

PCBs in Fish Tissues at the Hudson River PCBs Superfund Site: Results of the Baseline, Remedial Action, and Post-Phase 1 Remediation Timeframe

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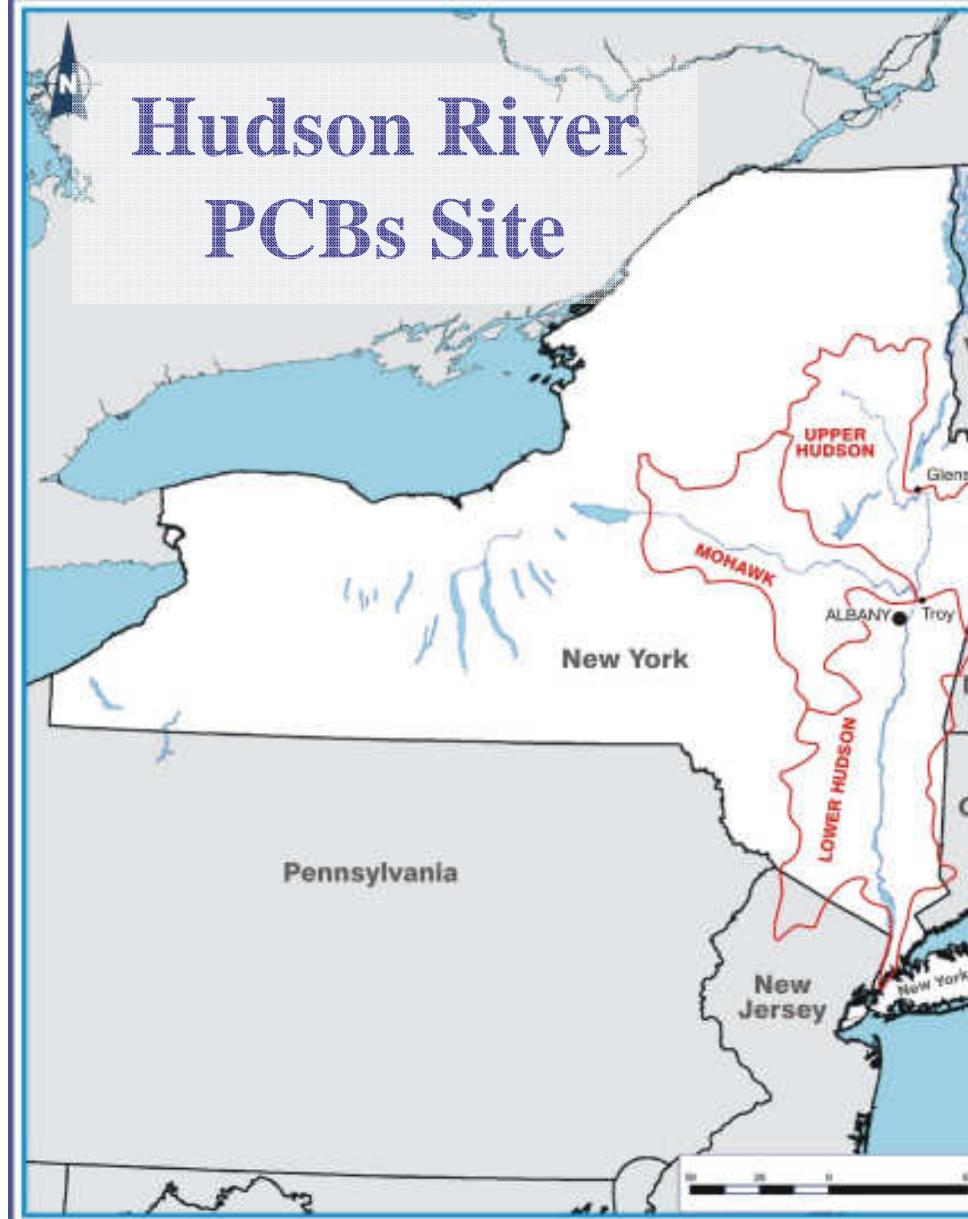


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*SETAC North America 31st Annual Meeting, Portland
OR, 7-11 Nov 2010
Preliminary analyses within*



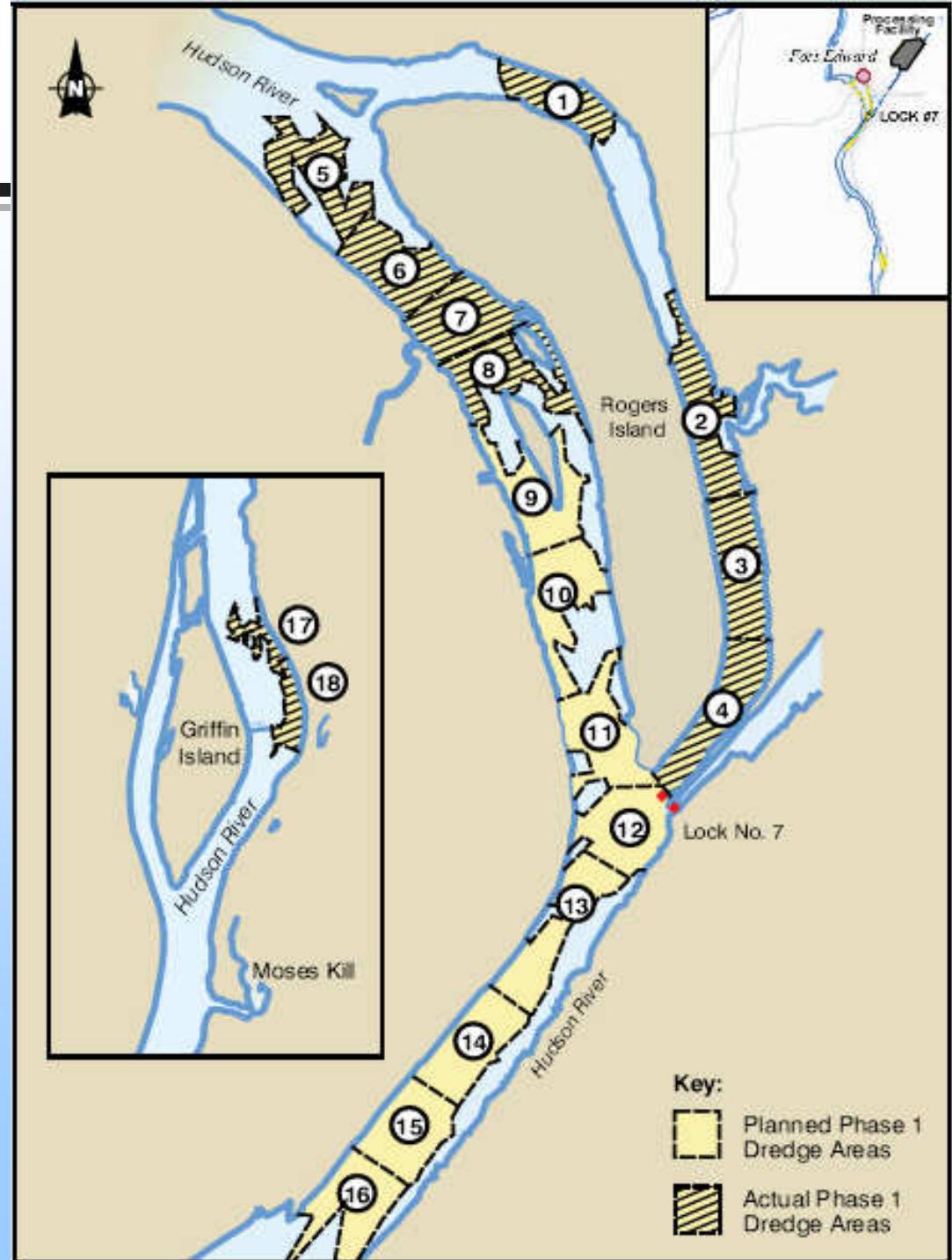
Hudson River PCBs Site





Phase 1 Dredging

- May 15-Oct 27, 2009
- Original target: 265,000 yd³ (cy) sed from 88 acres in Thompson Island Pool
- Actual volume removed 288,000 cy from 48 acres
- Approx. 20,000 kg PCBs
- CUs 1-8, 17 & 18
- CUs 9-16 were not dredged
- Phase 2 will begin with the CUs that could not be completed during Phase 1





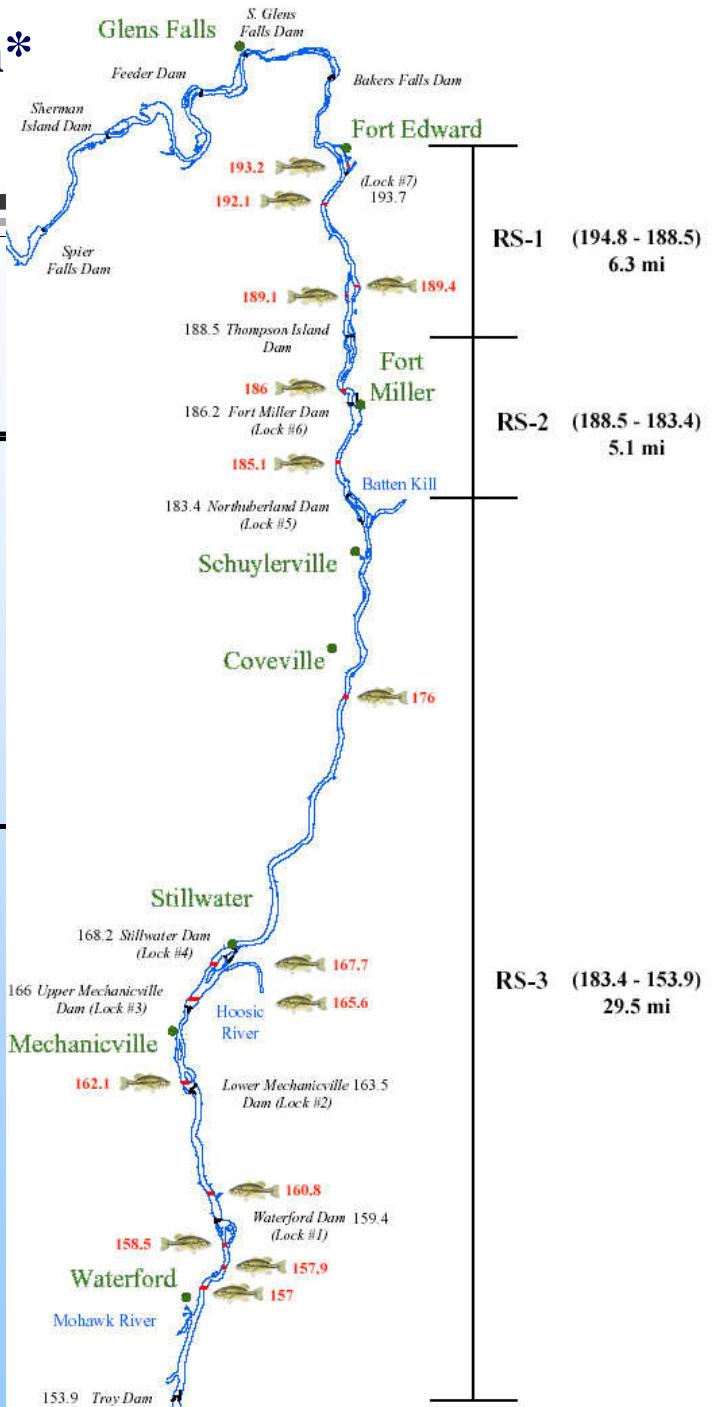
Baseline, Remedial Action & Long Term* Fish Monitoring Plans for UHR

| River Area | No. Spp. Groups | No. Indiv/Spp Groups | Total Samples |
|-------------|-----------------|----------------------|---------------|
| Feeder Dam | 4 | 20 | 80 |
| RS-1 | 4 | 30 | 120 |
| RS-2 | 4 | 25 | 100 |
| RS-3 | 4 | 30 | 120 |
| Albany/Troy | 4 | 20 | <u>80</u> |
| | | | 500 |

Four species/groups sampled ANNUALLY:

- Top-level pred: Blk Bass (LMB, SMB) SF
- Water col feeder: Perch (YP) SF
- Bottom-feeder: Bullhead (YB, BB) SF
- Yearling: Pumpkinseed WH

Annual composites of Forage Fish; n=10 per RS





Analysis Methods: *Baseline Condition*



- **Longitudinal data: Temporal trends were estimated simultaneously for each species; log linear model**

$$\begin{aligned} \text{Log}(C_f) = & \beta_0 + \beta_1 \text{Log}(f_l) + \beta_2 \text{Year} + \beta_3 (\text{Sex}) + \beta_4 (\text{Sex} \times \text{Year}) \\ & + \sum_{k=5}^8 \beta_k (\text{Species}_{k-4}) + \sum_{k=9}^{12} \beta_k (\text{year} \times \text{Species}_{k-4}) + \varepsilon \end{aligned}$$

- **Spatial Variation: Temporal trends tested for each species for differences in decay rates among sampling stations**

$$\begin{aligned} \text{Log}(C_f) = & \beta_0 + \beta_1 \text{Log}(f_l) + \beta_2 \text{Year} + \beta_3 (\text{Sex}) + \beta_4 (\text{Sex} \times \text{Year}) \\ & + \sum_{k=5}^{18} \beta_k (\text{Station}_{k-4}) + \sum_{k=19}^{32} \beta_k (\text{Year} \times \text{Station}_{k-4}) + \varepsilon \end{aligned}$$



Analysis Methods: *Apparent Effects of Dredging*

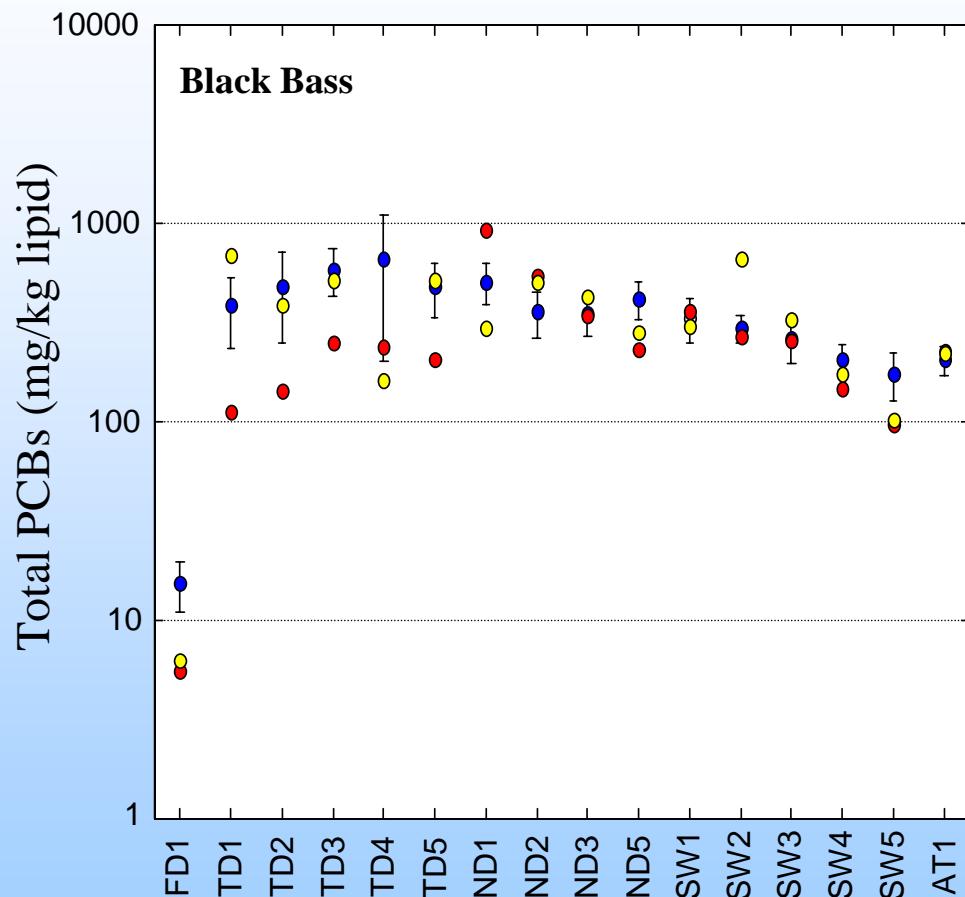


➤ Numerous statistical comparisons:

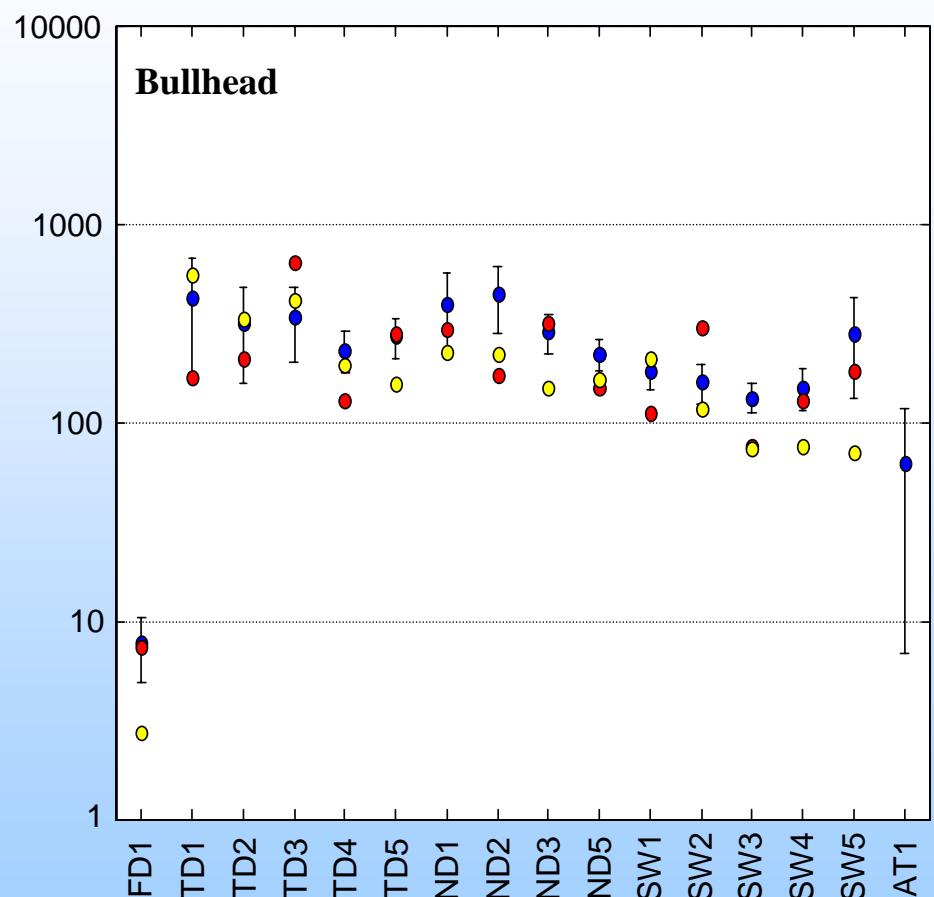
- Forecasted concentrations for 2009 & 2010 compared to observations at stations where longitudinal data are available
- Geometric mean baseline (2004-2008) concentrations compared to geometric mean of 2009 & 2010 concentrations. Spatial considerations:
 - River Section basis
 - At each of 13 stations
- Geometric mean of 2009 vs 2010 concentrations



Hudson River Fish: Baseline vs. 2009 and 2010

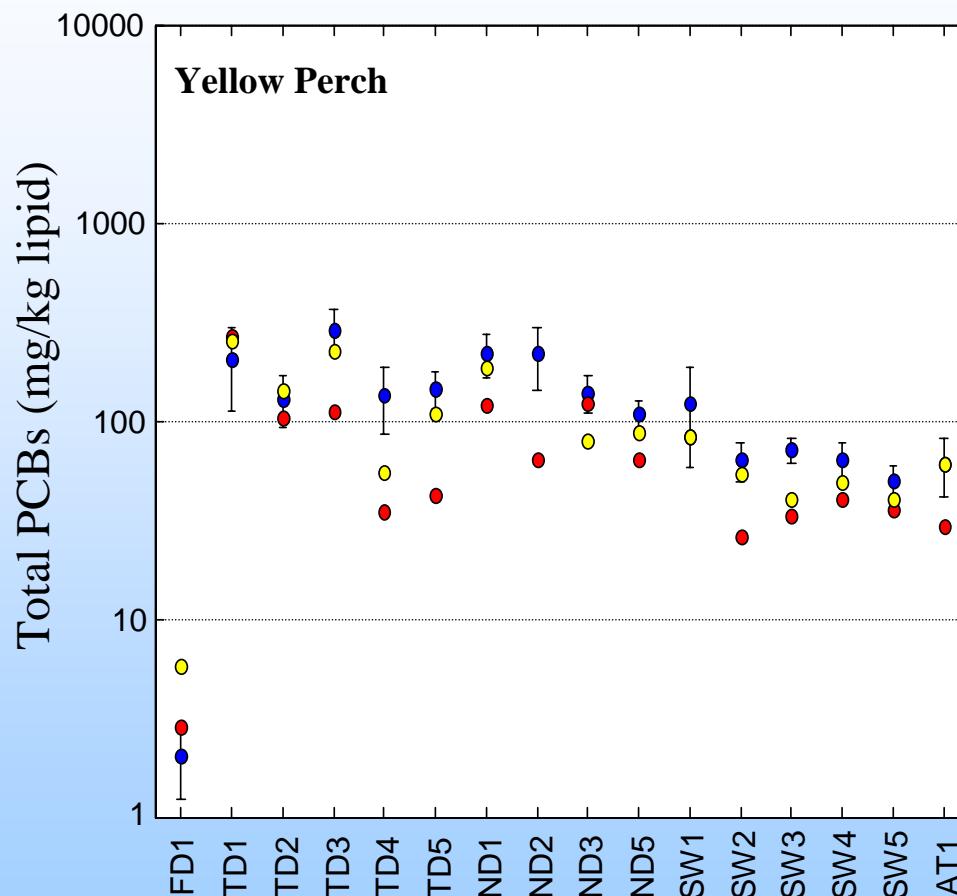


- Baseline (2004-2008)
- 2009
- 2010

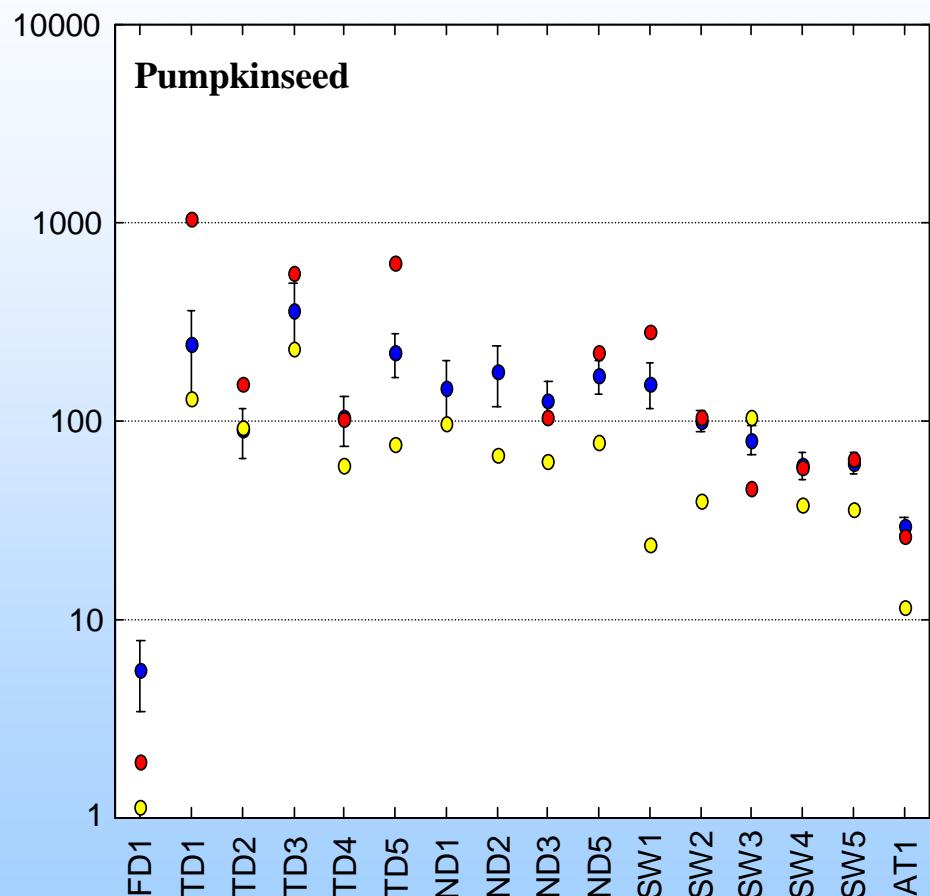




Hudson River Fish: Baseline vs. 2009 and 2010

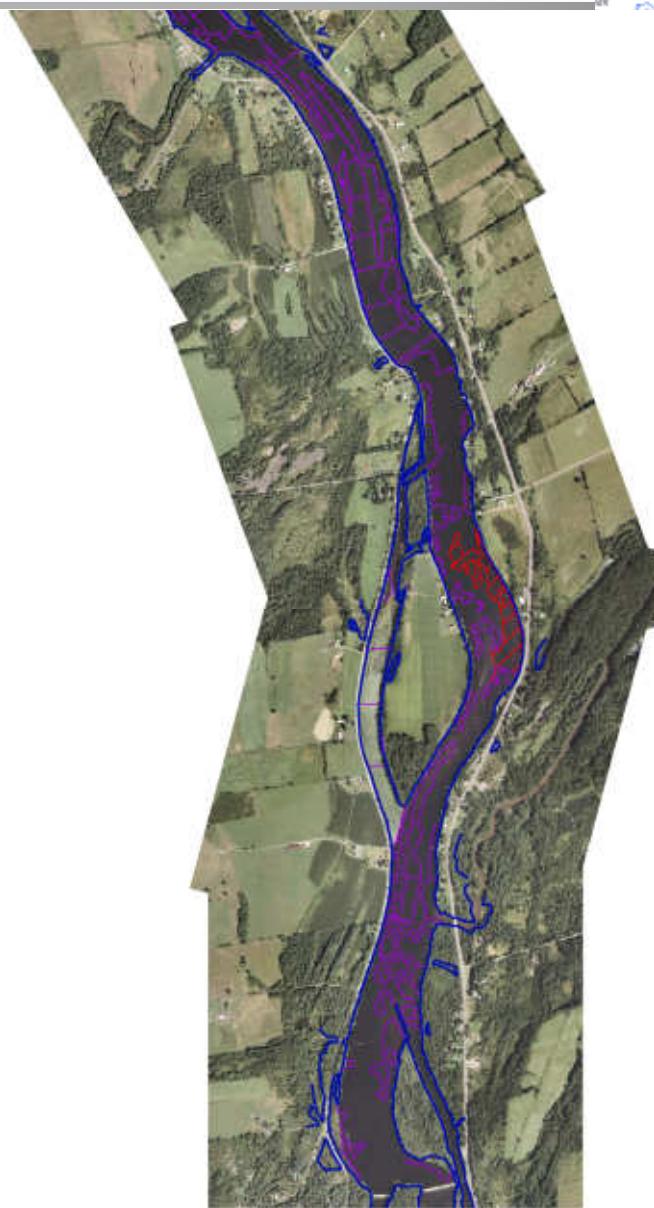
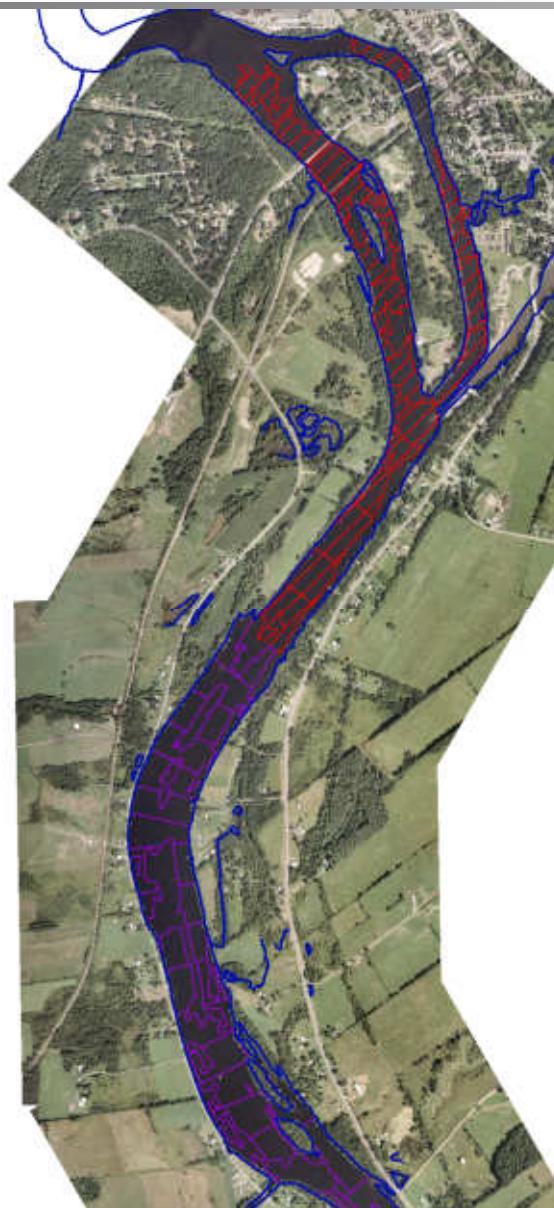


- Baseline (2004-2008)
- 2009
- 2010





BMP Fish Sampling Transect Locations: Thompson Island Pool (River Section 1)

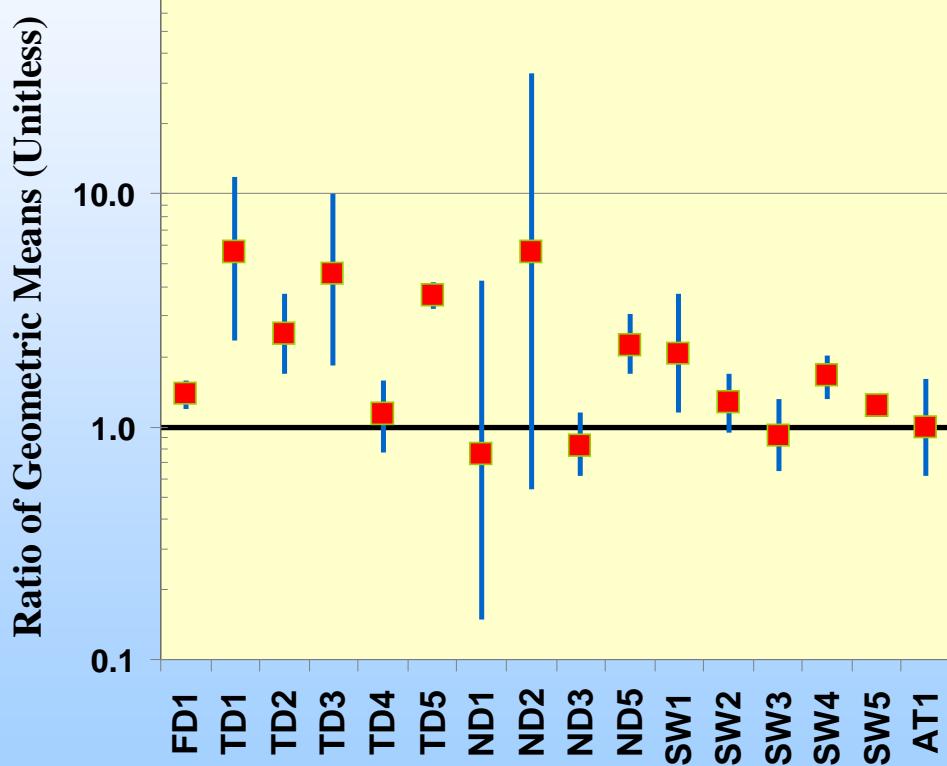




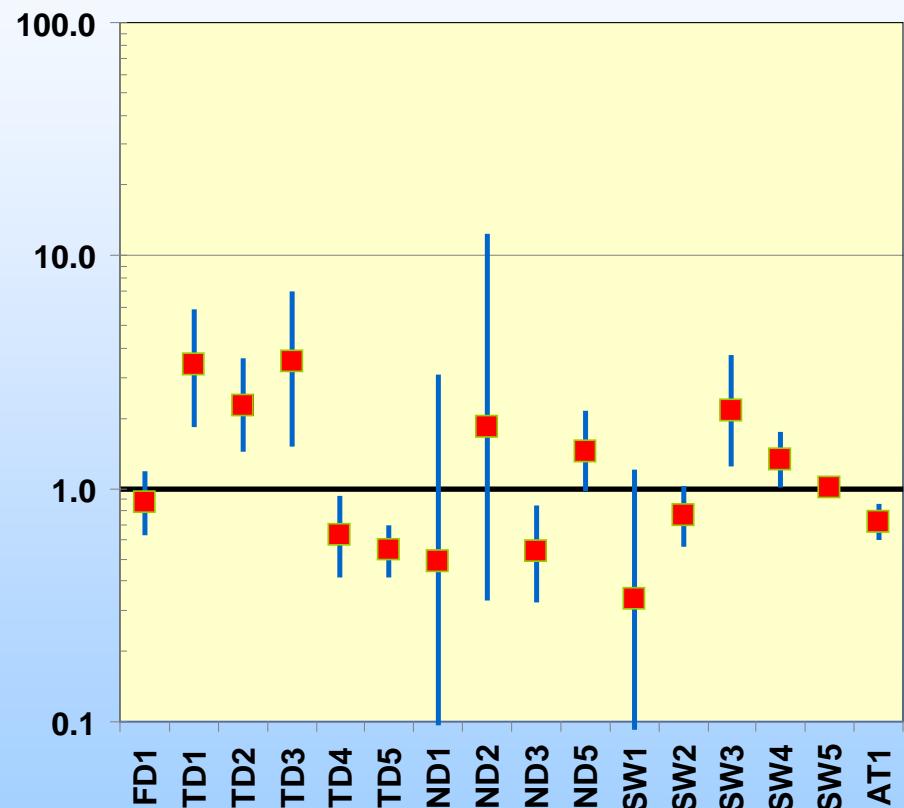
Ratio of Observed to Expected PCBs in Pumpkinseed



2009

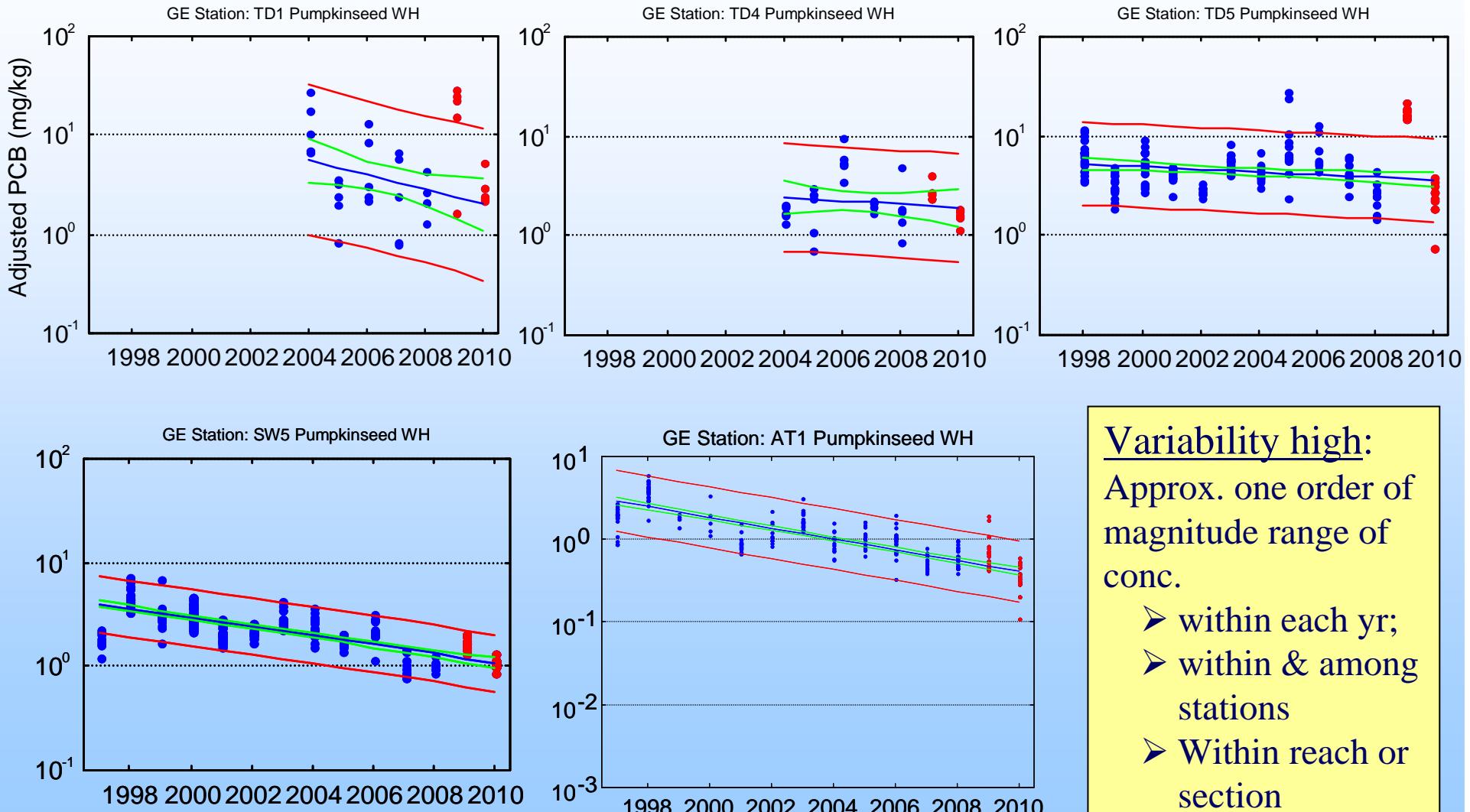


2010



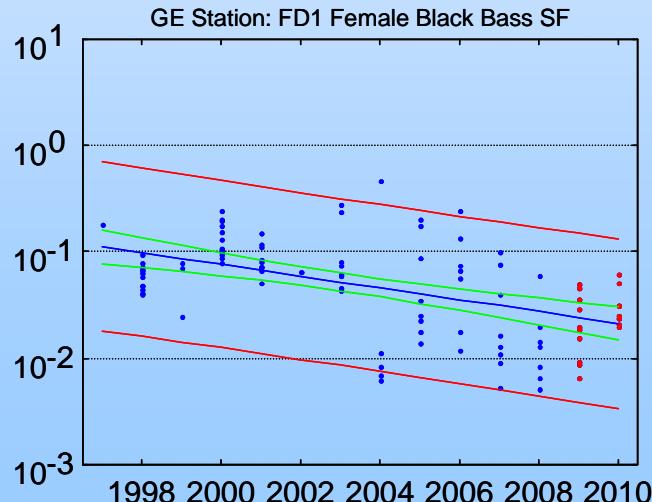
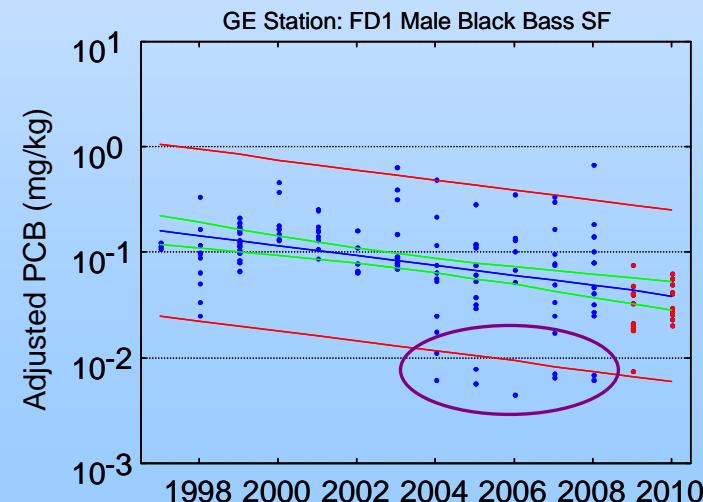
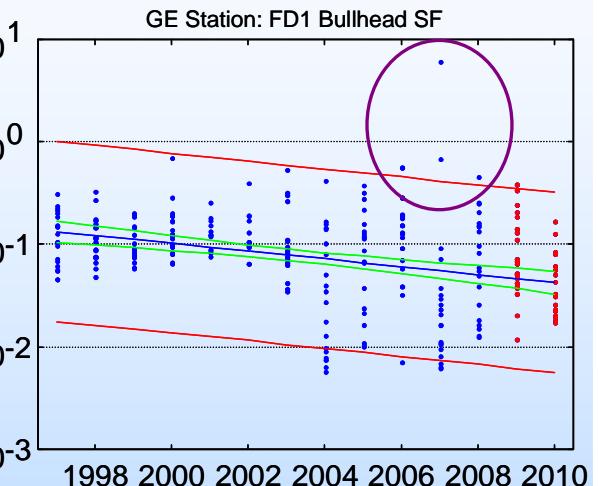
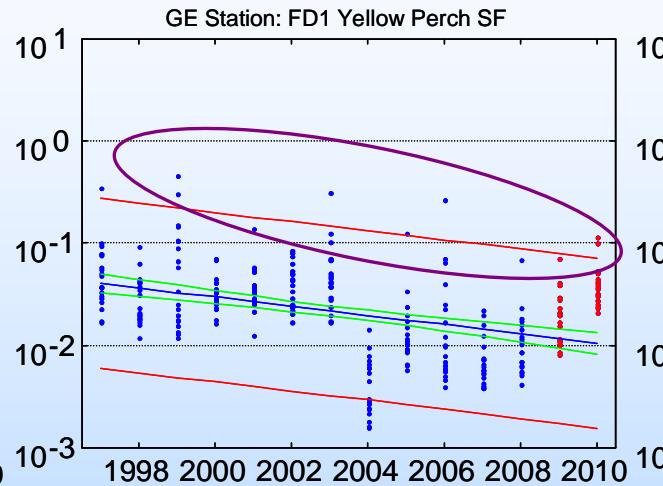
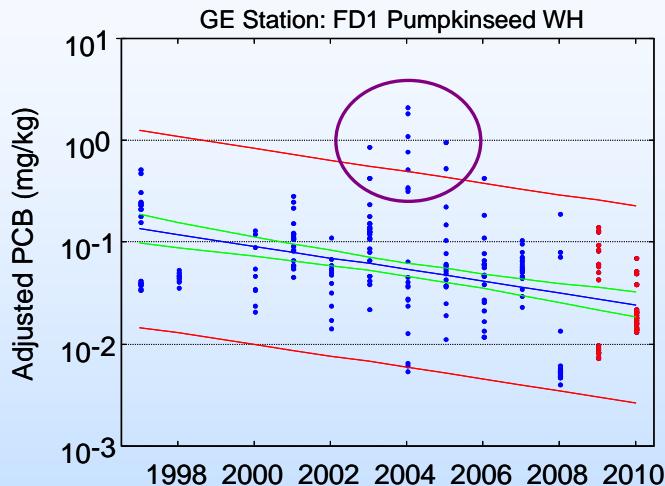


Annual & spatial patterns can be important





Need to account for natural and system-wide variability



These data are
from the
upstream
reference site
(Feeder Dam)



Total PCBs in Fish Tissues: Baseline vs. 2009



| SECTION | STATION | Approx. River Mile | Black Bass | Bullhead | Yellow Perch | Pumpkin-seed | Forage Fish |
|---------|---------|--------------------|------------|----------|--------------|--------------|-------------|
| 1 | ALL | 188.5-195 | - | | - | + | + |
| 2 | ALL | 183.4-188.5 | (-) | | - | + | |
| 3 | ALL | 168.2-183.2 | | - | - | | |
| SECTION | STATION | | | | | | |
| -- | FD1 | 201.1 | | | + | | (+) |
| 1 | TD1 | 194 | | | + | + | |
| 1 | TD2 | 193 | - | | | + | |
| 1 | TD3 | 192 | - | | (-) | | |
| 1 | TD4 | 190-191 | | | - | | (+) |
| 1 | TD5 | 189.3 | - | | - | + | |
| 2 | ND1 | 187 | | (-) | | (+) | |
| 2 | ND2 | 186.4 | | | - | | - |
| 2 | ND3 | 185.5 | | | | | |
| 2 | ND5 | 183.5 | - | | - | | |
| 3 | SW1 | 181.2 | | | | | + |
| 3 | SW2 | 178.2 | | | | | |
| 3 | SW3 | 177.3 | | - | - | | |
| 3 | SW4 | 172.1 | | | | | |
| 3 | SW5 | 167.8 | | | | | |
| -- | AT1 | 153.2 & 142 | | NA | - | | |

Neutral $p > 0.10$
- Decrease between 2004-8 and 2009; $p < 0.05$
+ Increase between 2004-8 and 2009; $p < 0.05$
(-) $p < 0.10$



Total PCBs in Fish Tissues: 2009 vs. 2010



| Section | Station | Approx River Mile | Black Bass | Bullhead | Yellow Perch | Pumpkin-seed |
|---------|---------|-------------------|------------|----------|--------------|--------------|
| 1 | All | 188.5-195 | + | | + | - |
| 2 | All | 183.4-188.5 | (+) | | (+) | - |
| 3 | All | 168.2-183.2 | (+) | (-) | | - |
| Section | Station | | | | | |
| --- | FD1 | 201.1 | + | | + | |
| 1 | TD1 | 194 | + | (+) | | (-) |
| 1 | TD2 | 193 | + | | | - |
| 1 | TD3 | 192 | | | + | |
| 1 | TD4 | 190-191 | | | | - |
| 1 | TD5 | 189.3 | (+) | - | + | - |
| 2 | ND1 | 187 | | (-) | | - |
| 2 | ND2 | 186.4 | | | NA | - |
| 2 | ND3 | 185.5 | | - | - | |
| 2 | ND5 | 183.5 | + | | | - |
| 3 | SW1 | 181.2 | | | | - |
| 3 | SW2 | 178.2 | | | + | - |
| 3 | SW3 | 177.3 | (+) | | | (+) |
| 3 | SW4 | 172.1 | | | | - |
| 3 | SW5 | 167.8 | | | | - |
| --- | AT1 | 153.2 & 142 | | NA | NA | - |

Neutral p>0.10
 - Decrease btwn 2009 and 2010; p < 0.05
 + Increase btwn 2009 and 2010; p < 0.05
 () 0.05< p < 0.10



Total PCBs in Fish Tissues: Baseline vs. 2010



| Section | Station | Approx River Mile | Black Bass | Bullhead | Yellow Perch | Pumpkin-seed |
|---------|---------|-------------------|------------|----------|--------------|--------------|
| 1 | All | 188.5-195 | | | | - |
| 2 | All | 183.4-188.5 | | - | | - |
| 3 | All | 168.2-183.2 | | - | | - |
| Section | Station | | | | | |
| --- | FD1 | 201.1 | | | + | (-) |
| 1 | TD1 | 194 | | + | | |
| 1 | TD2 | 193 | | | | |
| 1 | TD3 | 192 | | | | |
| 1 | TD4 | 190-191 | | | | |
| 1 | TD5 | 189.3 | | - | | - |
| 2 | ND1 | 187 | | | | |
| 2 | ND2 | 186.4 | | | NA | - |
| 2 | ND3 | 185.5 | | - | (-) | (-) |
| 2 | ND5 | 183.5 | | | | - |
| 3 | SW1 | 181.2 | | | | - |
| 3 | SW2 | 178.2 | (+) | - | | - |
| 3 | SW3 | 177.3 | | - | | |
| 3 | SW4 | 172.1 | | - | | - |
| 3 | SW5 | 167.8 | | - | | - |
| --- | AT1 | 153.2 & 142 | | NA | | - |

Neutral $p > 0.10$
- Decrease btwn 2004-8 and 2010; $p < 0.05$
+ Increase btwn 2004-8 and 2010; $p < 0.05$
(-) $p < 0.10$



EPA's Perspective

- We expected that short-term, localized increases in fish PCB levels would occur during Phase 1
 - These apparent dredging impacts were clearly observed within or immediately below the Phase 1 dredging areas

- We anticipate that short-term, dredging related, localized body burden increases of PCBs in fish will rapidly return to baseline levels, and continue to decline thereafter following remediation
 - Exposures related to dredging are expected to be brief
 - Dredging only occurs in a given area for single dredging season, or a portion thereof (weeks to months)
 - Tissue concentrations of PCBs in fish have been shown to decrease rapidly following spikes related to exposure events and environmental dredging.



Spikes in tissue concentrations linked to exposure events have been observed to recover



Brown Bullhead - Thompson Island at Griffin Island (RS-1; RM 189)

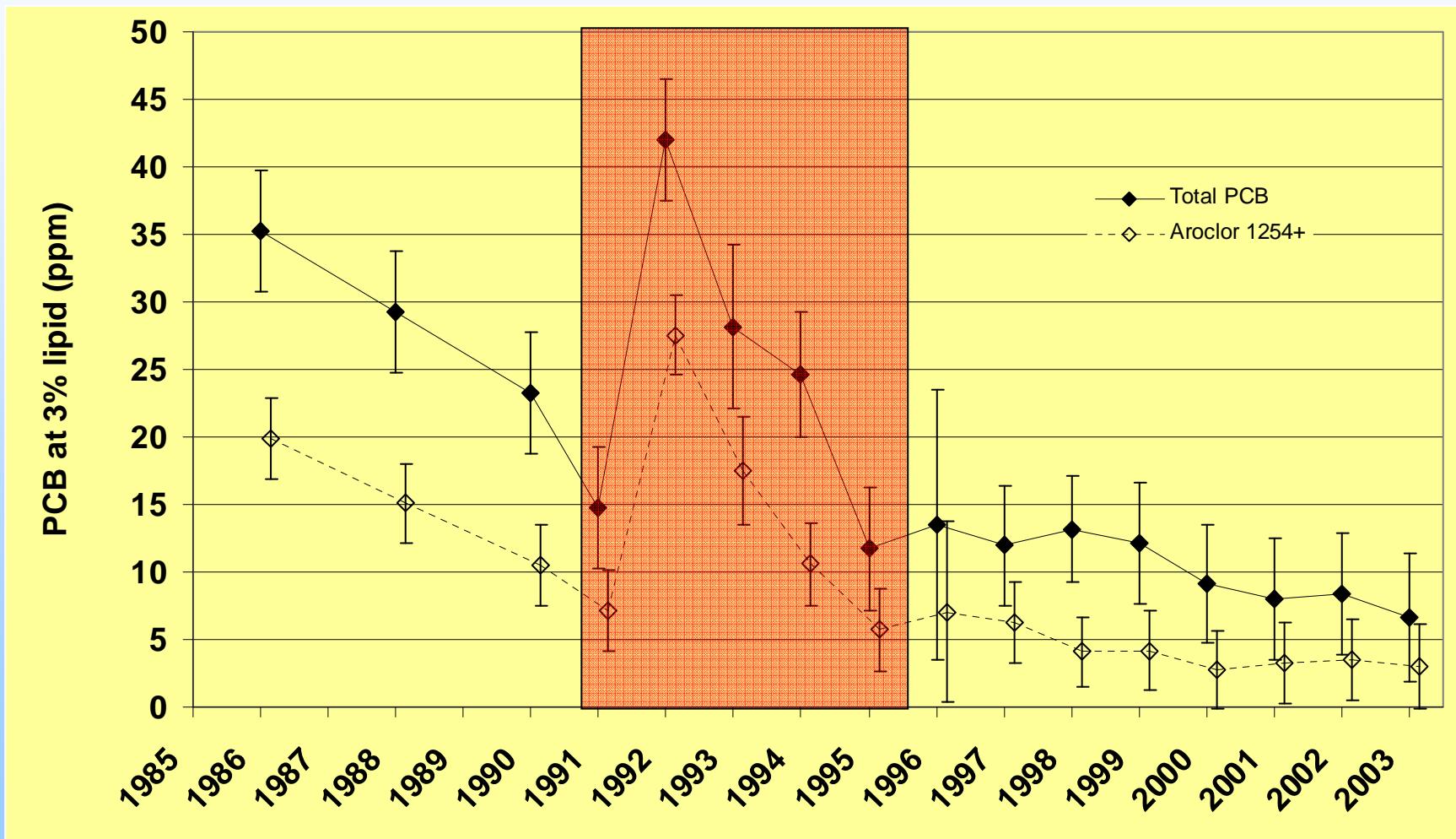


Figure courtesy of NYSDEC (2005)



Conclusions

- Apparent downward trends in some of the BMP data (2004-2008)
 - But regression statistics indicated many of these were weak, or tentative, relative to interannual variability

- PCB Conc. in fish tissues generally stable within this variability during the BMP—helpful for statistical comparisons



Conclusions



- Overall, monitoring data indicated that resuspension of PCBs from sediments during dredging affected fish locally in 2009
 - Greatest impact in the immediate vicinity of the dredging activity (Thompson Island Pool)
 - Current data do not indicate that dredging had an appreciable effect on PCB levels in fish >2-3 miles downstream of the TIP