

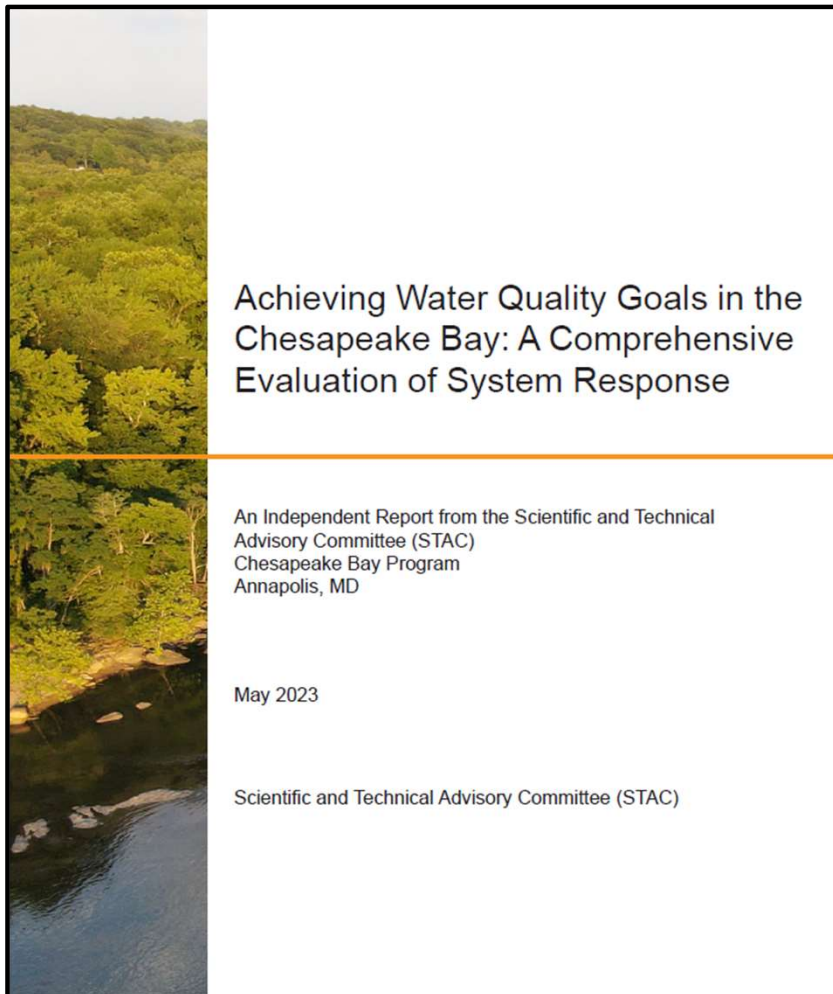
Achieving Water Quality Goals in the Chesapeake Bay: Comprehensive **E**valuation of **S**ystem **R**esponse (CESR)

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July 21, 2023

Presentation to Principals' Staff Committee





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

An Independent Report from the Scientific and Technical
Advisory Committee (STAC)
Chesapeake Bay Program
Annapolis, MD

May 2023

Scientific and Technical Advisory Committee (STAC)

CESR Report

- Self-initiated
- Inclusive of STAC Membership
- Multiple levels of internal and agency review
- Over 50 contributors with unanimous STAC inclusion
- Main report (Co-editors and Steering Committee) plus 3 “Resource Documents”

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

| | | |
|---|-------------------|------------------|
| 4 | Striped Bass: 5-6 | American Shad: 5 |
| 5 | White Perch: 5 | Yellow Perch: 5 |
| 4 | Hard Clams: 5 | Alewife: 3-6 |
| 3 | Crabs: 3 | Bay Anchovy: 3 |
| 2 | Spot: 2 | |
| 1 | Worms: 1 | |

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

Living Resource Response

How are living resources responding to changing water quality conditions?

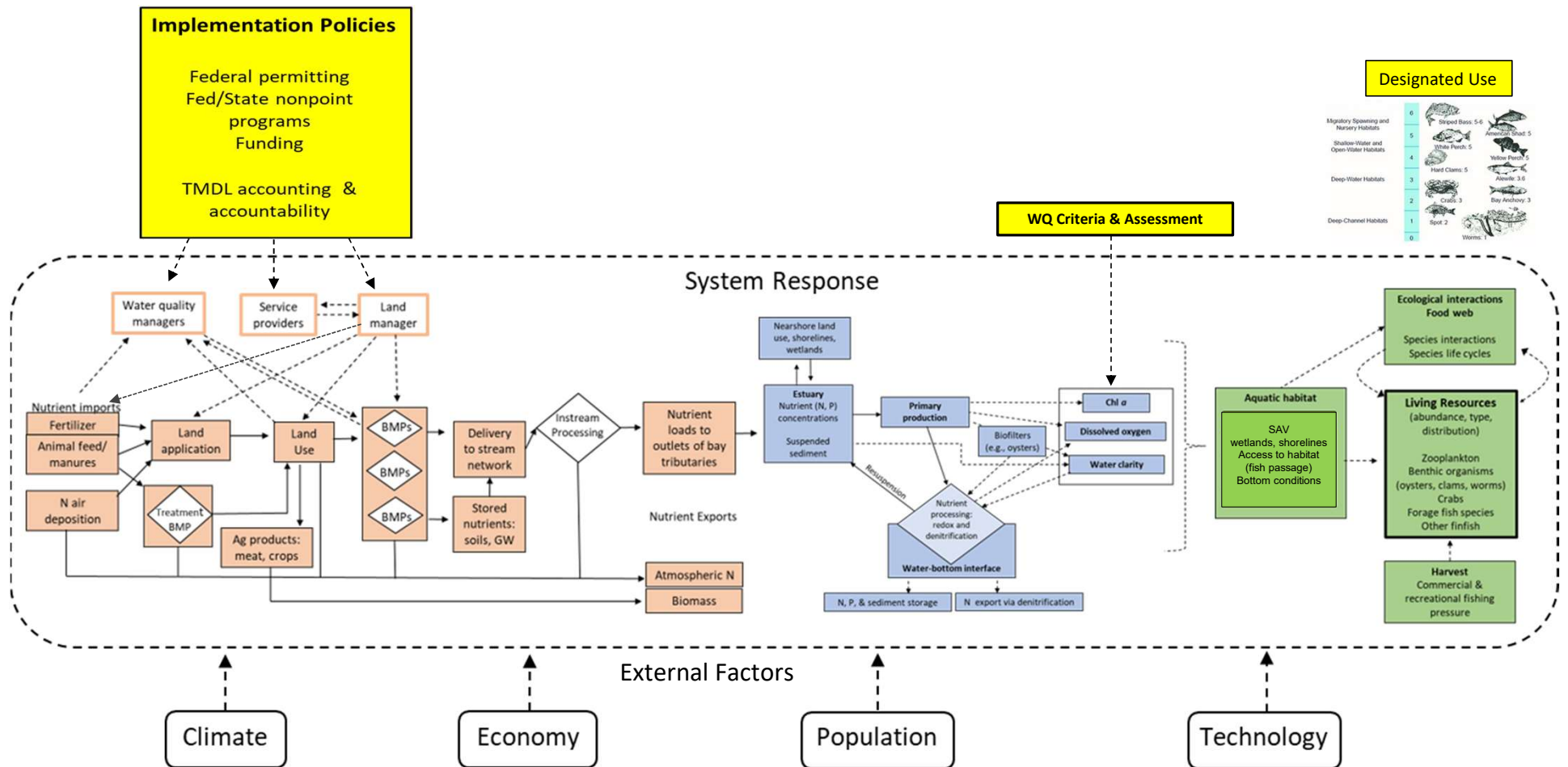
Achieving Water Quality Standards

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



Summary of CESR Findings and Implications

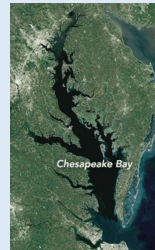
Living Resource Response



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 under existing technologies

Achieving TMDL



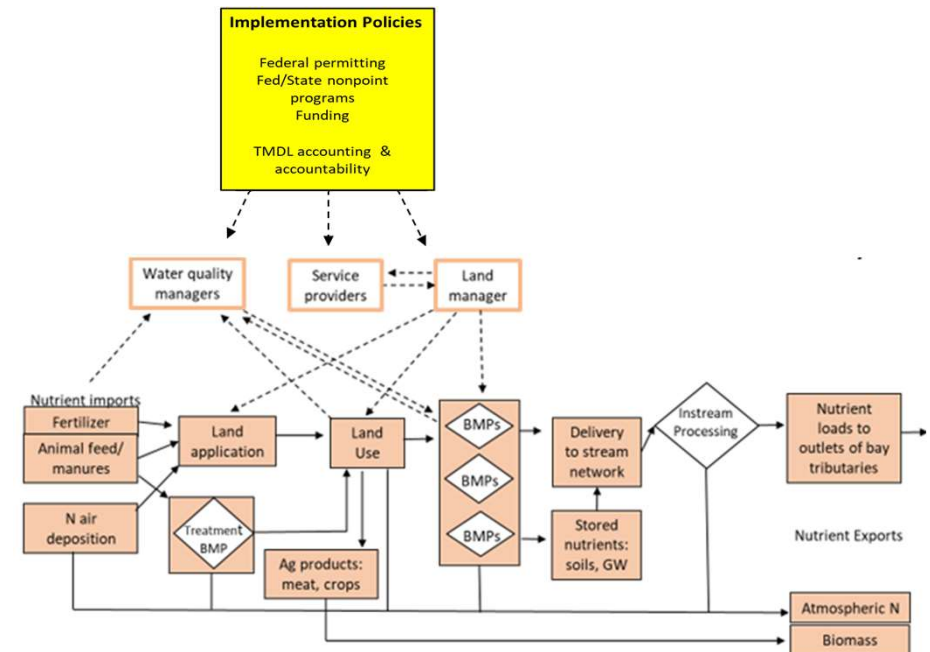
Finding: Nonpoint source programs are not generating the scale of reductions needed to achieve TMDL

Implication: Substantial improvement in nonpoint source outcomes will require new programs and approaches

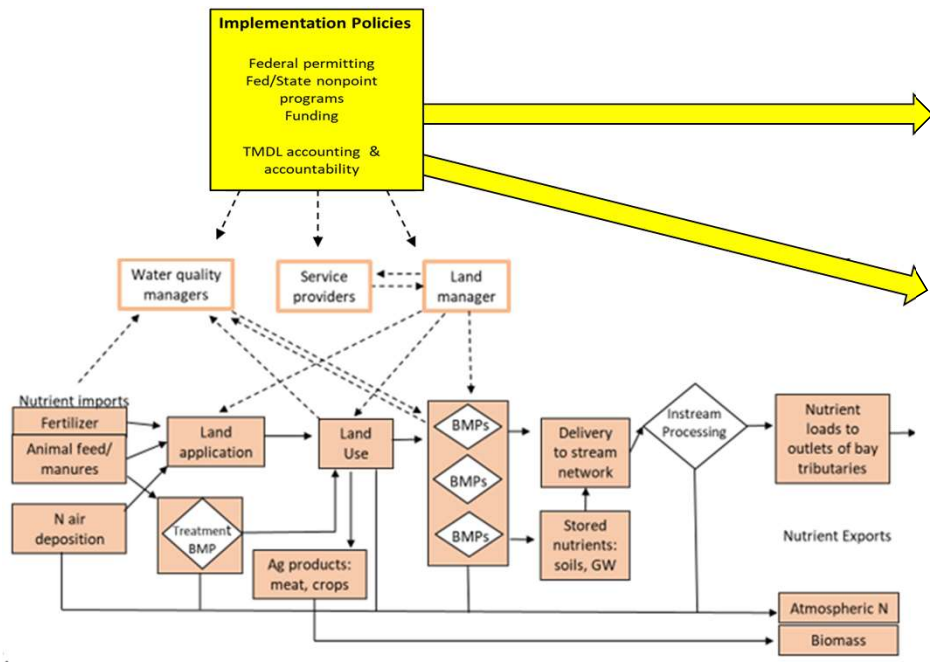
Overarching Finding: Challenging problem with tradeoffs, uncertain outcomes, and no single “silver bullet” answer

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

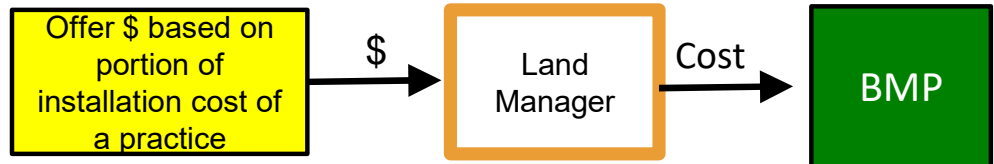
Achieving TMDL: Findings and Implications



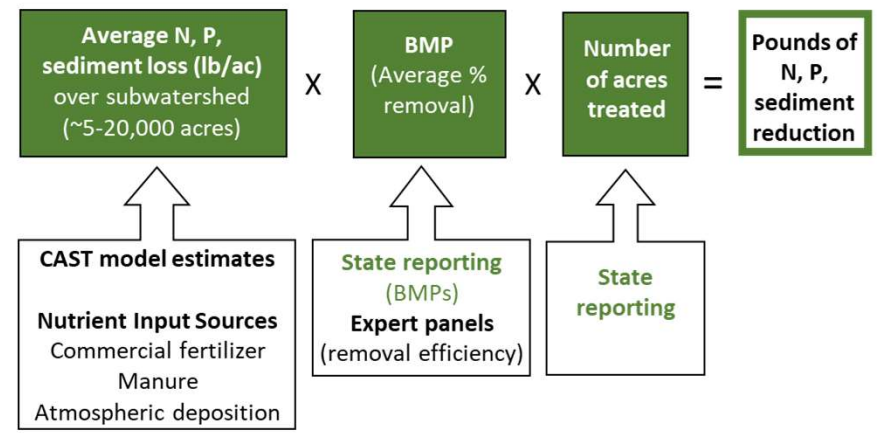
Nonpoint Source Implementation Policy



Voluntary Financial Assistance: Cost-Share



Crediting nonpoint source reductions & the CAST model



Finding:

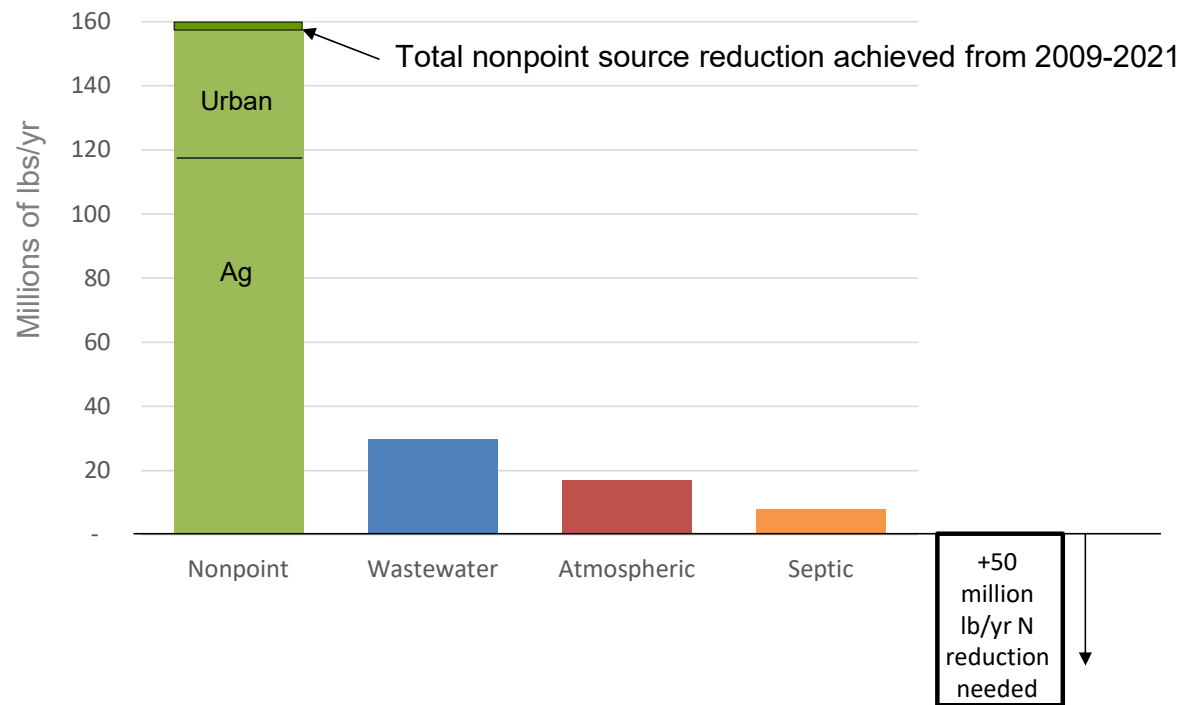
Nonpoint source programs are not generating the scale of reductions needed to achieve TMDL

Two Challenges

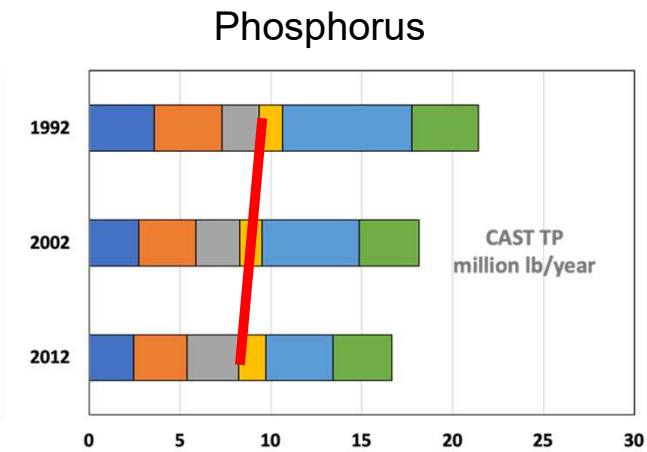
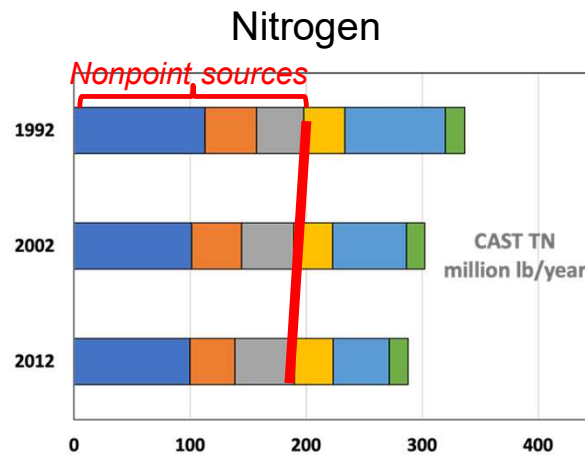
- 1) Nonpoint source programs are not generating sufficient levels of adoption/behavior change
- 2) The actions/practices being implemented may not be as effective as expected in producing pollutant reductions

Nonpoint source programs are not generating a sufficient level of implementation

Controllable N Loads to the Chesapeake Bay, 2021
(estimated by CAST Model)



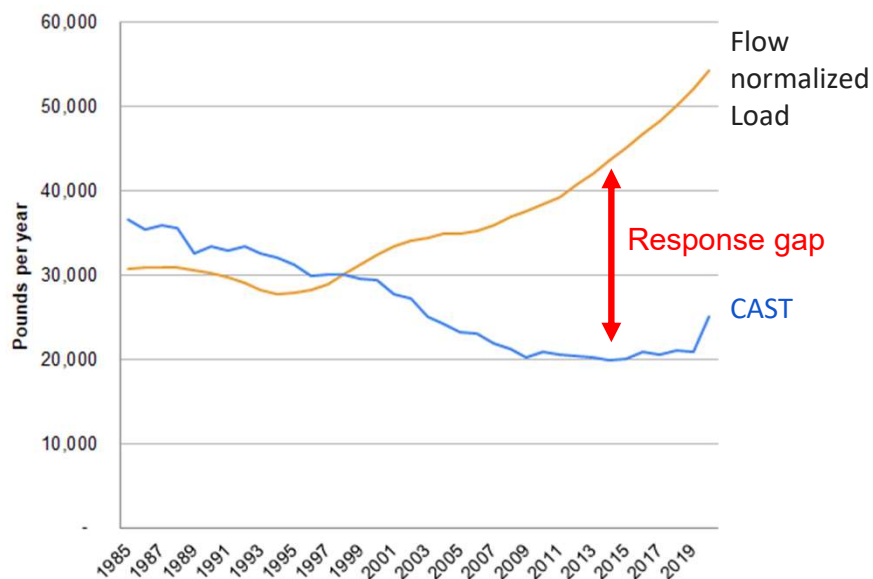
Nonpoint source programs may not be as effective as expected



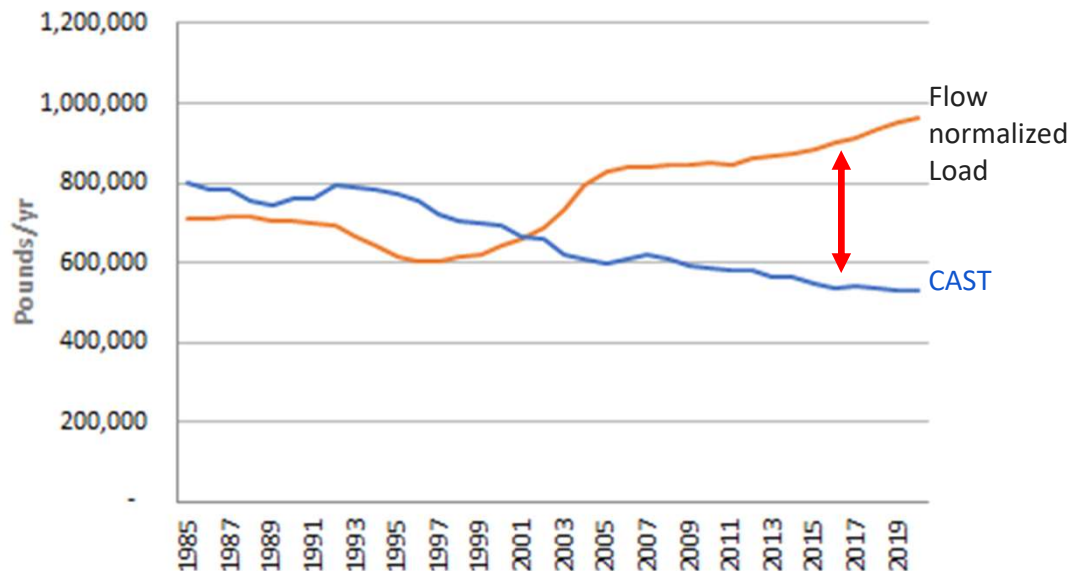
Estimated flow-normalized total and source sector TN and TP fluxes to the Chesapeake Bay for the CAST and SPARROW models Ator et al. 2020

Difference between expected and observed outcomes

Total Phosphorus Loads, Choptank



Total Phosphorus Loads, Rappahannock



Implications:

To substantially improve nonpoint source outcomes will require new programs and approaches

Ideas to improve nonpoint source program effectiveness

Incentivize Outcomes



Cover crops



Livestock Exclusion Fencing



Denitrifying Bioreactor

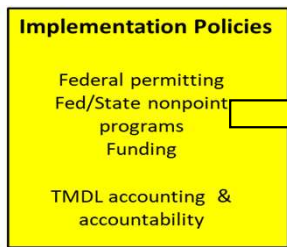
Low upfront installation costs
Private benefits

High up front installation costs
No private benefits

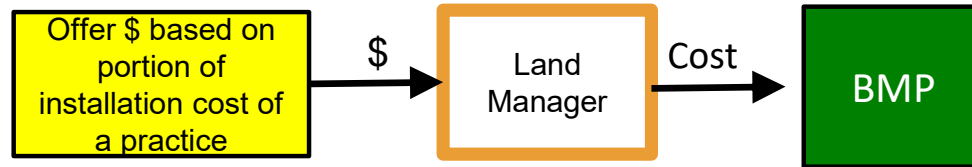
Under voluntary cost-share programs, adoption rates fall from left to right

Which is the most cost-effective (\$/lb) at reducing pollutants?
Which practice provides most assurances of delivering reductions?

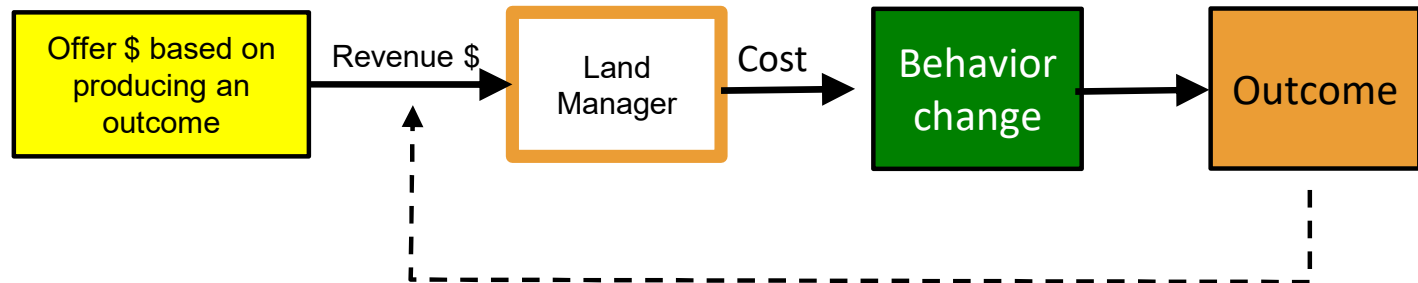
Incentive Programs



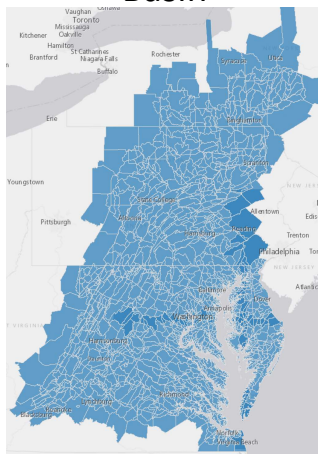
Voluntary Financial Assistance: Cost-Share



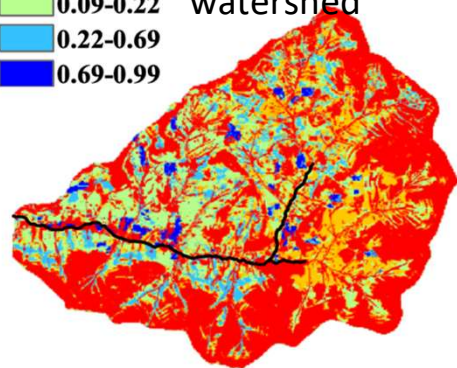
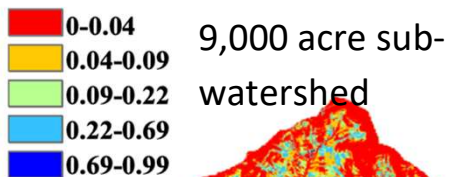
Payment for outcomes/success



Basin



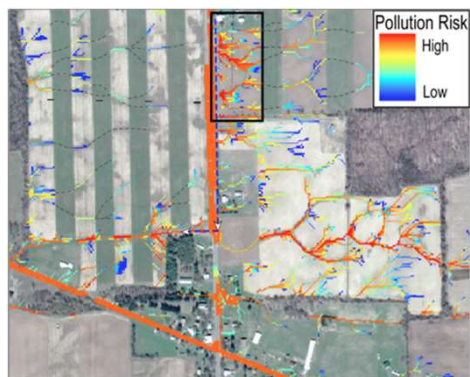
Dissolved P (kg ha⁻¹)



Improve tools and incentives for targeting

Nutrient loads are highly variable across the landscape across multiple scales and across land managers).

25 acre parcel



Total phosphorus balance across 58 dairy farms in Shenandoah Valley Virginia, 2018

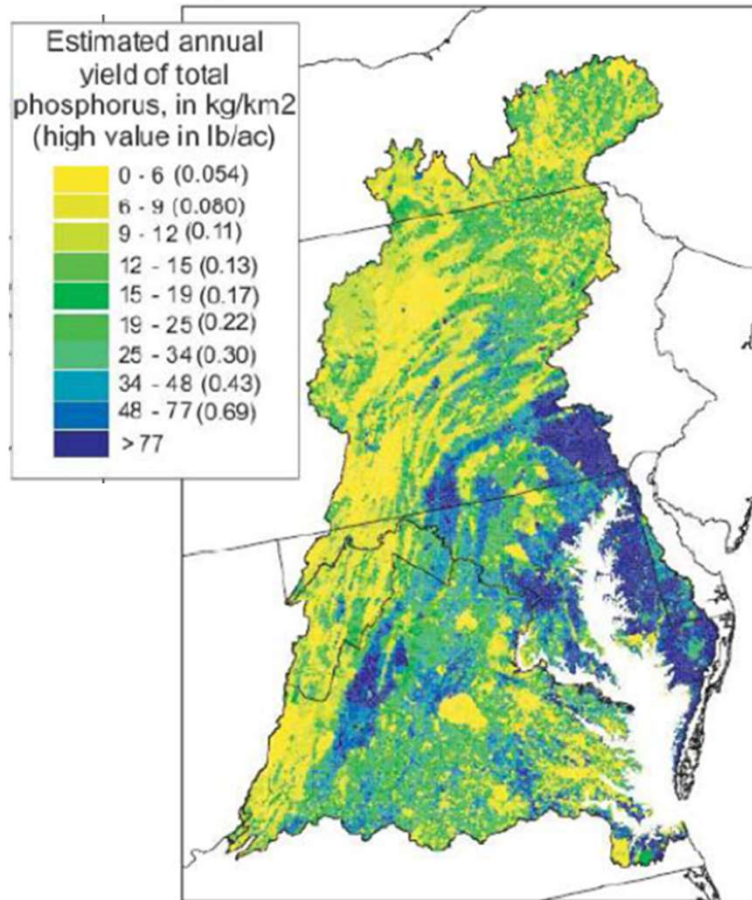
| Quartile | Total P balance (kg/ha) |
|--------------|-------------------------|
| Minimum | -30.9 |
| 1st Quartile | 1.5 |
| Median | 12.4 |
| 3rd Quartile | 18.7 |
| Maximum | 97.6 |

(Source: Pearce & Maguire 2020)

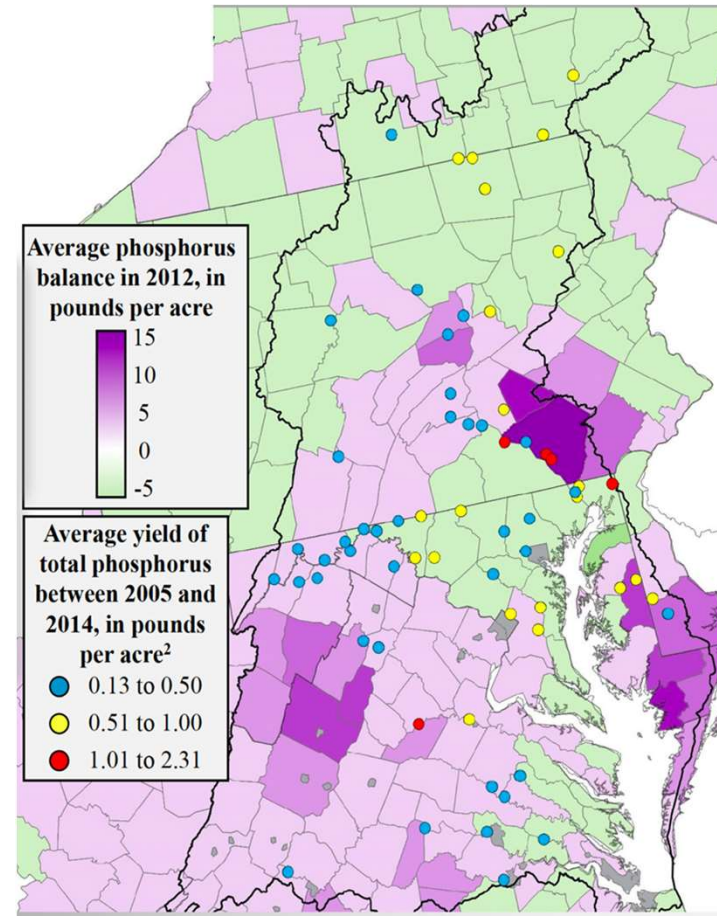
Our accounting and incentive systems only provide limited opportunity to target.

Improve efforts to address mass balance

b) Delivered



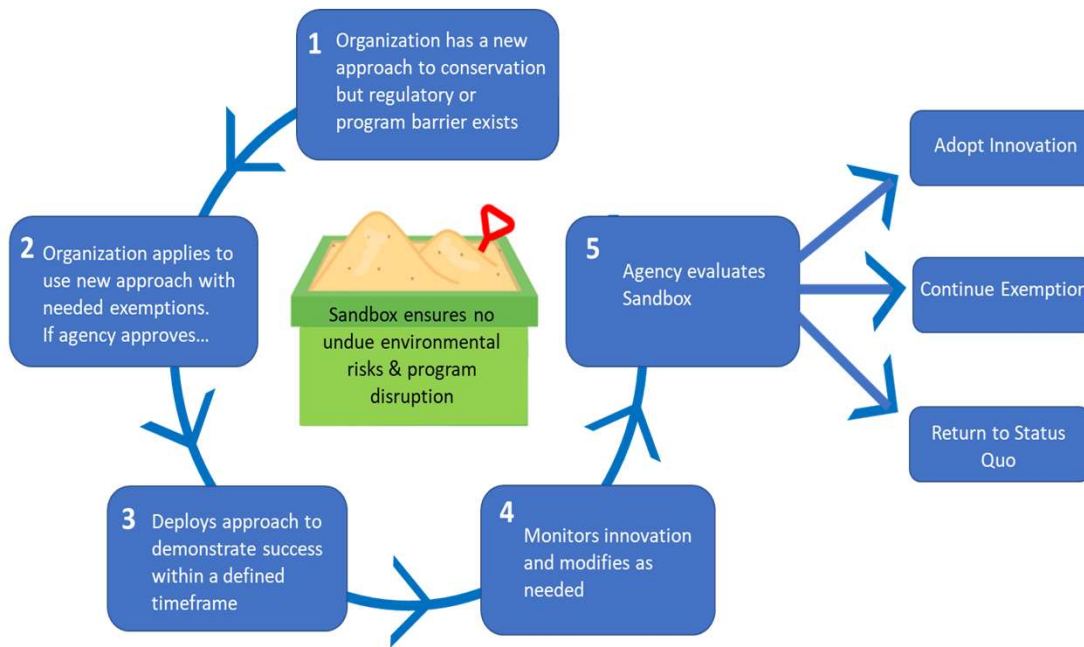
Source: USGS Sparrow Model Output



Moyer et al. 2017, Webber, 2017

Encourage Institutional/policy Innovation

Sandboxing



Ideas for what to “Sandbox”

TMDL accounting & accountability (alternative to CAST)

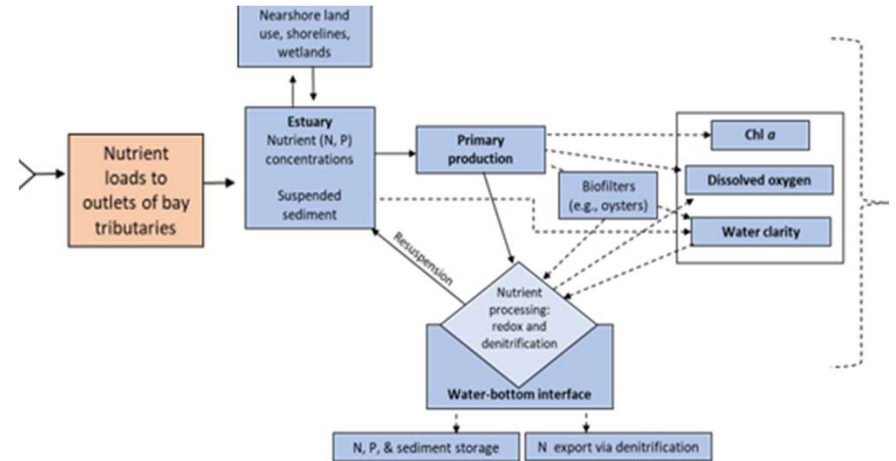
Types of outcome-based incentive programs

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

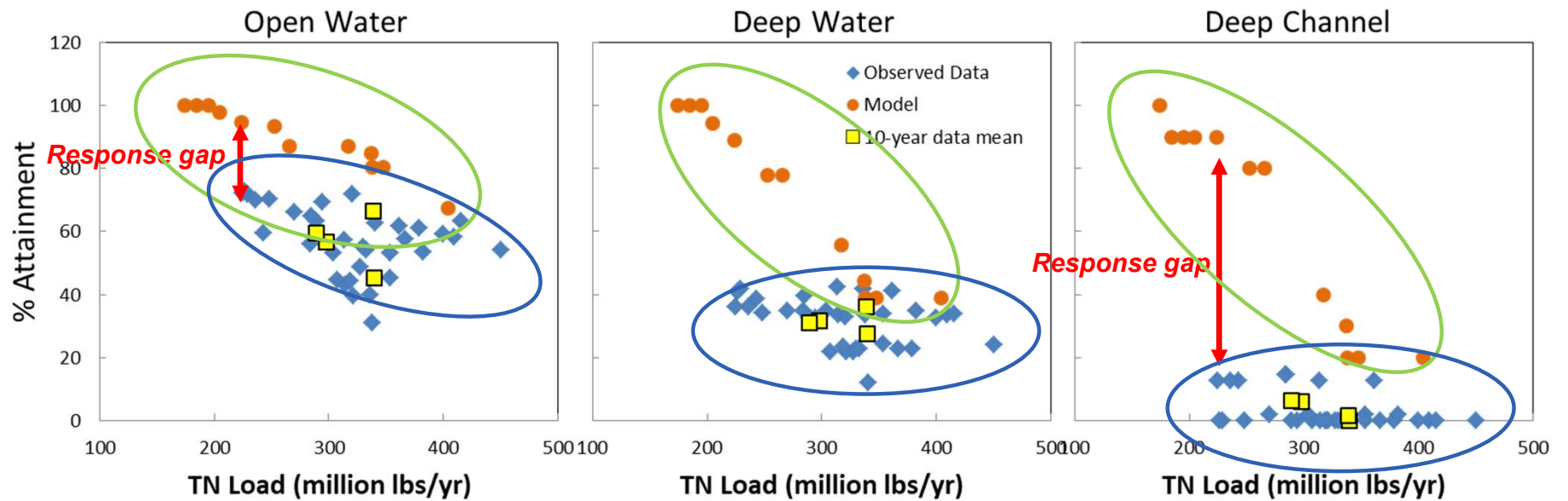
Achieving Water Quality Standards:



Finding: 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?

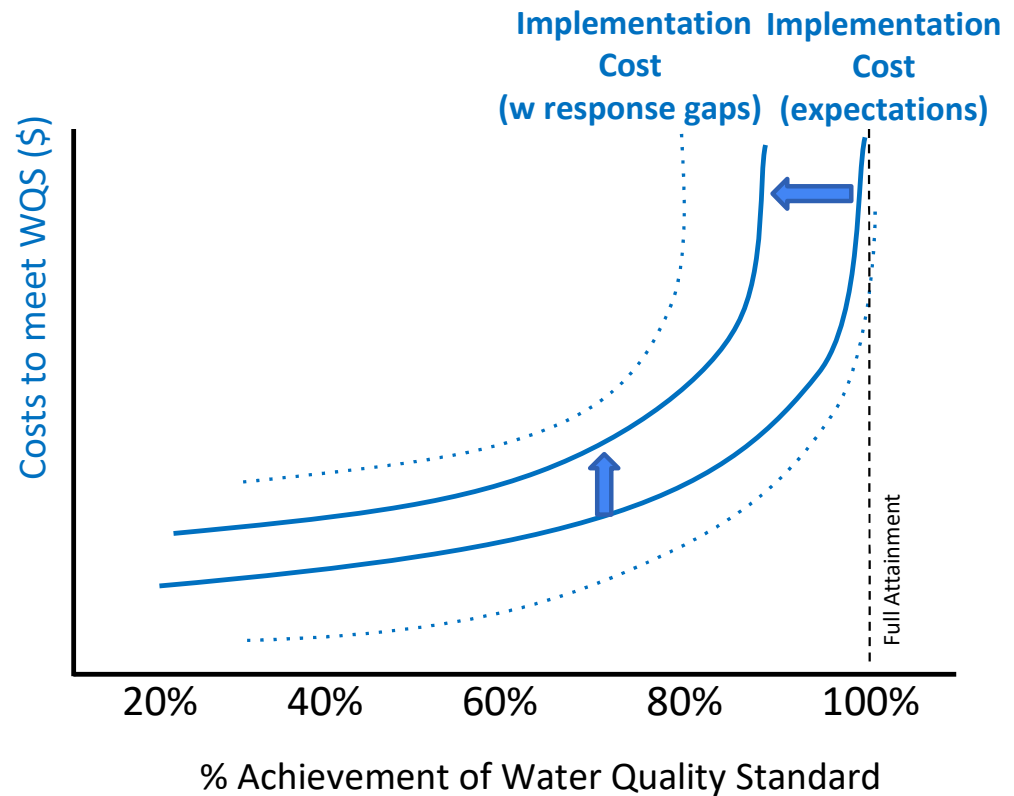
- Climate change (ex. warming waters)
- “Tipping points”

Achieving Water Quality Standards:

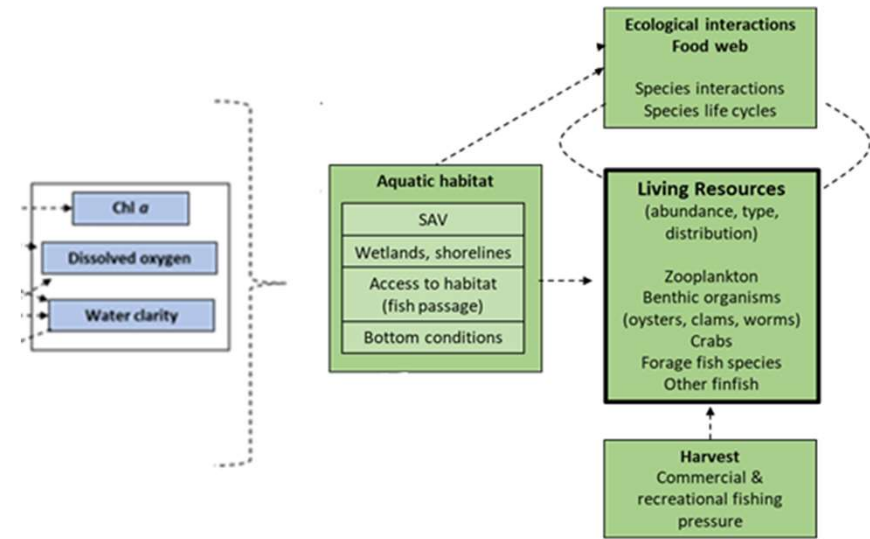


Implication: Water quality criteria may be unattainable in some regions of the bay under existing technology

Costs of Achieving TMDL and Water Quality Criteria



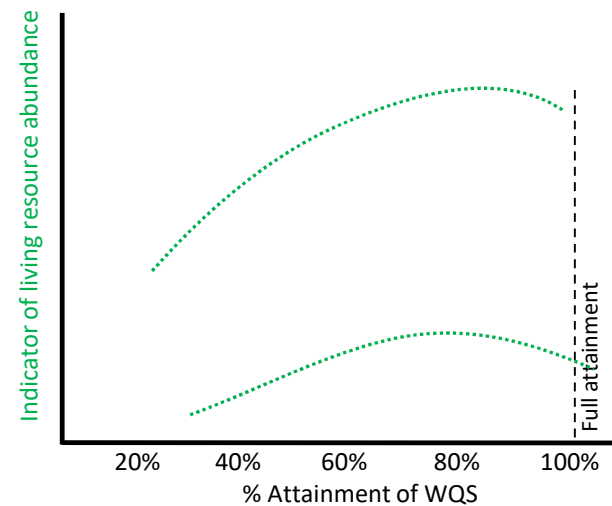
Living Resource Response



Living Resource Response

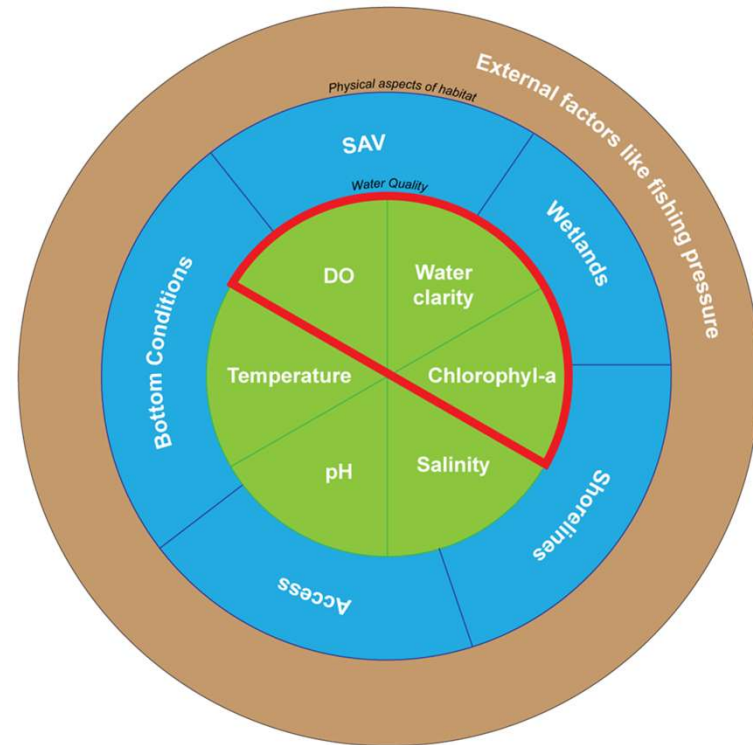
Finding: The impact of WQ improvements on living resources depends on where WQ improvements occur and antecedent conditions; impact varies across species.

Living resource response to attainment of water quality standards



Living Resource Response

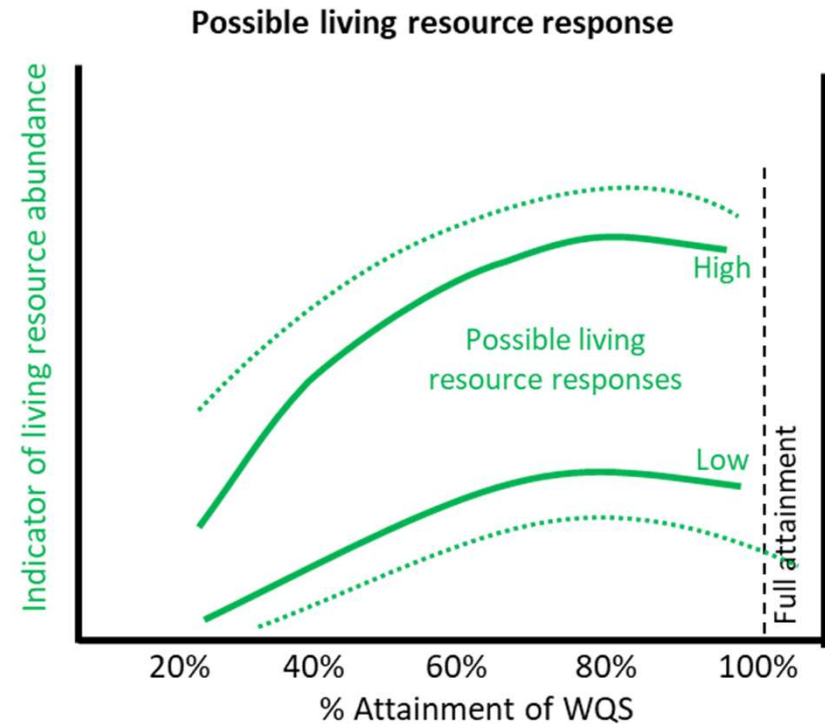
Findings: The impact of WQ improvements on living resources depends on where WQ improvements occurs, antecedent conditions, & impact varies across species.



Managed by Bay water quality standards

Living Resource Response

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

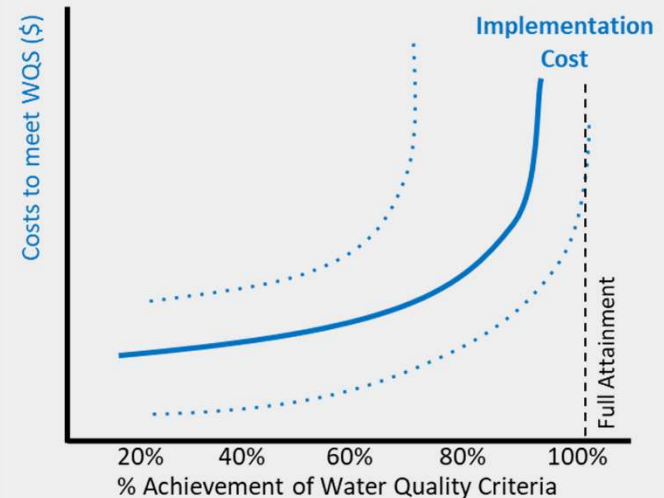


Implications

Tradeoffs & Uncertainties

Full attainment may not be necessary to improve and support living resources goals

Costs of Achieving TMDL and Water Quality Criteria



Panel B: Possible Living Resource Response

