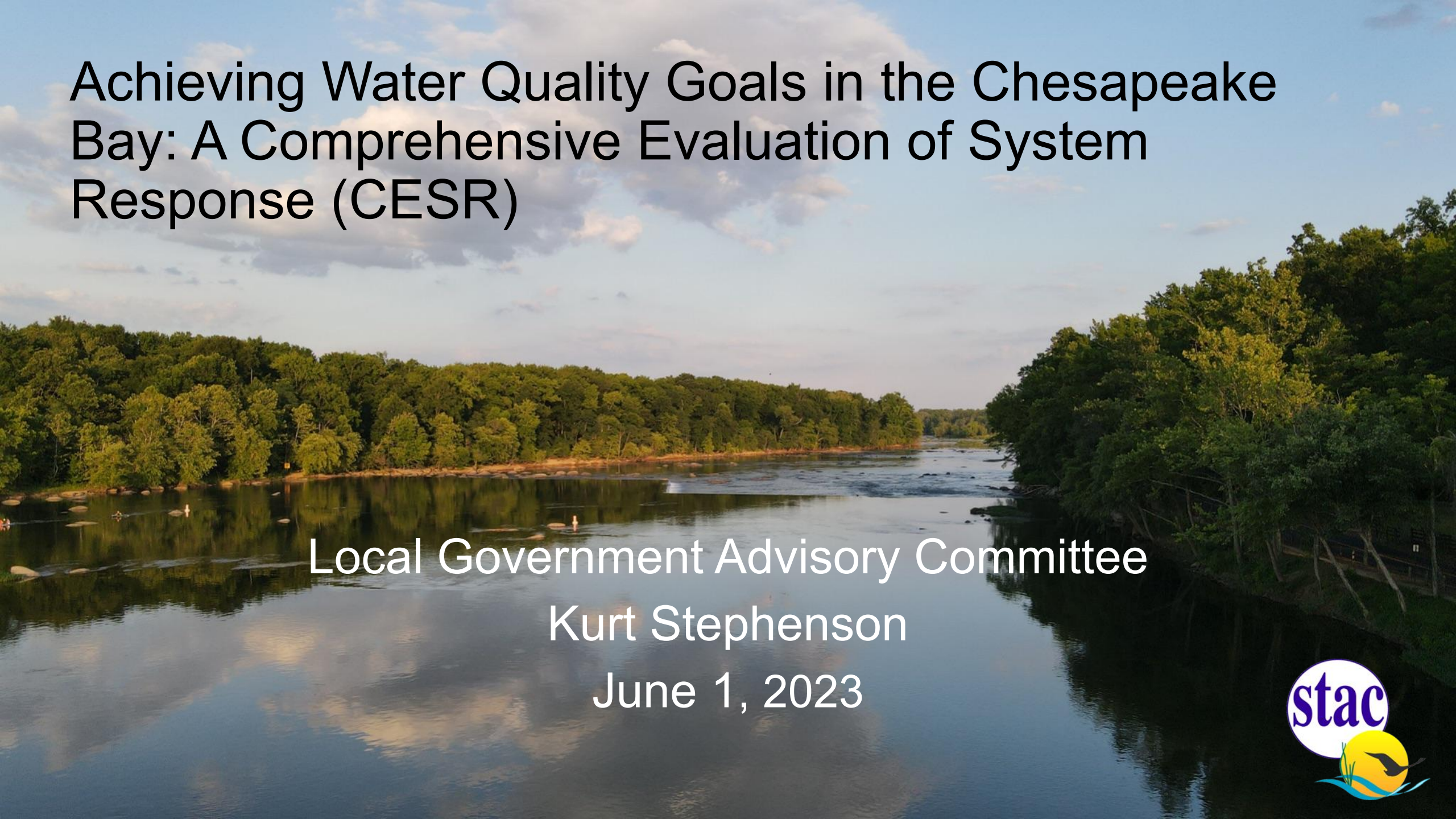
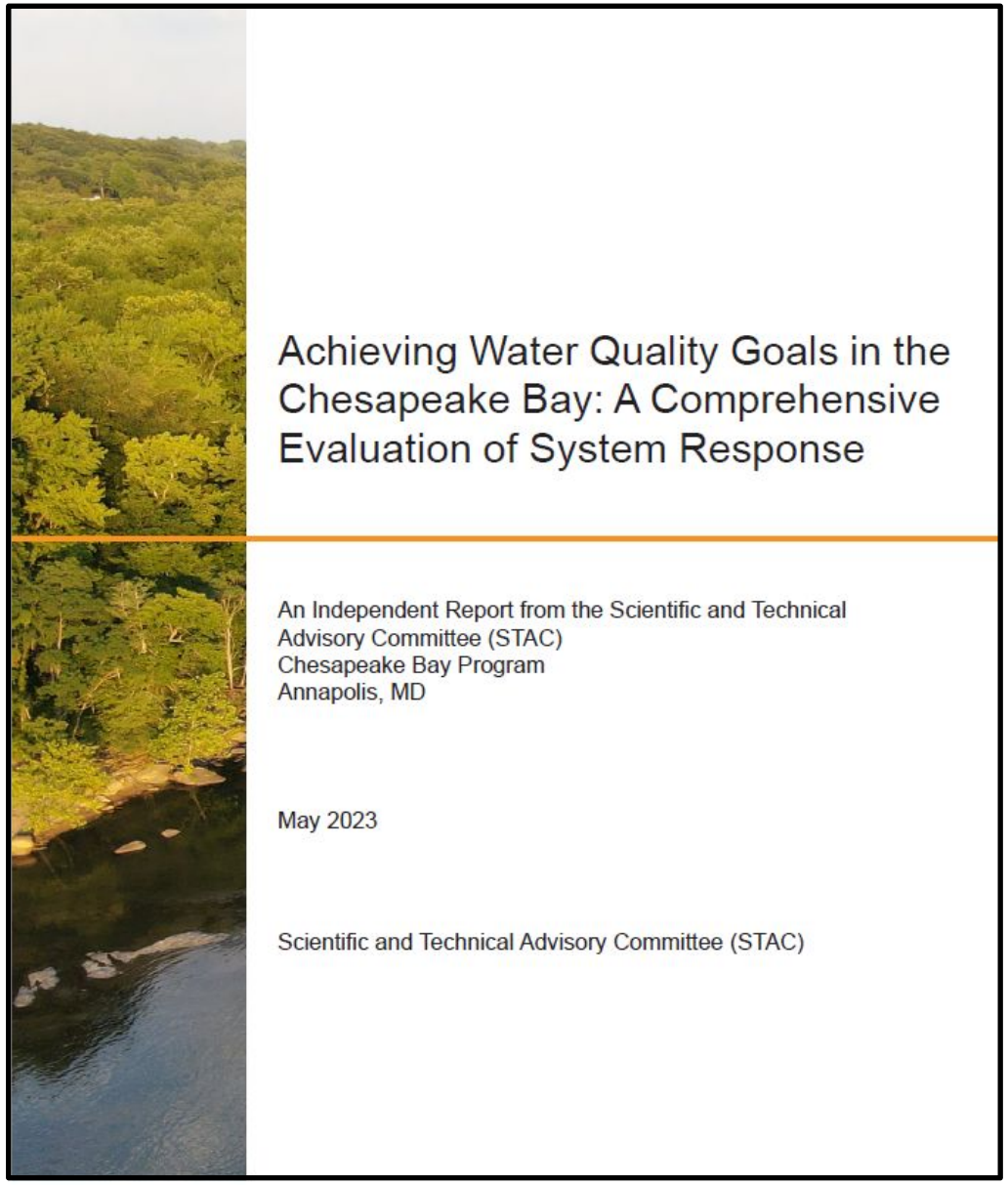
Achieving Water Quality Goals in the Chesapeake Bay: A Comprehensive Evaluation of System Response (CESR)



Local Government Advisory Committee

Kurt Stephenson

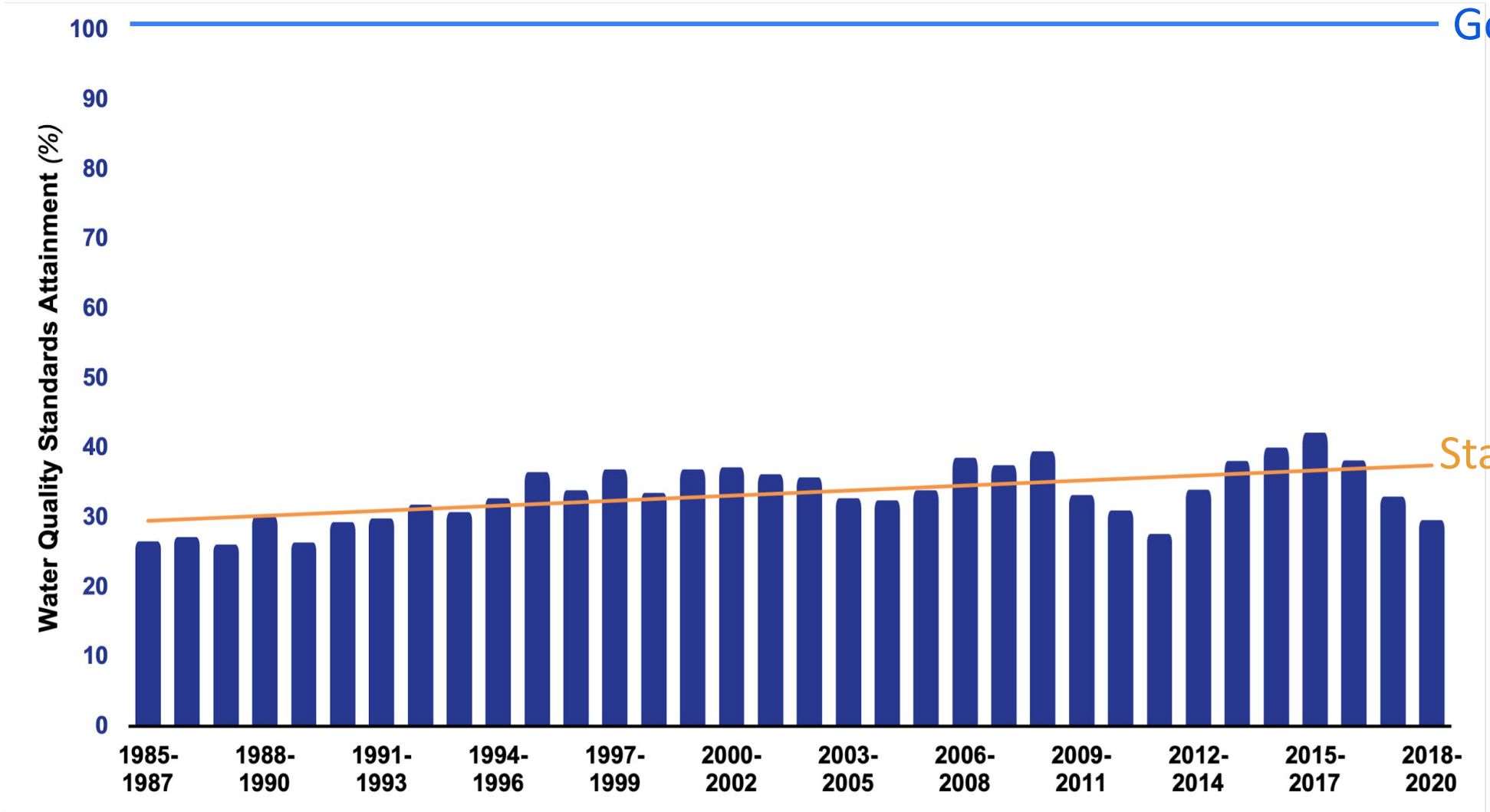
June 1, 2023



"CESR" Report

- 2 editors
- 8 members of a writers group
- 11 steering committee members
- 50+ contributing members of Scientific and Technical Advisory Committee (STAC)

Achieving Bay Water Quality Standards



Why?

How to Improve response?

CESR Conclusions

Gaps in implementation and system response present major challenges to achieving TMDL, water quality goals & improving living resource response.

Opportunities to improve program effectiveness exist but require programmatic change (not just spending more on doing the same things).

Photo by Will Parson/Chesapeake Bay Program

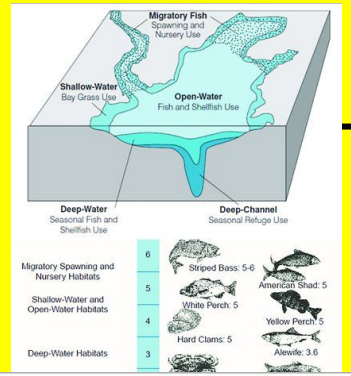
Public Policy

Chesapeake Bay Agreement: Restoration Goals

Sustainable Fisheries
Vital Habitat
Water Quality
Toxic Contaminants
Heathy Watershed
Climate Resiliency
Land Conservation
Stewardship
Public Access
Environmental Literacy

Water Quality Standards

Designated Uses



Water Quality Criteria
Dissolved Oxygen,
Water clarity/SAV,
& Chl-a
across 5 habitats

TMDL: Stressor Reduction Goals

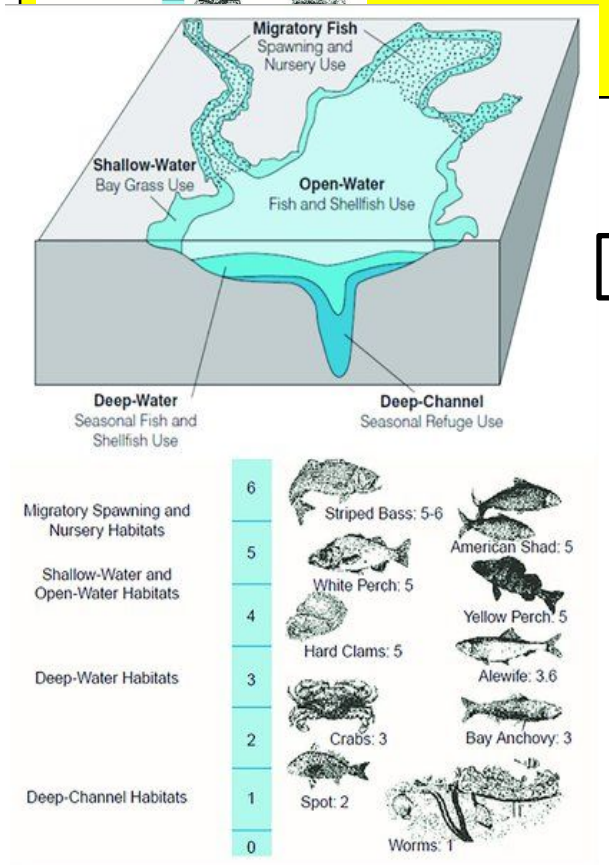
Targets: Nitrogen, phosphorus, sediment

TN: 214.6 m/lbs/yr
TP: 13.3m lb/yr
TSS: 18,587m lb/yr

Implementation Policies

Federal permitting
Fed/State nonpoint programs
Funding

TMDL accounting & accountability



Numeric criteria for:

Dissolved Oxygen
Water Clarity/Submerged vegetation
Chlorophyll a

Public Policy

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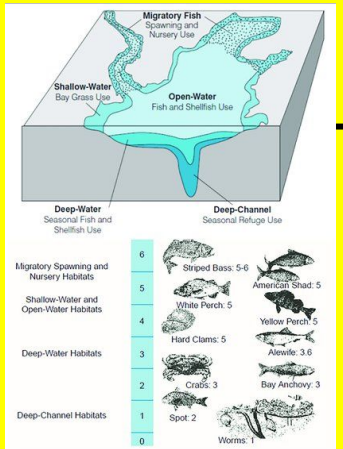

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Biological, Physical, and Social System Response

Living Resource Response

How are living resources responding to changing water quality conditions?

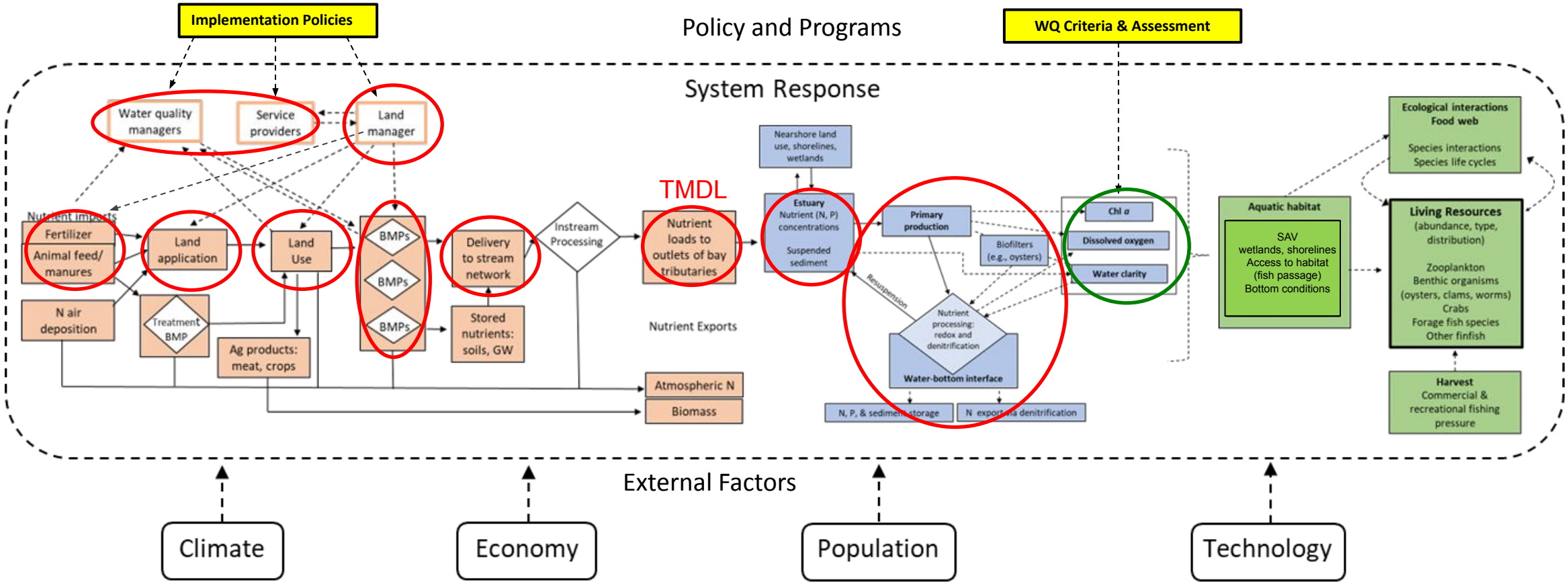
Achieving Water Quality Standards

Are nutrient & sediment reductions producing expected water quality response?

Achieving TMDL:

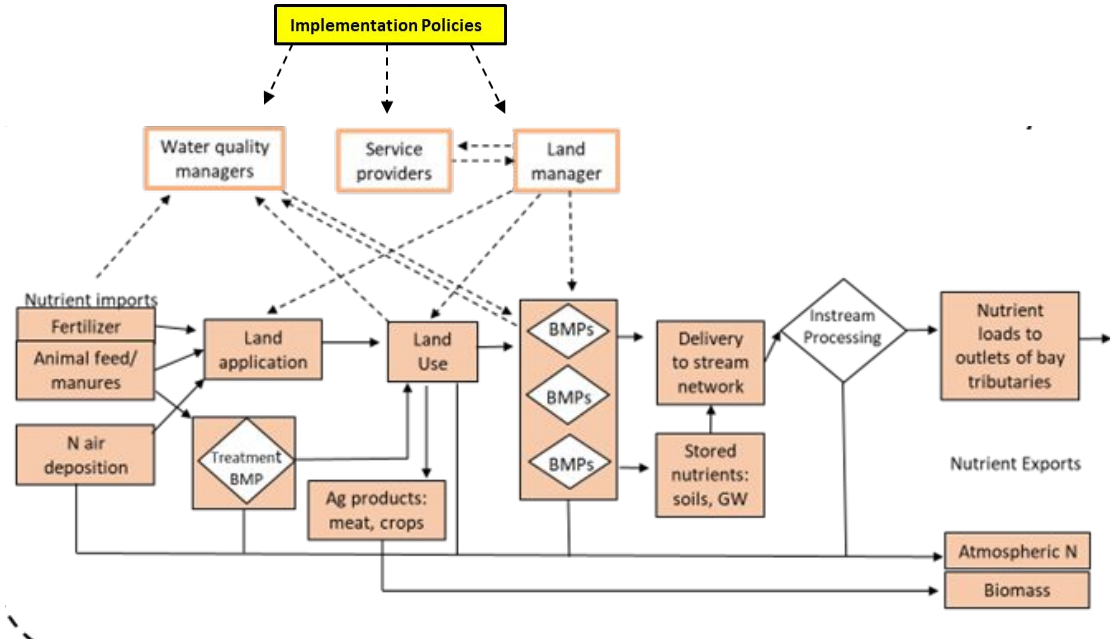
Are implementation policies and management actions sufficient to achieve nitrogen, phosphorus and sediment goals in the TMDL?

System Response to Meeting Bay Water Quality Standards



Findings and Implications:

Pollutant Response to Management Efforts

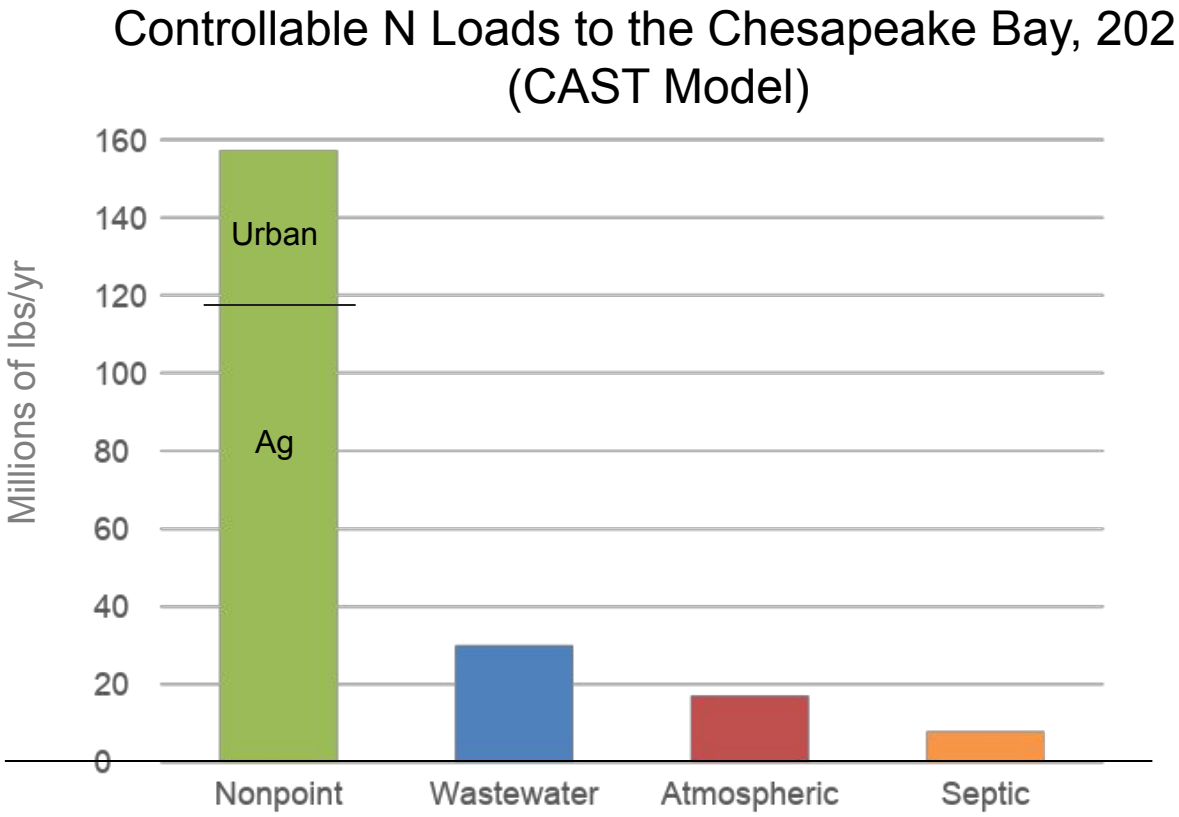


FINDINGS: Achieving TMDL dependent on significant reductions agricultural & urban nutrient runoff (nonpoint).

Existing nonpoint source water quality programs are insufficient to achieve the nonpoint source reductions required by the TMDL

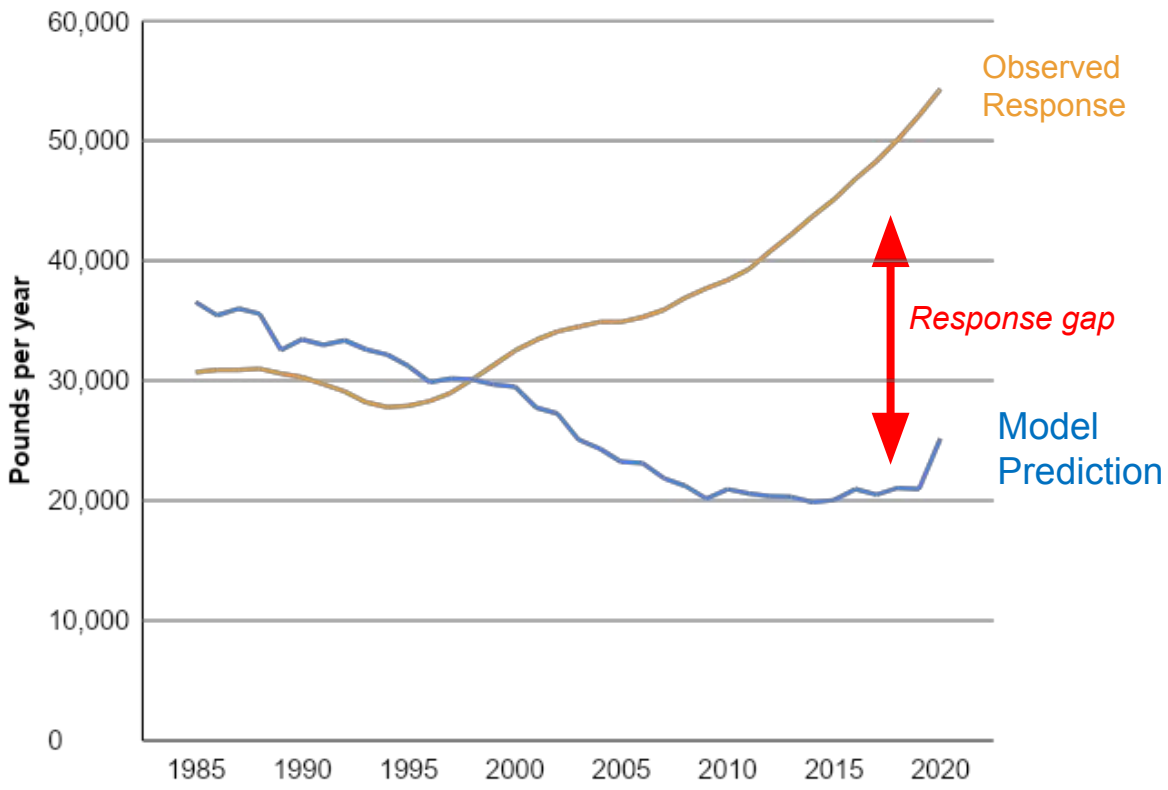
1. Not generating enough implementation
2. Implementation not as effective as expected

Point #1: Nonpoint source programs not generating sufficient levels or types of adoption

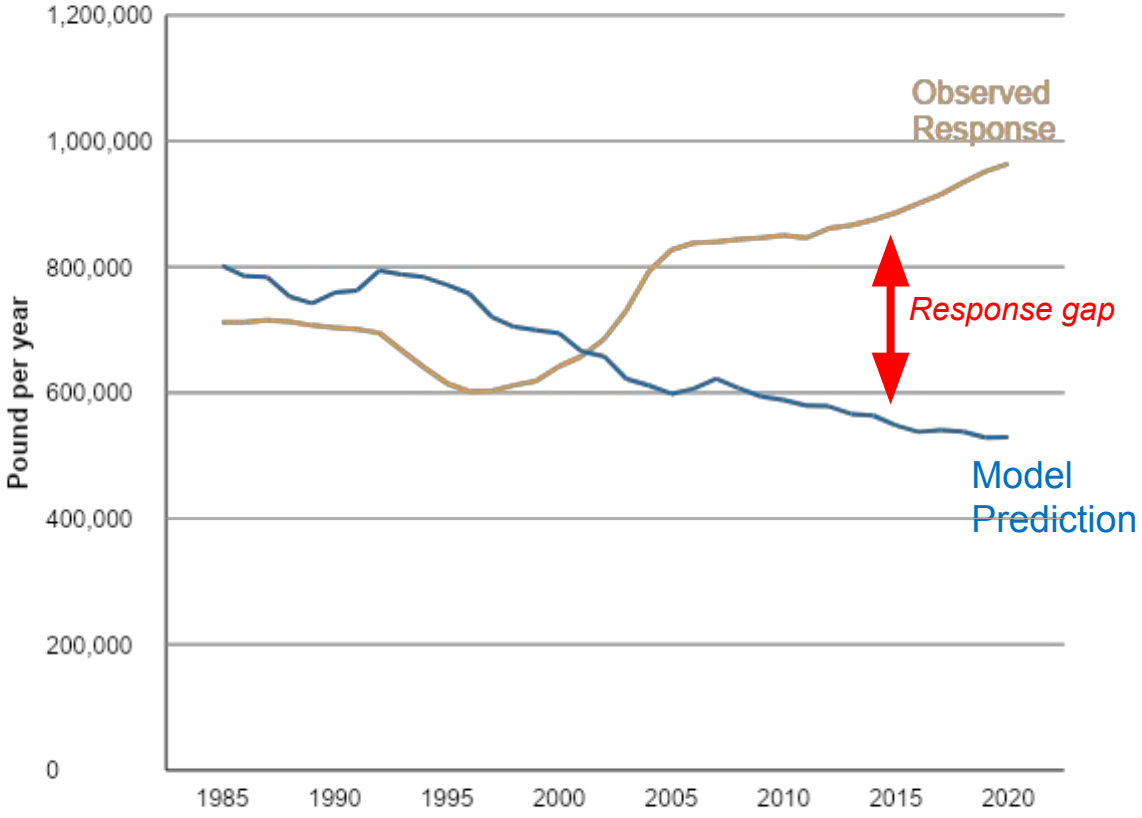


Point #2: Nonpoint source practices may not be as effectives as expected

Total Phosphorus Loads, Choptank



Total Phosphorus Loads, Rappahannock



Opportunities for improving nonpoint source effectiveness

Improving Nonpoint Source Program Effectiveness:

Practices v Outcomes

Cover crops

Livestock Exclusion Fencing

Denitrifying Bioreactor

Low upfront installation costs
Private benefits

High up front installation costs
No private benefits

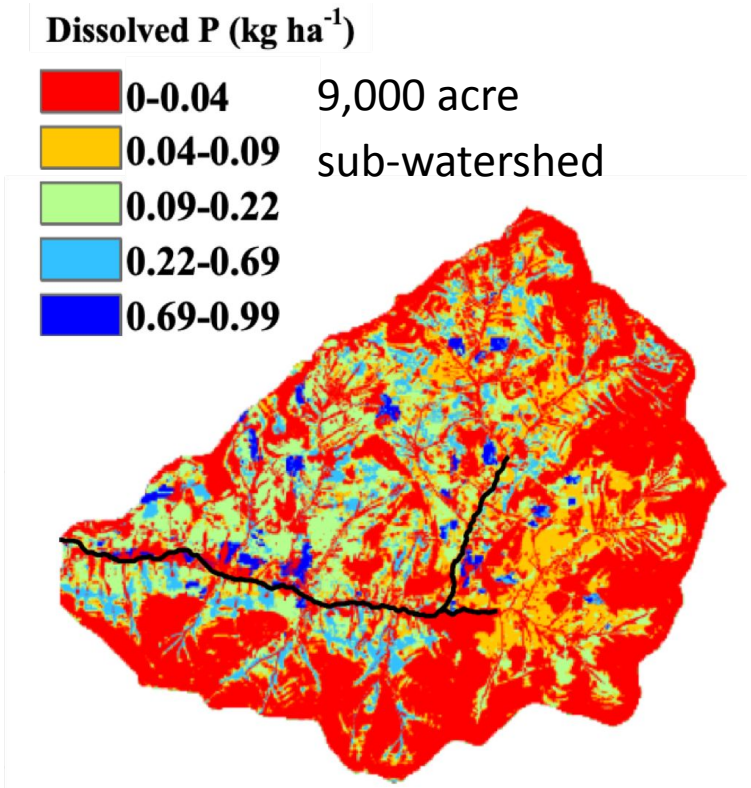
Public benefits: Pollutant removal benefits?

$ ➡ Outcome

- Pay for Performance/Success
- Incentives for demonstrated outcomes (greater certainty)

Improving Nonpoint Source Program Effectiveness:

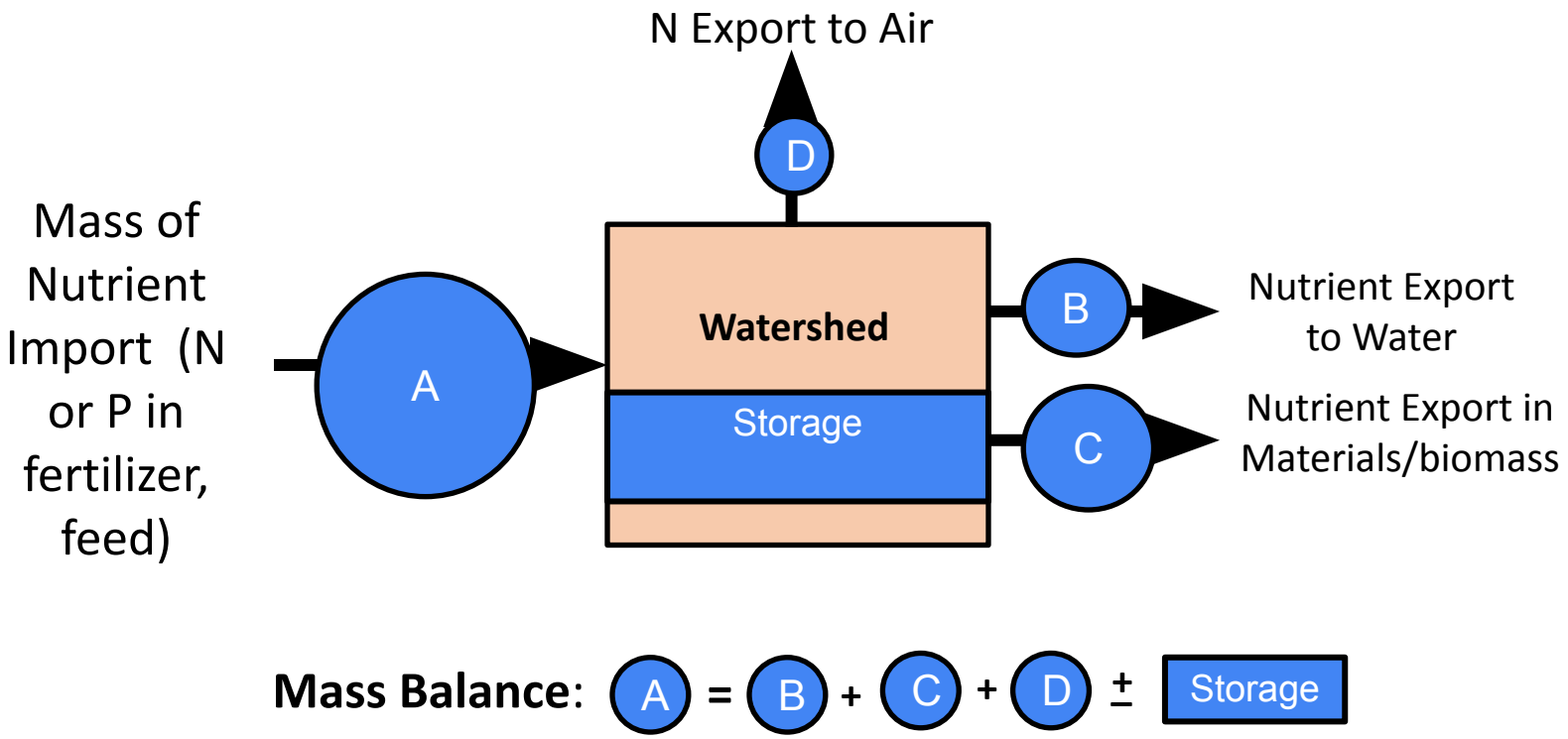
Targeting Outcomes



Large variation in nonpoint source loads and BMP effectiveness across landscape and land managers

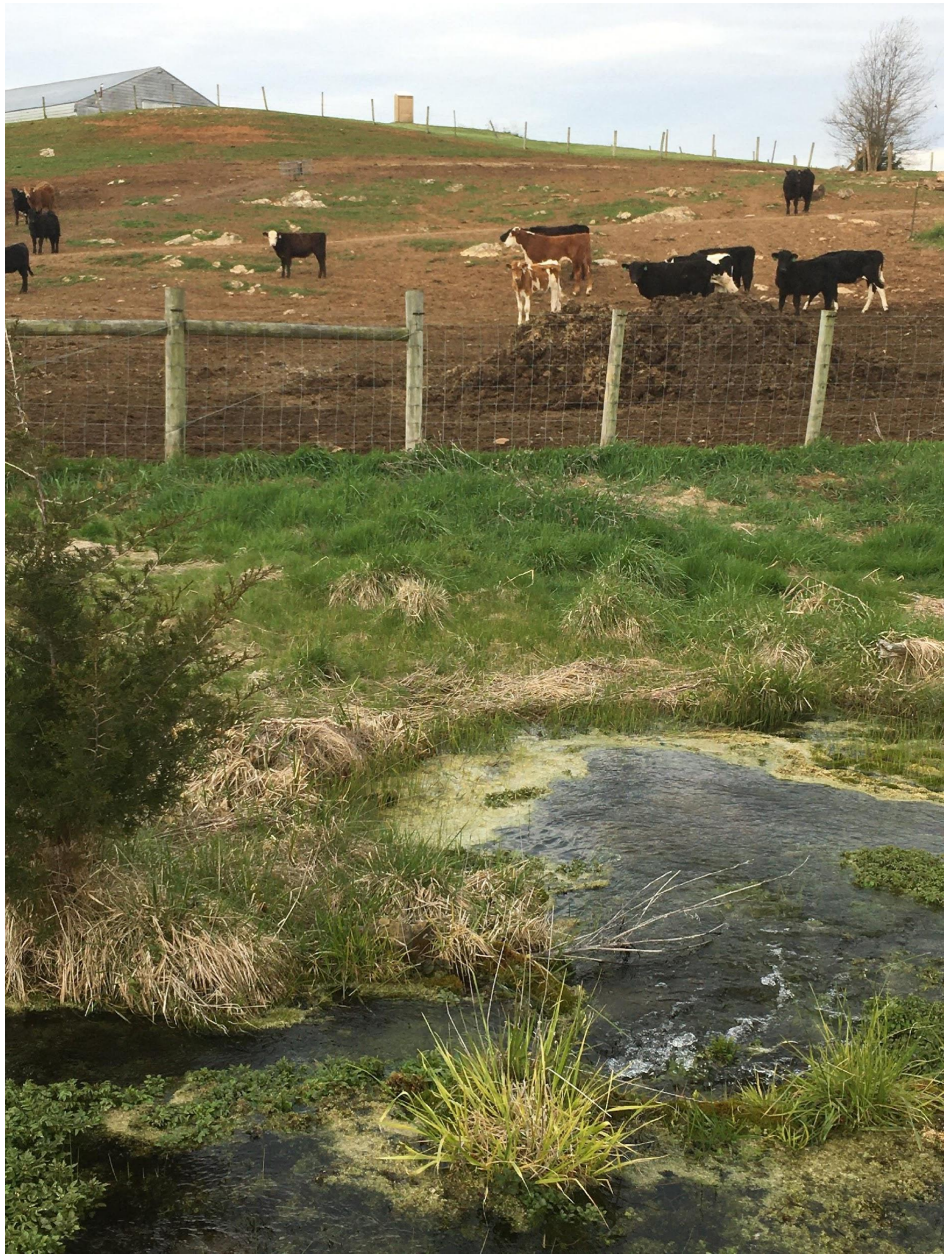
- Finer scale modeling & monitoring
- Incentives to find & address high load area
- Alternatives to TMDL accounting/crediting

Improving Effectiveness: Addressing Mass Balance



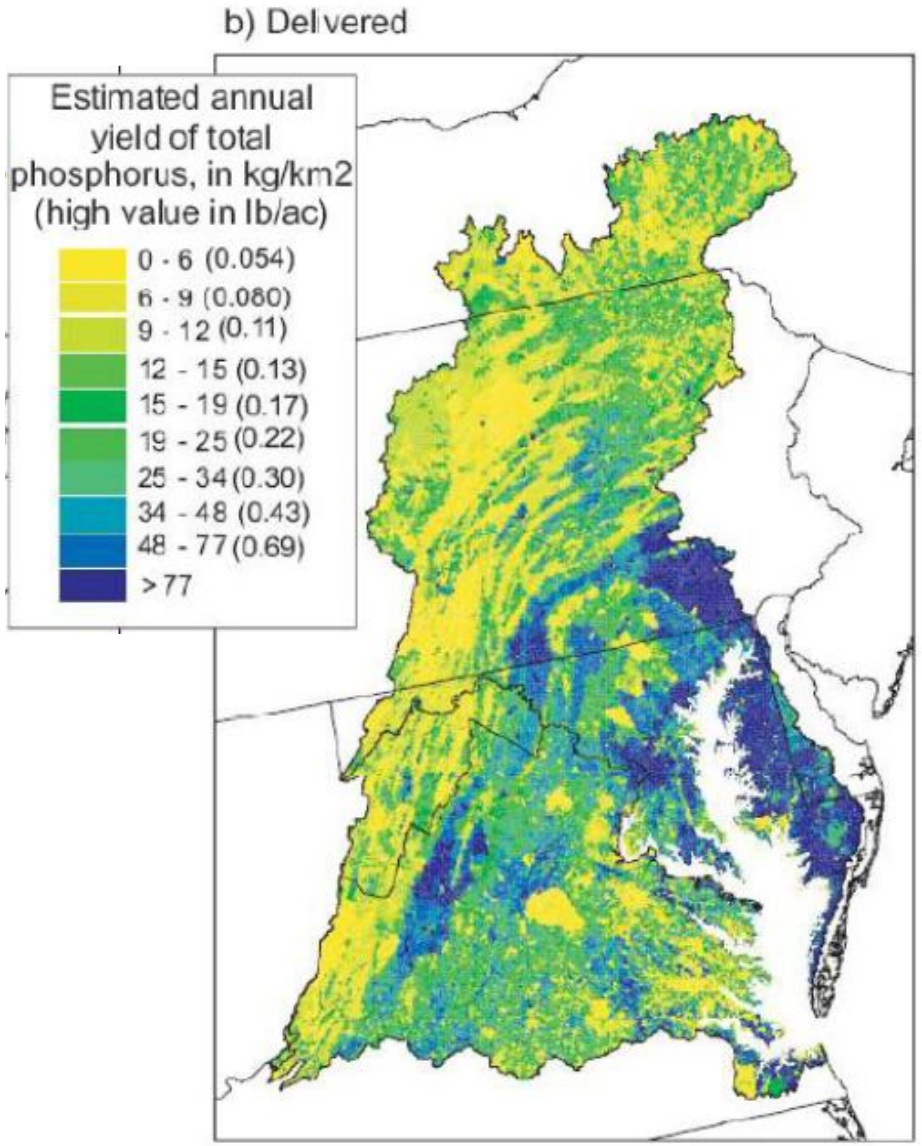
Mass Balance: A = B + C + D ± Storage

Nutrient Mass Balance



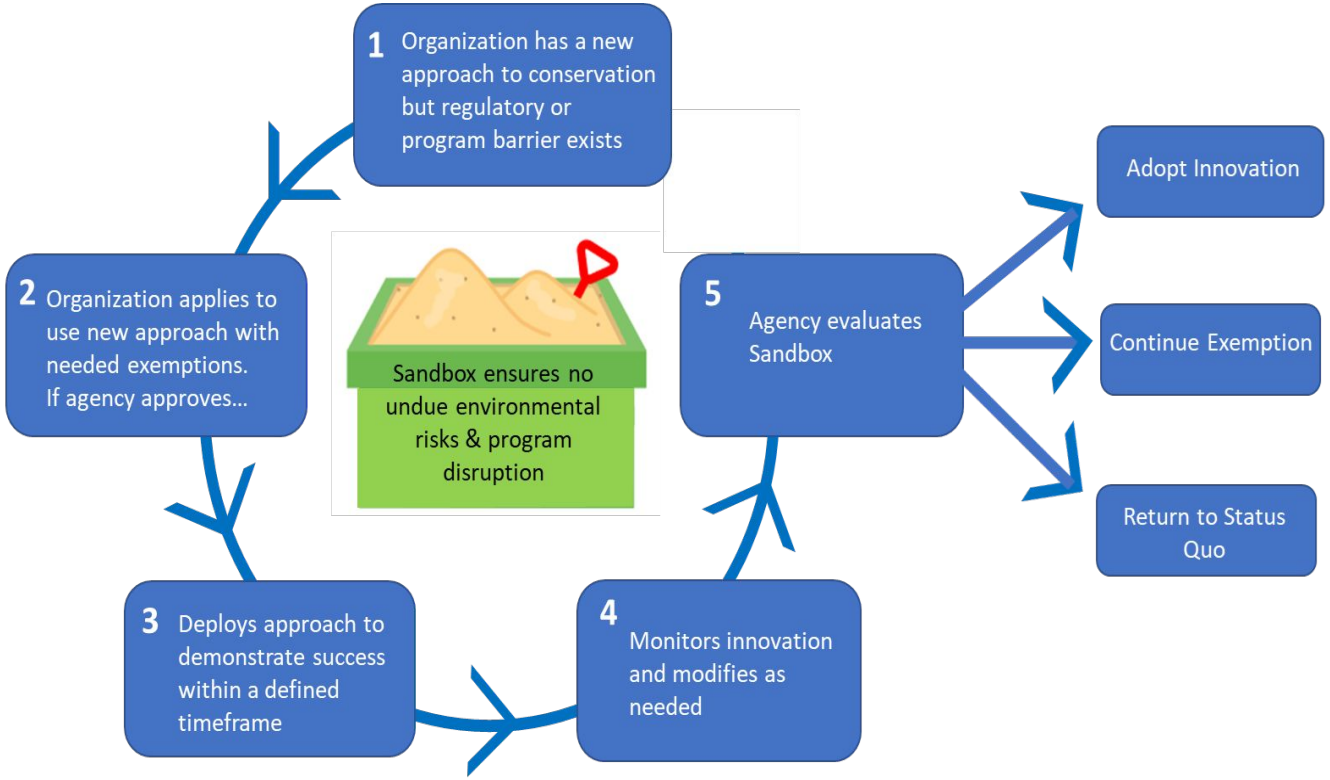
Livestock manure

Well designed and maintained riparian buffer (BMP)



Source: USGS Sparrow Model Output

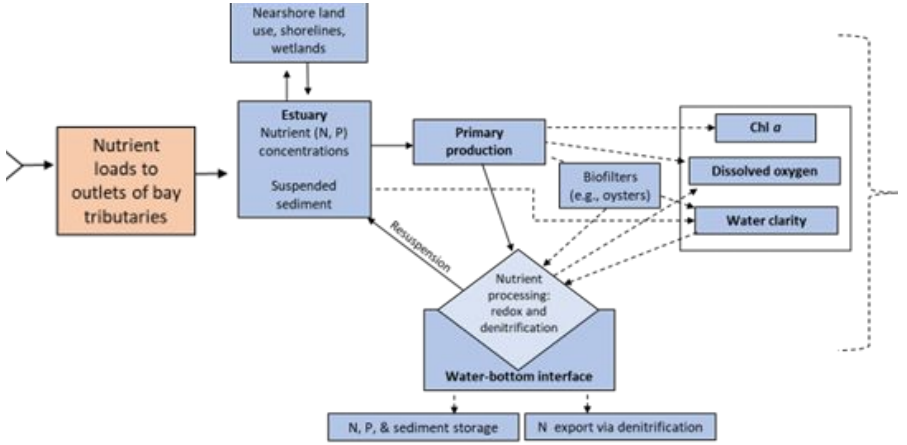
Improving Nonpoint Source Program Effectiveness:
New Opportunities for Technological & Institutional Innovation



The Sandboxing Process (Figure adapted from Higgins and Male, 2019)

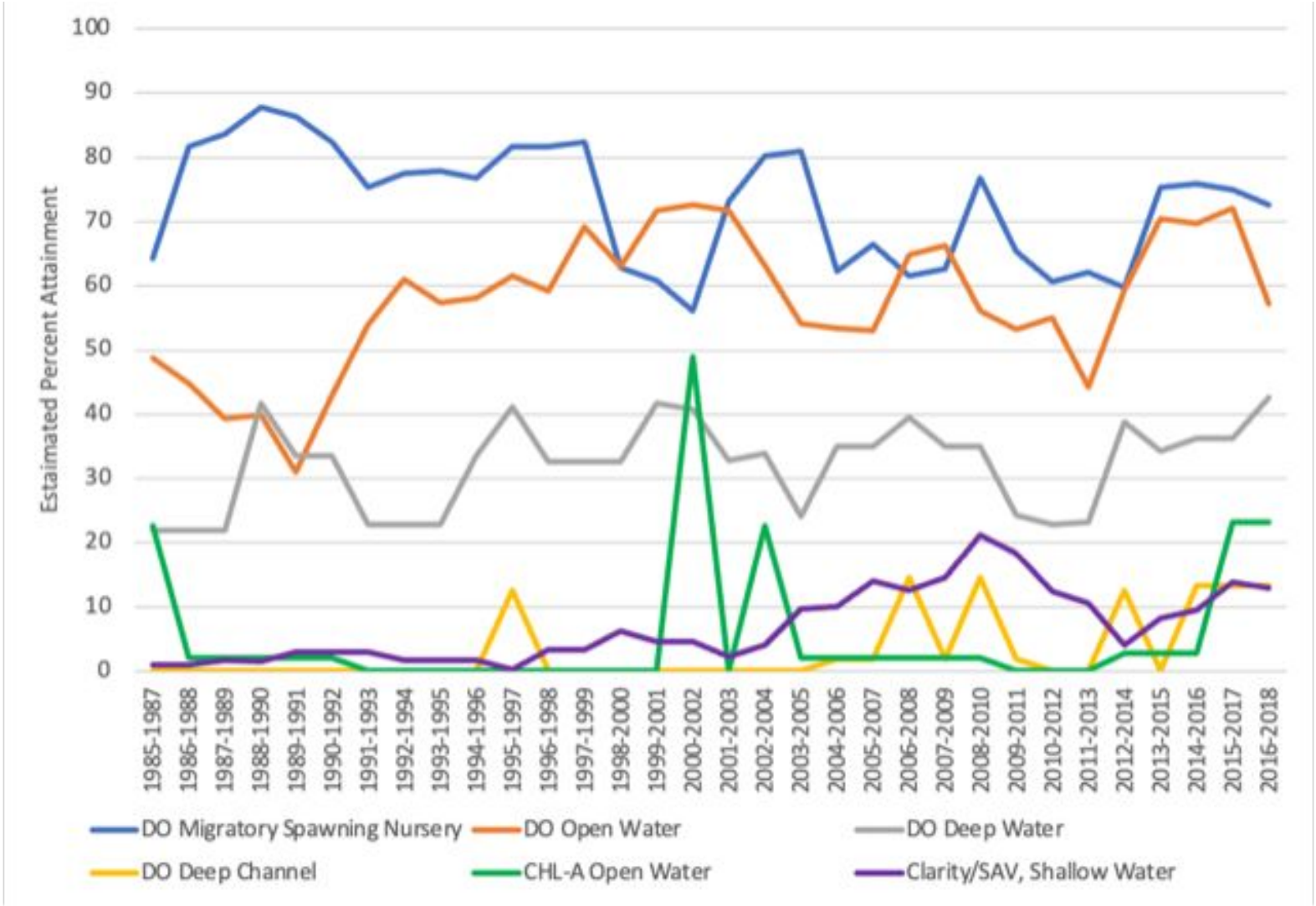
Findings:

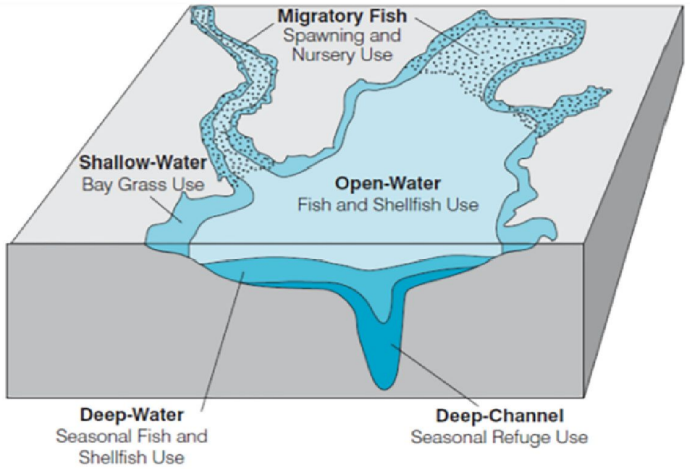
Bay Water Quality Response to Nutrient Reductions



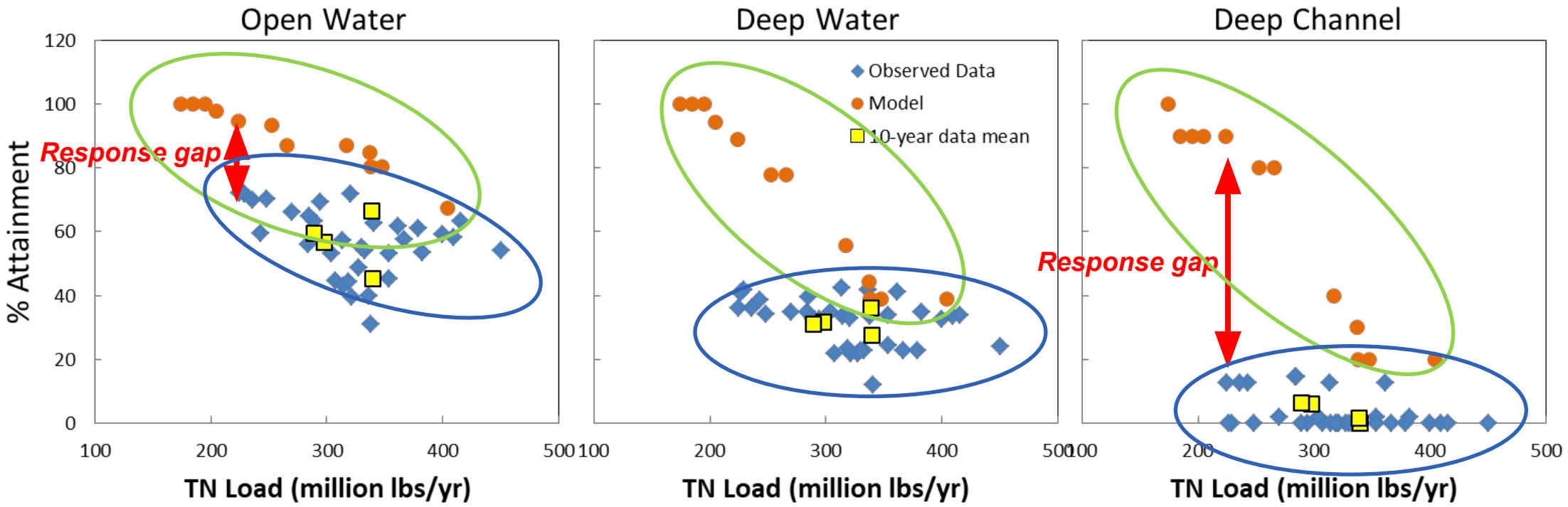
FINDING: Load reductions have produced water quality improvements in some areas but often not at levels expected. Full achievement of WQS is distant & unlikely, particularly for deep water DO

Observed Attainment of Water Quality Criteria Across Habitats





Was this Expected?
Possible Response Gap for Dissolved Oxygen across Habitats

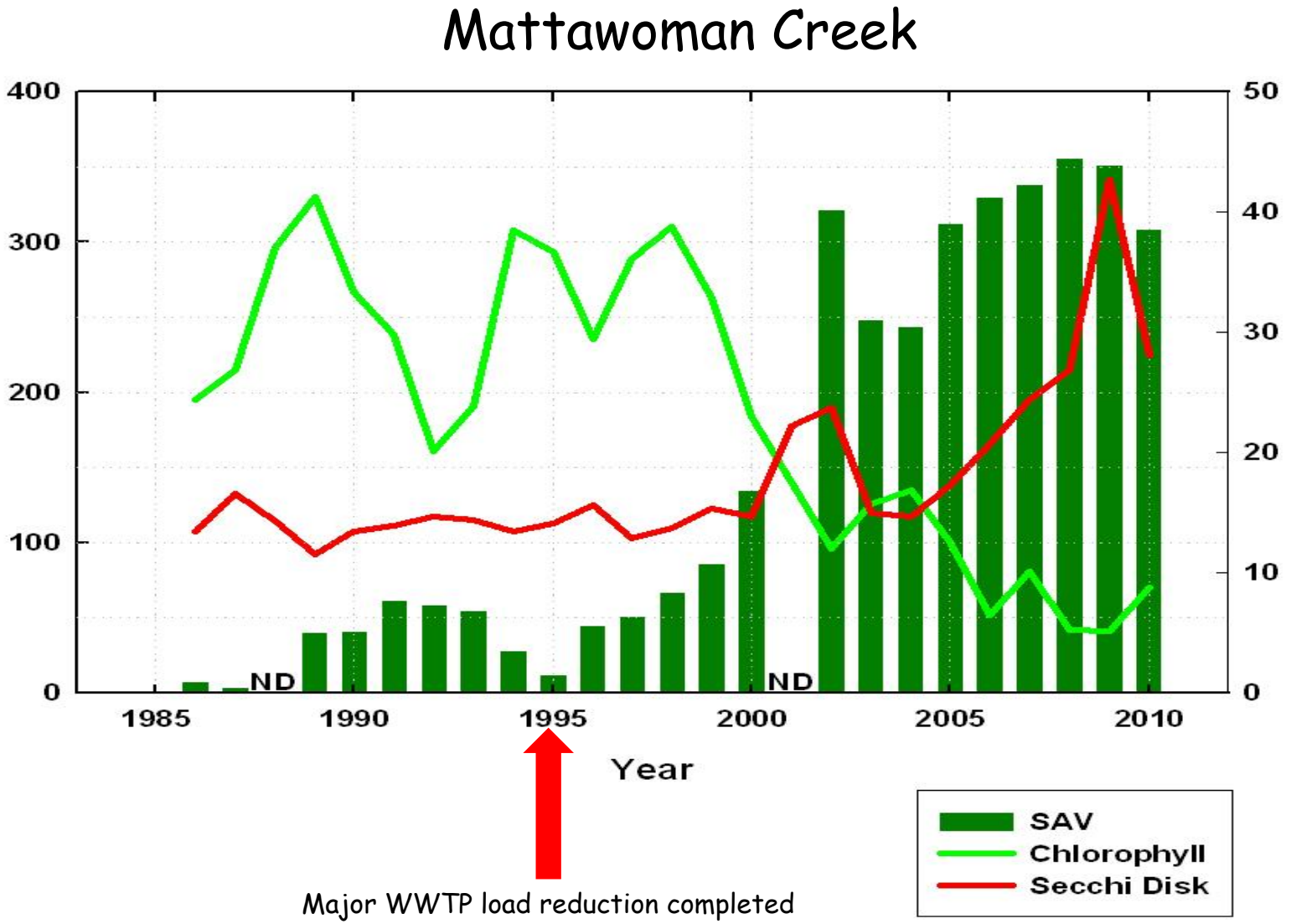


Expected and realized relationships between TN loads and DO criteria attainment for open water, deep water, and deep channel habitat, calculated as 3-year running mean observed values (blue diamonds) and expected responses from estuary model (orange dots) for the same time periods. Yellow squares are 10-year means of the observed data.

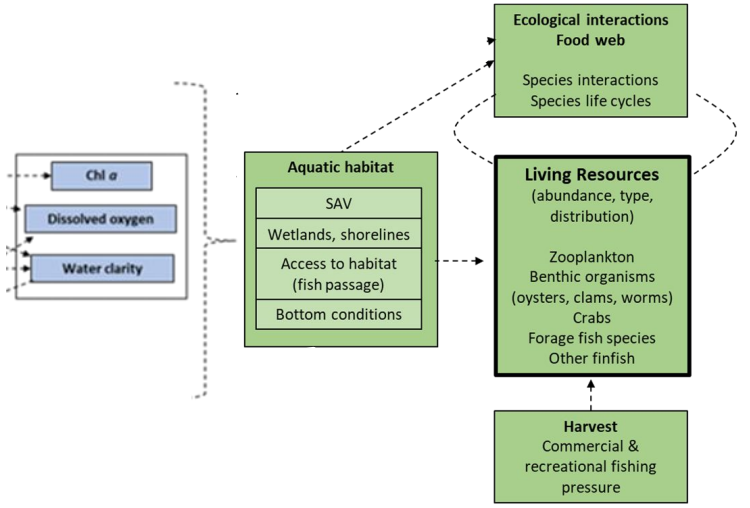
Why response gaps?

- Climate change (ex. warming waters)
- “Tipping points”

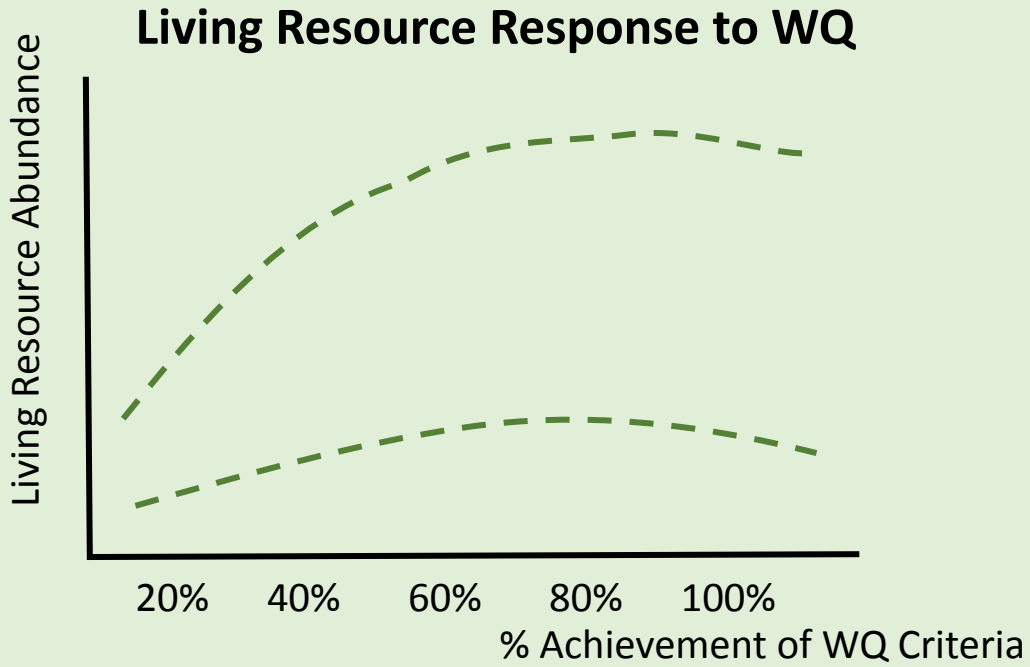
Examples of rapid recovery in regions of the Bay

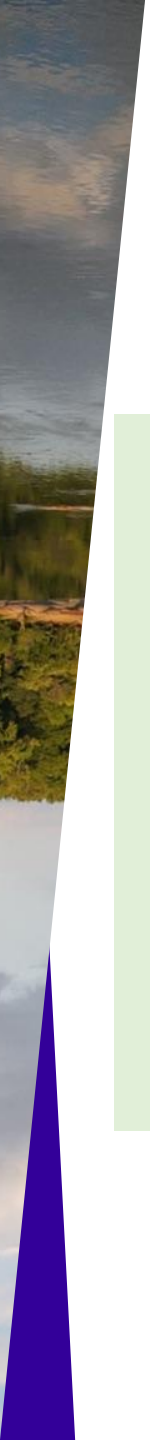


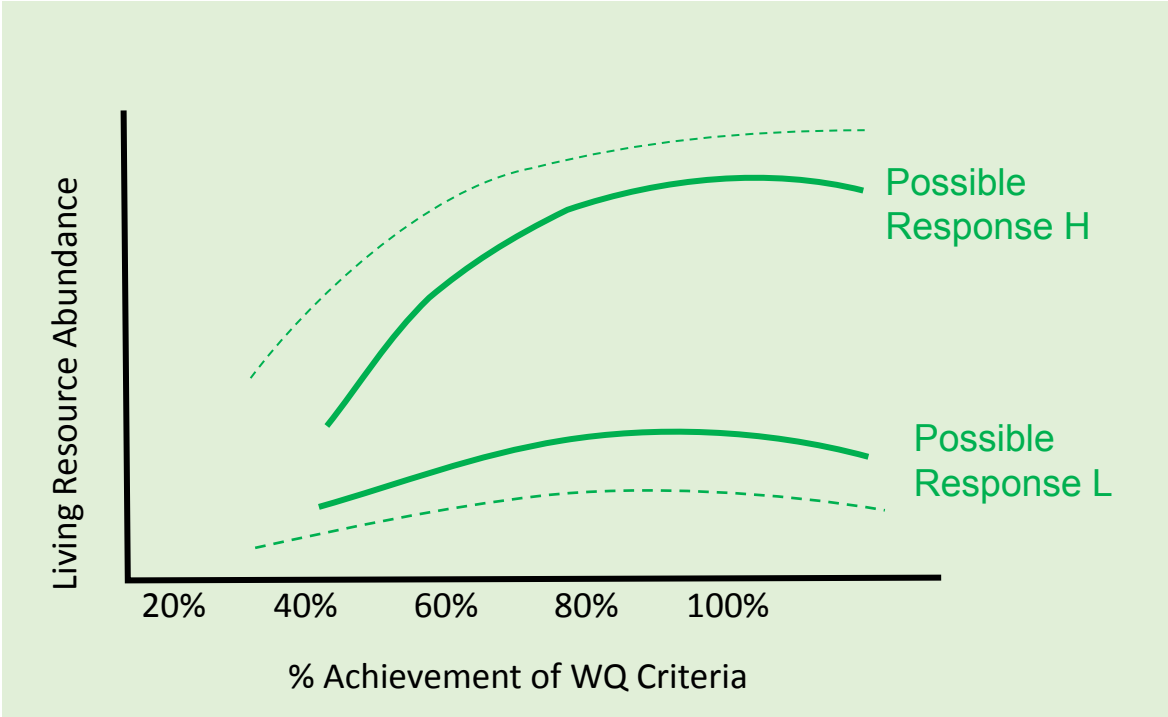
Findings: Living Resource Response to Water Quality Improvement



Living resource response to changes in water quality criteria







Findings

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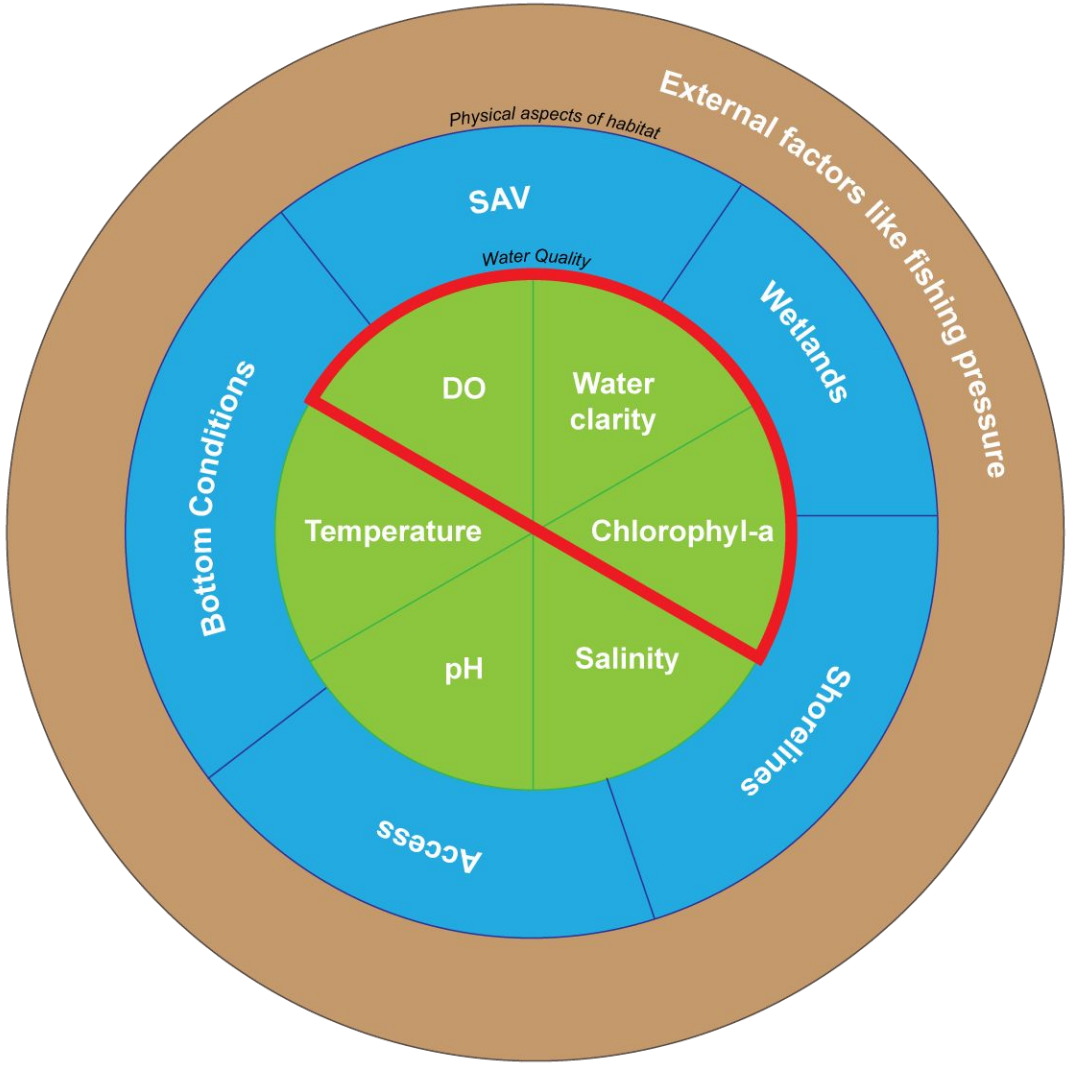
The living resource response to water quality improvement (H or L response) depends on:

- Where WQ response to nutrient and sediment reductions occur
- Status of other factors that influence living resource response

Many Knobs of Living Resource Response



Managed by Bay water quality standards

CESR Implications for Water Quality Goals & Living Resources

Additional nutrient reductions needed to maintain and improve water quality.

Opportunities to improve living resource response without achieving full attainment

Prioritize management actions that improve living resource response

- Example: targeted attention water quality improvements in shallow water habitats through tiered approach to TMDL implementation