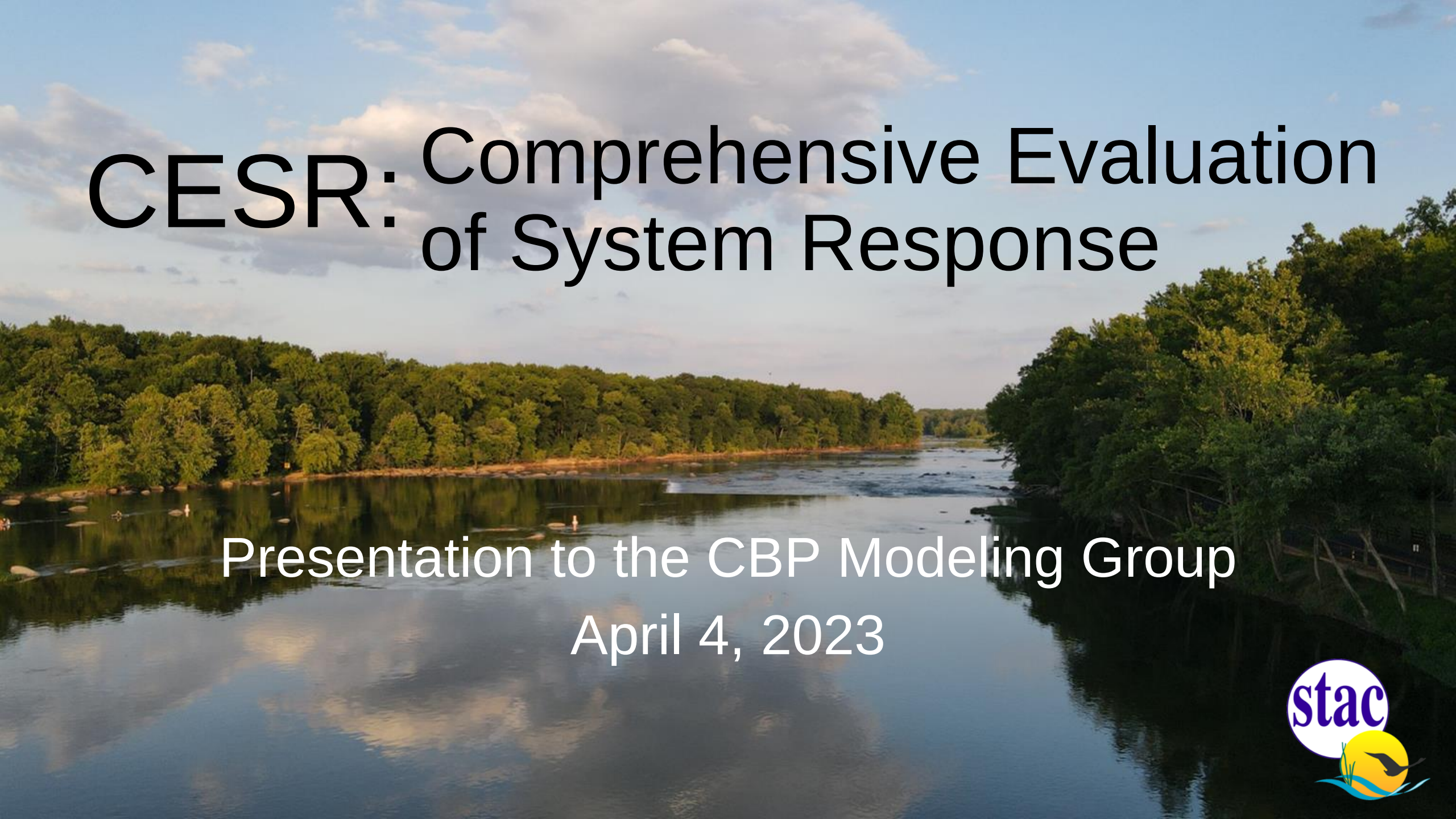
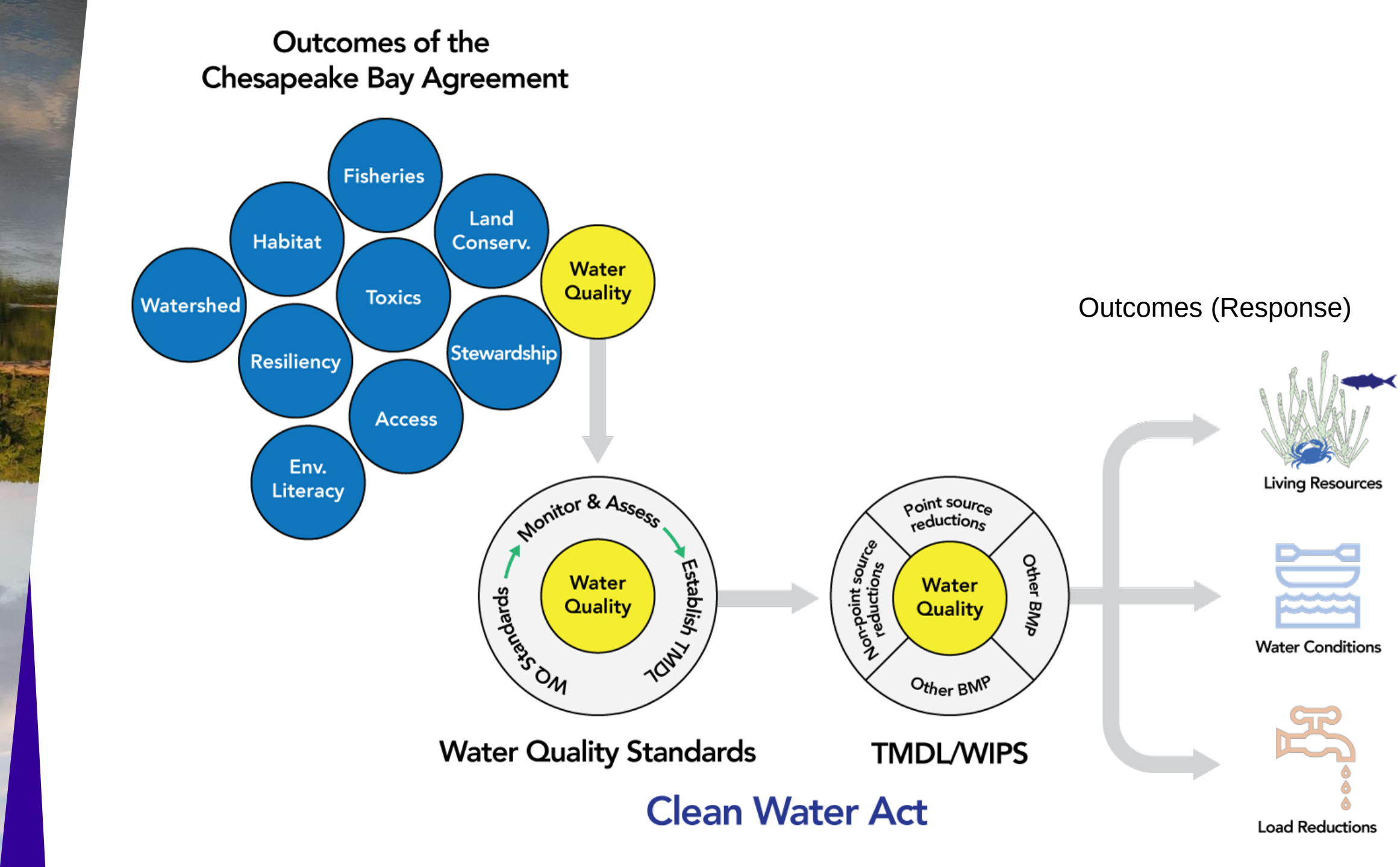


CESR: Comprehensive Evaluation of System Response

Presentation to the CBP Modeling Group

April 4, 2023


Outcomes of the
Chesapeake Bay Agreement
Fisheries
Habitat
Land Conserv.
Watershed
Toxics
Water Quality
Resiliency
Stewardship
Access
Env. Literacy
Monitor & Assess
Establish TMDL
WQ Standards
Water Quality
Point source reductions
Non-point source reductions
Other BMP
Water Quality
Other BMP
Outcomes (Response)
Living Resources
Water Conditions
Load Reductions
Water Quality Standards
TMDL/WIPS
Clean Water Act

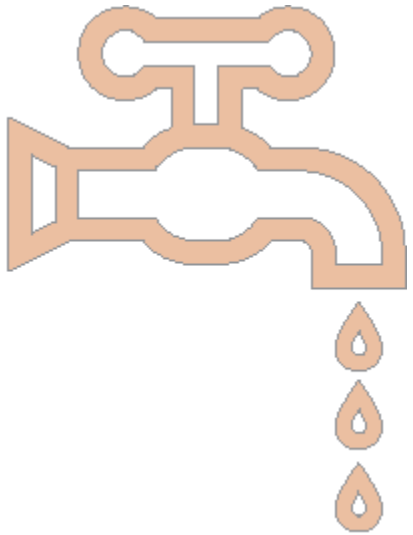
Achieving our desired outcomes is proving more challenging than we expected.

There are opportunities to improve our effectiveness, but they will require a significant change in our thinking and our programs.

Photo by Will Parson/Chesapeake Bay Program

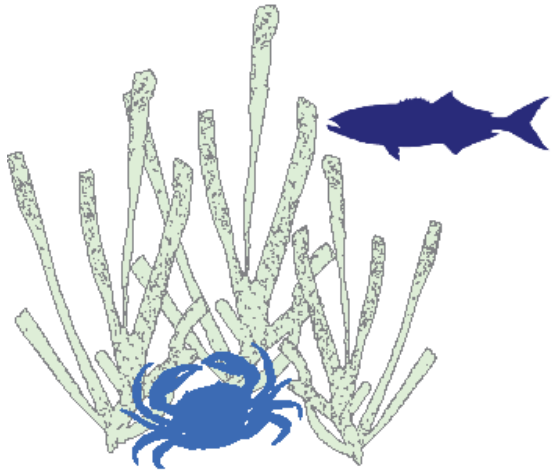
Today's Discussion

What we concluded about



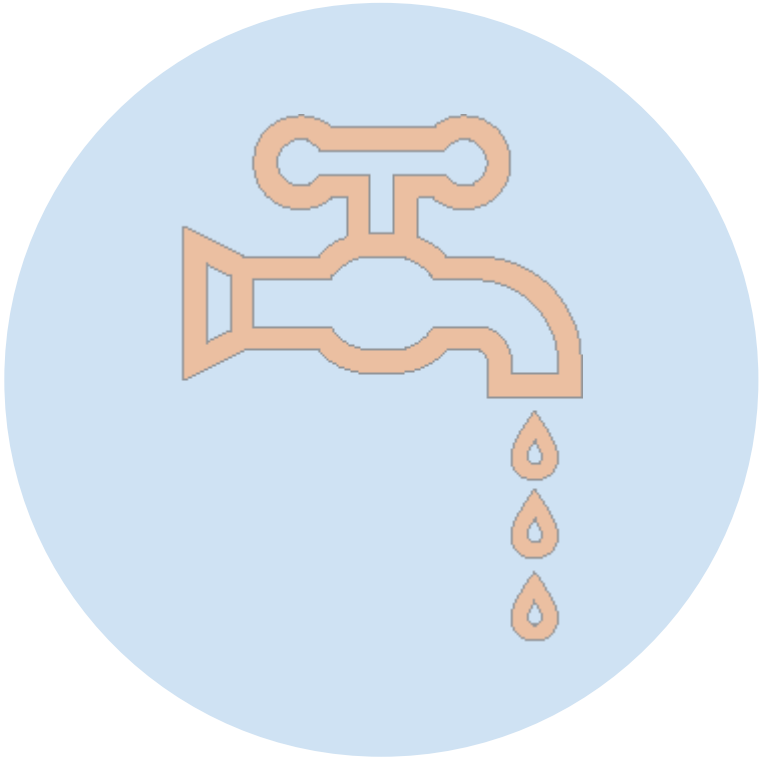
Load Reductions

Water Conditions



Living Resources

Load Reductions



Nutrient and Sediment Response (TMDL)

As we approach 2025, we aimed to reflect on the following questions:

a) Have management efforts to meet TMDL nutrients and sediment reductions produced outcomes consistent with our expectations?

and if not

b) Why? What are the possible gaps and uncertainties in system response to reducing nutrient and sediment?

***and if so*,**

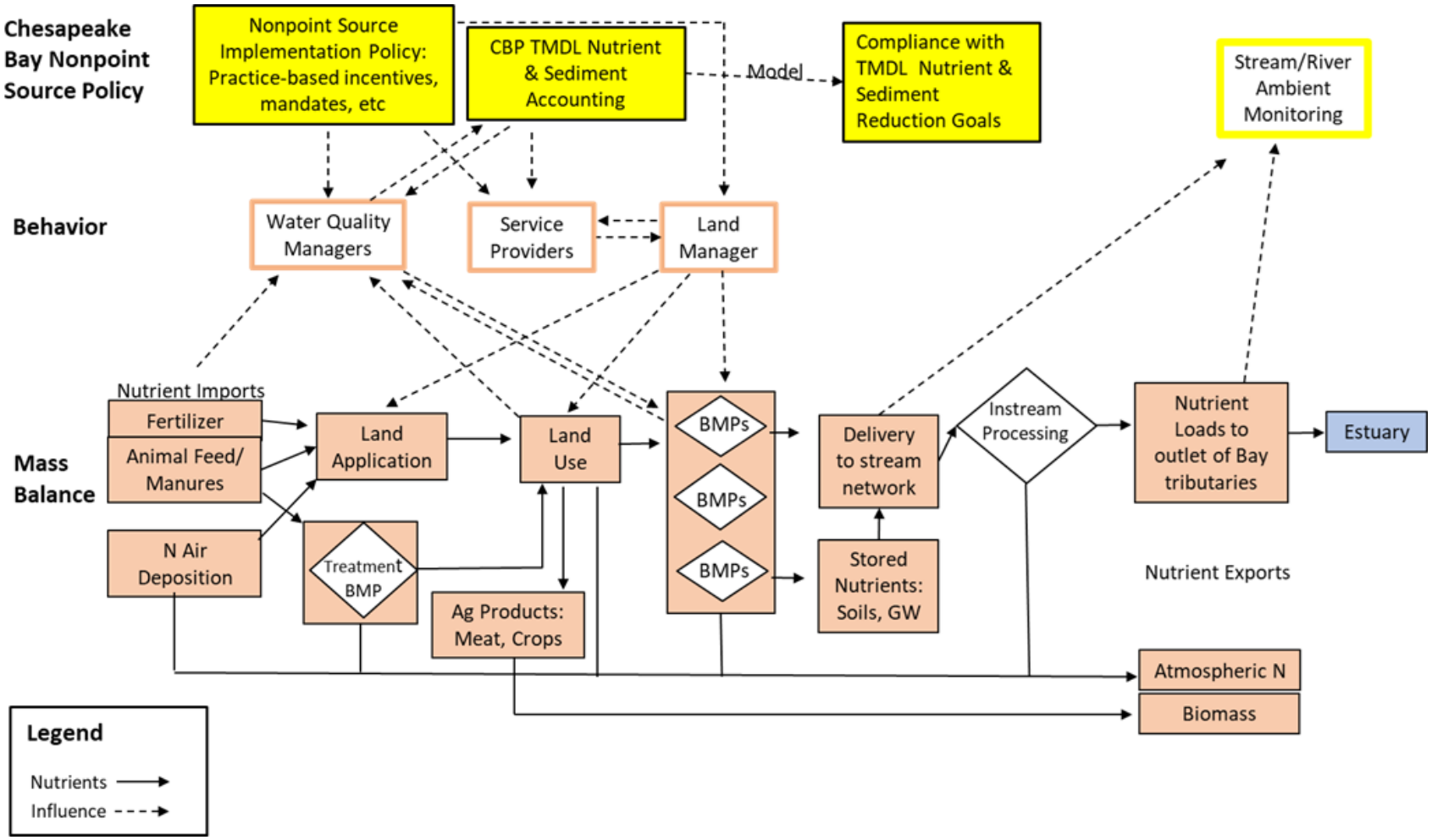
c) What can be done to improve outcomes?

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

Policy

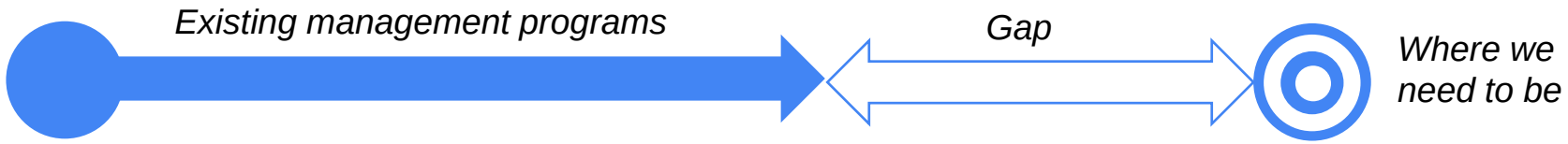
Behavior

Nutrients

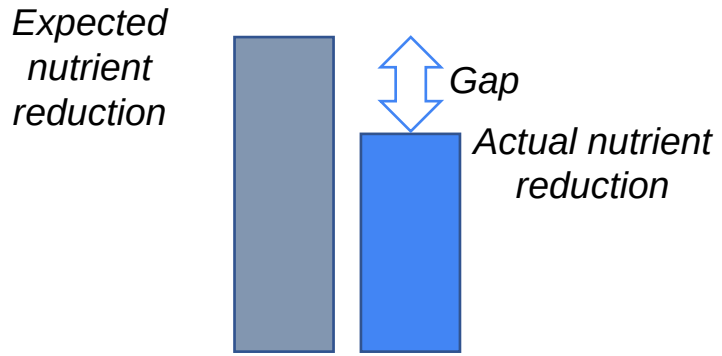


Nutrient/Sediment Load Reductions

- **Implementation gap:** Are management programs able generate enough adoption to achieve TMDL?

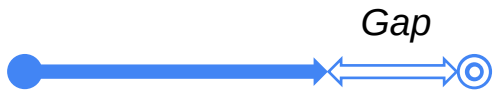


- **Response gap:** Are management actions as effective as we think at reducing pollutants?



- **Uncertainty**

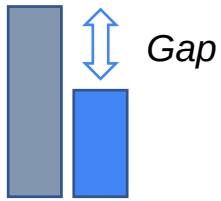
Possible Reasons for Nonpoint Source “Gaps”



Implementation Gap

Limits to Adoption (cost-share, TMDL accounting)

Mass Nutrient Imbalances



Response Gap

Lag Time/Legacy Pollutants

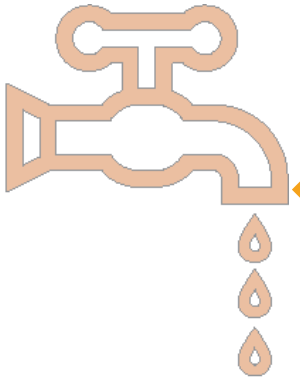
BMP Effectiveness

Behavior

Data/Monitoring Limitations

IMPLICATIONS: New nonpoint source programs and approaches needed to improve NPS program effectiveness.

Additional funding alone likely will be insufficient



Improving effectiveness of nonpoint source management programs

- Improved targeting NPS investments
- Outcomes-based incentive programs
- Additional attention on addressing mass imbalances. Targeted, performance-based requirements
- Facilitating policy innovation through “sandboxing”

Water Conditions

Water Quality Response

As we approach 2025, we aimed to reflect on the following questions:

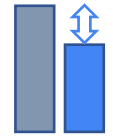
a) Has the recovery trajectory of Bay water quality criteria in response to reduced loads matched our expectations in both direction and magnitude?

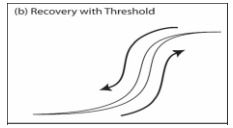
and if not

b) Why is there a gap in the response between what we have measured and that which we expected?

FINDING: Nutrient load reductions have not produced the expected level of improvement in water quality, and a response gap may be particularly pronounced in the Bay's deep channel.

- The modest reductions in nutrient loads we have achieved Baywide, which are substantial in some locales, have initiated a recovery.
- Water quality response to nutrient reductions is less than expected.
- In the deeper waters of the Bay, progress towards attainment has been slow.
- There are tipping points in the Bay ecosystem that can slow recovery in early stages but potentially accelerate recovery down the road.
- Some Bay conditions are changing, permanently altered, and irreversible.





Loads and Nutrient Concentrations

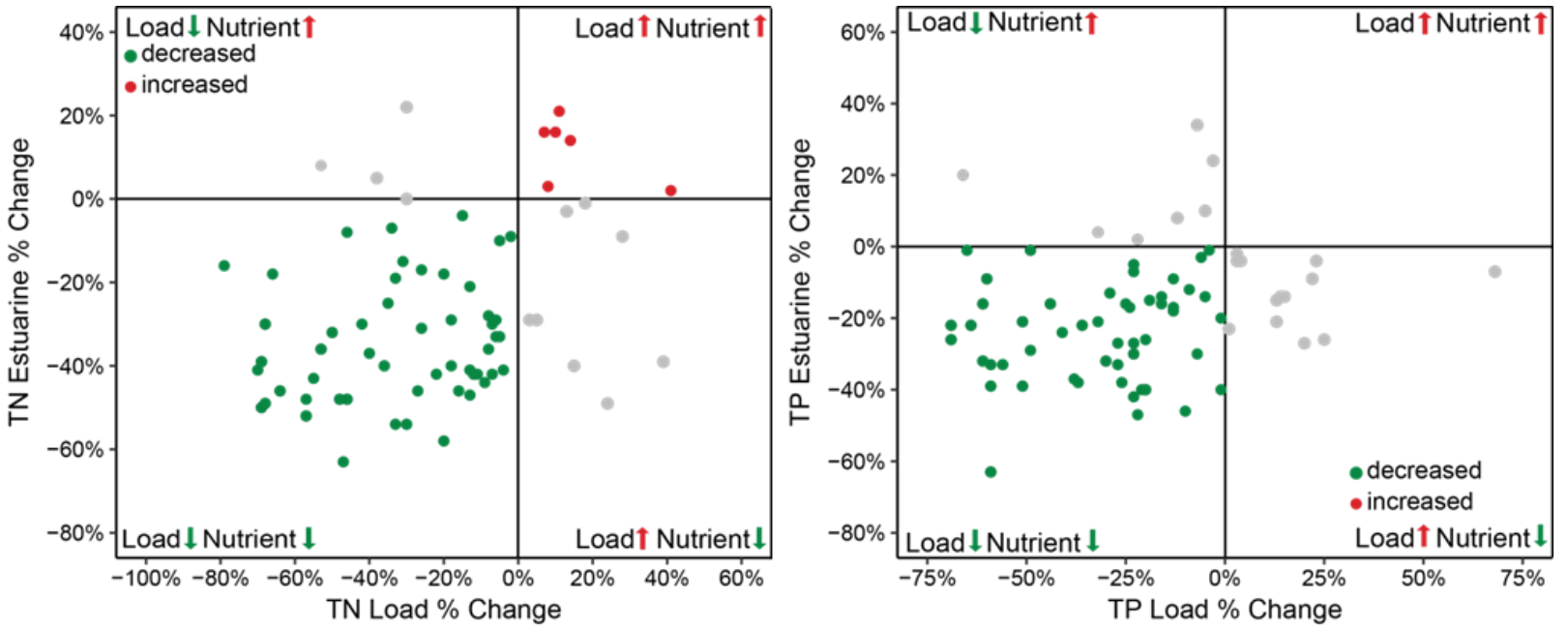


FIGURE 4.6.—Percent change in estuarine TN and TP loads and concentrations, late 1980s to mid-2010s, where each dot represents a Bay segment (Source: Testa et al., 2018).

Water Quality Response at Bay Scale

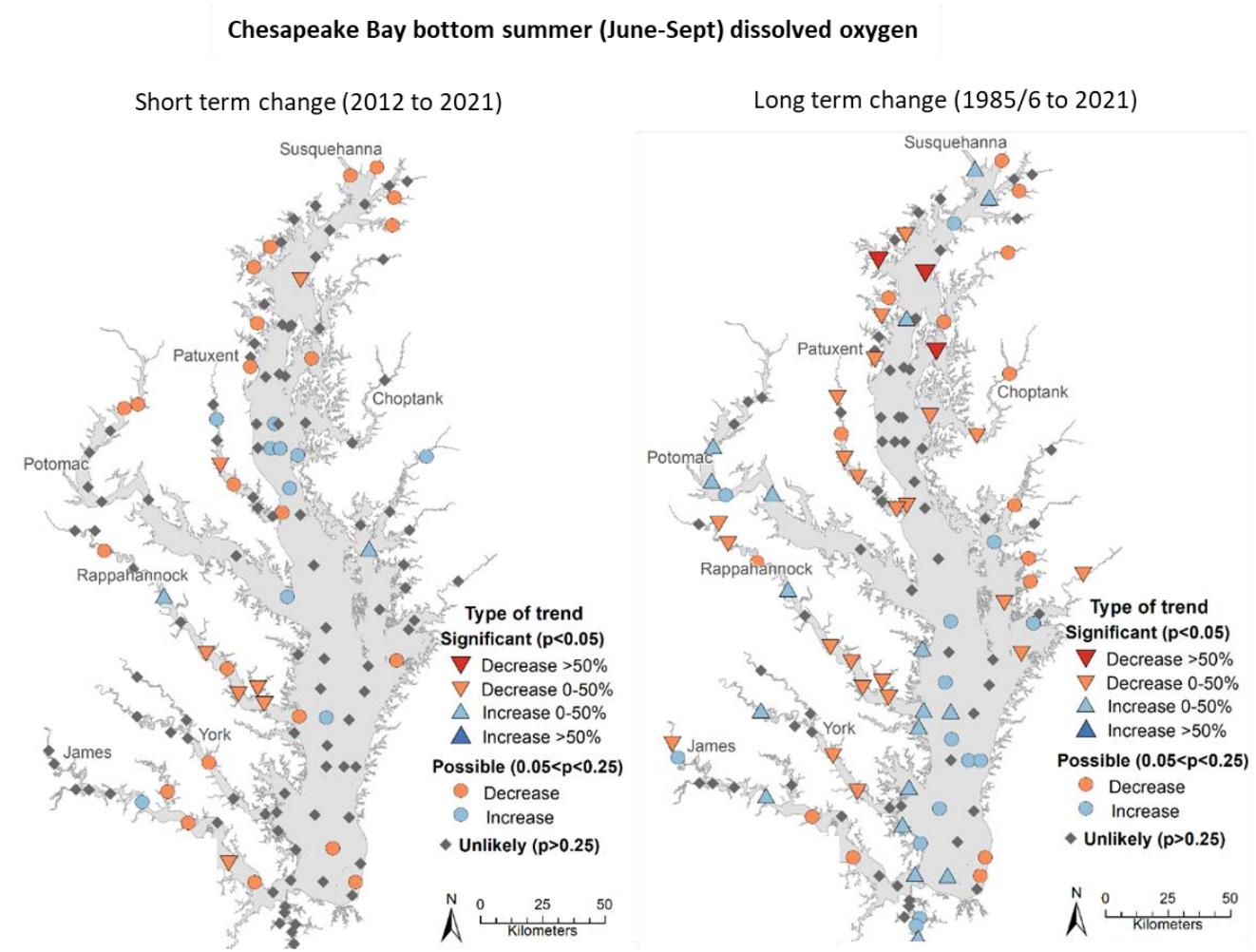
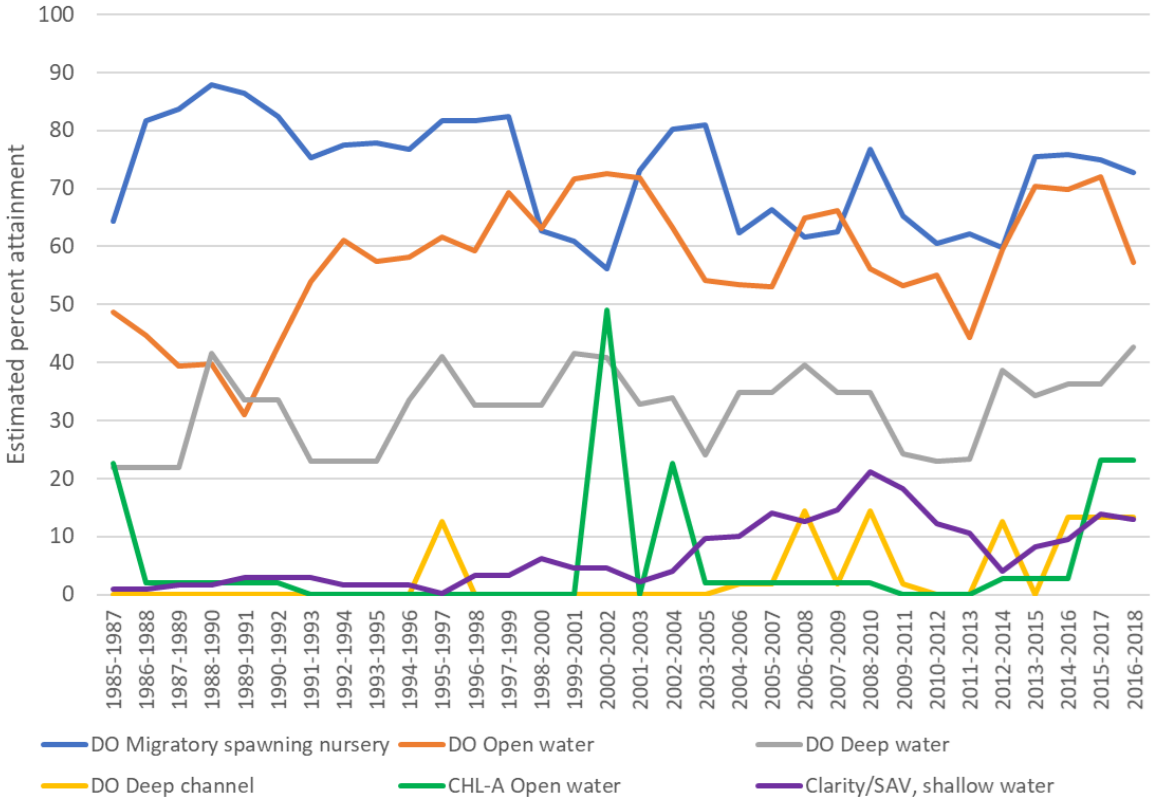


FIGURE 4.7.—Changes in DO in bottom water layer measured during June–September, short-term (left panel) and long-term (right panel); starting dates for long-term measurements vary (Source: CBP, n.d.-b).

Breaking Down WQC Attainment



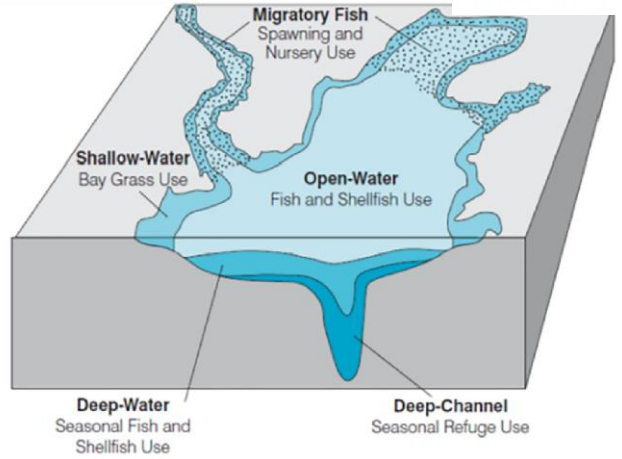
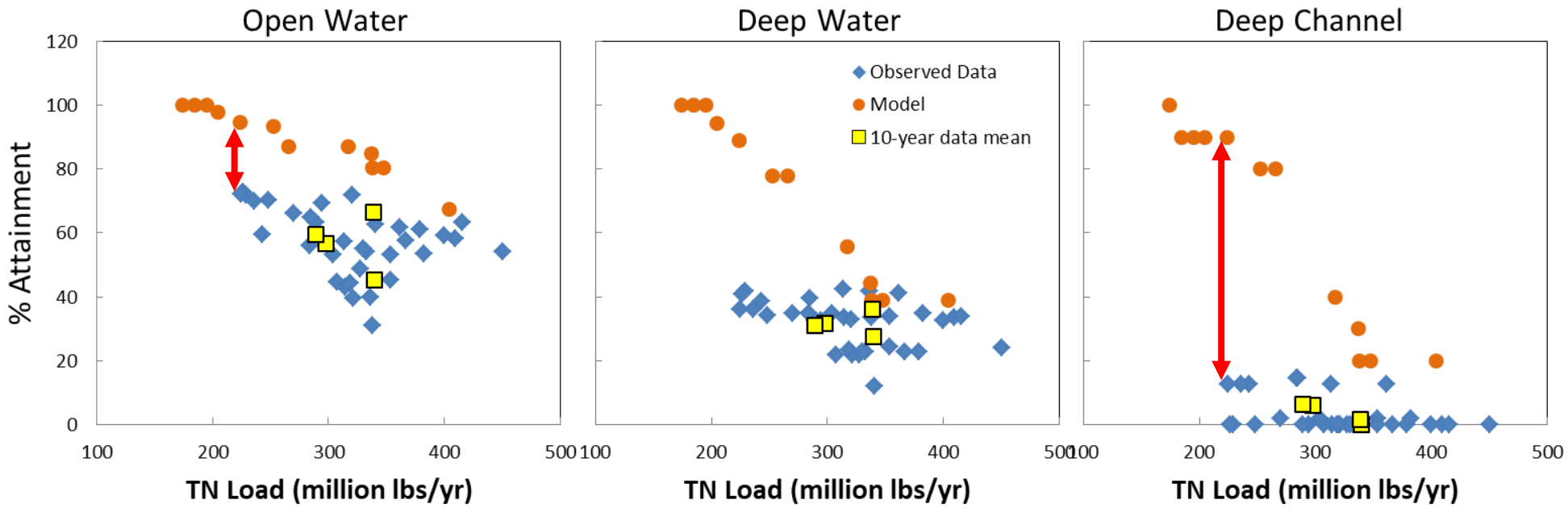


FIGURE 4.8.—Time series of area-weighted estimated WQC attainment for the five DUs, 1985–1987 through 2016–2018 (Source: Zhang, Murphy, et al. [2018] with updated data).

These estimates show high attainment in some habitats, but negative trend
AND low attainment in other habitats, but positive trend

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.

Why Do We have Response Gaps?

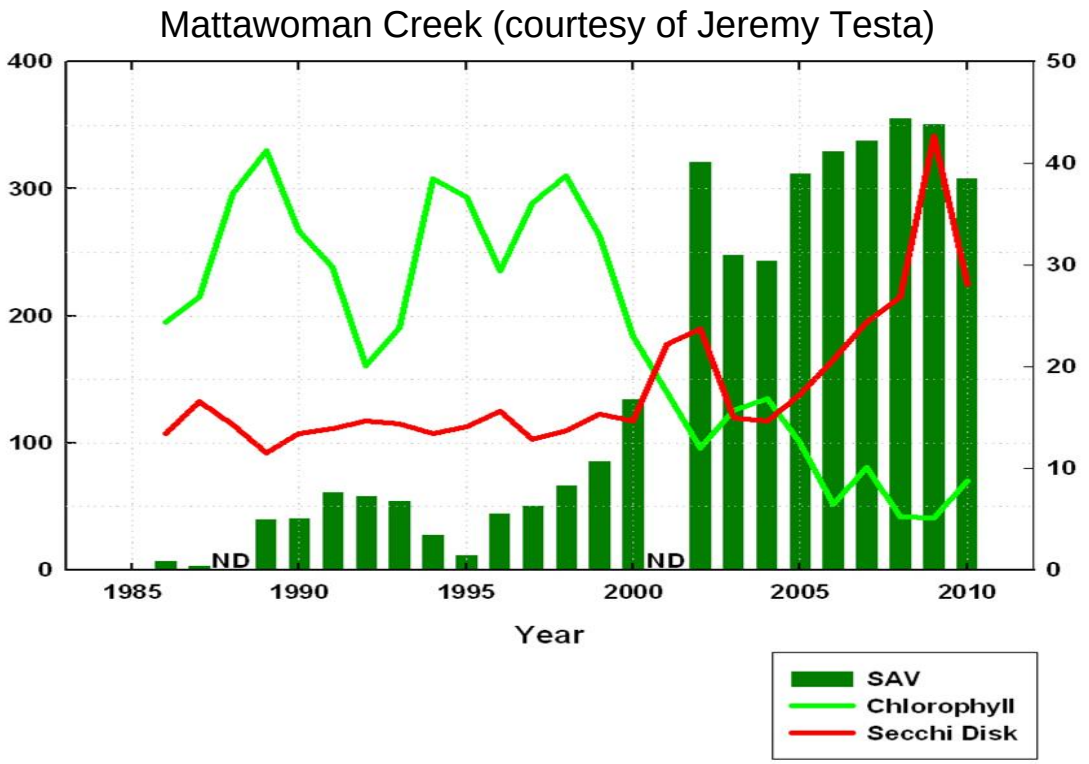
Some Answers (all have uncertainties):

Climate change: warming, sea level rise, precipitation

Tipping points and associated feedbacks: features that make Bay changes not always immediately available

Loads not accounted for: land surface loads contributed during king tides

Monitoring gaps: not able to fully assess attainment

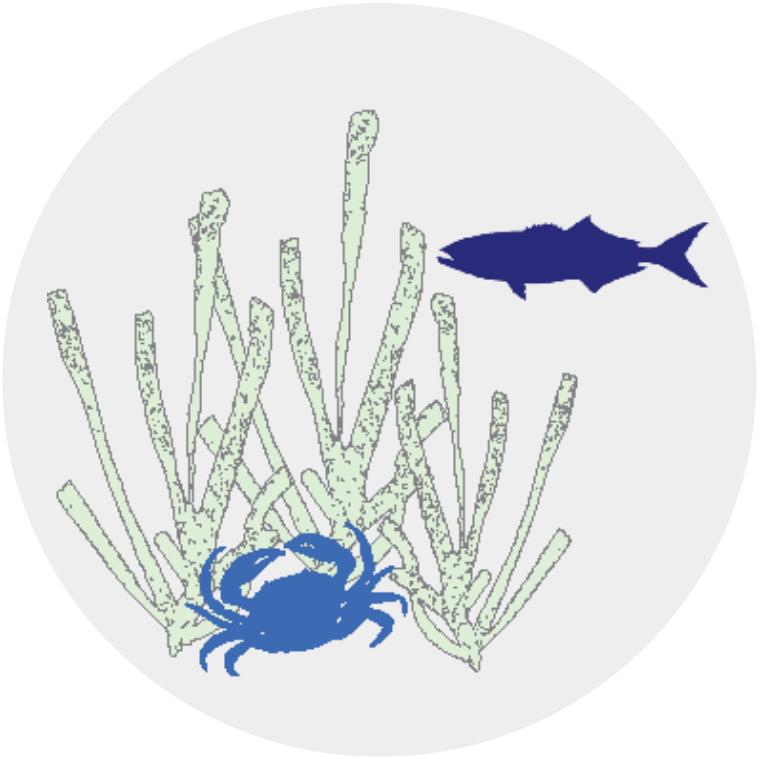


IMPLICATIONS:

Additional nutrient reductions will improve water quality, but water quality criteria may be unattainable in some regions of the bay under existing technologies.

This reality may necessitate assessing the costs and tradeoffs of attaining numerical water quality criteria in specific situations and locations and adapting numeric goals if desired.

Living Resources

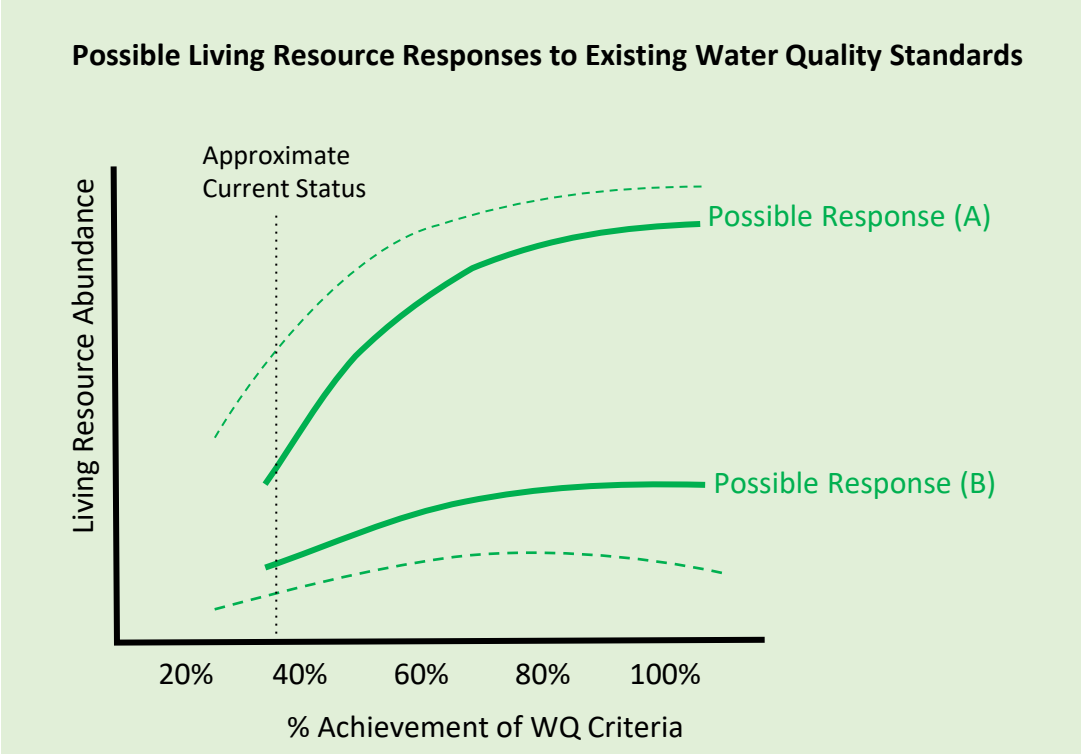


Living Resources Response

As we approach 2025, we aimed to reflect on the following question:

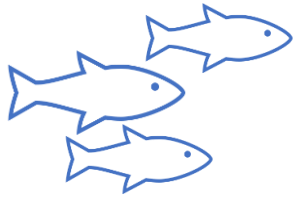
To what extent are Bay living resources improving as a result of efforts to improve water quality conditions (particularly the identified water quality criteria DO, water clarity, and Chl-a)?

Multiple Possible Living Resources Responses



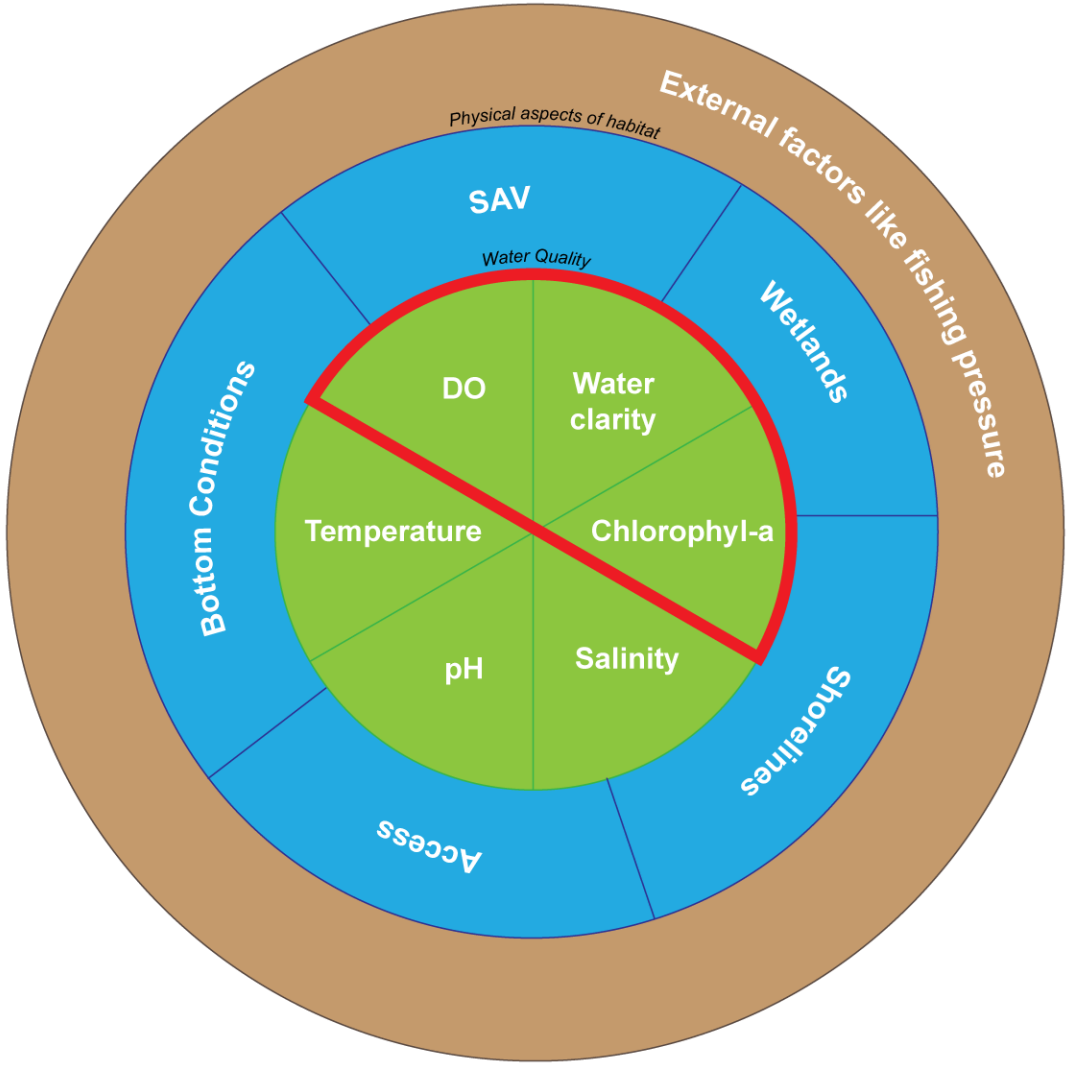
FINDING: It might not be possible to meet the all TMDL and WQ goals **but** this may not be necessary to meet and support living resource goals.

- Water quality improvements in shallow water may have more of a benefit to living resources than elsewhere.



- Water quality alone does not guarantee improvements in Living Resources. There are other factors!

Many Knobs of Living Resource Response



Managed by Bay water quality standards

IMPLICATIONS:

The legal requirements of the Clean Water Act (the water quality goal) divert attention away from considering multiple means of improving living resources (support of aquatic life as the designated use) as articulated in the Chesapeake Bay Watershed Agreement.

Opportunities exist to adjust water quality goals to prioritize management actions that improve living resource response.

Improving living resource response to water quality management efforts

- Express benefits in terms other than water quality
- A tiered approach to TMDL implementation would identify the locations or habitats expected to achieve pollutant reduction limits first
- Policy options would be enhanced with additional analytical capacities and analyses capable of more fully articulating potential living resource responses to water quality management.