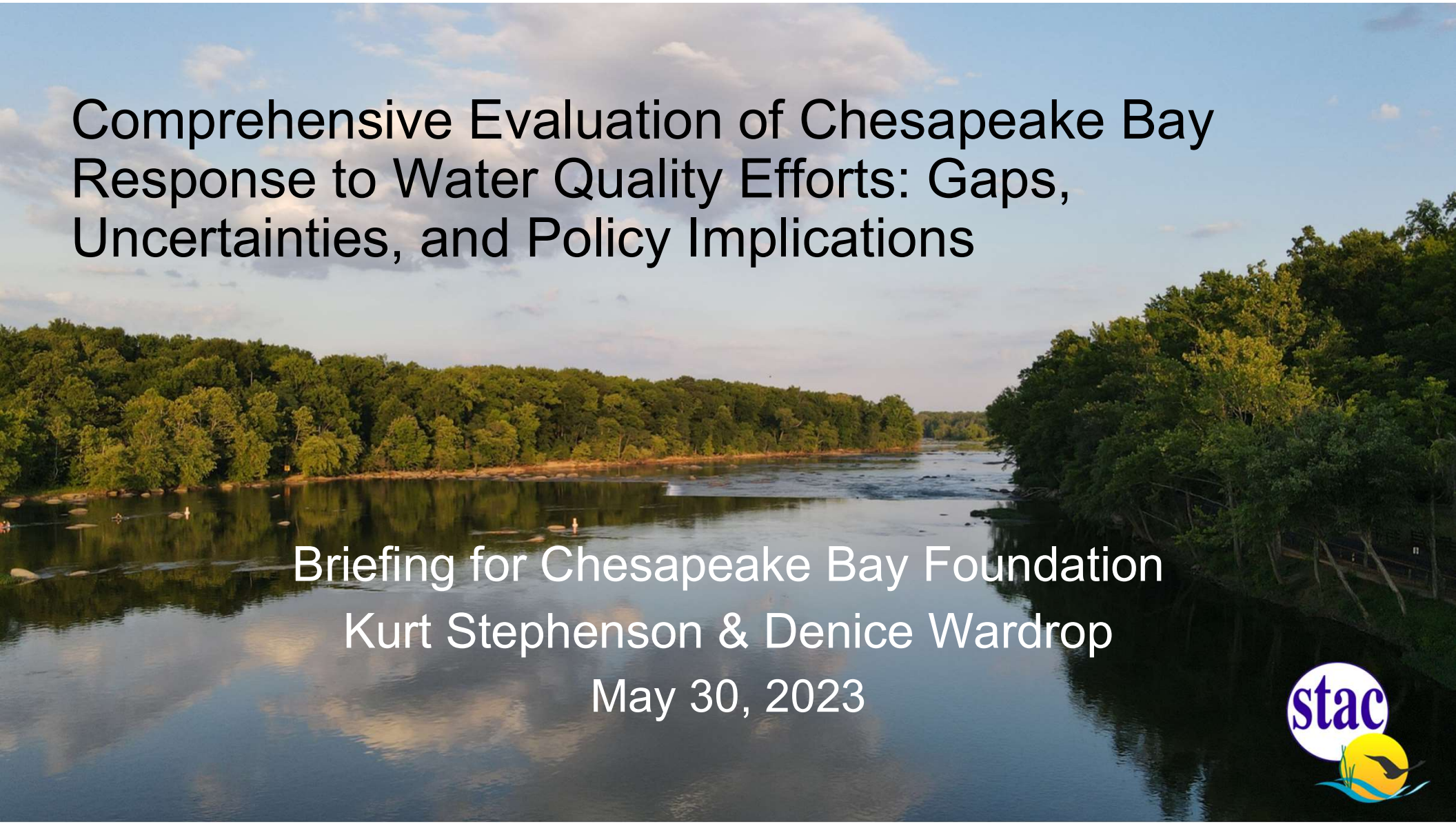


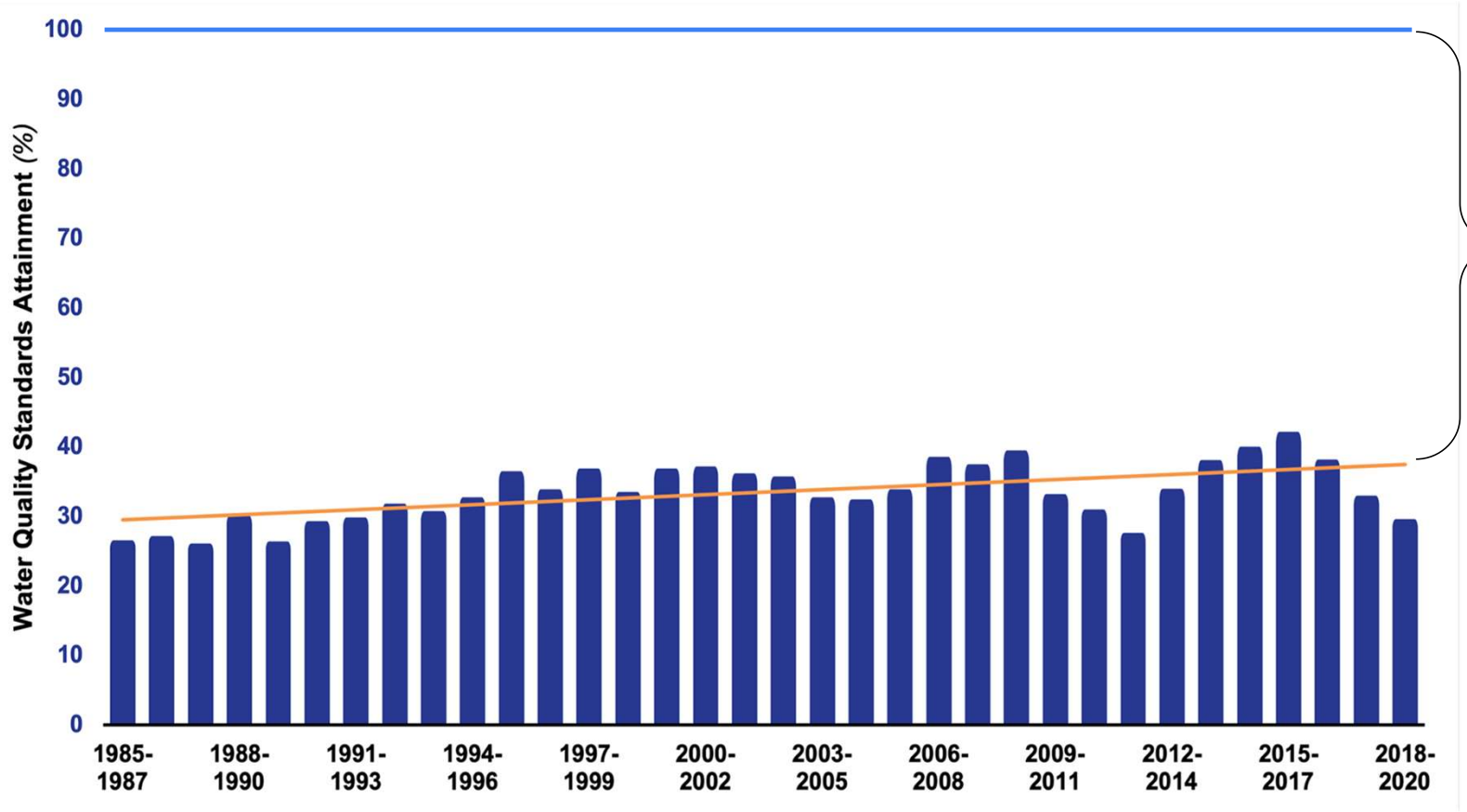
# Comprehensive Evaluation of Chesapeake Bay Response to Water Quality Efforts: Gaps, Uncertainties, and Policy Implications

Briefing for Chesapeake Bay Foundation

Kurt Stephenson & Denice Wardrop

May 30, 2023

# Achieving Bay Water Quality Standards

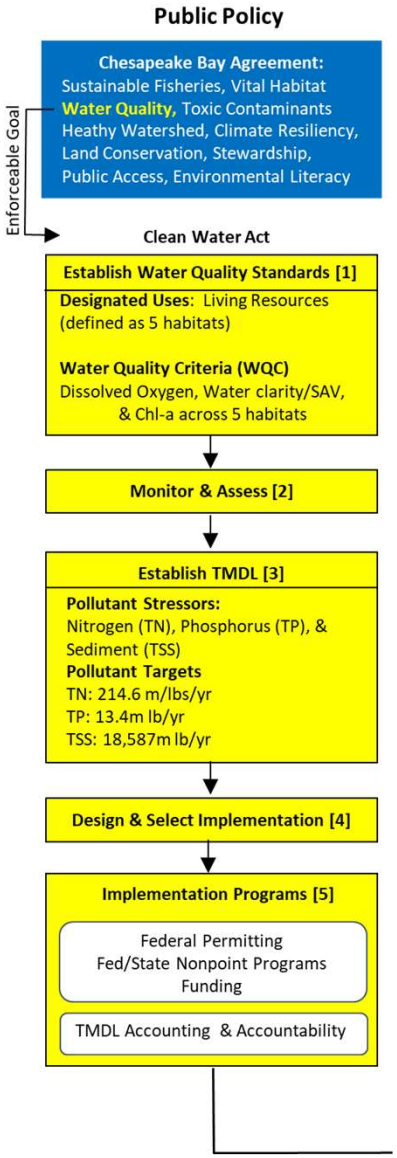


# CESR Conclusions

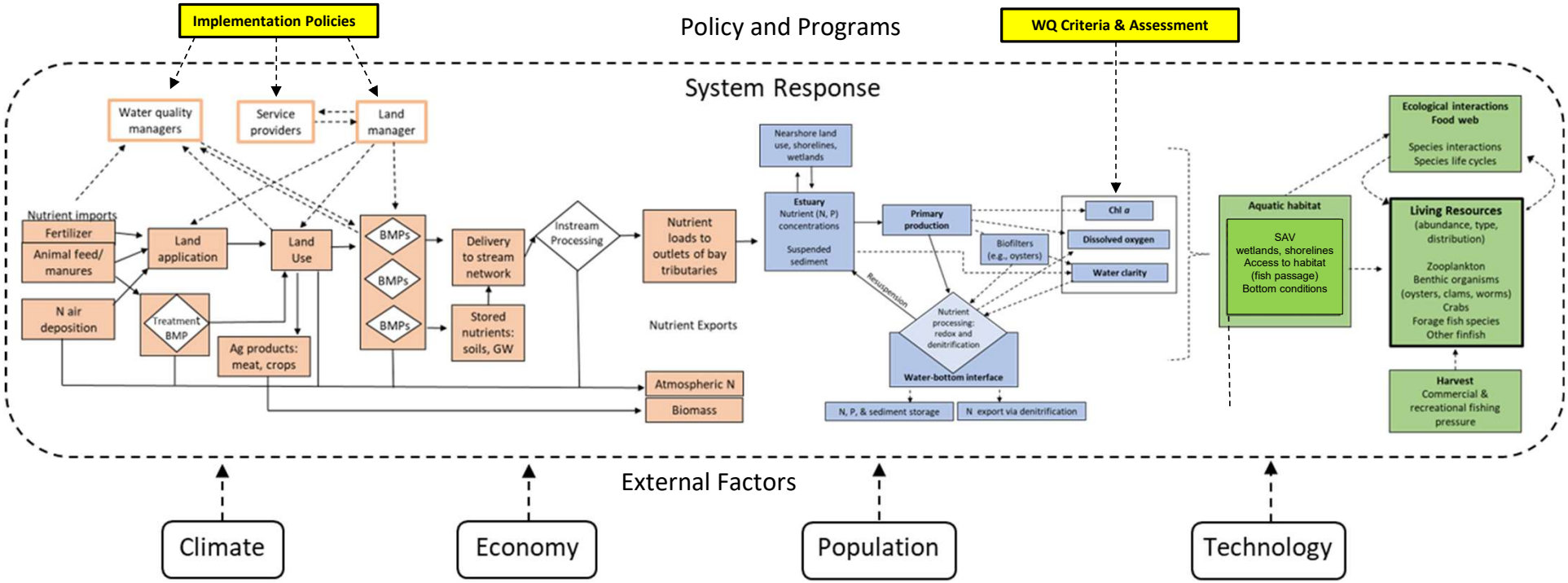
Gaps in implementation and system response present major challenges to achieving water quality goals & improving living resource response.

Opportunities to improve program effectiveness exist but require programmatic change (not simply doing more of the same).

# Water Quality Policy and System Response

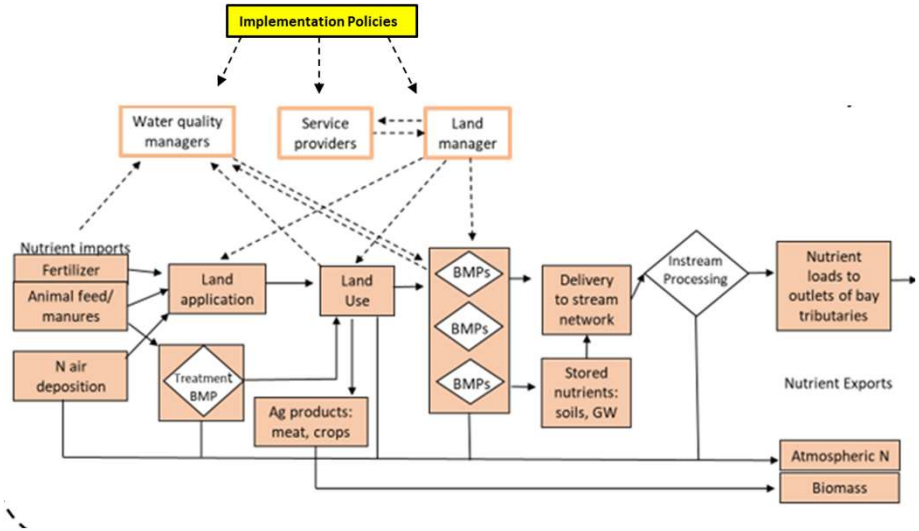


# System Response to Meeting Bay Water Quality Standards

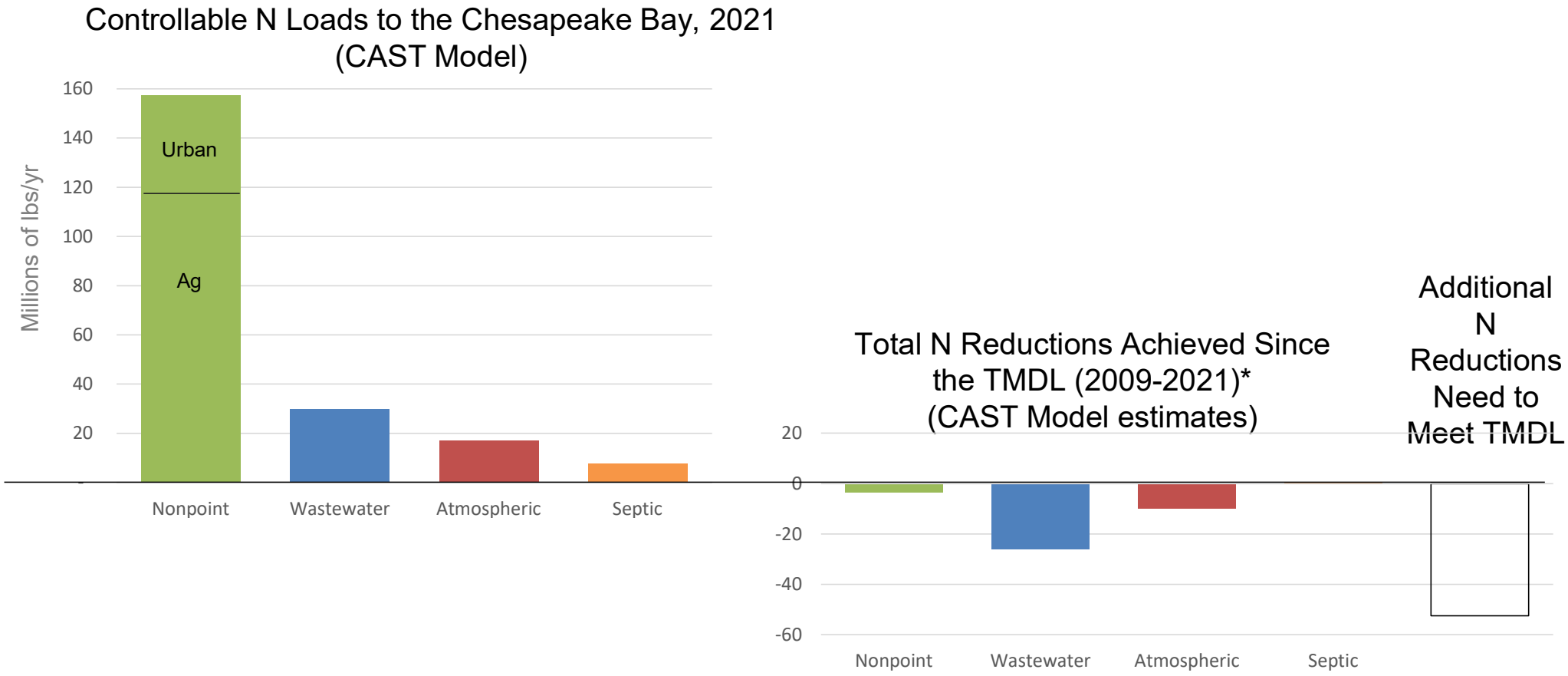


# Findings:

## Pollutant Response to Management Efforts



# Are nonpoint source programs generating enough adoption/change ("implementation gap")?

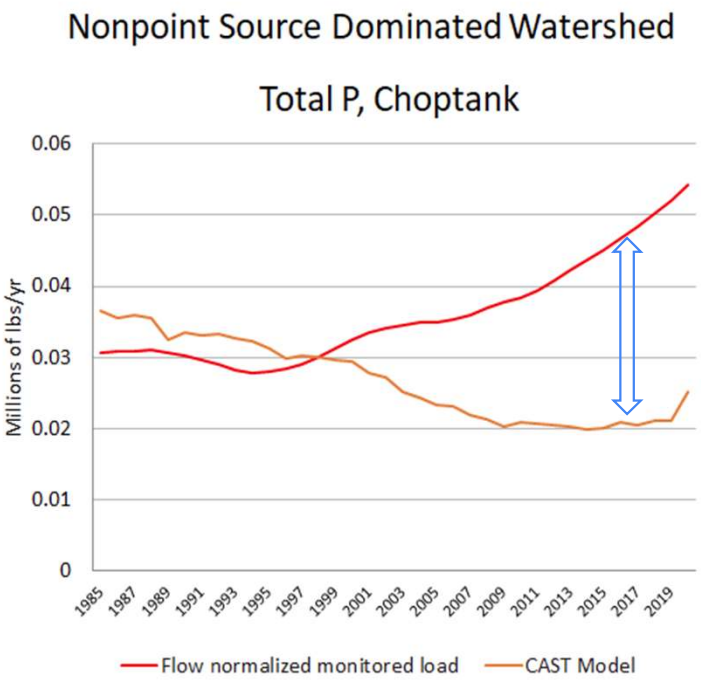


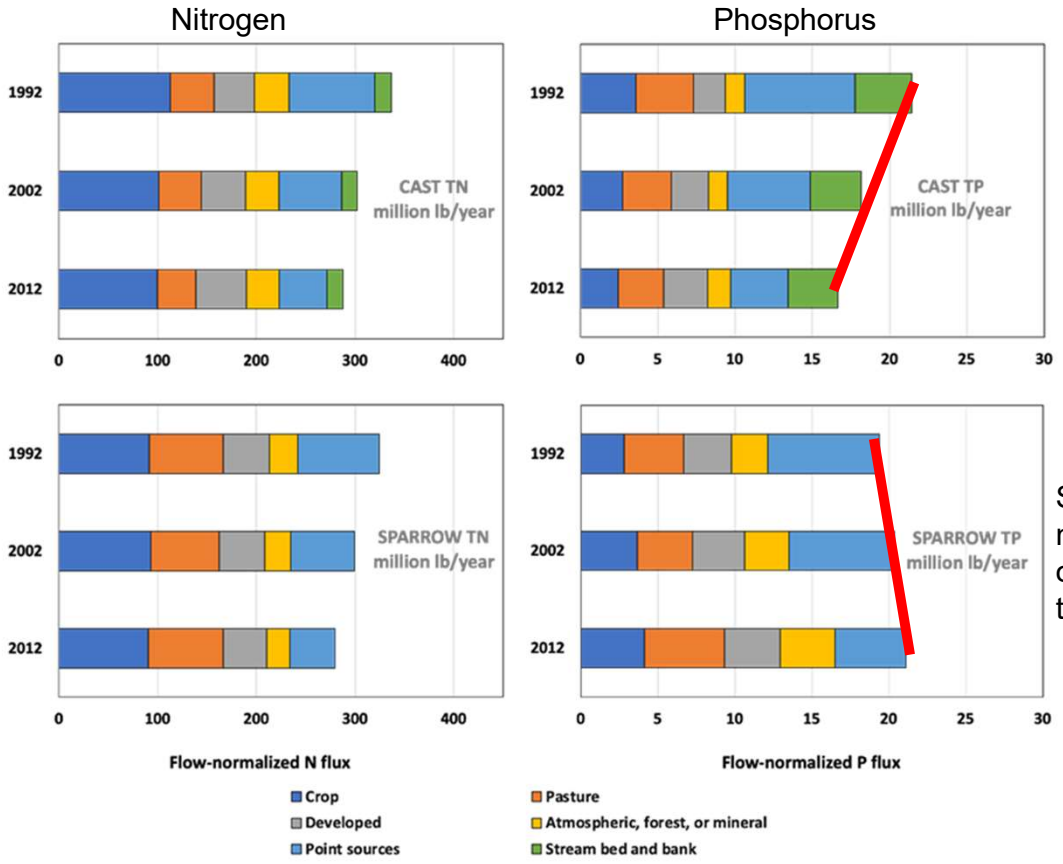
# Are nonpoint programs as effective as predicted ("response gap")?

"Current research suggests that the estimated effects of conservation practices have not been linked to water-quality improvements in most streams"

Keisman, J., et al. 2018. Integrating Recent Findings to Explain Water-Quality Change: Support for the Mid-Point Assessment and Beyond. STAC Publication Number 18-005, Edgewater, MD. 27 pp.

# Are nonpoint programs as effective as predicted (“response gap”)?




CAST Model Predictions

Statistical model of observed trends

Ator, et al., 2020

# Why Implementation/ Response Gaps?

- Lag times/Legacy sources
- Behavior/Implementation (who, what, where)
- BMP Effectiveness
- Nutrient Mass Imbalances
- Data/Monitoring Limitations

# Implementation Gap
# Limits to Adoption (practice-based cost share)

Cover crops

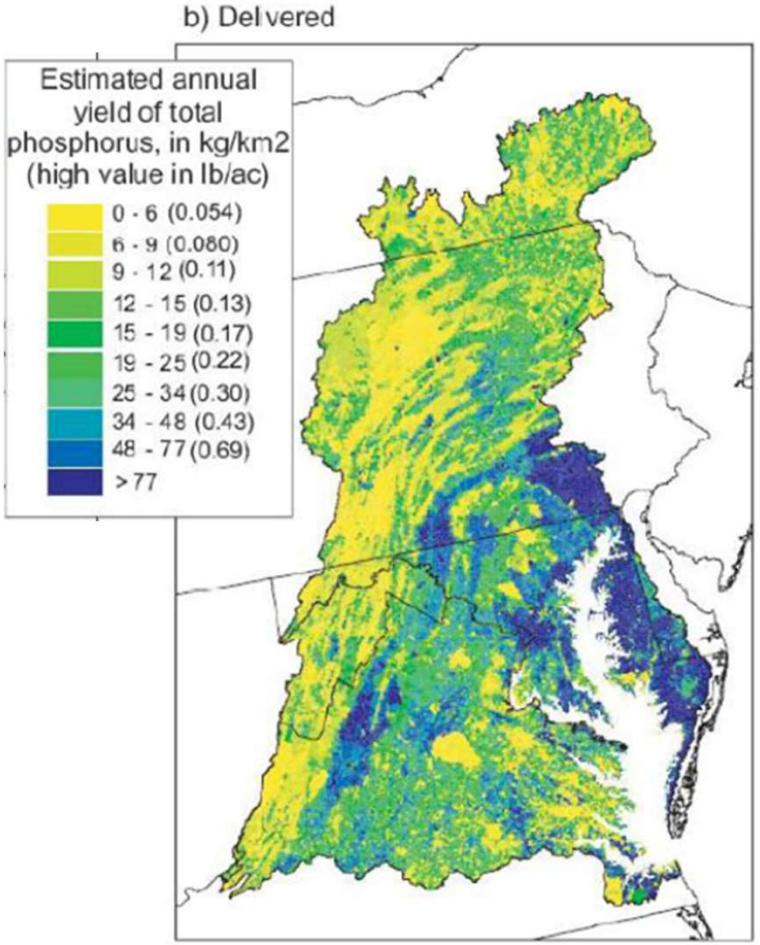
Livestock Exclusion Fencing

Denitrifying Bioreactor

Low upfront installation costs
Private benefits

High up front installation costs
No private benefits

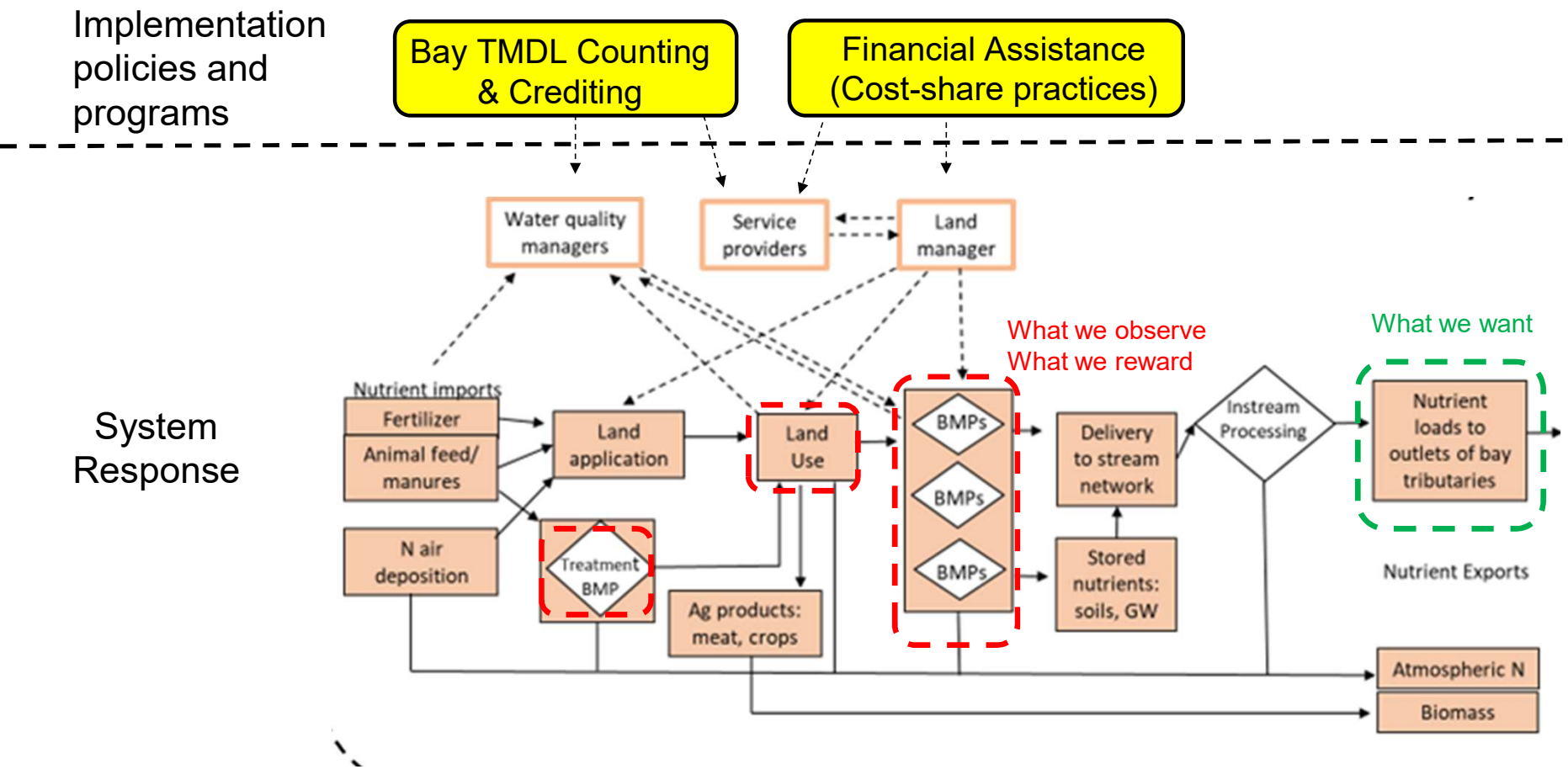
# Nutrient Mass Balance




Source: USGS Sparrow Model Output

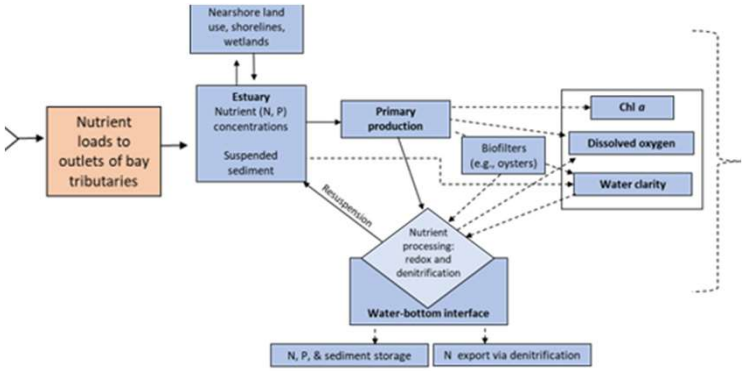
**FINDING:** Existing nonpoint source water quality programs are insufficient to achieve the nonpoint source reductions required by the TMDL

Outcomes are a function (partly) of structure of incentives and rules



# Findings:

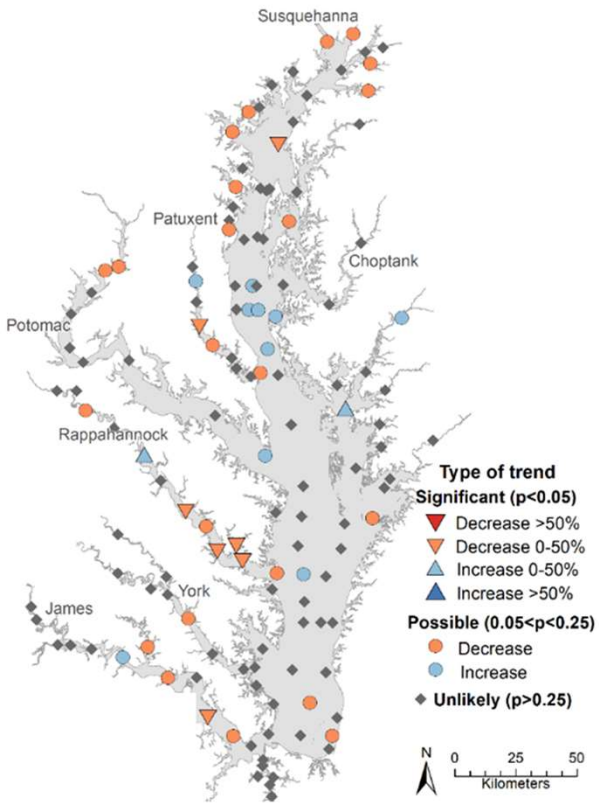
## Bay Water Quality Response to Nutrient Reductions



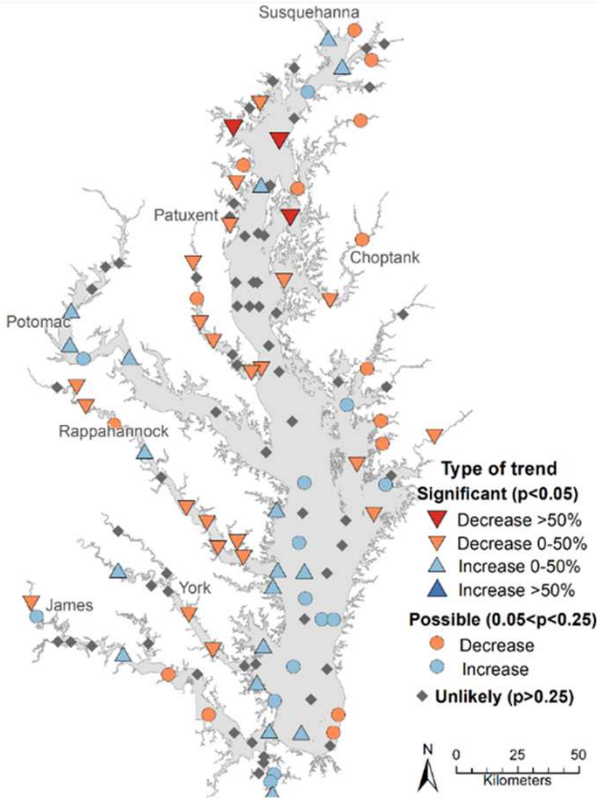
# Water Quality Response at Bay Scale; DO

**Chesapeake Bay bottom summer (June-Sept) dissolved oxygen**

Short term change (2012 to 2021)

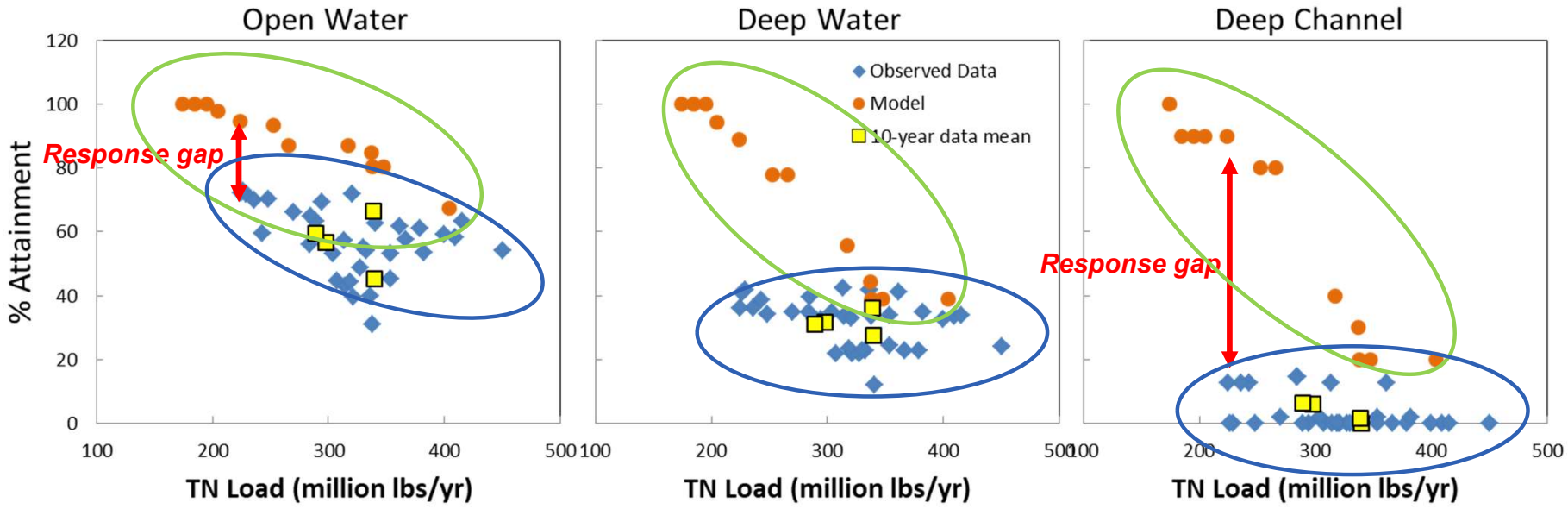



Long term change (1985/6 to 2021)



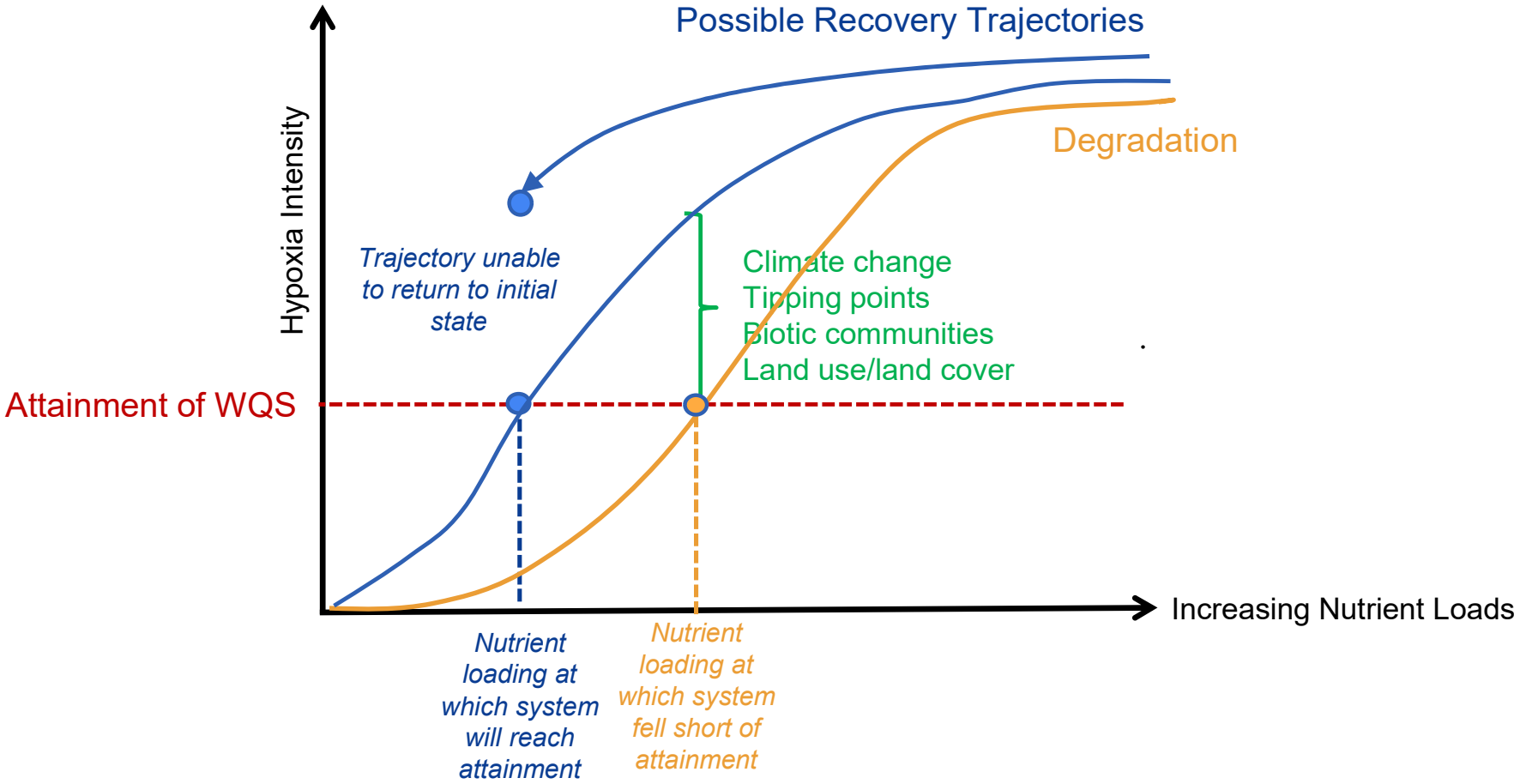

**(Source: CBP)**

# Response Gap for DO 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.**

# Trajectories of Response



**FINDING:** Load reductions have not produced expected level of WQ response. Full achievement of WQS is is distant and unlikely, particularly for deep water DO

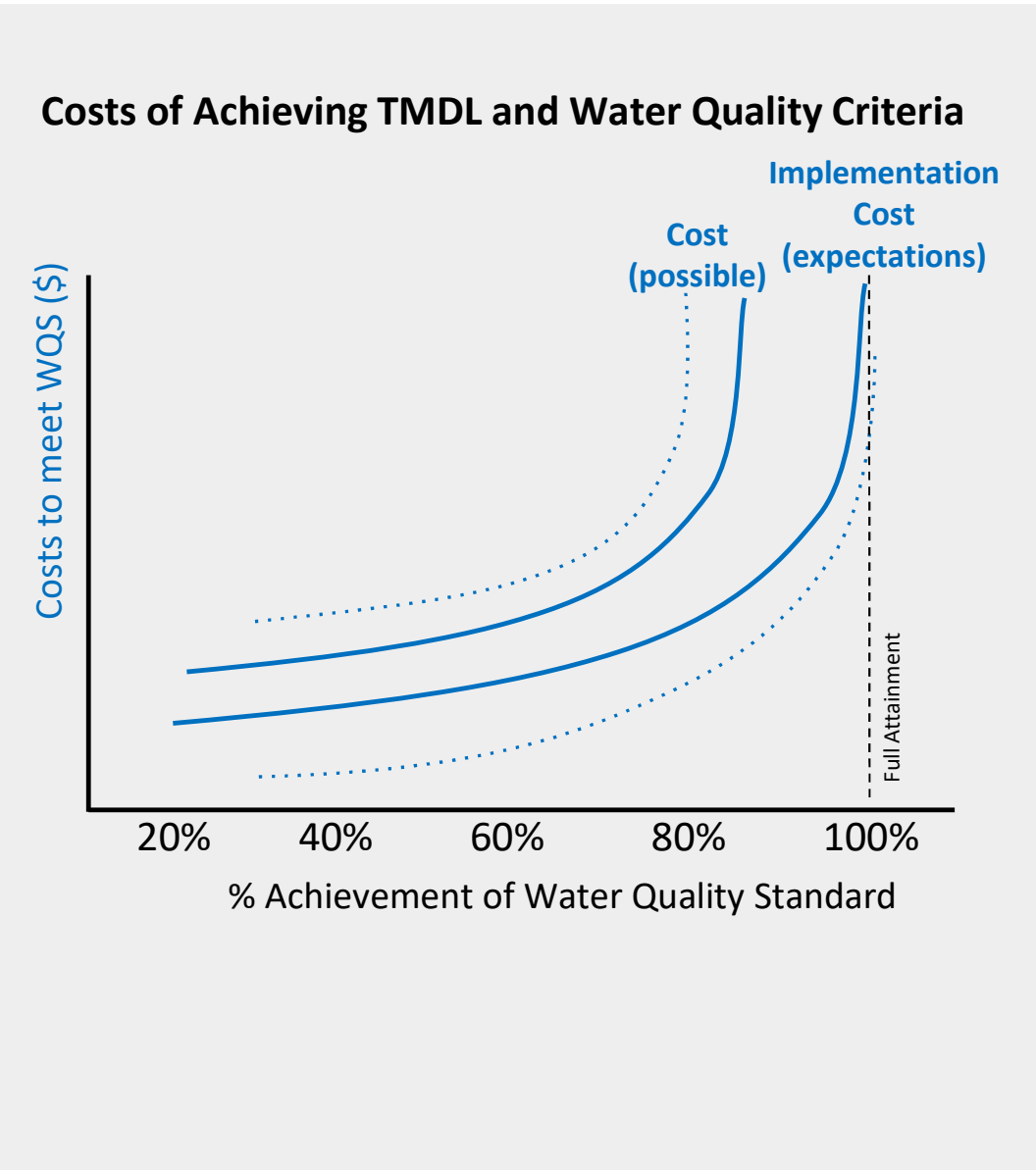
# Implications

*Load reductions have not produced expected level of response and the deep channel may be the last to reach attainment*

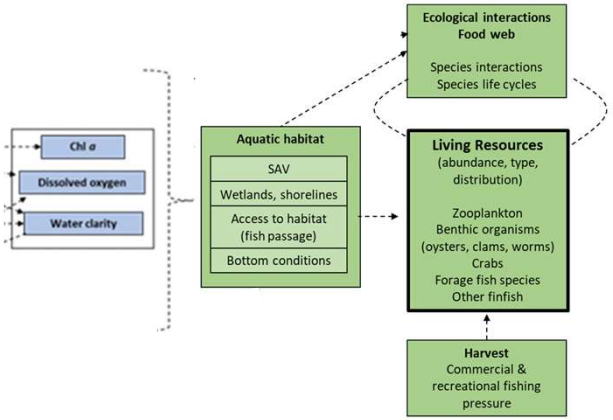
- Refocus attention to habitats where recovery is most probable
- Monitor for understanding (versus accountability)
- Assess costs and tradeoffs of attainment in specific areas
- Rethink goals

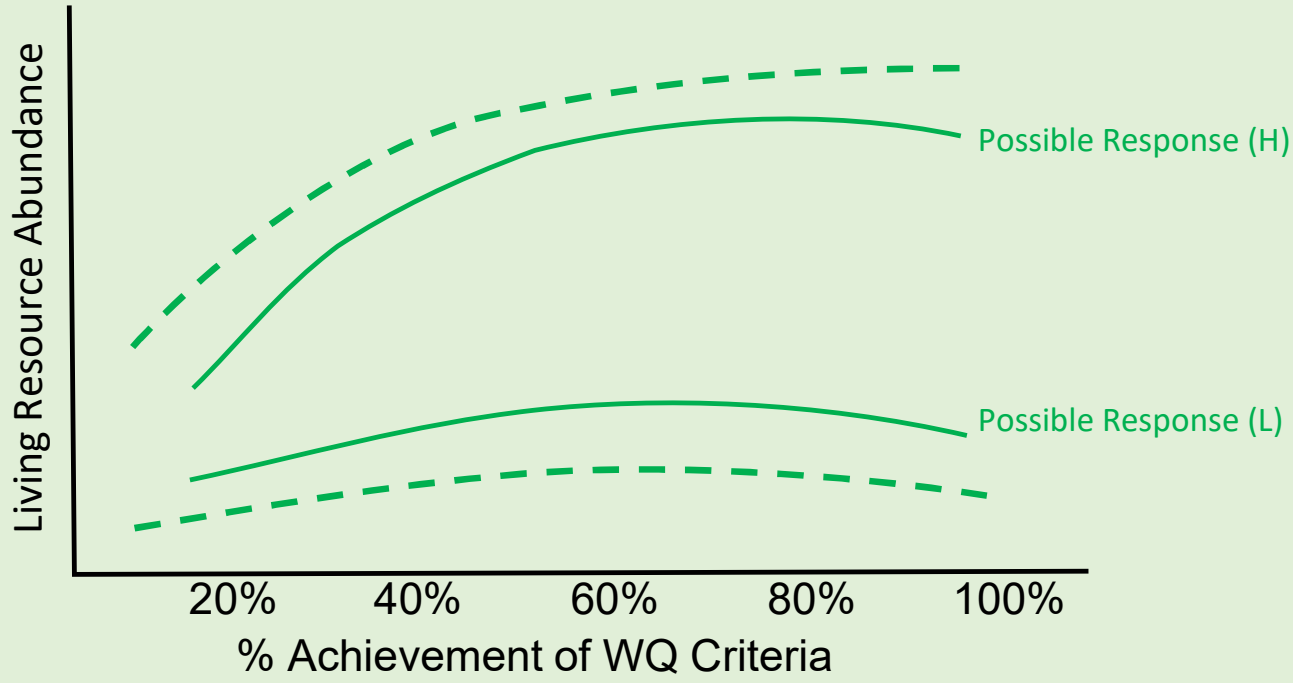
# Implications

*The Bay of the future is not the Bay of the past*

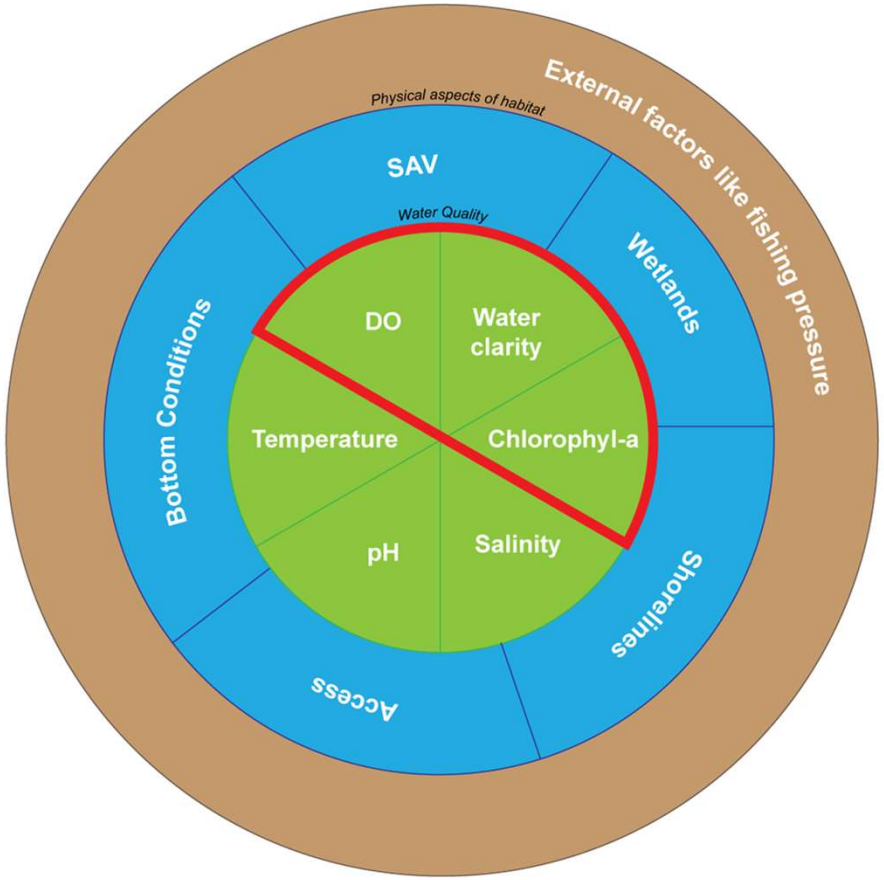


# **Findings:** Living Resource Response to Water Quality Improvement



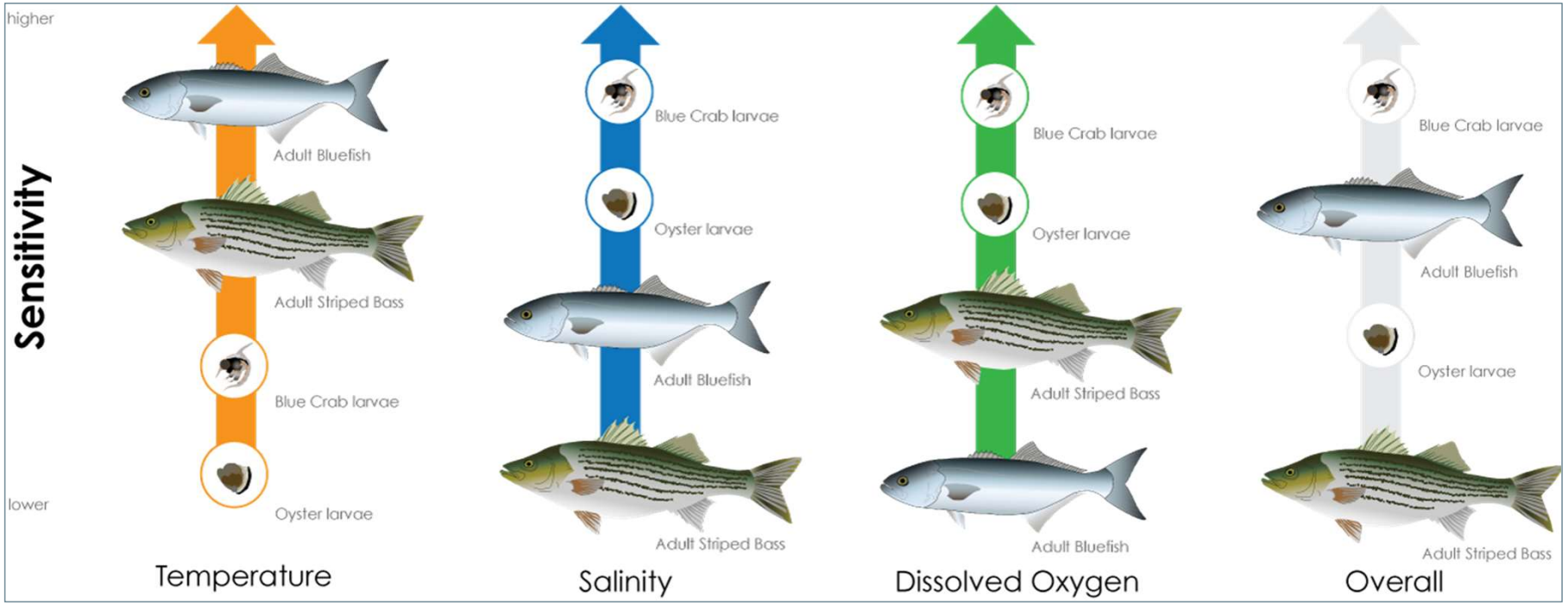

Living Resource Abundance
Possible Response (H)
Possible Response (L)
20%
40%
60%
80%
100%
% Achievement of WQ Criteria

# Many Knobs of Living Resource Response



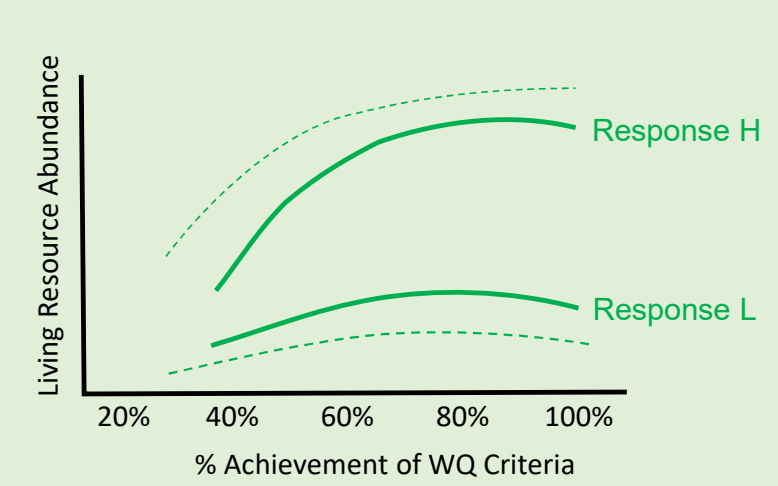

**Managed by Bay water quality standards**

# Sensitivity varies over life history stage




*Reinterpreted from Schelnger et al., 2022*

# Boosting the Curve




*Full attainment may not be necessary to meet and support living resource goals*

.

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

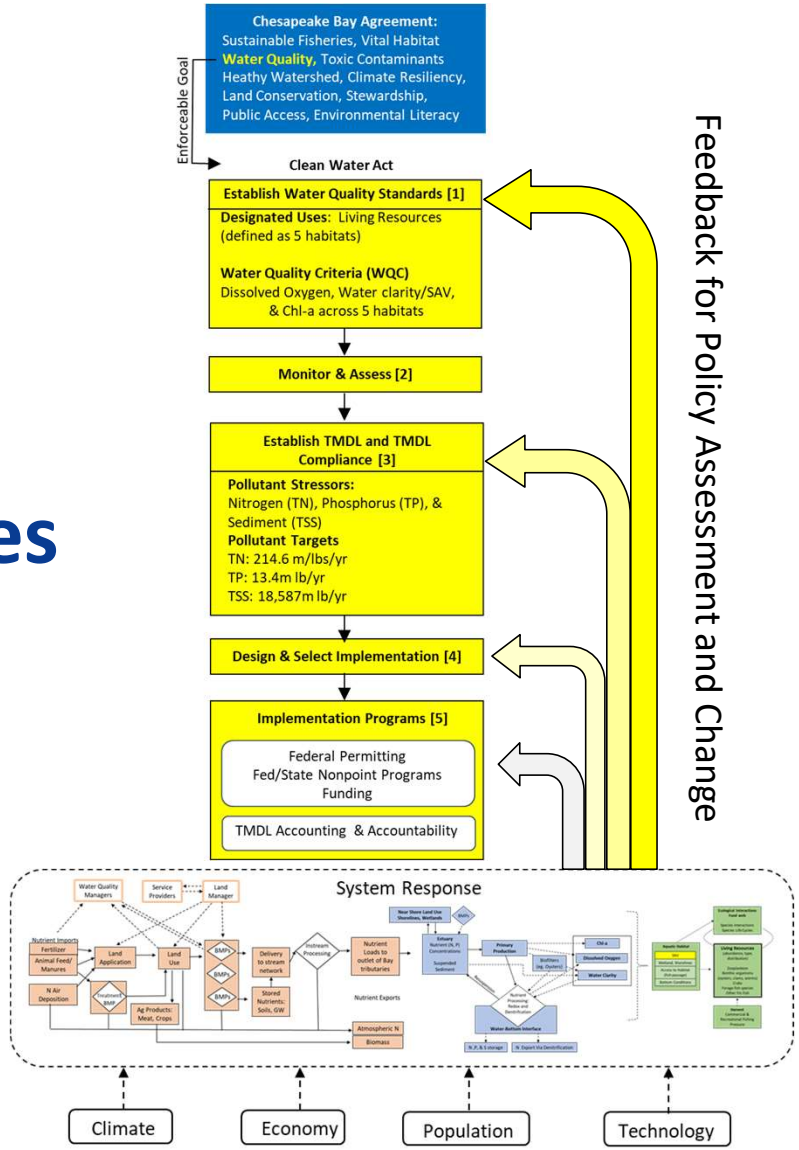
# CESR Implications

Improving WQ outcomes

Improving living resource outcomes

Improving decision-making under uncertainty

# Post 2025 Opportunities



# CESR Implications: Addressing the nonpoint source challenge

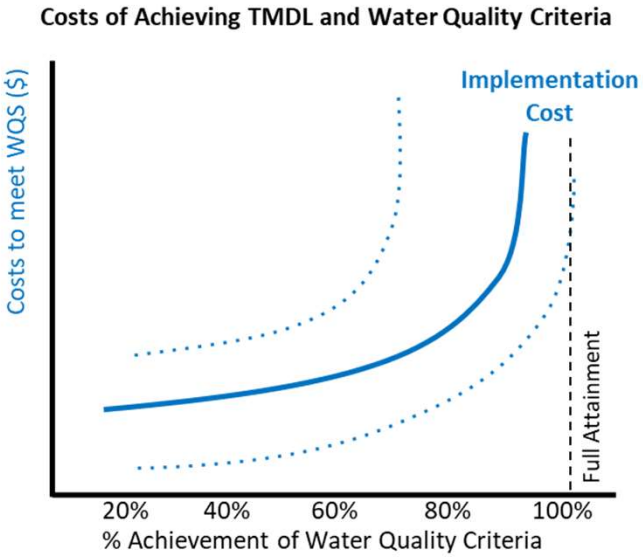
Shift in capacity and incentives for pollutant reduction outcomes (finer scale modeling/monitoring, outcome based incentives)

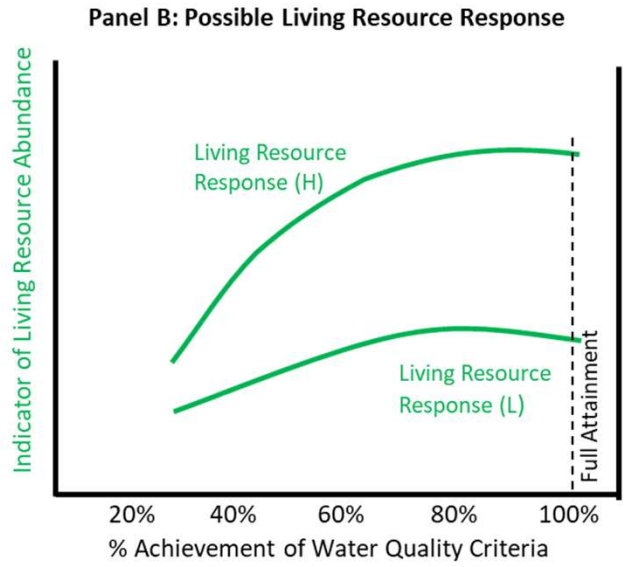
Addressing mass imbalances

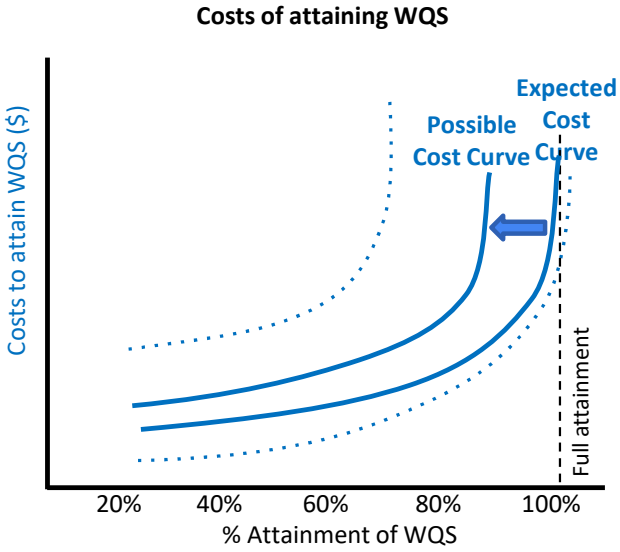
Institutional innovation and willingness to experiment ("Sandboxing")

# CESR Implications: Water Quality Goals

*How to direct more WQ management attention to living resources?*

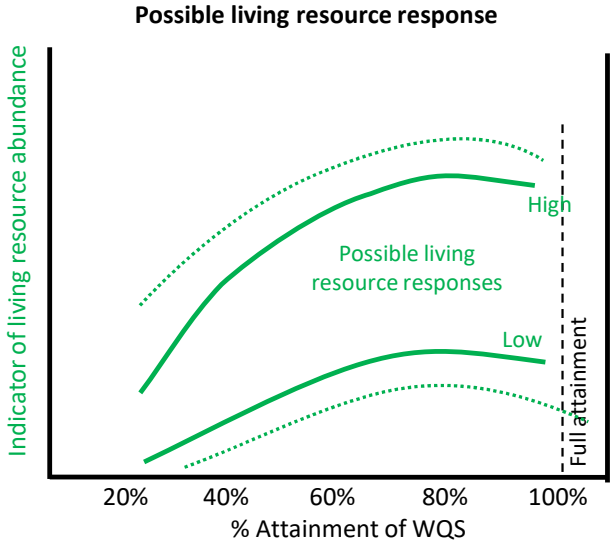





Expected cost curve: costs increase rapidly as nutrient reductions approach TMDL goals and full attainment is expected to be achieved.

Possible cost curve: Gaps in nonpoint source and estuary response likely shifting cost curve to left and full attainment may not be possible




What is the consequence for living resources?

High LR curve: Maximum LR response for water quality improvements

Lower LR curve: LR response is dampened but could be shifted to High LR curve by changing the location & timing of Bay water quality improvements and improving other factors that influence living resource abundance (habitat, harvest, etc)

# CESR Implications: Water Quality Goals

"2025 was an important deadline, but it wasn't the finish line"

– *Hilary Harp Falk.*

*Corollary:*
The choice of finish line influences the race you run

# CESR Implications for Water Quality Goals

Revising water quality standards (additional criteria, revise existing criteria, etc.

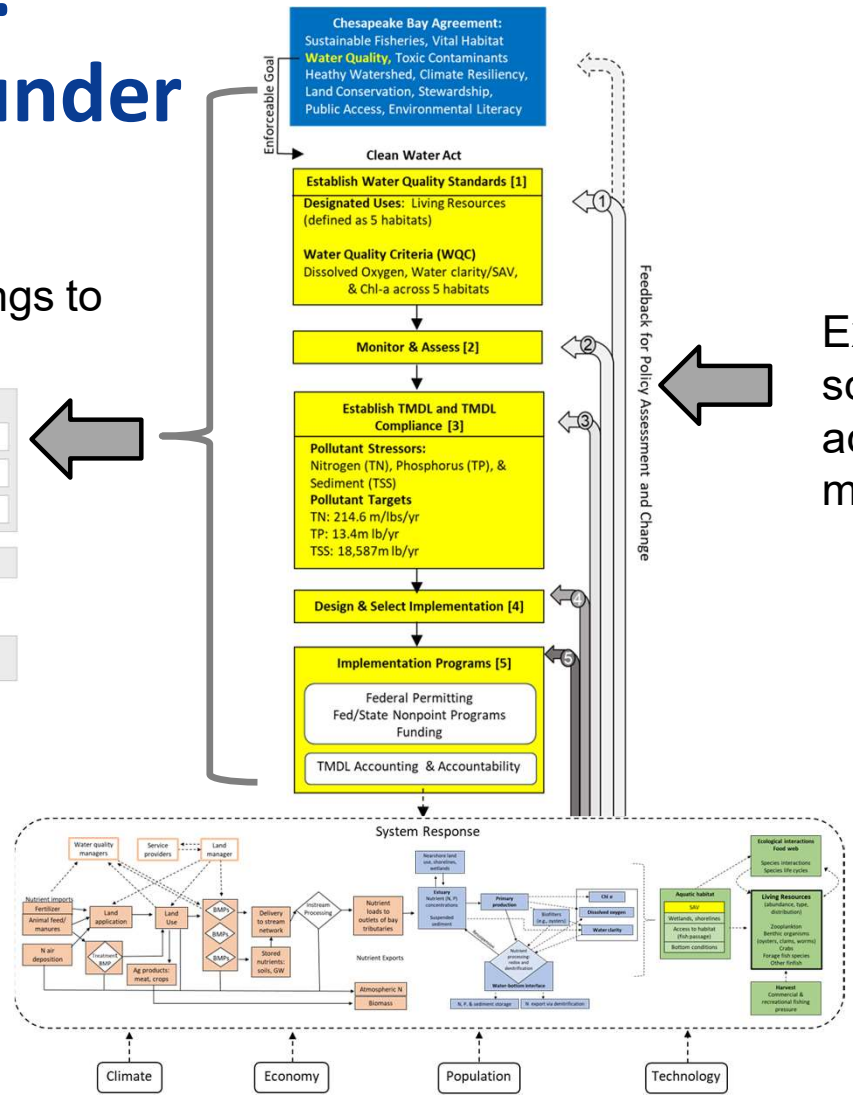
Changing expression of criteria

Variances for specific segments (particularly those with deep water habitats

Prioritizing attainment in different habitats like shallow waters (ex. differential deadlines for habitats)

# CESR Implications: Decision-making under uncertainty

Improve transfer of learnings to relevant decisionmakers


Expand the scope of adaptive management

Improve capacity to identify and evaluate uncertainties and gaps in system response