Biogeochemical and Community Structural Controls on Mercury in Everglades Food Webs

R-EMAP Phases I - III

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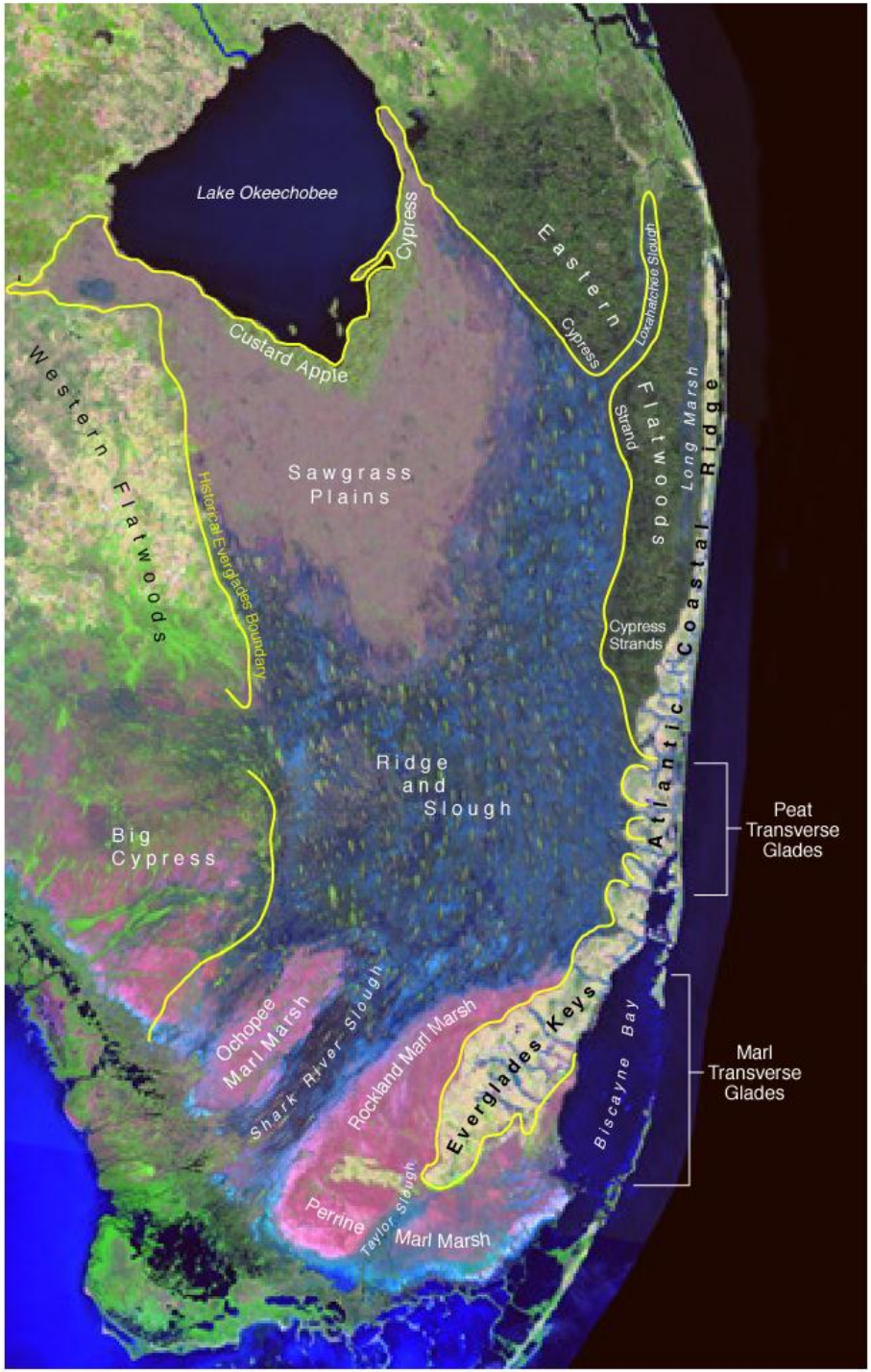
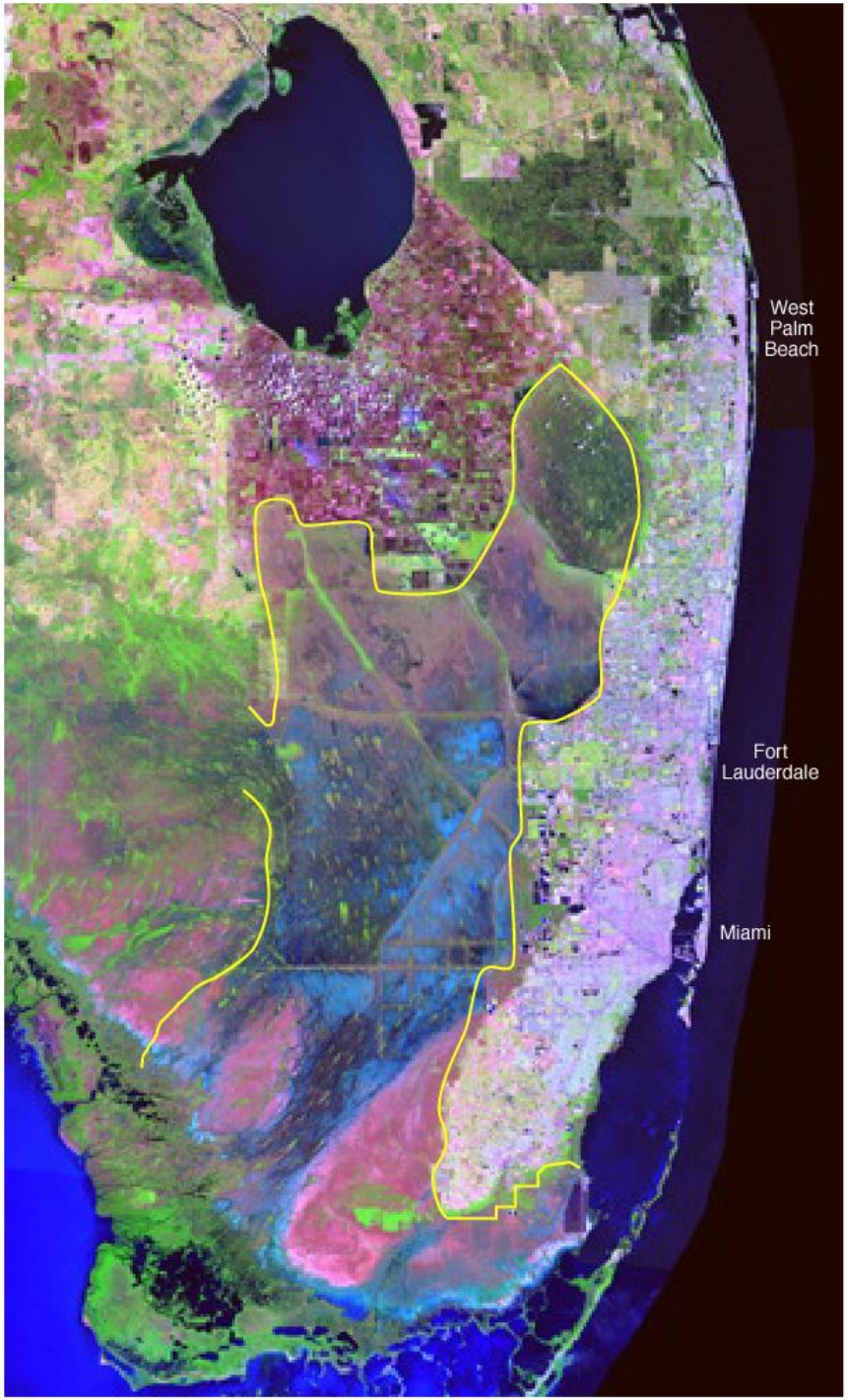
INTECOL 9


Lake Okeechobee
Cypress
Eastern
Cypress
Loxahatchee Slough
Custard Apple
Western Flatwoods
Historical Everglades Boundary
Sawgrass Plains
Strand
Flatwoods
Long Marsh
Ridge
Cypress Strands
Atlantic Coastal
Ridge and Slough
Big Cypress
Peat Transverse Glades
Ochopee Marl Marsh
Shark River Slough
Rockland Marl Marsh
Everglades Keys
Biscayne Bay
Marl Transverse Glades
Perrine Marl Marsh
Taylor Slough


West Palm Beach
Fort Lauderdale
Miami

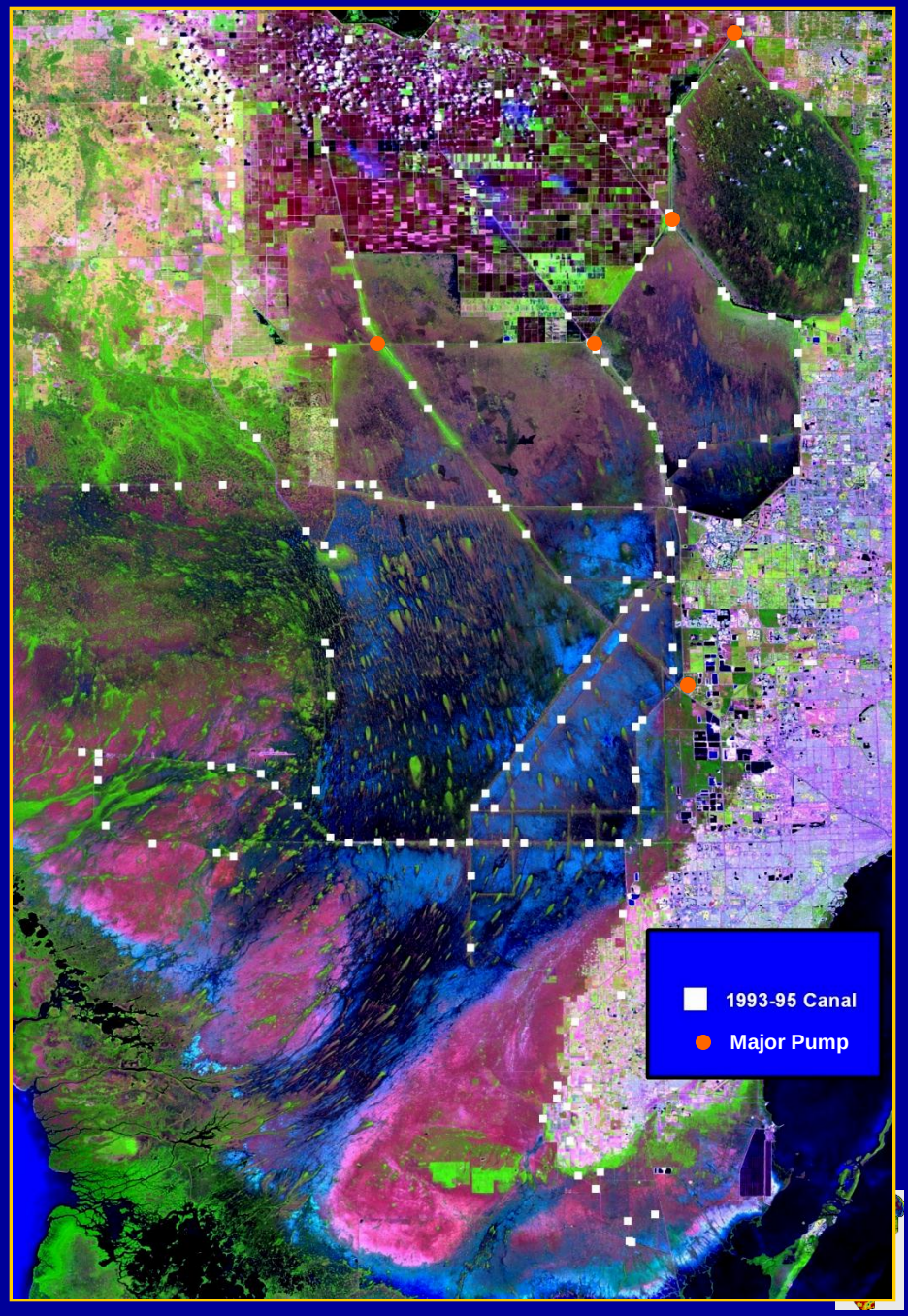
Study Area
Initial Focus
Initial Findings

Phase I Canal = 1993-95

199 stations

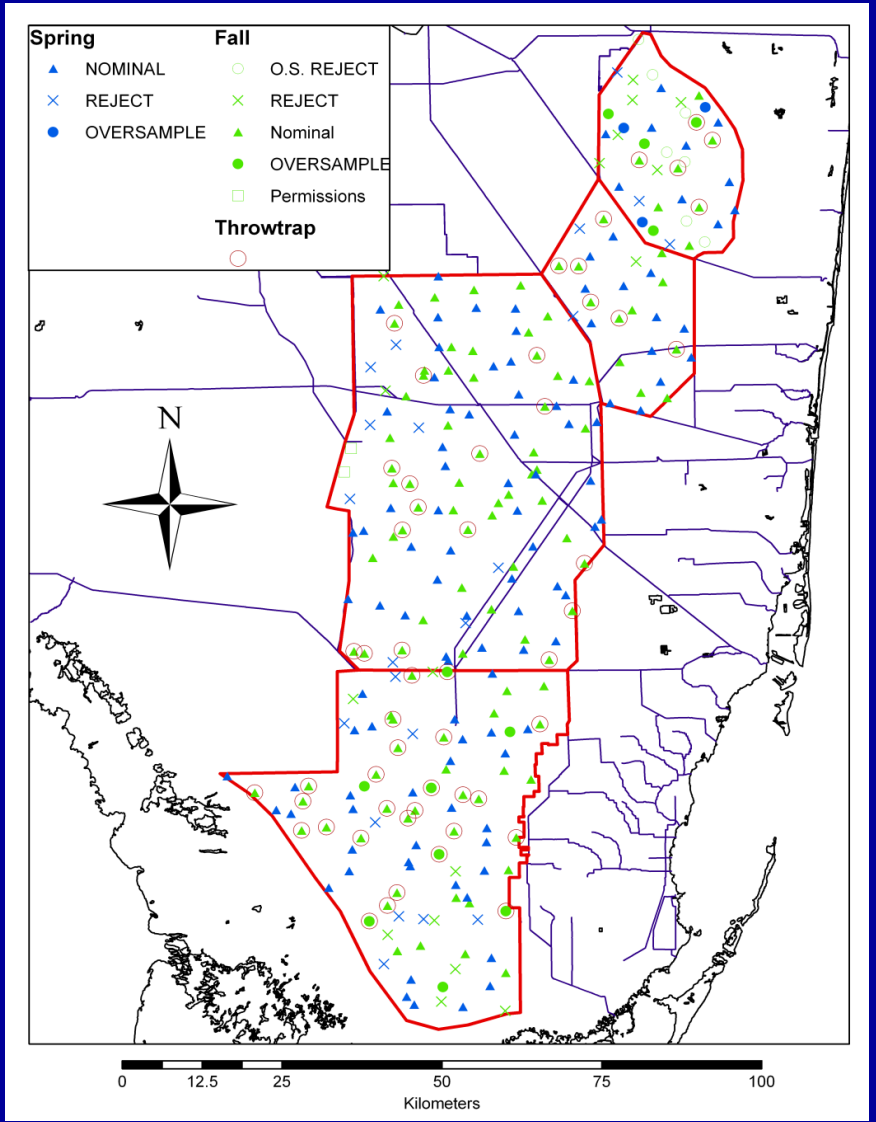
Distinct gradients in phosphorus, sulfur, and carbon

Canals are a conduit for stormwater transport from the Everglades Agricultural Area.



Probability-based Designs

- **RANDOM SAMPLING:**
- Allows description of the whole by only sampling parts.
- Used in economic surveys, opinion polls.
- Used in all U.S.EPA National Aquatic Resource Surveys.

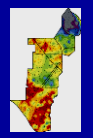


EVERGLADES ECOSYSTEM ASSESSMENT PROGRAM

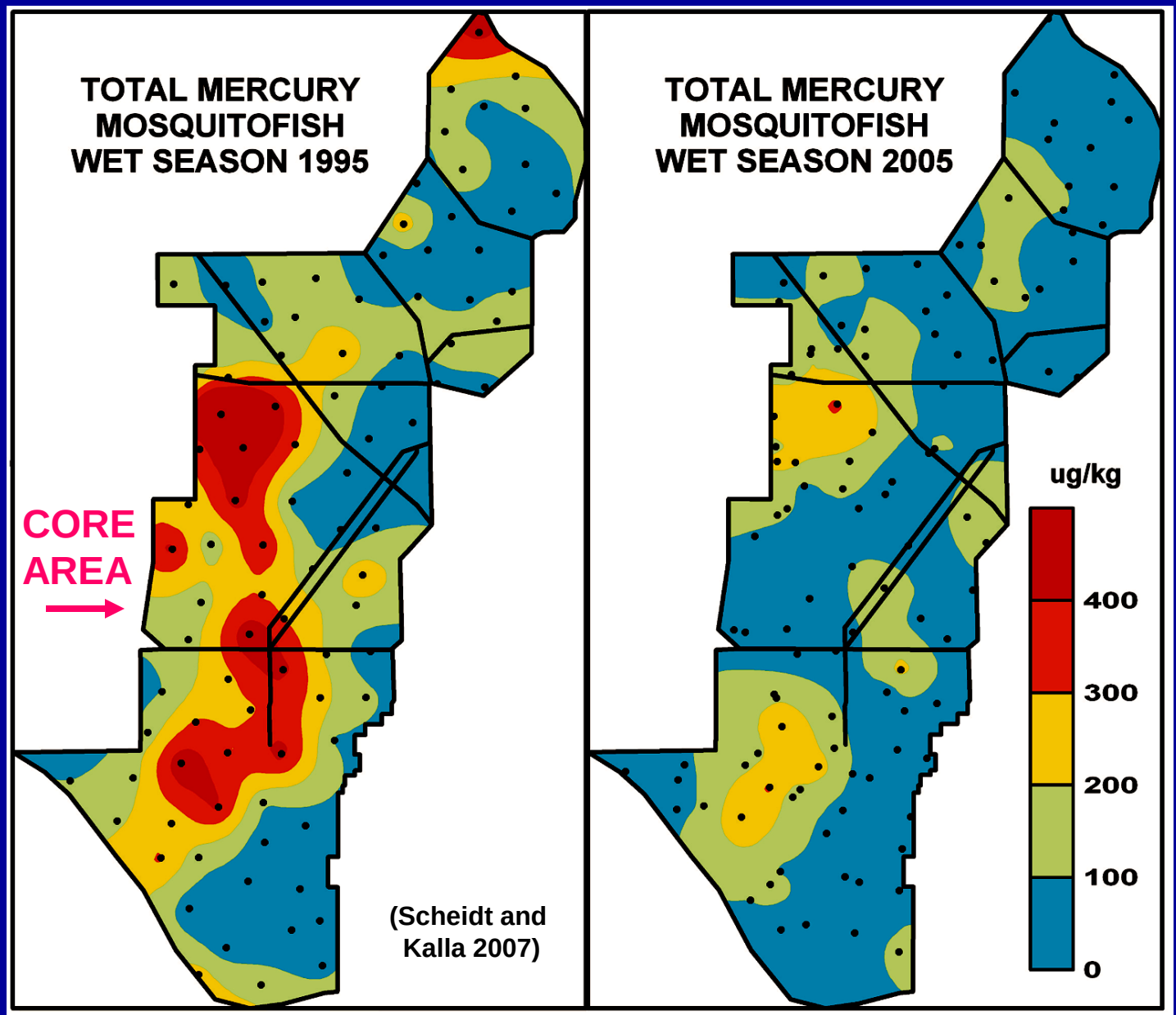
Biogeochemical Sampling Everywhere

Media and Techniques

Gambusia affinis

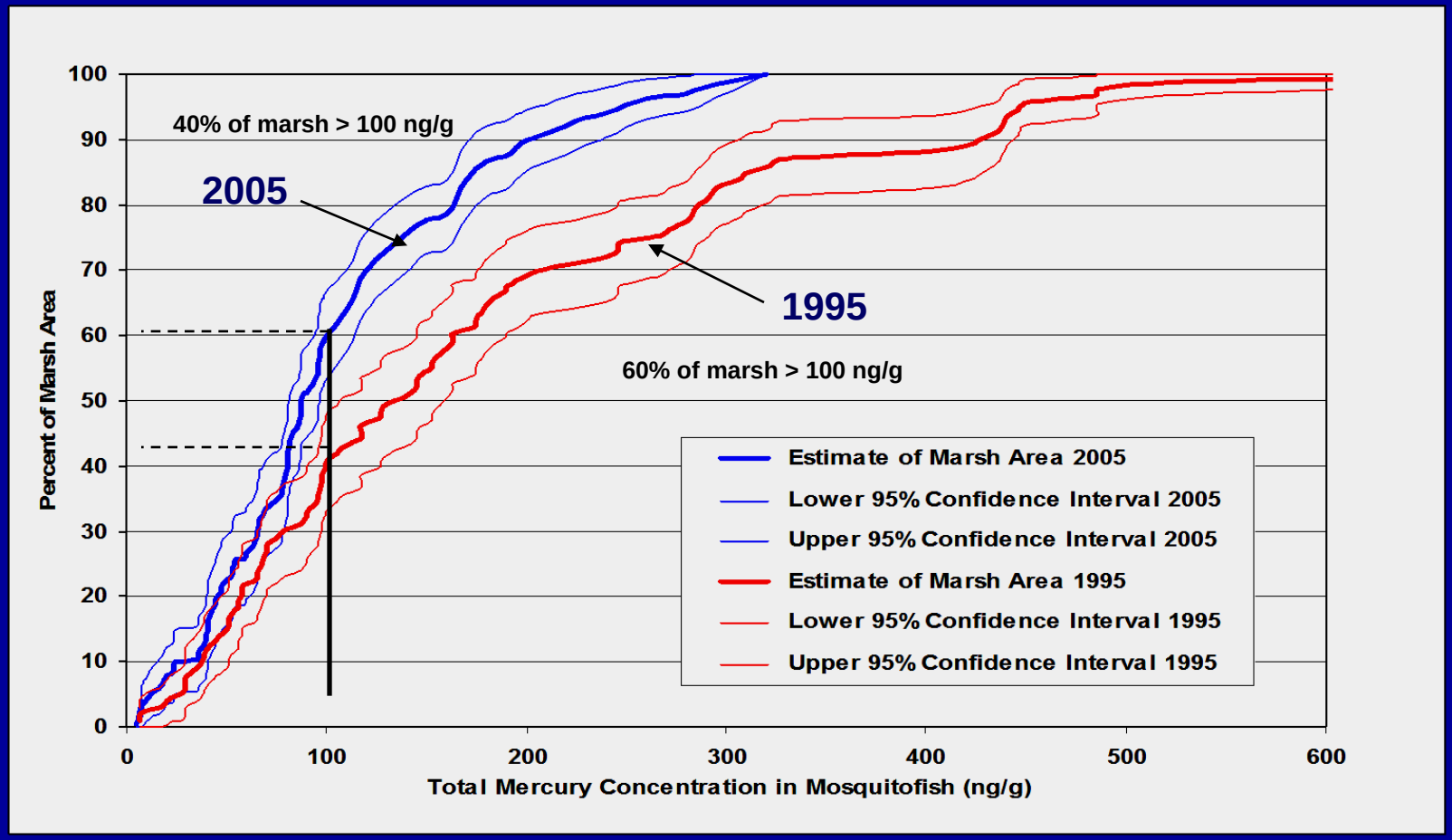


Mosquitofish Mercury, 1995 & 2005

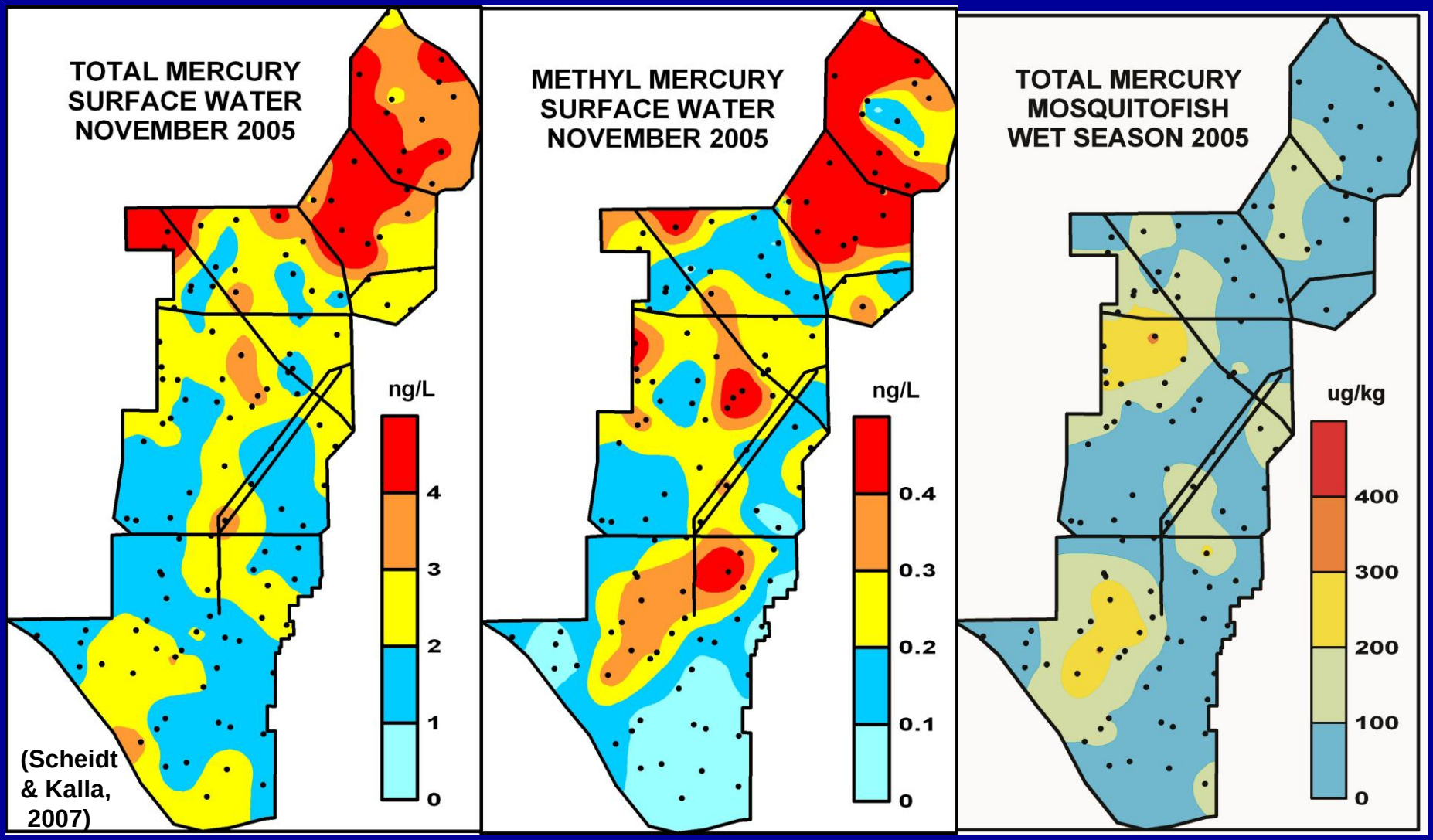


Mosquitofish Mercury, 1995 & 2005

Wet Season

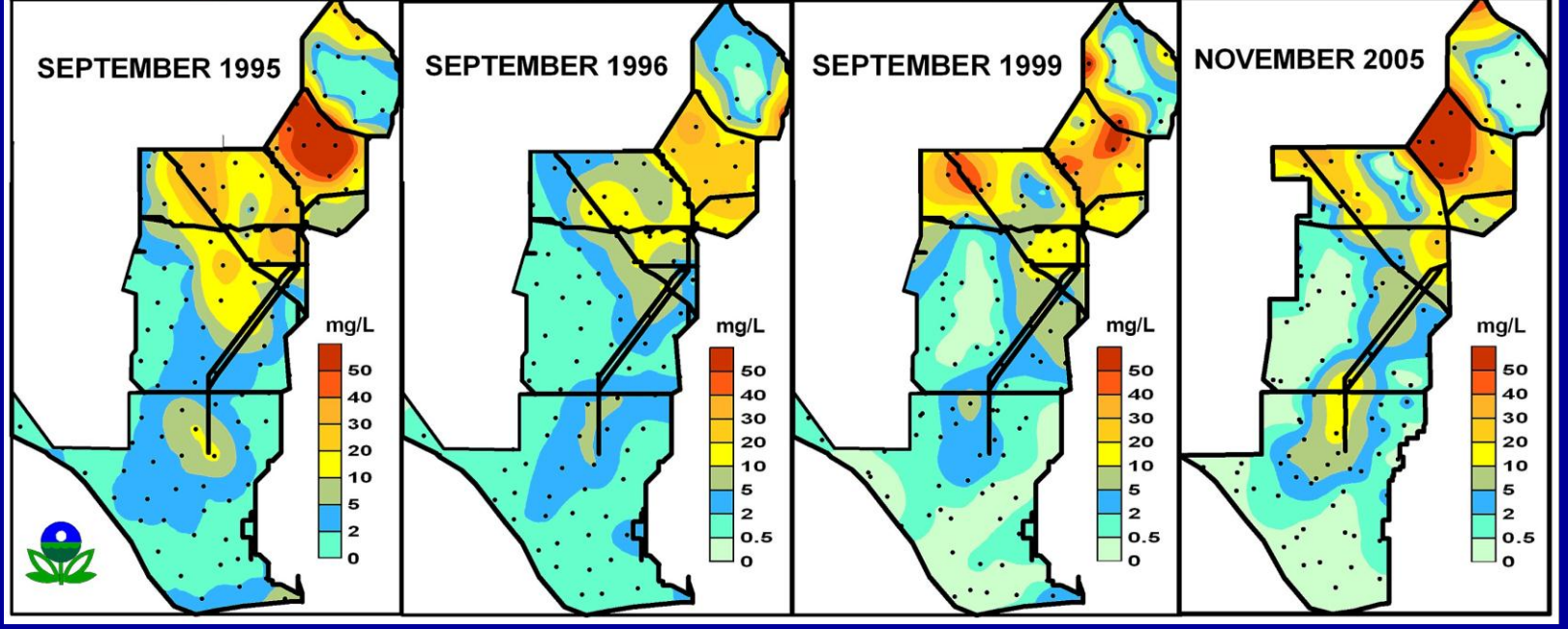


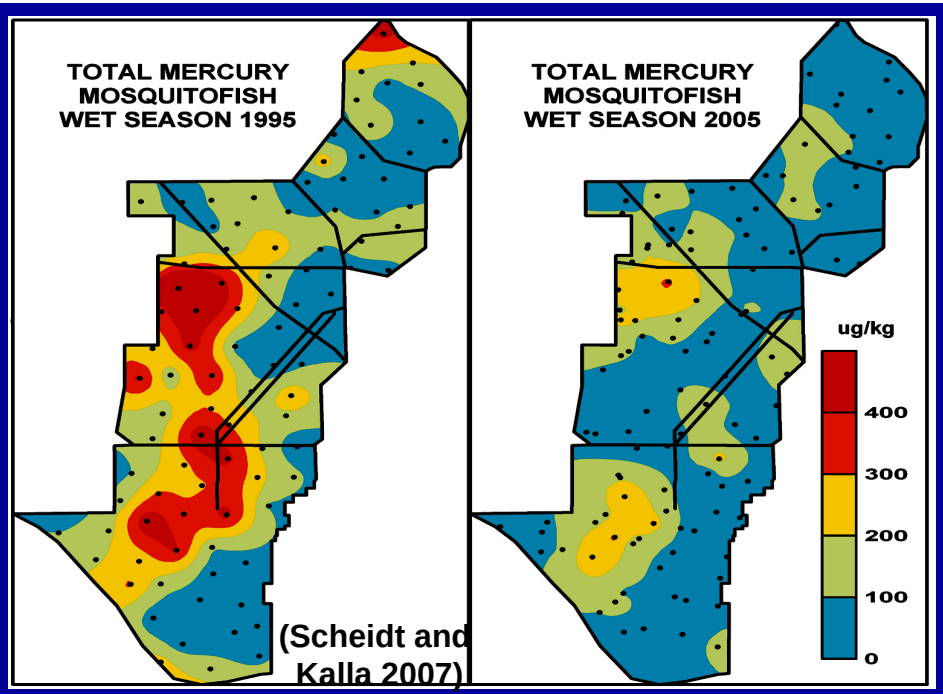
Mercury, Wet Season 2005



(Scheidt & Kalla, 2007)

SO4 in Surface Water

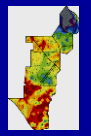




(Scheidt and Kalla 2007)

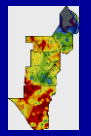
Optimal Biogeochemical Conditions for Elevated Mercury in Mosquitofish

- Surface water SO4: 0.5 – 40 mg/L
- Bulk density: 0.07 – 0.6 g/cm^3
- Soil TP: 100 – 800 mg/kg
- Surface water DOC: 7 – 35 mg/L
- Surface water pH: 6.6 < pH < 8.0

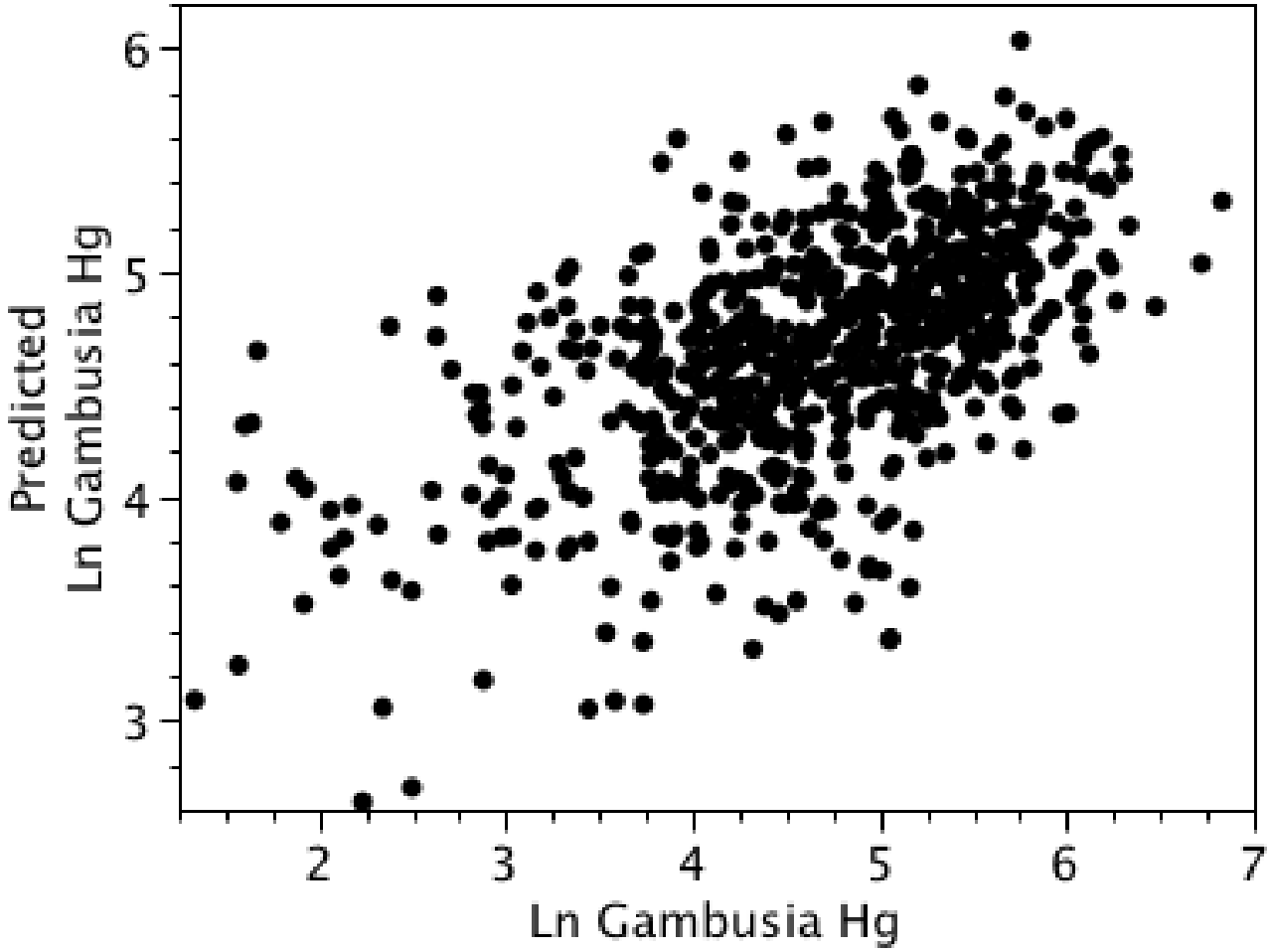


Biogeochemical Prediction of Mosquitofish Mercury

Ln fish Hg = *f* (time, sigmoid SO_4, soil Hg, soil TP, TOC/DOC)

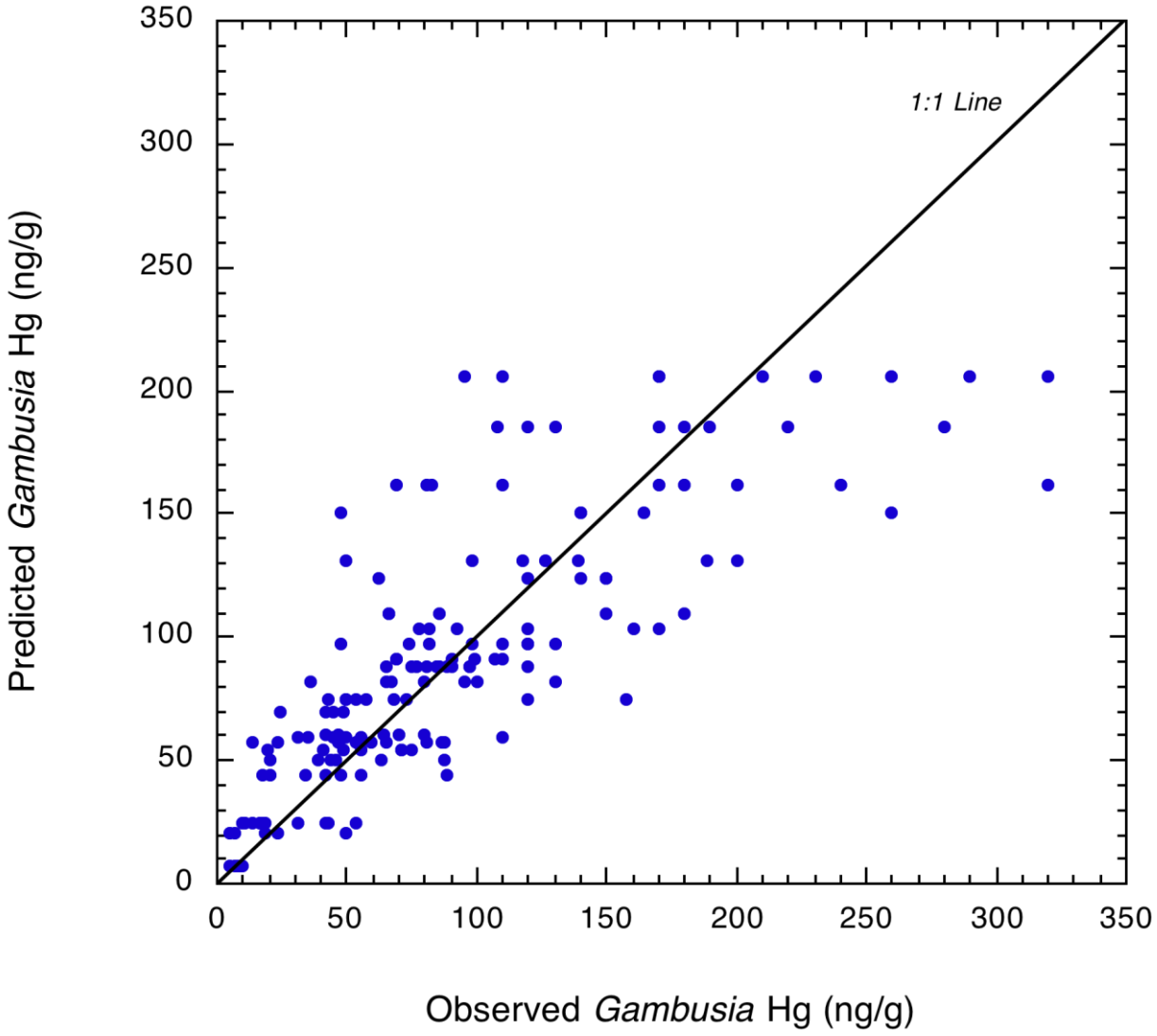


Model Prediction vs. Observed Concentration

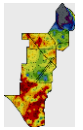


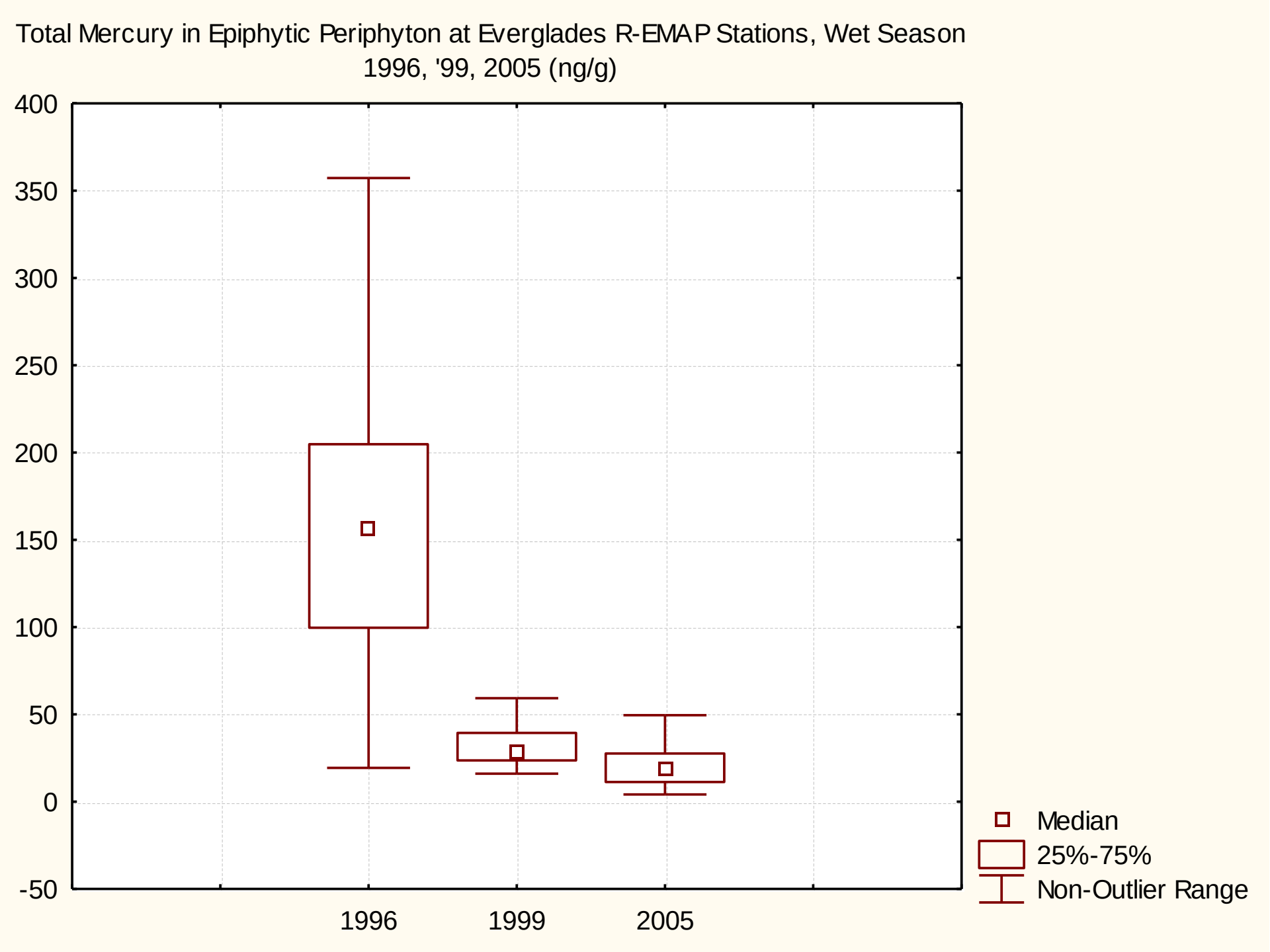
Aggregate $r^2 = 0.33$

Recursive Partitioning Modeled *Gambusia* Hg *vs.* Observed Concentrations

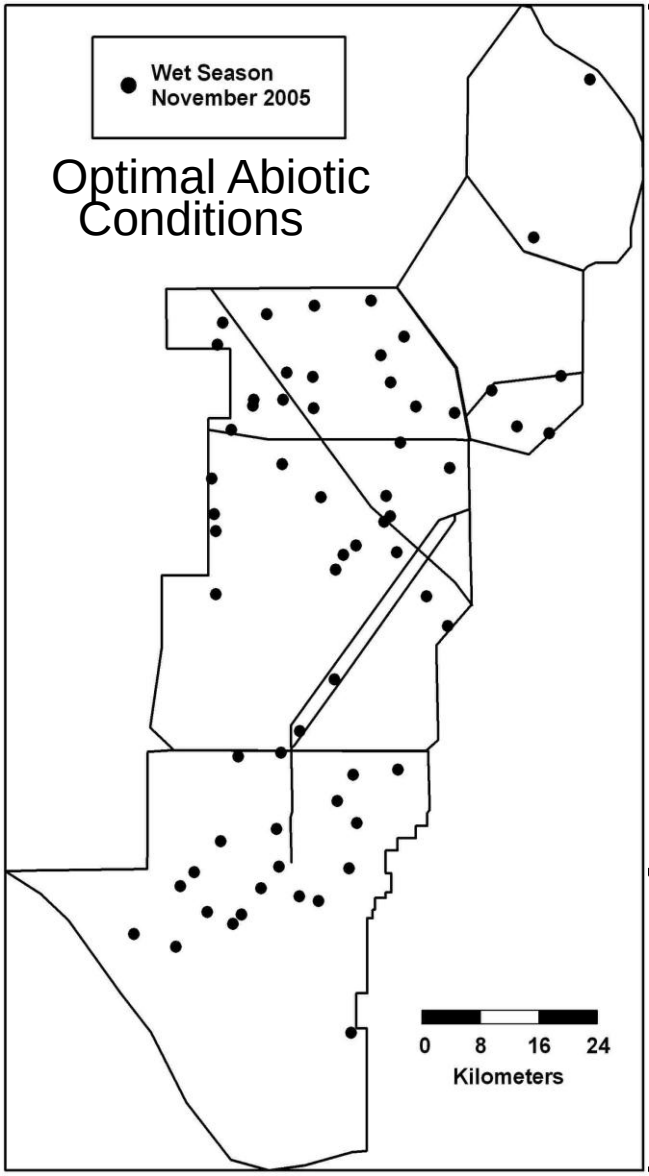


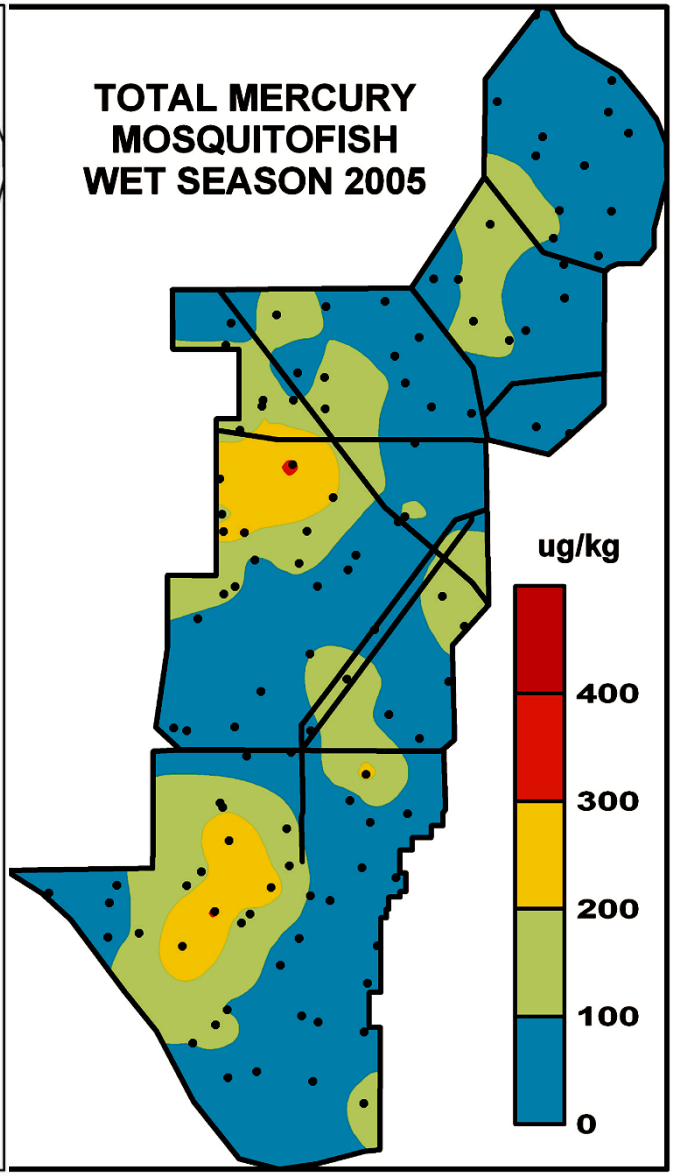
	THgFish	BAFMeHg
THGSW		-0.4217
MeHgSW	*0.4702*	-0.7801
BAFTHG	0.9133	0.7763
BAFMeHG	0.6477	
MeHgPE	**0.678**	
MeHgPF		-0.9391
MeHgPB	0.583	
TCSD		*-0.3345*
FDOCPW		-0.4917
DOCSW		-0.646
AFDWSD		*-0.3661*
BDSD		0.4271
COND		-0.2614
CLSW		-0.4659
SO4SW		-0.4697
SO4PW		-0.538
H2SPW		-0.6261
depth		*-0.5278*
APASW	0.5054	0.5299
CHLASW		-0.2581
TPSW	-0.3804	-0.4656
TPFC	-0.5834	
TPSD1		-0.3185

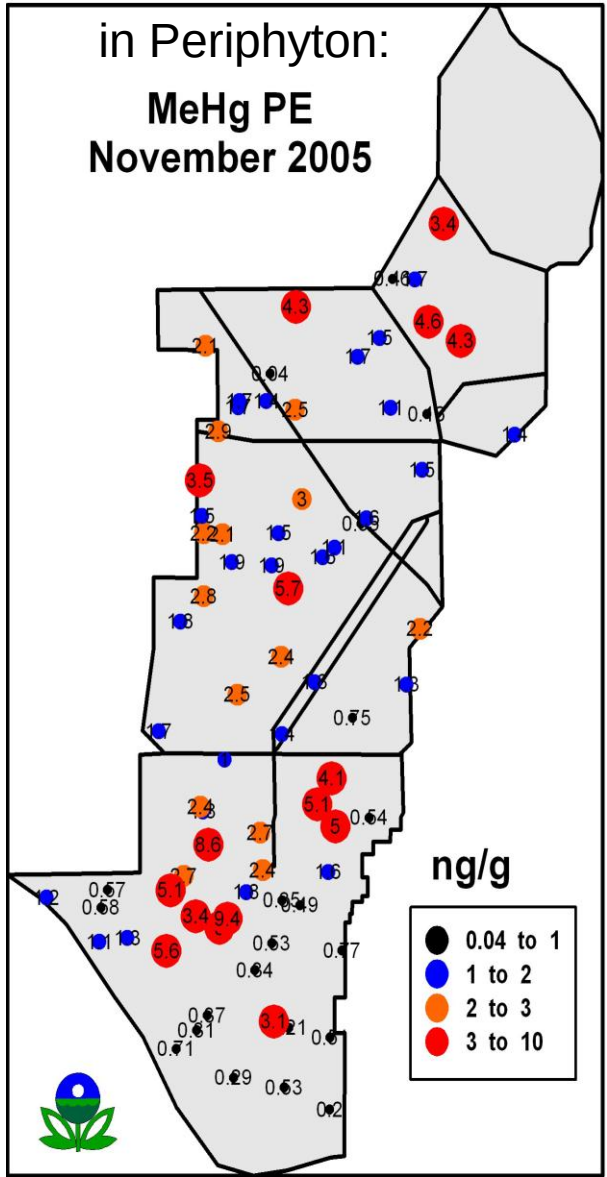



Total Mercury in Epiphytic Periphyton at Everglades R-EMAP Stations, Wet Season 1996, '99, 2005 (ng/g)
400
350
300
250
200
150
100
50
0
-50
1996
1999
2005
Median
25%-75%
Non-Outlier Range

Methylation and the Food Web



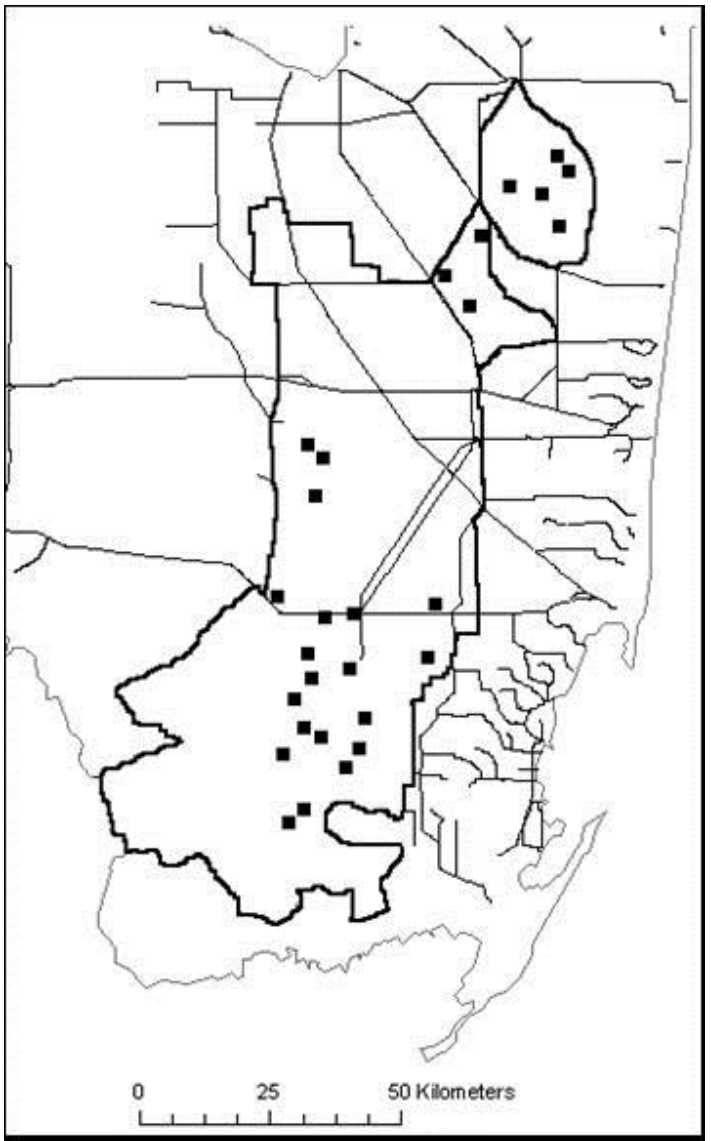




Throw-Trapping

Trophic Hypothesis:
R-EMAP interaction web

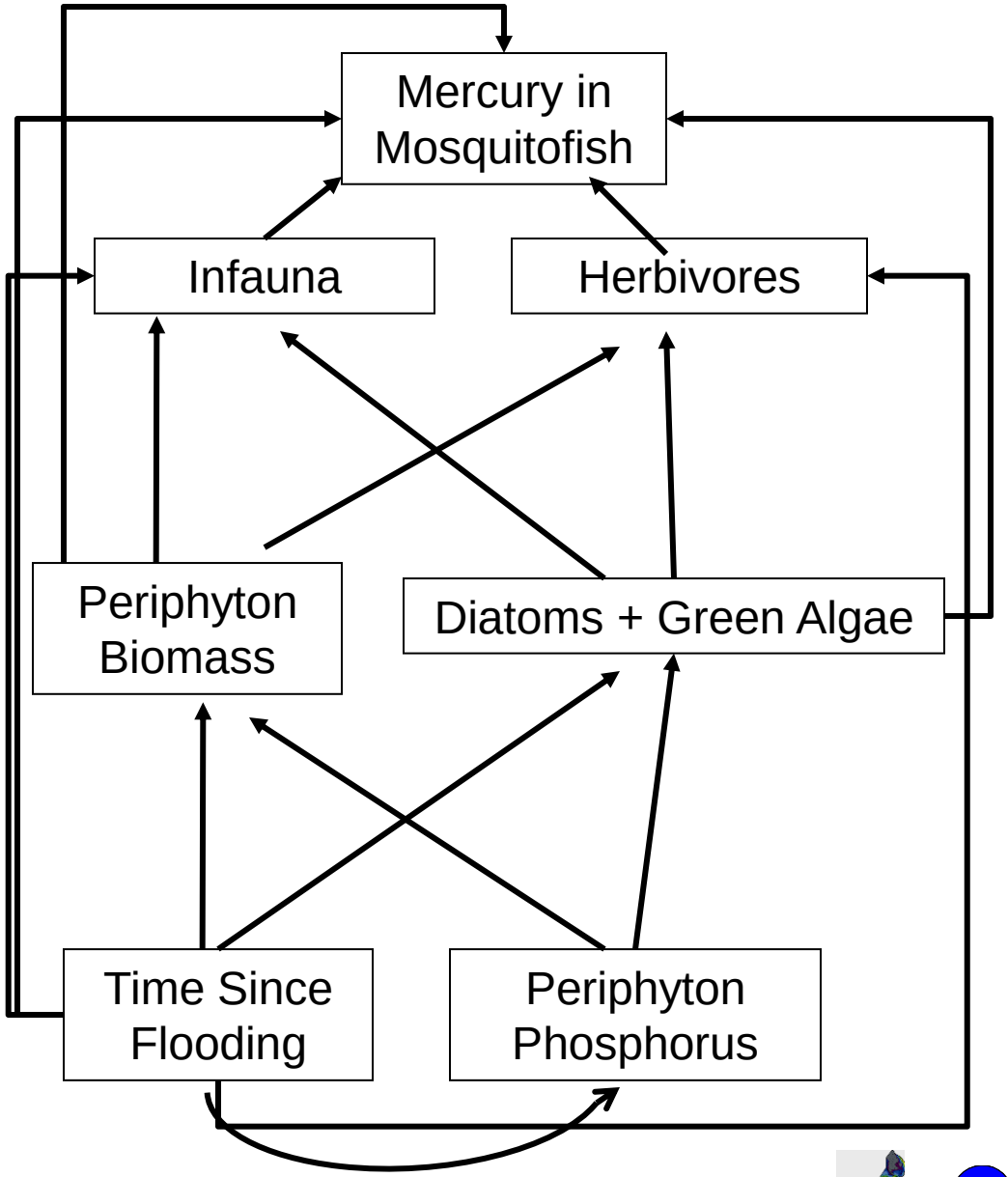
- Used path analysis to test food-web hypothesis
- Density-mediated bioaccumulation was considered because mercury was not measured for each food-web component.
- Hydrology, Periphyton TP, species composition and biomass, macroinvertebrate infauna, small herbivorous and omnivorous fish, and large macroinvertebrates



Food-Web Hypothesis:
R-EMAP interaction web

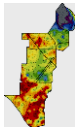
Model 1: All bottom-up effects

Hypothesis: all effects are density-mediated

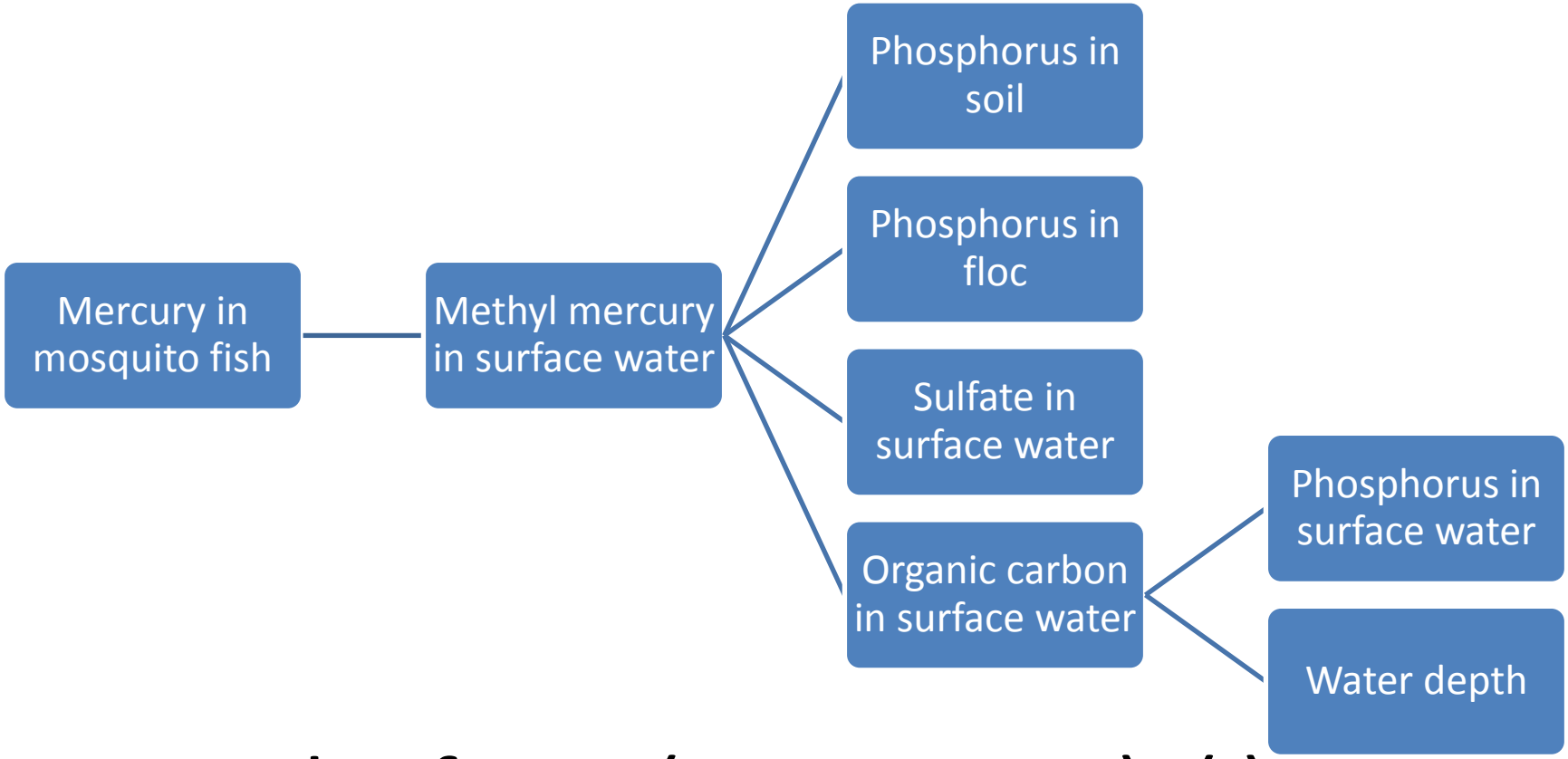


Food Web Hypothesis:
R-EMAP interaction web

- Both nutrient and hydrological effects propagate through the food web to affect omnivore density…; all effects are indirect.
- No indirect density-mediated effects were documented for mosquitofish mercury; direct effect of hydrology was noted.
- Future models should consider biomass and uptake-mediated hypotheses.

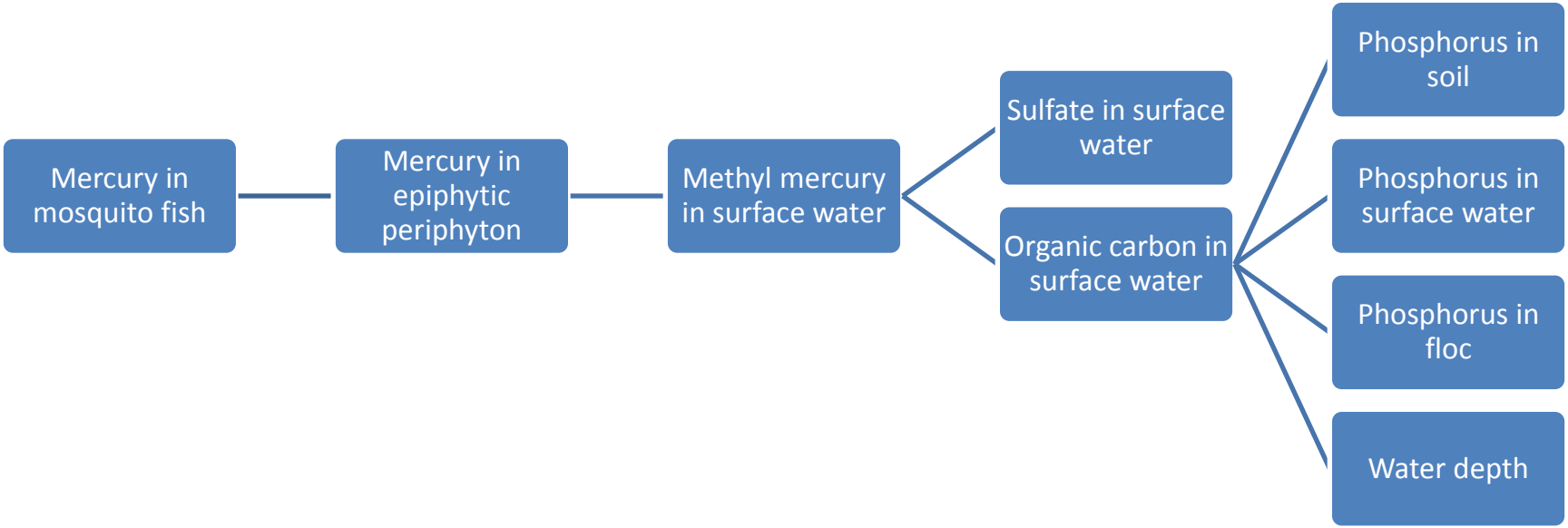


Abiotic Path Analysis Model



South of I-75 (~Core Area) (i)

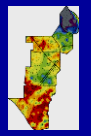
Epiphytic Periphyton Model



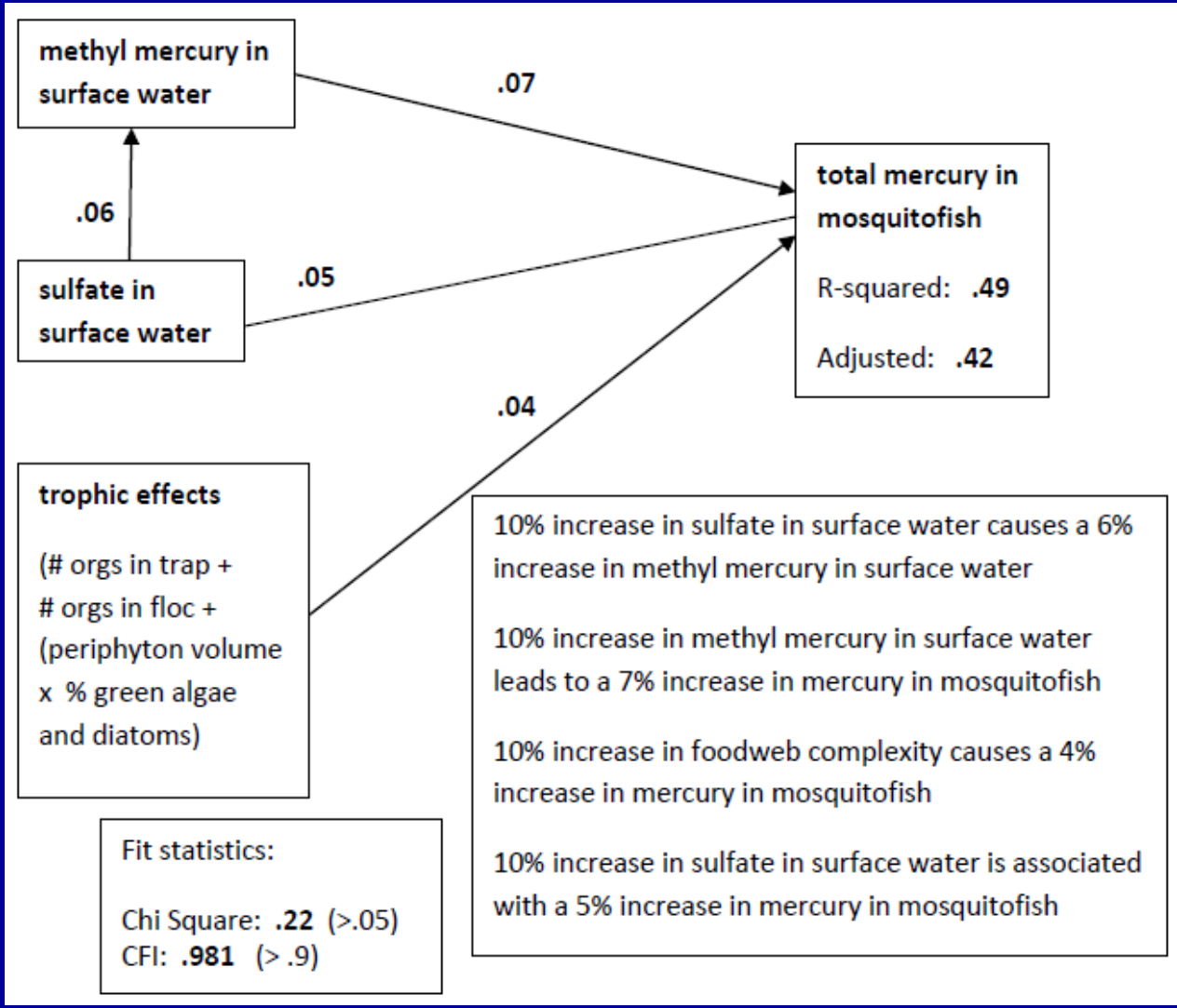
South of I-75 (~Core Area) (ii)

Trophic Effects

- Total organisms in trap
- Total organisms in floc
- (Periphyton volume) x (% green algae & diatoms)



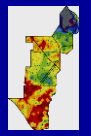
Sulfate - Trophic/Web Model



Log-N, back-transformed
Predictors: .001 > P = .007

Conclusions, Synthesis, Hypothesis, and Implications

- Mercury in mosquitofish declined, but remains above acceptable limits for about half of the system.
- Methylation is affected locally by relatively small changes in sulfate, phosphorus, and organic carbon.
- Bioaccumulation of mercury is dampened or amplified by food web effects, which vary widely throughout the system.
- Synergistic effects of driving methylation in complex food webs should be avoided when modifying water deliveries.



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