

# The Importance of Scientific Monitoring in Restoring Ecosystems

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Environmental Measurement Symposium

*a combined meeting of the National Environmental Monitoring Conference and The NELAC Institute*

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University of Maryland  
CENTER FOR ENVIRONMENTAL SCIENCE

# How Did I Get Here?



*"The Future Landscape of Science"*



A black and white photograph of a man with dark hair, wearing a light-colored suit and tie, singing into a microphone on stage. In the background, a drum set is partially visible.

Techniques for Organics  
Laboratory Accreditation  
Volatile Organics by GC/MS  
ICP-MS Metals Analysis  
Metal Speciation Analysis  
Citizen Science  
Consensus Standards Development  
SERDP  
Air Methods  
Forensic Environmental Chemistry  
Whole Effluent Toxicity

# Purposes of Environmental Monitoring

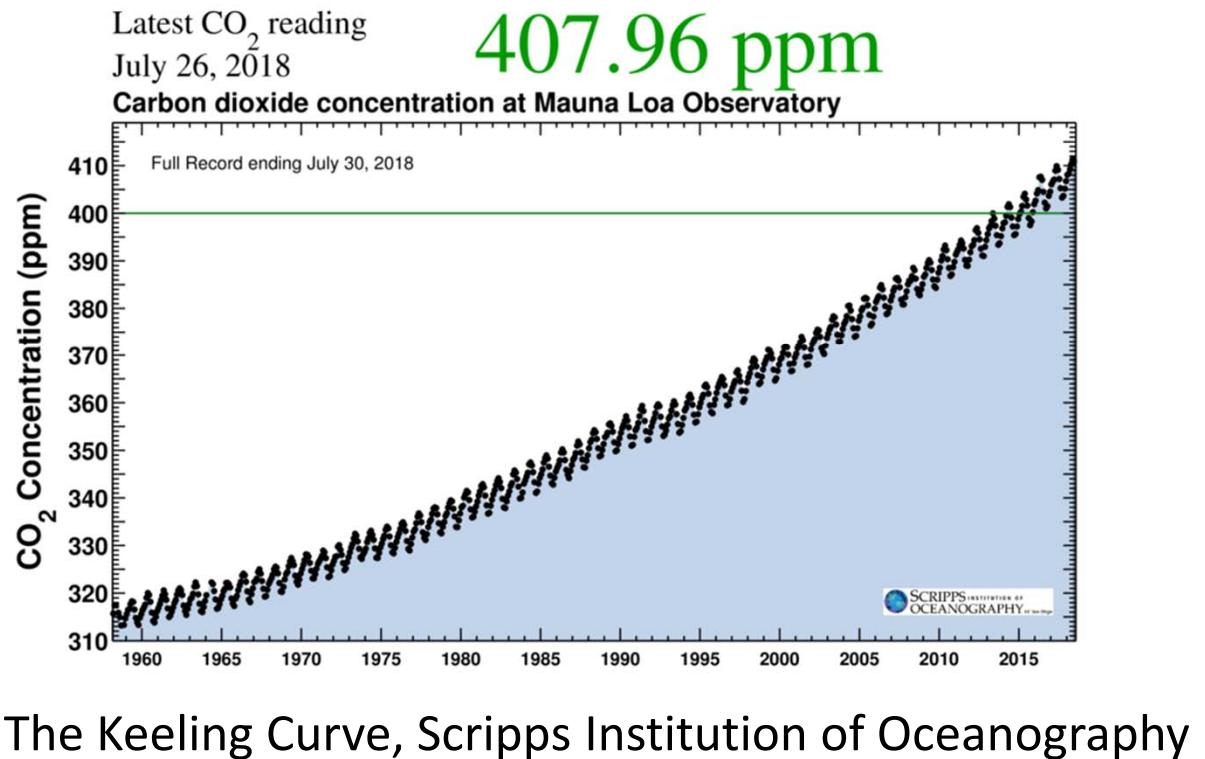
- Permit compliance
- Source quantification
- Public and occupational safety
- Remediation
- Resource management
- Project design and risk assessment
- Environmental status and trend assessment
- Ecosystem restoration

# Accurate Measurements Are Critical in This Changing World

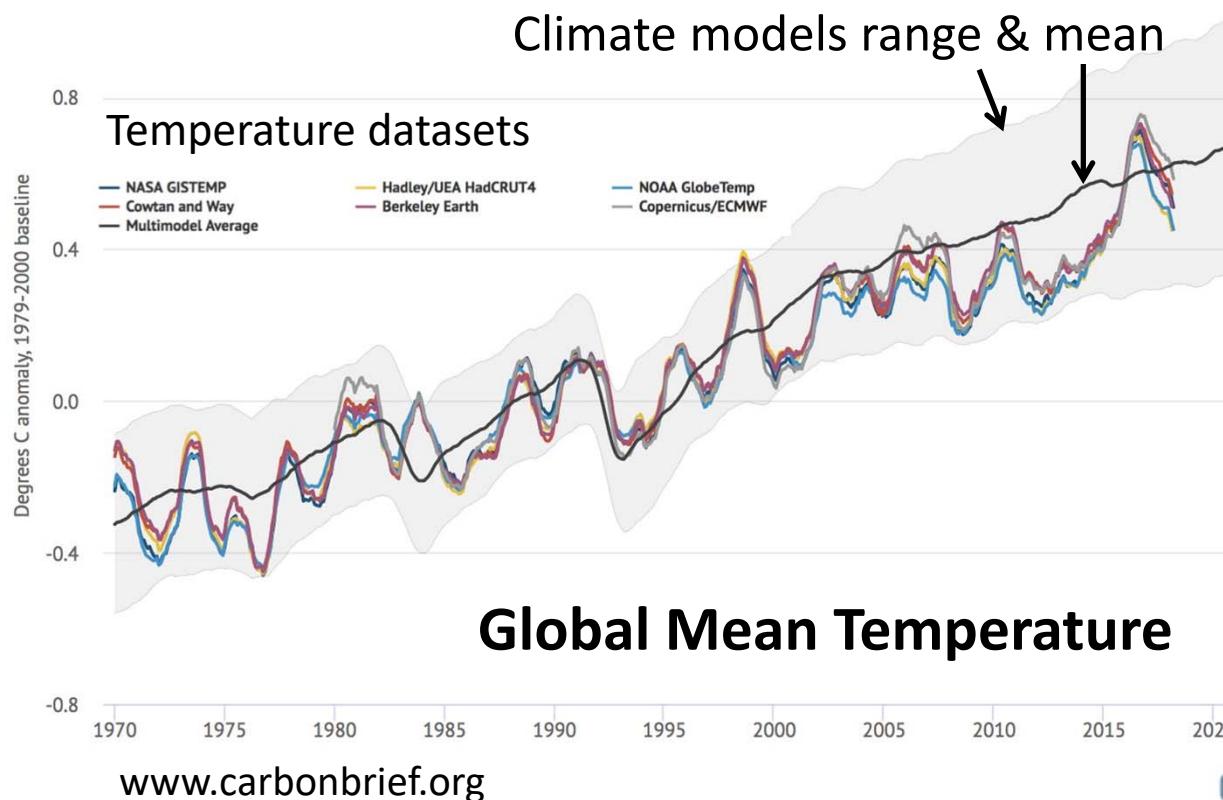
Concentration of CO<sub>2</sub> has grown by 46% since pre-industrial period.



Charles David Keeling

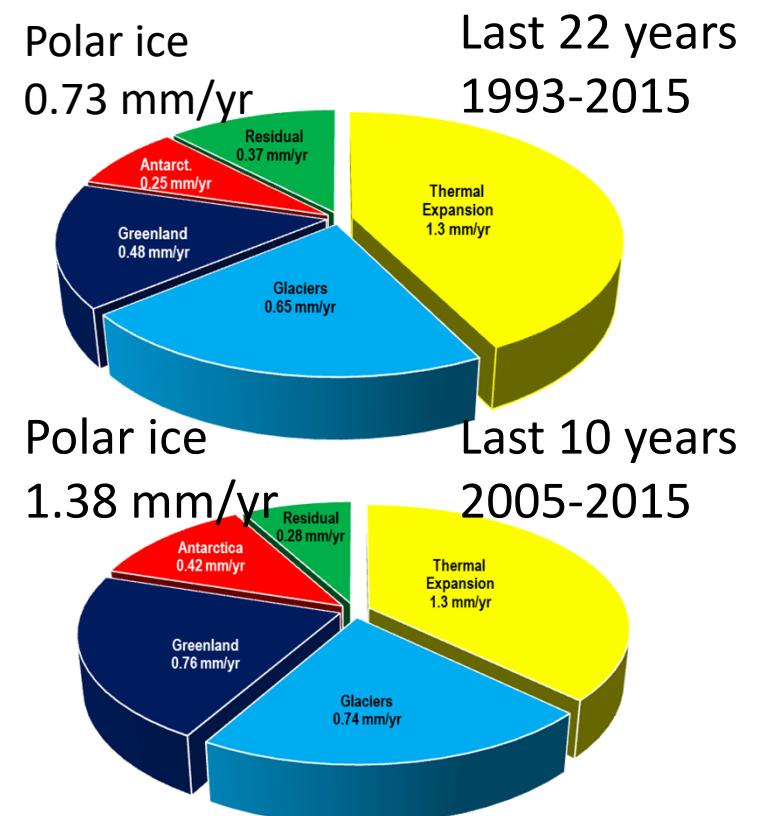
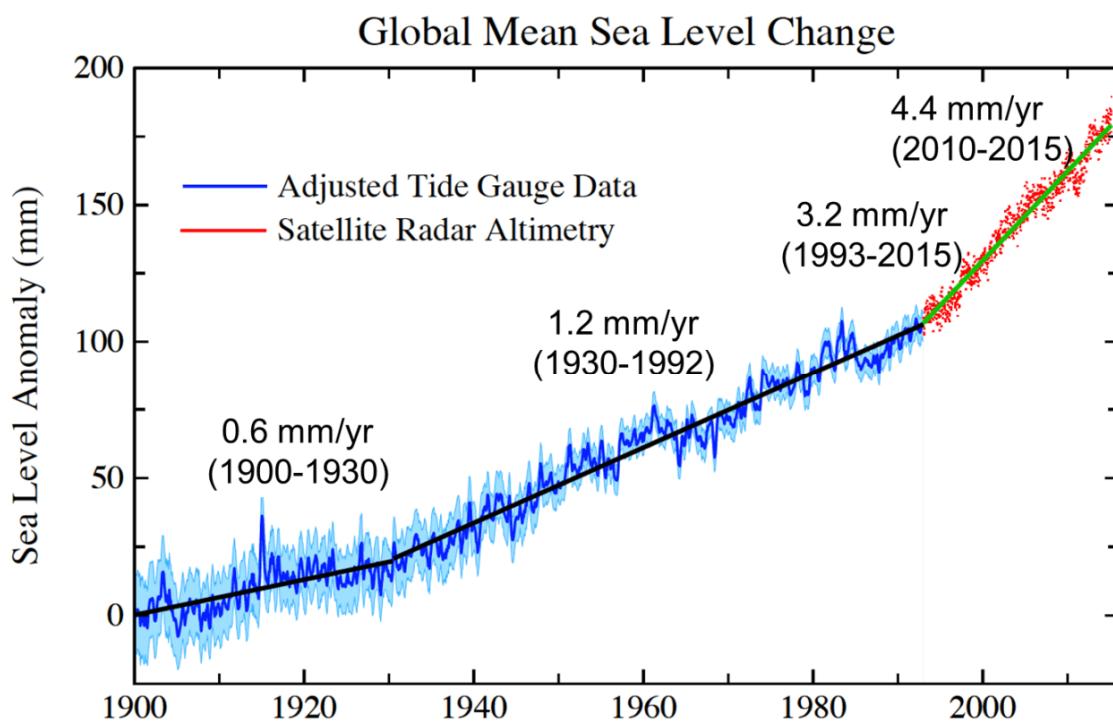


# Even a Little Thing Like Temperature



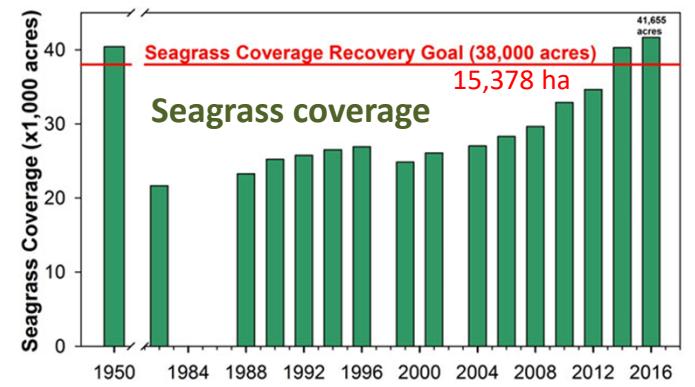
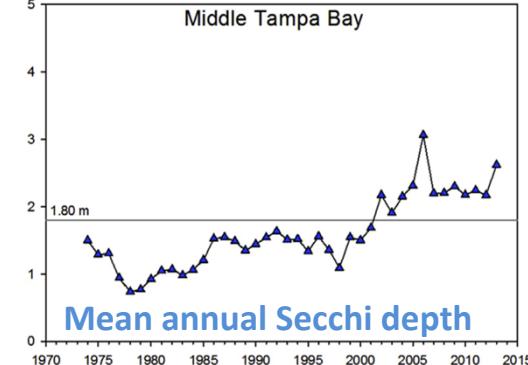
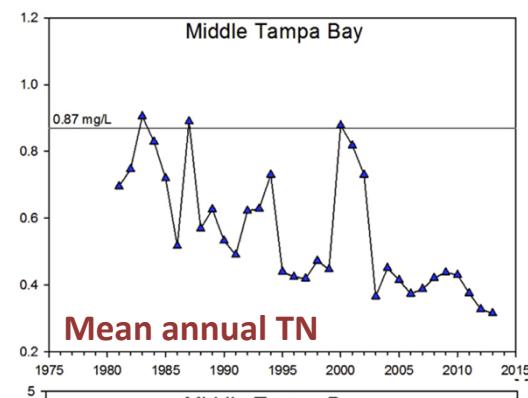
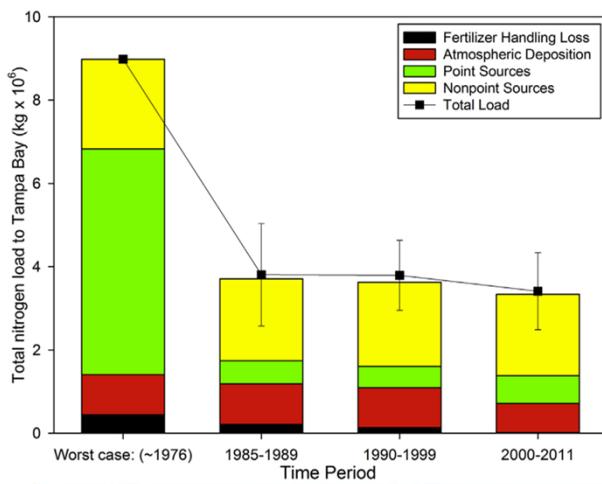
- $>0.8^{\circ}\text{C}$  warming since 1970
- No decline or pause
- Varies with climate cycles such as El Niño-Southern Oscillation
- 2016 was warmest year on record, 2017 second warmest

# Sea-Level Rise: Tide Gauges to Satellites



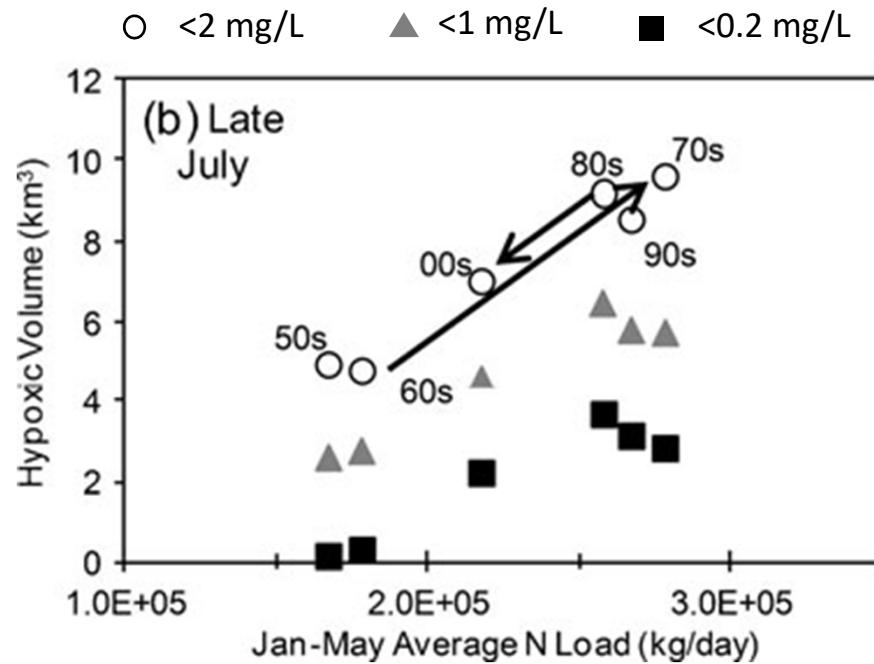
Cazenave et al. 2018 *Advances in Space Research*

# Tampa Bay: Impressive Recovery

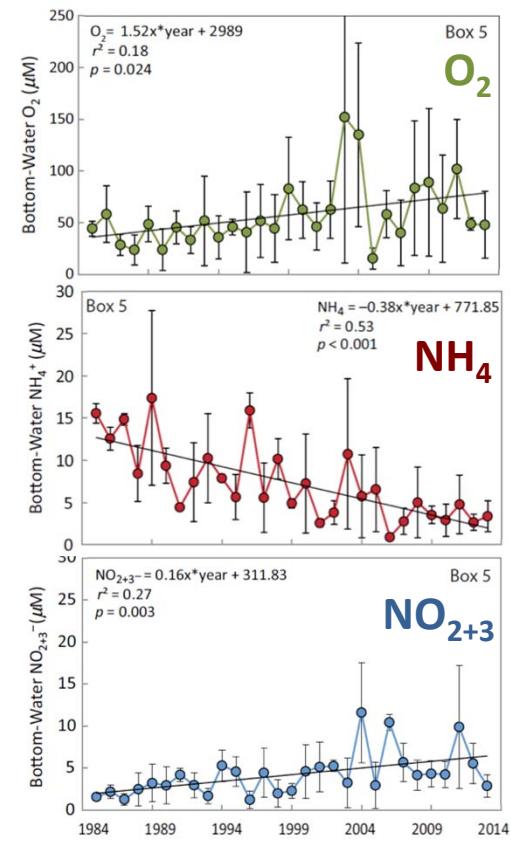


Greening et al. 2014. *Estuar. Coast. Shelf Sci.* 214:A1

# Chesapeake Bay: Hypoxia & N Cycling



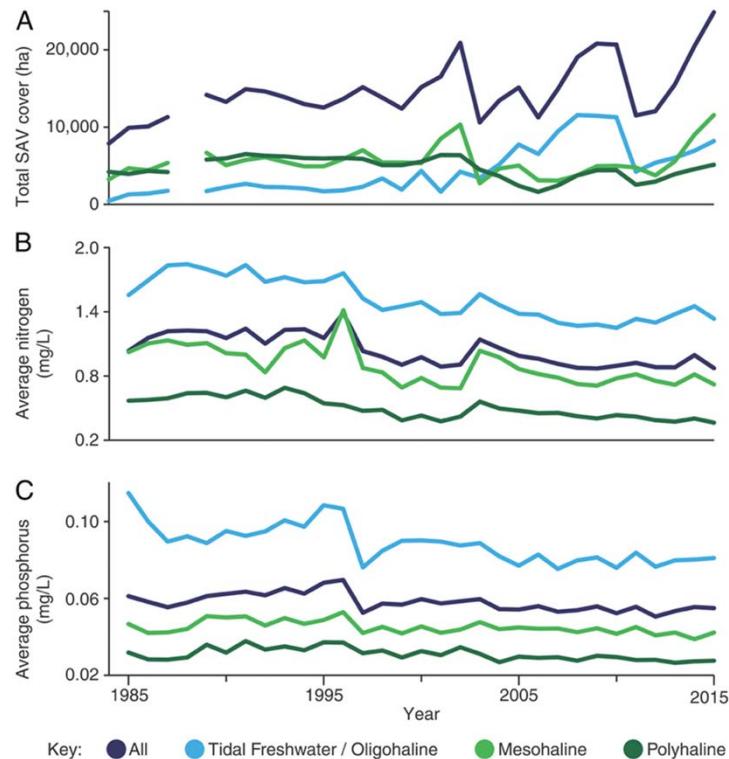
Murphy et al. 2011 *Estuaries & Coasts* 34:1293



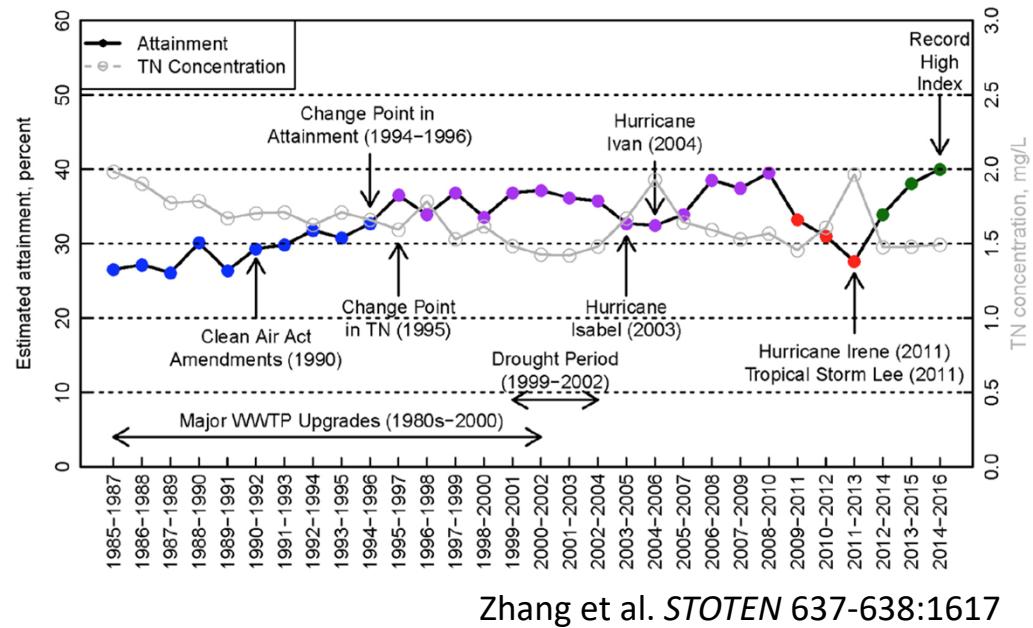
Testa et al.  
2018 *Limnol.*  
& *Oceanogr.*

# Chesapeake Bay: Broader Responses

## Submersed aquatic vegetation



## Multimetric indicator (DO, clarity, SAV, Chl $\alpha$ )



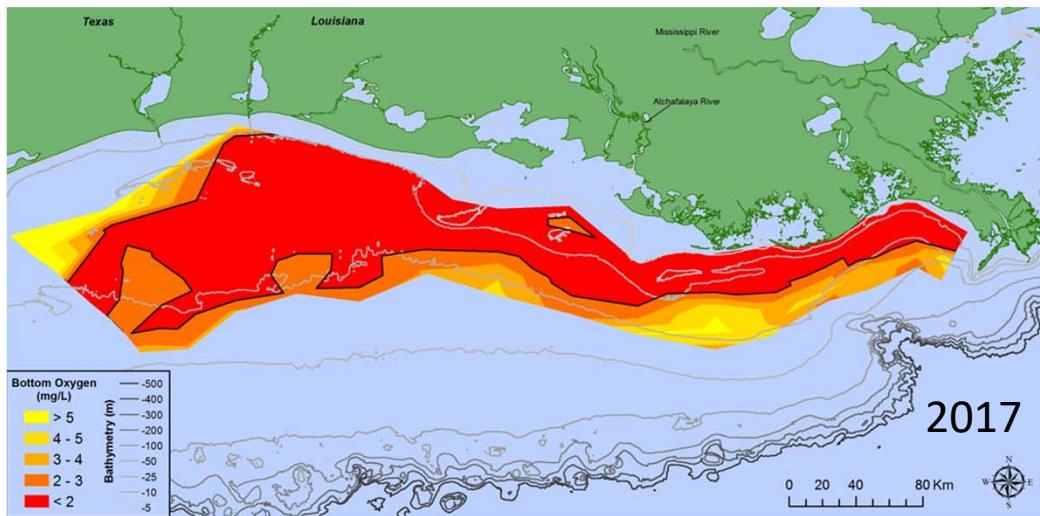
Lefcheck et al. 2018 PNAS 115:3658

# Northern Gulf of Mexico Hypoxia

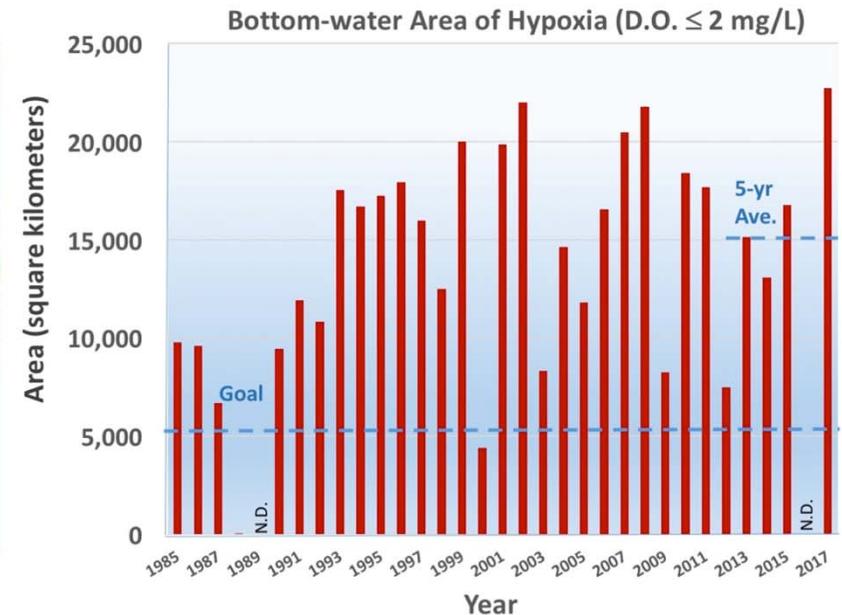


2000 Integrated Assessment  
2001 Action Plan  
2007 SAB Report  
2008 Action Plan

<5,000 km<sup>2</sup> by 2015 → 2035 ~45% N & P  
Voluntary Action  
Task Force – 12 states & Federal agencies

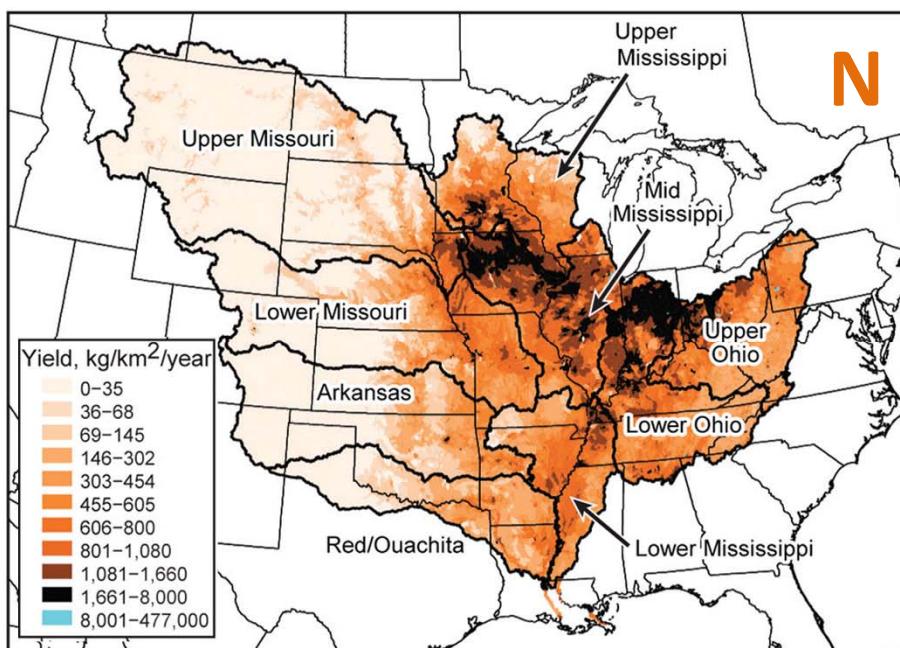


[gulfhypoxia.net/research/shelfwide-cruises/](http://gulfhypoxia.net/research/shelfwide-cruises/)

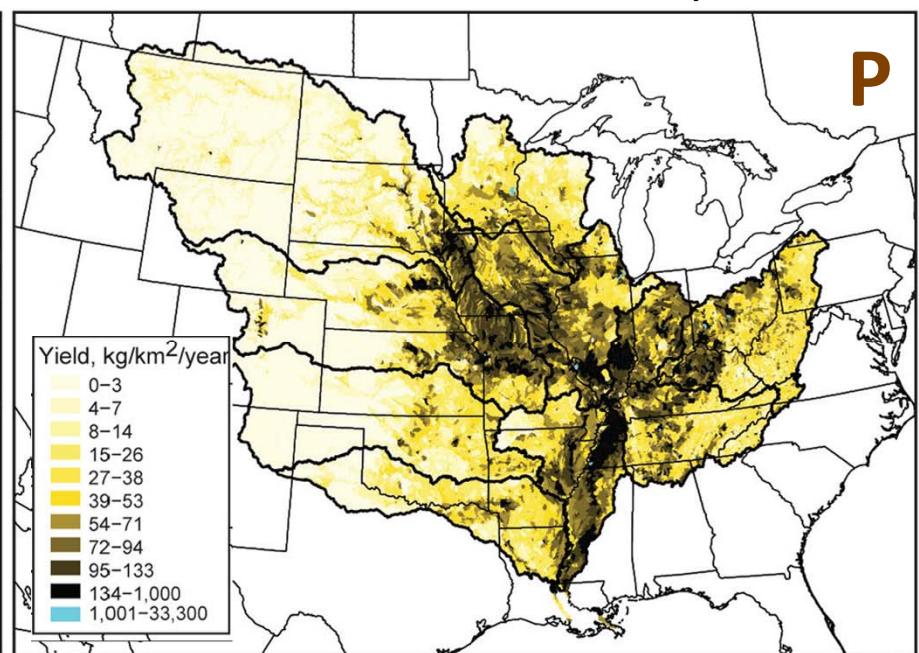


# Mississippi River Basin Sources

Delivered Incremental N Yield



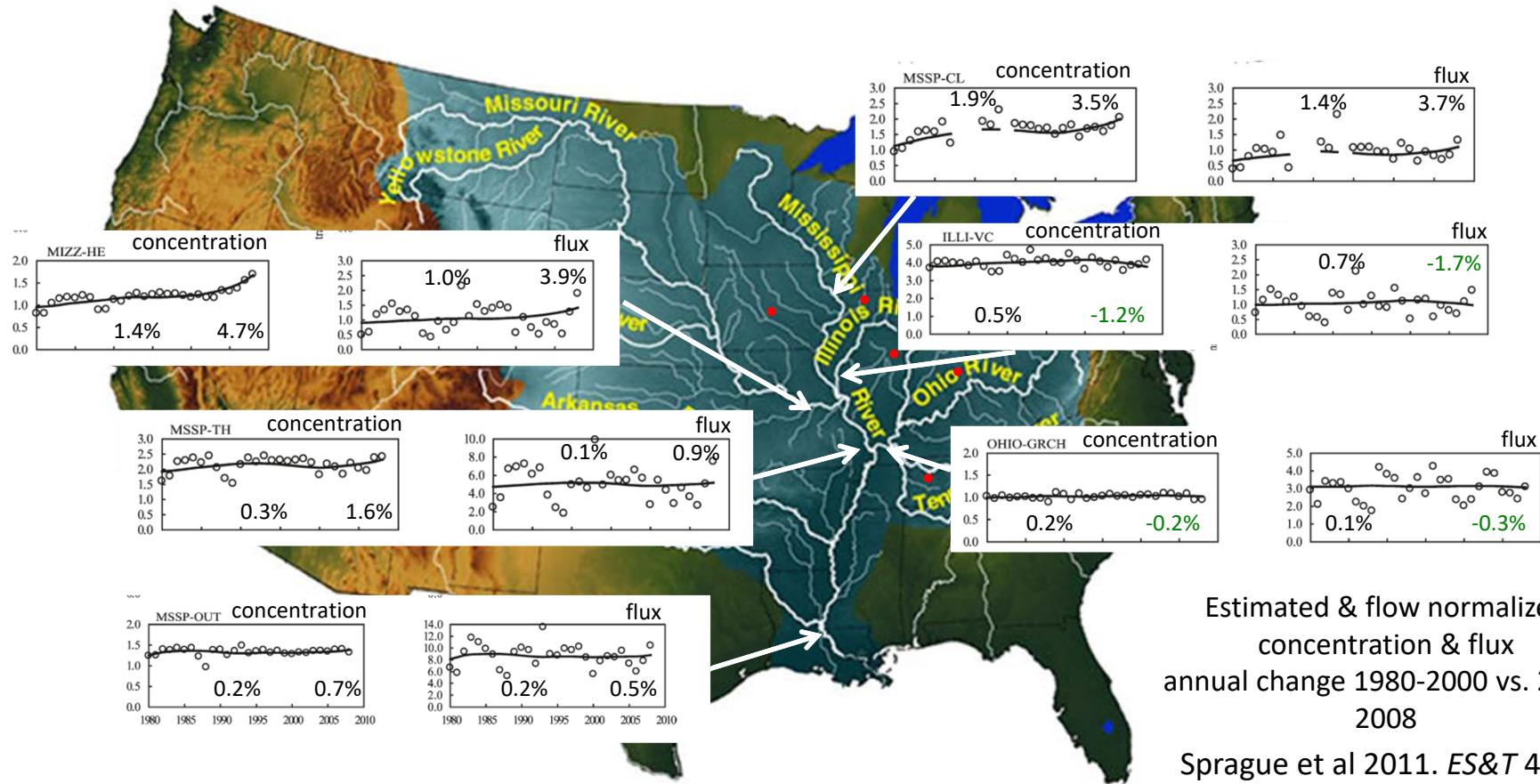
Delivered Incremental P yield



Spatially Referenced Regression on Watershed Attributes (SPARROW) Model

Robertson & Saad 2014 *Journal of Environmental Quality* 42:1422

# Nitrate Trends: Mississippi River Basin

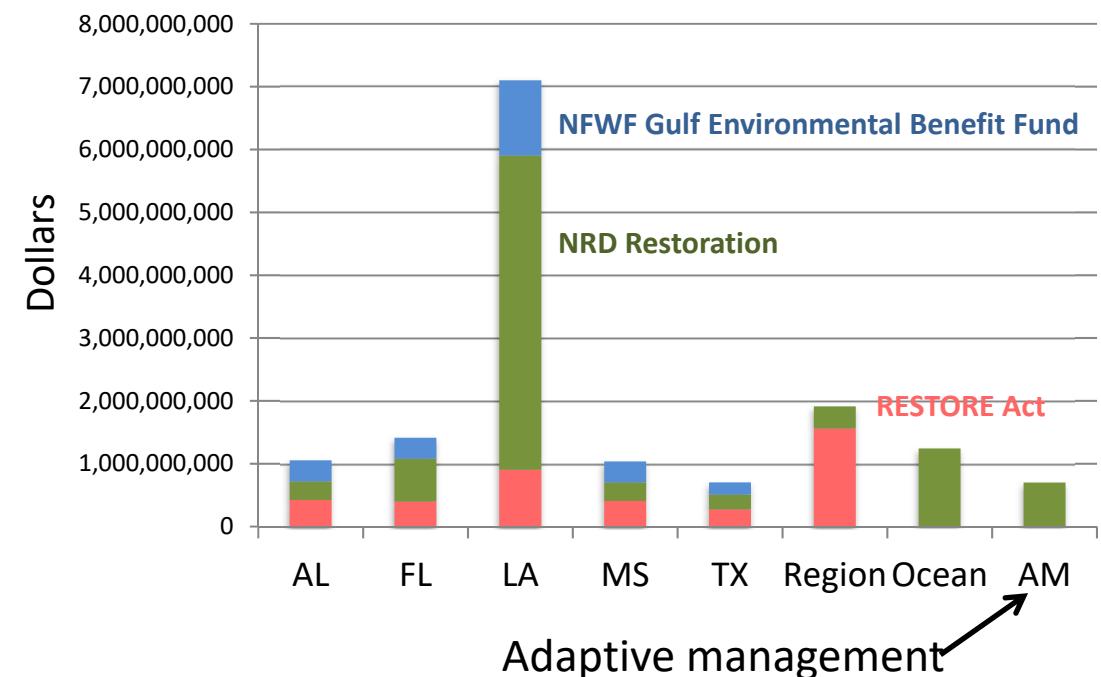


Estimated & flow normalized  
concentration & flux  
annual change 1980-2000 vs. 2000-  
2008

Sprague et al 2011. *ES&T* 45:7207

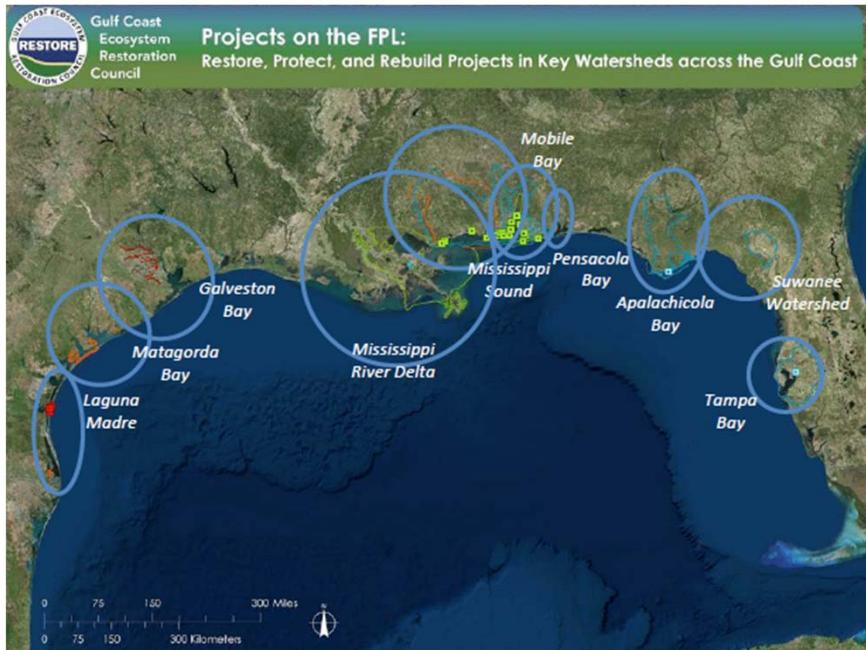
# Gulf Ecosystem Restoration

## A Singular, Multi-Billion Opportunity



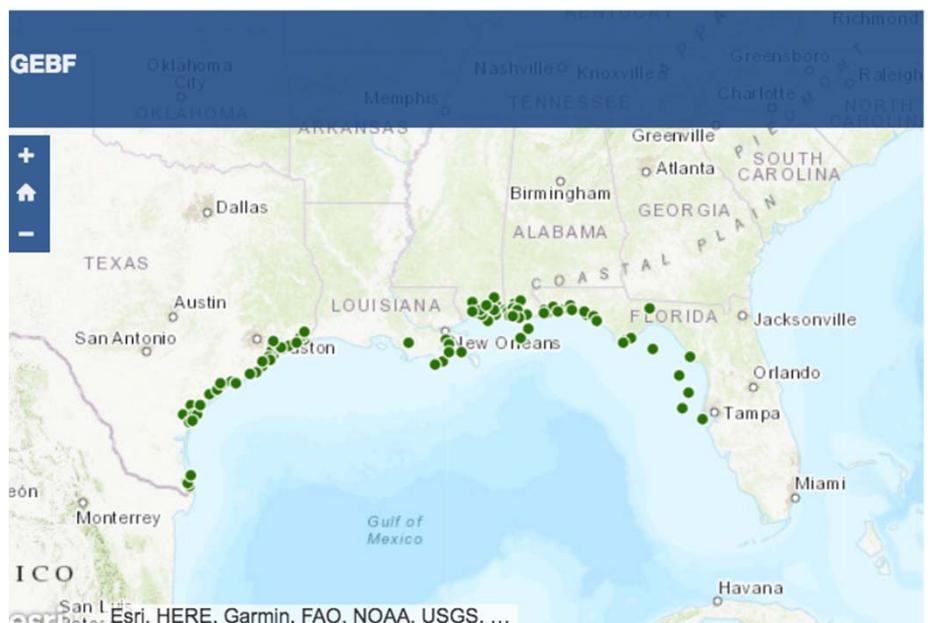
# Random Acts of Restoration?

## RESTORE Act initial projects



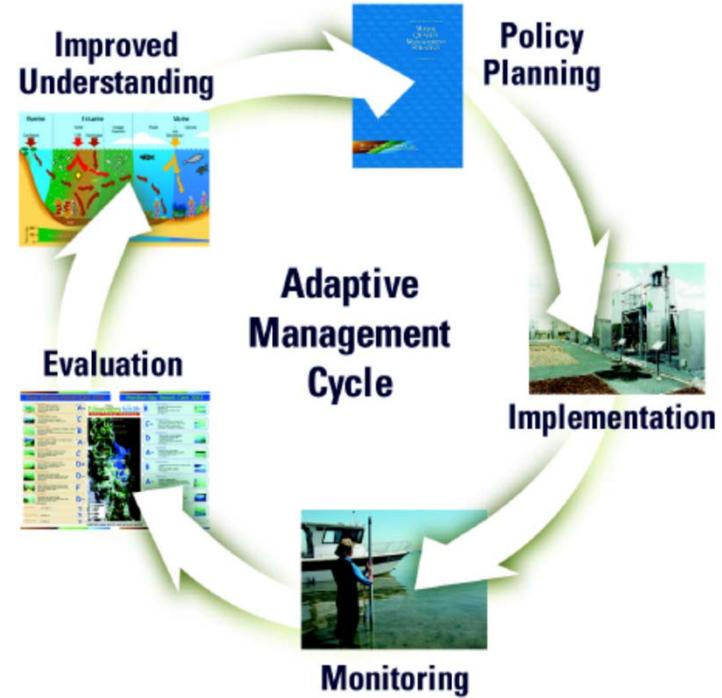
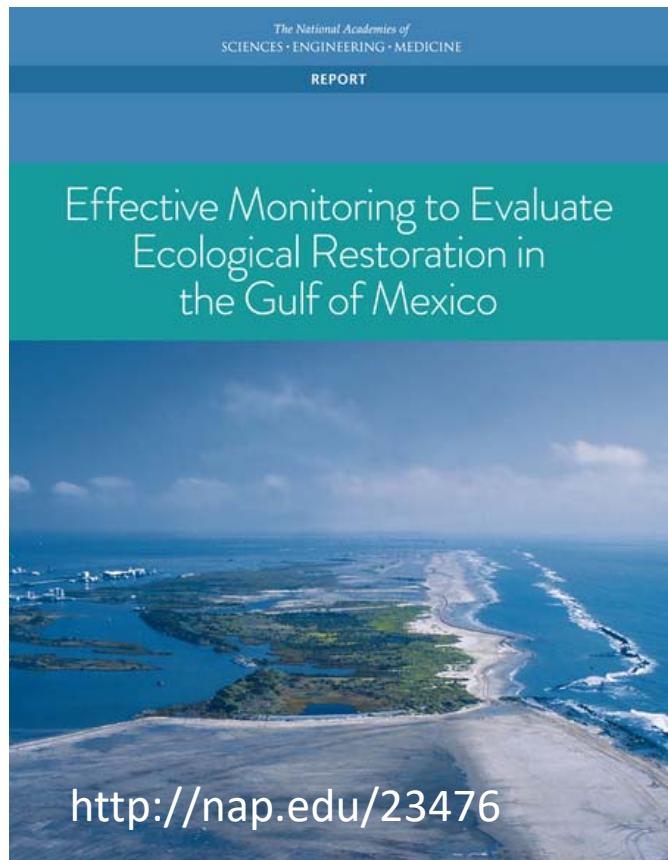
[www.restorethegulf.gov](http://www.restorethegulf.gov)

## Gulf Environmental Benefit Fund projects

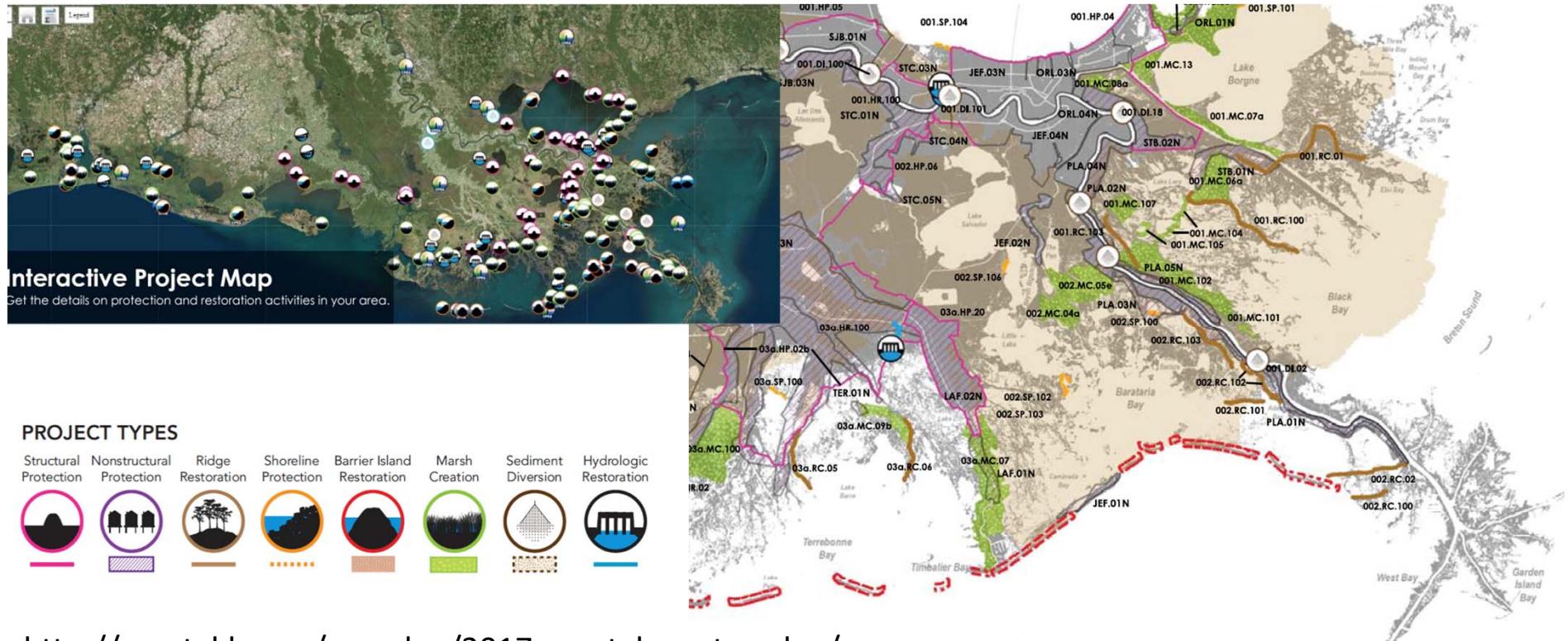


[www.nfwf.org/gulf](http://www.nfwf.org/gulf)

# Monitoring & Adaptive Restoration

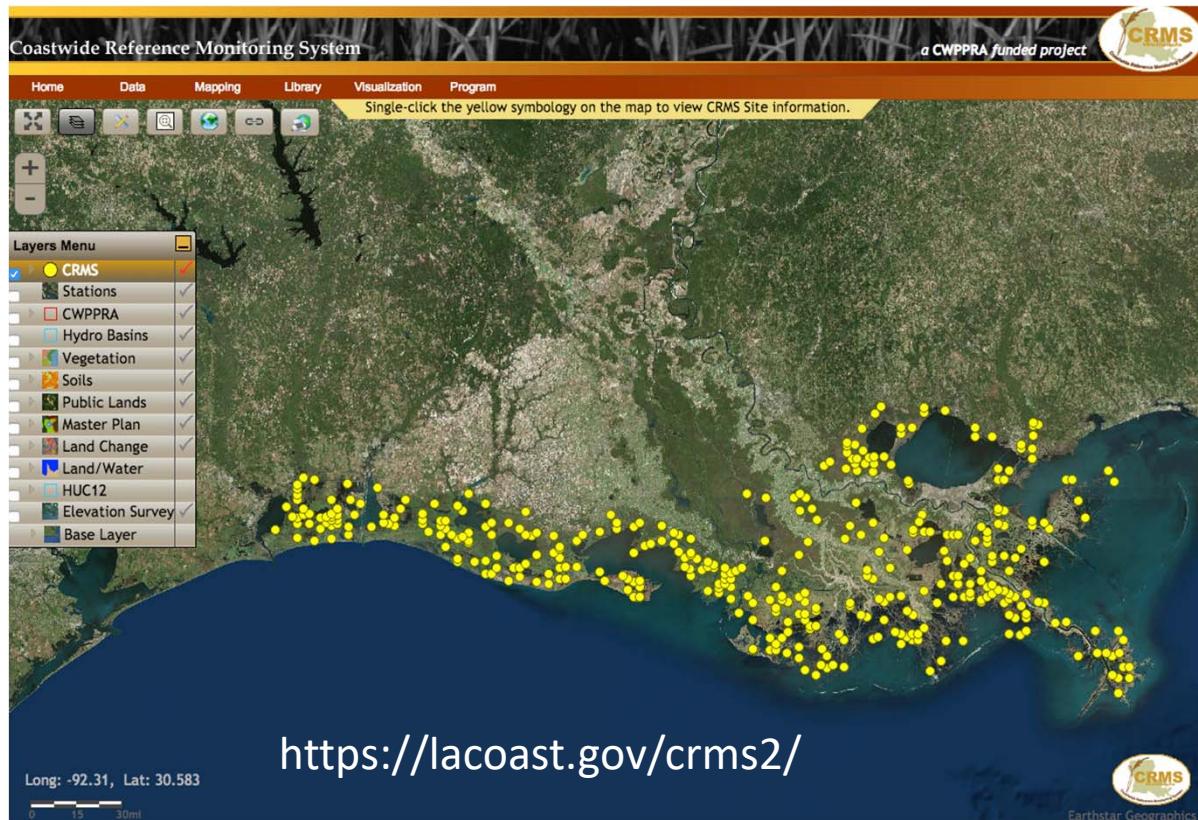


# Louisiana's Ambitious Coastal Master Plan

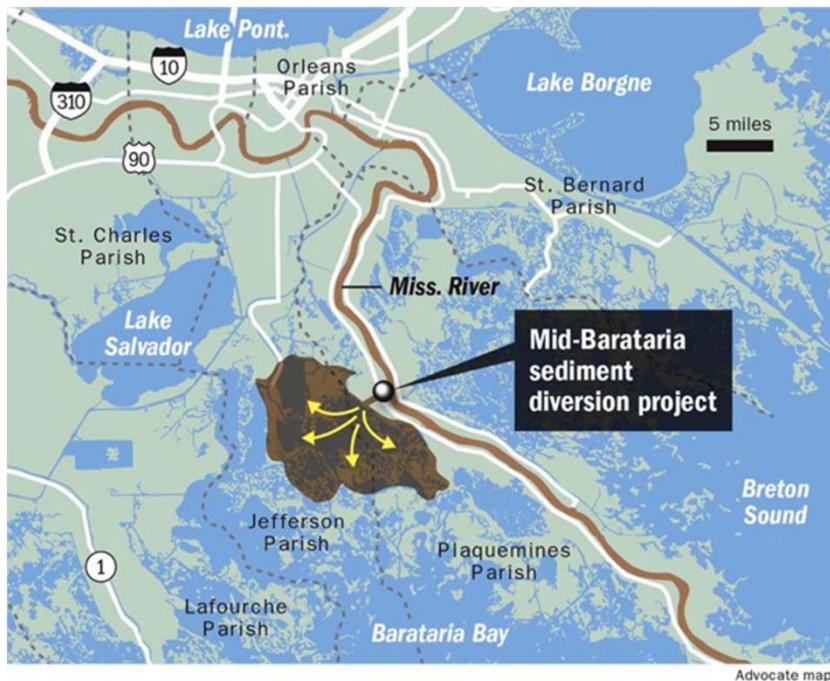


<http://coastal.la.gov/our-plan/2017-coastal-master-plan/>

# Coastwide Reference Monitoring System



# Sediment Diversions from Mississippi River



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