United States
Environmental Protection
Agency

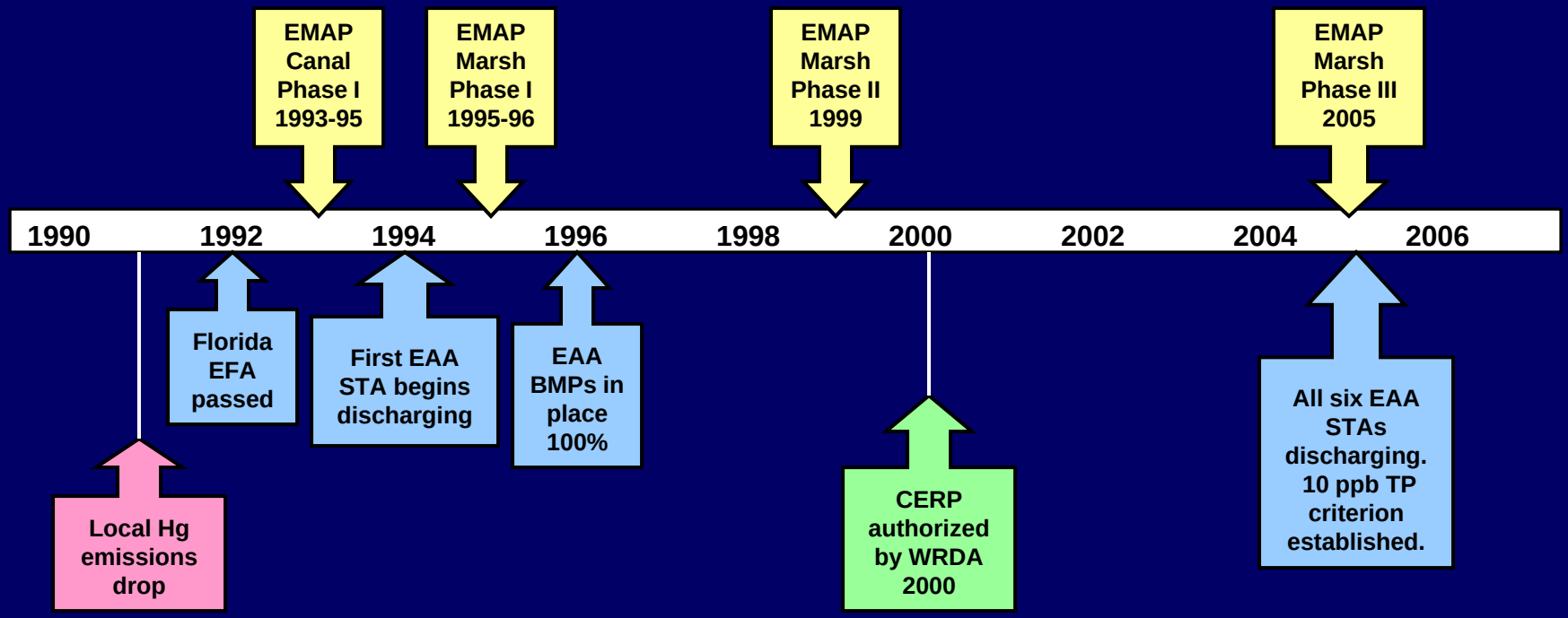
Region 4 Science &
Ecosystem Support Division
and Water Management
Division

EPA 904-R-07-00x
January 2007

Everglades Ecosystem Assessment: Water Management and Quality, Eutrophication, Mercury Contamination, Soils and Habitat

Monitoring for Adaptive Management: Implications for Ecosystem Restoration

R-EMAP Program Timeline

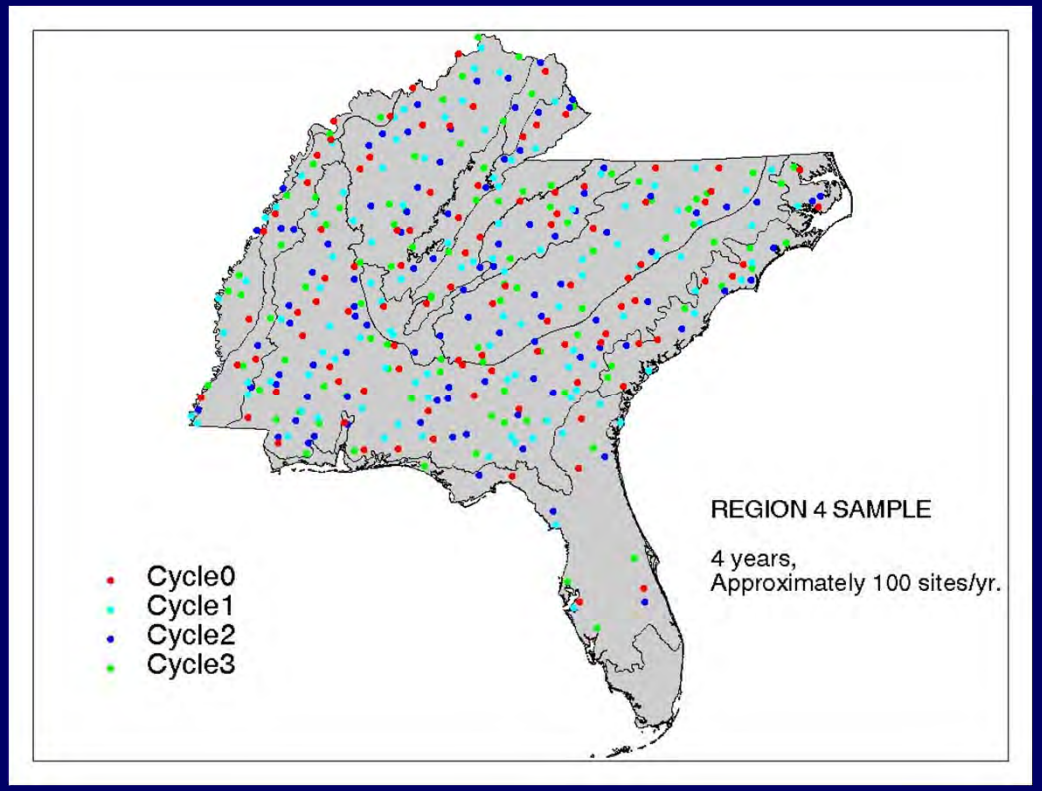


Everglades Program Overview

- Initiated in 1992 primarily because of mercury
- Multiple stressors: mercury, phosphorus, sulfur, drainage, invasive species
- Design provides uniformity, consistency, comparability over space and time
- Guided by 7 management questions
  - ***magnitude, extent,*** cause, sources, trend, risk, solutions.

Probability-based Designs

- **RANDOM SAMPLING:**
- Allows description of the whole by only sampling parts
- Used in economic surveys, opinion polls
- Used in all EPA NARS



Sampling sites through 2005

Phase I Marsh = 1995-96

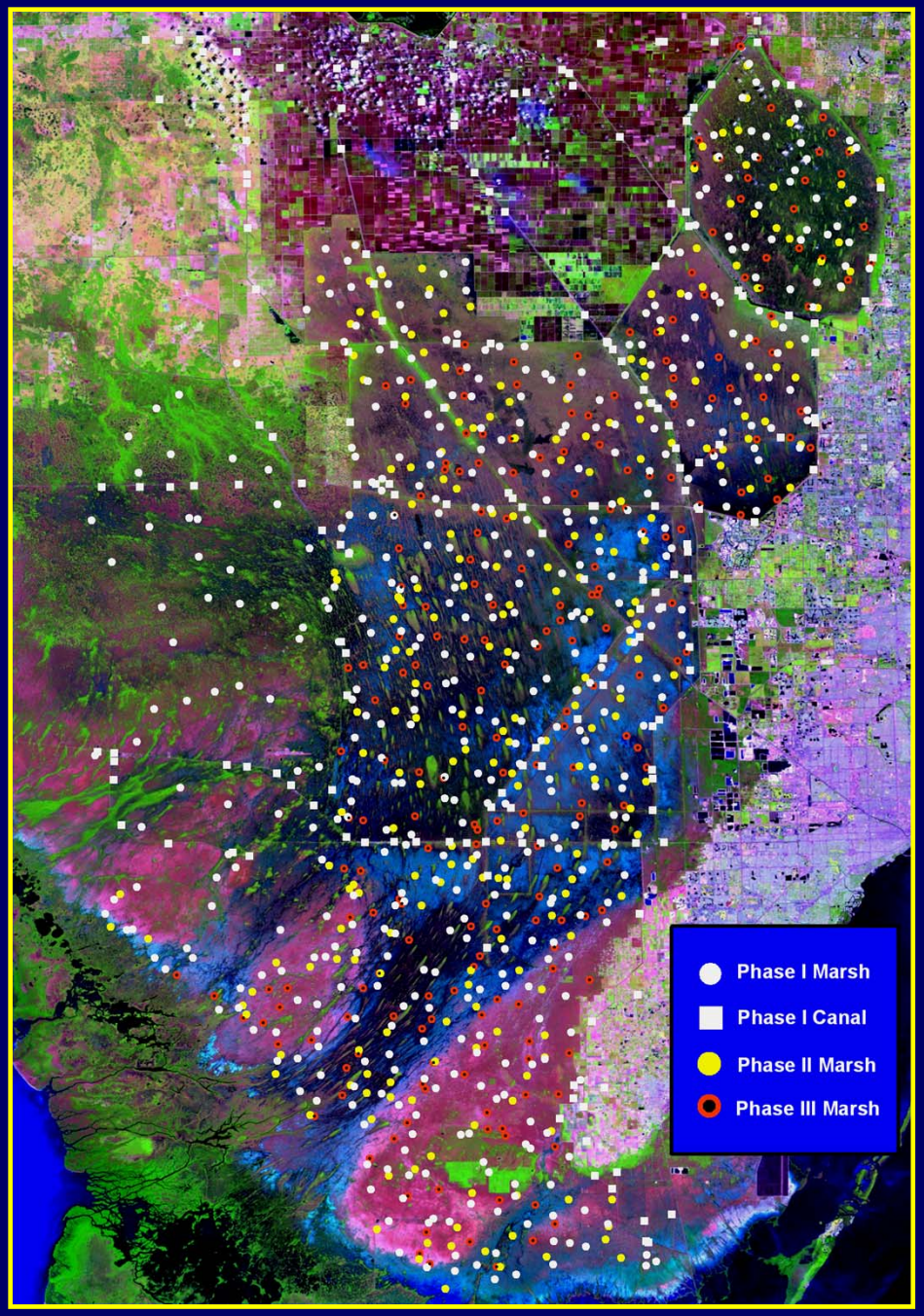
Phase II Marsh = 1999

Phase III Marsh = 2005

1145 Sample Sites

~100,000 biogeochemical data values

~$6M total cost to date



2005 Phase III Effort

- May (dry season), November (wet season) sampling
  - 228 stations, 3000 square miles, 25,000 data points, 7 field weeks, 3 helicopters
- Field crew EPA/FIU~ 30 people
- 8 analytical labs, including EPA and FDEP
- Intensive QA/QC

Collaboration

- **R-EMAP Phase III data are featured in ~25 peer-reviewed publications to date by the Principal Investigators, collaborators, post-Doctoral students, and others.**
  - Over 30 co-authors
  - *Environmental Science & Technology; Environmental Pollution; International Journal of Plant Science; Aquatic Botany; Journal of Freshwater Biology; Marine & Freshwater Research; Reviews in Environmental Science & Technology*
    - Over 200 journal citations.

Everglades R-EMAP 2005 - Windows Internet Explorer provided by EPA

http://digir.fiu.edu/gmaps/EverREMAP.php

Live Search

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US Government eTravel, Fed... | Everglades R-EMAP 2005

Page

Everglades R-EMAP
Data 2005

Environmental Protection Agency
Florida International University
National Park Service

Everglades Ecosystem Assessment

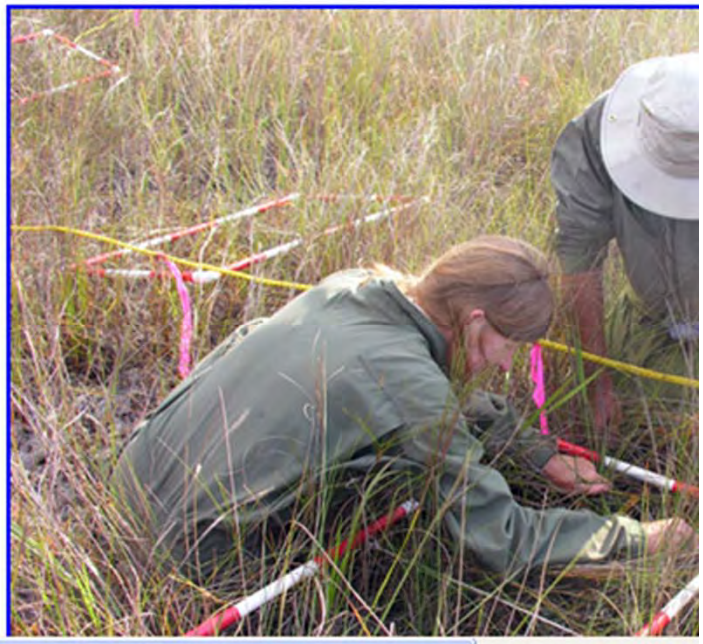
Map & Data | Photos & Movies | Statio

The Everglades R-EMAP project for year 2005 produced large quantities of data

2005 Data Collection for Everglades R-EMAP

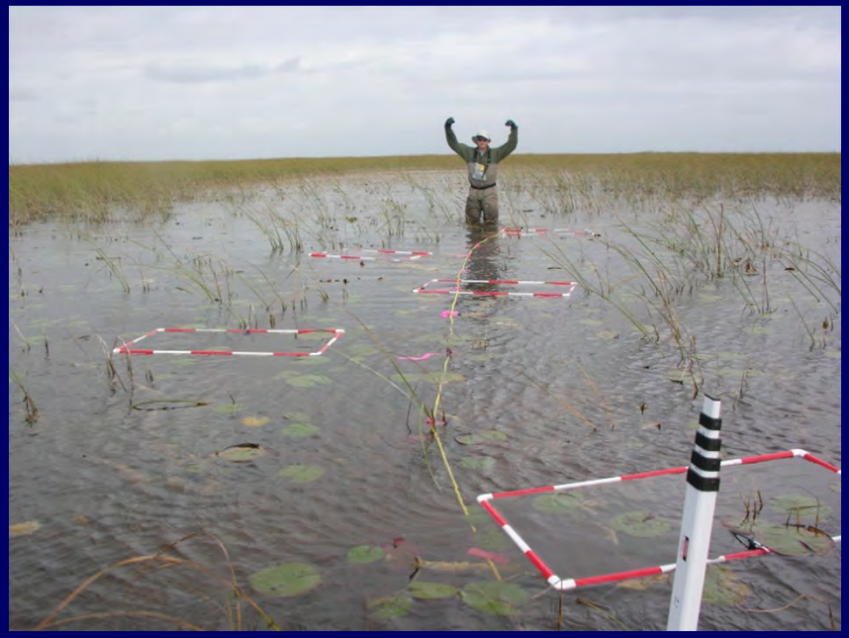
Highlights

- Map & Data
- Photos & Movies
- Station List



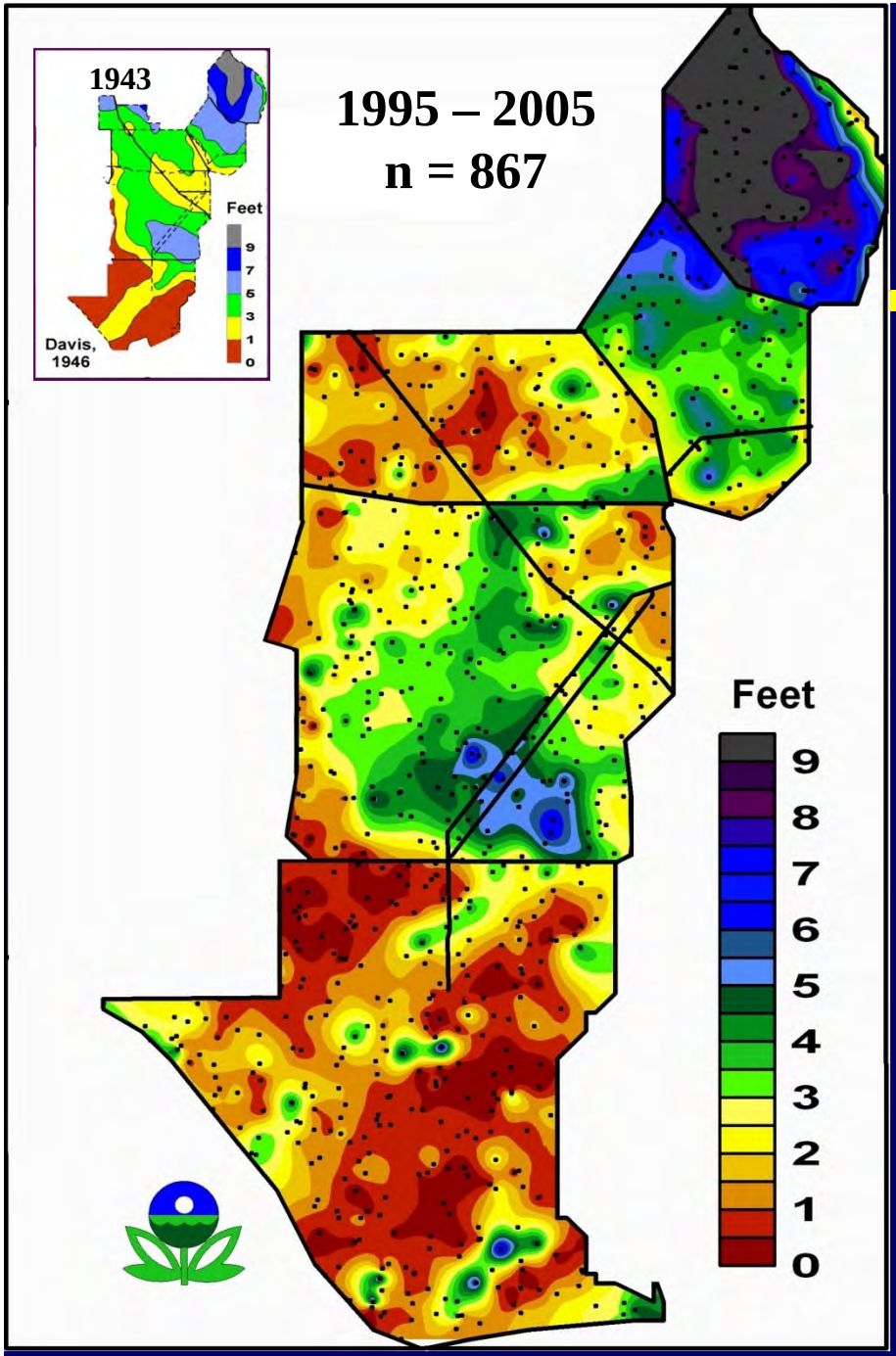
Biogeochemical Media

Plant Species Sampling



- **Plant Community Analysis**
- **Exotic Plant Species Surveys**
  - Survey on fly-in
  - Survey from helicopter pontoons

Phase	I	II	III
Year(s)	1995 & 1996	1999	2005
Distinguishing features	Baseline data. Multiple stressors. Big Cypress included. Canals included 1993-95.	Plant studies added. Periphyton assessment added. Canals & Big Cypress omitted.	Change detection. Food web studies added. Invasive plant survey added.
Marsh Stations	240 + 240 = 480	119 + 119 = 238	109 + 118 = 228
Biogeochemical media:			
Surface water	Yes	Yes	Yes
Floc	No	Yes	Yes
Porewater	No	Yes	Yes
Soil	Yes	Yes	Yes
Periphyton	Yes	Yes	Yes
Mosquitofish	Yes	Yes	Yes
Macrophytic plants:			
Qualitative habitat categorization	Yes	Yes	Yes
Species frequency	No	Yes	Yes
Classified vegetation mapping	No	Yes	Yes
Invasive plant survey	No	No	Yes
Aquatic community ecology:			
Periphyton assemblage	No	Yes	Yes
Mosquitofish food habits	No	Yes	No
Macroinvertebrate assemblage	No	No	Yes
Isotope studies	No	No	Yes



Soil Thickness

- R-EMAP: only data since 1940s
- 25.1% (+/- 2.0%) of the area has soil < 1 foot. Median 2.3 feet
- From 1946 to 1996 northern WCA3A lost 39% to 69% of its soil.
- Soil subsidence associated with dry conditions, soil P increase, cattail expansion, increased risk of peat fire

Project Data Uses for EFA

- Assess surface water TP in EPA habitats other than wet prairie
- Assess soil TP throughout EPA
- Assess periphyton communities throughout EPA
- Assess mercury conditions throughout EPA
- Assess water quality conditions and transport throughout EPA (P, S, conductivity, Hg)

Project Data Uses for CERP

- Quantify CERP ecological responses in a statistically defensible manner at landscape scale
- Differentiate CERP effects, seasonality, and inter-annual variability
- Complement other monitoring by providing spatial coverage
- Provide input to CERP conceptual models, SFWMM, ELM, CALM, ATLSS, WQ models, Hg models, etc.

Other Data Uses

- **Phosphorus**
  - *Water Quality Criteria* ~ Soil TP used to define P-impacted area for 10 part per billion TP rule & annual water quality criterion application (FDEP)
  - *Everglades Restoration Program* ~ Model input to CALM and ELM to predict Everglades' response to water management and P control (SFWMD)
  - *Phosphorus Control Program* ~ used in Everglades Phosphorus Gradient Model to predict WCA cattail response to P enrichment from STA discharge (SFWMD, USACE)

Other Data Uses

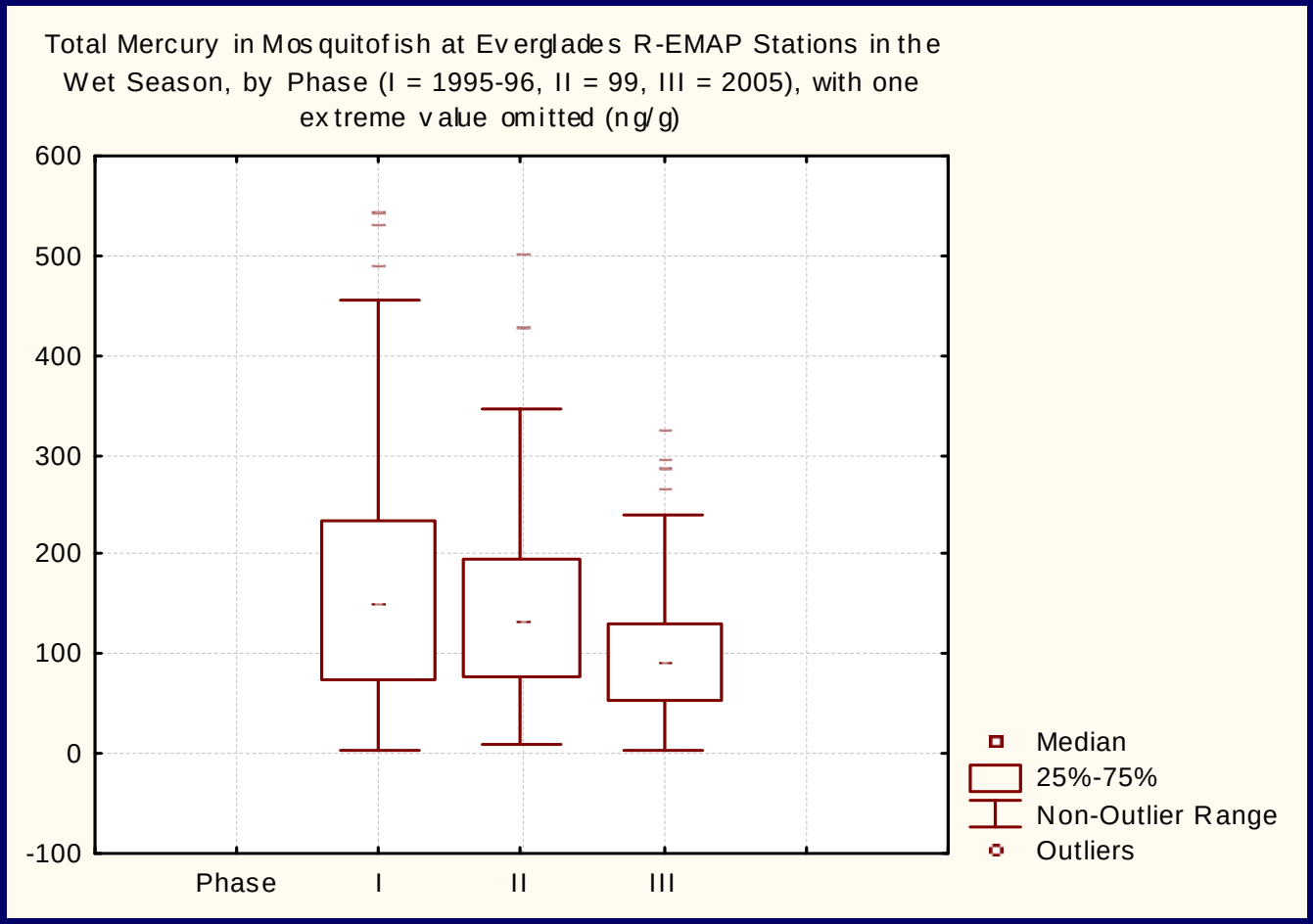
- **Mercury**
  - *TMDLs* ~Model input for marsh mercury cycling model, bioaccumulation, WCA3A mercury TMDL development (USEPA-ORD, TetraTech)
  - *Wading Bird Risk Assessments* ~used in several risk assessment calculations for Hg effects on wading bird populations (SFWMD, TetraTech)
  - *Environmental Impact Statements* ~ Everglades Construction Project EIS (USACE, SFWMD)

Other Data Uses

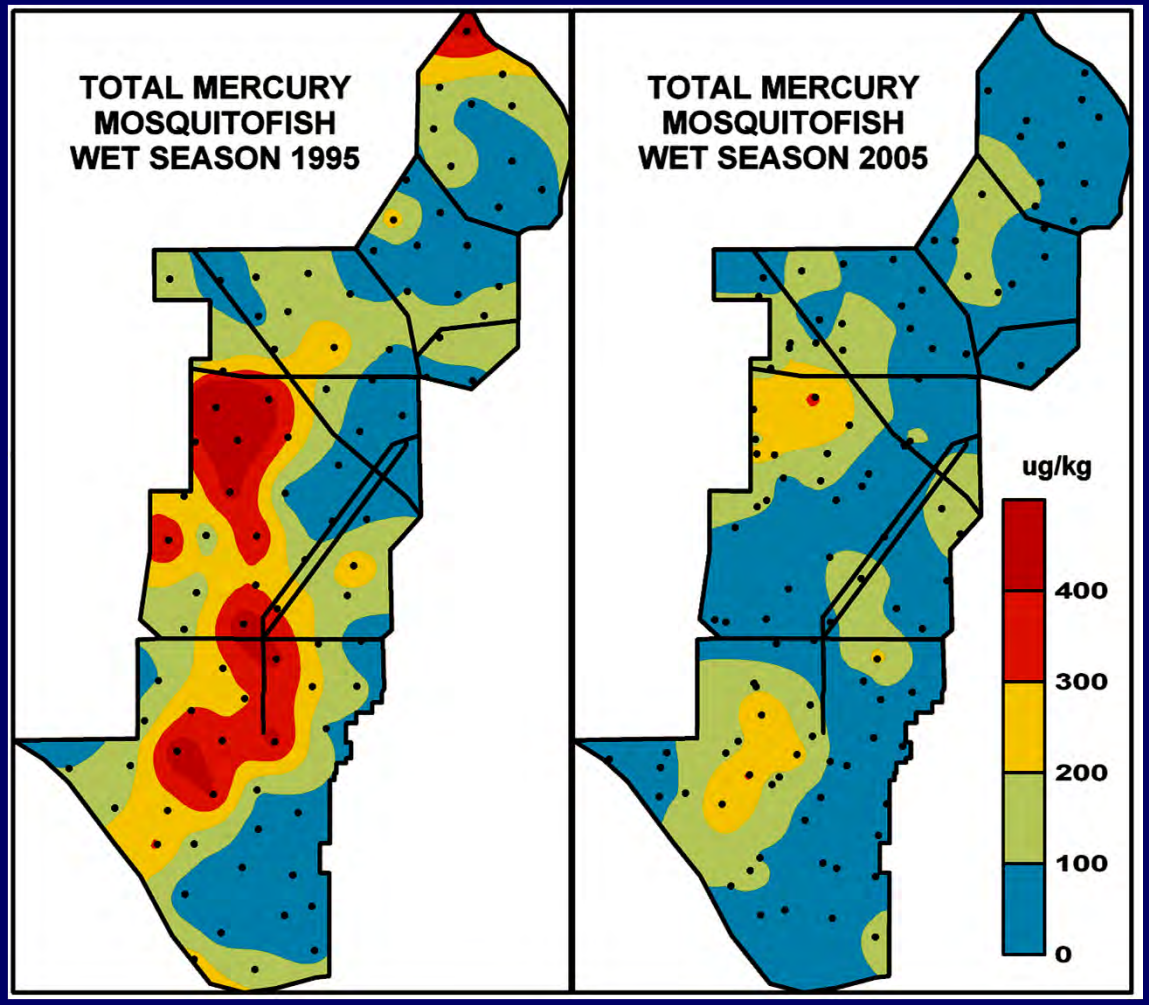
- **Mercury and Sulfur**
  - *Mercury Control Program* ~ Used to develop several empirical models of aquatic cycling to refine understanding of Hg, P, S, O, C inter-relationships (USEPA-R4, USGS, TetraTech)

- **Water Management**
  - *Everglades restoration modeling* ~Soil & water depth data used to update SFWMM v3.4 for WCA3B (SFWMD)

Mosquitofish Mercury 1995/96, 1999, 2005
Wet Season

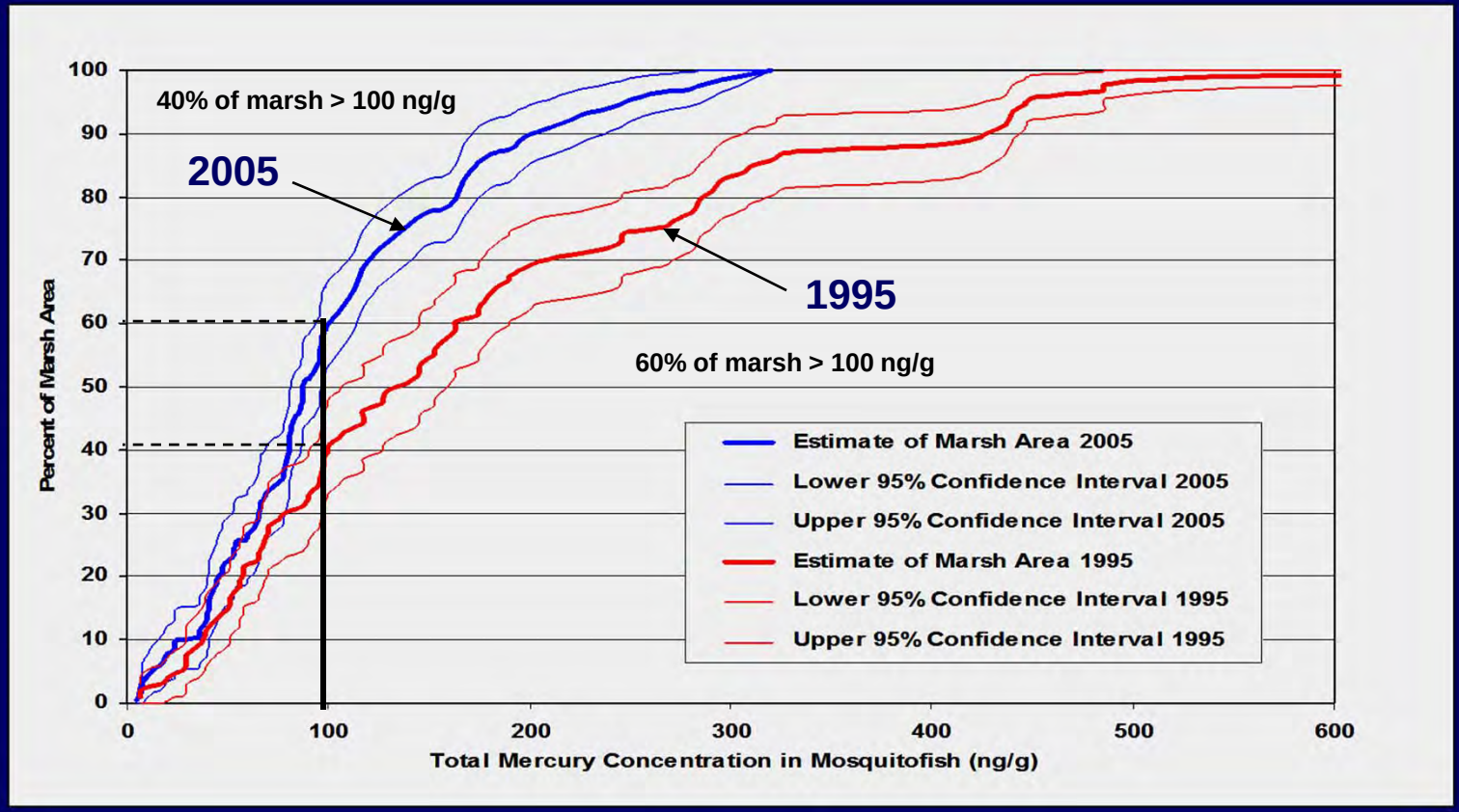


Mosquitofish Mercury, 1995 & 2005
Wet Season



EVERGLADES ECOSYSTEM ASSESSMENT PROGRAM

Mosquitofish Mercury, 1995 & 2005
Wet Season



Program Findings
Phase III

- **Areal Extent of Stressors**
  - TP in soil: 24% > 500 mg/kg; 49% > 400 mg/kg
  - Hg in mosquitofish: 40% > 100 ug/kg
  - Sulfate in water: 57% > 1.0 mg/L

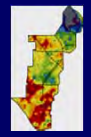
Phase IV Survey

- **What can be left out**
  - Vegetation sampling? Mapping?
  - Dry season?
  - Some BGC media?
    - Pore water
  - Some BGC analytes?
    - Hg
- **What should be kept/added**
  - ~200+ wet stations with throw-trapping?
  - AVS, etc.?

Phase IV Scope & Cost ($K)

Option: Dry & Wet BGC with Plants & Food Web

- **Biogeochemistry (~ 100+ & 100+ stations) 1013**
  - Helicopters 171
  - Sampling 234
  - Analysis 394
  - QA 116
  - Statistics 58
  - Reporting 40
- **Travel for scoping, pilots, training, peer review 68**
- **Plants (Dry & Wet, ~200+ stations) 191**
- **Plant community mapping 93**
- **Food web (Wet only, ~50 stations) 640**
- **TOTAL $2M**



Phase IV Scope & Cost ($K)
Option: Single Wet BGC without Hg

- **Wet-season biogeochemistry at ~100 stations**

– Helicopters	106
– Sampling	124
– Analysis	134
– QA	58
– Statistics	58
– Reporting	40

- **TOTAL** **520**

Phase IV Scope & Cost ($K)

Option: Double Wet BGC with Double Food Web

- **Wet-season biogeochemistry at ~200+ stations**
  - Helicopters 210
  - Sampling 268
  - Analysis 458
  - QA 116
  - Statistics 58
  - Reporting 40 **Subtotal 1150**
- **Aquatic diversity / food web**
  - Helicopters 80
  - Sampling 552
  - Taxonomy 498
  - Analysis 35 **Subtotal 1165**
- **TOTAL 2315**