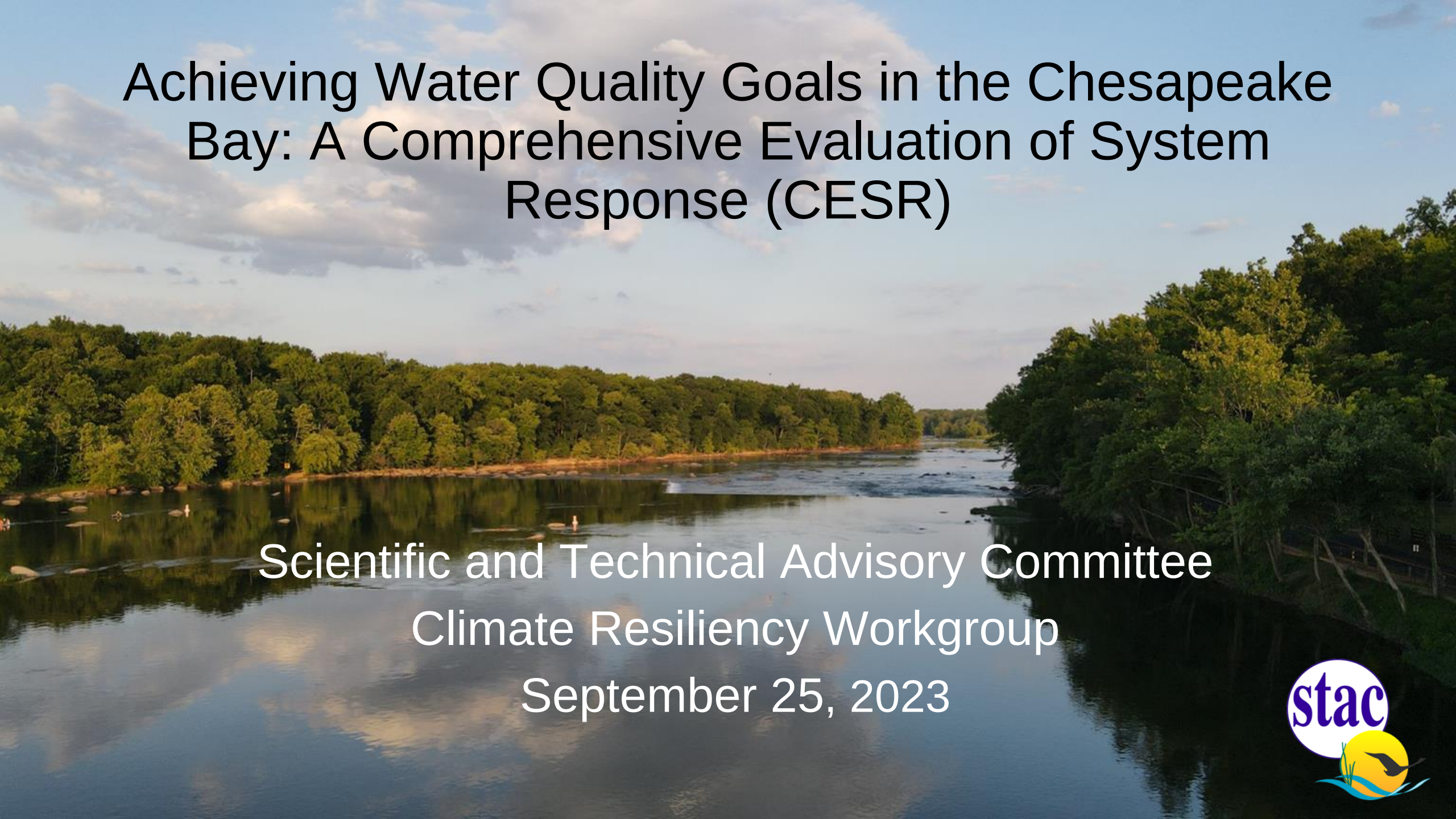
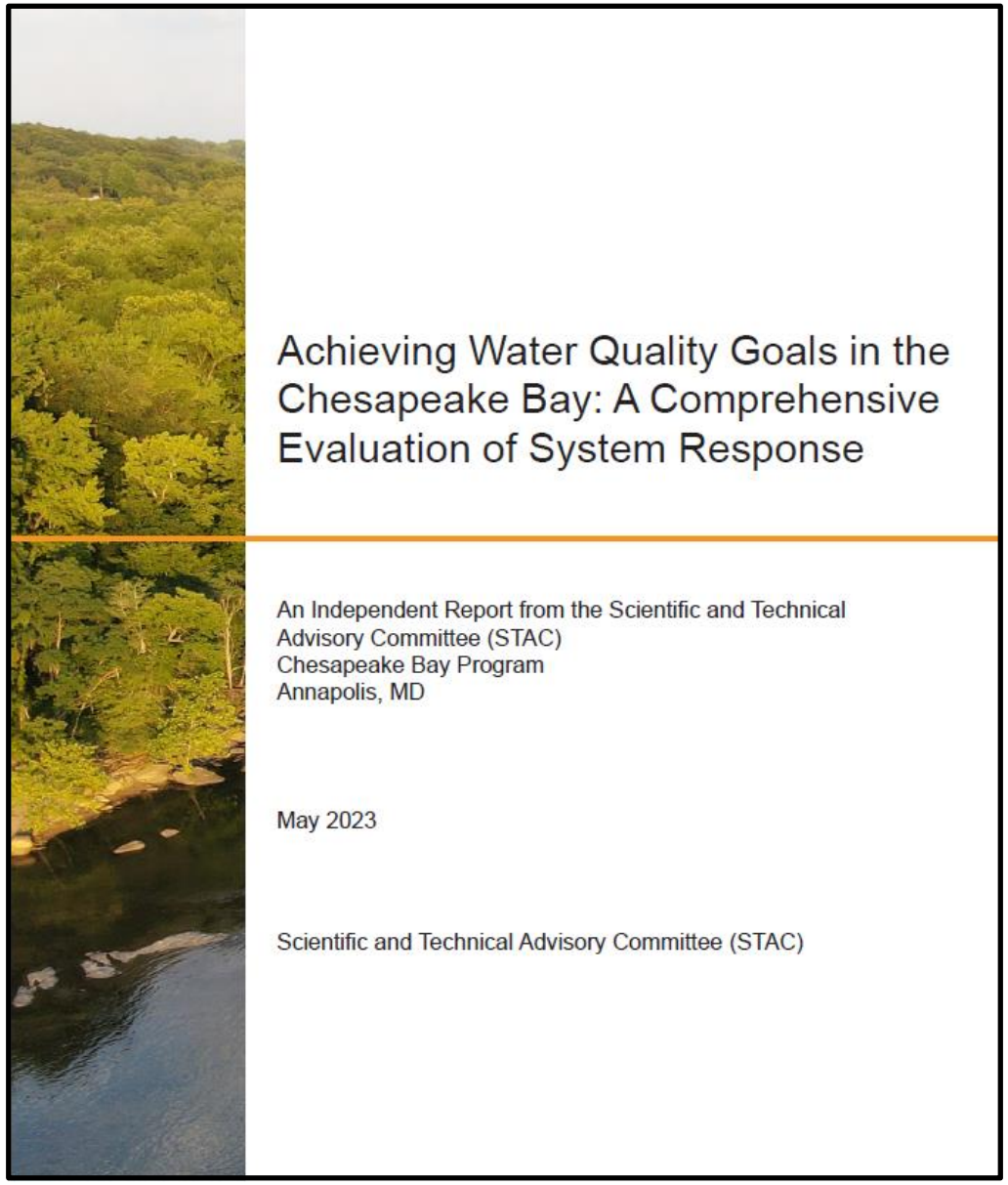
Achieving Water Quality Goals in the Chesapeake Bay: A Comprehensive Evaluation of System Response (CESR)



Scientific and Technical Advisory Committee

Climate Resiliency Workgroup

September 25, 2023



CESR Report

- Self-initiated
- Inclusive of STAC Membership
- Steering Committee

  Writer's Group

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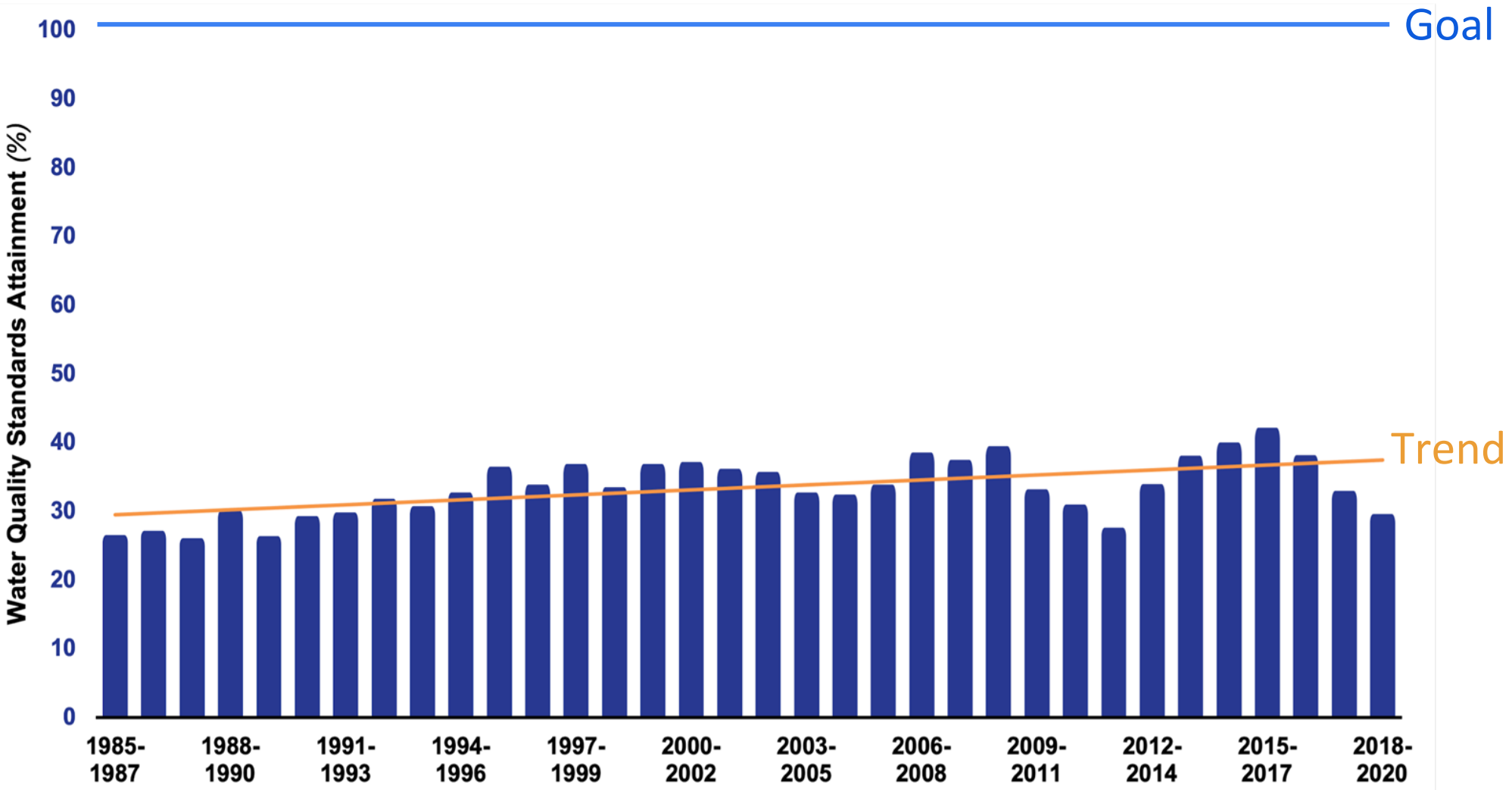
Motivation for CESR



Why?

How to Improve response?

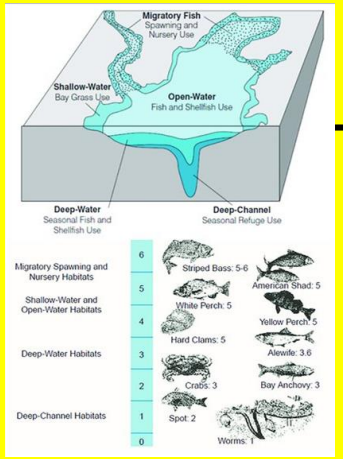
Public Policy

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: 13.4m lb/yr
TSS: 18,587m lb/yr

Implementation Policies

Federal permitting
Fed/State nonpoint programs
Funding

TMDL accounting & accountability

Biological, Physical, and Social System Response (CESR)

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 to meet WQS?

Achieving TMDL:

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

Summary of CESR Findings and Implications

Living Resource Response

Finding: The impact of WQ improvements on living resources depends on where WQ improvements occur and antecedent conditions; impact varies across species.

Implication: Potential to increase the living resource response to our WQ and restoration investments.

Achieving Water Quality Standards

Finding: Bay water quality is improving, but the magnitude of the improvement appears to be lagging behind expectations

Implication*:* Water quality criteria may be unattainable in some regions of the Bay

Achieving TMDL

Finding: Nonpoint source programs are not generating the scale of reductions needed to achieve TMDL

Implication: Substantial improvement in nonpoint source outcomes will require new programs and approaches. Additional funding alone is insufficient.

Overarching Finding: Challenging problem with tradeoffs, uncertain outcomes, and no single "silver bullet" answer

Overarching Implication: Recognize tradeoffs and uncertain outcomes, accelerate innovation, and learn

Achieving TMDL:

Finding: Nonpoint source programs are not generating the scale of reductions needed to achieve TMDL

Two Challenges

1) Nonpoint source programs not generating the scale and type of adoption/behavior change needed to meet TMDL ("Implementation Gap")

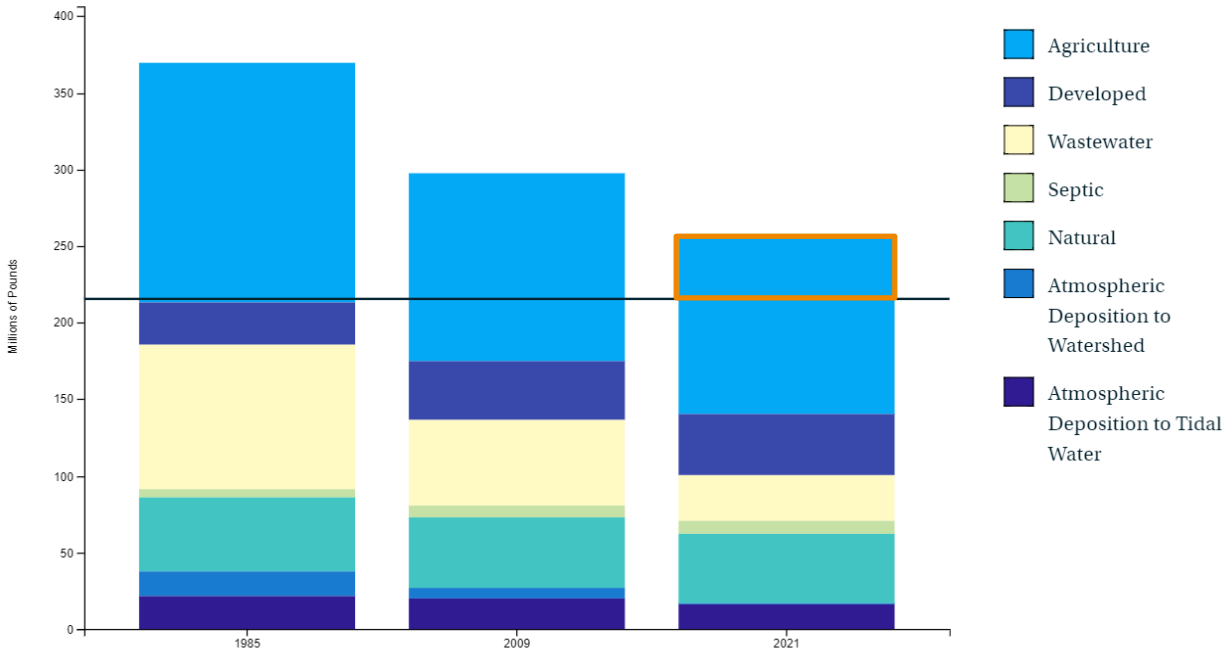
2) Nonpoint source programs may not be as effective as expected in producing nutrient reductions ("Response Gap")

Modeled Nitrogen Loads to the Chesapeake Bay (1985-2021)

Loads simulated using CAST19 and jurisdiction-reported data on wastewater discharges. *The natural sector includes, in part, forests and wetlands which are preferable land use types with the lowest loading rates among sources.

VIEW CHART VIEW TABLE

Loads by Source Loads by Jurisdiction



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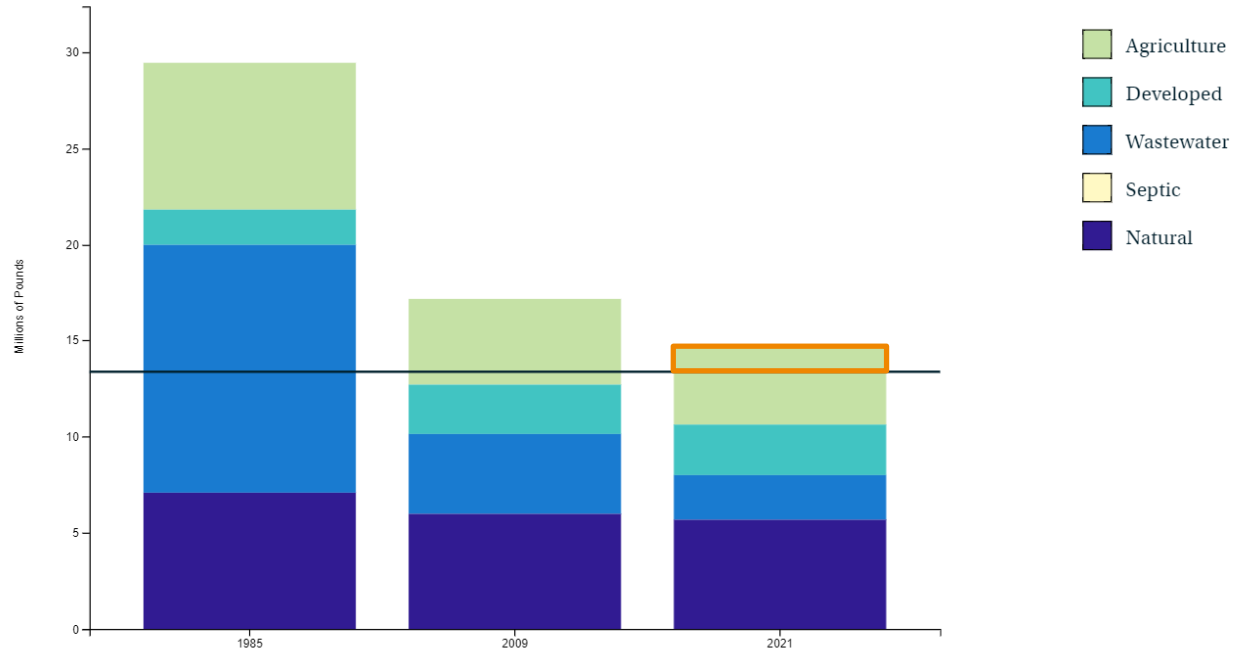

Nonpoint Source Implementation Gap (N illustration)

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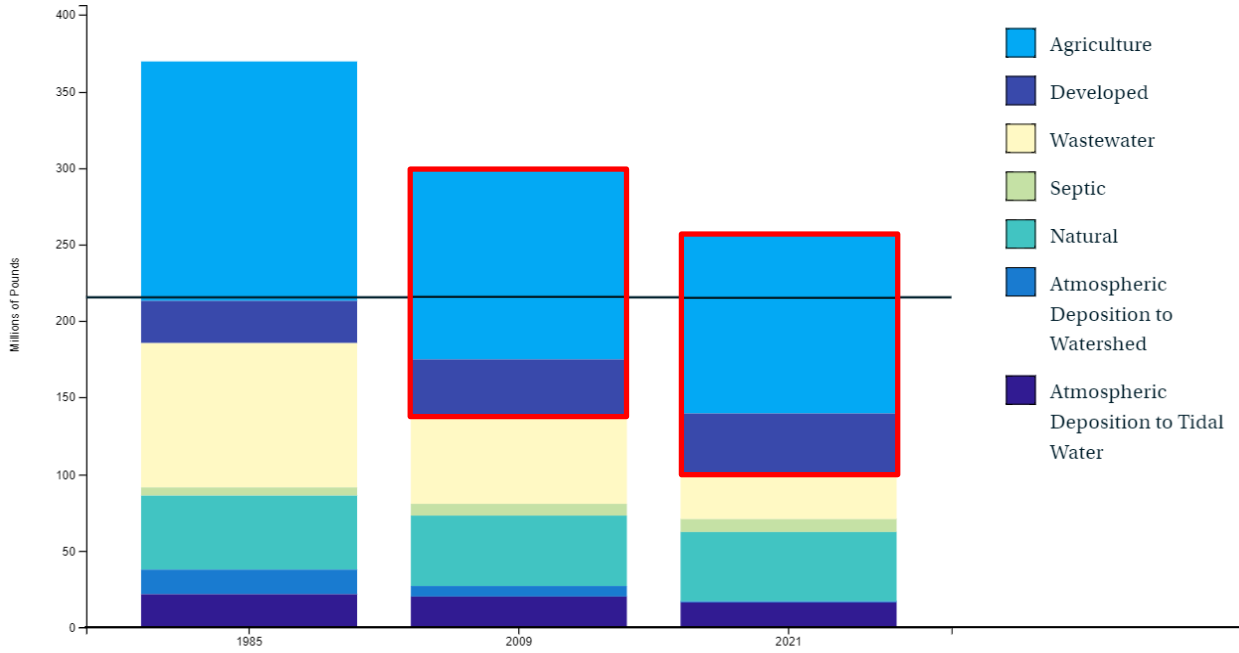
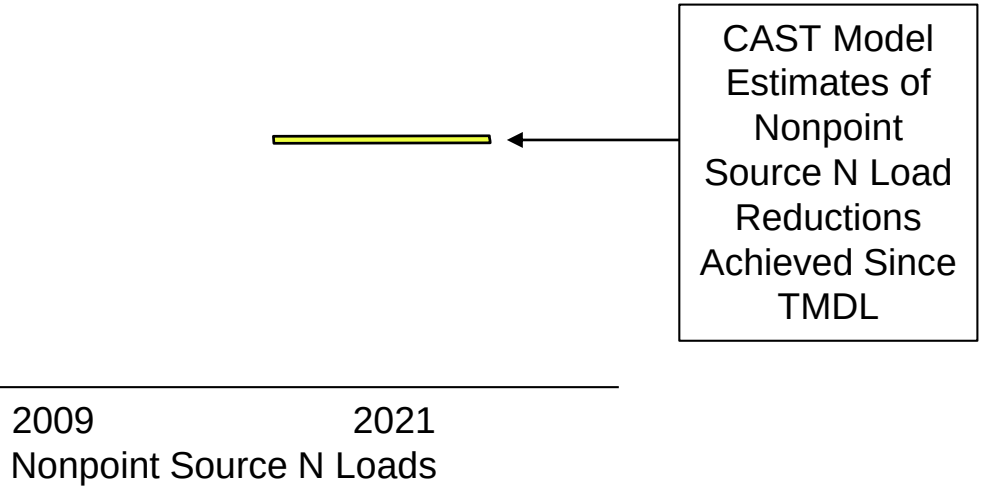
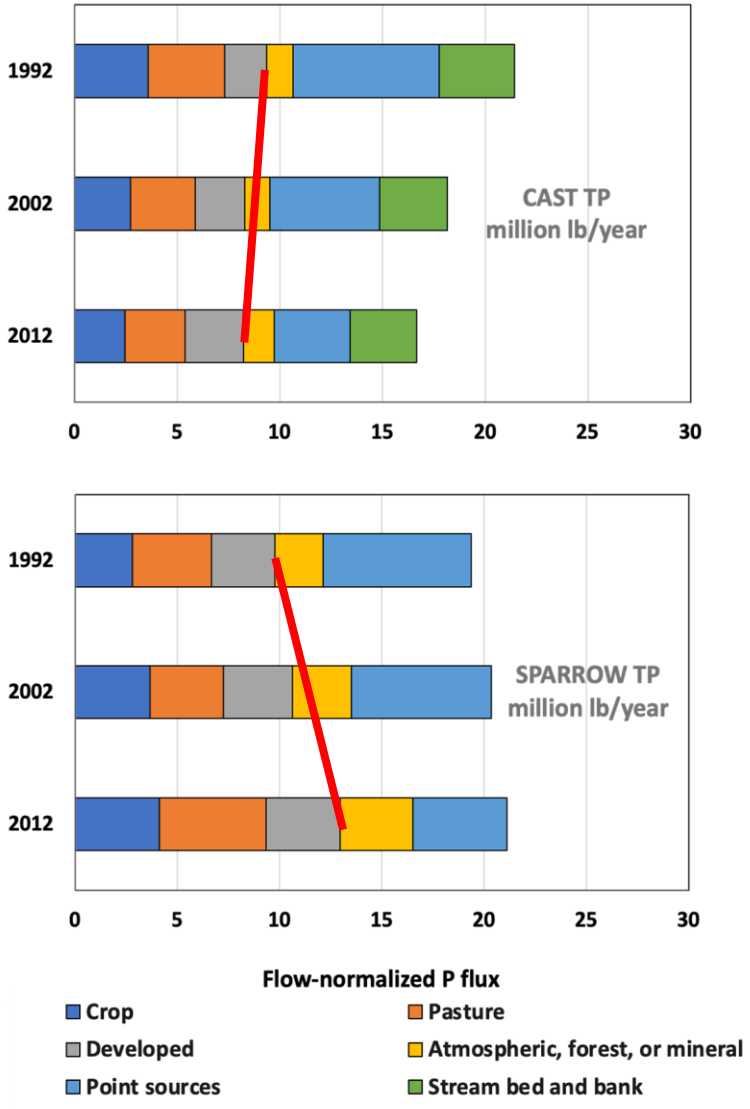
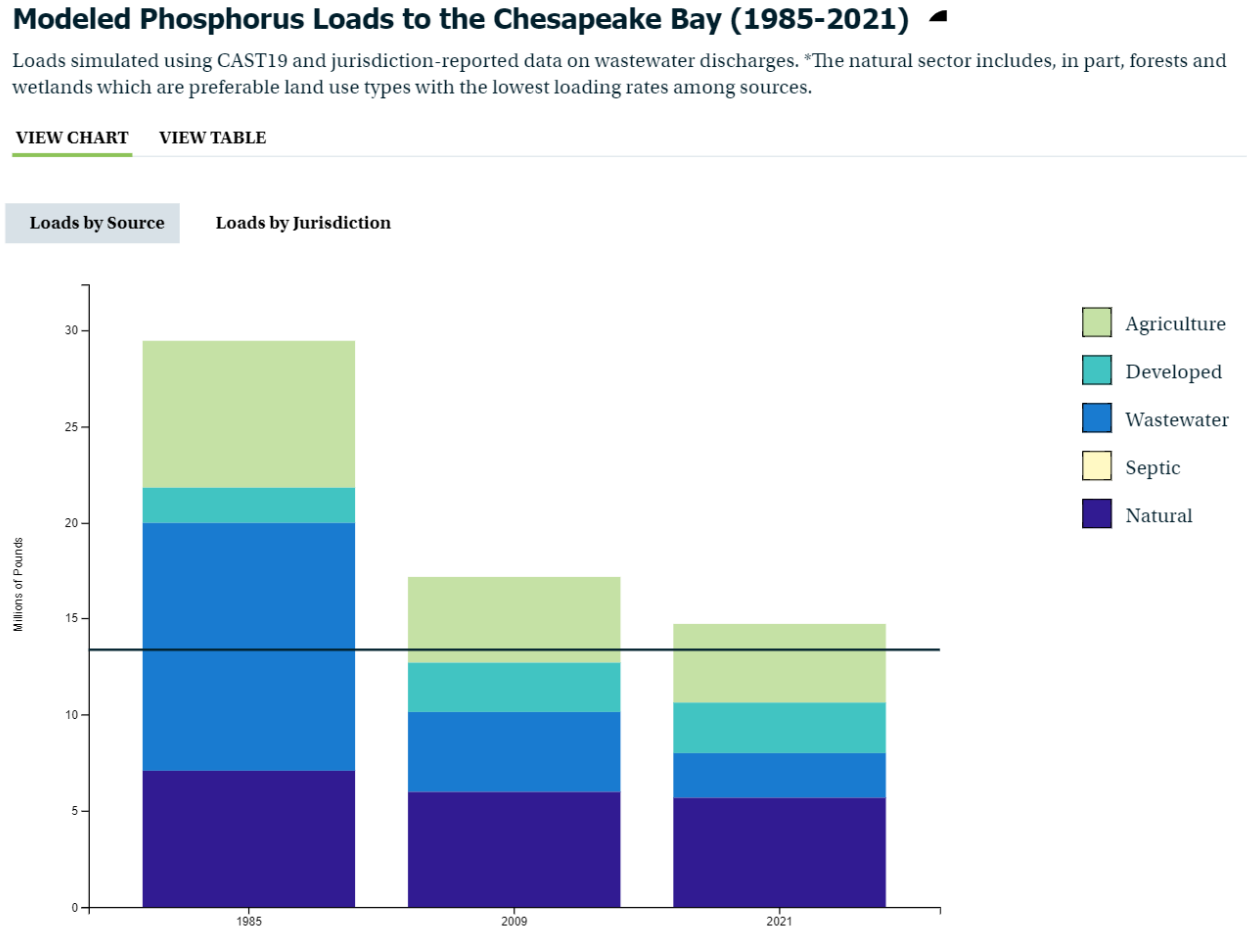




Nonpoint Source Response Gap (P illustration): Are we getting pollutant reductions we expected?

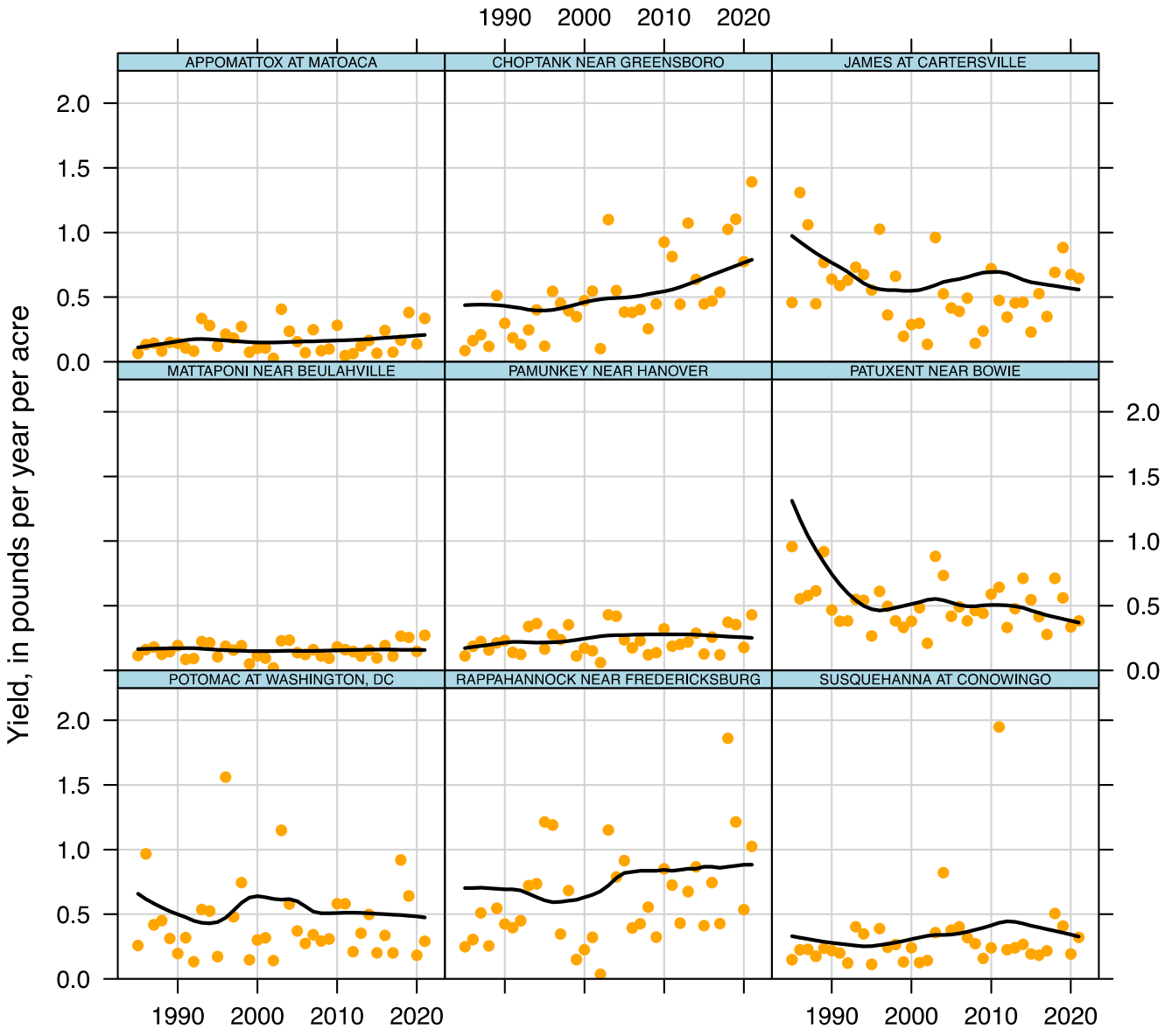
Estimated flow-normalized total and source sector TP Loads to the Chesapeake Bay for the CAST and SPARROW models (Ator et al. 2020)





Why so limited progress reducing Nonpoint Source Loads?

- *Legacy Nutrients & Lag Times*
- *Nutrient Mass Balance*
- *BMP Effectiveness*
- *Behavior*
- *Monitoring*



Total Phosphorus Yields at the RIM sites
Black Line is Flow–Normalized Yield, 1985–2021

Mason and Soroka, 2022

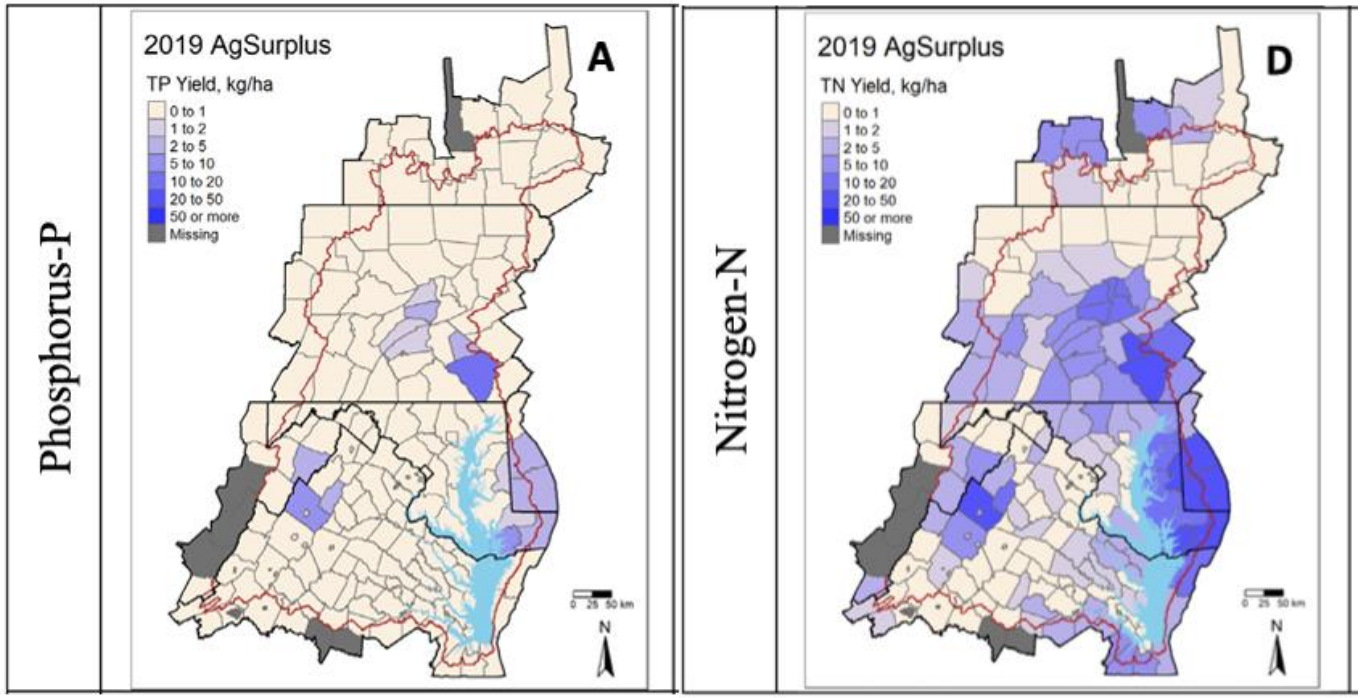
Opportunities to Improve Nonpoint Source Program Effectiveness

Shift emphasis on Outcomes
Improved Targeting
Outcome-based Incentives (“pay for performance” “pay for success”)
Additional Emphasis on Mass Balance

Mass Balance

How much have changes and intensification in ag production and imported nutrients affected quantifying BMP effectiveness?

County-level Mass Balances



Sabo et al. 2022

How/ how much have changes and intensification in ag production and imported nutrients affected quantifying BMP effectiveness?

Illustration of a CBP showcase watershed: Smith Creek, VA

Over past 3 decades, the number of animal units increasing

Over past 3 decades, 4x increase in # of BMPs installed in watershed

Pictured: riparian buffer at headwater spring

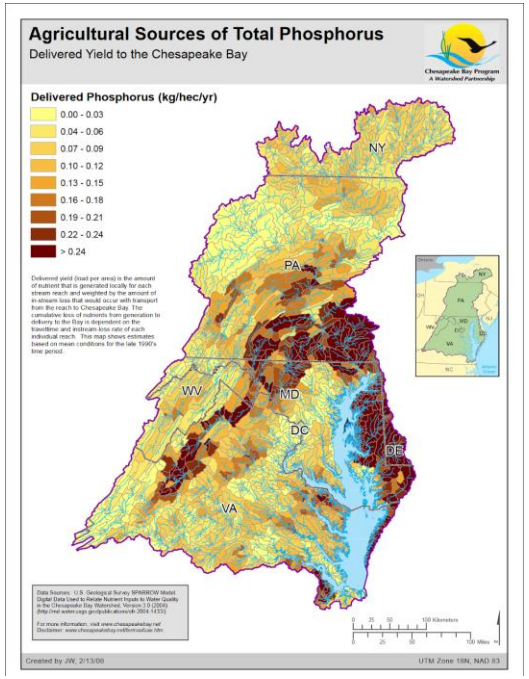
Net Result:

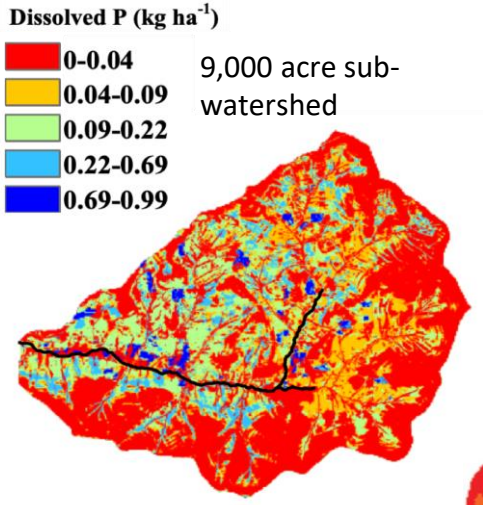
TN loads increasing over time

Data: Jimmy Webber, USGS

Opportunities to Target Nonpoint Source Investments

What will the report's impact be for efforts to get agricultural BMPs on the ground? ie: Targeted BMPs/watersheds?

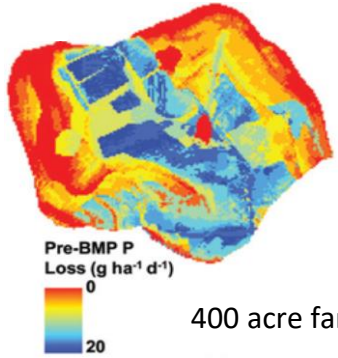




9,000 acre sub-watershed

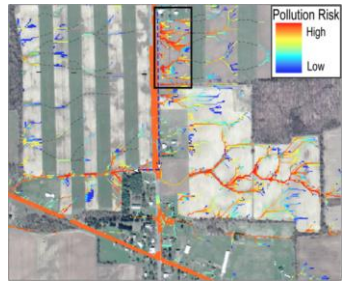
4 R's of Targeting

Right source
Right location
Right actors
Right treatment option



400 acre farm

25 acre parcel



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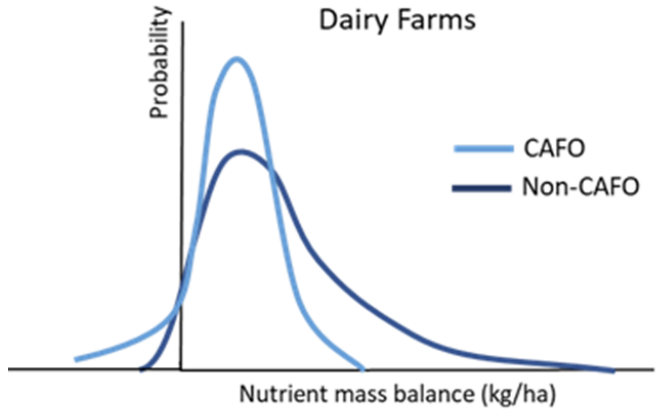
Nutrient loads also vary across land managers

Total Phosphorus Balance Across 58 Dairy Farms in Shenandoah Valley Virginia, 2018

Quartile	Total P balance (kg/ha)
Minimum	-30.9
1st Quartile	1.5
Median	12.4
3rd Quartile	18.7
Maximum	97.6



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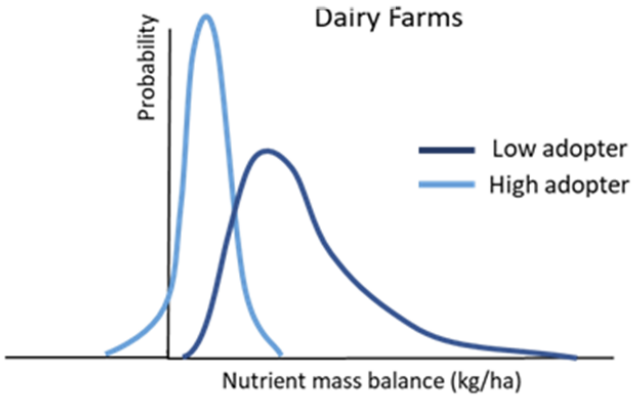
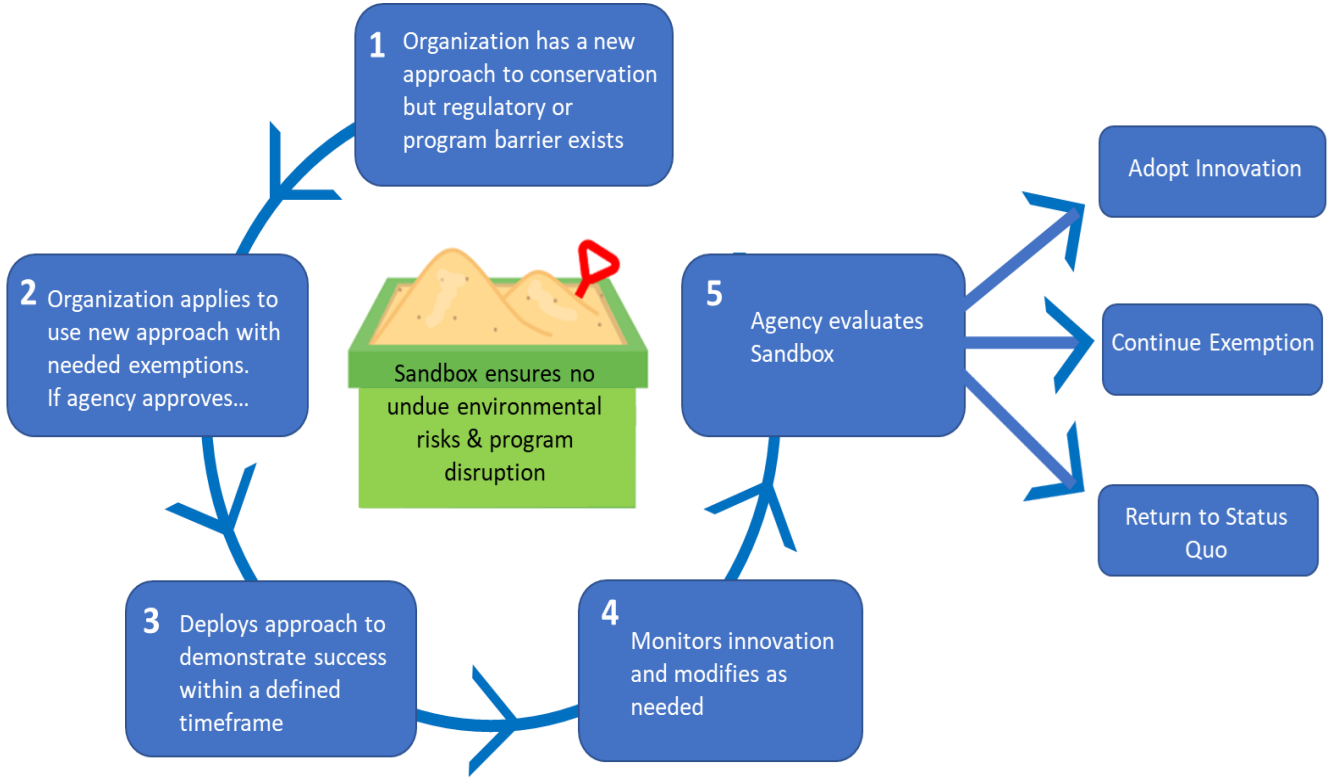


Pearce & Maguire 2020

What are examples of "sandboxing" innovations that you would like to see tested to improve ecosystem outcomes?



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

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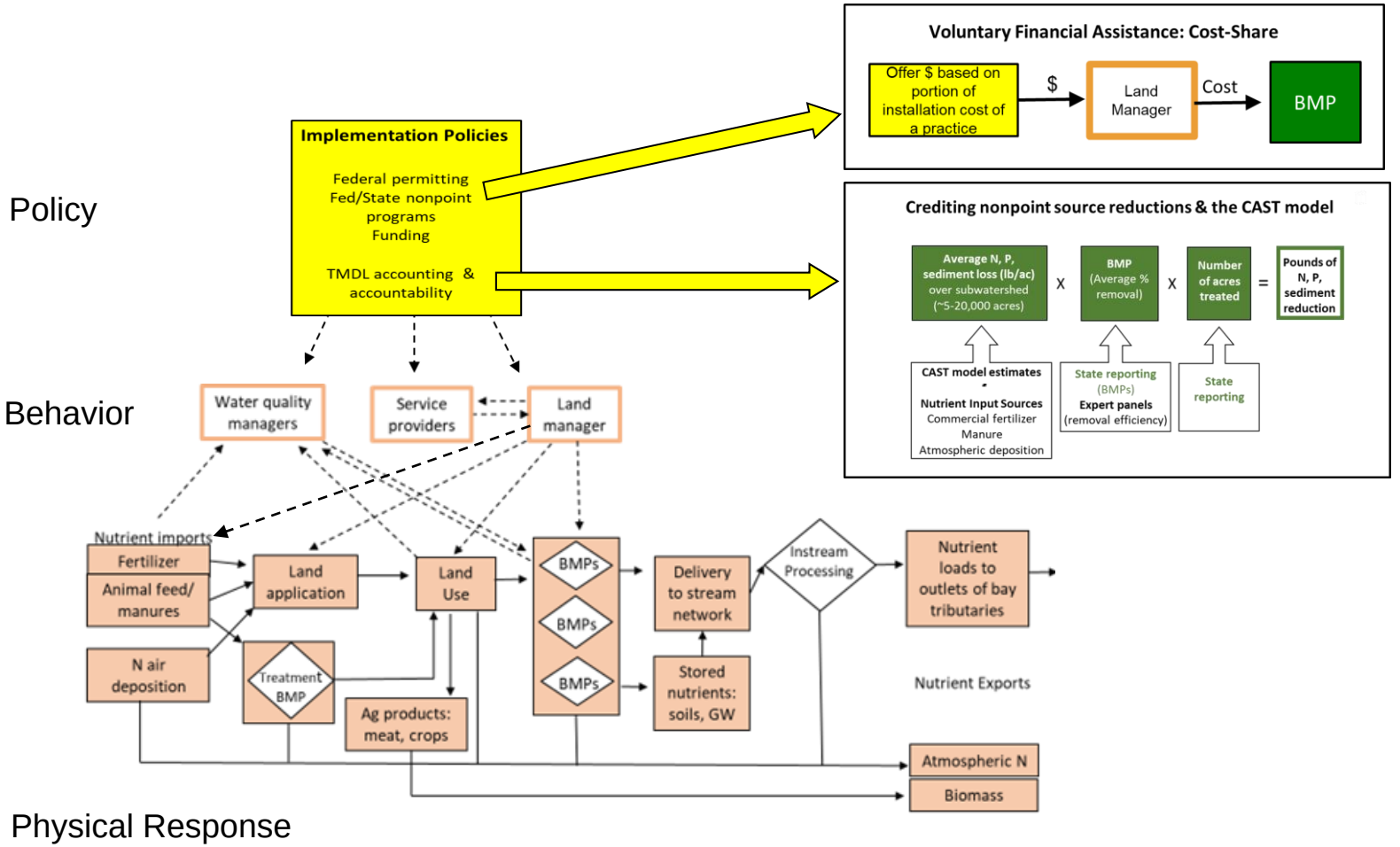
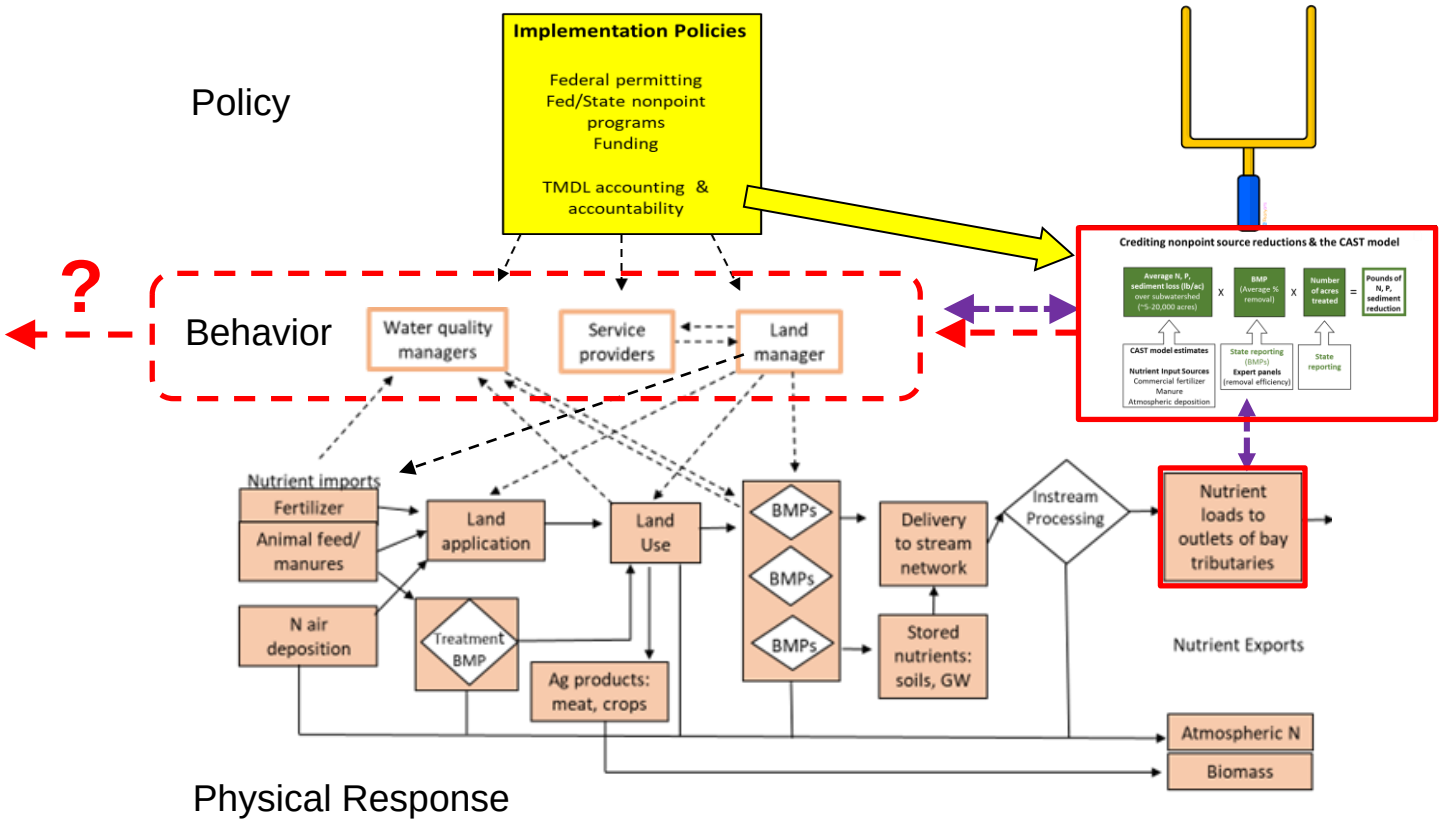


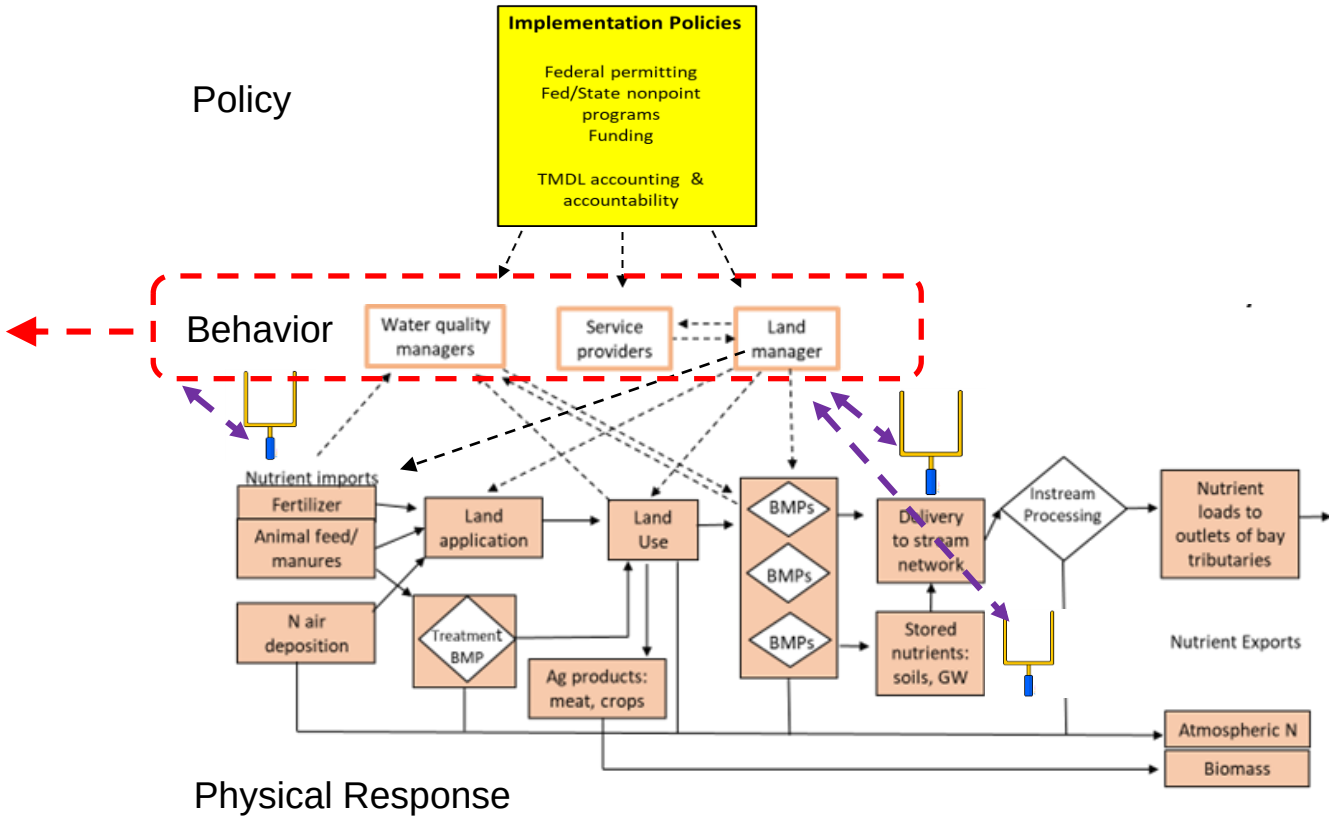
TMDL Accounting and Nonpoint Source Outcomes

Right source
Right location
Right actors
Right treatment option



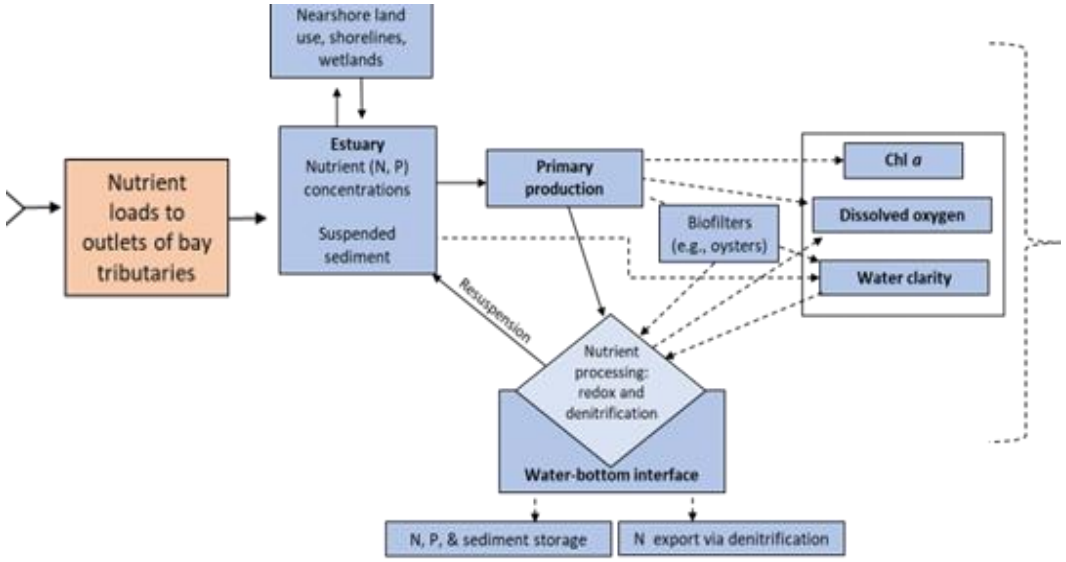
How would behavior and outcomes change with different TMDL “goal posts” (focused more on outcomes)?

Right source
Right location
Right actors
Right treatment option

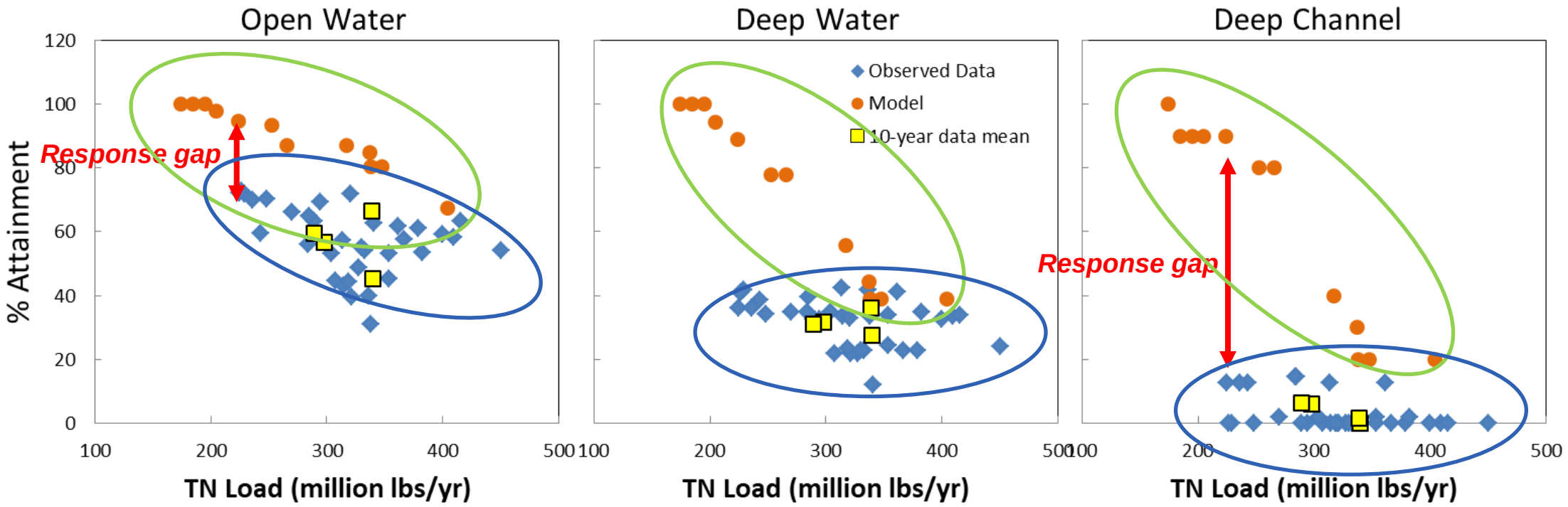


Achieving Water Quality Standards:

Findings: Bay water quality is improving, but the magnitude of the improvement appears to be lagging behind expectations



Finding: DO Response 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.

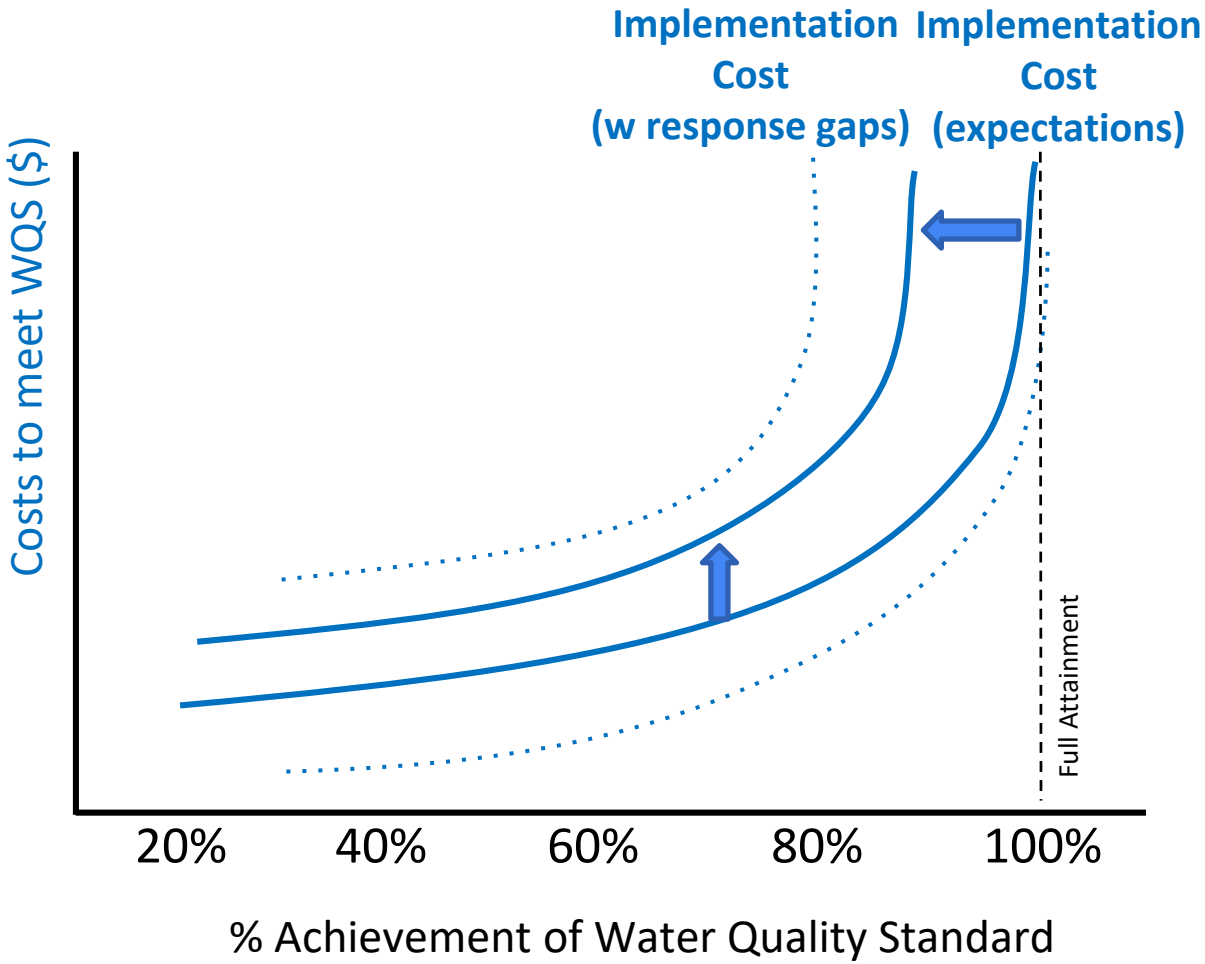
Why response gaps?

- Climate change/warming
- Tipping points
- Biotic communities
- Land use/land cover

Achieving Water Quality Standards:

Implications: Water Quality Criteria may be unattainable in some regions of the Bay under existing technologies.

Costs of Achieving TMDL and Water Quality Criteria



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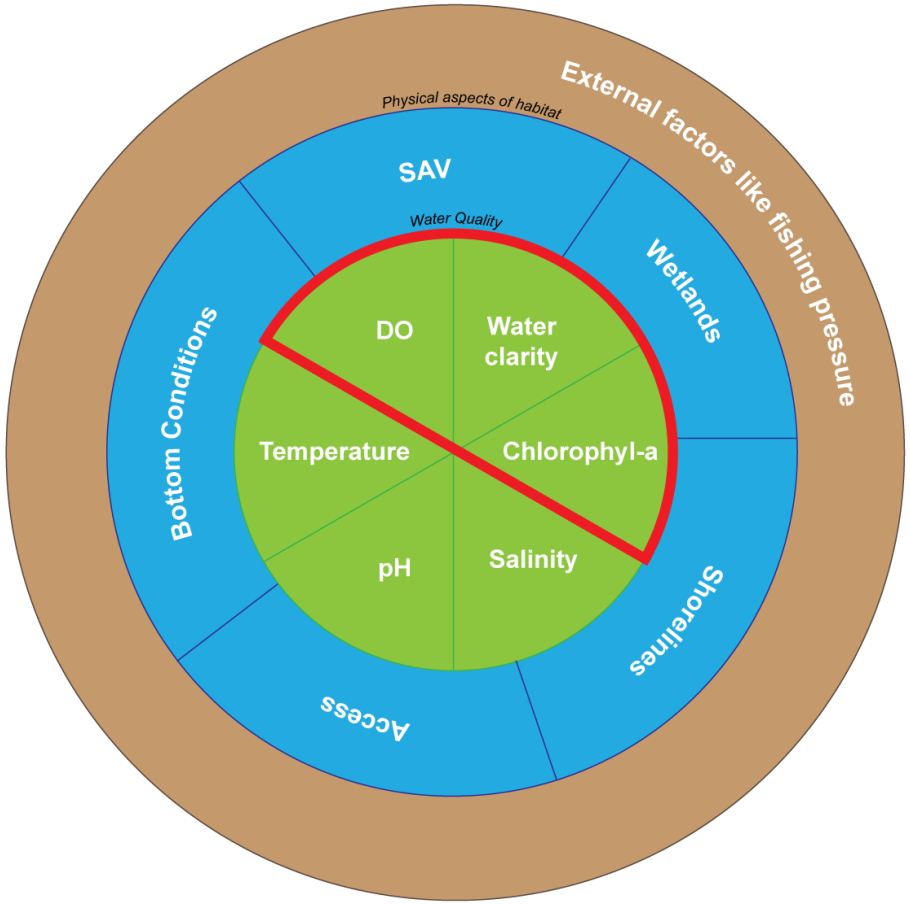
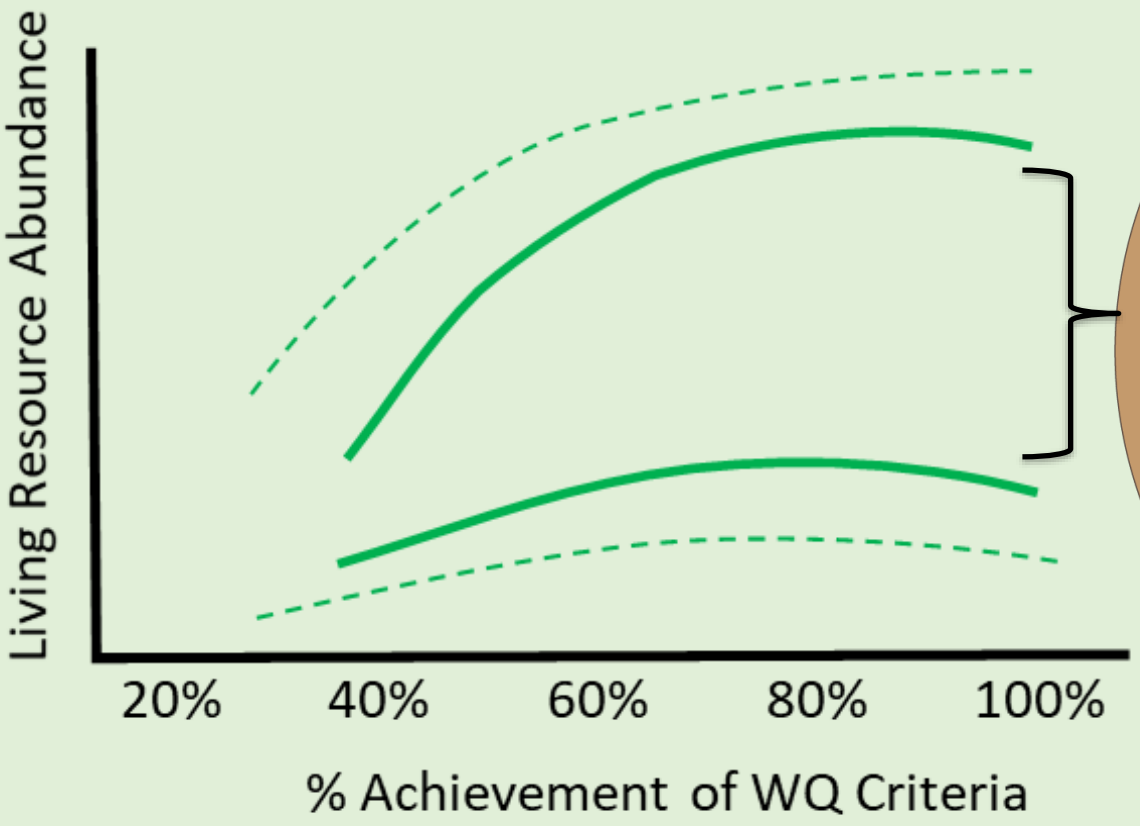
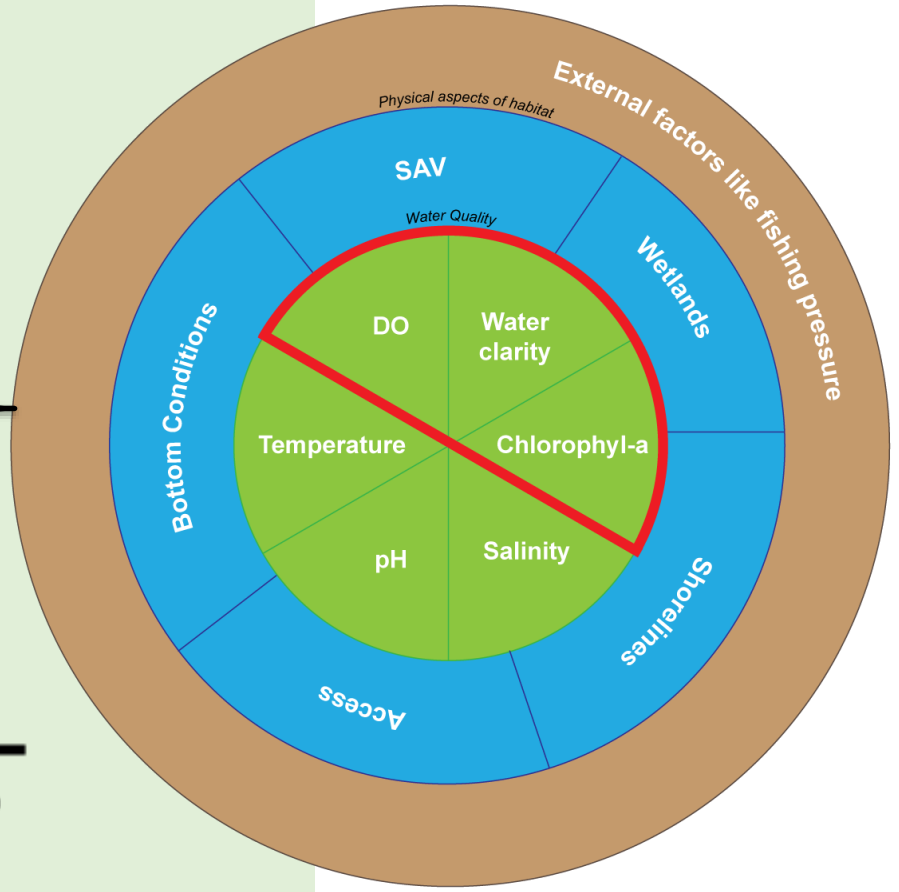


Managed by Bay water quality standards

Living Resource Response

Implications: Potential to increase the impact on living resources from our WQ and restoration investments





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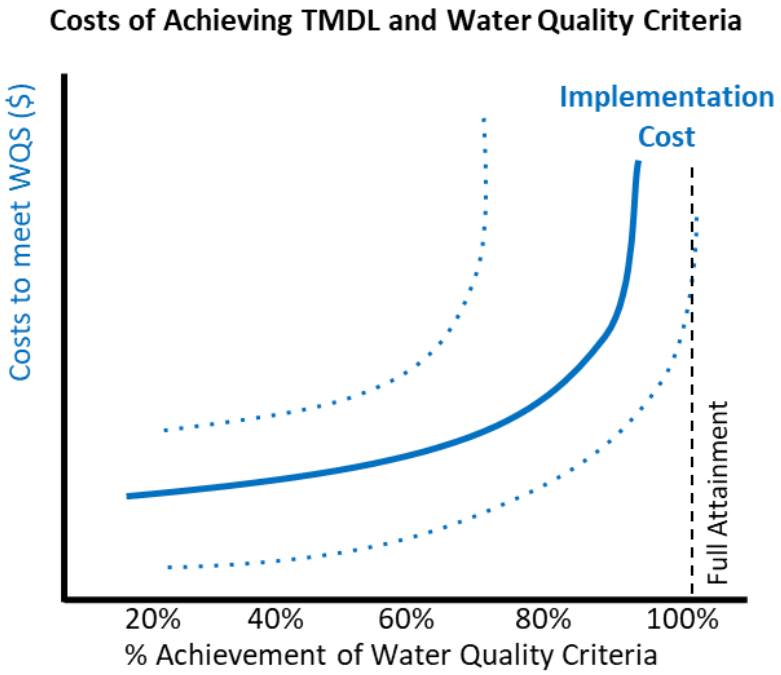

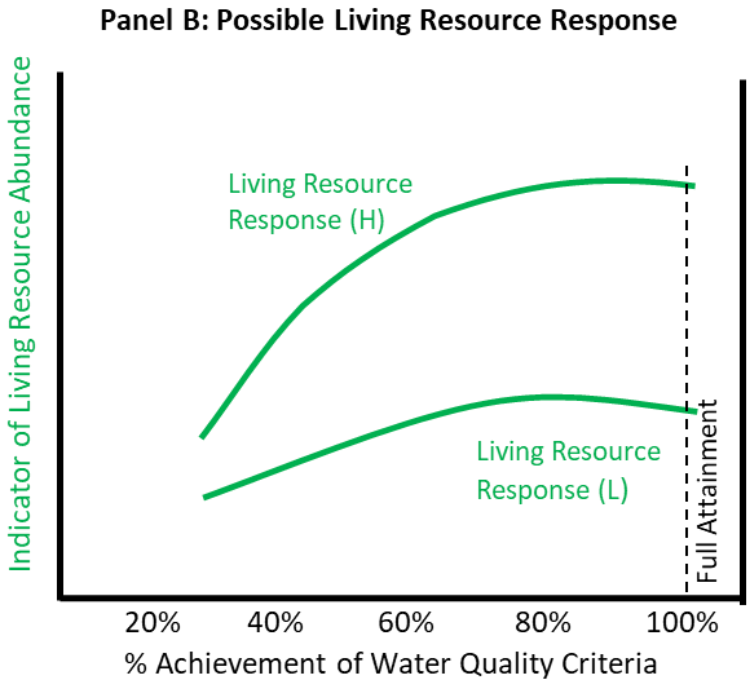

Implications for adaptive implementation