

Land-Based Marine Pollution

Donald F. Boesch

CONGRESS ON OCEAN POLICY

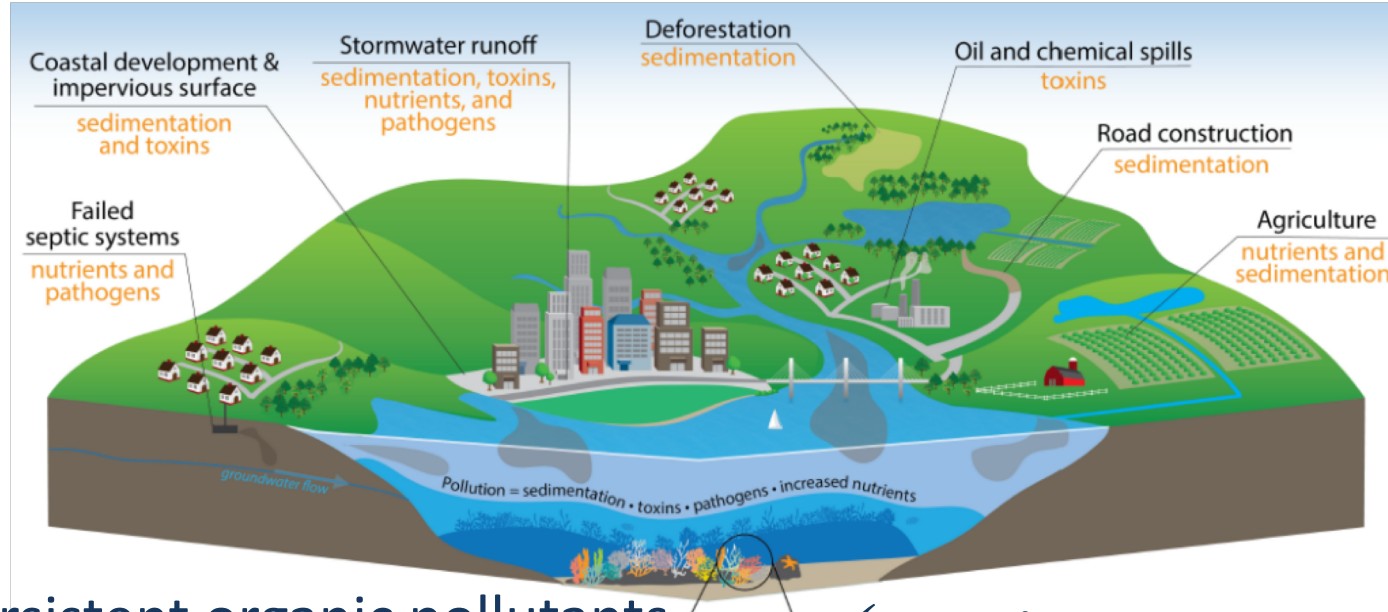
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University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

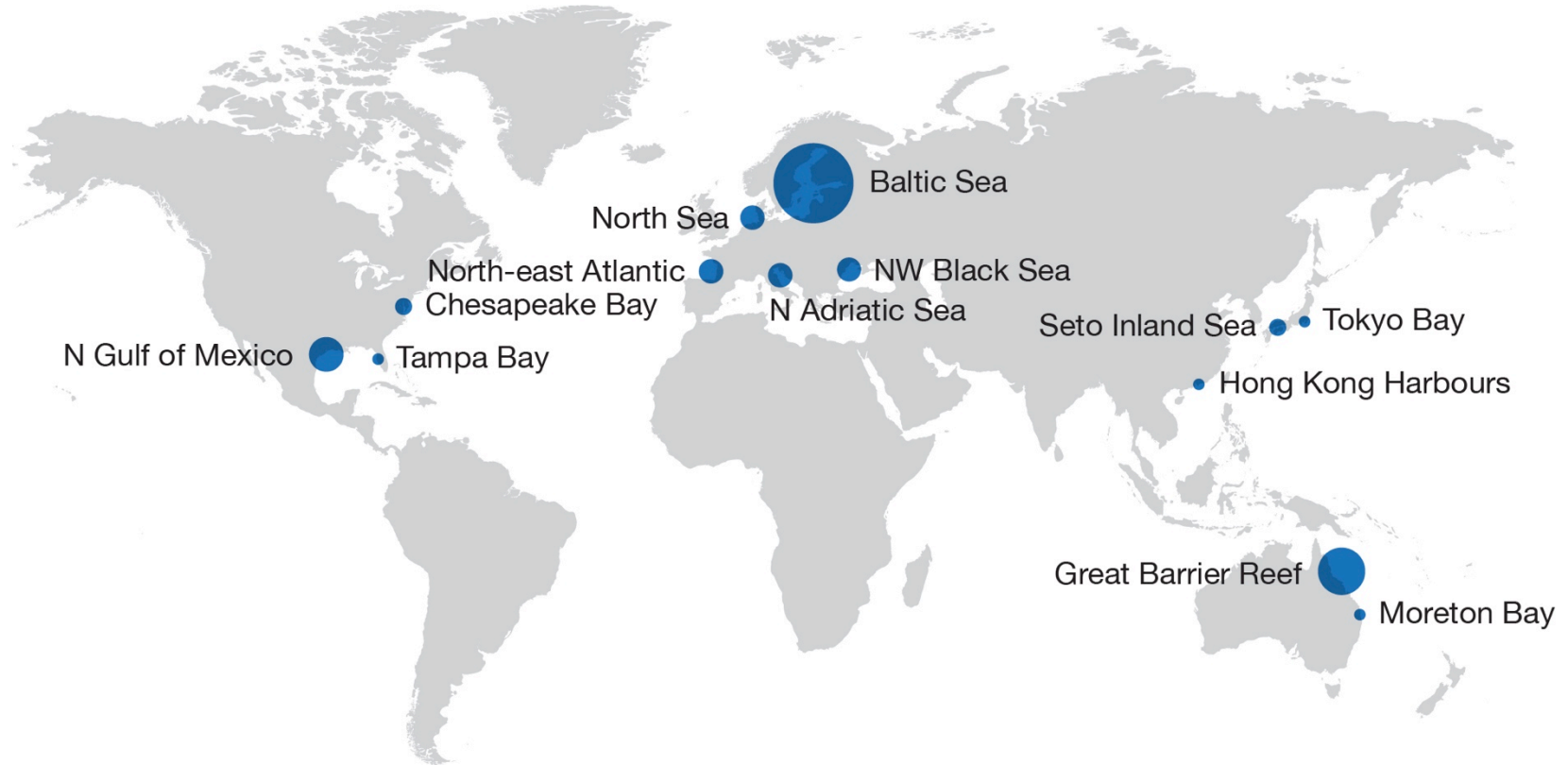


Land-Based Marine Pollution



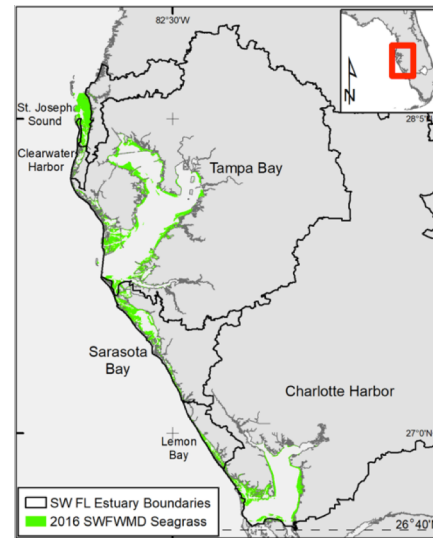
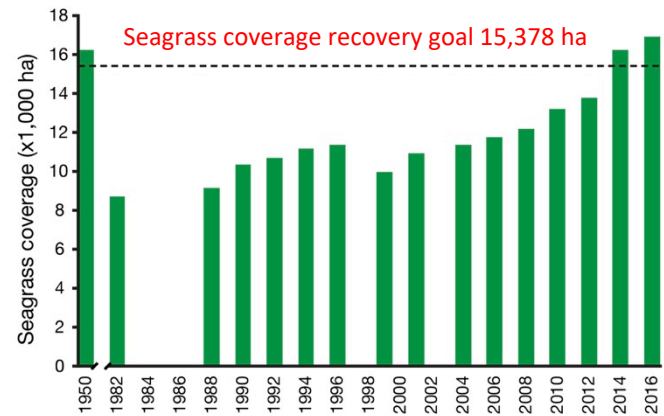
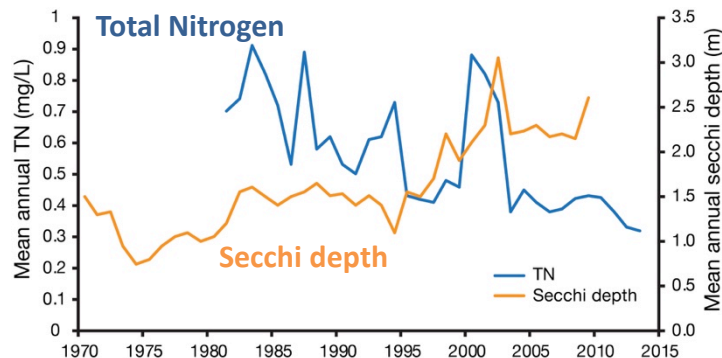
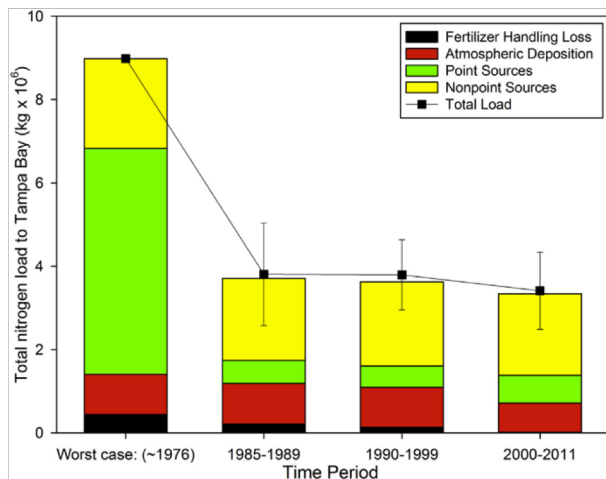
- Persistent organic pollutants
- Heavy metals
- Oils
- ✓ Nutrients
- Sediments
- ✓ Plastics

Eutrophication Abatement Case Studies



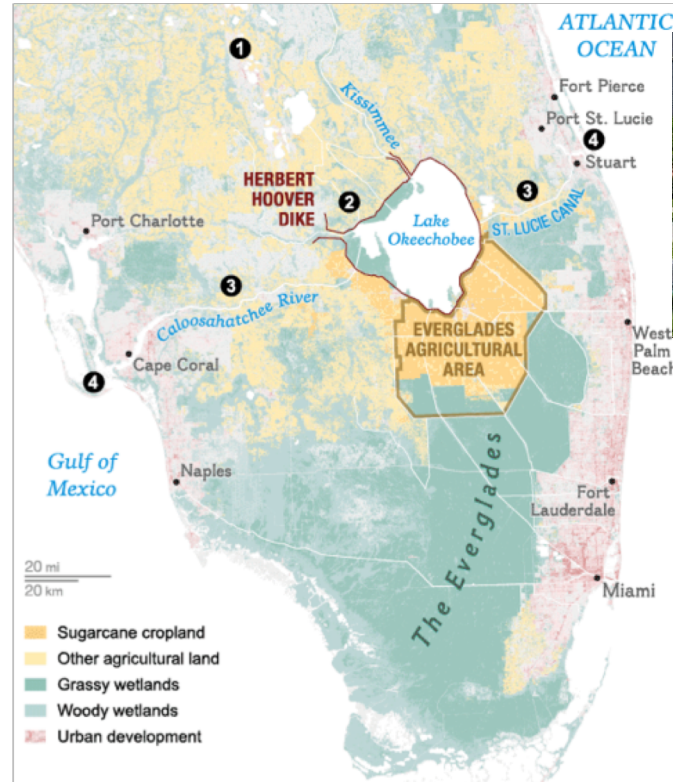
Boesch, D.F. (forthcoming). Barriers and bridges in abating coastal eutrophication.

Tampa Bay: Impressive Reversal



Toxic Algal Blooms Tied to Lake O Drainage

Red tide bloom
Florida West Coast



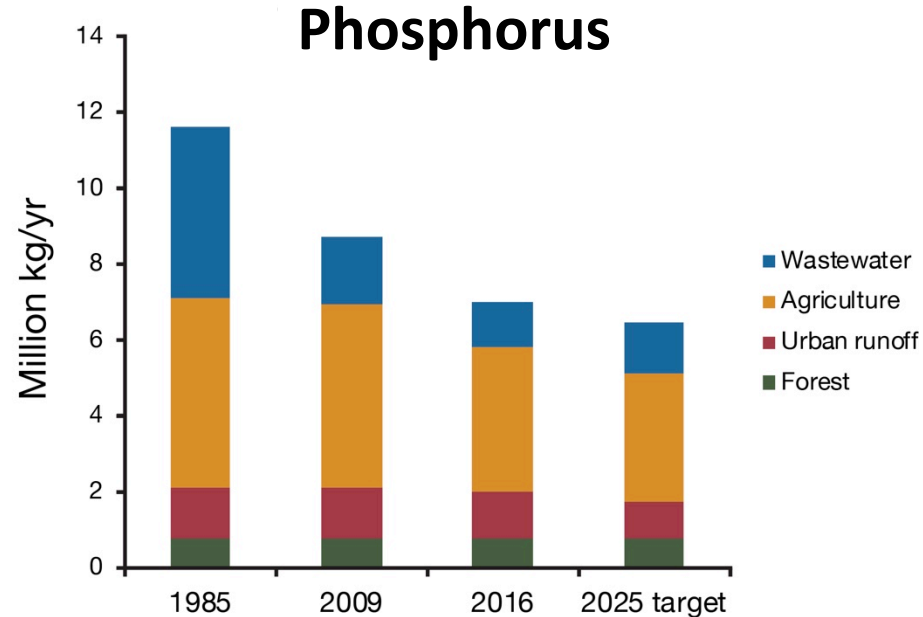
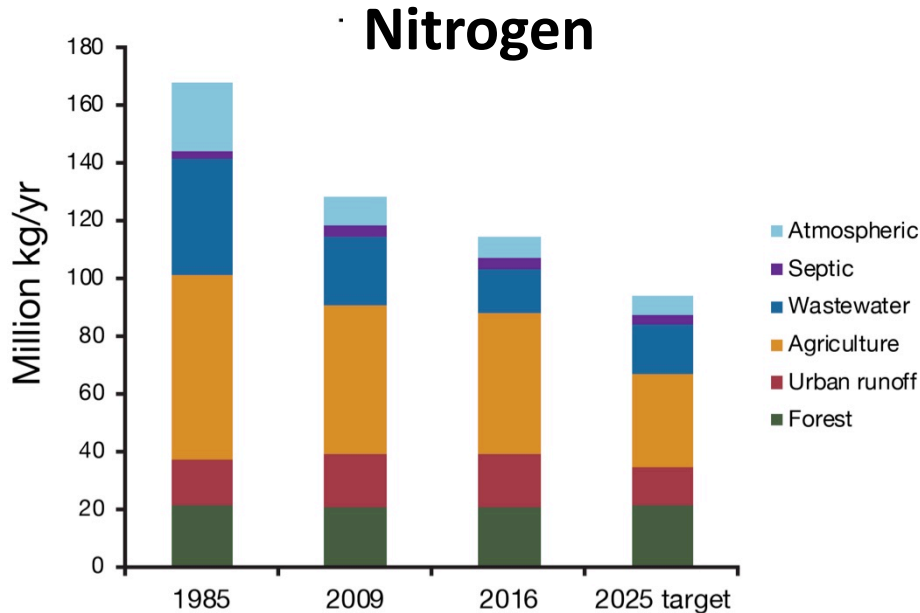
Cyanobacteria bloom
St. Lucie River

Original source of nutrients → Agriculture

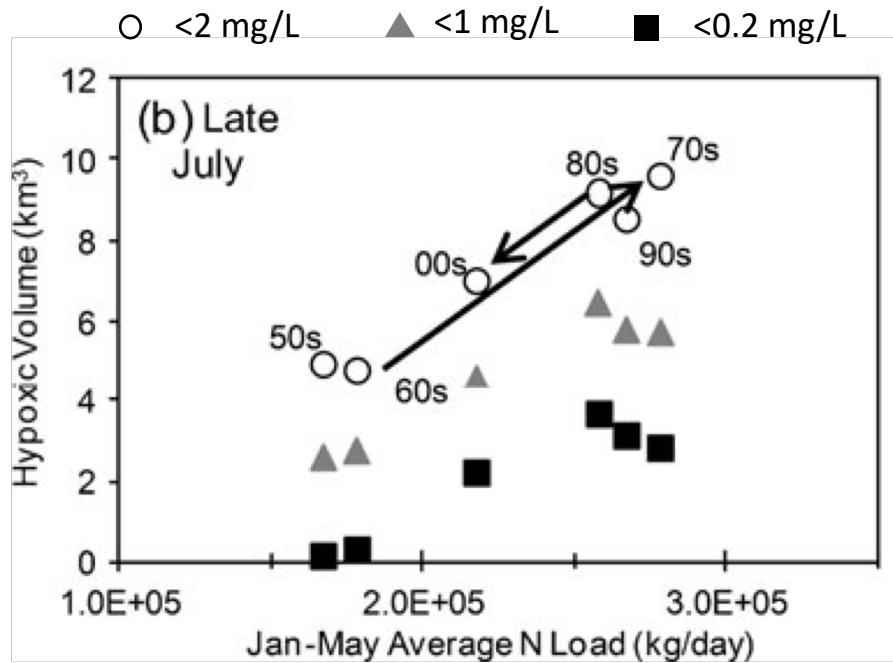
Chesapeake Bay



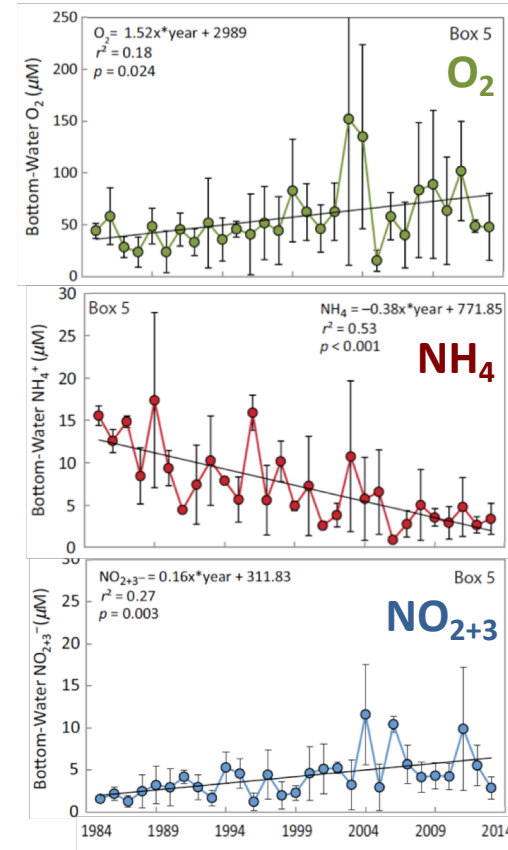
TMDL: total maximum daily amount of a pollutant that a body of water can receive while still meeting water quality standards



Chesapeake Bay: Hypoxia & N Cycling



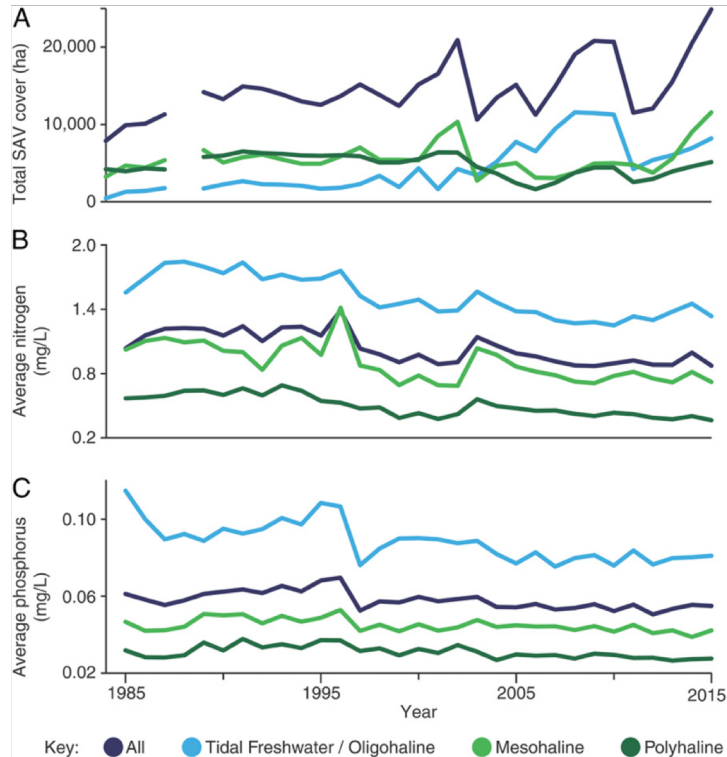
Murphy et al. 2011 *Estuaries & Coasts* 34:1293



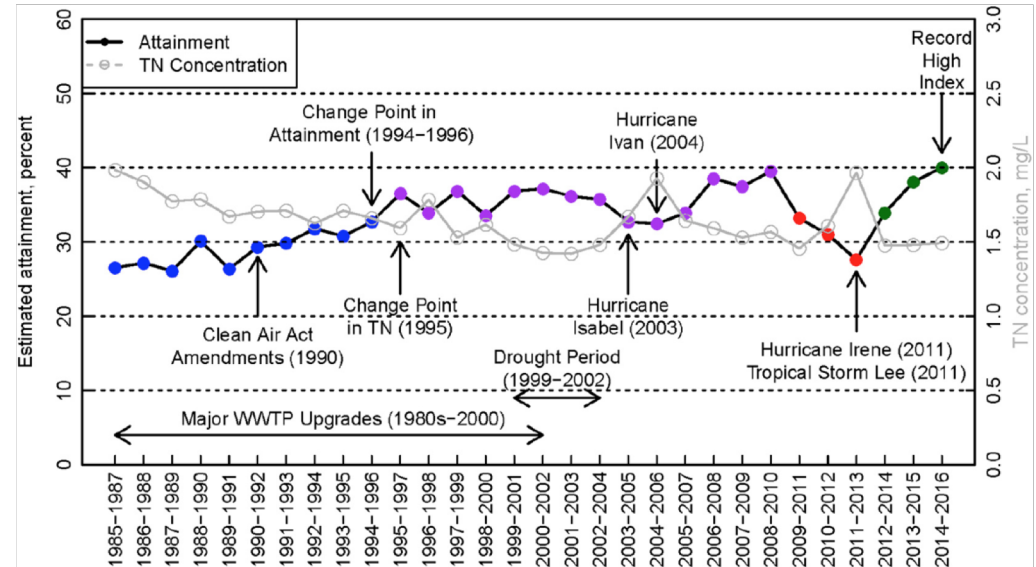
Testa et al.
 2018 *Limnol. Oceanogr.* 63:
 2045

Chesapeake Bay: Broader Responses

Submersed aquatic vegetation



Multimetric indicator (DO, clarity, SAV, Chl a)



Zhang et al. 2018 *Sci. Total Environ.* 637-638:1617

Lefcheck et al. 2018 *PNAS* 115:3658

Legal Challenge to Chesapeake TMDL



American Farm Bureau Federation®

- TMDL not lawful under Clean Water Act (detailed allocations, reasonable assurances, upstream states, implementation)
- Procedural violations: public access to critical information
- Arbitrary & capricious: overextended model and flawed data

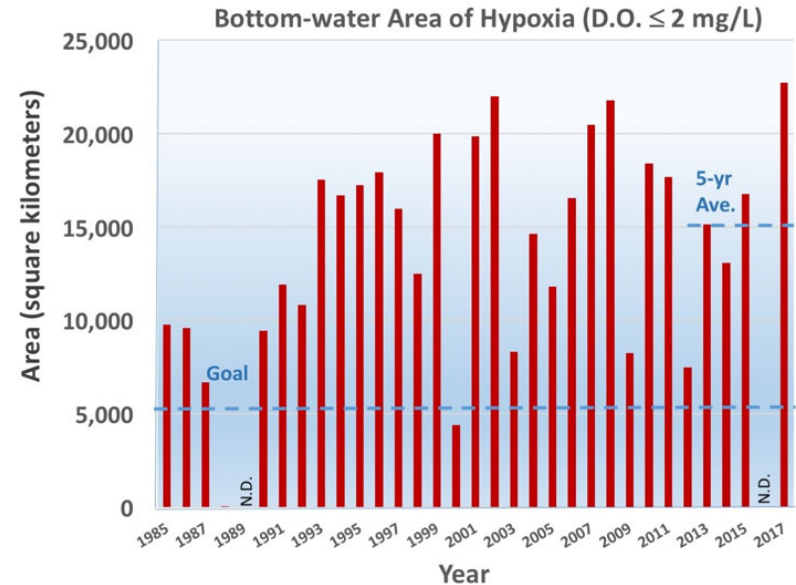
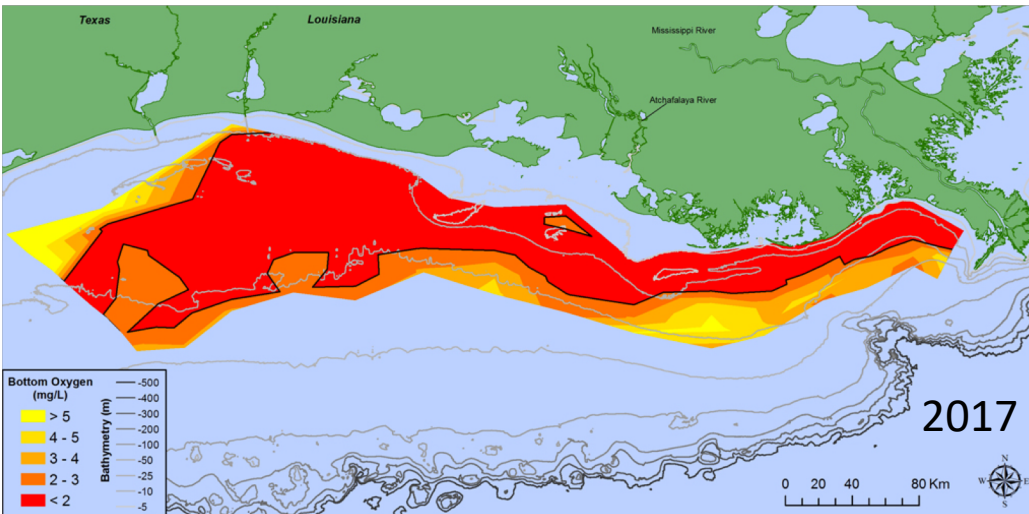


Northern Gulf of Mexico Hypoxia



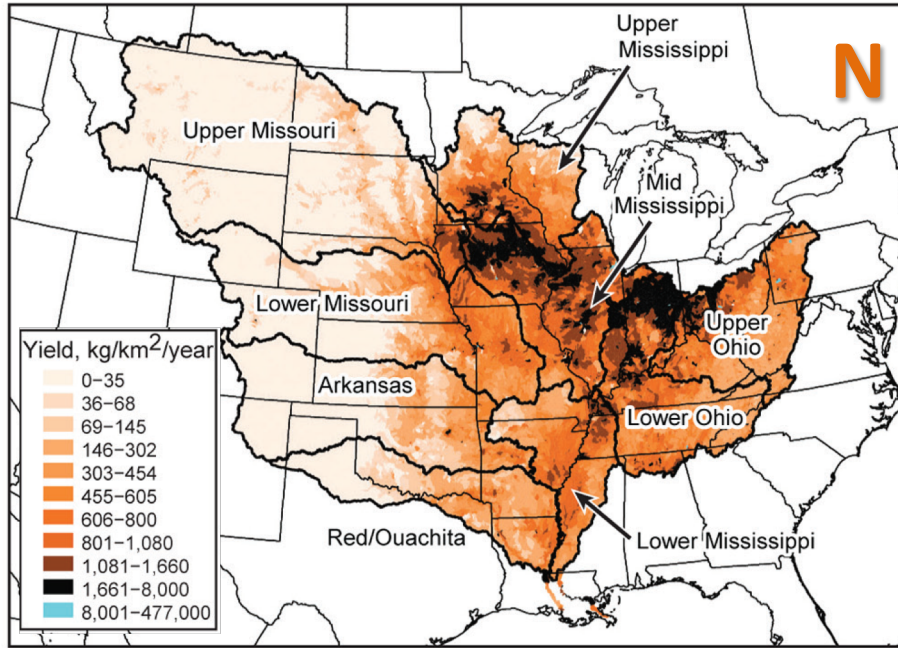
2000 Integrated Assessment
2001 Action Plan
2007 Science Advisory Bd. Report
2008 Action Plan, amended in 2013

<5,000 km² by 2015 → 2035
~45% N & P, -20% interim goal by 2025
Voluntary actions
Task Force – 12 states & Federal agencies

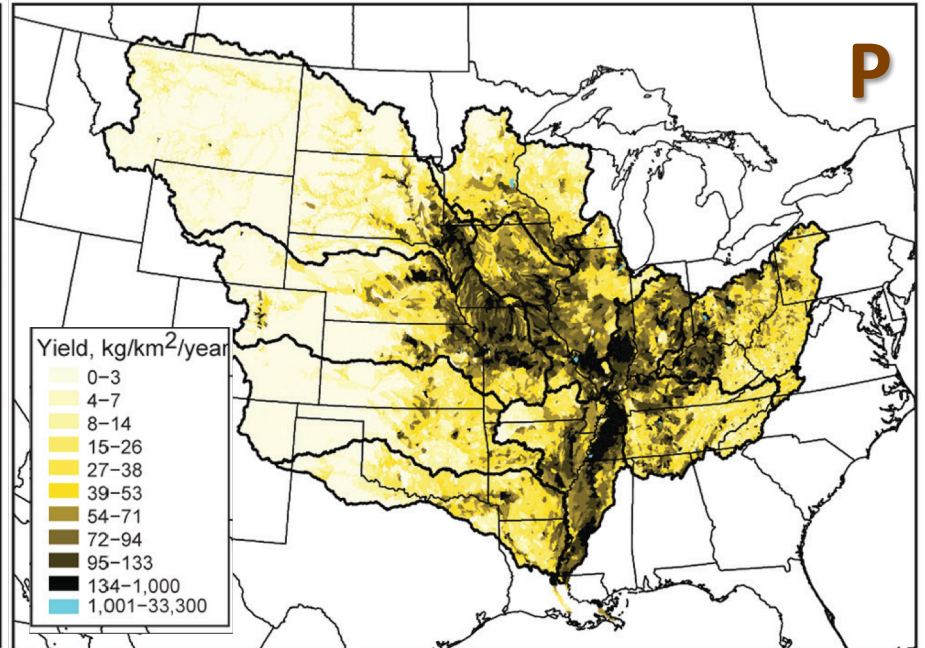


Mississippi River Basin Sources

Delivered Incremental N Yield



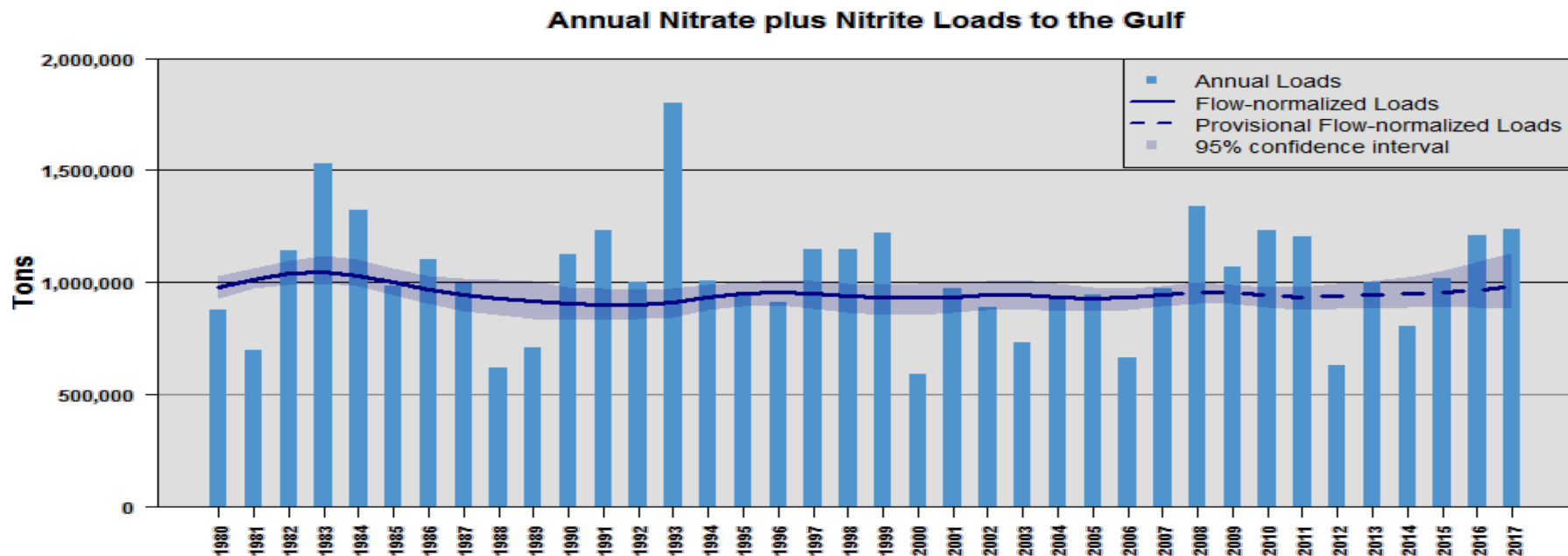
Delivered Incremental P yield



Spatially Referenced Regression on Watershed Attributes (SPARROW) Model

Robertson & Saad 2014 *J. Environ. Qual.* 42:1422

Nitrate Trends: Mississippi River Basin

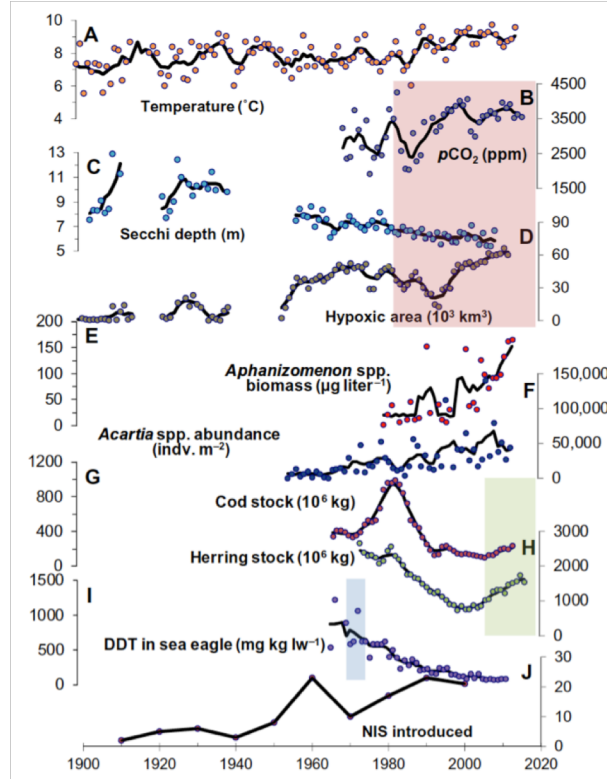
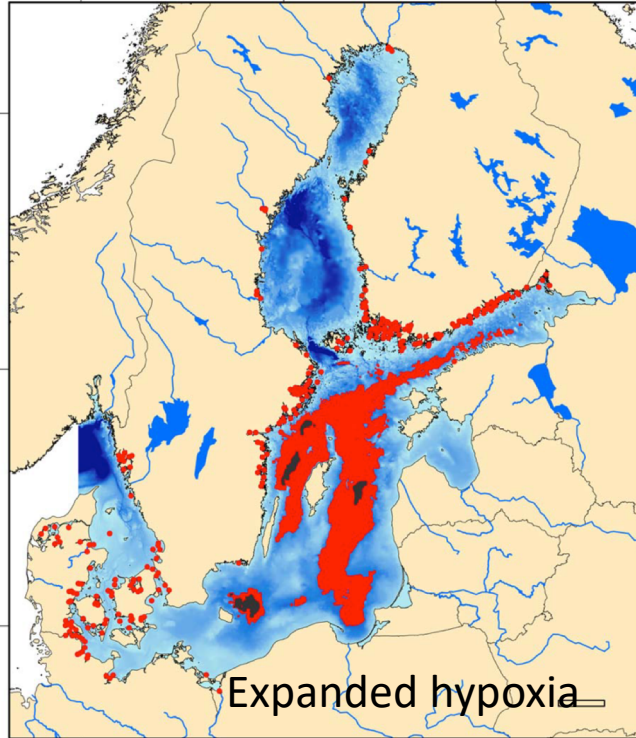


- Agricultural fertilizer use became more efficient
- Expanded intense cultivation for ethanol production
- Load reductions not allocated or targeted

Action Plan x → Amendment x → 203

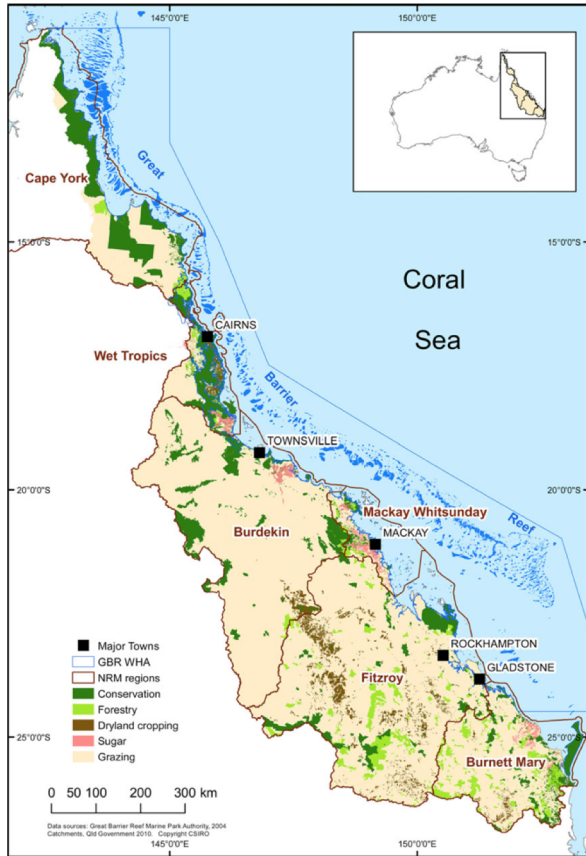
https://nrtwq.usgs.gov/mississippi_loads/#/GULF

The Baltic Sea: A Time Machine?

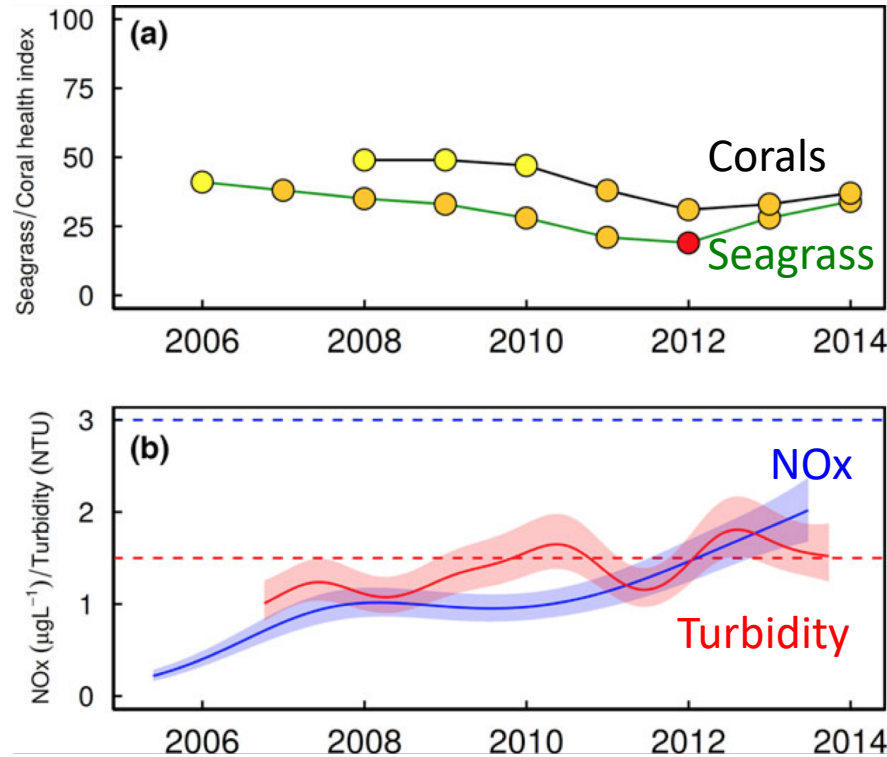


Reusch et al. 2018. The Baltic Sea as a time machine for the future coastal ocean. *Science Advances* 4: eaar8195

Great Barrier Reef: No Sanctuary



Inshore Areas



Agriculture
Reef Plans
2013 & 2050

Efforts
insufficient

Hydrological
restoration

Changes in ag.
production

Kroon et al. 2016 *Global Change Biology* 22: 1985

Barriers & Bridges to Abate Eutrophication

Themes	Barriers	Bridges
Actionable science	Knowledge of causes & effects Fragmentary understanding Parallelizing controversies	Apply experiences from other regions Client-responsive strategic research Responsive & conclusive adjudication
Accountable governance	Managers lack authority Public & stakeholder concern Overgeneralized commitments Voluntary, non-binding	Engagement of responsible parties Effective communication of risks/benefits Quantitative allocation & accountability Statutory requirements
Reducing loads	Debates re limiting nutrients Control of atmospheric sources Voluntary implementation Expanded biofuel production Legacies and lags	Holistic N plus P strategies Co-benefits of air quality regulations Performance compliance Transition to cellulosic biofuels Focus on short pathway sources, sinks

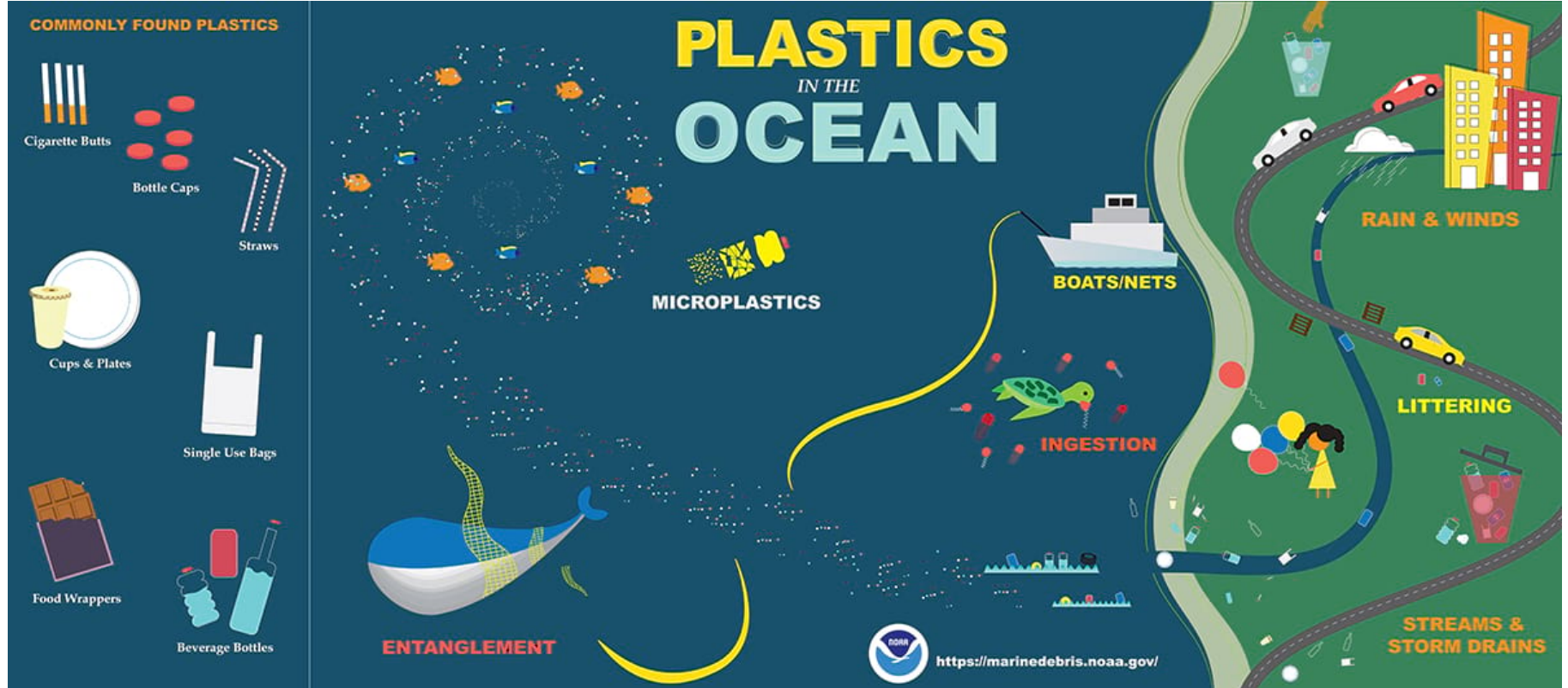
Boesch, D.F. (forthcoming). Barriers and bridges in abating coastal eutrophication.

Barriers & Bridges Part 2

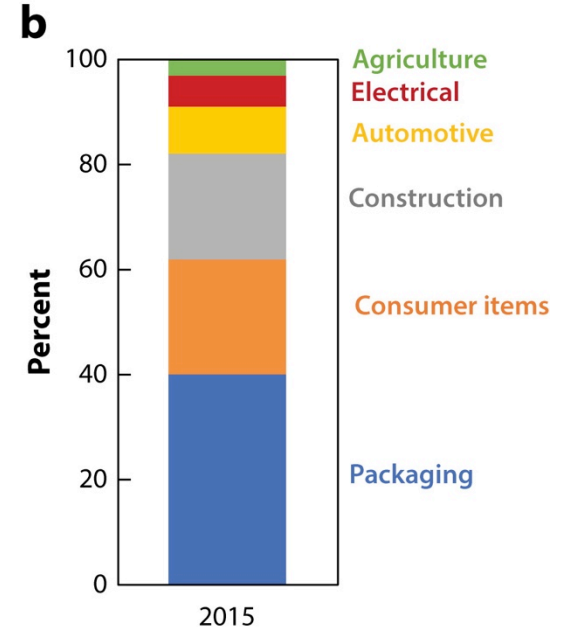
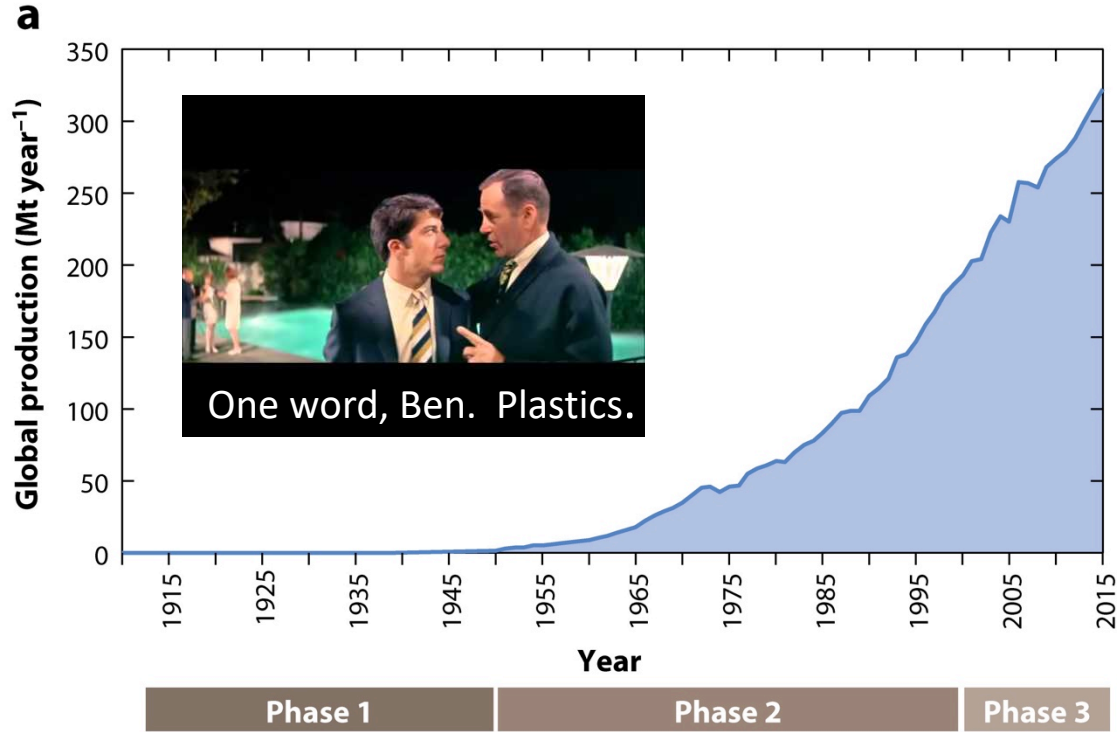
Themes	Barriers	Bridges
Assess outcomes & adapt strategies	Inadeq./underused monitoring Inadeq./overprescribed modeling Over-reliance on models Stalled or delayed rehabilitation	Sustained monitoring, periodic scorecards Multiple appropriate models Truly adaptive management Intervention actions w/i coastal system
Addressing climate change	Goals unachievable/impractical Decoupled water-quality & climate change strategies	Reassess achievable futures Mitigation & adaptation that limit climate change & reduce nutrient loads

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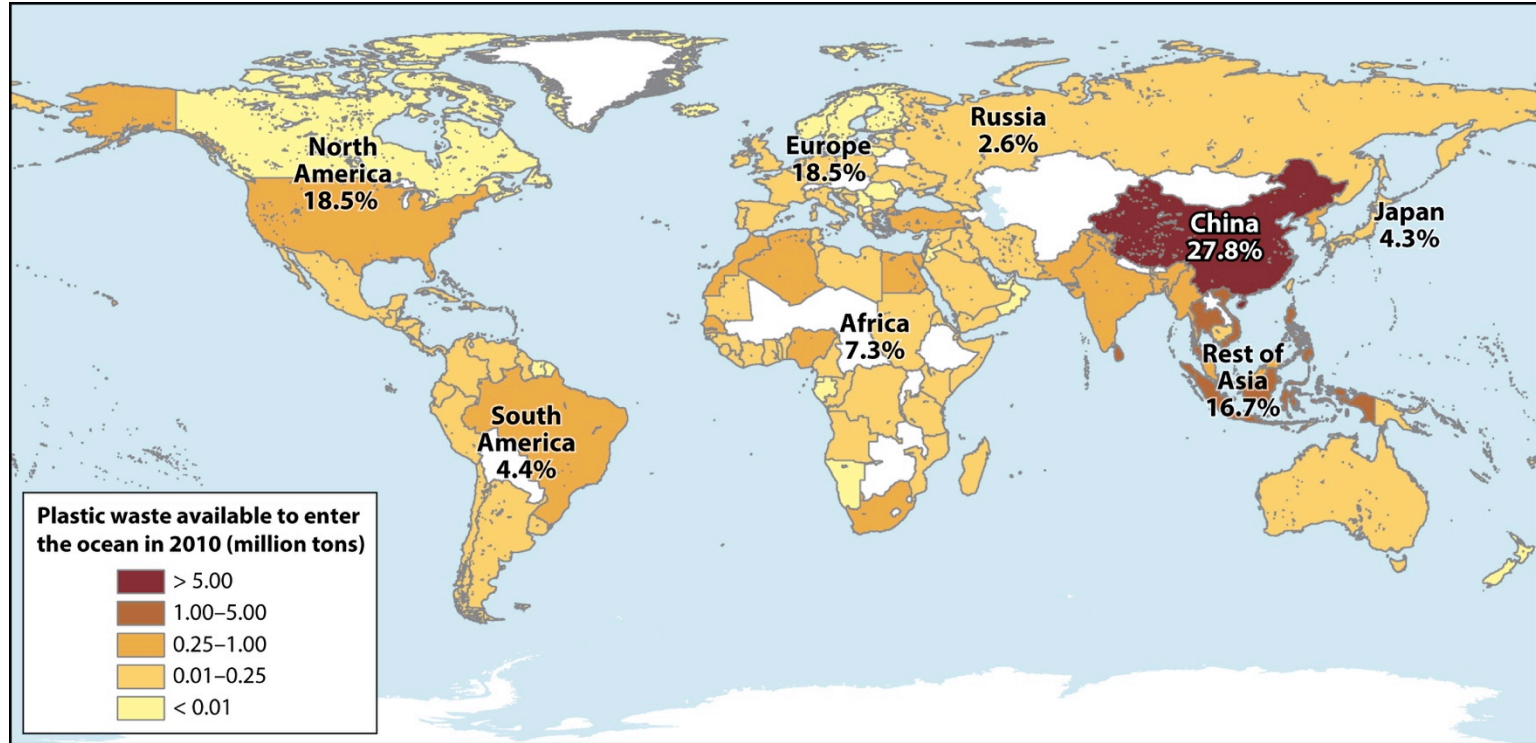
Plastic Pollution of the Oceans



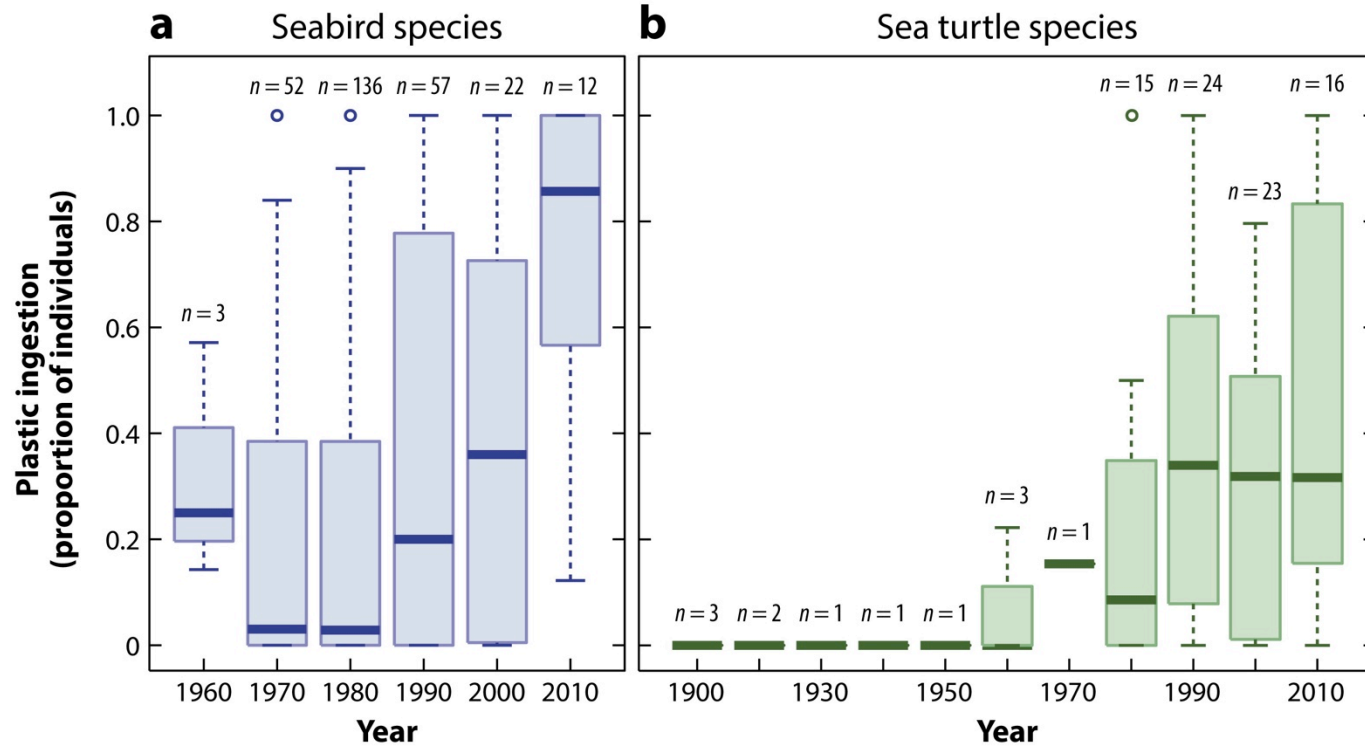
Total Worldwide Plastics Production



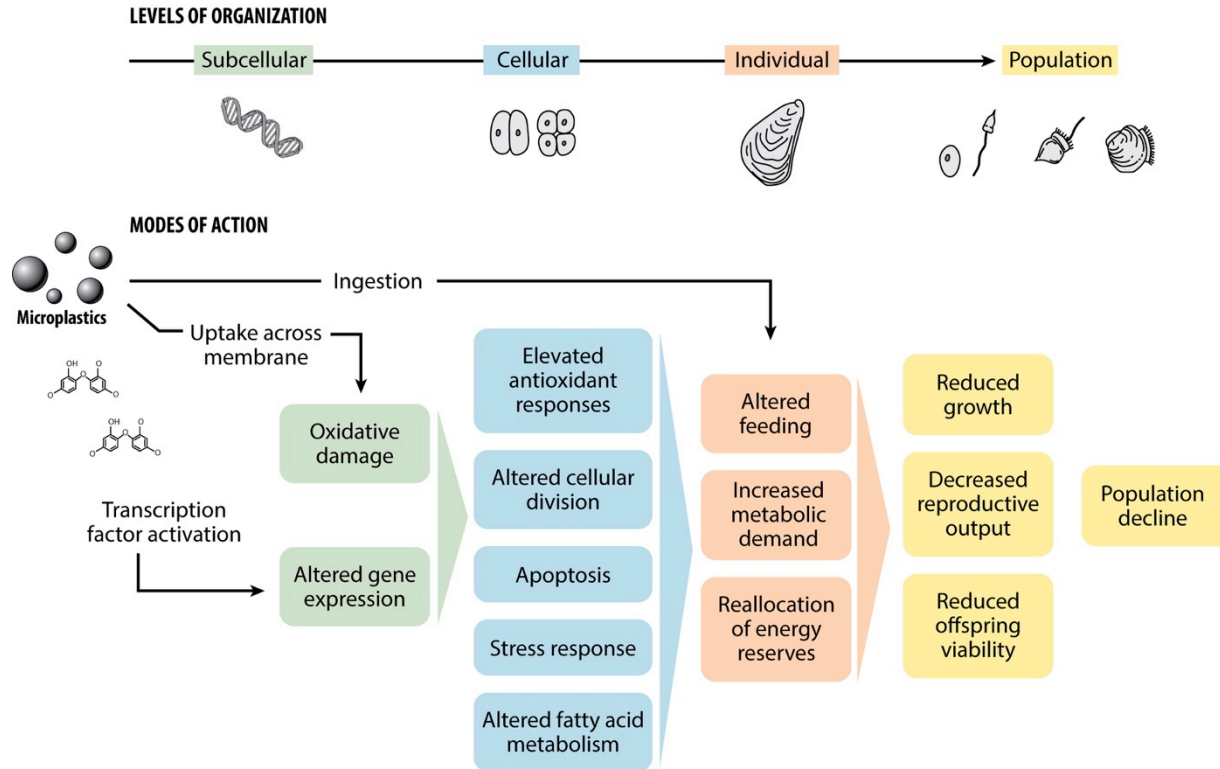
Plastic Production & Available to Ocean



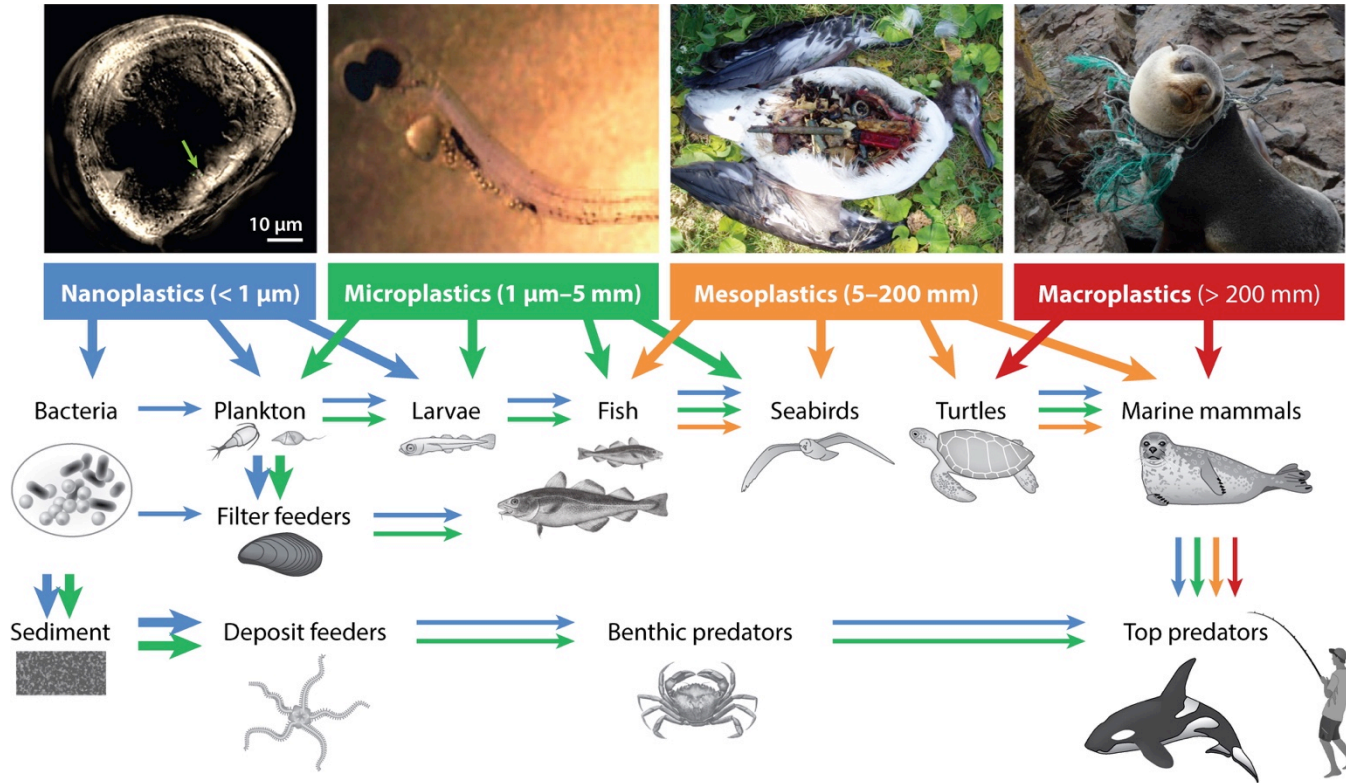
Another *Silent Spring*?



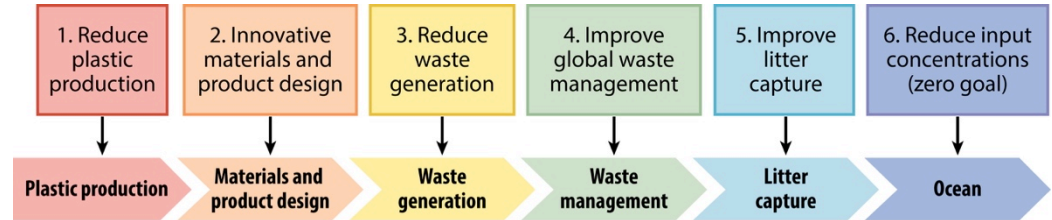
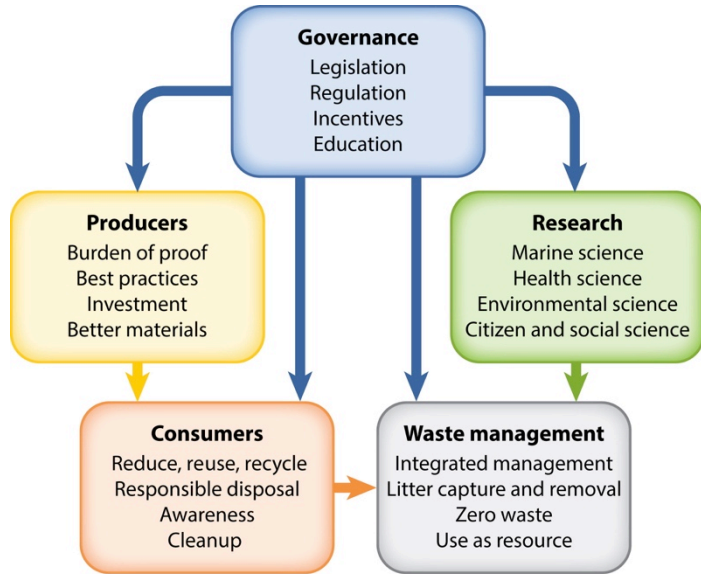
Outcome Pathways of Microplastic Pollution



Uptake and Transfer in Food Webs



Sectorial Cooperation & Reduction Strategy



- State and local ordinances
- National policies
- Large retailers
- Consumer pressure (e.g. drinking straws)
- Circular economy
- New materials
- Global Convention on Plastic Pollution



boesch@umces.edu
www.umces.edu/don-boesch
 **@DonBoesch**