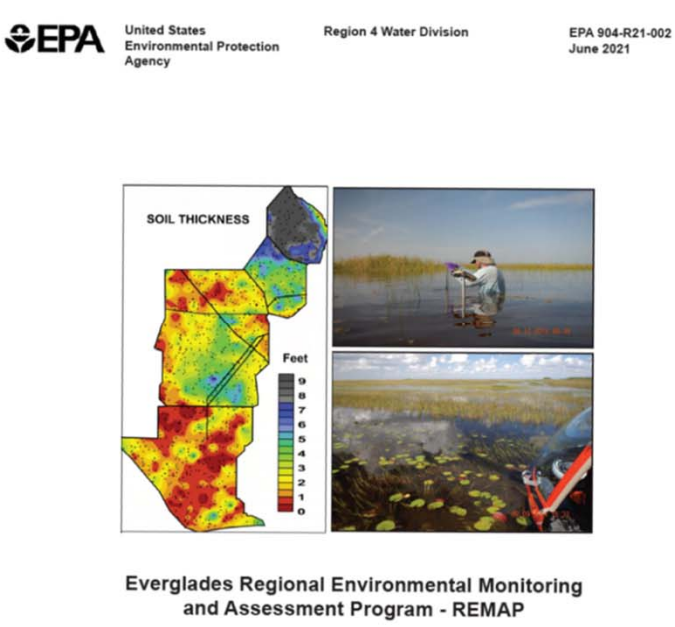
Everglades REMAP
Monitoring and assessing the health of the Everglades 1992-2014

Working Group and Science Coordination Group
September 28, 2021

Dan Scheidt, USEPA, REMAP Associate Program Leader
Pete Kalla, USEPA, REMAP Program Leader

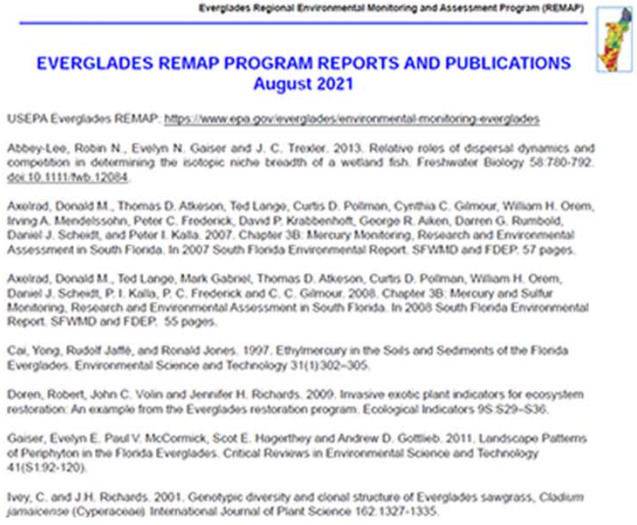
Regional Environmental Monitoring & Assessment Program (REMAP) Readaheads

2021 EPA Management Report

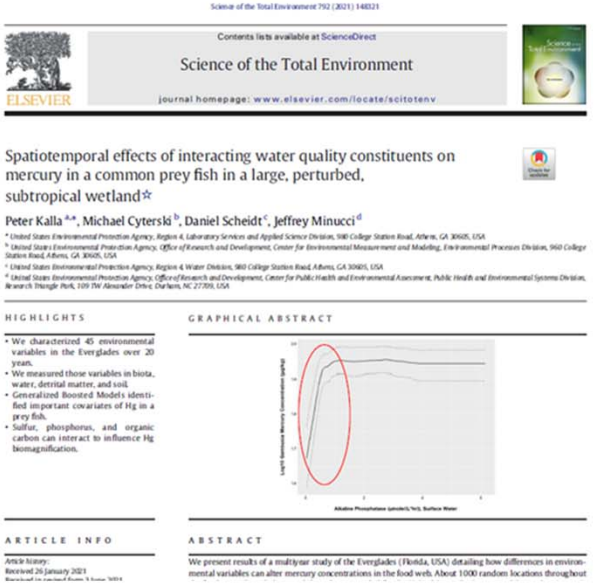


(Scheidt, Kalla, Surratt 2021; EPA-904-R21-002)

Program publications



Example multi-variate analyses



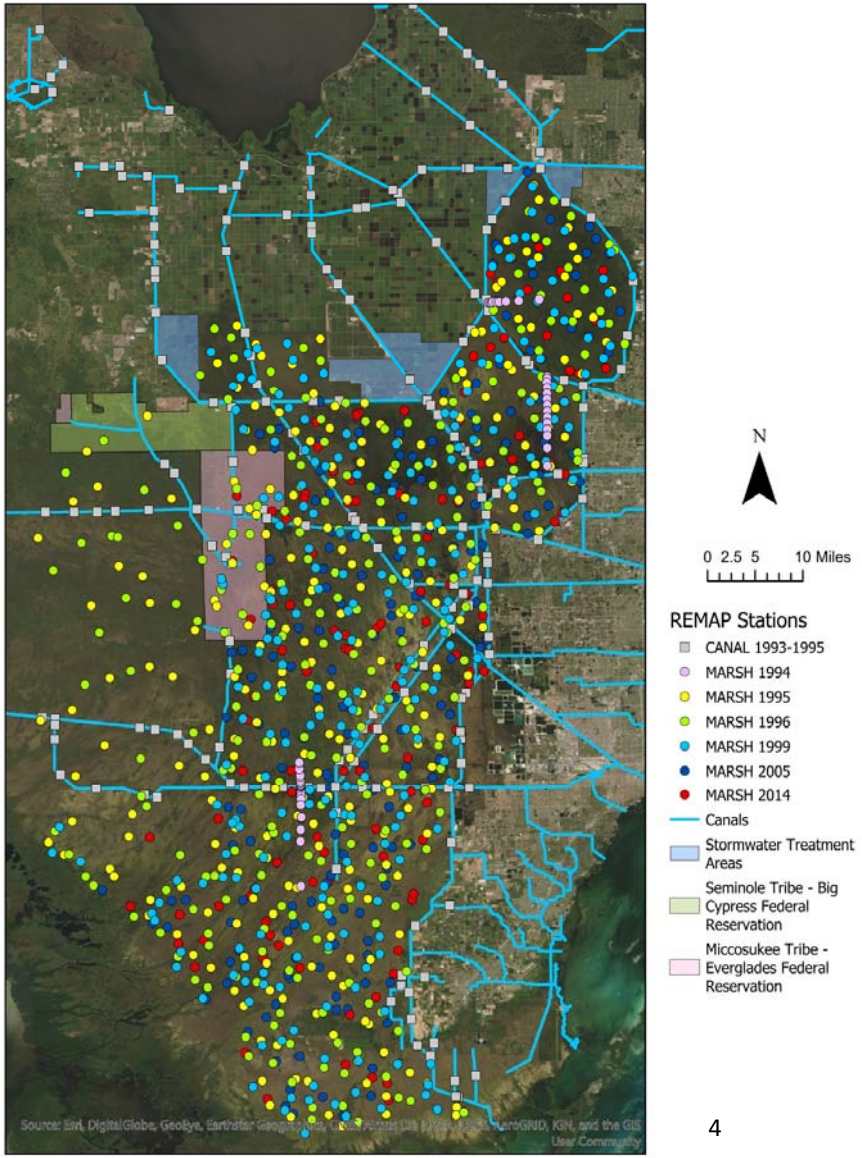
Overview, Results and the Ask: REMAP's Future

- Overview of REMAP and six example results
- Should REMAP Continue?
- Who will use the data?
- What are the environmental protection or restoration decisions that REMAP data will help to inform?
- Are we scientifically sound, strategic, collaborative, cooperative, relevant, timely, cost-effective?
- This presentation is not a commitment from USEPA

REMAP is Unique

- **<u>Can quantify conditions/health across area with a known confidence interval</u>**
- **<u>Multi-media (water, soil, fish, plants, periphyton)</u>**
- **<u>All of freshwater Everglades (2100 mi^2, 3000 mi^2 with Big Cypress)</u>**
- **<u>Nobody else does this</u>**

- Design and station draw by USEPA Office of Research & Development (ORD)
- Random sampling; probability-based design: polls, surveys
- Every random point has an equal chance of being sampled
- Can identify status, trends, associative factors for multiple environmental stressors.
- >1000 marsh locations 1995-2014
  - ~120 each time, 22 total events
- Assembled a massive amount of information
- <u>Snapshots.</u> Can make no statement about other years.



Everglades REMAP Phases 1993-2014

Phase	I	II	III	IV
Year(s)	1993 - 1996	1999	2005	2013 - 2014
Distinguishing features	Baseline data. Multiple stressors. Big Cypress & canals included.	Change detection. Added periphyton assessment & plant studies. Dropped Big Cypress & canals.	Change detection. Added food web studies & invasive plant survey.	Change detection. Dropped dry season. Dropped aquatic community ecology & some plant studies.
Canal Stations	199	0	0	0
Marsh Stations	240 dry season 240 wet season 480 total	119 dry season 119 wet season 238 total	109 dry season 118 wet season 228 total	51 wet season 2013 118 wet season 2014 169 total
Funding	EPA, FDEP	EPA, FDEP	EPA, RECOVER, NPS, FDEP	EPA, NPS
Biogeochemical Media				
Surface water	X	X	X	X
Floc		X	X	X
Porewater		X	X	
Bottom water				X
Soil	X	X	X	X
Periphyton	X	X	X	X
Mosquitofish	X	X	X	X
Macrophytic Vegetation		X		X
Macrophytic Plants				
Qualitative habitat categorization	X	X	X	X
Species frequency		X	X	
Classified vegetation mapping		X	X	X
Invasive plant survey			X	
Aquatic Community Ecology				
Periphyton assemblage		X	X	
Mosquitofish food habits		X		
Macroinvertebrate assemblage			X	
Isotope studies			X	

USEPA;
FIU- Scinto, Liu, Cai

FIU- Richards and Gann; USEPA

FIU- Gaiser and Trexler

2014 Sampling Partners
~70 people

- EPA Region 4 & contractors (39)
- EPA ORD (2)
- FIU (9)
- ENP NPS Science & Admin. (8)
- ENP NPS Aviation Support (3)
- DOI Aviation Safety (1)
- USFWS Loxahatchee (1)
- HMC Helicopters, Inc. (3)
- Miccosukee Tribe (1)

EPA Region 4

- Accredited field personnel, methods
- Accredited analytical labs

<u>Everglades 2014</u>

- 20 days
- 23 on-site field & support personnel
- 16 flight days
- 119 stations
- 2141 samples

Helicopter Operations- DOI, NPS

Flight Following
Helicopter Safety Training

>4000 take-offs/landings in remote marsh without incident. Reject station if can't safely land.

Sampling Everywhere

Soil, Water, Fish and Plants

USEPA Methods Development

Accredited Analytical Labs

~ 100,000 data results from marsh 1995-2014

~ 2,100 sample containers in 2014; 6000 data values

Extensive Data Quality Process, 100% QA/QC

Accredited labs - USEPA, FIU, FDEP, Battelle

Key analytes:

- Mercury
- Phosphorus
- Sulfur
- Nitrogen
- Carbon
- Physical characteristics

Everglades REMAP Partners & Some Data Users

Smithsonian Environmental Research Center

Everglades REMAP

Example CERP Everglades Ecosystem Restoration Performance Measures

(RECOVER 2007)

Water Management	Reinstate system-wide natural hydropatterns and sheet flow
Habitat Alteration	Increase spatial extent of habitat and wildlife corridors
Eutrophication	Water total phosphorus is not to exceed 10 micrograms per liter and should not exceed OFW concentration levels. Decrease the areal extent of areas with soil phosphorus exceeding 500 milligrams per kilogram (mg/kg) and maintain or reduce to 400 mg/kg or less. Surface water total nitrogen should be ≤ 1994-2004 baseline.
Mercury Contamination	No statistically significant increase in levels of mercury in fish tissue, state water quality standards will be met
Sulfate Contamination	Maintain or reduce surface water sulfate to 1 milligram per liter or less
Surface Water Specific Conductance	No more than 25% increase above background, maintain low specific conductance in the Refuge
Periphyton	Increase aerial coverage of habitats that reflect Natural Systems Model
Soil Loss	Restore natural soil formation processes and rates

Scheidt Kalla Surratt 2021 EPA-904-R21-002, page 10

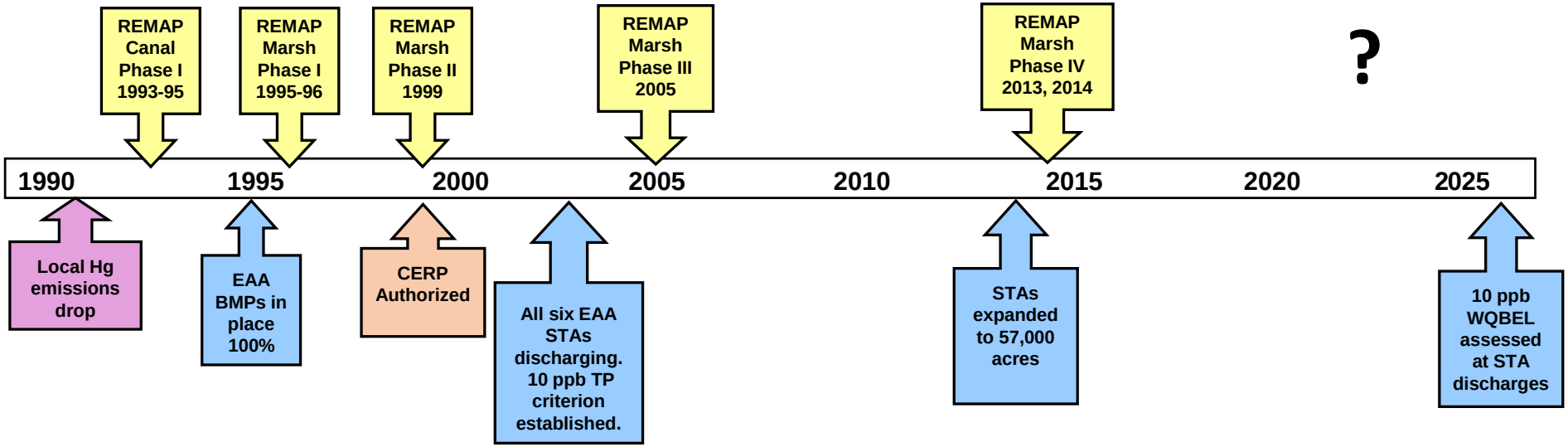
- Data relevant to 14 of 28 **CERP RECOVER** performance measures for the Greater Everglades
- **South Florida Environment Reports** by **SFWMD and FDEP to Governor and Legislature** (mercury, sulfur, phosphorus, soil thickness)
- **Committee on Independent Scientific Review of Everglades Restoration Progress (CISRERP)** (mercury, sulfur, phosphorus, soil thickness)
- **19 data uses** (50 non-EPA reports listed, Scheidt et al. 2021, EPA-904-R21-002, pages 20-21)

CERP: Comprehensive Everglades Restoration Plan
RECOVER: Restoration Coordination and Verification for CERP

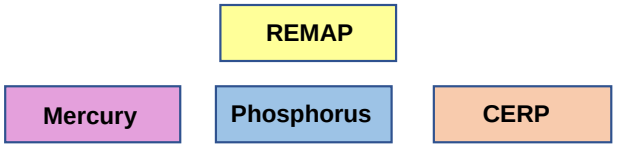
Collaboration and Scientific Credibility

- National Academies of Sciences
  - Peer-reviewed EPA ORD REMAP study design 1990s
  - CISRERP Everglades review panel uses the data (2008, 2010, 2012, 2014)
- EPA Everglades REMAP data used in >40 peer-reviewed publications or agency reports authored by EPA or collaborators https://www.epa.gov/everglades/environmental-monitoring-everglades
  - > 50 co-authors, EPA & Florida and federal agencies and universities
  - *Environmental Science & Technology; Environmental Pollution; International Journal of Plant Science; Aquatic Botany; Journal of Freshwater Biology; Marine & Freshwater Research; Reviews in Environmental Science & Technology; Environmental Management; Science of the Total Environment*
- These project publications cited 1000s of times
- Hundreds of publications by others
- Scores of presentations at Greater Everglades Ecosystem Restoration (GEER) Conferences

REMAP Timeline & Everglades Restoration Milestones

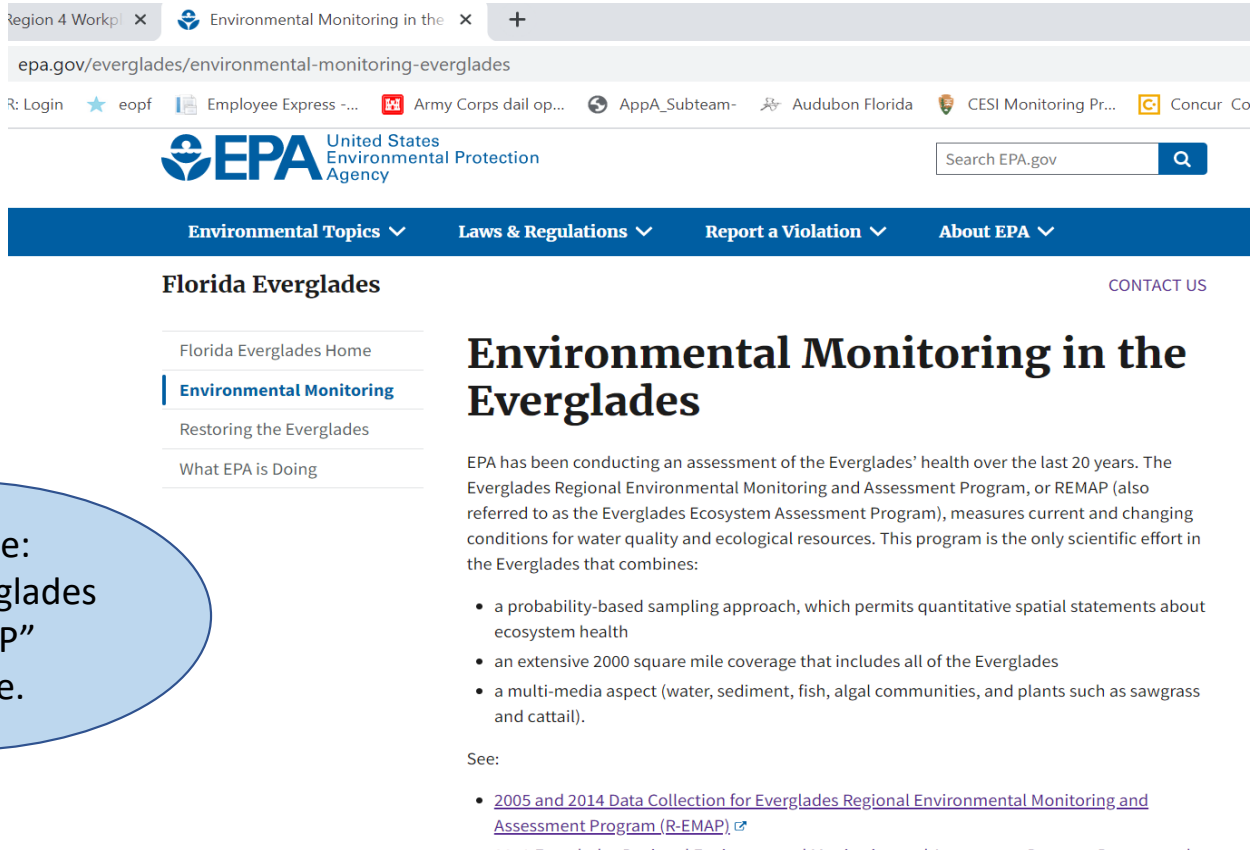


Hg = mercury
EAA = Everglades Agricultural Area
BMPs = Best Management Practices
CERP = Comprehensive Everglades Restoration Plan
STAs = Stormwater Treatment Areas
WQBEL= Water Quality-Based Effluent Limit



All Data and Reports (1990s-present) are Available to the Public EPA R4 Everglades REMAP website

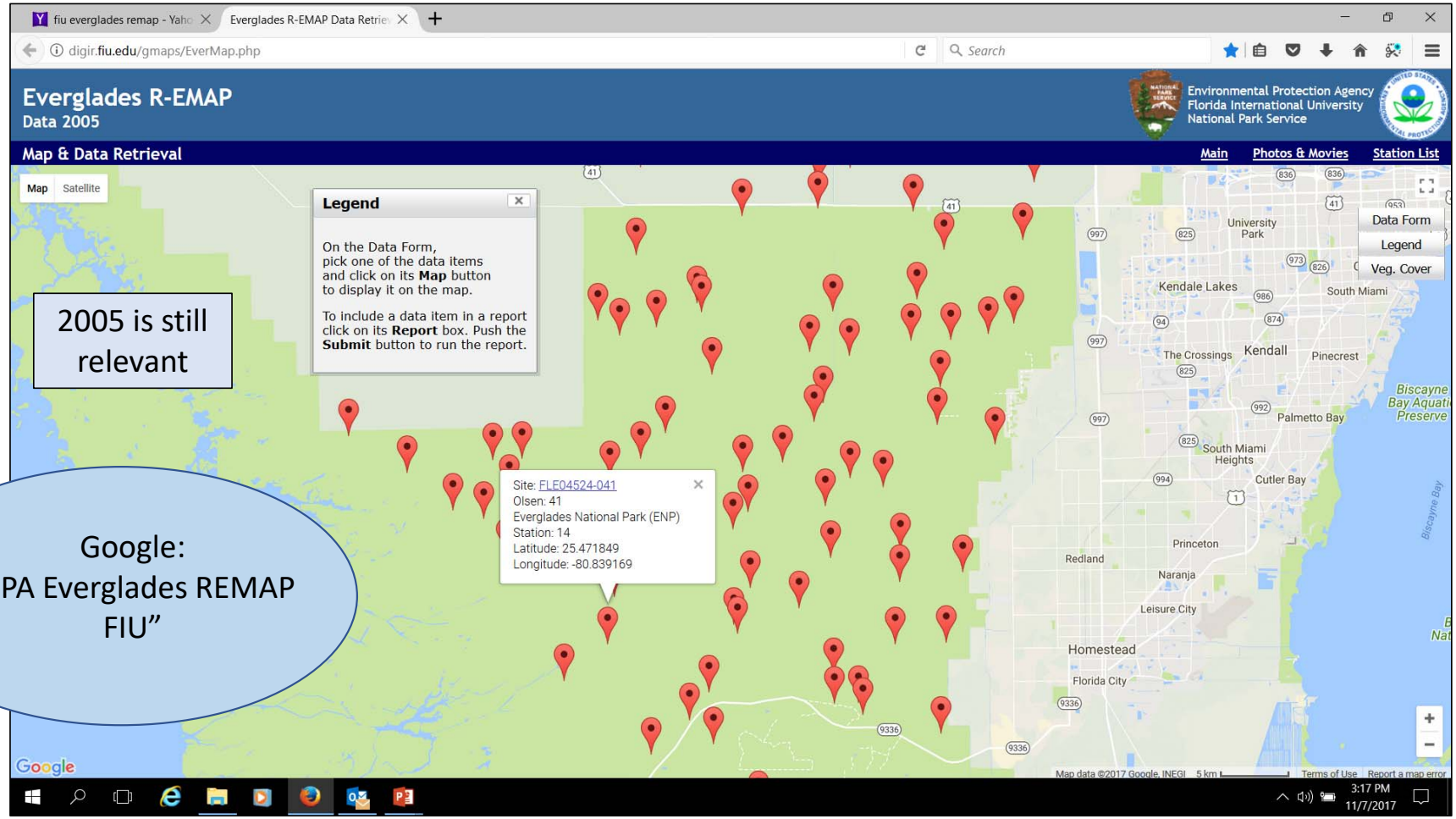
https://www.epa.gov/everglades/environmental-monitoring-everglades



Google:
"EPA Everglades REMAP"
Please.

All Data are Available to the Public

http://digir.fiu.edu/gmaps/EverMap.php GIS-based data retrieval



Google:
"EPA Everglades REMAP FIU"

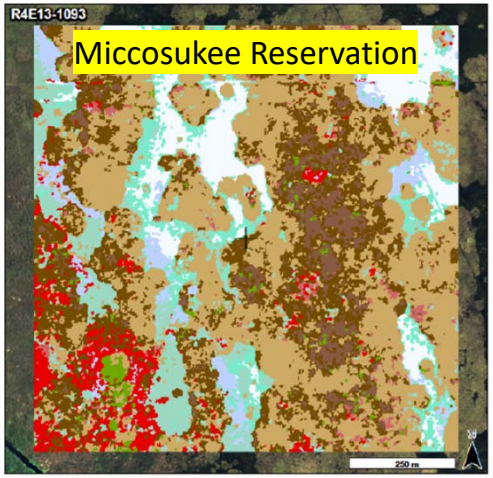
Vegetation maps 2014 (Richards et al. 2017)

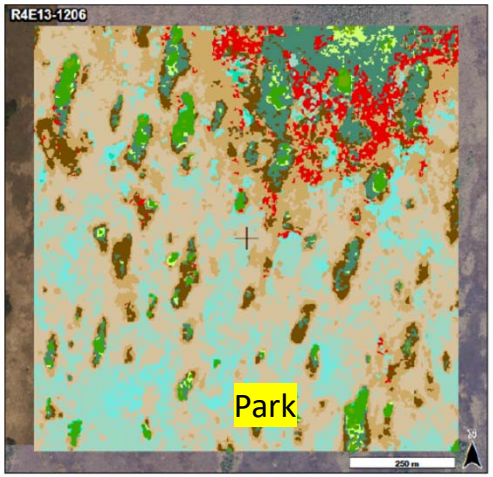
- Classified, 1 km^2
- Ground-truthed, 62 stations
- Worldview-2
- C,N,P standing stocks for sawgrass, periphyon
- 360-degree panorama 9 digital photos

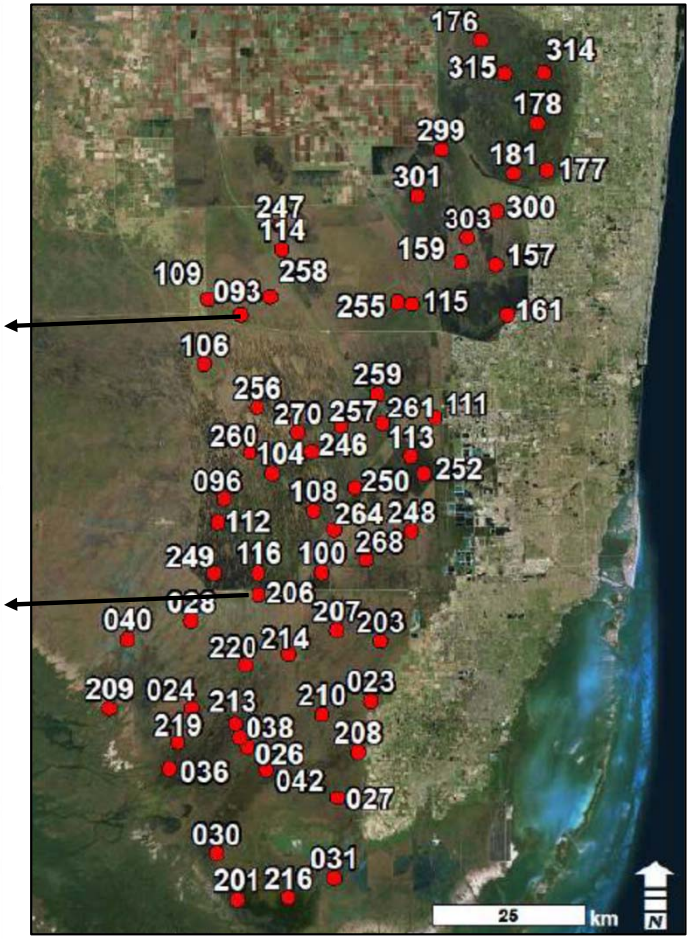
Vegetation Type

Grm.Mrsh.	Grm.Mrsh.Clad-Dns.	Shrb.
Grm.Mrsh-Dns.	Grm.Mrsh.Clad-Sprs.	Shrb.Sali.
Grm.Mrsh_Shrb.	Grm.Mrsh-Shrt.	Tree
Grm.Mrsh.Clad.	Grm.Mrsh.Typh	

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

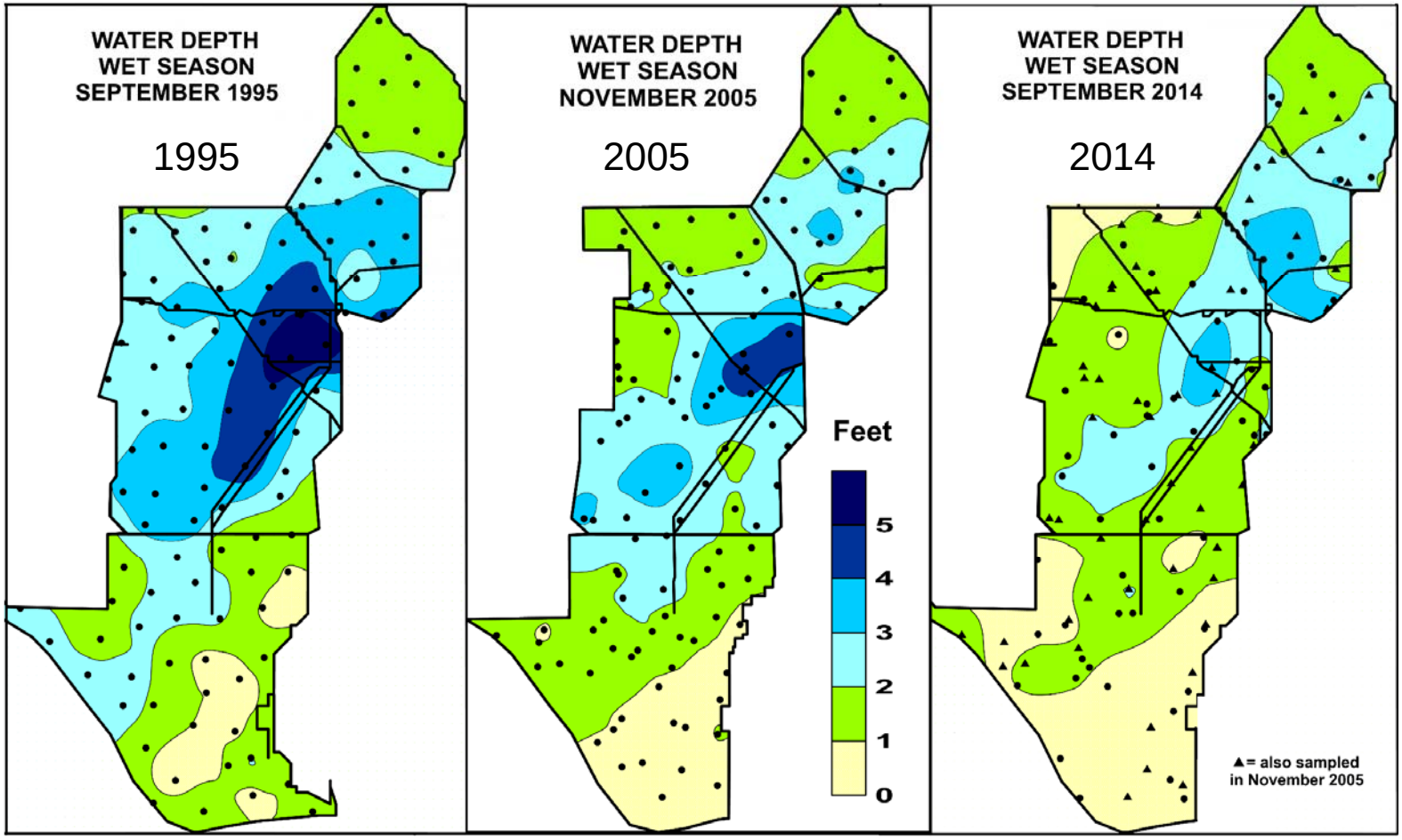






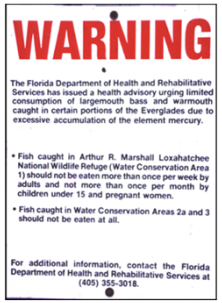
Measured **water depth** 1995, 2005, 2014

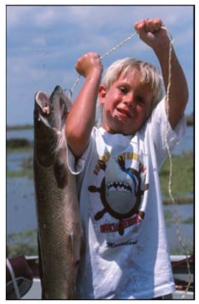
Wet season sampling snapshot context



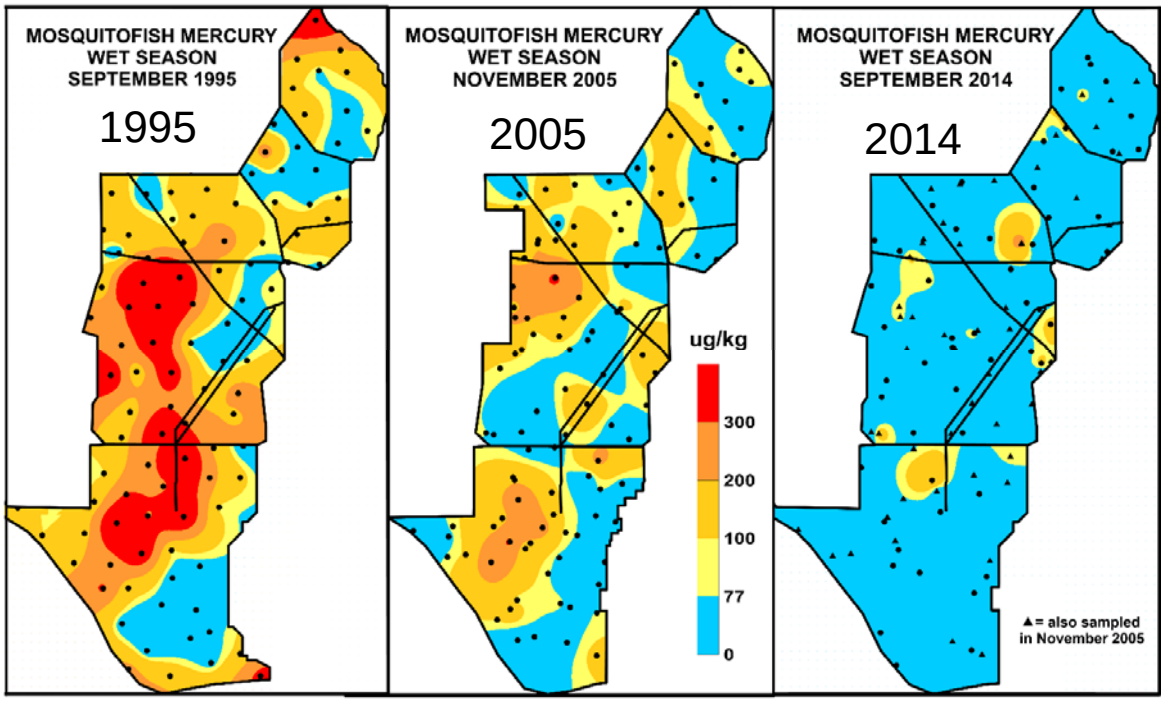
Management Issue example #1: **Mercury** in preyfish

1995>2005>2014. Lowest in 2014, not ok everywhere.





Loxahatchee NWR



77 ug/kg protective level for birds

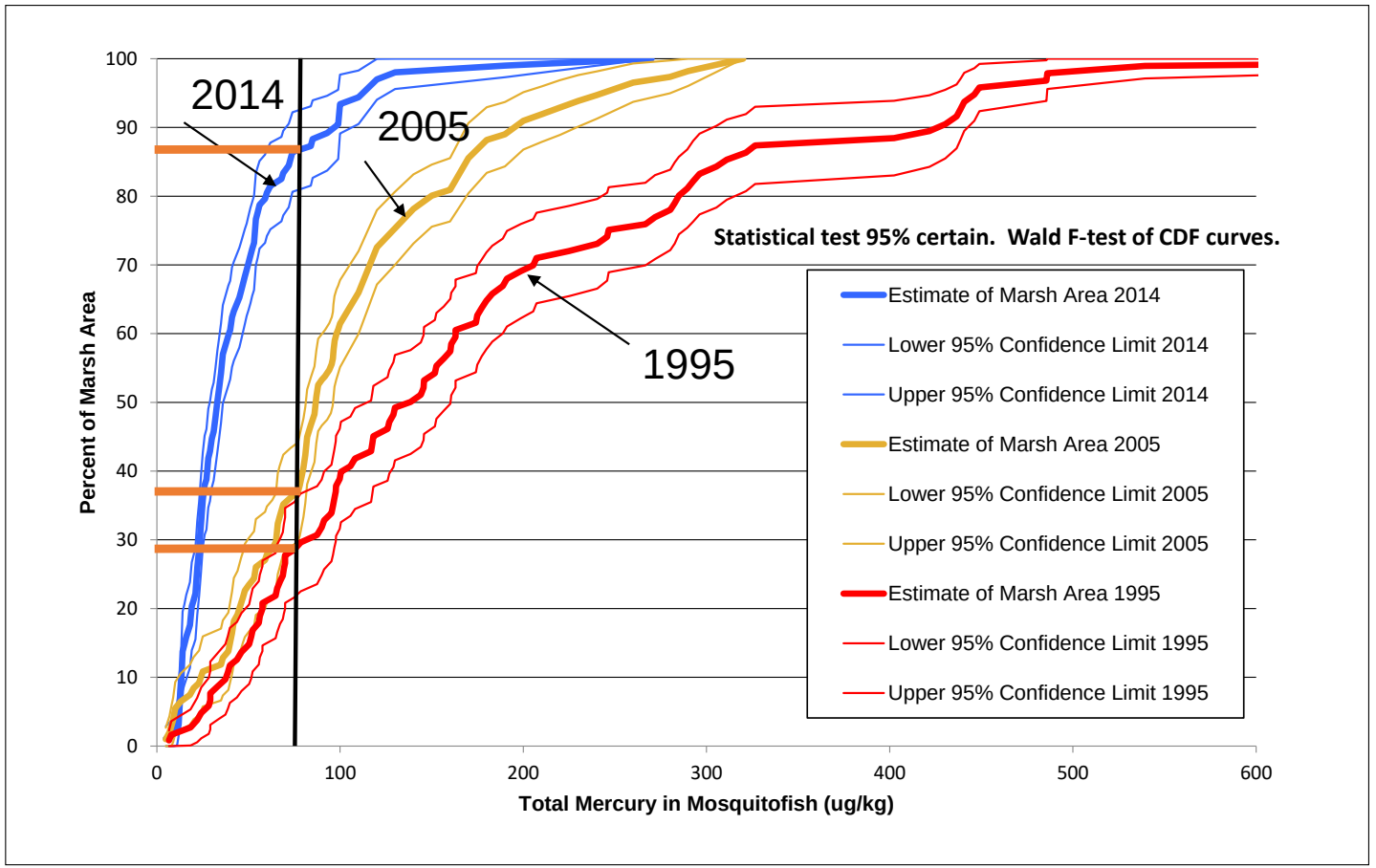
Krigs are illustrative only
No conclusions drawn only from krigs

"Women of childbearing age, young children:
DO NOT EAT" largemouth bass"
17 other species listed
FDOH, 2020

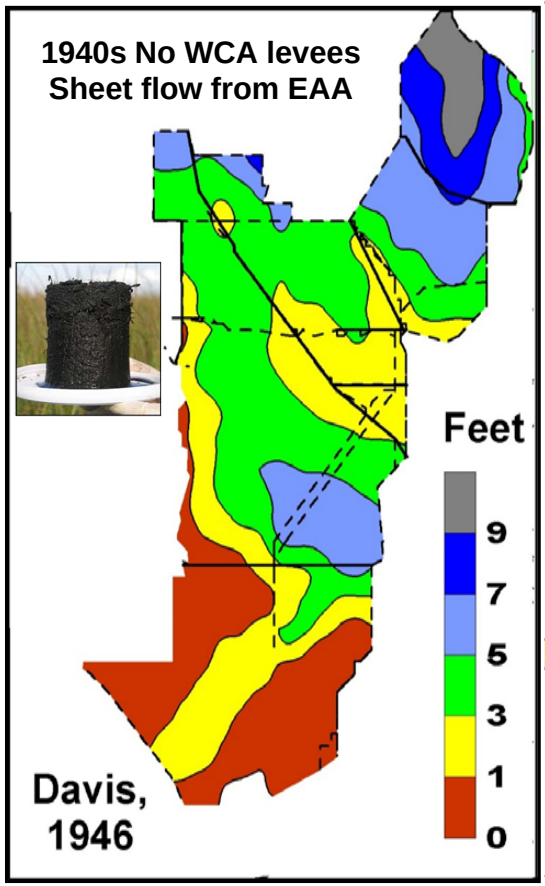
- Can make no statement about other years
- Multivariate analyses suggest biogeochemical associative factors

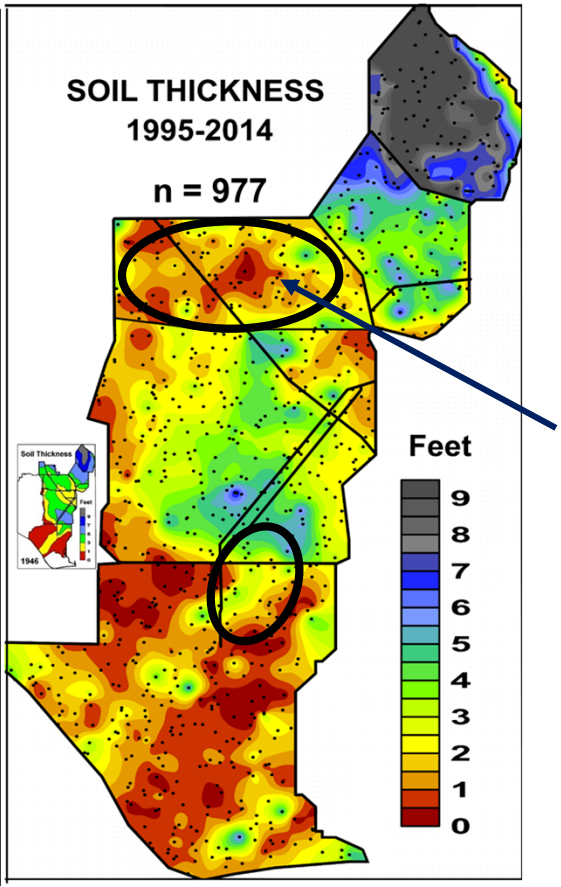
Mercury in Prey Fish – 2014 lowest

77 ug/kg trophic level 3 protection: 2014, 13 ± 6% of the marsh area > 77 ug/kg; 2005: 65 ± 7%. Different.



Management Issue Example #2: **Soil Thickness**
Is Everglades soil still being lost due to drier hydroperiods?
No system-wide change 2014 vs. 2005.





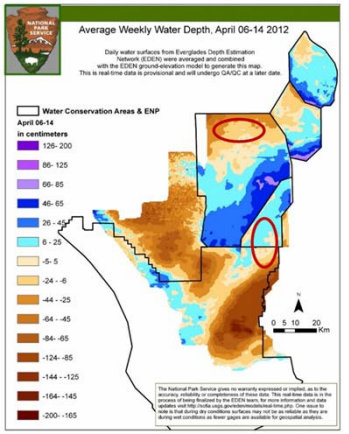
A major REMAP finding:

Soil loss 1940s vs. 1995-96.

- N WCA3A lost 39-69% of its soil from 1940s to 1990s No longer green.
- 2-6 x 10^8 m^3 loss (Scheidt et al 2000).

- Soil subsidence - soil less organic - increase in soil TP due to decrease in soil mass and volume - vegetation change associated with higher TP
- **CERP Central Everglades Planning Project Goal: restore Everglades sheetflow and soil, NWCA3A and NESS**

Data users: CEPP. CISRERP



Management Issue Example #3: **Phosphorus**

- 10 ug/L water quality standard
- EAA BMPs and STAs have removed 5000 tons 1994-2015. Taxpayers ~ $2-3 billion.
- Phosphorus impacts >40,000 acres. Refuge, WCA2A, Miccosukee Reservation

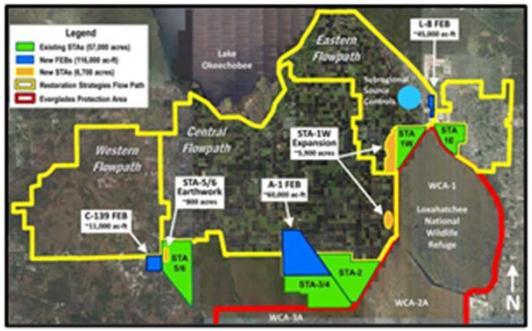
Surface Water Phosphorus, October 2014

N = 261, REMAP + SFWMD

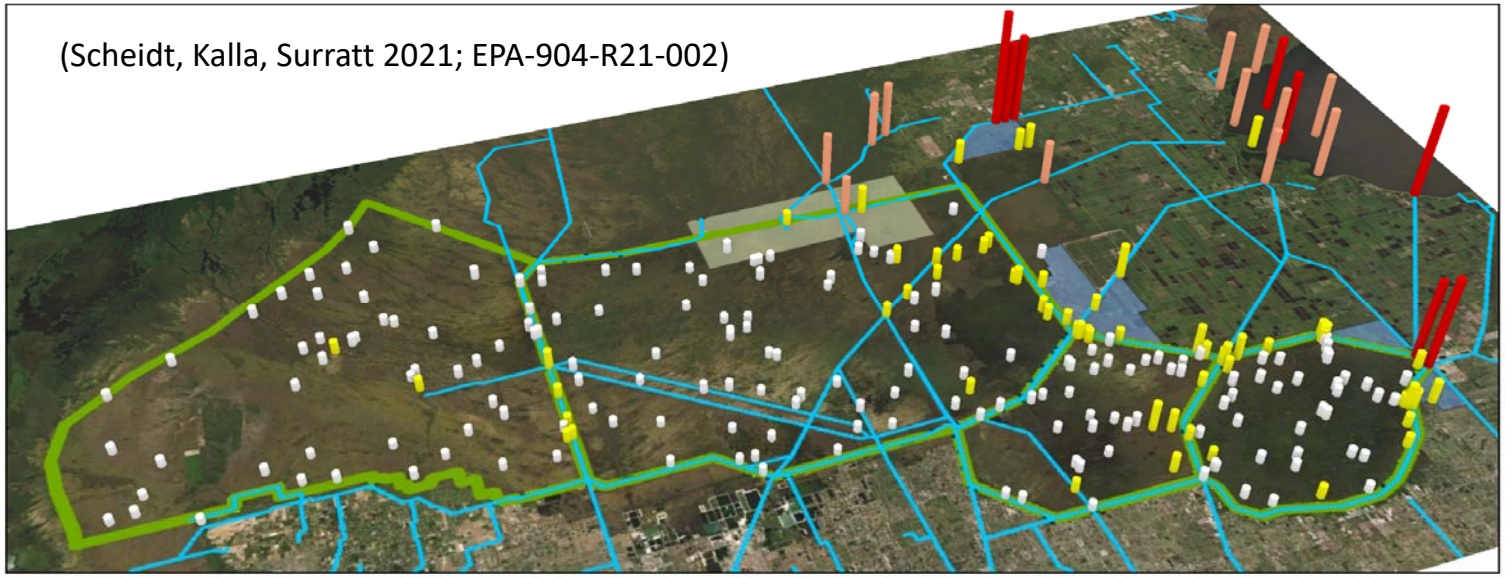
0 5 10 20 Miles

Canals
Stormwater Treatment Areas
Miccosukee Tribe Federal Reservation
USEPA REMAP Study Area

Total Phosphorus (µg/L)
≤10
>10 - 50
>50 - 100
>100



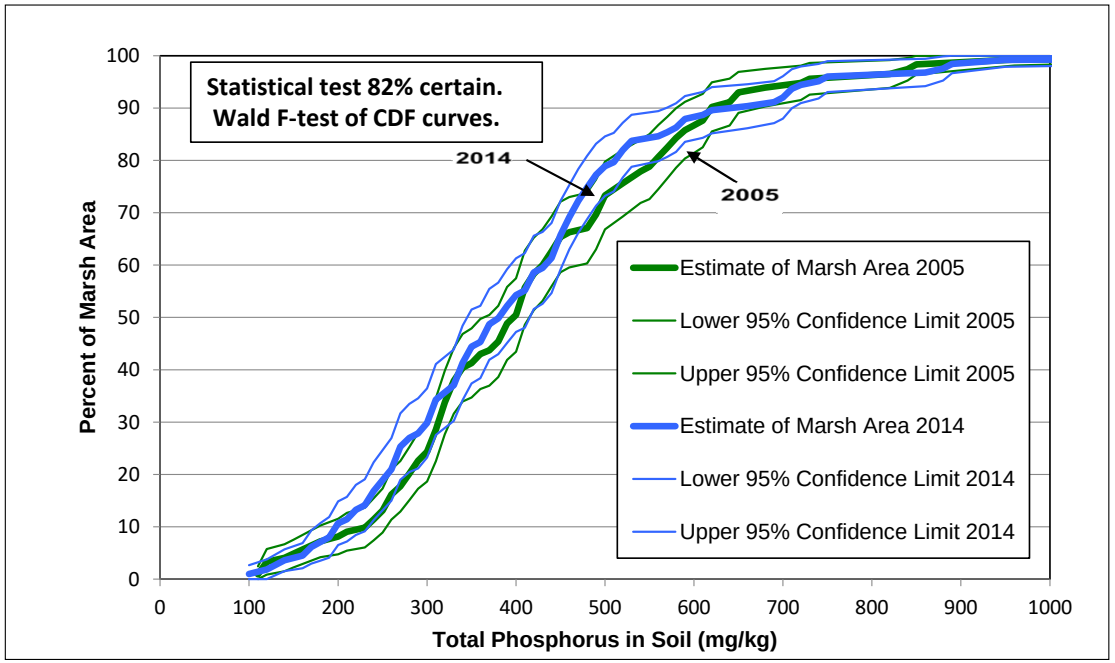
Restoration Strategies

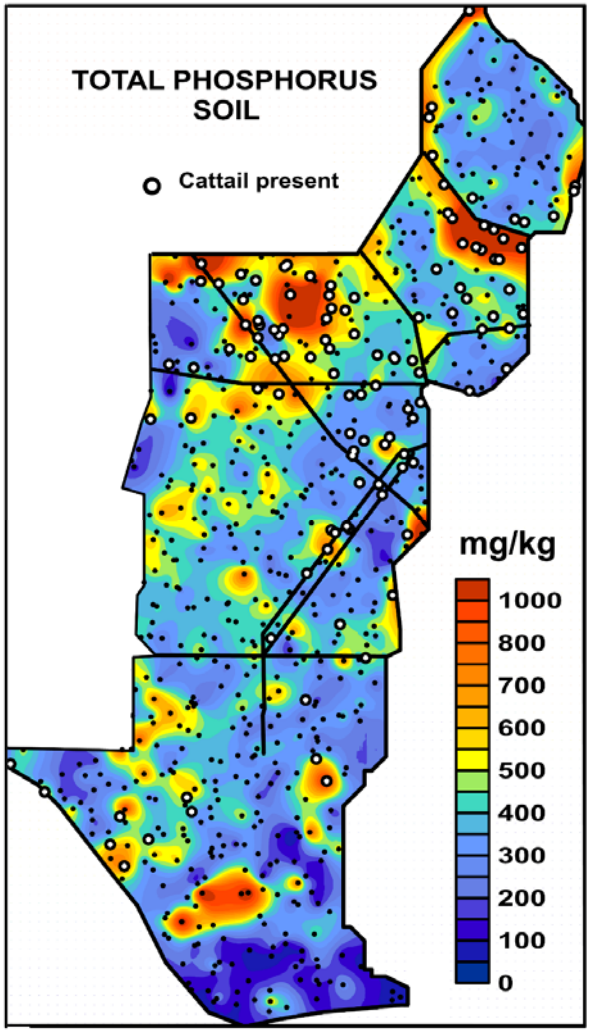


Soil Phosphorus Landscape-wide

no change detected 2005 vs.2014

- 2014 median 390 mg/kg = 2005 median 390 mg/kg > 1995-96 median 343 ($p<0.05$)
- 400 mg/kg CERP performance target:
  - 2014, 45 ± 7% of the marsh > 400 mg/kg
  - 2005: 49 ± 7%. No change.





Management Issue Example #4: **Water Sulfate**

Surface Water Sulfate, October 2014

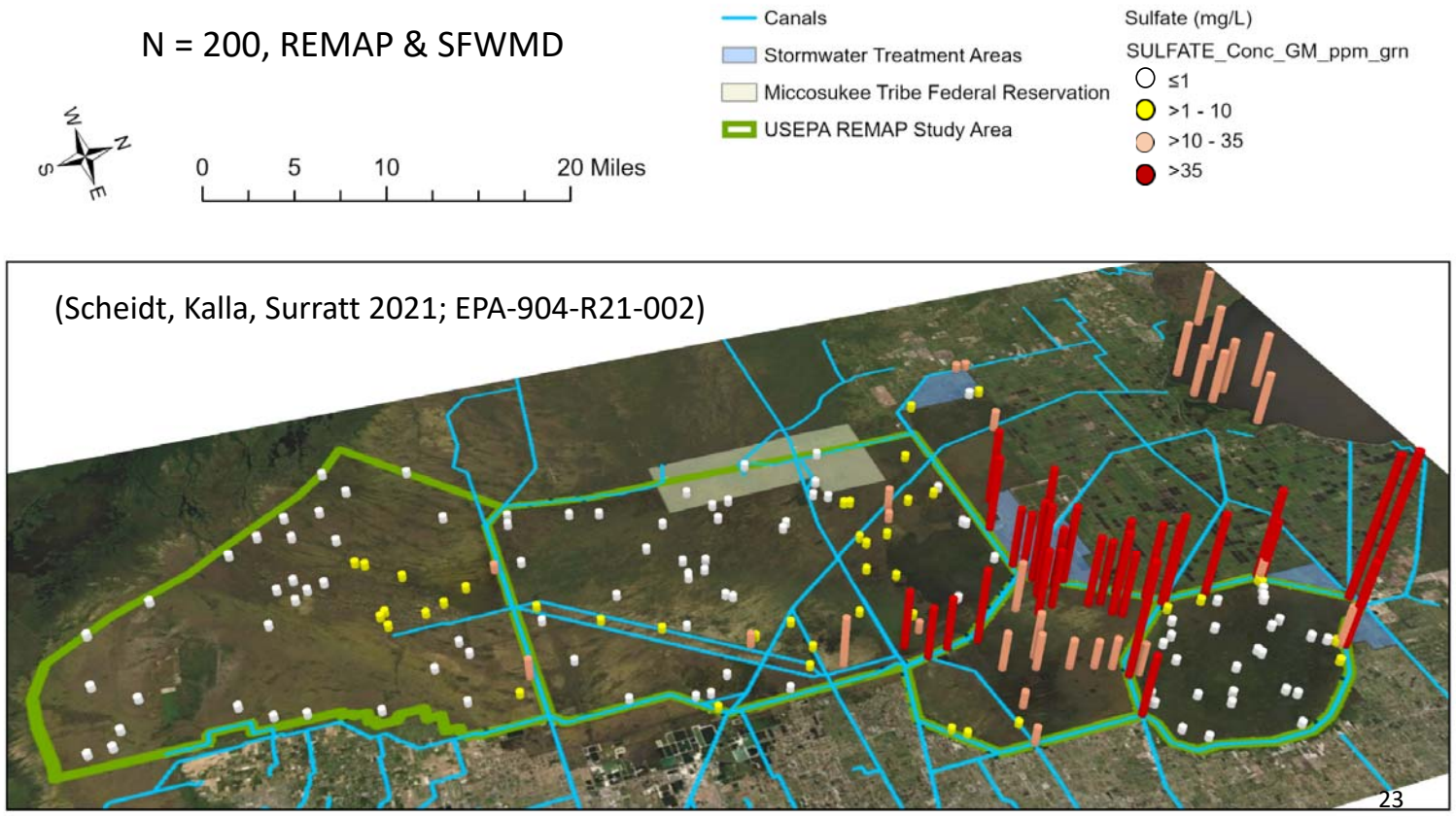
Sulfate is a factor associated with high mercury bioaccumulation

Rainfall has < 1mg/L

Raised as a concern with CERP efforts

Agricultural area has highest concentrations

Driven mostly by rainfall and discharge from EAA and STAs

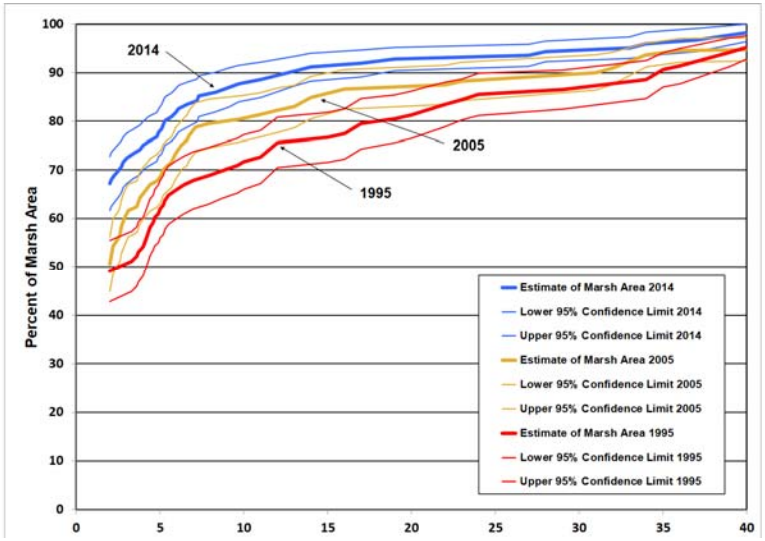


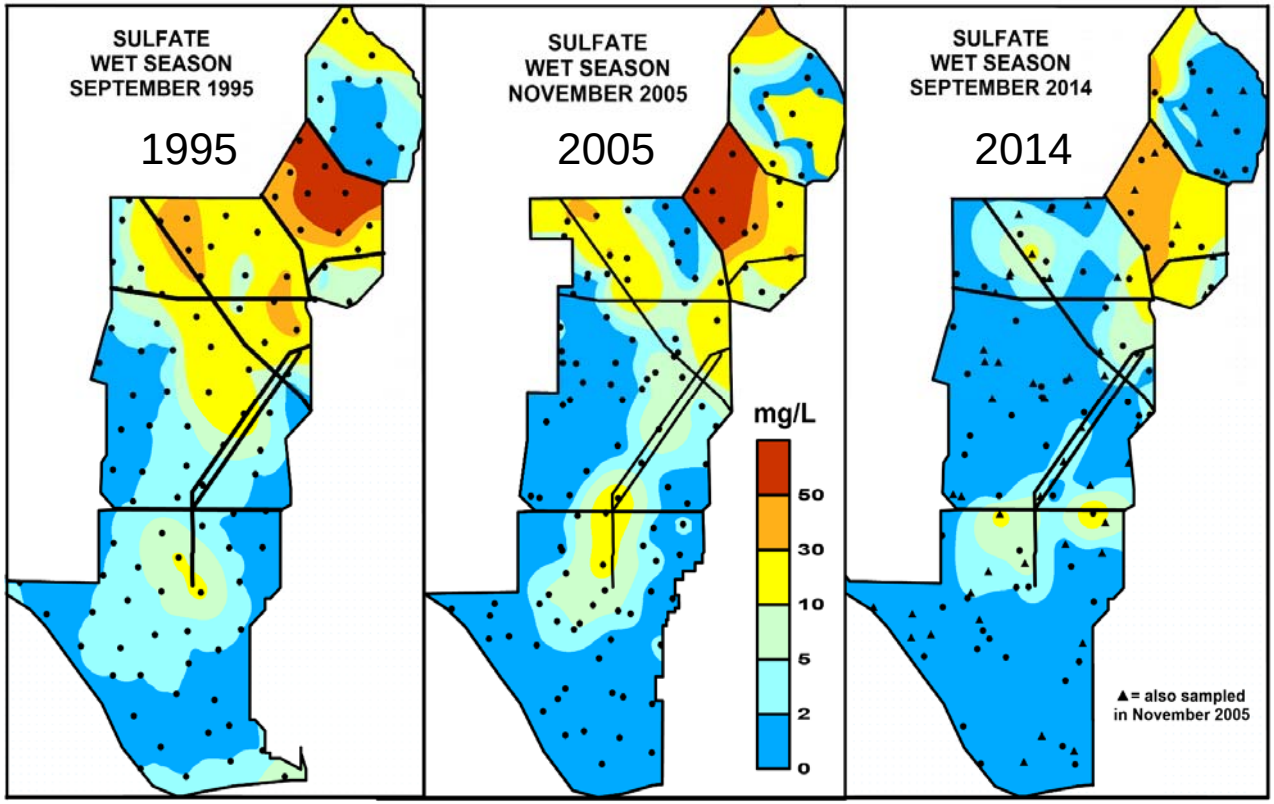
Sulfate lowest in 2014

Wet Season 1995, 2005, 2014

CERP performance measure: < 1.0 mg/L

2014: 37 ± 6% of Everglades area > 1.0 mg/L
2005: 57 ± 6% of Everglades area > 1.0 mg/L





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