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) Readahead

2021 EPA Management Report  
Program publications  
Example multi-variate analyses

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

- Can quantify conditions/health across area with a known confidence interval
- Multi-media (water, soil, fish, plants, periphyton)
- All of freshwater Everglades (2100 mi² - 3000 mi² with Big Cypress)
- Nobody else does this

- 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
- Snapshots. Can make no statement about other years.
## Everglades REMAP Phases 1993-2014

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Distinguishing features</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canal Stations</td>
<td>199</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Marsh Stations</td>
<td>240 dry season 240 wet season 480 total</td>
<td>119 dry season 119 wet season 238 total</td>
<td>109 dry season 118 wet season 228 total</td>
<td>51 wet season 2013 118 wet season 2014 169 total</td>
</tr>
<tr>
<td>Marsh Stations</td>
<td>199</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Funding</td>
<td>EPA, FDEP</td>
<td>EPA, FDEP</td>
<td>EPA, RECOVER, NPS, FDEP</td>
<td>EPA, NPS</td>
</tr>
<tr>
<td>Biogeochemical Media</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface water</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Floc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Porewater</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Bottom water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Periphyton</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mosquitofish</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Macrophytic Vegetation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macrophytic Plants</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qualitative habitat categorization</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Species frequency</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Classified vegetation mapping</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Invasive plant survey</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aquatic Community Ecology</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Periphyton assemblage</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mosquitofish food habits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macroinvertebrate assemblage</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isotope studies</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Funding:** 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

Everglades 2014
- 20 days
- 23 on-site field & support personnel
- 16 flight days
- 119 stations
- 2141 samples
Helicopter Operations- DOI, NPS

>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

- 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)
Collaboration and Scientific Credibility

• National Academies of Sciences
  • Peer-reviewed EPA ORD REMAP study design 1990s

• EPA Everglades REMAP data used in >40 peer-reviewed publications or agency reports authored by EPA or collaborators
  • > 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

https://www.epa.gov/everglades/environmental-monitoring-everglades
REMAP Timeline & Everglades Restoration Milestones

- **1990**: REMAP Canal Phase I 1993-95
- **1995**: REMAP Marsh Phase I 1995-96
- **2000**: REMAP Marsh Phase II 1999
- **2005**: REMAP Marsh Phase III 2005
- **2010**: REMAP Marsh Phase IV 2013, 2014

**10 ppb WQBEL assessed at STA discharges**

- **1993**: Local Hg emissions drop
- **1995**: EAA BMPs in place 100%
- **2000**: CERP Authorized
- **2005**: All six EAA STAs discharging. 10 ppb TP criterion established.
- **2015**: STAs expanded to 57,000 acres

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

2005 is still relevant

Google: “EPA Everglades REMAP FIU”
Vegetation maps 2014 (Richards et al. 2017)

- Classified, 1 km²
- Ground-truthed, 62 stations
- Worldview-2
- C,N,P standing stocks for sawgrass, periphyon
- 360-degree panorama 9 digital photos

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**


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

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
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.
A major REMAP finding:

**Soil Thickness**

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**

\[ N = 261, \text{ REMAP + SFWMD} \]

![Map of Surface Water Phosphorus](image)

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

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

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
The Ask: REMAP’s Future

- 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?