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The Aqutic Cycling of Mercury in the Everglades (ACME) Project: Challenges of Linking Field Data to Conceptual Models

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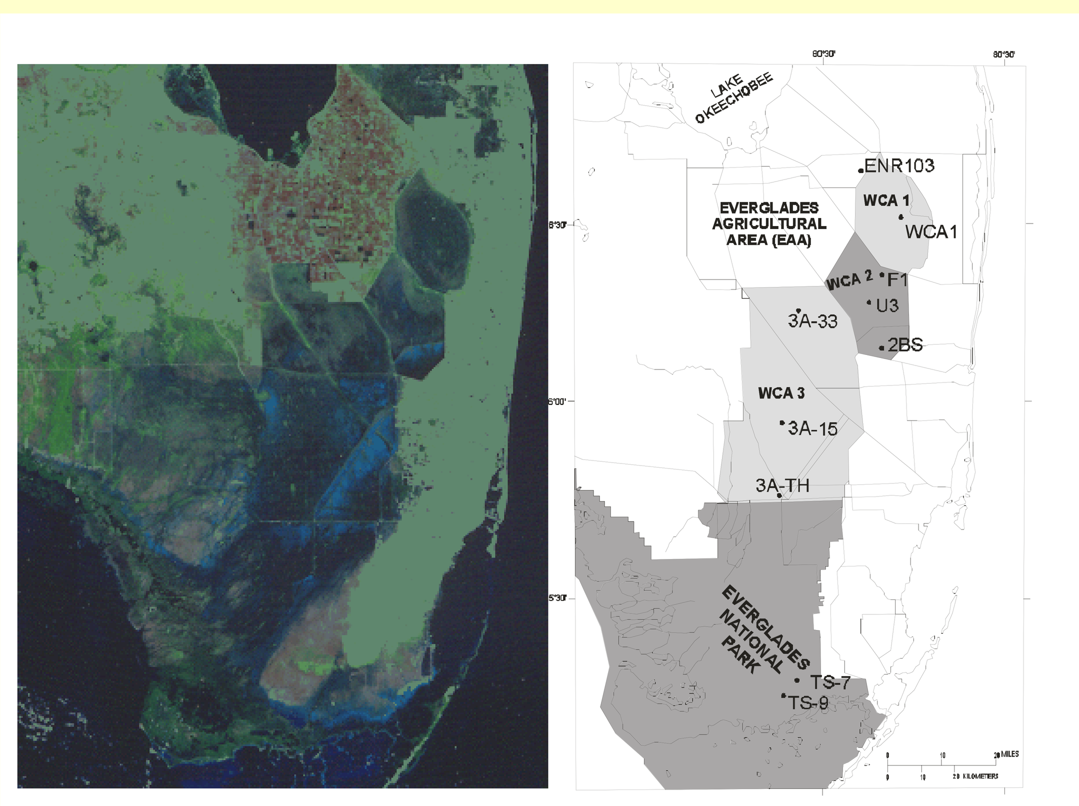
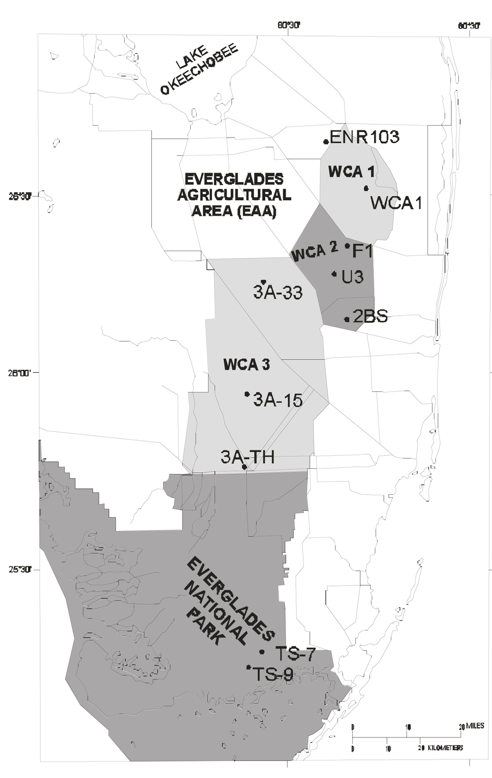
ABSTRACT

The Everglades mercury problem h as been known for over a decade, and during this time a great deal has been learned about what drives the problem. The USGS led Aquatic Cycling of Mercury in the Everglades (ACME) project has been investigating this issue since 1995, and has as its overall goal to conduct intensive, process-oriented research that focuses on the primary mercury cycling pathways in the Everglades, and which can be synthesized by a m odel for restoration and predictive purposes. Although we have leaned a great deal about the Everglade mercury problem, complexities of the aquatic mercury cycle coupled with the inherent complexities of the Everglades ecosystem have prevented us from providing absolute difinition of the problem and prescribing a solution. Phase I studies have docuemnted status and trends of mercury (Hg) and methylmercury (MeHg) in most components (water, porewater, sediment, biota) of the Everglades, and rates of important cycling processes, relations to other geochemical cycles (sulfur, carbon). Phase II studies will provide more direct information to important management questions relating to reducing the magnitude of mercury contamiation of the Everglades.

What is the spatial and temporal distribution of Hg and MeHg in surface water across the Everglades?



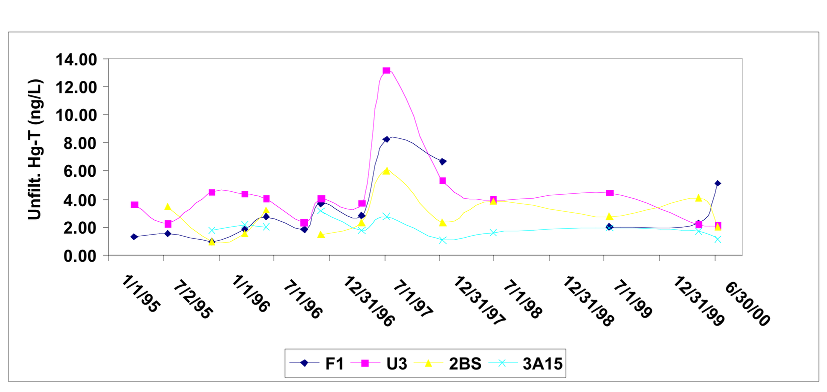
Location of ACME sampling sites across the remnant Everglades.

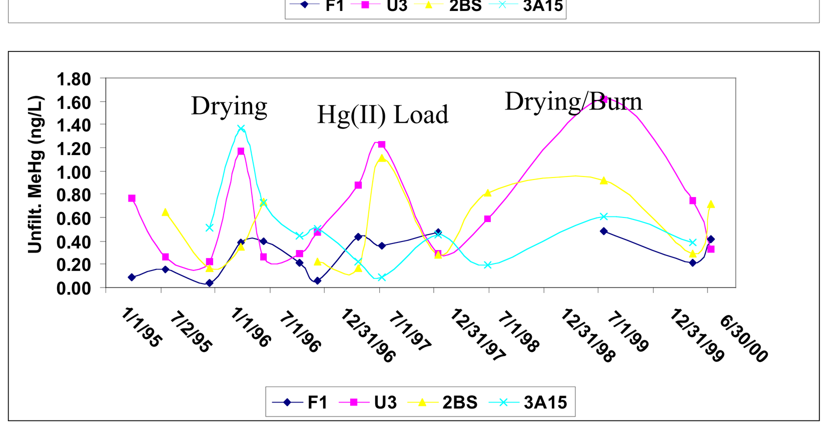


Averages for Primary ACME Sites

Hg-T (ng/L)	MeHg (ng/L)	%MeHg
2.2	0.03	
2.1	0.22	
3.1	0.11	
3.6	0.41	
2.4	0.48	
1.9	0.42	
2.6	0.22	
1.9	0.20	
1.2	0.10	

Spatial variation of Hg and MeHg in surface water for the ACME sampling sites.

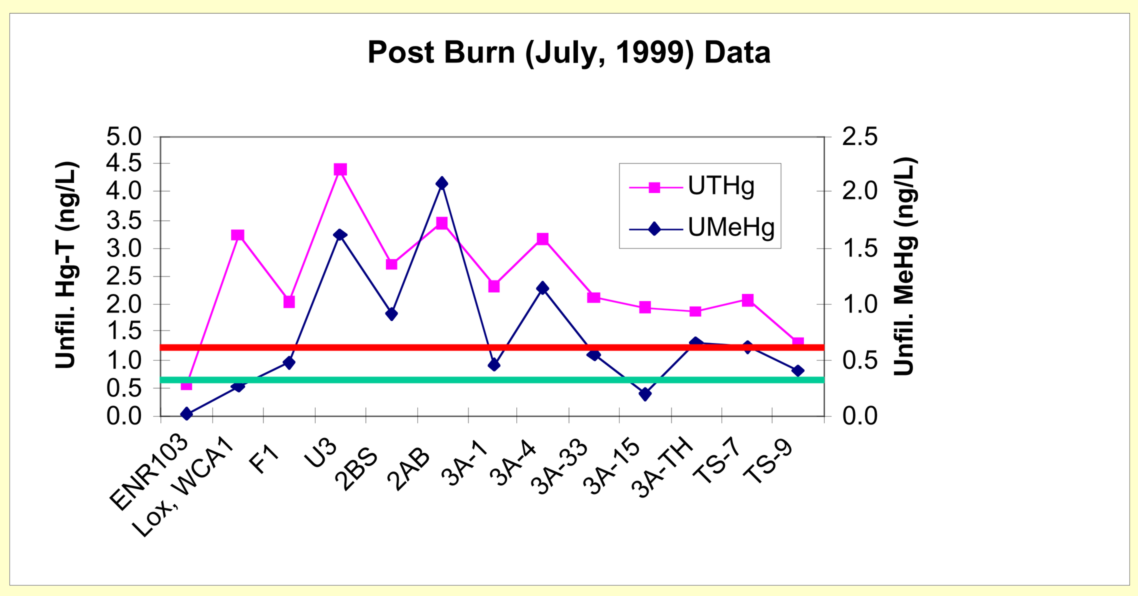


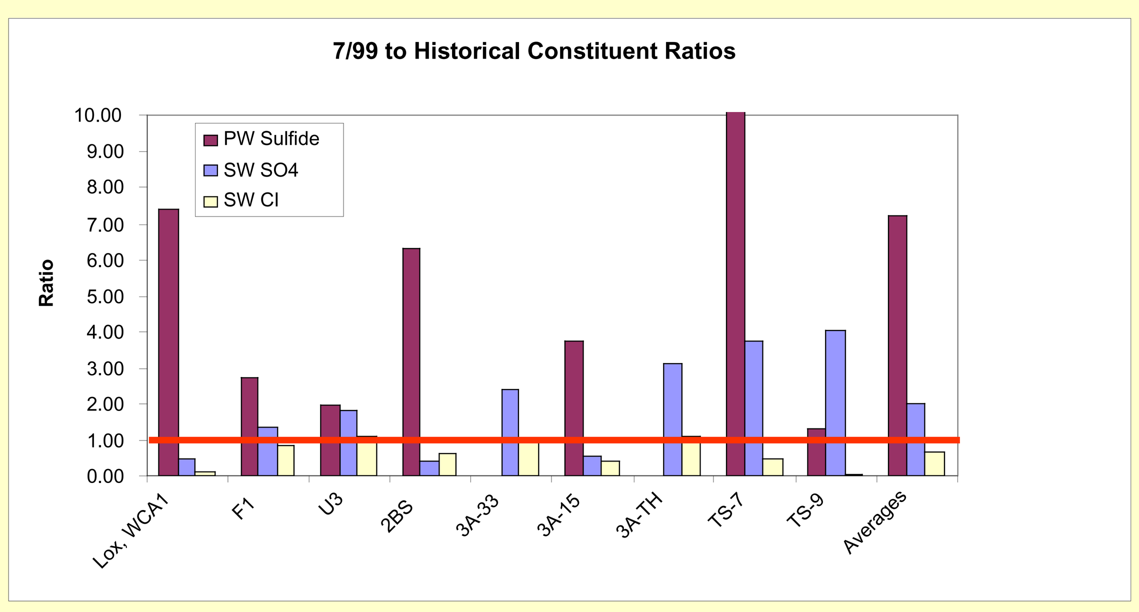


Temporal variability of Hg and MeHg in surface water for the ACME sampling sites.

How do seasonal wet/dry cycles affect Hg cycling and MeHg production in the Everglades?

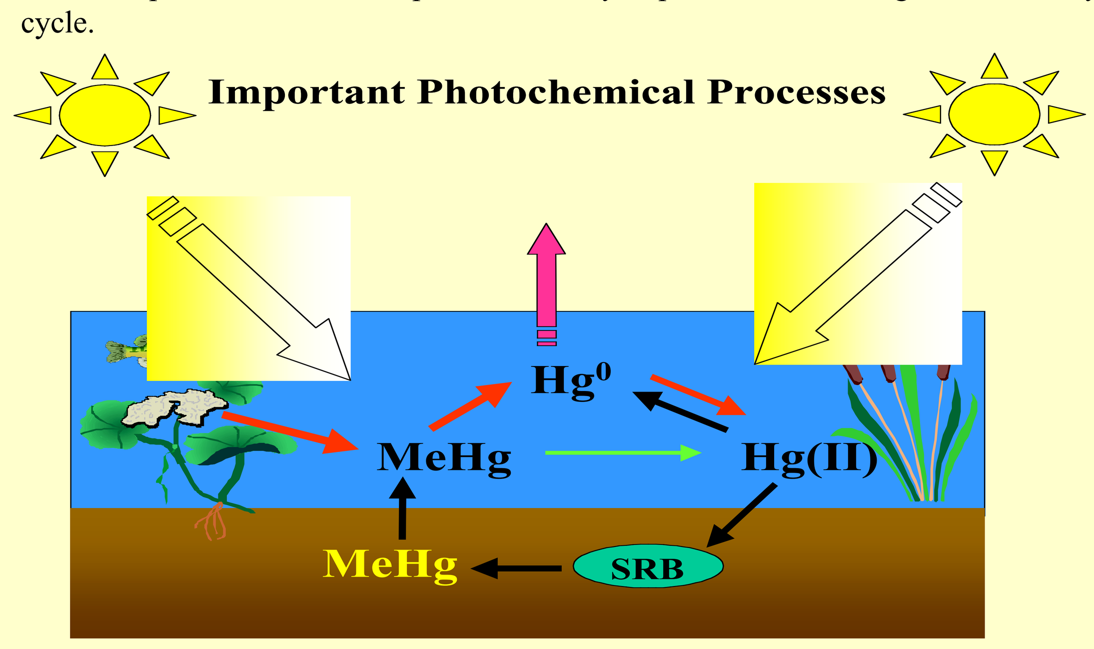
In July 1999, the USGS and South Florida Water Management District conducted a cooperative study to evaluate the possible effects of prolonged drought, peat drying and fires in the Everglades. To address this question, we sampled 13 sites 5 weeks after the drought and re-flooding had occurred (including 10 ACME sites), of which 3 were burned, and most had been dried. Sample results (below) show that extremely high levels of MeHg production occurred in response to the drying and fires, and that it appears this was in response to oxidation of organic sulfur in sediments, which in turn stimulated methylation by sulfate reducing bacteria.

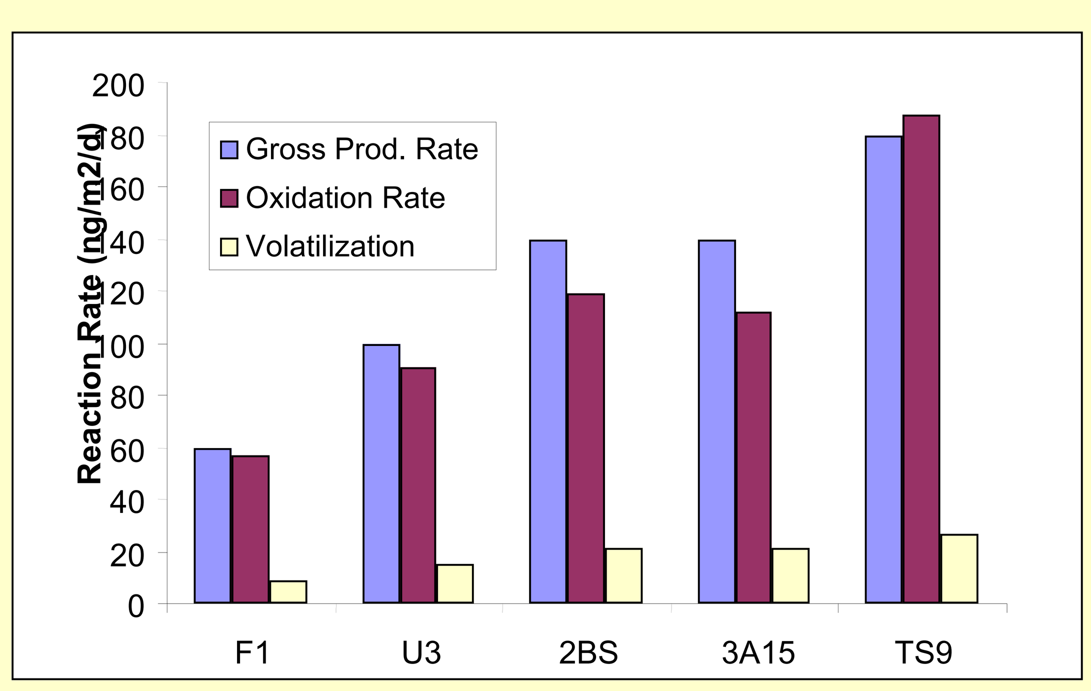




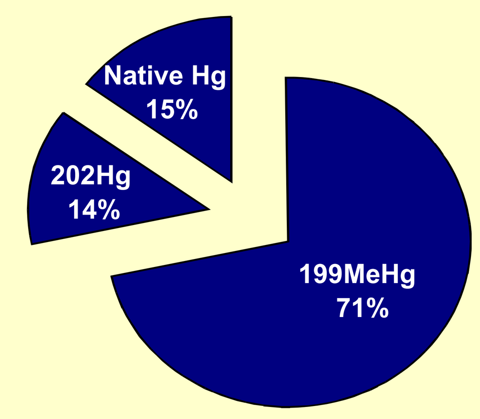
How does the sun affect the Everglades mercury cycle?

Mercury is a photo-sensitive contaminant, however the two primary photo reactions both serve a detoxification role. First, inorganic Hg(II) can undergo photo reduction to gaseous elemental Hg(0), which may then volatilize from the water surface. Second, MeHg is also photo sensitive, and undergo photo-demethylation, yielding far less toxic Hg(II) or possibly even less toxic Hg(0). Experiments on these process on Everglades water samples show that these process are very important in the Everglades m ercury cycle.





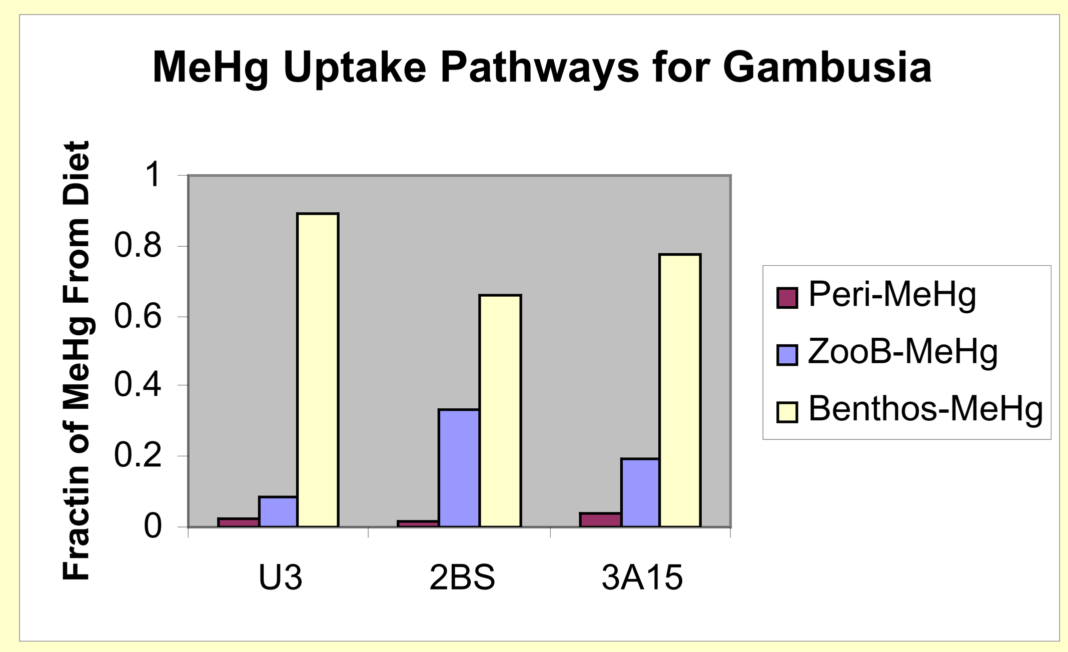
Rates of photo reduction, photo oxidation, and volatilization show that most of the Hg(0) produced is reoxidized an stays in the water column as Hg(II), lesser amounts volatilizing from the system.



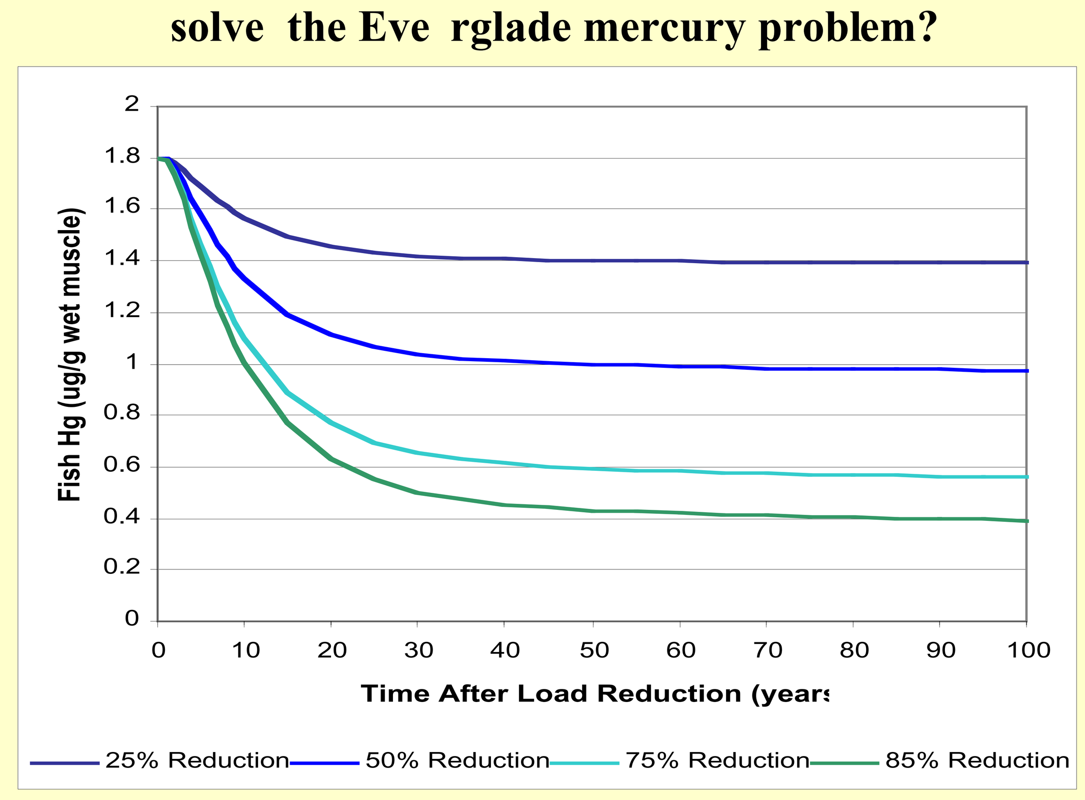
Recent experiments have shown that the majority of Hg(0) produced in Everglades water results from the reduction of MeHg. This shows that the availability of MeHg at any point in the system may drive gaseous Hg(0) production, and that photo-demethylation may be an extremely important detoxicification mechanism.

Where do *Gamubsia* in the Everglades get their MeHg?

A basic understanding as to where and how mercury transfers to the foodweb is important for effect decision making and knowing how future ecosystem changes may affect the mercury problem. By combing gut-content analysis and MeHg analysis of the material observed in the guts of gambusia, an initial evaluation was achieved. Our results show that uptake pathways are intimated tied to the sedimentary pools of MeHg and benthic organisms.



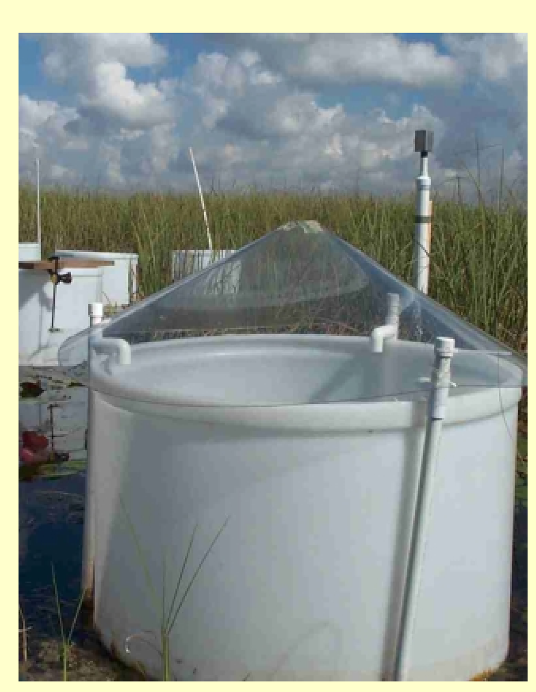
Can source reductions and/or ecosystem management solve the Eve rglade mercury problem?



The Everglades Cycling Model (Tetra Tech, Inc) predicts a nearly linear proportional response of Hg load reduction to bioaccumulation in game fish.

Phase II research to validate these predicitons.

The next phase of ACME will employ the use of stable Hg isotopes and *in situ* mesocosms to establish what the load versus ecosystem response for mercury.



Questions asked in ACME phase II:

What is the Hg(II) loading response (net MeHg production and bioaccumulation) for sites across the trophic gradient?

Does only new mercury become methylated and bioaccumulate?

Better resolution of the complicated Hg, S, P, and C story.

Better discrimination of Hg/MeHg bioaccumulation pathways through the foodweb, reaction products, etc...