Fish Mercury in the Everglades: Management Implications for Everglades Restoration

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FWC

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Collaborators/Acknowledgements

SFWMD

Water Quality Monitoring Section, South Florida Water Management District, West Palm Beach

Florida DEP

Division of Environmental Assessment and Restoration, Florida Department of Environmental Protection, Tallahassee

Florida DOH

Bureau of Epidemiology, Division of Disease Control and Health Protection, Florida Department of Health, Tallahassee

USGS

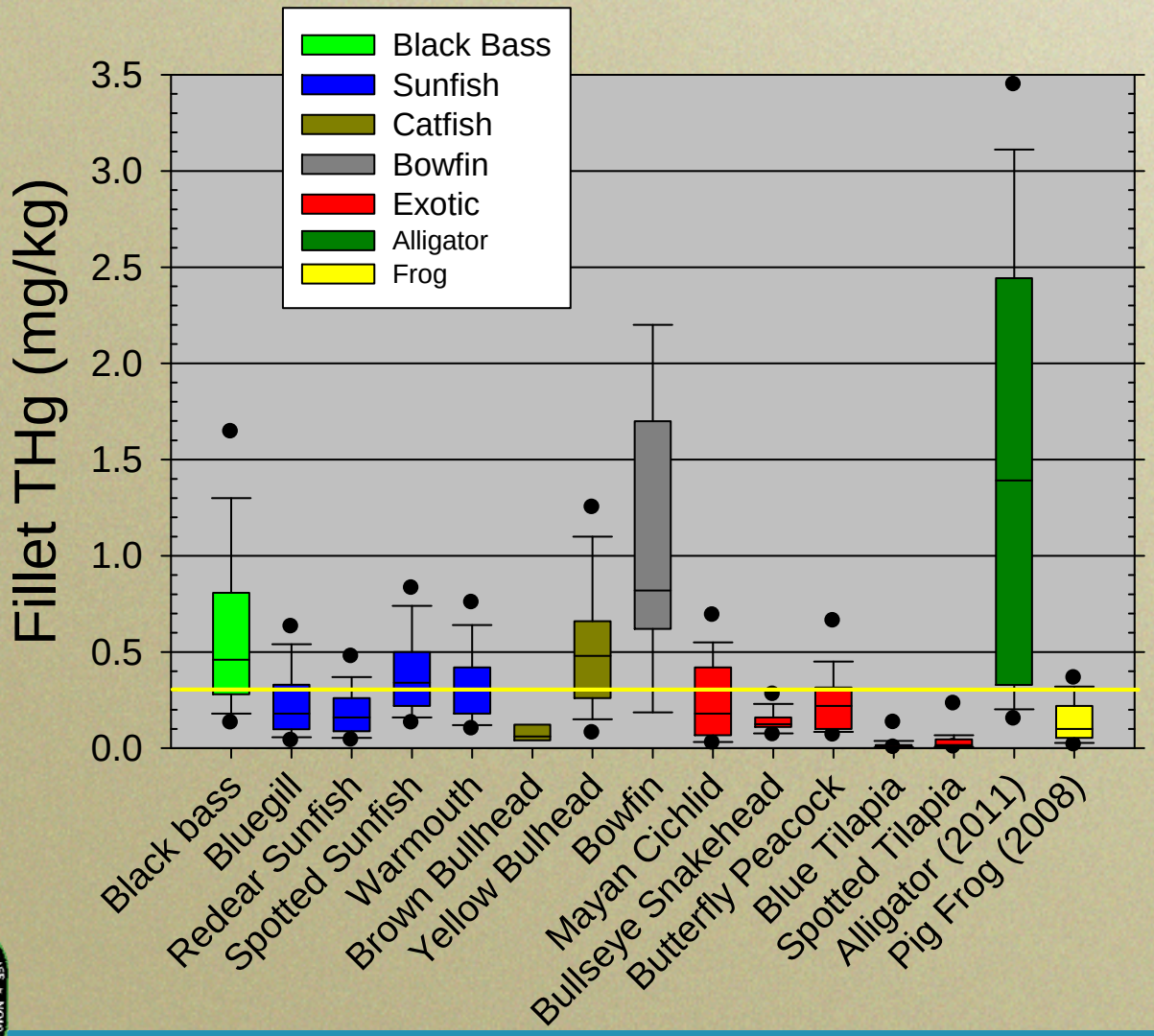
Mercury Research Laboratory, Madison WI

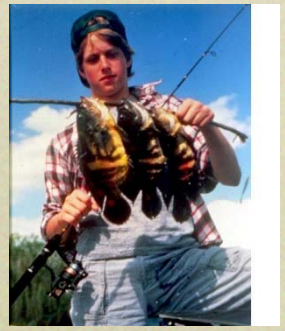
FGCU

Coastal Watershed Institute, Ft Myers

Current Sport Fish THg in FW EPA

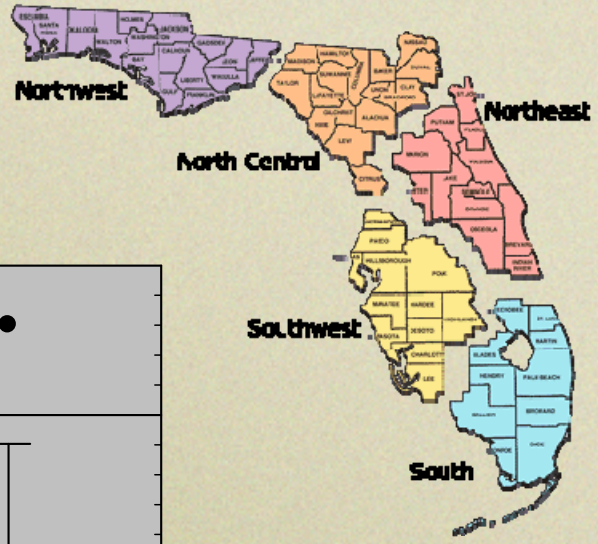
- WCA1, WCA2, WCA3, and ENP-Harvestable size
- USEPA Human Health MeHg Tissue Criterion = 0.3 mg/kg

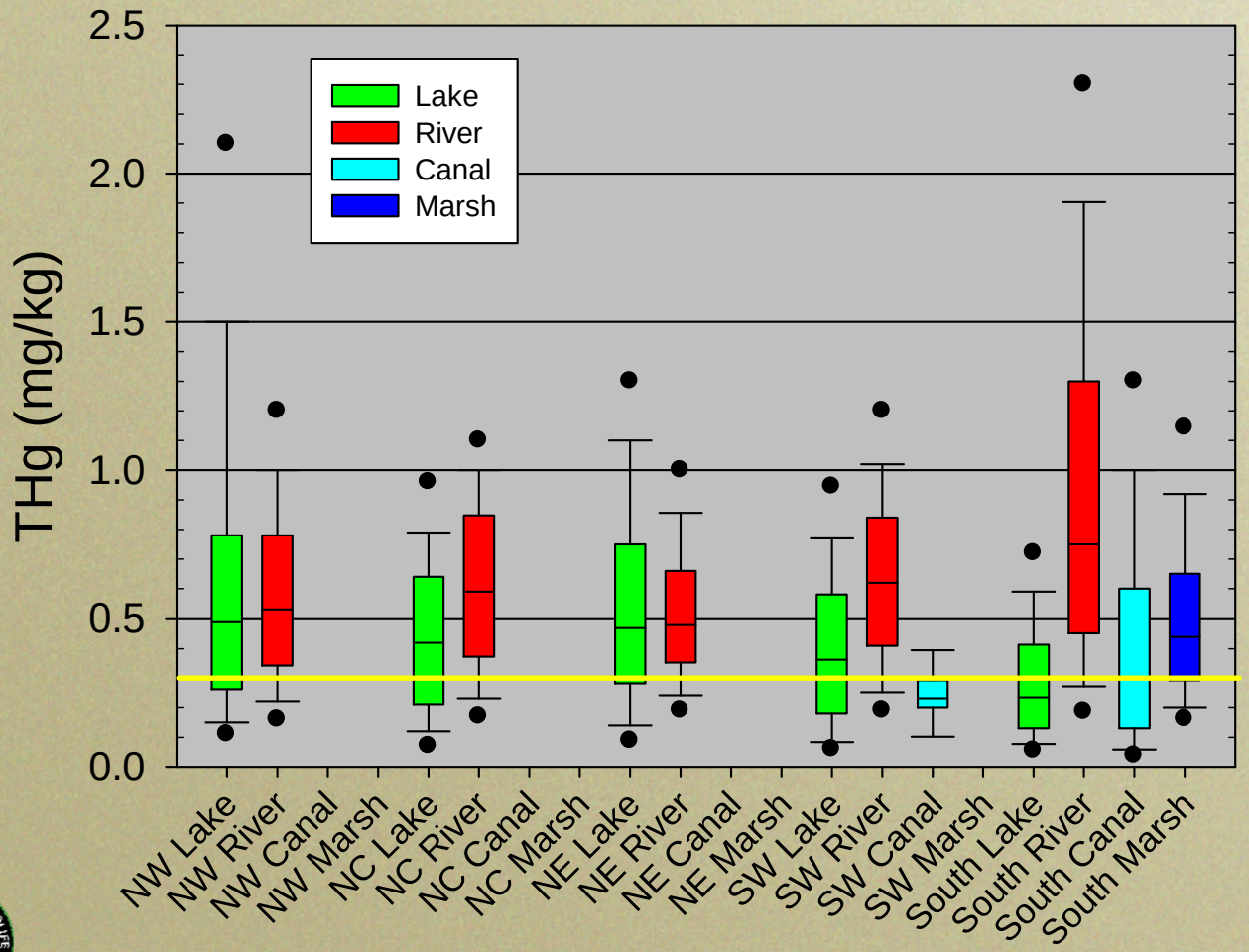




S. FL. Black Bass vs State

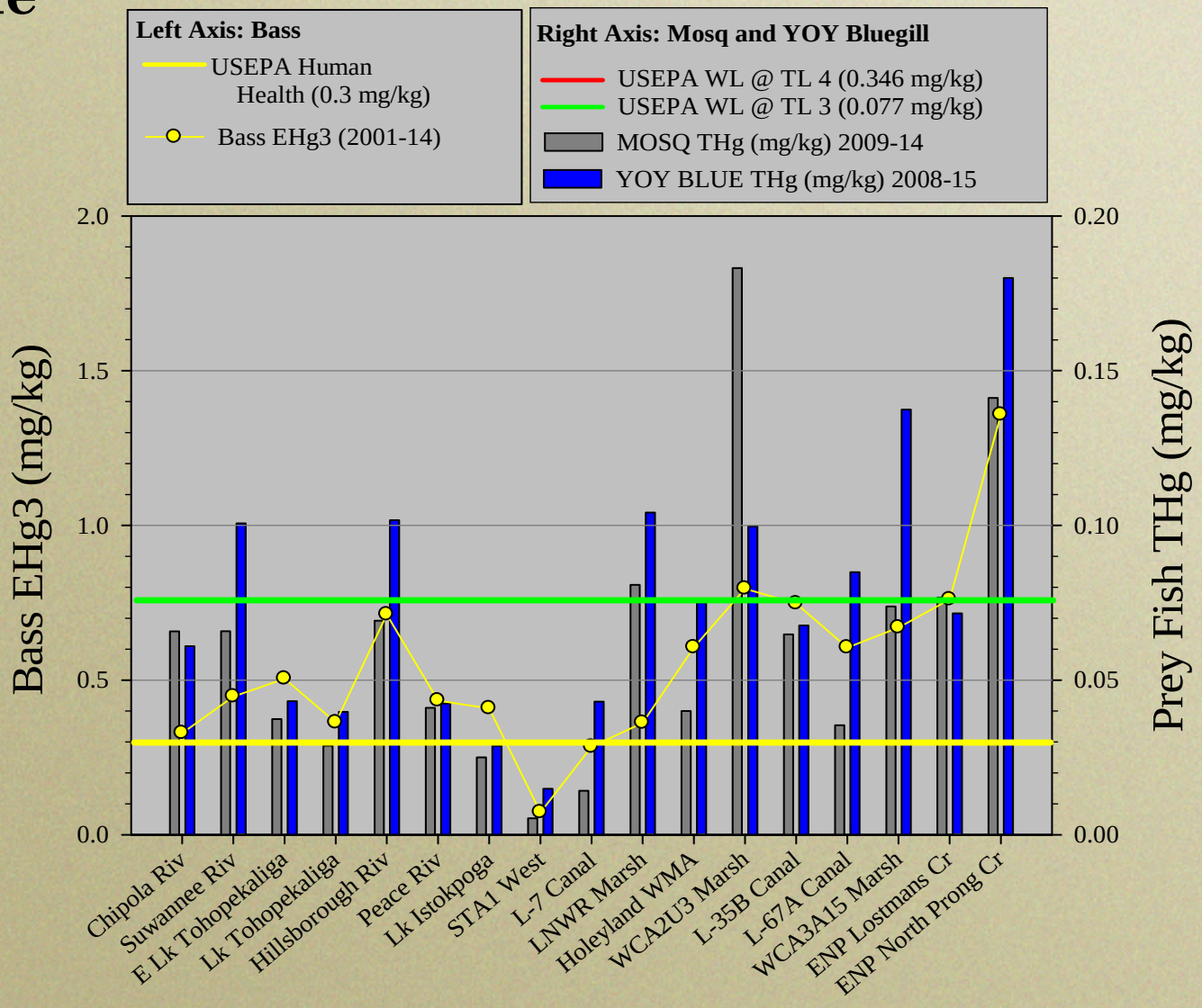
- FWC Regions-Harvestable size
- USEPA Criterion - 0.3 mg/kg





Human and Ecological Risk Fish & Wildlife

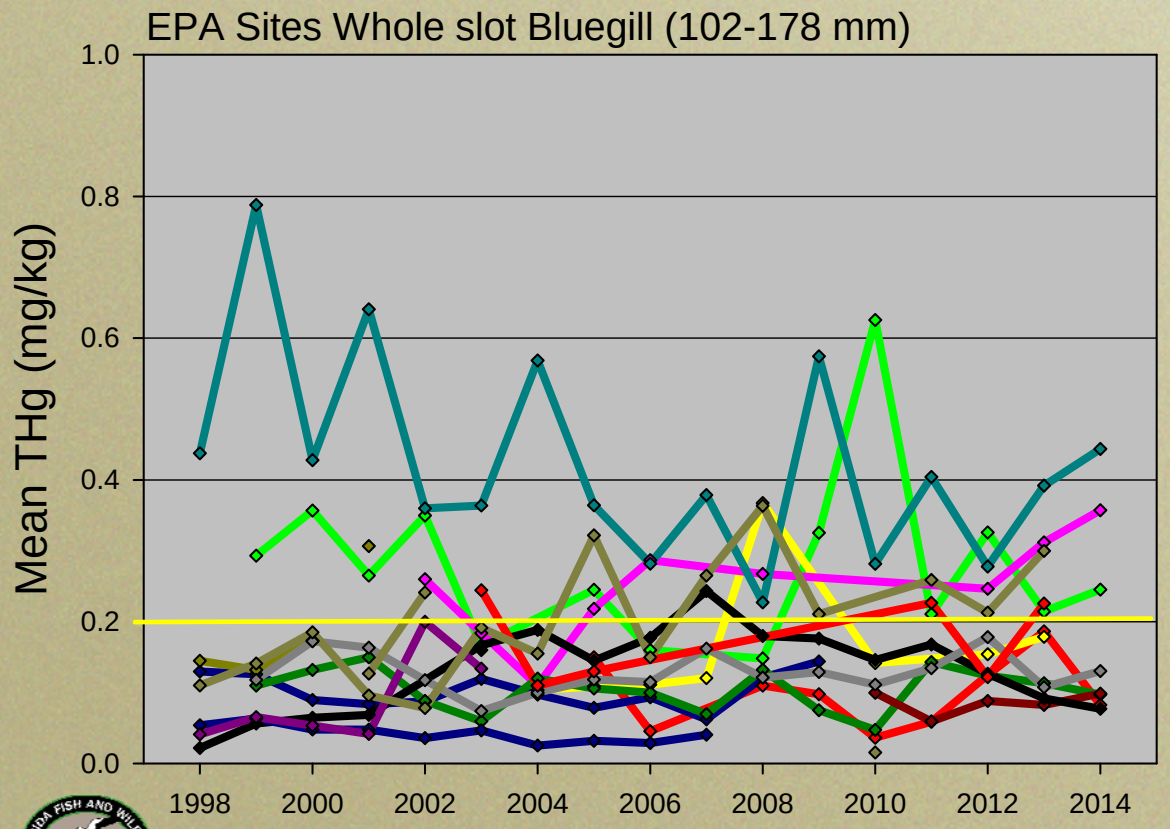
•TL3= Carnivores feeding on Omnivores (YOY BLUE and MOSQ)

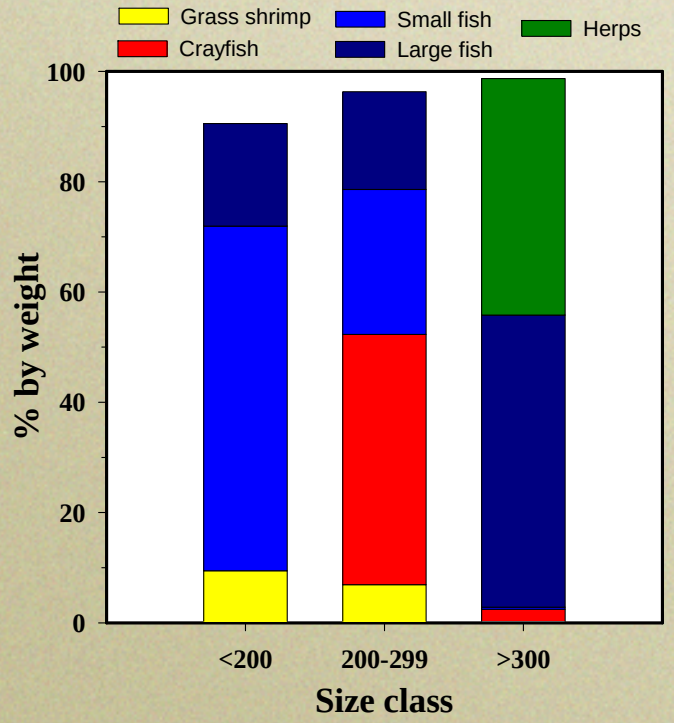


Ecological Risk Fish

Wild Fish Pop Effects (MeHg in Diet) Depew et al. 2012

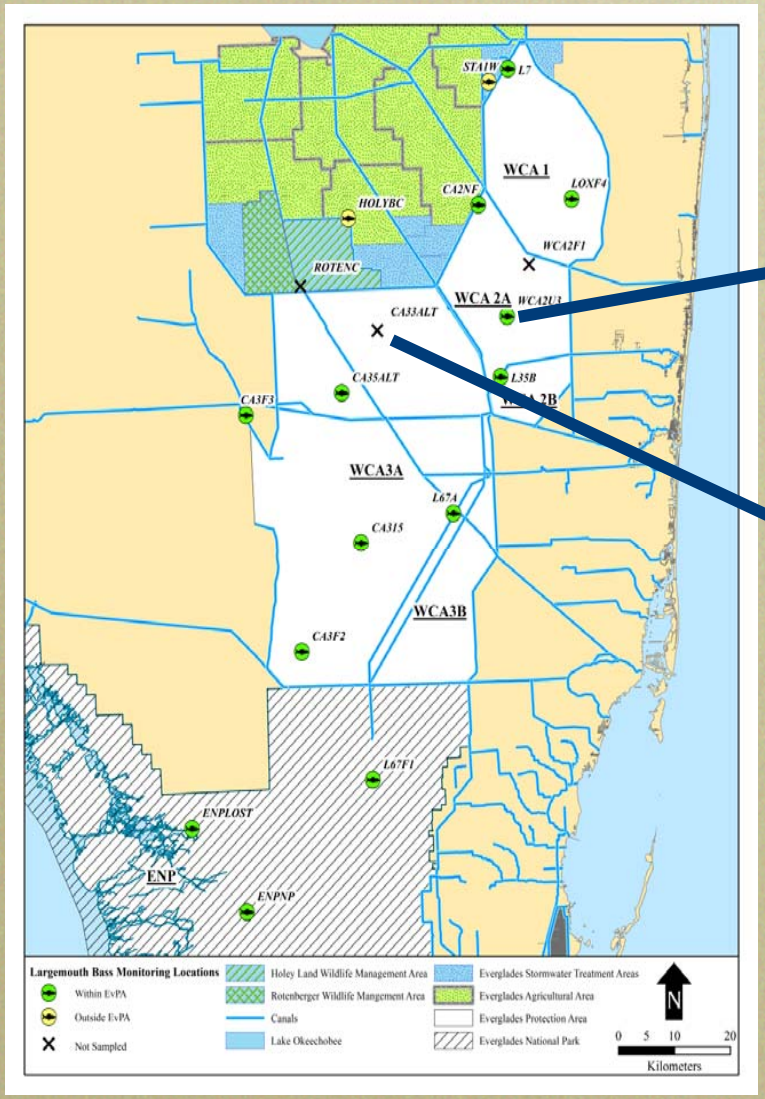
- Growth – 2.5 mg/kg
- Behavior – 0.5 mg/kg
- **Reproduction sub-clinical effects - <0.2 mg/kg**

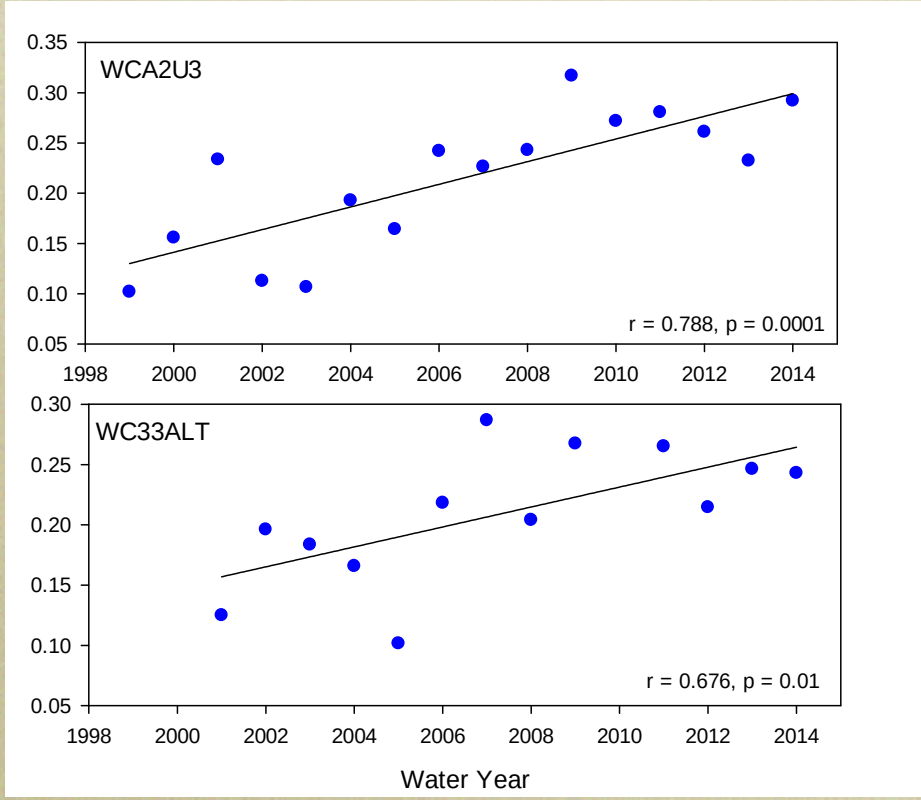




U3 Bass

Compartmentalized EPA-Site Specific Trends

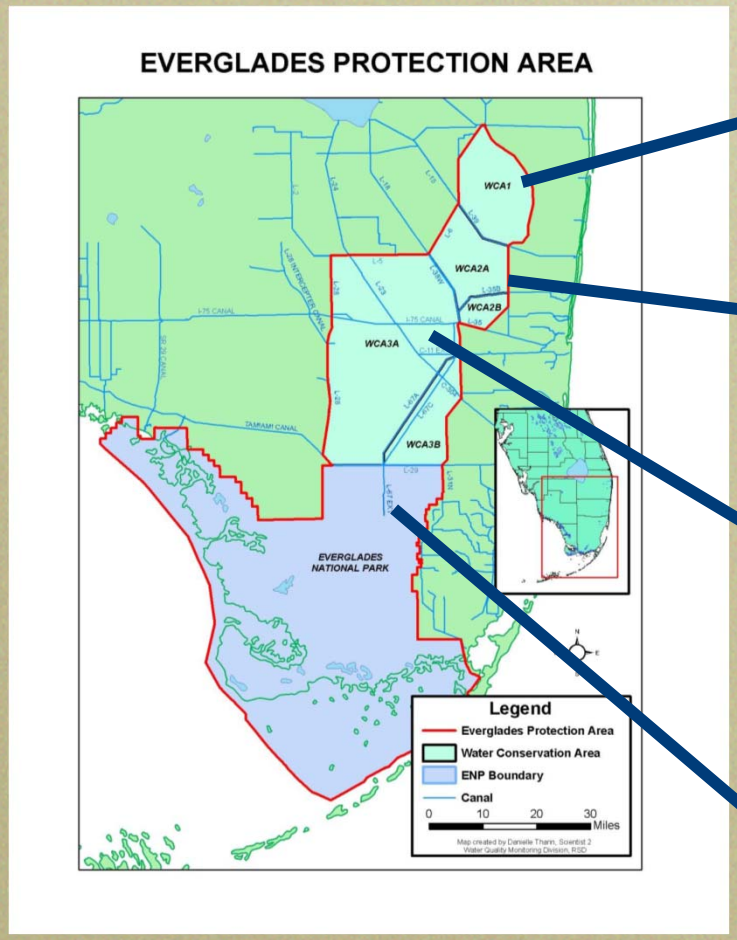


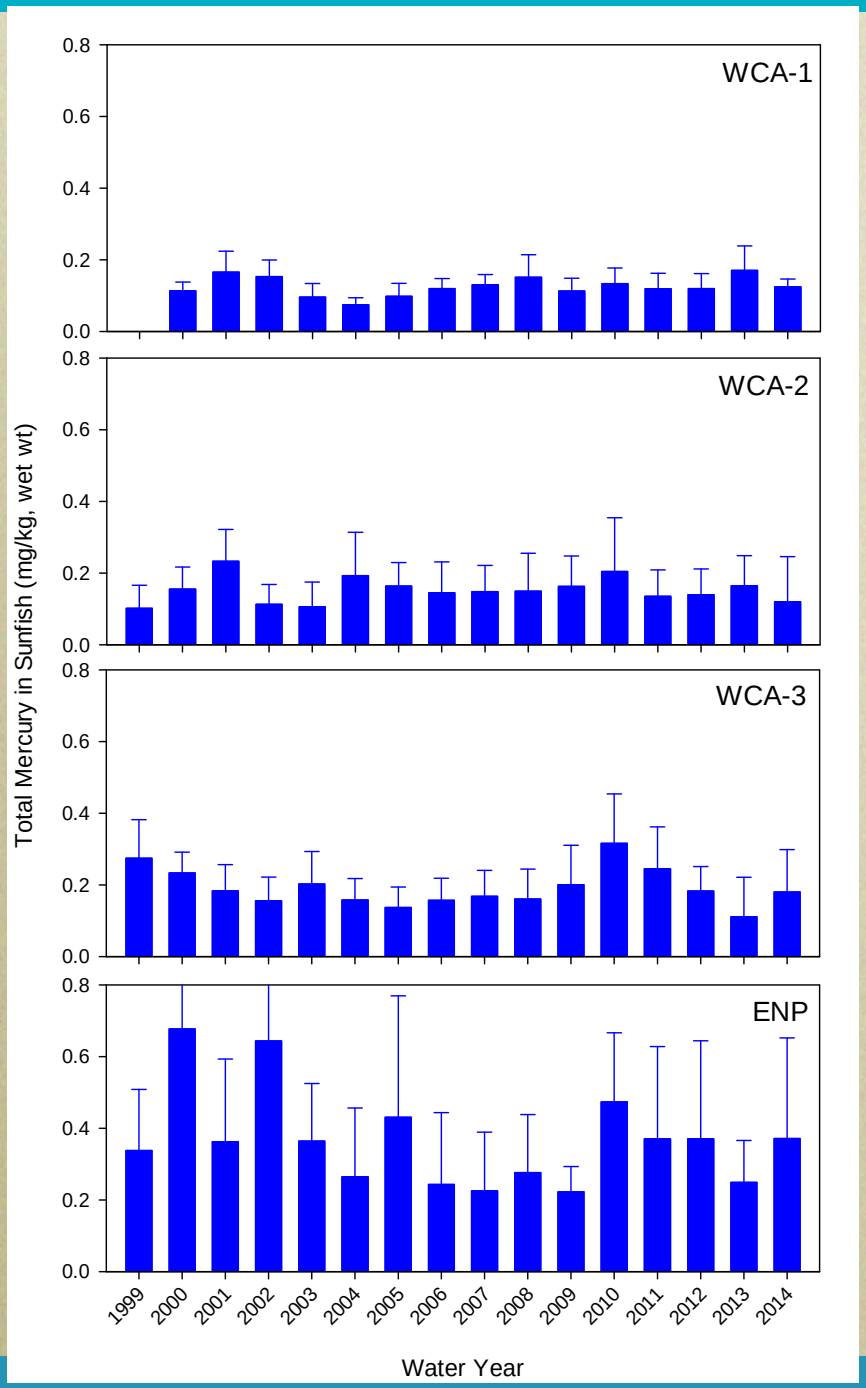


Slot Bluegill (102-178 mm)

Increasing Trends 2 locations

Compartmentalized EPA





Mean THg in TL3 sunfish WY1999–WY2013. Error bars = 1 SD.

Trends in Bass

WCA1, 2 and 3

Restricted Cubic spline with knots selected to best fit data.

- 1988 to 2001 - Decline

  (t_{4023} = -27.86, P < 0.001).

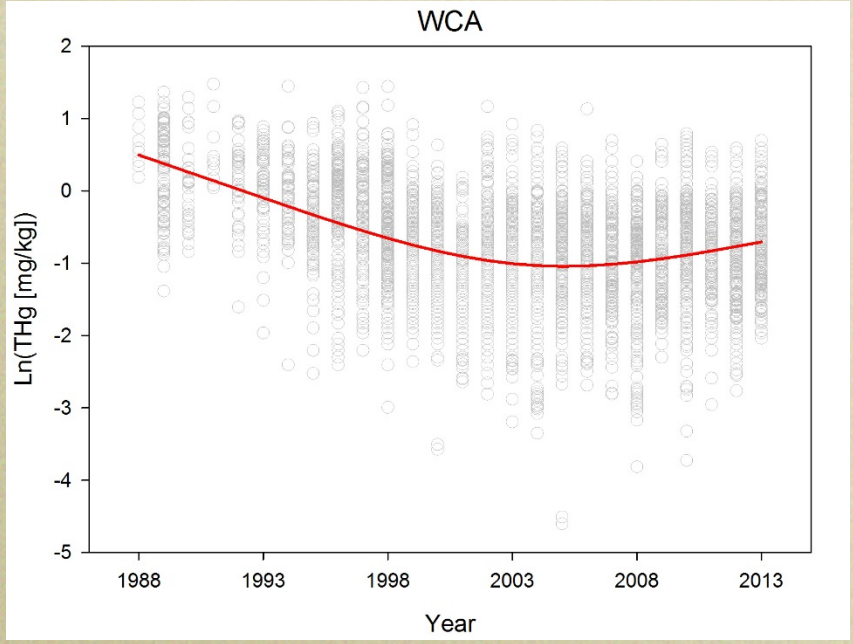
- 2001 to 2013 - Increase

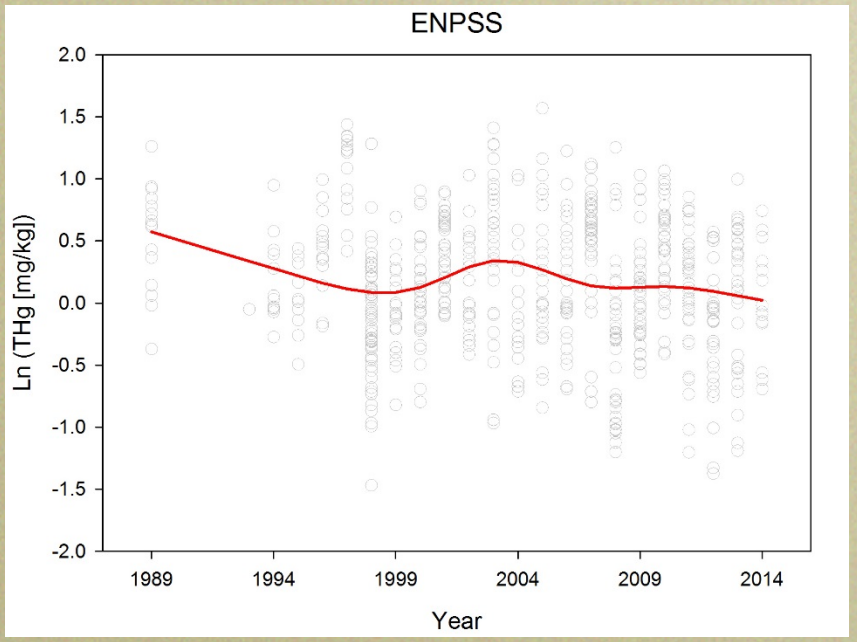
  (t_{4023} = 5.38, P < 0.001)

ENPSRS

- 1989 to 2014-Delcine

  ($F_{5,691}$ = 5.85, P < 0.001)





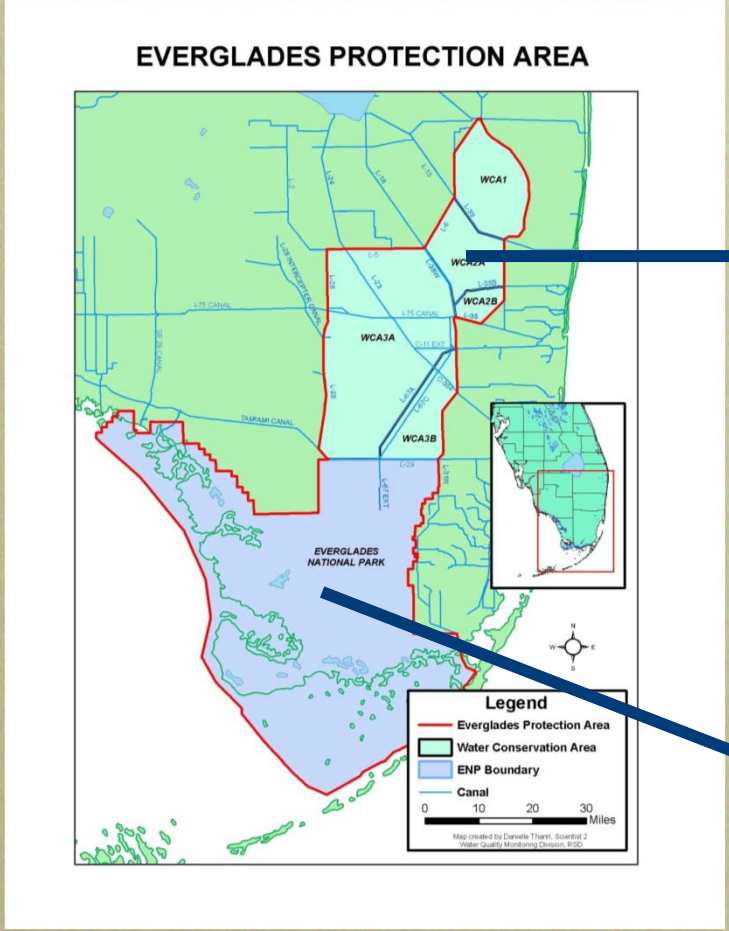
Risk Management-Consumption Advisories

- Based on USEPA MeHg Rfd of 0.1 µg / kg BW – day
- Encourages 2 fish meals/week
- FL Dept of Health Criteria
  - Sensitive population: Women of childbearing age and young children
  - General population: All other individuals

Florida Department of Health Guidelines		
Meal Frequency[1]	**Sensitive Population**	**General Population**
2 meals per week	< 0.1 mg/kg methylmercury[2]	< 0.3 mg/kg methylmercury
1 meal per week	< 0.2	< 0.6
1 meal per month	< 0.85	< 1.5
DNE	≥ 0.85	≥ 1.5

Seek to encourage consumption of fish for health benefits but guide decisions toward selecting fish meals low in mercury.

Managing Public Health-Advisories



FW Fish Consumption Recommendations

LOCATION	SPECIES	Sensitive	All Others
WCA2A	Mayan cichlid	1/WK	2/WK
	Bluegill, Redear sunfish	1/MO	2/WK
	Butterfly Peacock, Spotted Sunfish, Bass < 14"	1/MO	1/WK
	Bass > 14	DNE	1/MO

LOCATION	SPECIES	Sensitive	All Others
ENP SRS	Redear sunfish, Gray snapper	1 / MO	2 / WK
	Bluegill, Spotted sunfish	1 / MO	1 / WK
	Mayan cichlid	1 / MO	1 / MO
	Common snook, Red drum, Bass < 14", Yellow bullhead catfish	DNE	1 / MO
	Bass > 14 inches	DNE	1 / MO

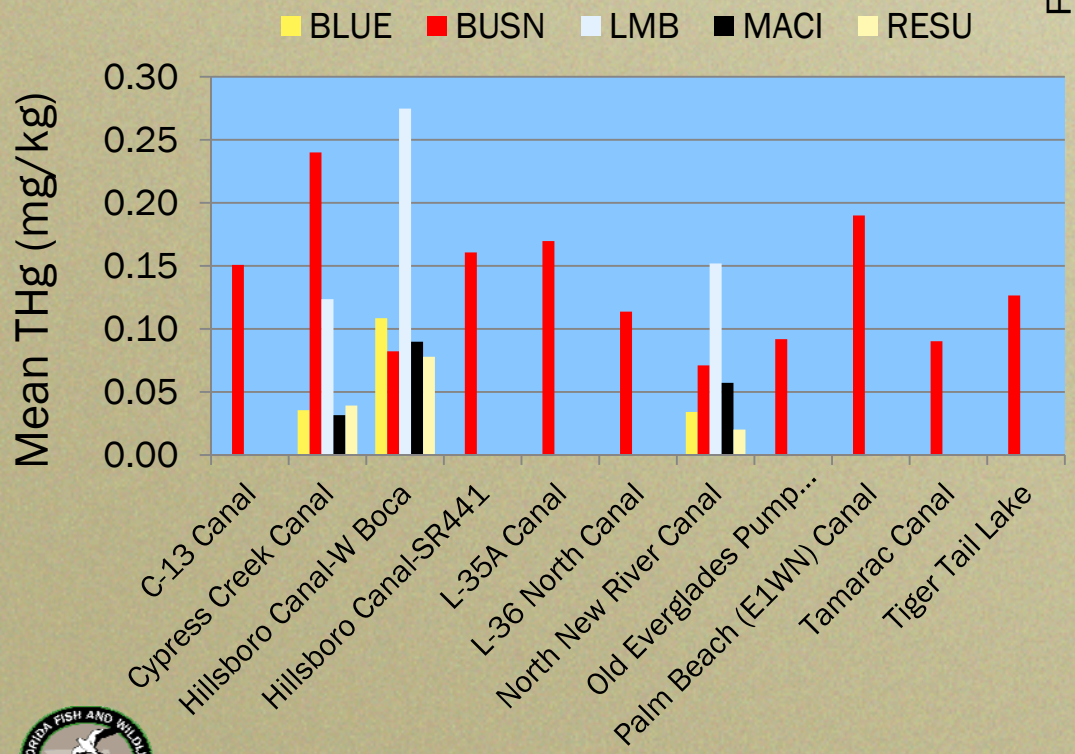
Other Advisories

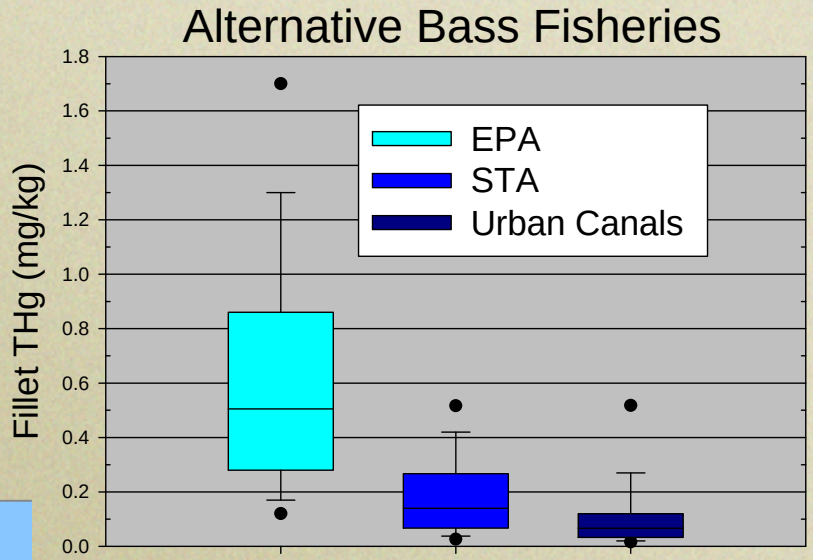
- Pig frogs, Alligators
- 55 Coastal species; 7 are elevated in FL Bay & Keys

Managing Public Health- Alternatives

Direct Harvest away from EPA

- Urban Fisheries
- STAs-Alligator hunts, fisheries
- Other CERP Projects
- Exploit new species





Bullseye Snakehead
Channa marulius
Excellent edibility; up to 15 lbs, top-water baits

Managing Sources-EPA

- Nearly all of the Hg entering the EPA is derived from atmospheric deposition.
- Deposition remains relatively constant with an N-S increase in loading
- Deposition of mercury and subsequent methylation is the source of MeHg in EPA biota
- FL BAY: Atm Dep likely more important than inflows (Rumbold 2010)

- E-MCM predicts decadal time-frame for reductions in fish THg
  - Immediate response
  - Protracted due to labile sed mercury supporting methylation

DEP, 2003. Integrating Atmospheric Mercury Deposition and Aquatic Cycling in the Florida Everglades...TMDL Approach.

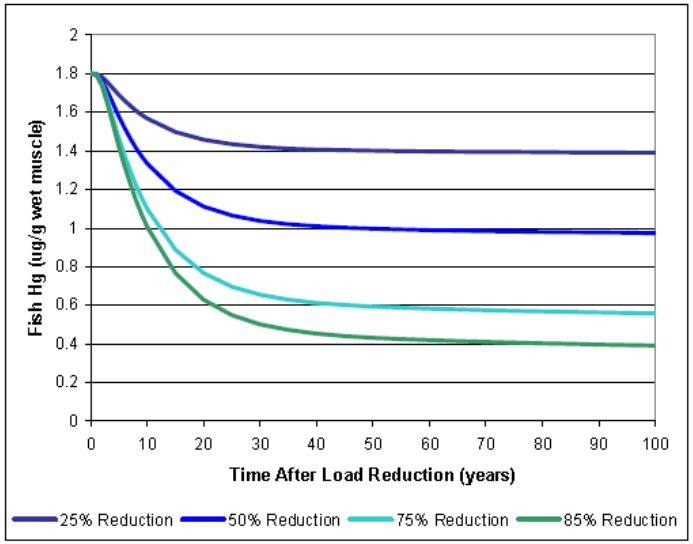


Figure 10. Predicted dynamic response of Hg concentrations in largemouth bass in WCA 3A-15 following different reductions in Hg(II) deposition. Predictions are based on calibration to current loading of 35 $\mu g/m^2/yr$.

Statewide Mercury TMDL (October 2013)

- DEP completed a statewide TMDL for mercury in fresh water and estuaries in September 2012.

- Two Approaches for risk assessment
  - **Market Basket:** examine distributional characteristics of fish consumption by the sensitive population and the likelihood of mercury exposure from eating fish.
  - **Indicator species:** calculate a reduction factor for 90% of largemouth bass populations to reach desired target for consumption

- Both approaches support reductions to limit human exposure
  - **86% reduction from all emission sources (local, regional, and global)**
  - Waste load allocation of 23 kg/yr (MINIMAL)

Mercury TMDL for the state of Florida

Appendix F: Deterministic Atmospheric Modeling and Receptor Modeling

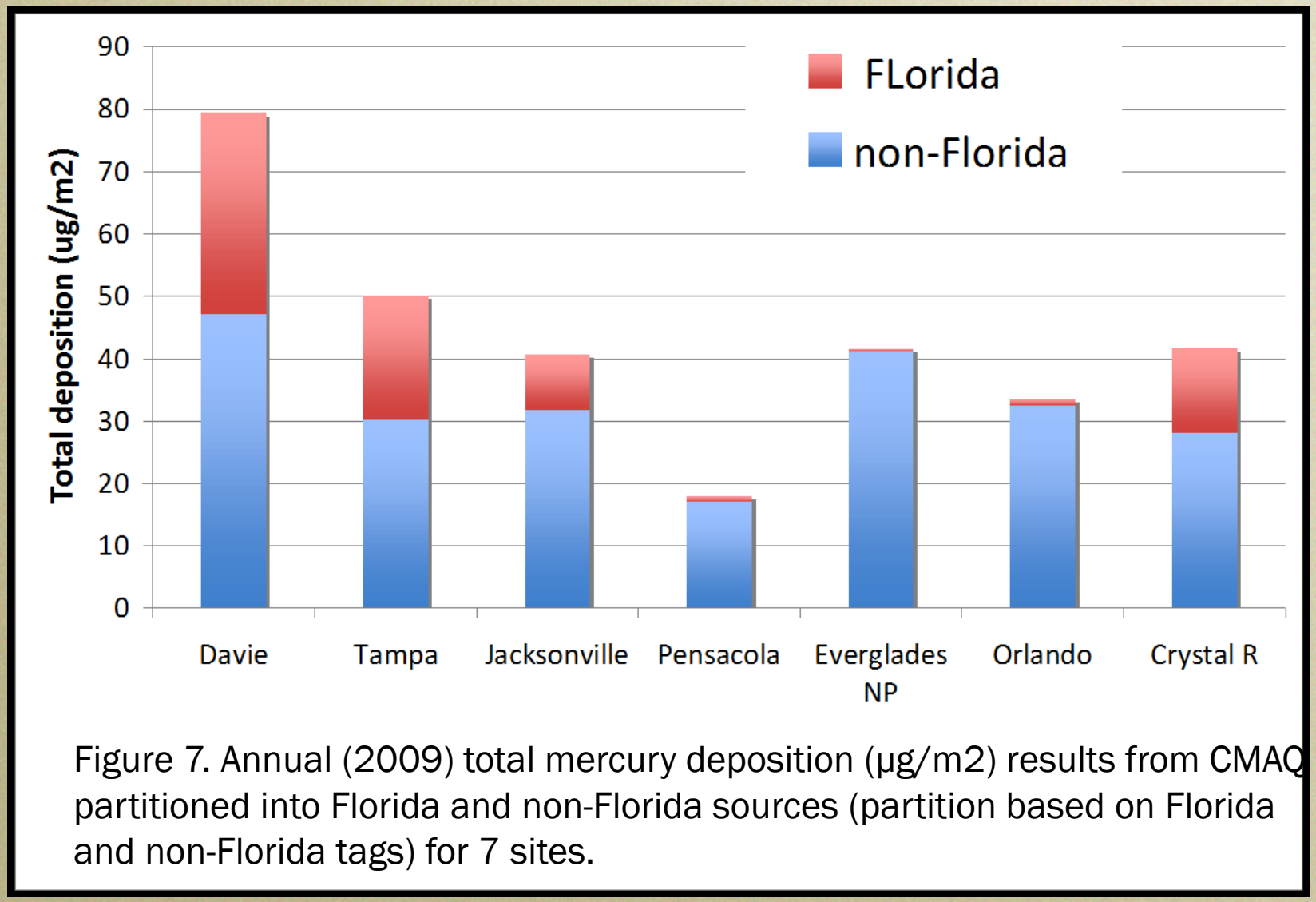
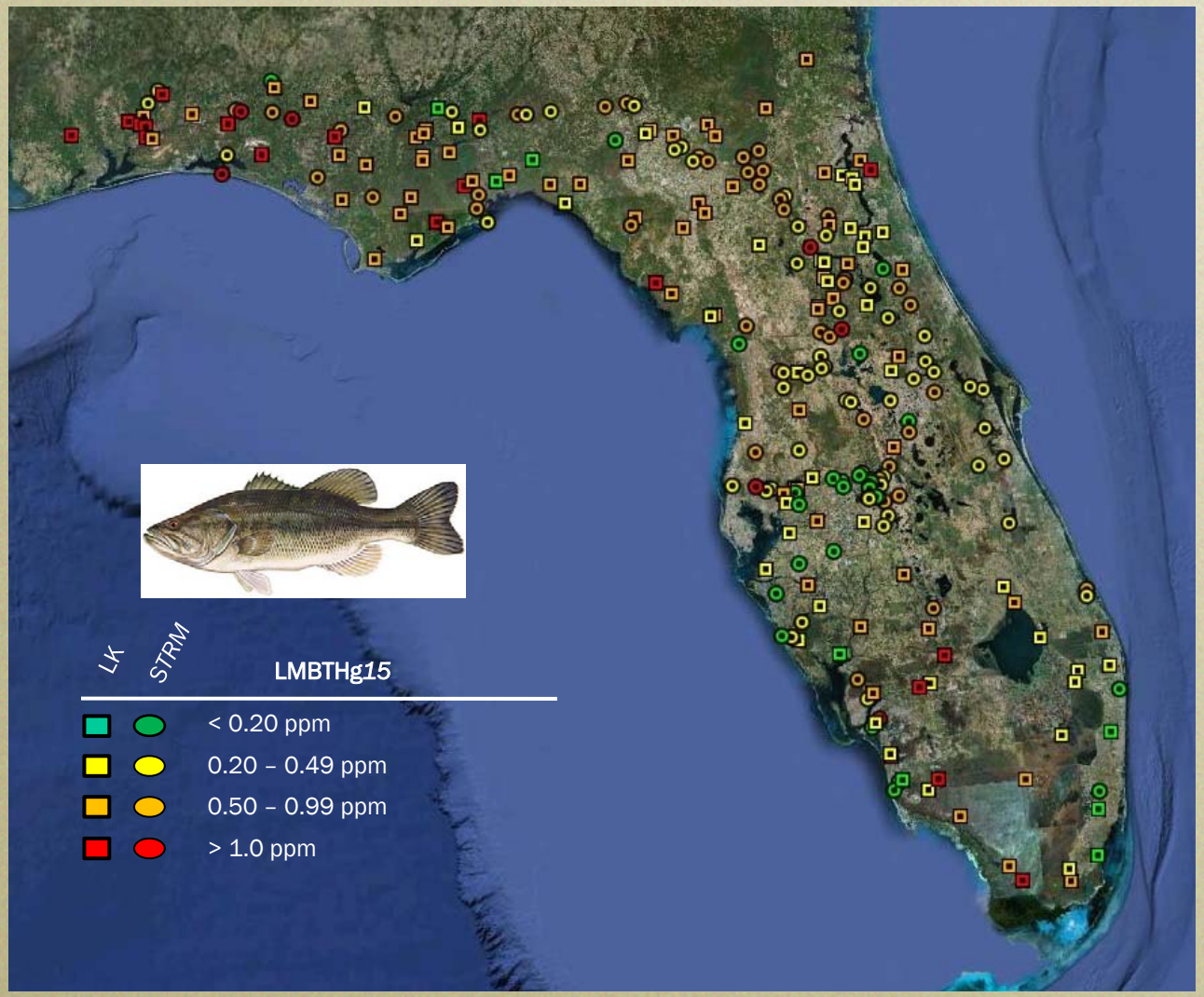


Figure 7. Annual (2009) total mercury deposition (µg/m2) results from CMAQ partitioned into Florida and non-Florida sources (partition based on Florida and non-Florida tags) for 7 sites.

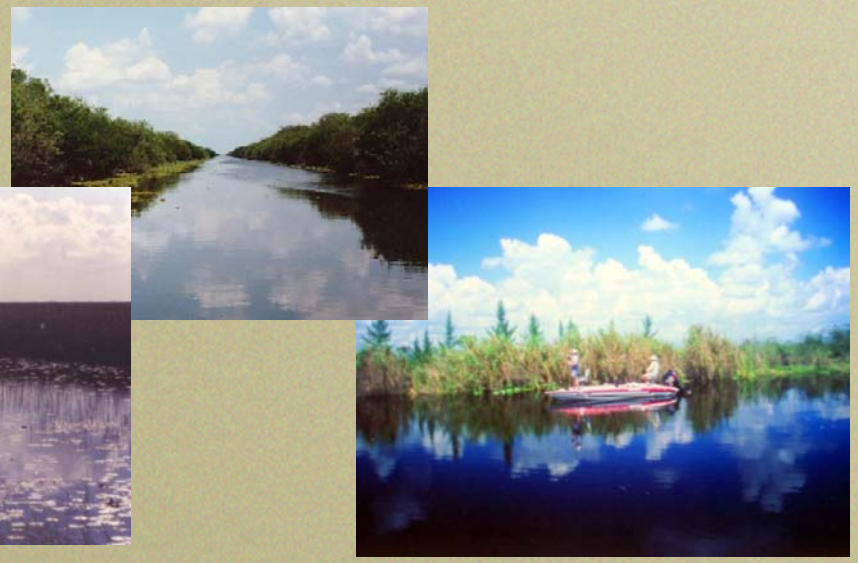
Statewide Distribution in Bass

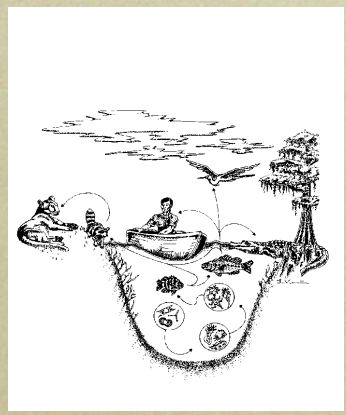


Deposition, Methylation and bioaccumulation of Hg into the food web is a statewide issue

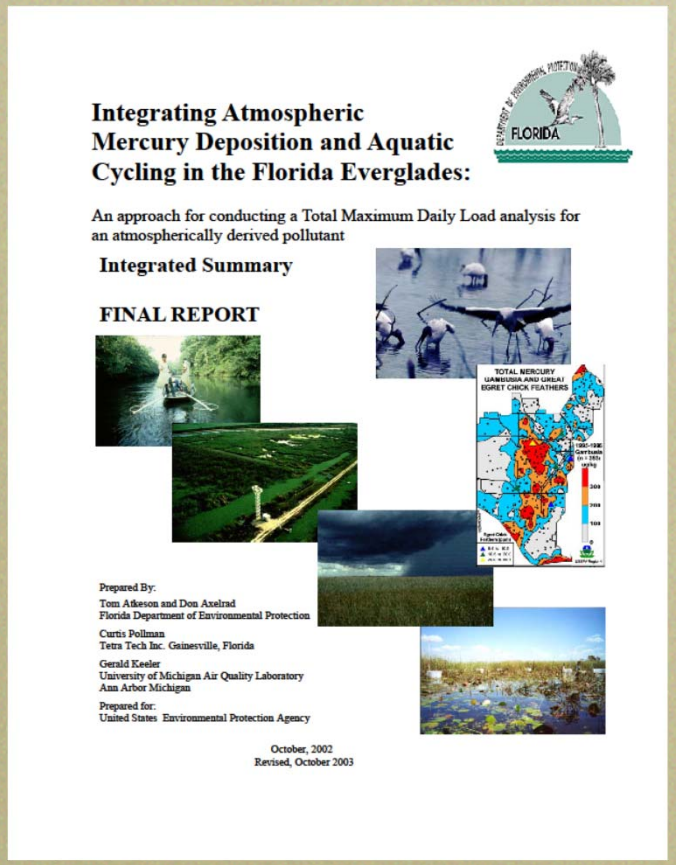
Managing Methylation and Bioaccumulation Processes

- Everglades: Hydrologically altered and spatially fragmented
- EPA consists of nearly independently operating “Marsh Impoundments” where methylation processes,
    - Varies between impoundments
    - Varies within impoundments along gradients of biogeochemical parameters (e.g. Organic Carbon, Sulfate, and Nutrients) which are influenced by management (Quantity and Quality of surface waters).
- Similarly, bioaccumulation processes vary across the EPA





Managing Mercury Bioaccumulation: Influence of Food Webs on Biota MeHg



Integrating Atmospheric Mercury Deposition and Aquatic Cycling in the Florida Everglades:

An approach for conducting a Total Maximum Daily Load analysis for an atmospherically derived pollutant

Integrated Summary

FINAL REPORT

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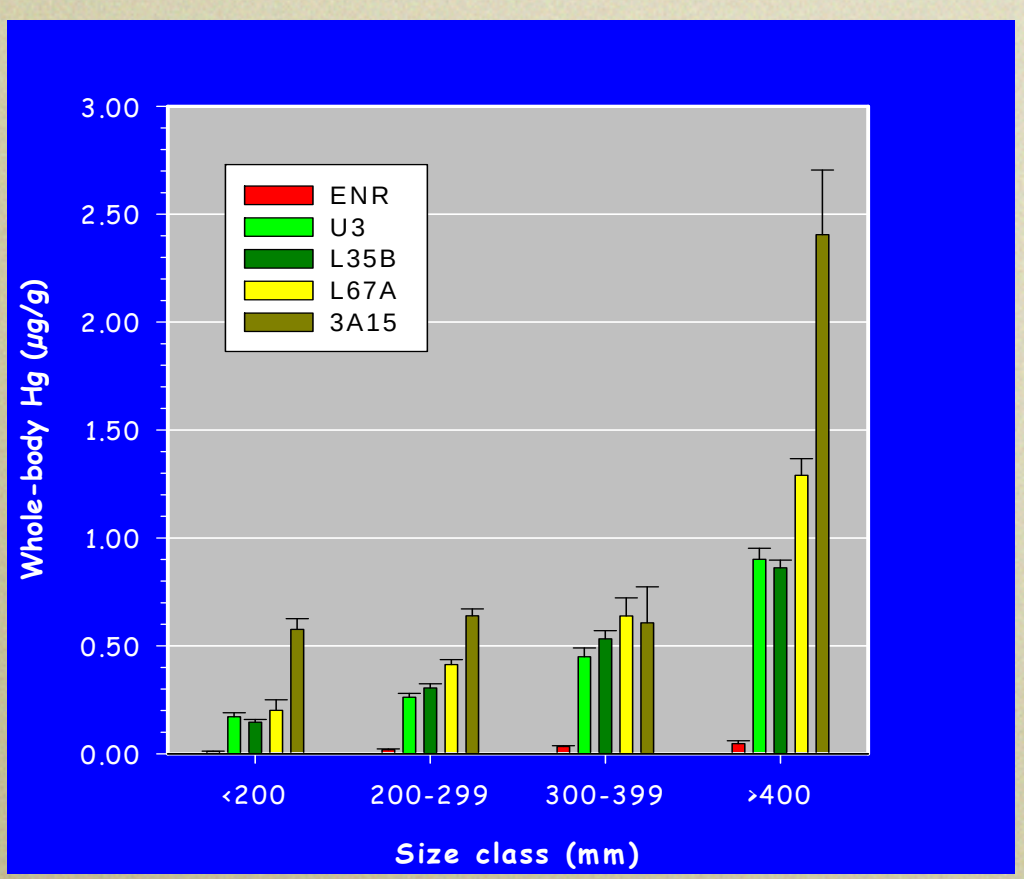
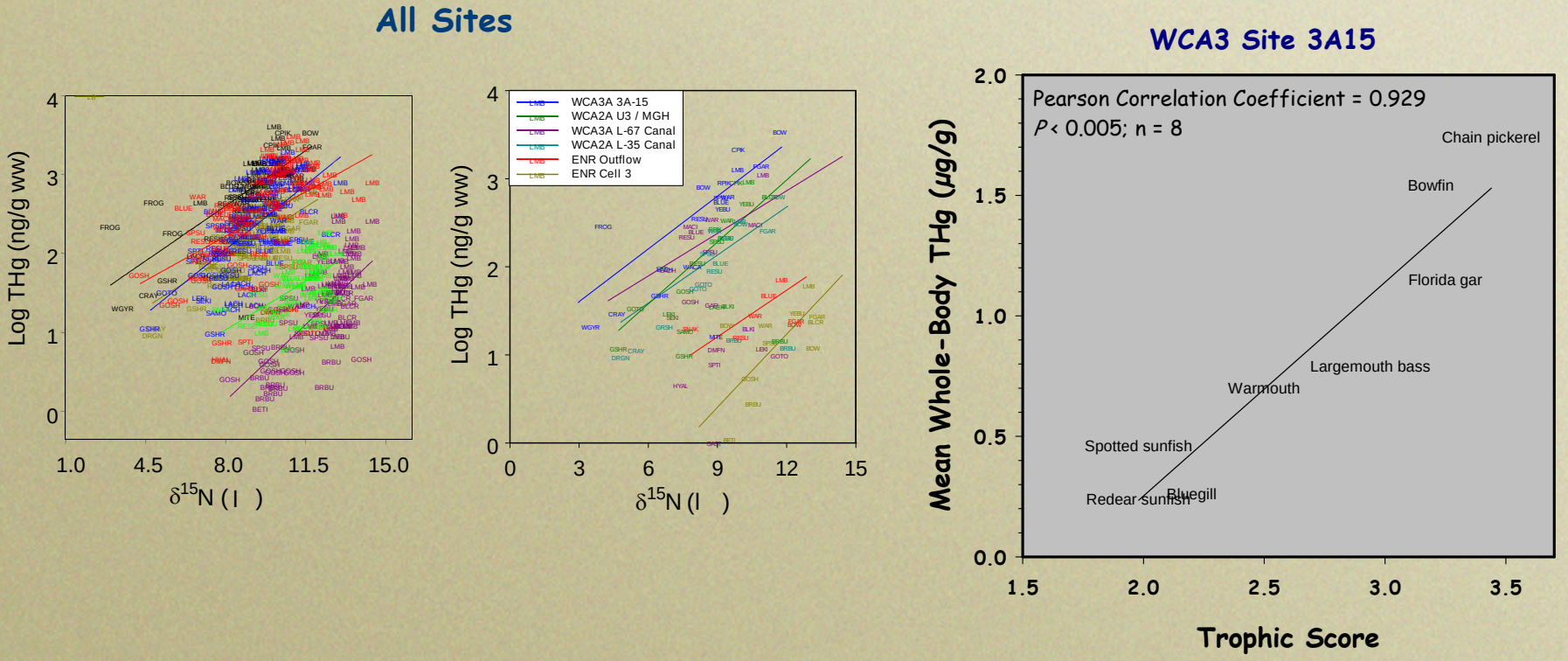
Prepared for:
United States Environmental Protection Agency

October, 2002
Revised, October 2003



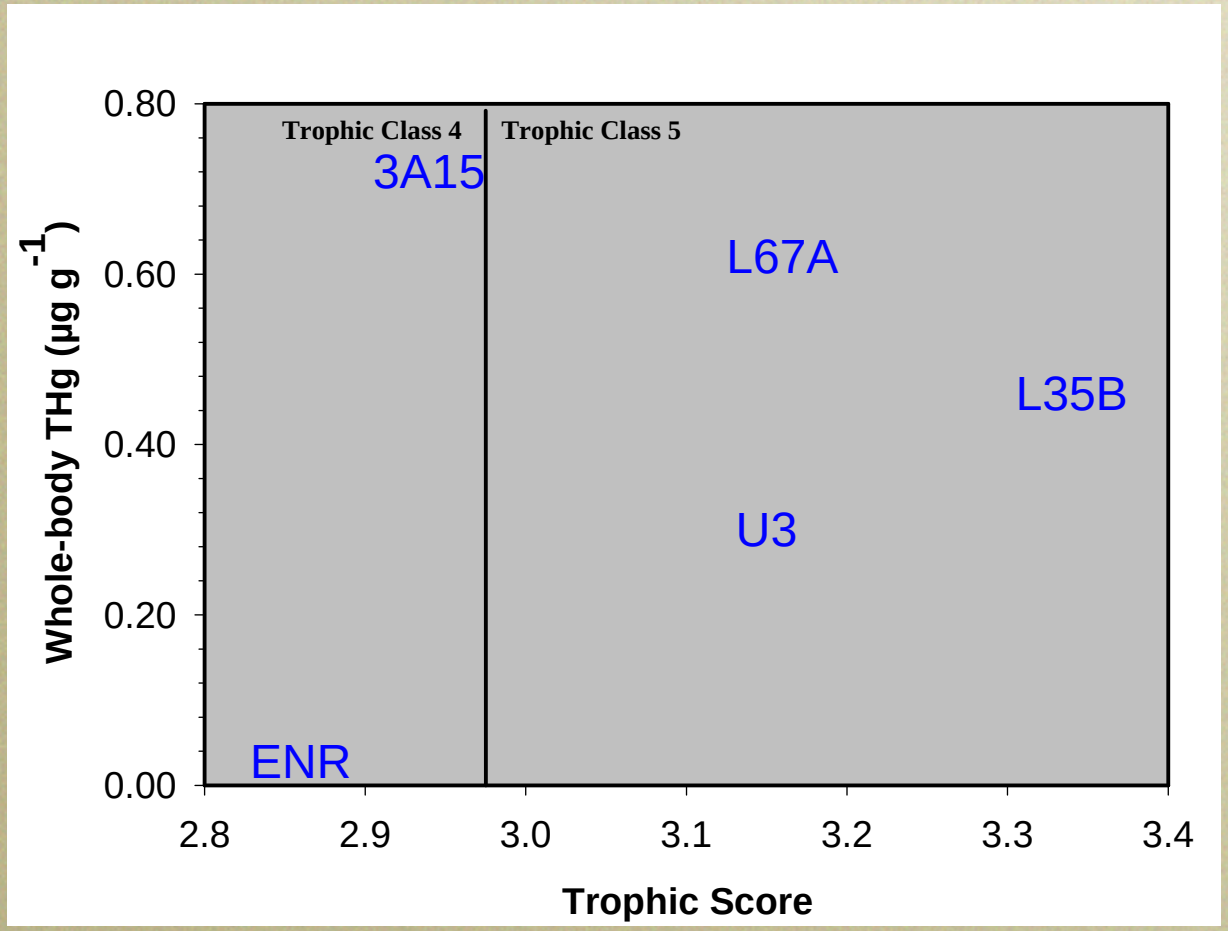
Can Variability in Fish Hg concentrations can be explained by site specific characteristics (length/complexity of food web, trophic position, growth, and availability of MeHg)

Fish and prey mercury varied by location and trophic position



- Isotopes and Food habits estimated trophic position show consistent positive relationships to biota THg
  - Slopes not sig different
  - Intercepts sig different

Variations in Trophic Position do not explain variations in bass THg



Management of Mercury in the EPA

- Monitoring spatial and temporal trends in fish and wildlife mercury
  - Support risk assessment for humans and piscivorous wildlife
  - Means to evaluate influence of Everglades management
- Evidence suggests that variations in food web dynamics (complexity, length, and trophic position) are less influential than the availability of MeHg at the base of the food web
- Field studies suggest that methylation and bioaccumulation processes vary among “Marsh Impoundments” and are influenced by gradients of biogeochemical parameters (e.g. hydroperiod, Organic Carbon, Sulfate)
- This compartmentalization and complexity impedes development of concise empirical relationships between fish THg and environmental variables that influence MeHg production and bioaccumulation.

  - Fish and Wildlife Hg will be reduced through
    - Reductions in Deposition
    - Managing for reductions in the rate of methylation