Region 4 Science & Ecosystem Support Division; Water Protection Division

Everglades Ecosystem Assessment: Regional Environmental Monitoring and Assessment Project (R-EMAP)

Program Status
TOC May 30,2012

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EVERGLADES ECOSYSTEM ASSESSMENT PROGRAM

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.

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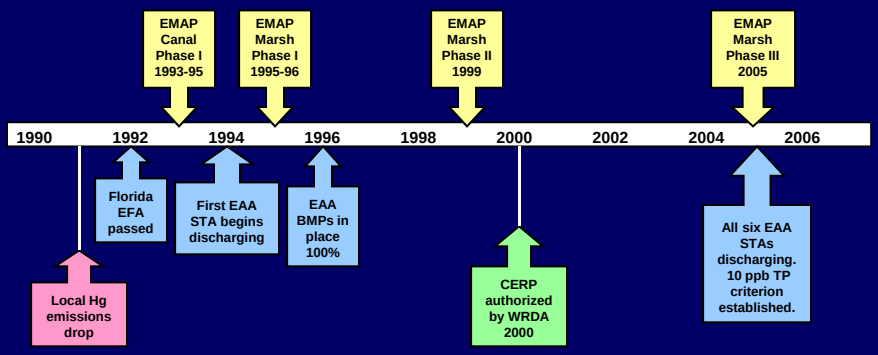
R-EMAP Program Timeline



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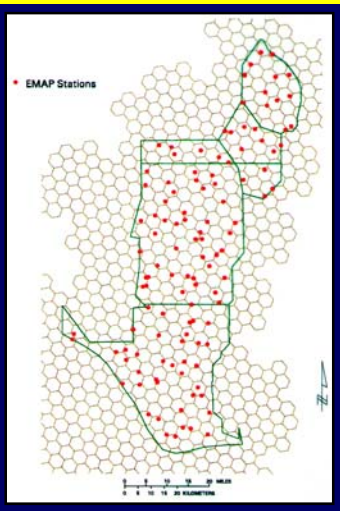
Probability-based Designs

- **RANDOM SAMPLING:**
- Allows description of the whole by only sampling parts
- Used in economic surveys, opinion polls
- EPA's standard approach for aquatic resource surveys



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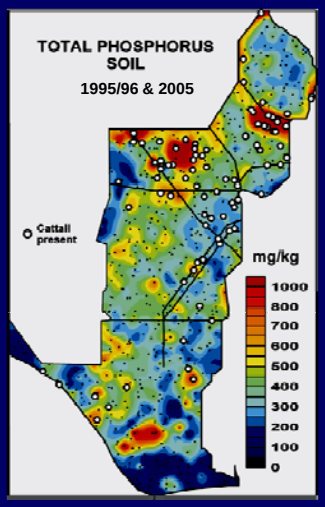
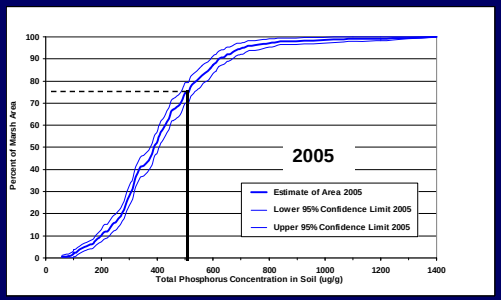
Phase III 2005 Program Findings

- **Areal Extent of Stressors**
  - TP in soil:
    - 24.5 +/- 6.4% > 500 mg/kg 'impacted'
    - 49.3 +/- 7.1% > 400 mg/kg CERP restoration goal
  - Hg in mosquitofish: 40.1 +/- 6.7% > 100 ug/kg predator protection level
  - Sulfate in water: 57.3 +/- 6.0% > 1.0 mg/L CERP restoration goal
  - Soil thickness: 25.1 +/ – 2.0% < 1.0 feet.

Total Phosphorus in Soil



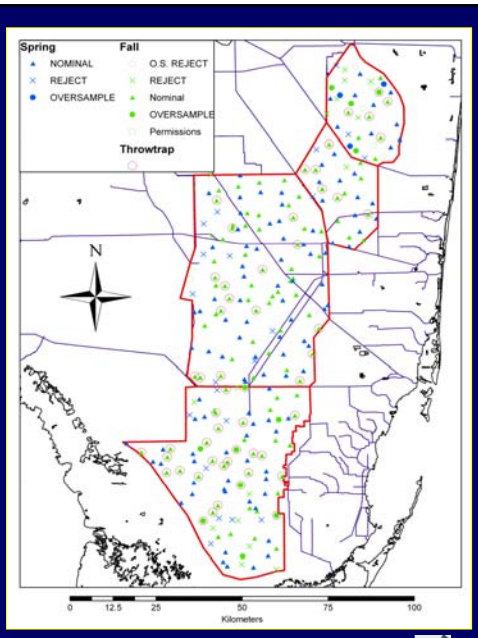


- **2005: 24 % > 500 mg/kg [= "impacted" (FDEP)], 49 % > 400 mg/kg (CERP restoration goal)**
- **Cattail present at 19 % of stations in 2005**

2005 Sampling

- **111 dry season sites, 119 wet season sites**
- **90 personnel, 30 field personnel**

– Biogeochemical (soil, surface water & pore-water nutrients, mercury, physical parameters)
  – 25,000 data points
  – Extensive QA/QC
  – 8 analytical labs
– Plant species presence and vegetation mapping
– Fish (fall only)
– Invertebrates (fall only)
– Periphyton (fall only)



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2005 Program Planning

- **2003 – 04. Input from FDEP, SFWMD, COE, USFWS, ENP, USGS, others**
  - Media, parameters, methods.
  - Maximize program utility.
- **P, Hg, S experts consulted.**
- **Coordinated with CERP Monitoring**
- **Independent scientific peer review of study plan.**

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Collaboration

- **R-EMAP Phase III data are featured in ~25 peer-reviewed publications to date by the Principal Investigators or collaborators.**
  - Over 30 co-authors
  - *Environmental Science & Technology; Environmental Pollution; Ecosystems; Reviews in Environmental Science & Technology ; Water, Air & Soil Pollution; International Journal of Plant Science; Aquatic Botany; Journal of Freshwater Biology; Marine & Freshwater Research;*
  - Over 200 journal citations.
  - Appear in several SFER chapters (Hg, TP, S, soil thickness)

2005 Program data website

- **http://digir.fiu.edu/gmaps/EverMap.php**

Biogeochemical Media

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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

R-EMAP Program Data Users

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Program Data Uses: EFA

- Assess *TP* in EPA habitats other than wet prairie
- Assess soil TP throughout EPA, independently corroborate other sampling efforts
- Assess *periphyton communities* & TP throughout EPA
- Assess *mercury* conditions throughout entire EPA, track response in water & fish due to atmospheric controls
- Assess water quality conditions and transport throughout EPA (*P, S, conductivity, Hg*), SFER.

Program Data Uses: CERP

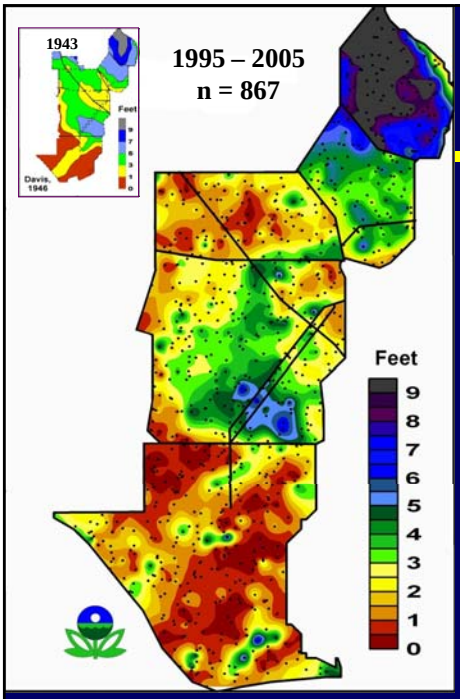
- Baseline established in 1995-6, 1999
- Quantify CERP ecological response in a statistically defensible manner
- Differentiate CERP effects, seasonality and inter-annual variability
- Fill monitoring and assessment gaps while providing consistent, comparable coverage
- Provide input to CERP conceptual models, SFWMM, ELM, CALM, ATLSS, WQ models, etc.

Program 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)

Program Data Uses: Mercury & Sulfur

- *Wading Bird Risk Assessments* ~ several risk assessment calculations for Hg effects on wading bird populations (SFWMD, TetraTech)
- *Environmental Impact Statements* ~ Everglades Construction Project EIS (USACE, SFWMD)
- *Empirical models* of aquatic cycling to refine understanding of Hg, P, S, O, C inter-relationships (USEPA-R4, USGS, TetraTech)



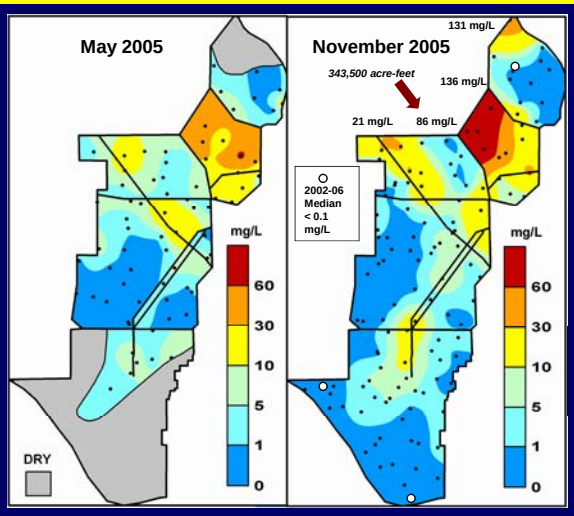
Soil Thickness

- 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

Program Statistical Tools 1995/96 -- 1999 -- 2005

- Weight of Evidence Approach
  - Box-and-whisker plot (data distribution, changes)
  - Krig (spatial patterns, changes)
  - Cumulative Distribution Function plot (impacted area [%, +/- CI])
  - Cumulative Distribution Function test (Has impacted proportion changed over time?)
  - z-test [of means (are years different?)]
  - Multivariate analyses (associations, causative factors)

Surface Water Sulfate 2005



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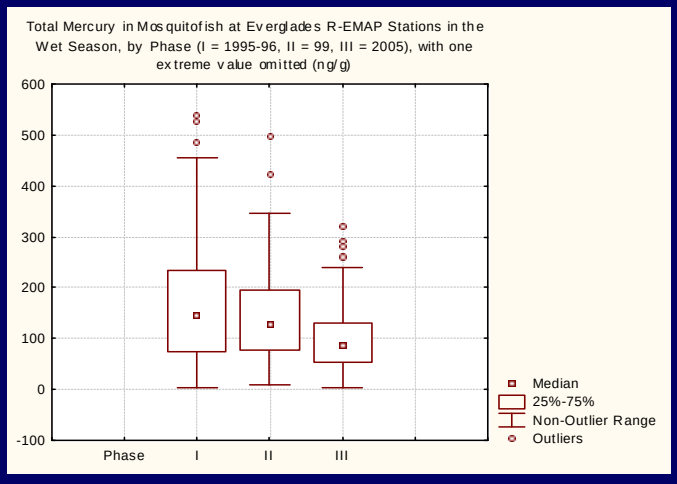
Mosquitofish Mercury 1995/96, 1999, 2005
Wet Season



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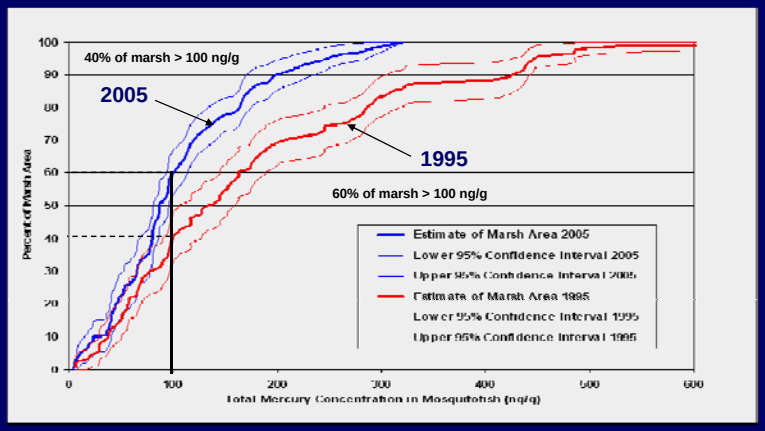
Mosquitofish Mercury, 1995 & 2005
Wet Season



Phase IV Planning

- Timing
- Funding
- IAGs/Contracts
- Scoping
- Labs
- Methods
- Design
- Permits

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**

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Phase IV Survey

- **What can be left out?**
  - Food web
  - Vegetation sampling
  - Vegetation mapping
  - Dry season
  - Some biogeochemical analytes

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