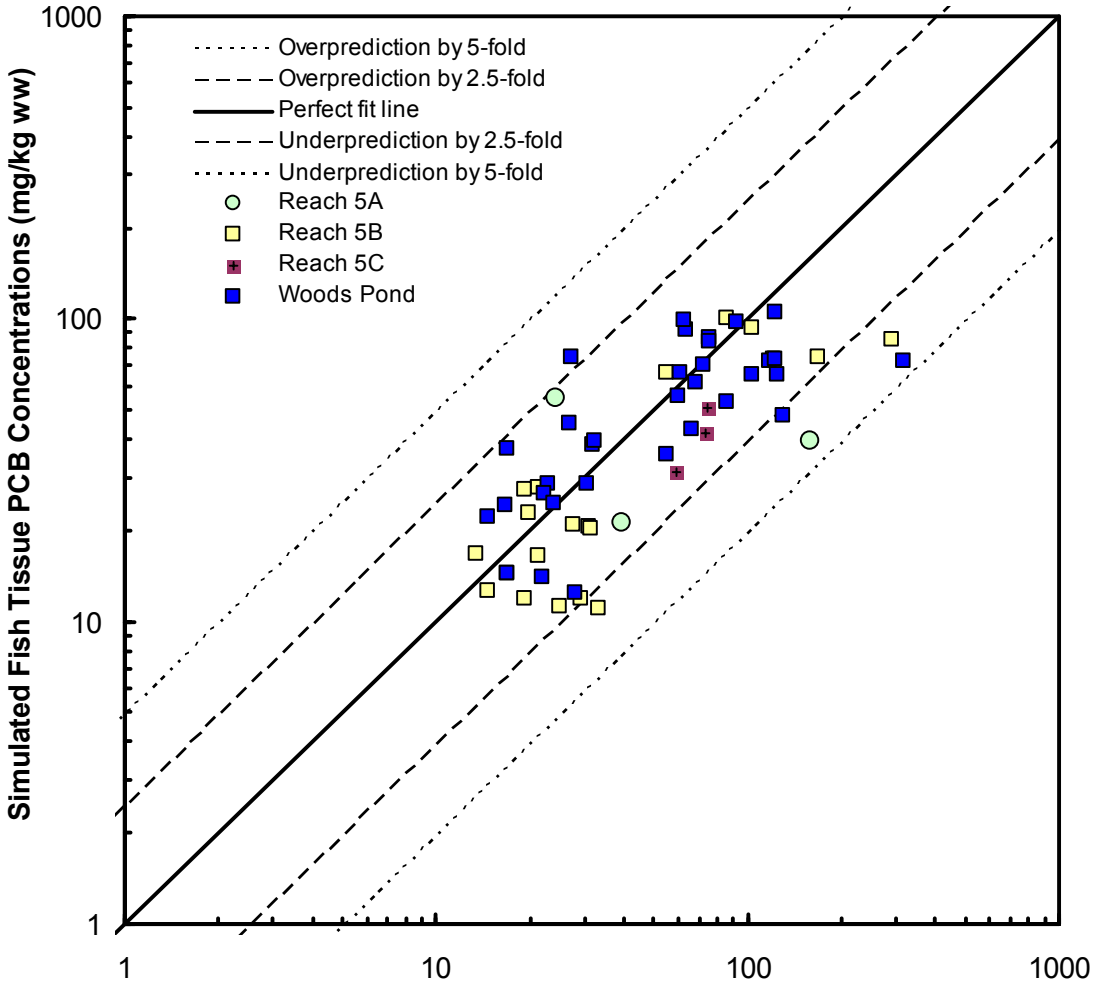






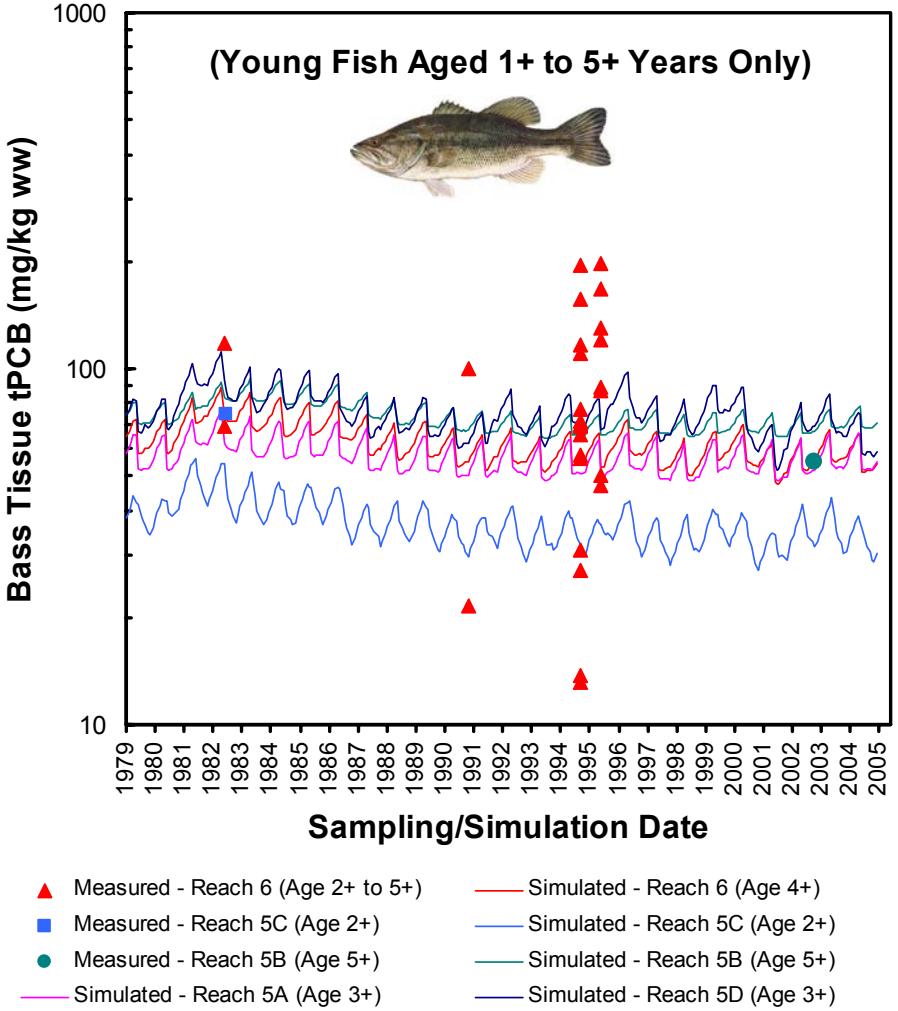
Validation Data Set, Measured PCB Concentrations (mg/kg ww)
Expressed as Averages for each Combination of
FCM Species, Age, Reach, and Date Collected

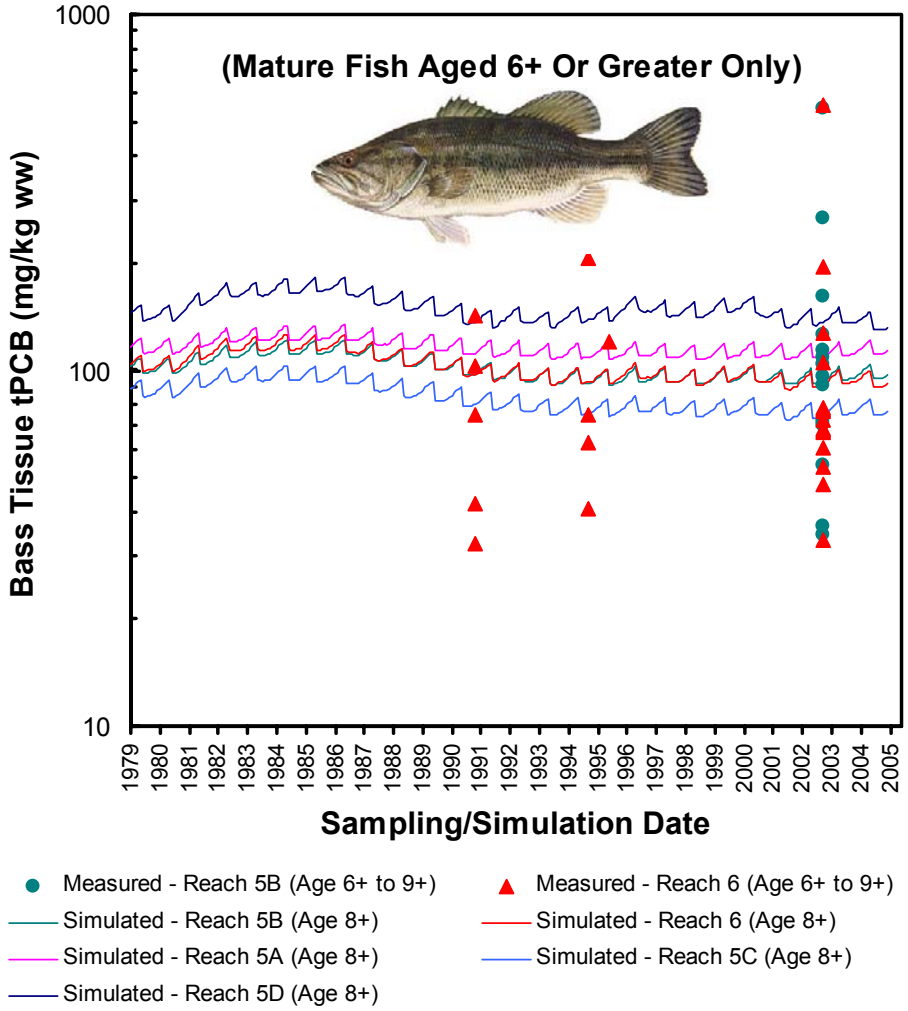
Validation – By River Reach



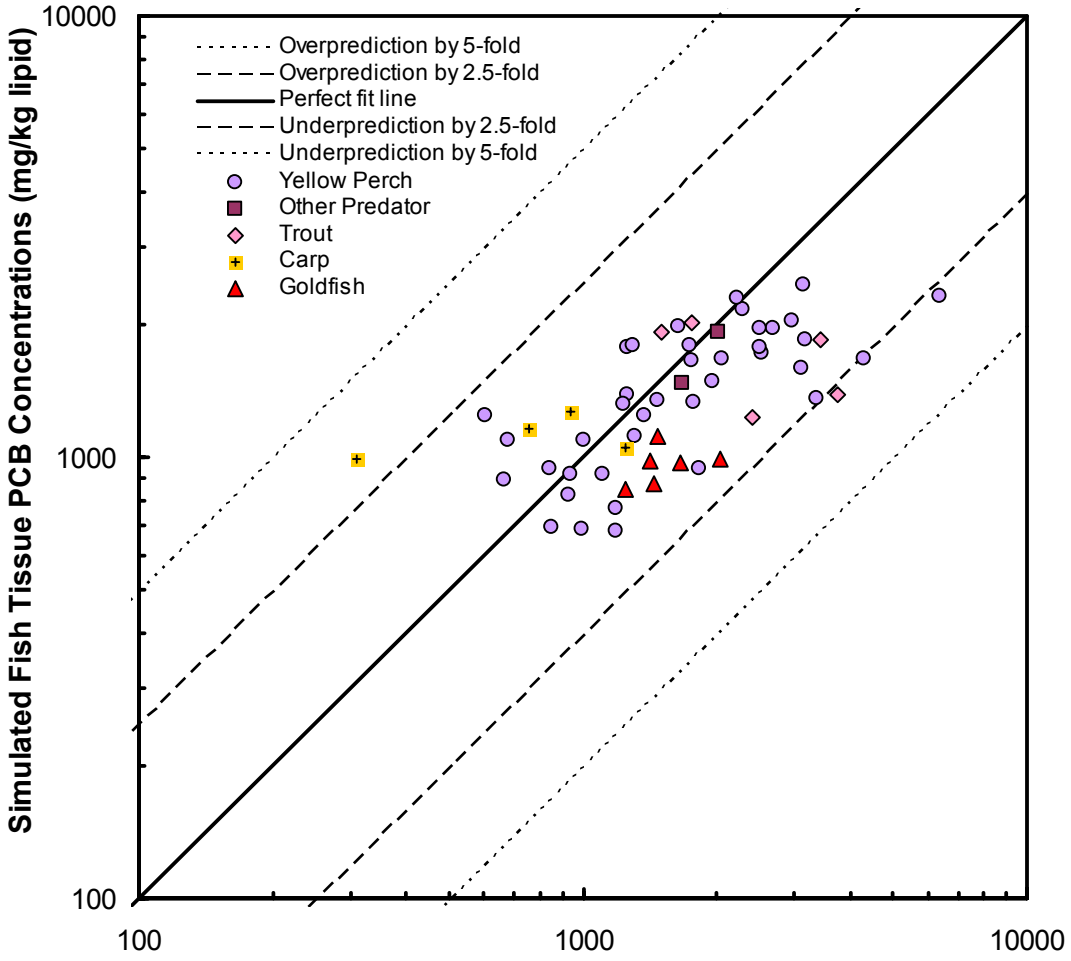
**Validation Data Set, Measured PCB Concentrations (mg/kg ww)
Expressed as Averages for each Combination of
FCM Species, Age, Reach, and Date Collected**

Validation – Adult Largemouth Bass (By Time Period)

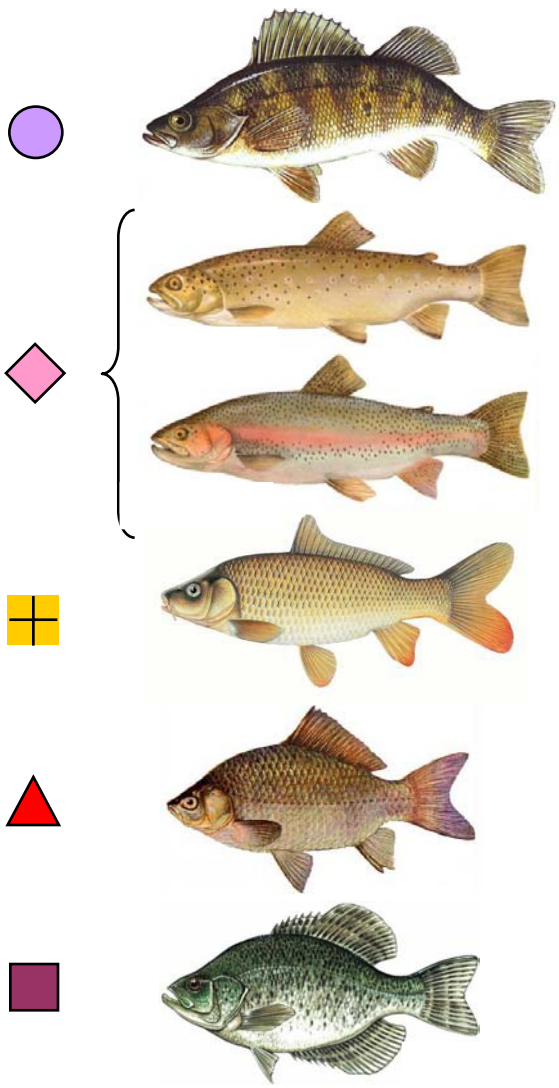




Validation – Interspecies Extrapolation (lipid-normalized tPCB)



Validation Data Set, Measured PCB Concentrations (mg/kg lipid) Expressed as Averages for each Combination of FCM Species, Age, Reach, and Date Collected



Model Performance Measures

Data Grouping	Samples	MAPE	MB*
Type of Measure		Accuracy	Bias
All Samples	484	39%	0.94
FCM Representative Species	247	44%	0.91
All Other Species[1]	237	34%	0.99
Reach 5A	35	35%	0.95
Reach 5B	195	40%	0.86
Reach 5C	8	60%	0.67
Reach 6	246	38%	1.03
Bass	153	39%	1.04
Bullhead	4	73%	0.68
Carp[1,2]	8	57%	1.66
Goldfish[1,2]	42	43%	0.73
Other Predator[1]	3	38%	1.31
Sunfish	89	51%	0.72
Trout[1,2]	6	74%	1.35
White Sucker	1	3%	0.97
Yellow Perch[1]	178	29%	1.02
All YOY Samples	244	36%	0.89
All Adult Fish	240	42%	1.00

MB* > 1.0 = Overprediction

MB* < 1.0 = Underprediction

[1] Species extrapolations required

[2] Lipid-normalized results used

MFD/QAPP validation performance measure:

0.40 < MB* < 2.50

Observed range:

0.68 < MB* < 1.66