Recovery Dynamics of a PCB-Contaminated Creek Fish Community

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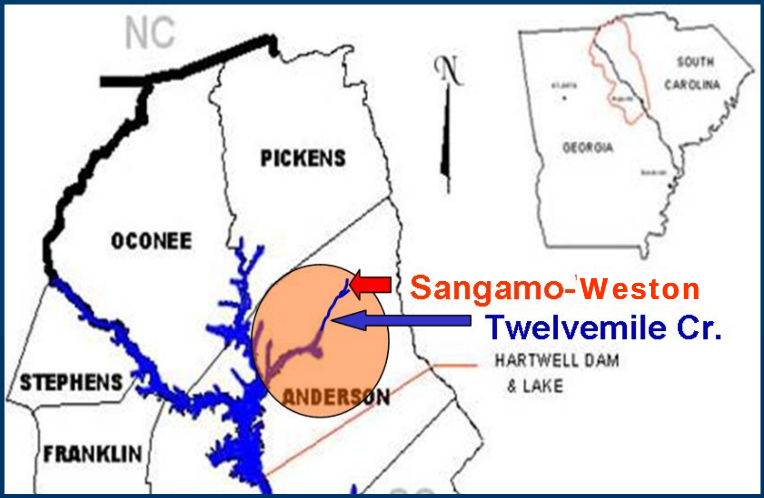
Background



- Sangamo-Weston (Superfund Site) discharged 400,000 lbs of PCBs into Twelvemile Creek from 1955-1990s
- Creek/lake treated via Monitored Natural Recovery
- PCB concentrations in fish in this creek have remained elevated
  - levels in six target fish species > wildlife limits for kingfisher and mink

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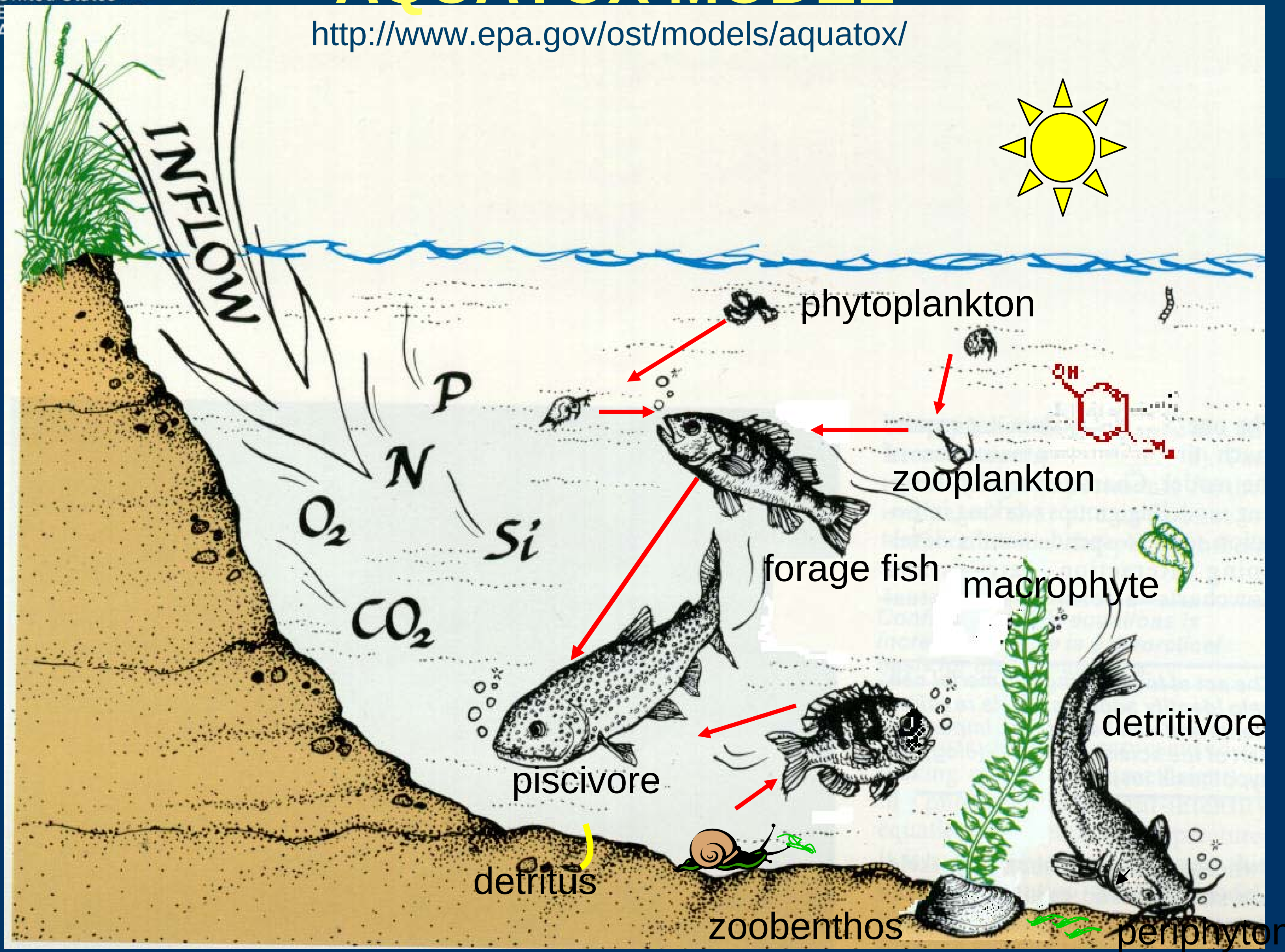
Objectives

- Estimate recovery for different fish species, creek segments, and system as a whole
- Compare future PCB concentrations in fish under different scenarios

AQUATOX MODEL

http://www.epa.gov/ost/models/aquatox/



Bioaccumulation in AQUATOX

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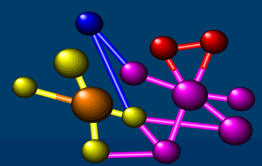
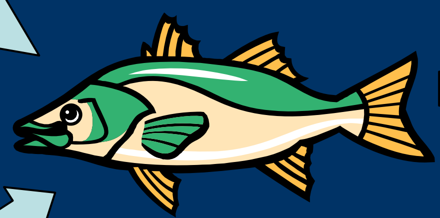


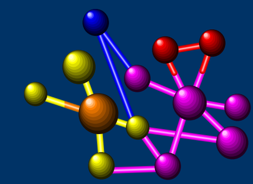
Toxicant in water
- ionization
- volatilization
- hydrolysis
- photolysis
- microbial degradation

partitioning

Uptake through gill
- respiration rate
- assimilation efficiency

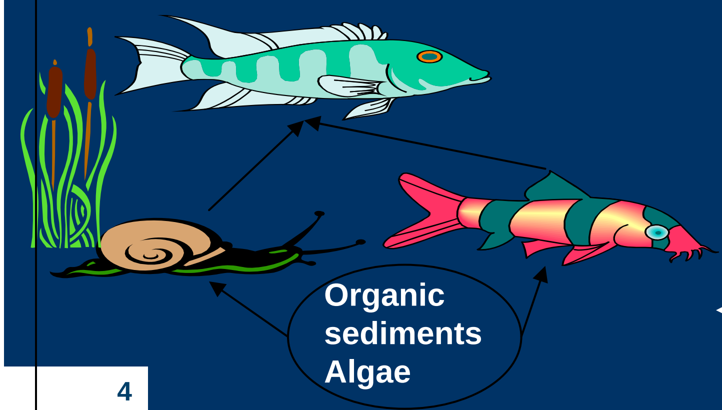


Losses of toxicant:



- predation
- mortality
- depuration
- biotransformation
- spawning
- promotion
- emergence

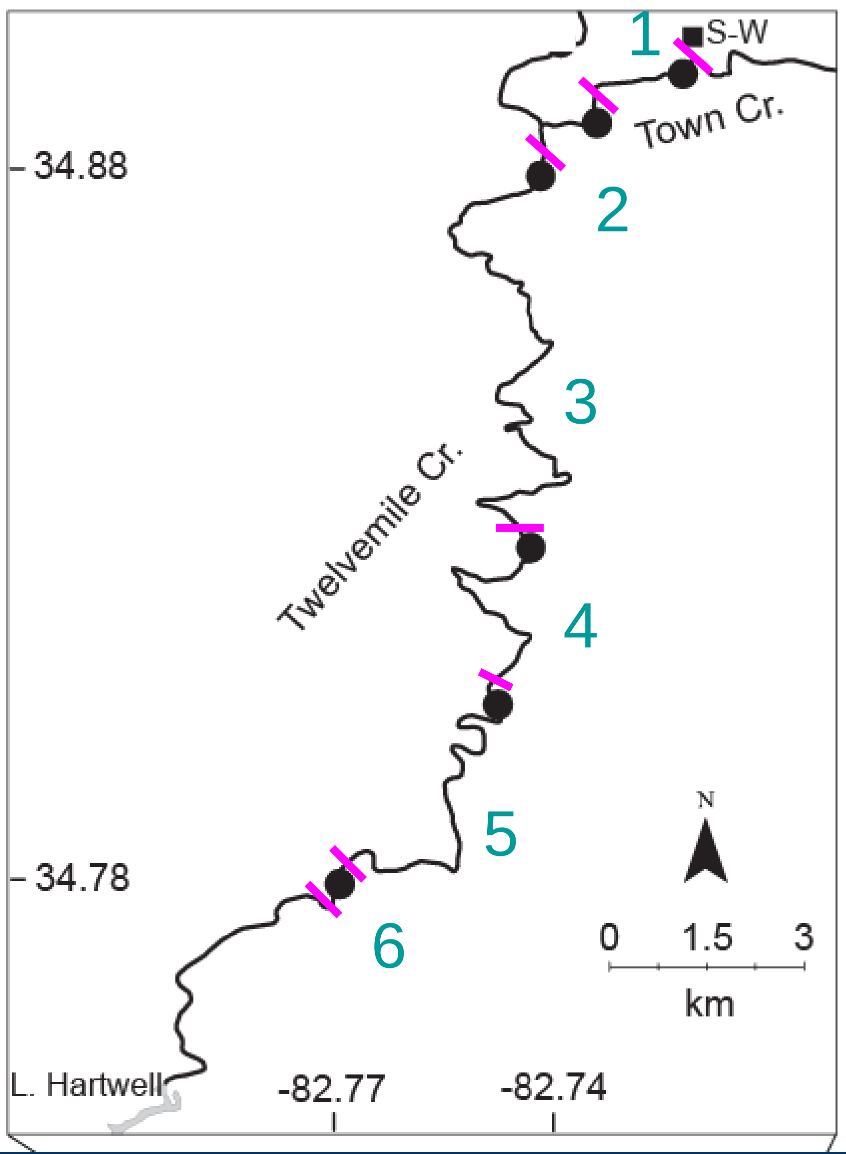
Toxicant in food



Uptake from diet
- consumption rates
- assimilation efficiency
- toxicity
- lipid content

Methods

- We used the AQUATOX model to represent dynamics of total PCB in a six-segment creek system



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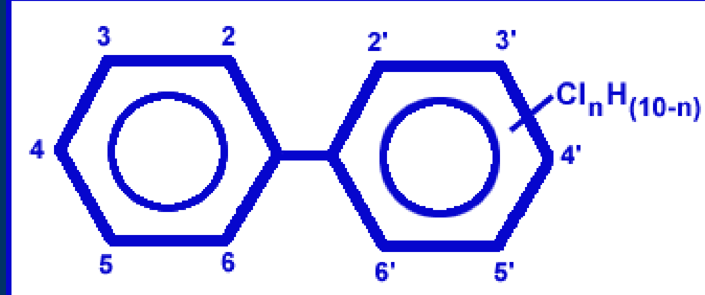
Parameterization

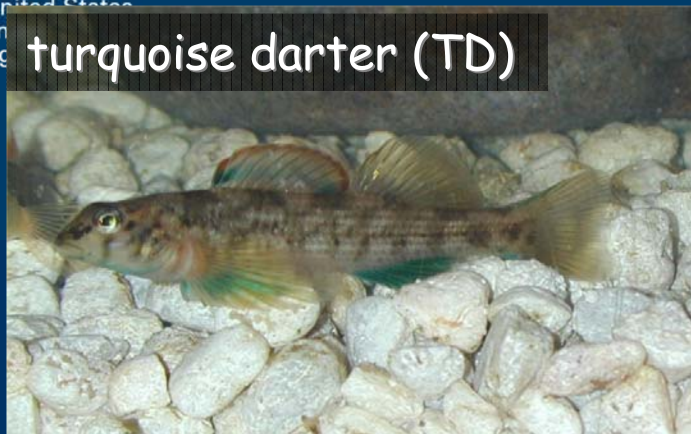
- Flow – NHD Plus (USGS/EPA)
- Water quality – EPA STORET
- Habitat – Field data
- Plants and Invertebrates – AQUATOX defaults
- Fish life history – www.fishbase.org
- Toxicant - tPCB ~ Aroclor-1254

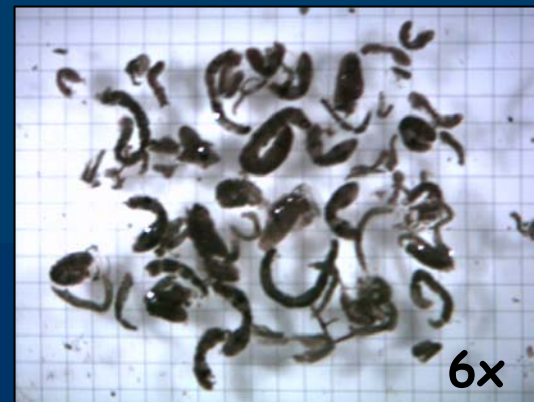
STORET

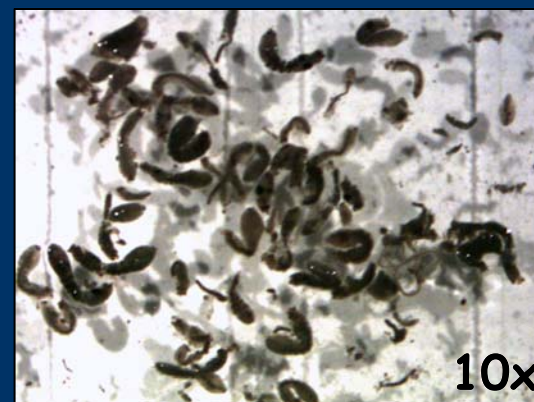


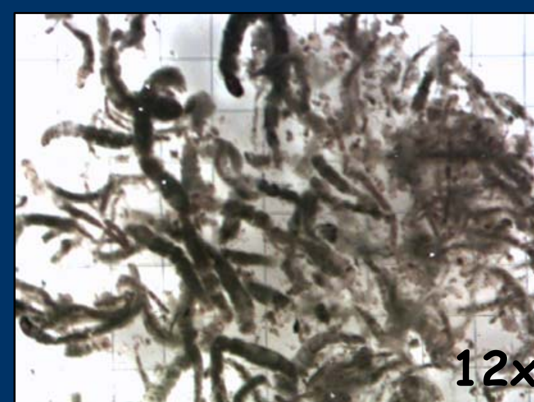
Polychlorinated Biphenyl (PCB)

Fishes and their diets

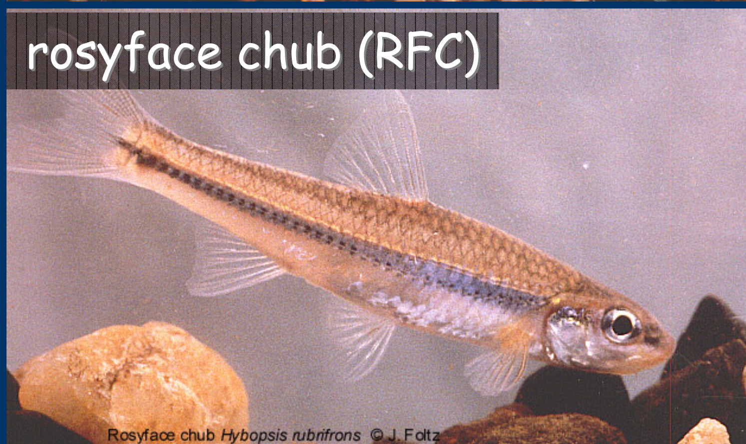


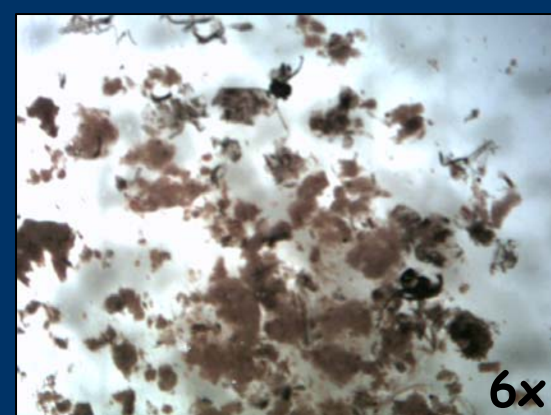






Fishes and their diets





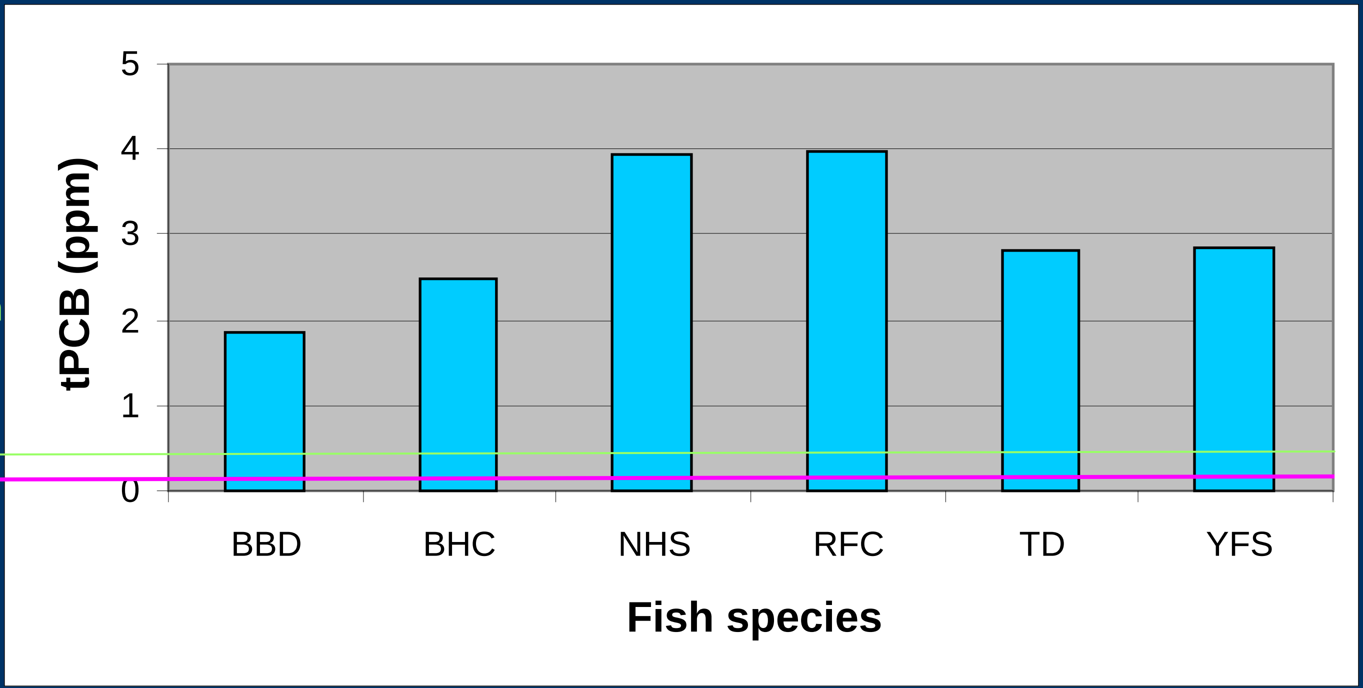
Fish Diets from Gut Content Studies

Fish spp.	Algae	Inverts	Detritus	Fish eggs	Macrop hyt.	T plant	T inverts
BBD	0	0.98	0	0.02	0	0	0
BHC	0.14	0.20	0.16	0.02	0.02	0.41	0.02
NHS	0	0.98	0.02	0	0	0	0
RFC	0	0.69	0.07	0.02	0	0.12	0.05
TD	0	1.00	0	0	0	0	0
YFS	0.09	0.36	0.16	0.01	0.02	0.12	0.24

Source: Rybczynski et al. 2007, Ecology of Freshwater Fish

Modeling

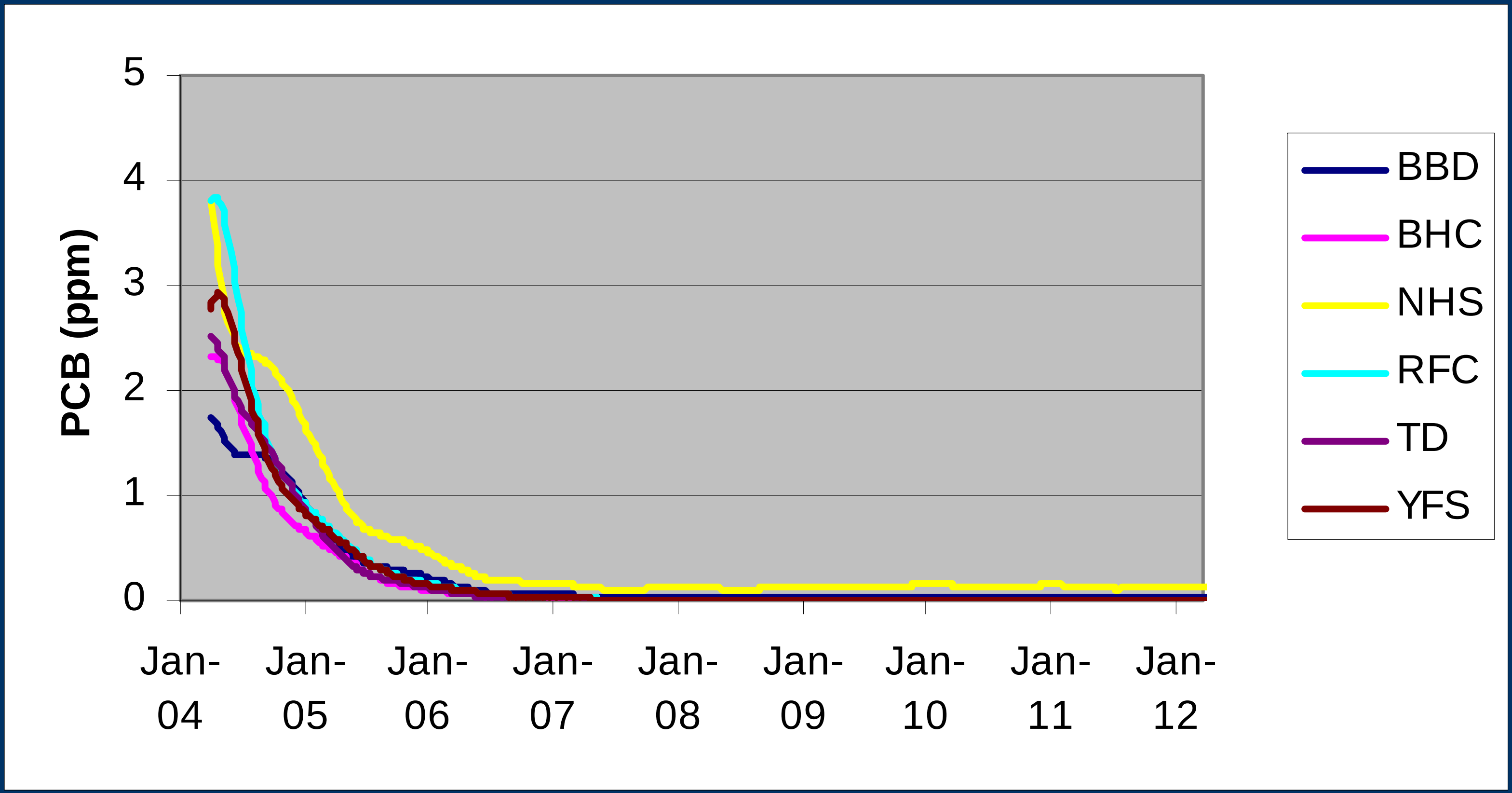
- Calibrate fish biomass
- Initial PCB values – field studies (Walters et al., 2008 ES&T)
- Run model until 2012 under different scenarios



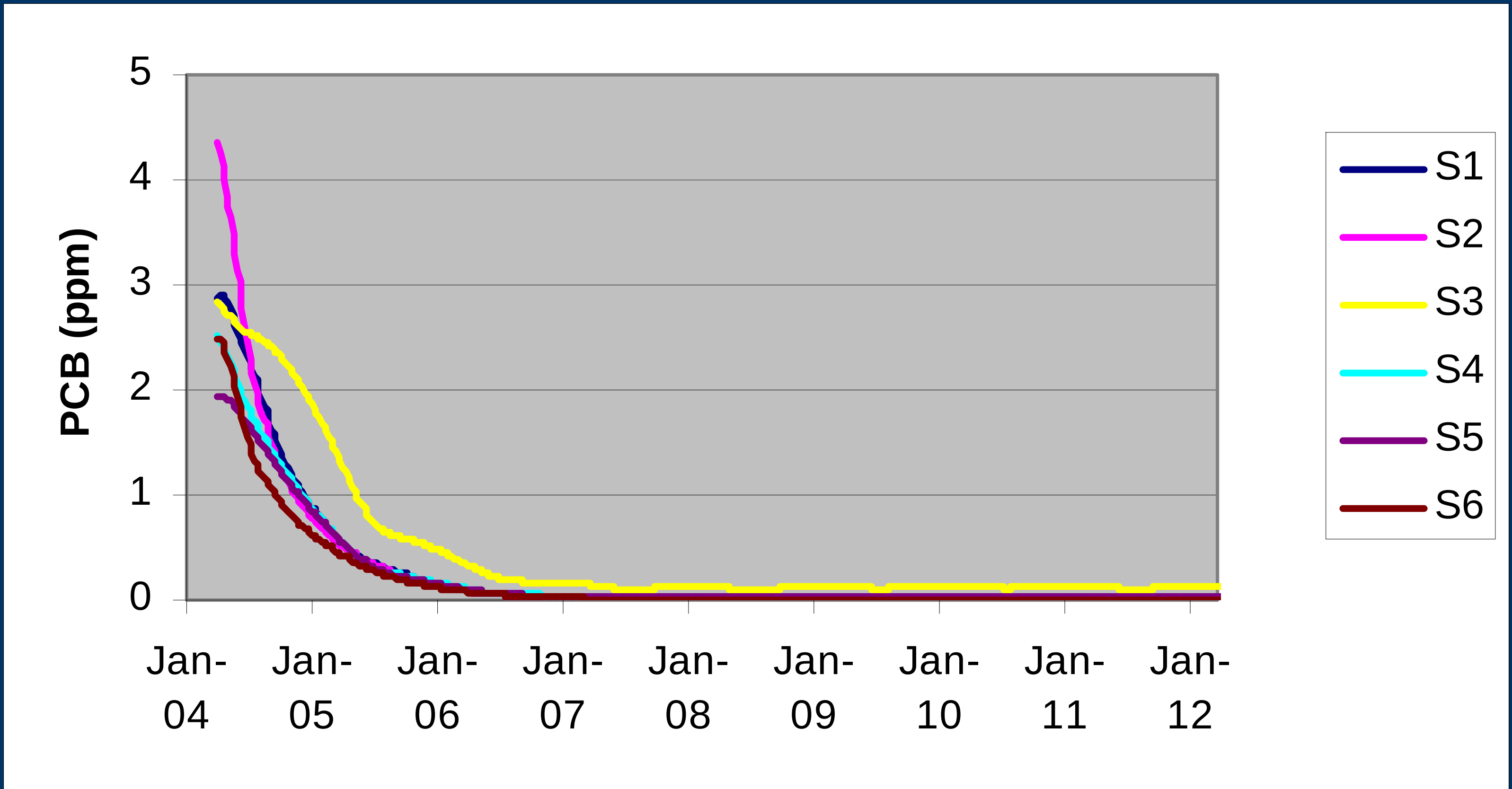
0.44 ppm in fish protective of kingfisher (Lazorchek et al., 2003, ETC)

0.13 protective of Mink

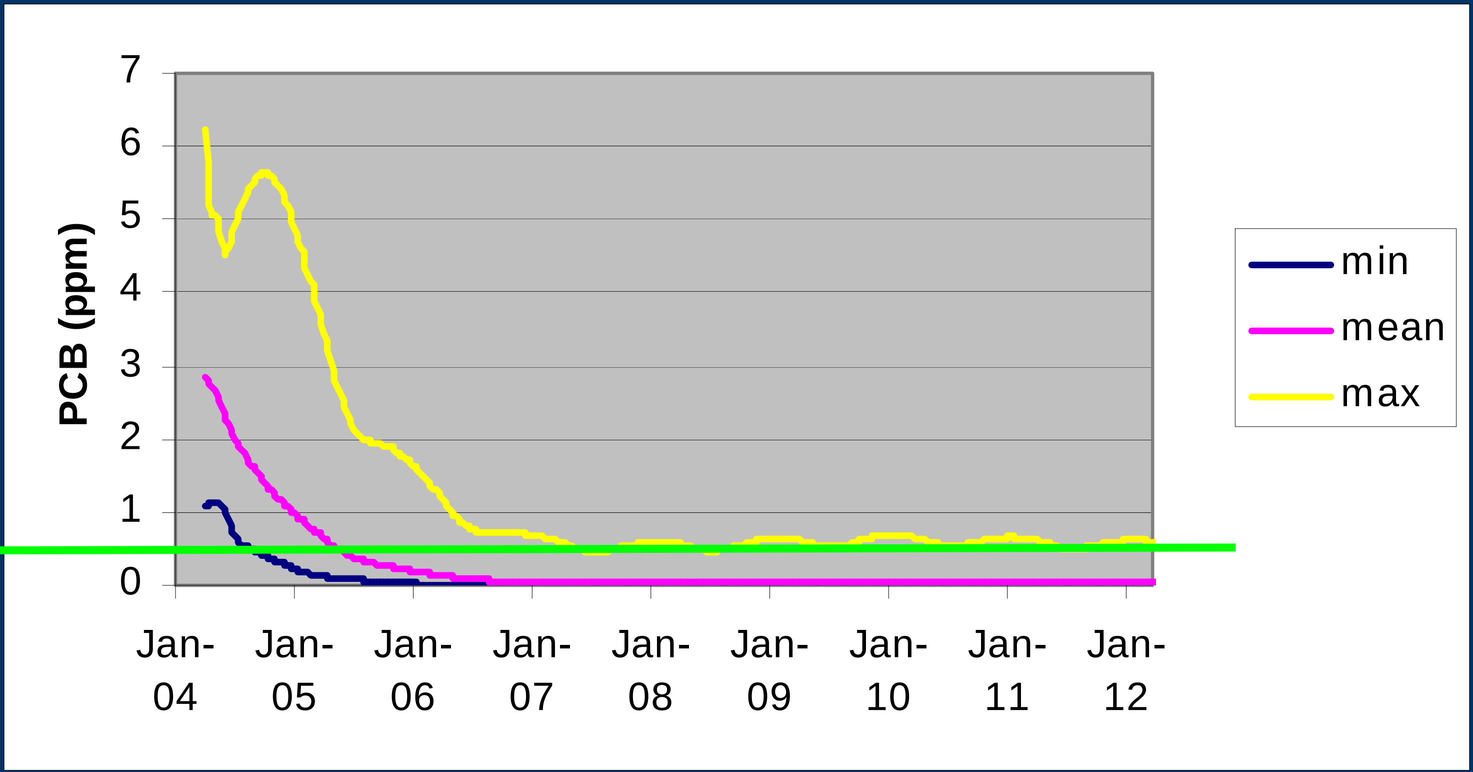
PCB Dynamics Differed by Species



PCB Dynamics Differed by Creek Segment



Overall Recovery



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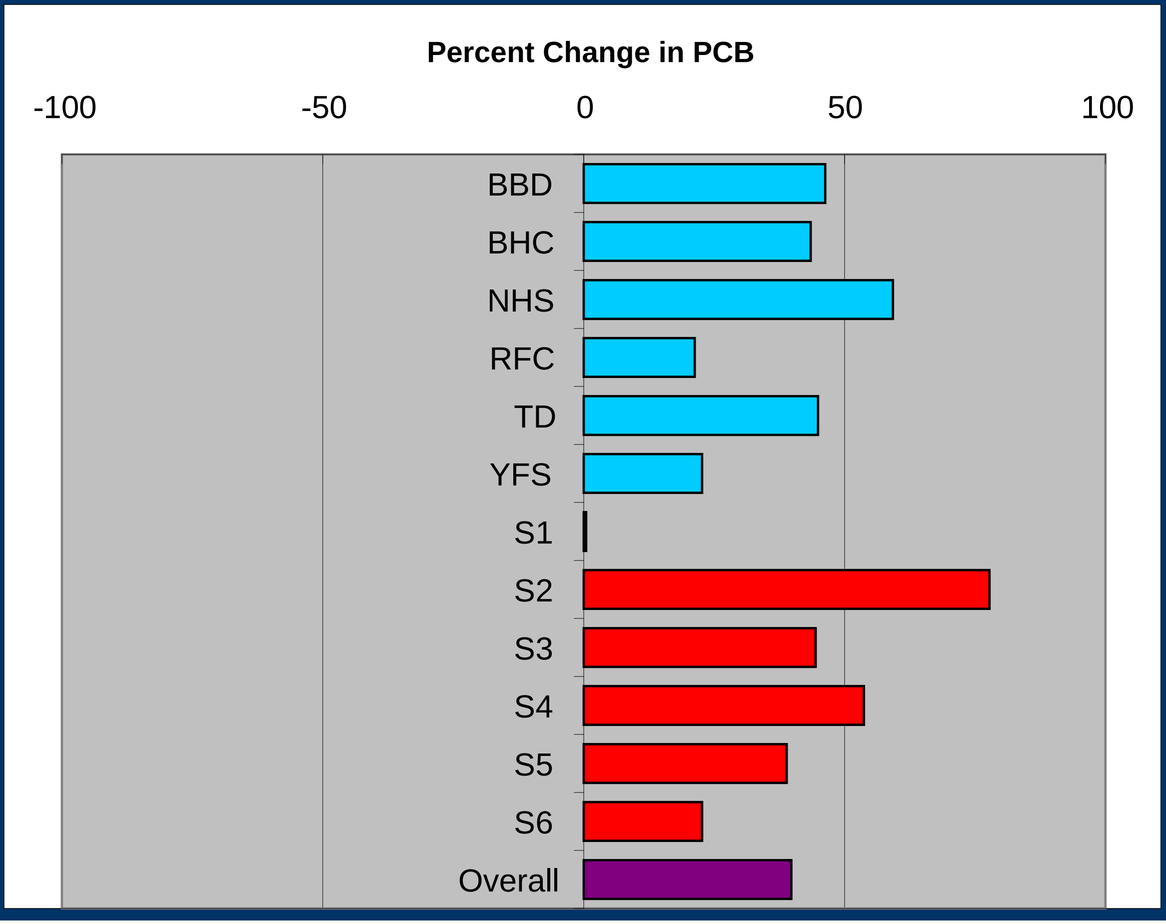
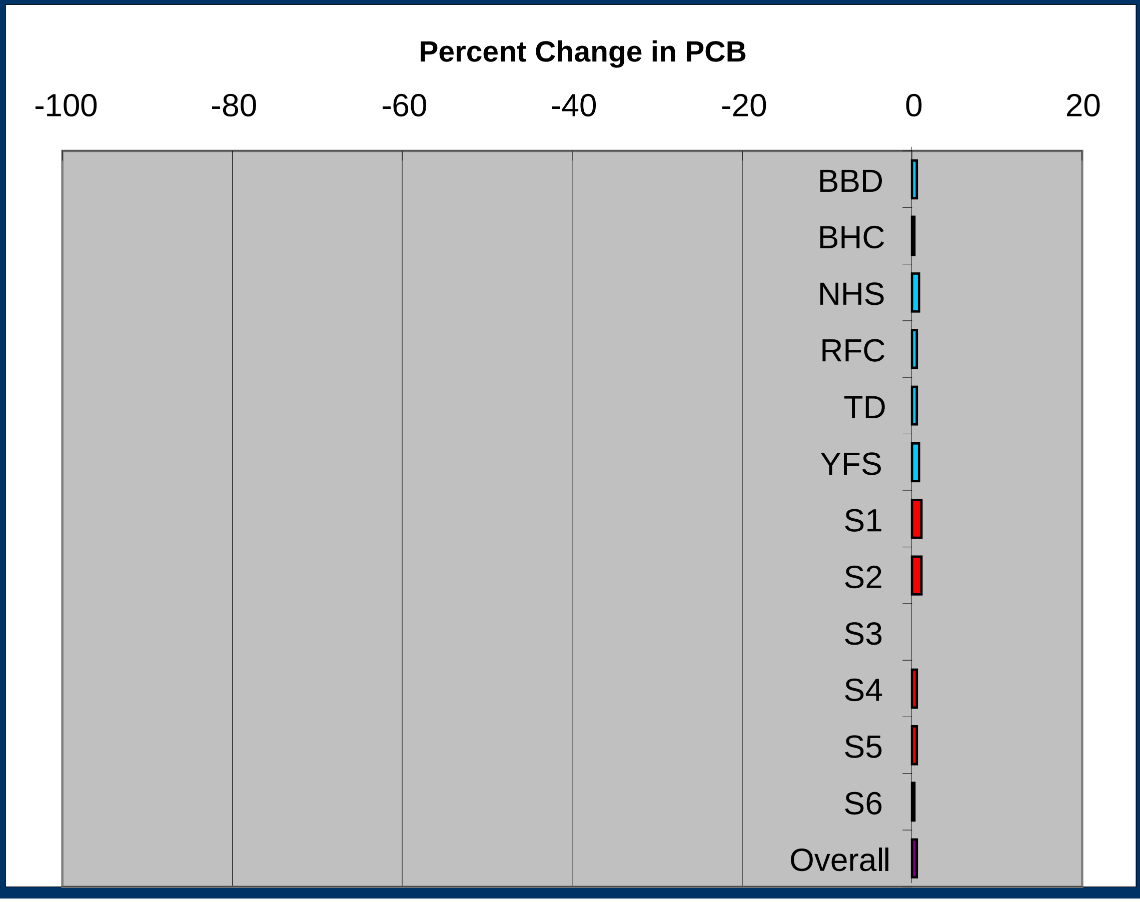
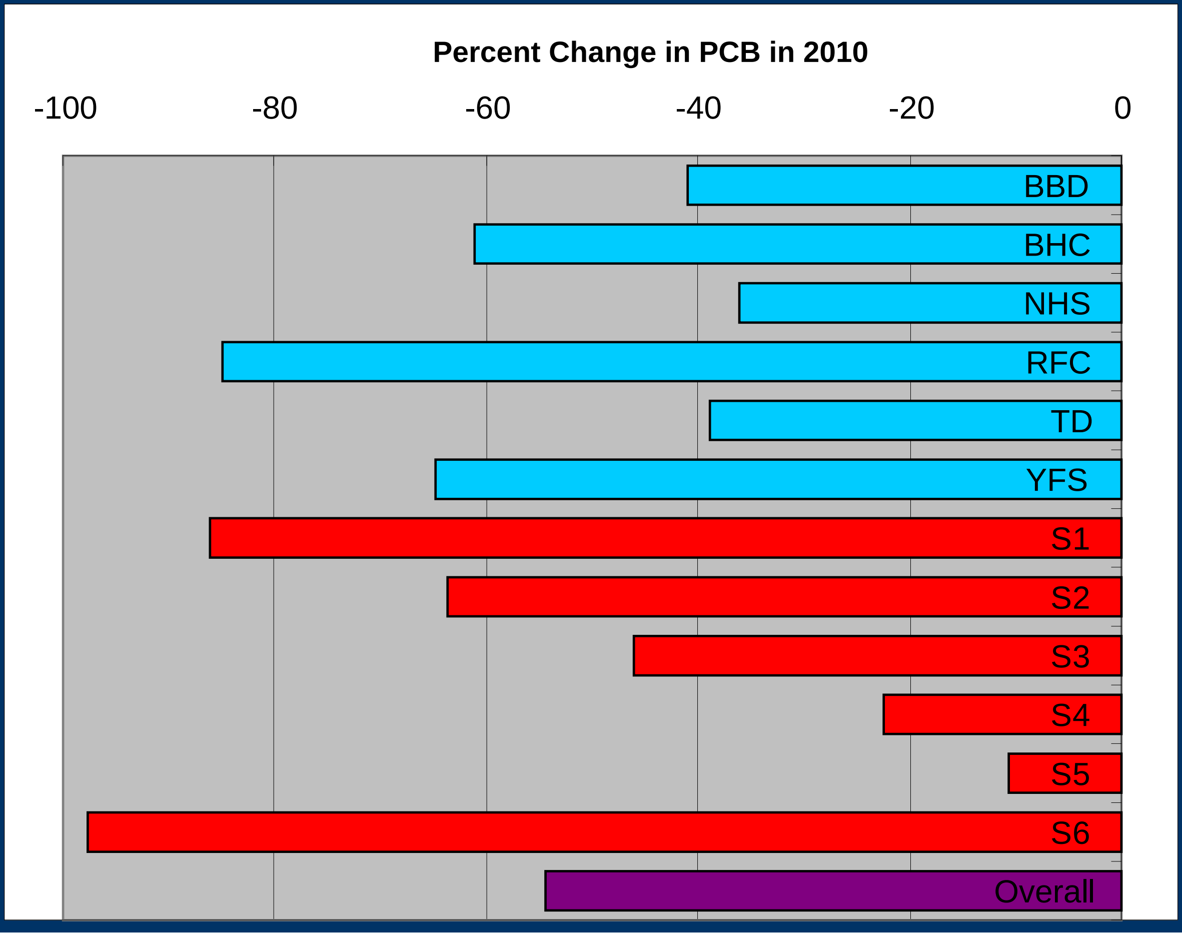
Response to Drought – Flow Decreased by 10%



Response to Land Development – Sediment Input Increased by 10%



Response to Fish Migration Among Segments



Summary

- PCB dynamics differed by species and site
  - –Slowest recovery for:
    - Northern hogsucker
    - Creek segment 3

- Recovery by end of simulation
  - –Most fish species recover quickly
  - –Structural uncertainty?

Summary

- Recovery is sensitive to flow
- Recovery is not sensitive to sediment
  - Ingestion, degradation > Burial
- The assumption of movement among segments reduces the predicted PCB values
  - Movement is important to consider in recovery predictions
- Model provides insight to ecosystem dynamics

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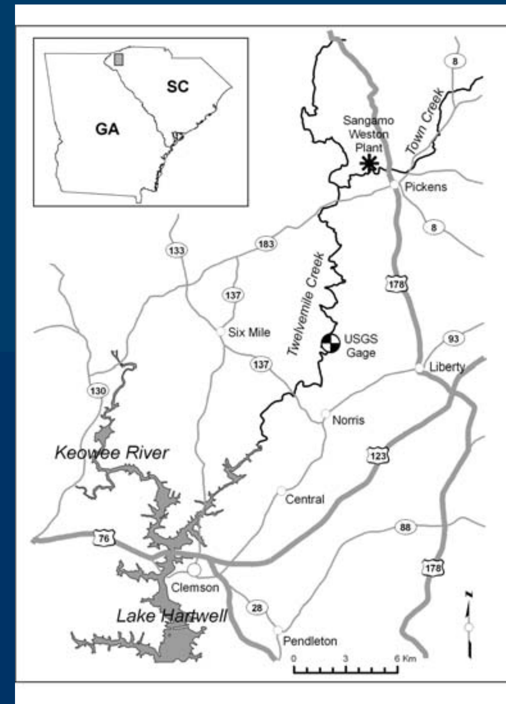
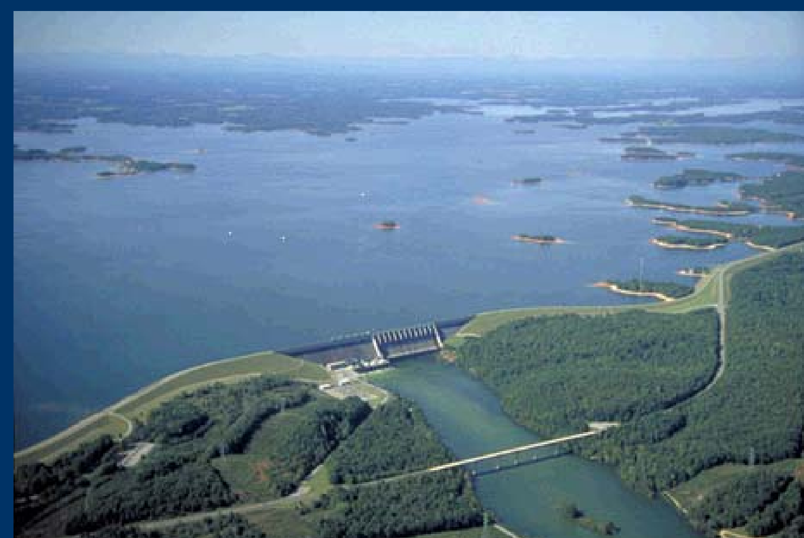
Future Directions

- Use variable flow inputs
- Include multiple stressors
- Link to Lake Model





Acknowledgements

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