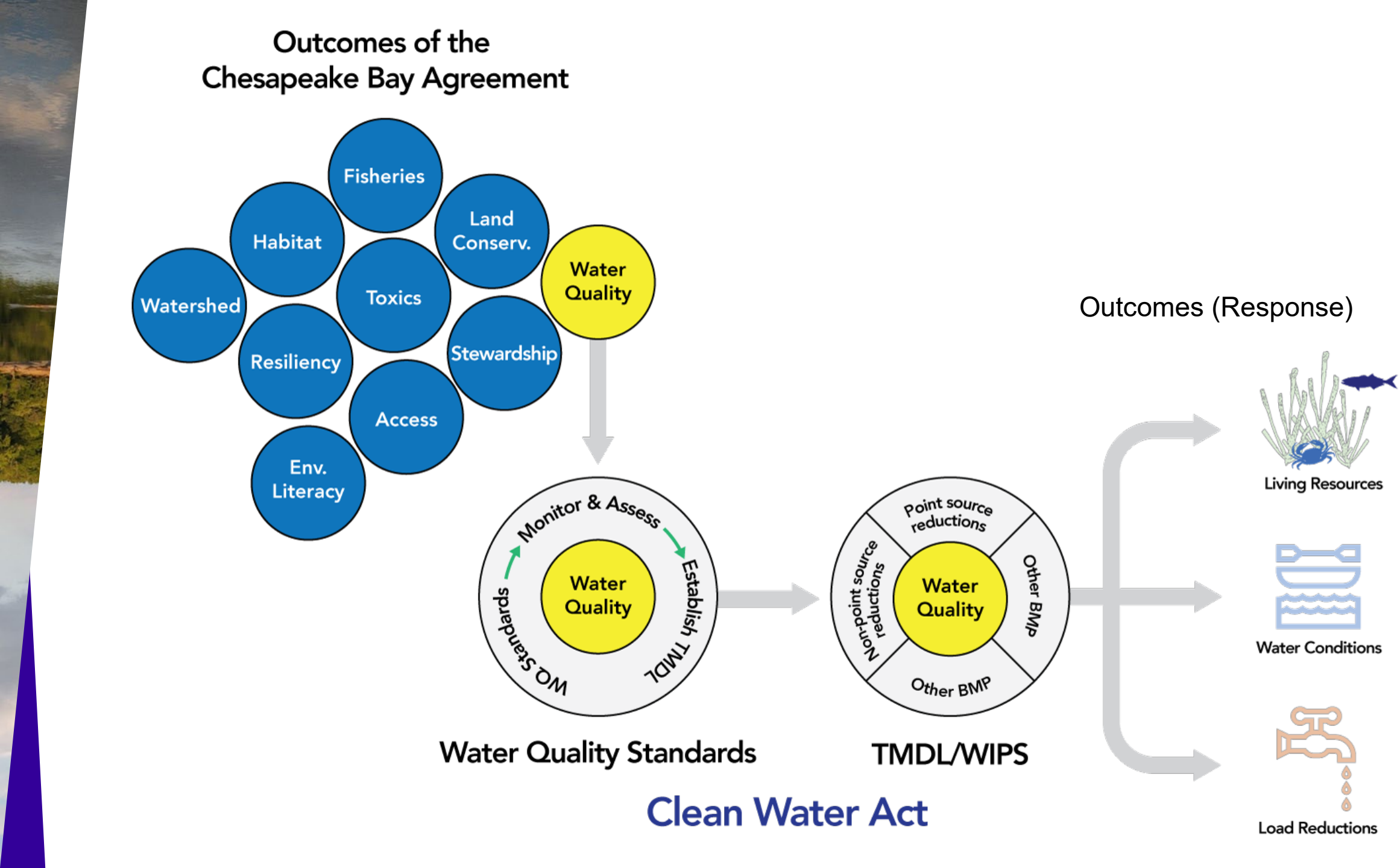
CESR: Comprehensive Evaluation of System Response

A presentation to the Chesapeake Bay Commission

November 17th, 2022


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

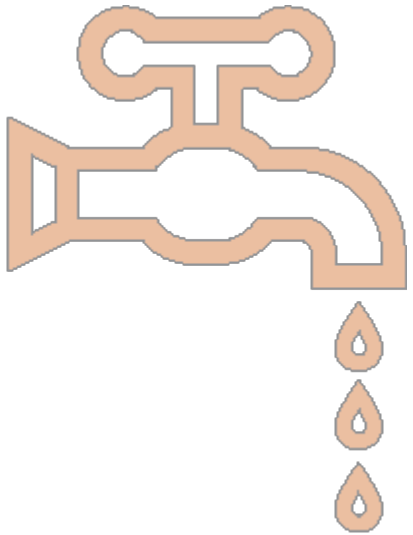
Achieving our desired outcomes is proving more challenging than we expected.

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

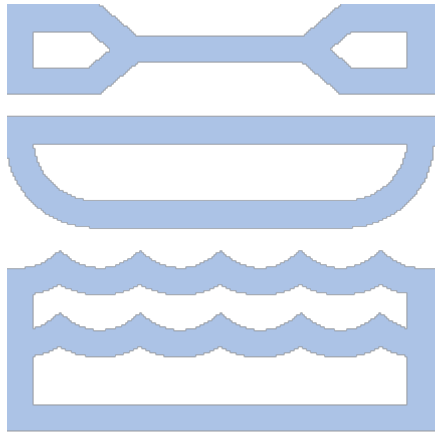
Photo by Will Parson/Chesapeake Bay Program

Today's Discussion

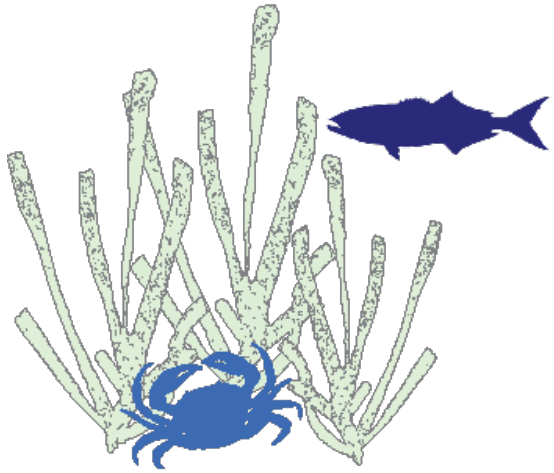
What we have learned about:



Load Reductions

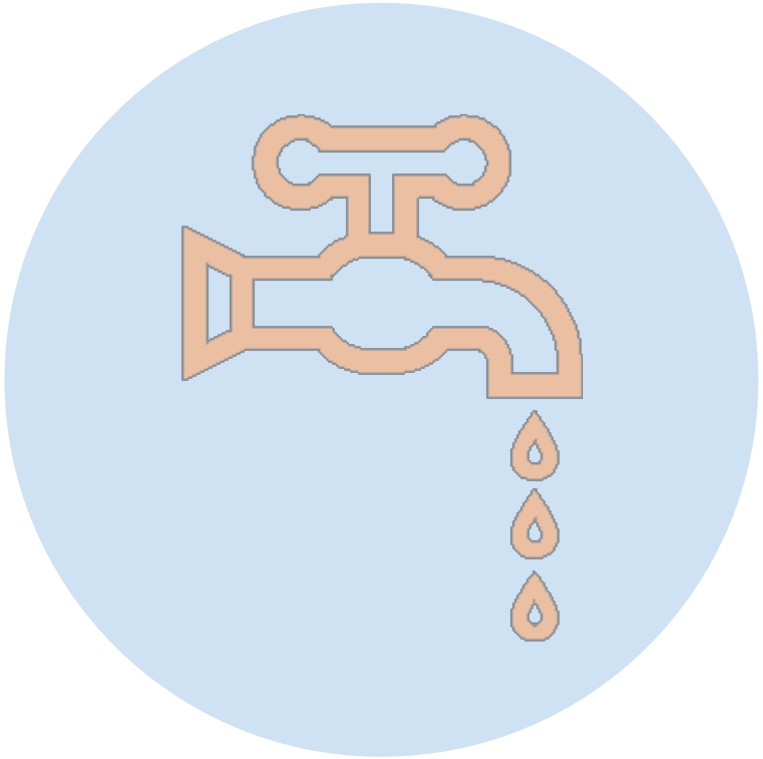


Water Conditions



Living Resources

Load Reductions



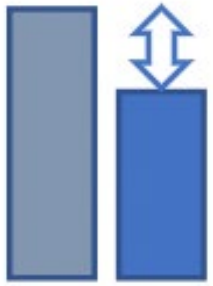
Nutrient and Sediment Response (TMDL)

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?

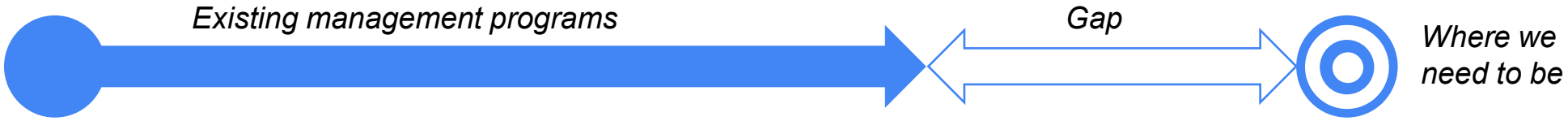
and if not

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

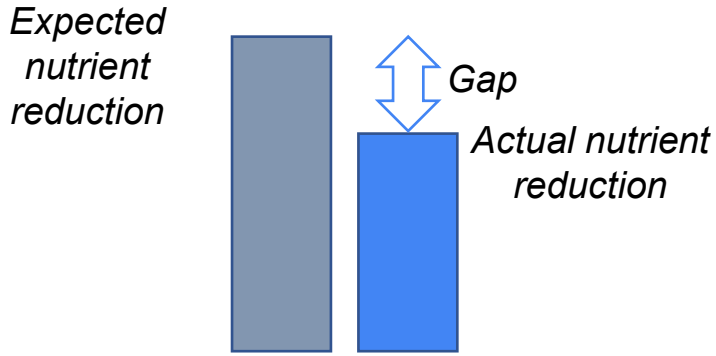


Nutrient/Sediment Load Reductions

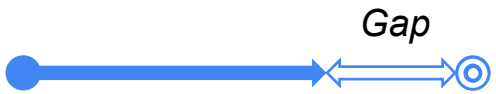
- **Implementation gap:** Are management programs able generate enough adoption to achieve TMDL?



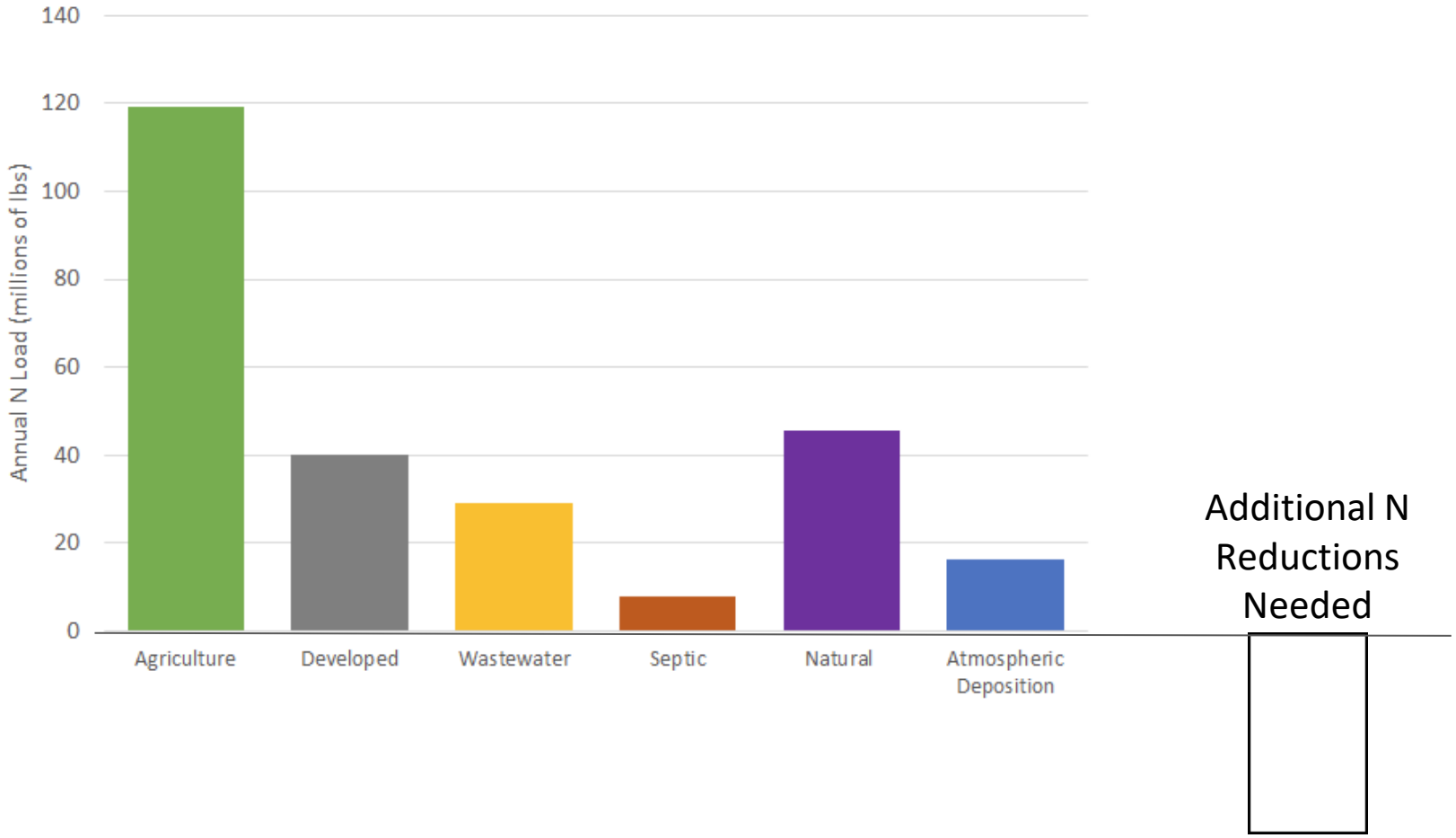
- **Response gap:** Are management actions as effective as we think at reducing pollutants? (difference between expected and actual reductions)



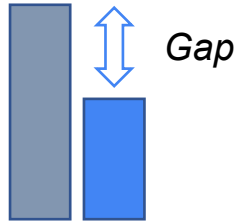
Implementation gap (N example)

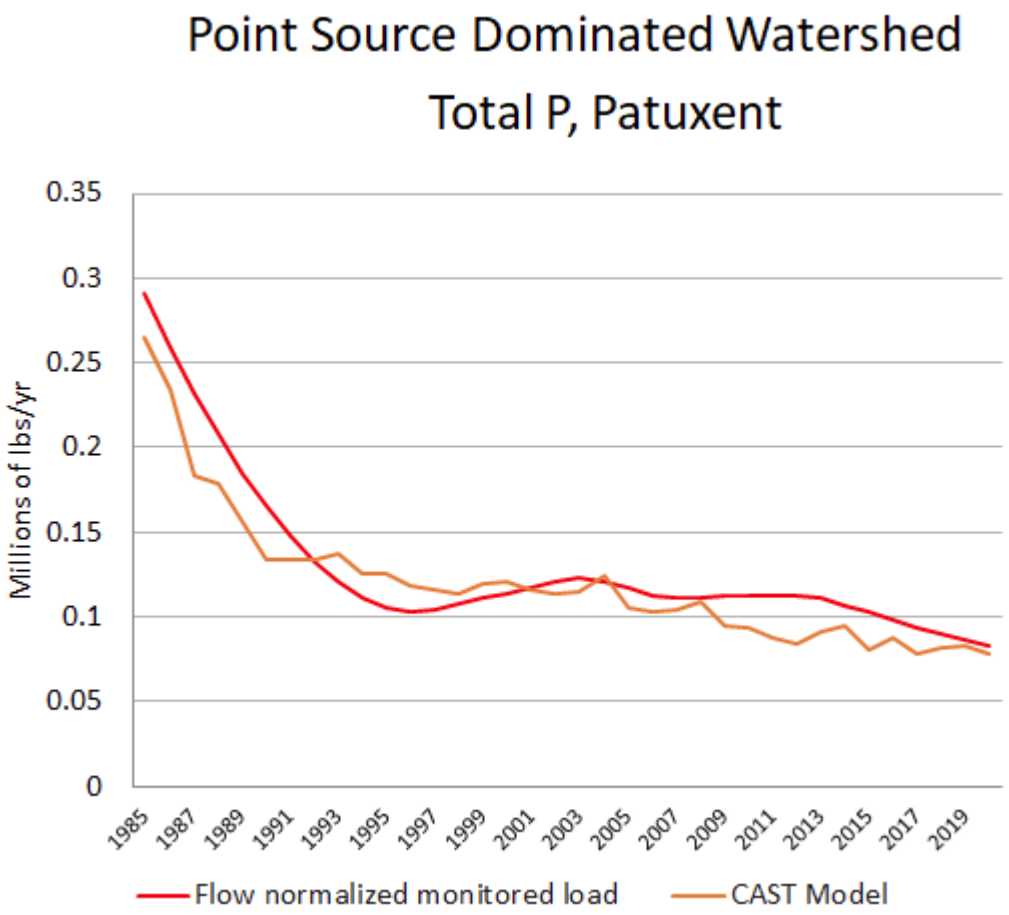


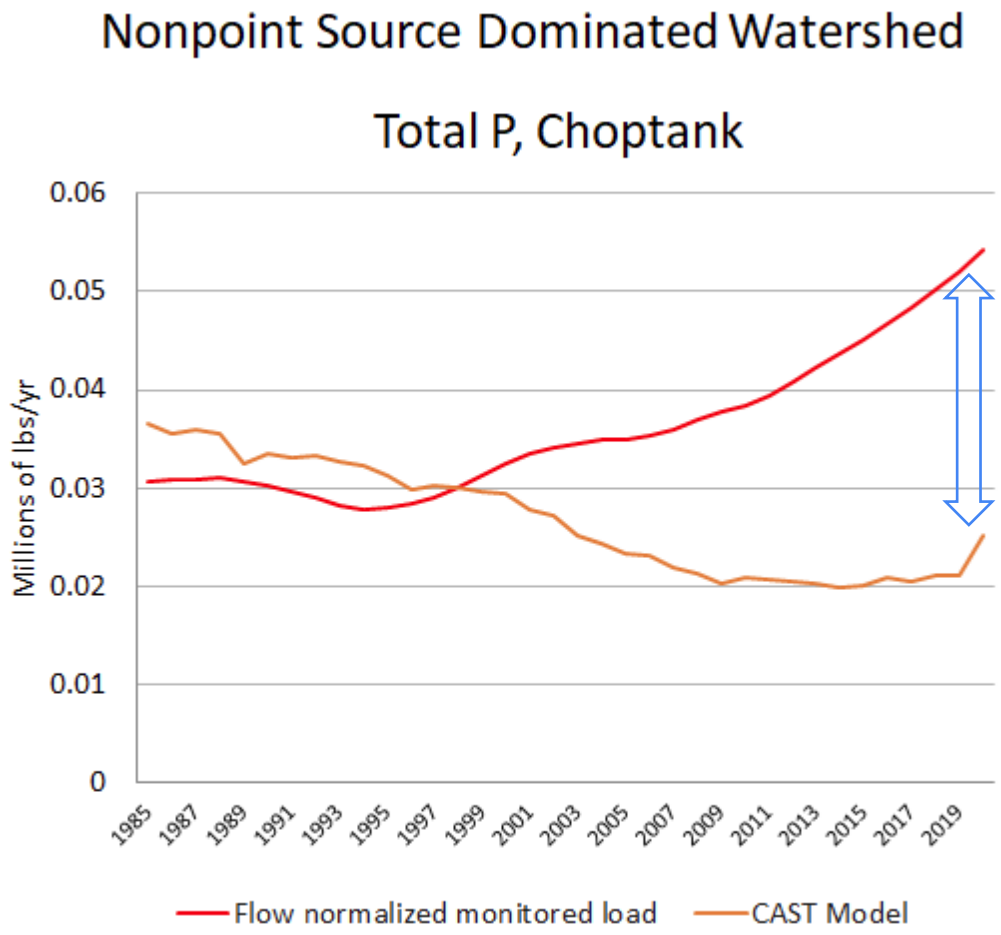
CAST Estimates of N Load to Chesapeake Bay, 2020



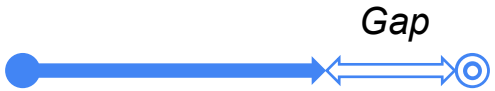
Response Gap (particularly phosphorus)







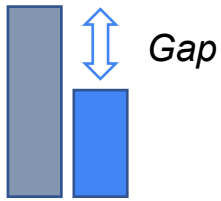
Why Do We Have These Gaps?



Implementation Gap

Limits to Adoption (cost-share)

Mass Nutrient Imbalances



Response Gap

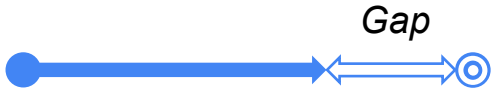
Lag Time/Legacy Pollutants

BMP Effectiveness

Behavior

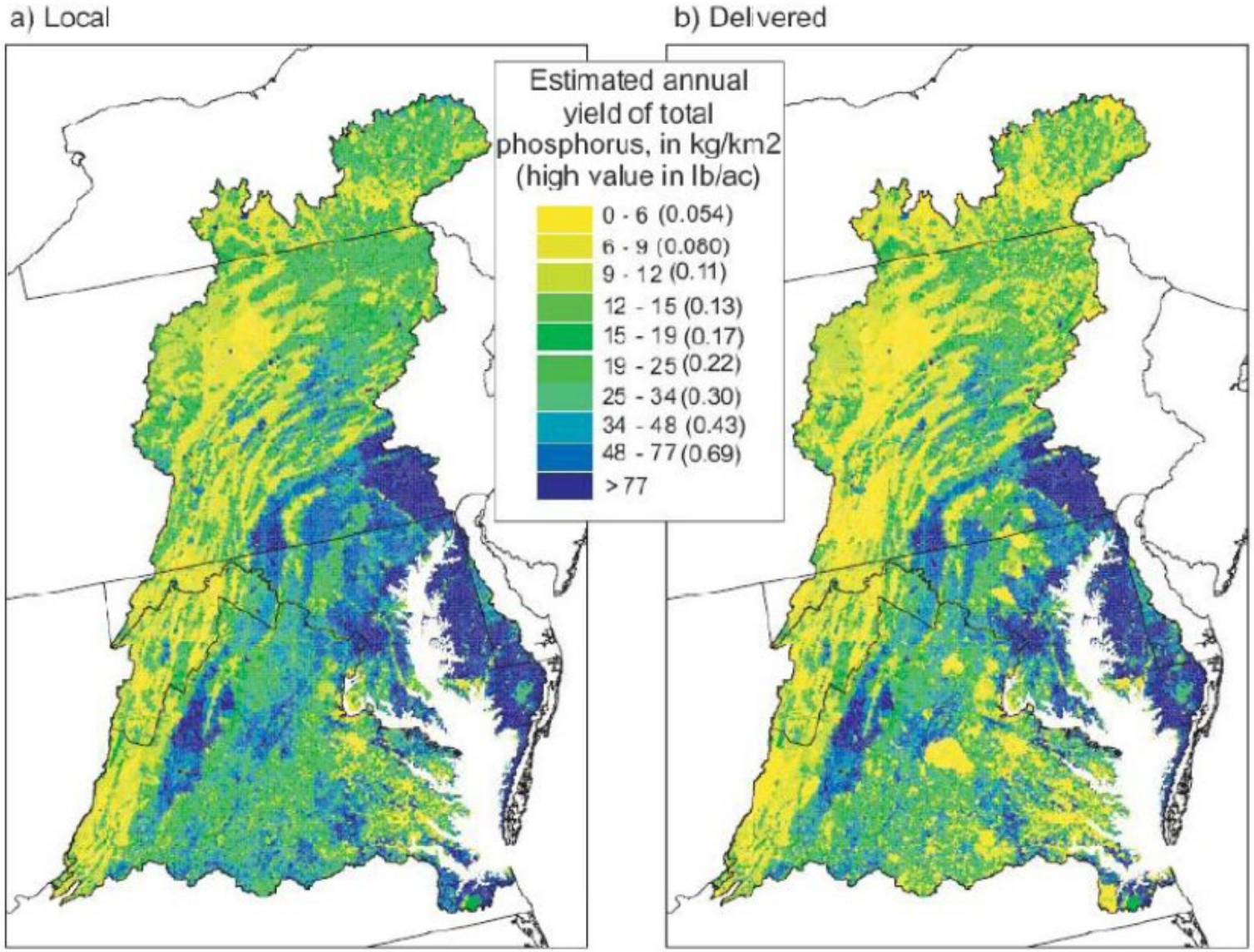
Data/Monitoring Limitations

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



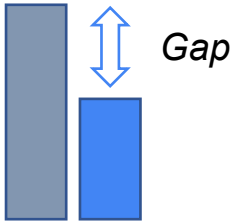
Mass Balance

Gap

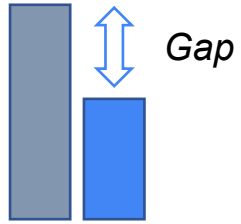


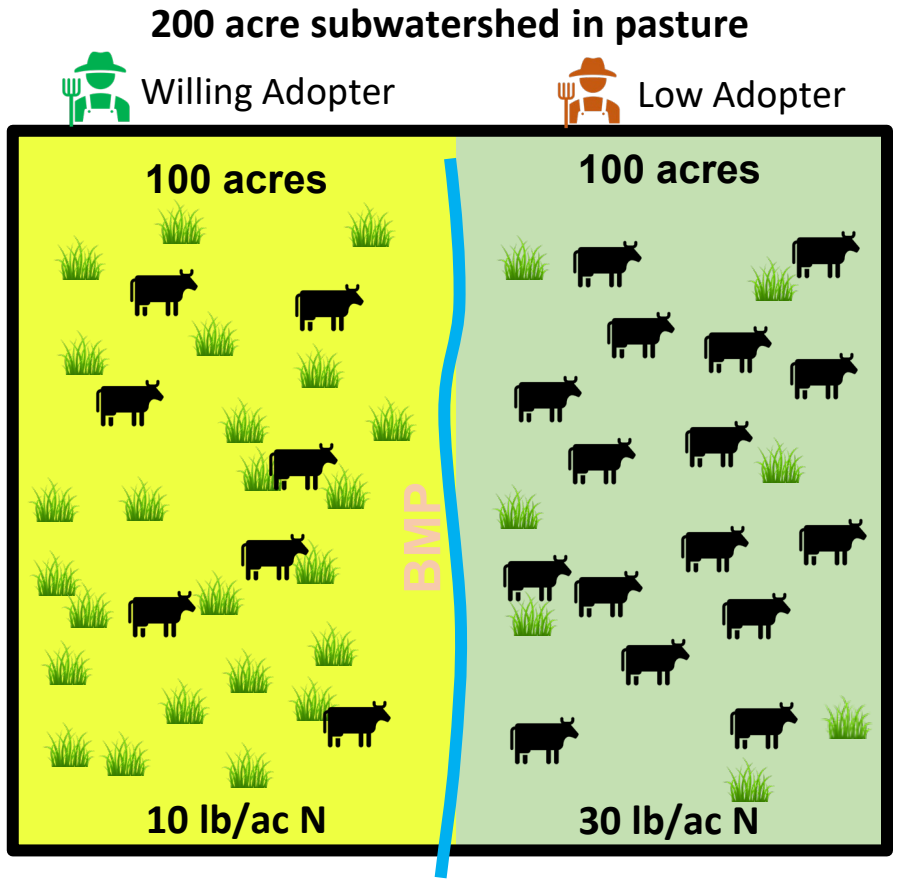
Source: USGS Sparrow Model Output

Response Gap: BMP Effectiveness



Response Gap: Behavior





Avg 20lb/ac N runoff

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

Improving Pollutant Reduction Response

POLICY: There are opportunities to improve program effectiveness, but it will require policy change.

- Shift the focus to **achieving outcomes** and away from counting practices.
- Emphasis and understanding of mass balance
- Willingness to reform and experiment

Water Conditions

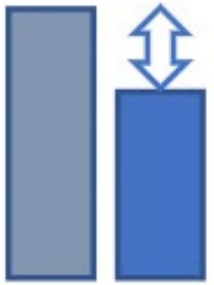
Water Quality Response

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

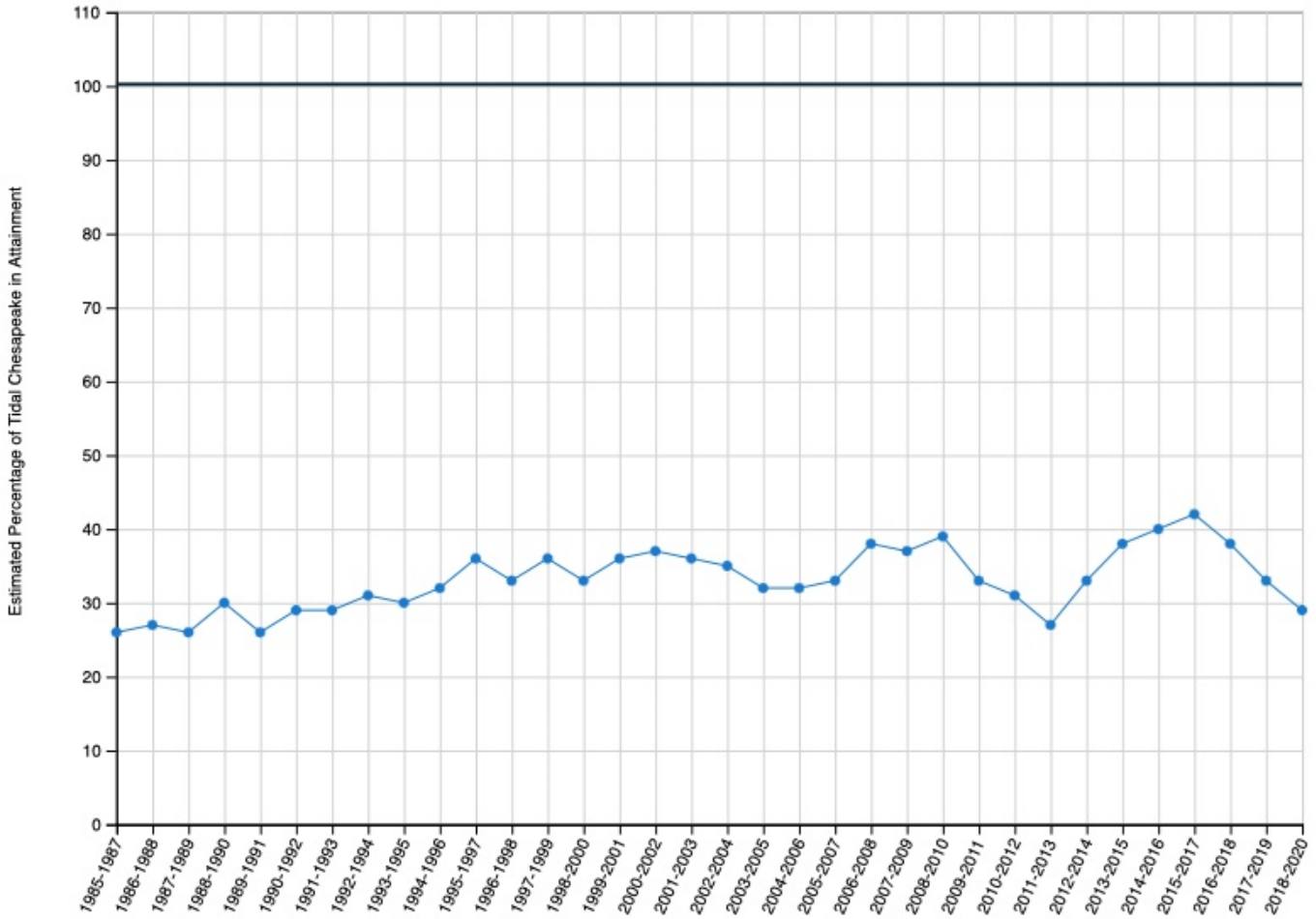
b) Why is there a gap in the response between what we have measured and that which we expected?



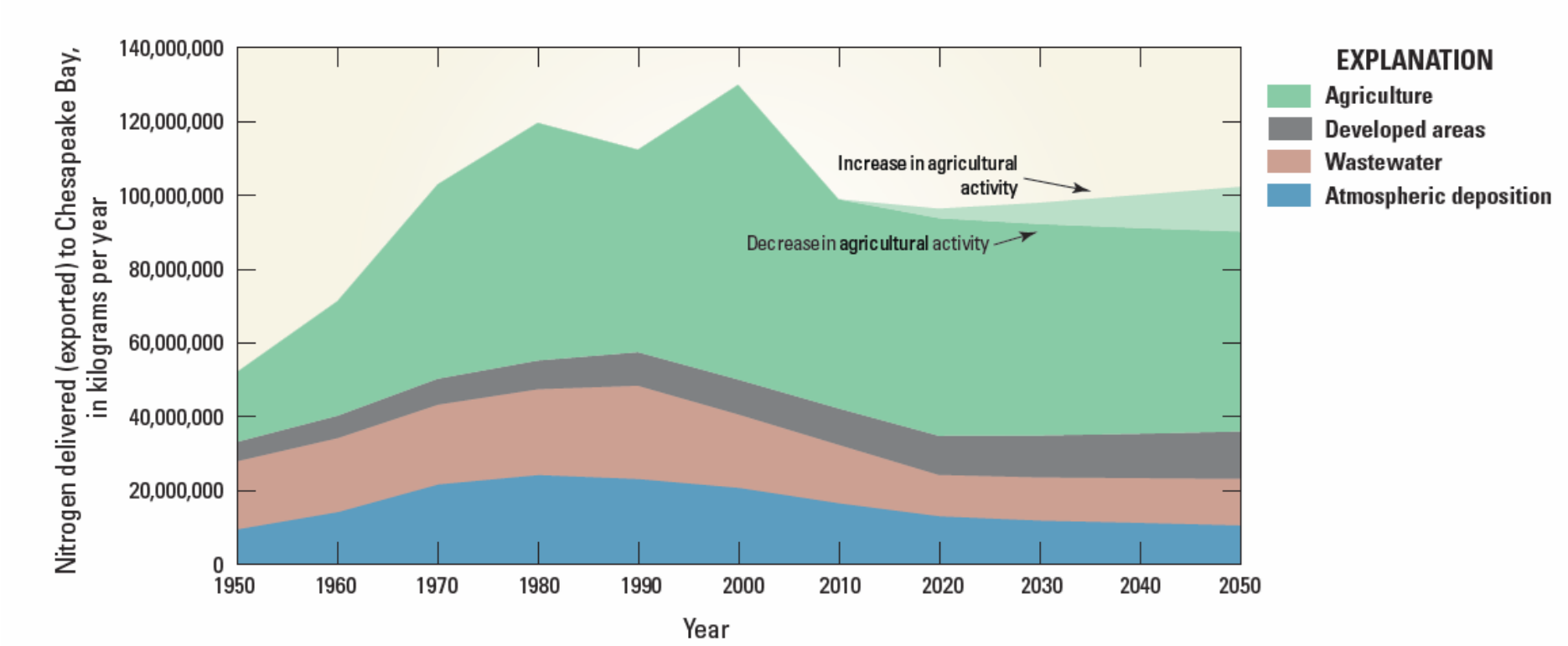
Water Quality Standards Attainment (1985-2020)

Water quality is evaluated using three parameters: dissolved oxygen, water clarity or underwater grass abundance, and chlorophyll a (a measure of algae growth).

VIEW CHART VIEW TABLE

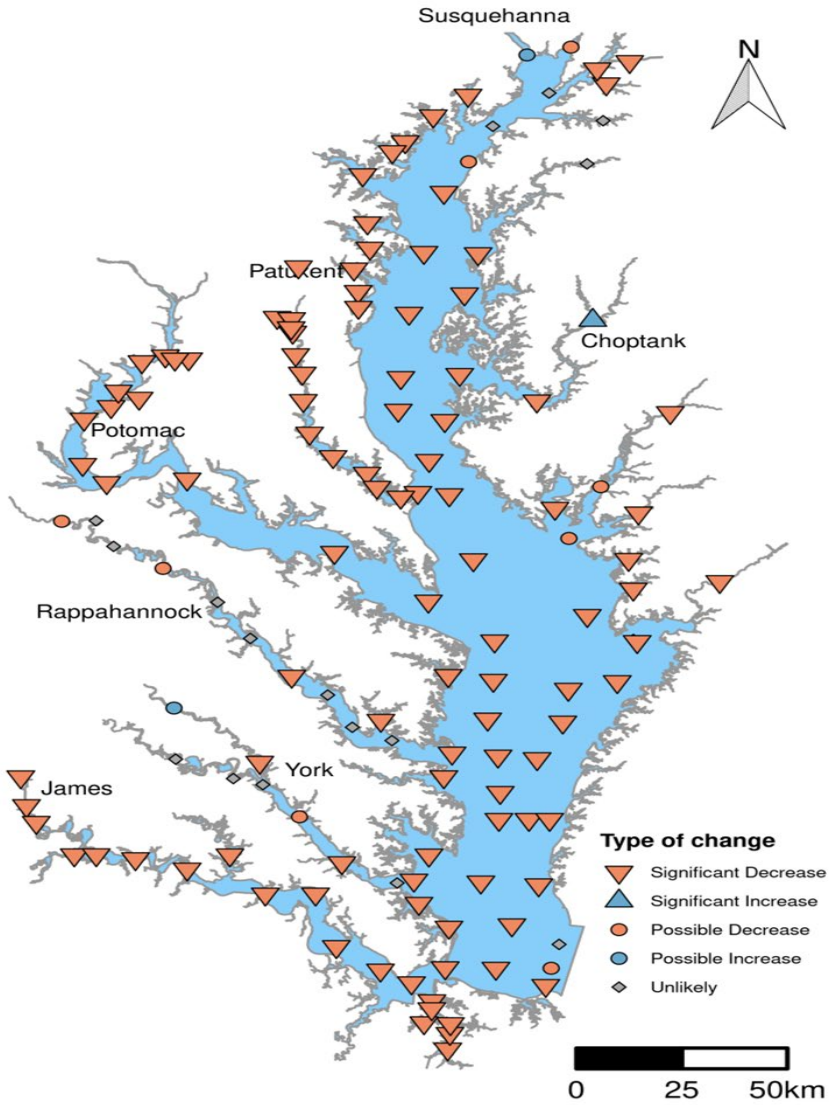


How Has Nutrient Load Changed Over Time?

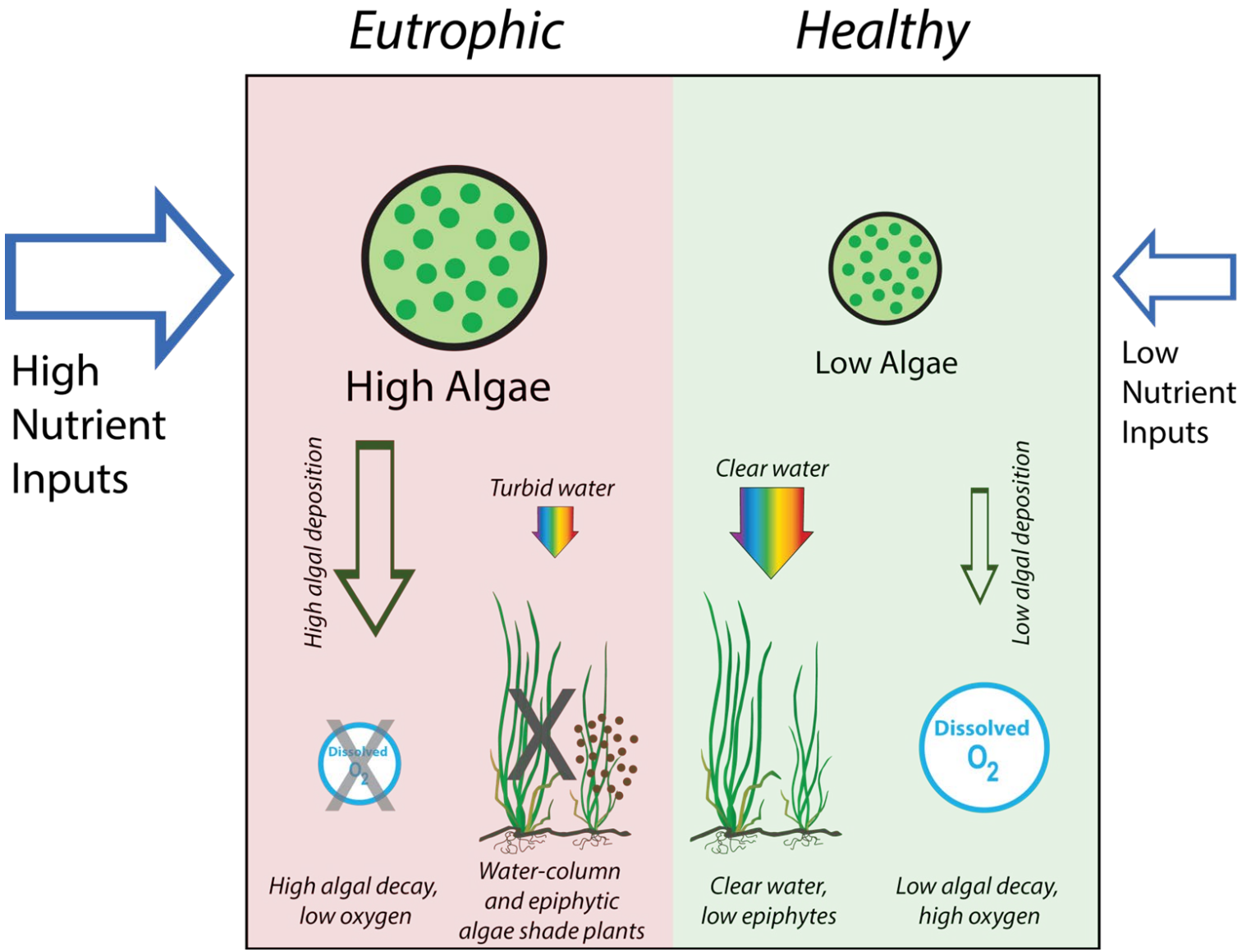


Water Quality Response at Bay Scale

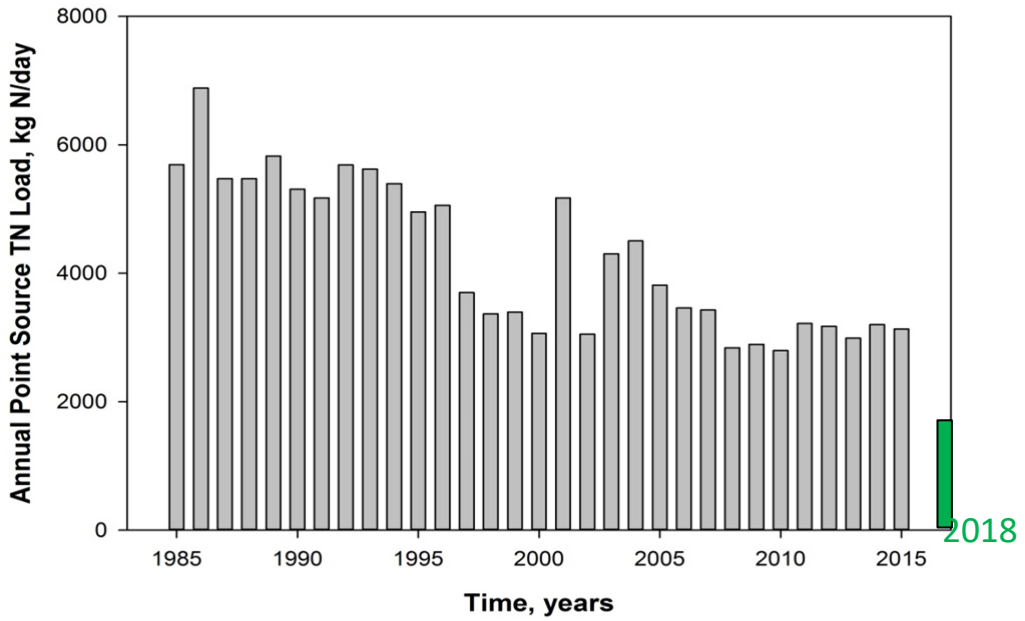
(1985-20XX? long term trends correct?)

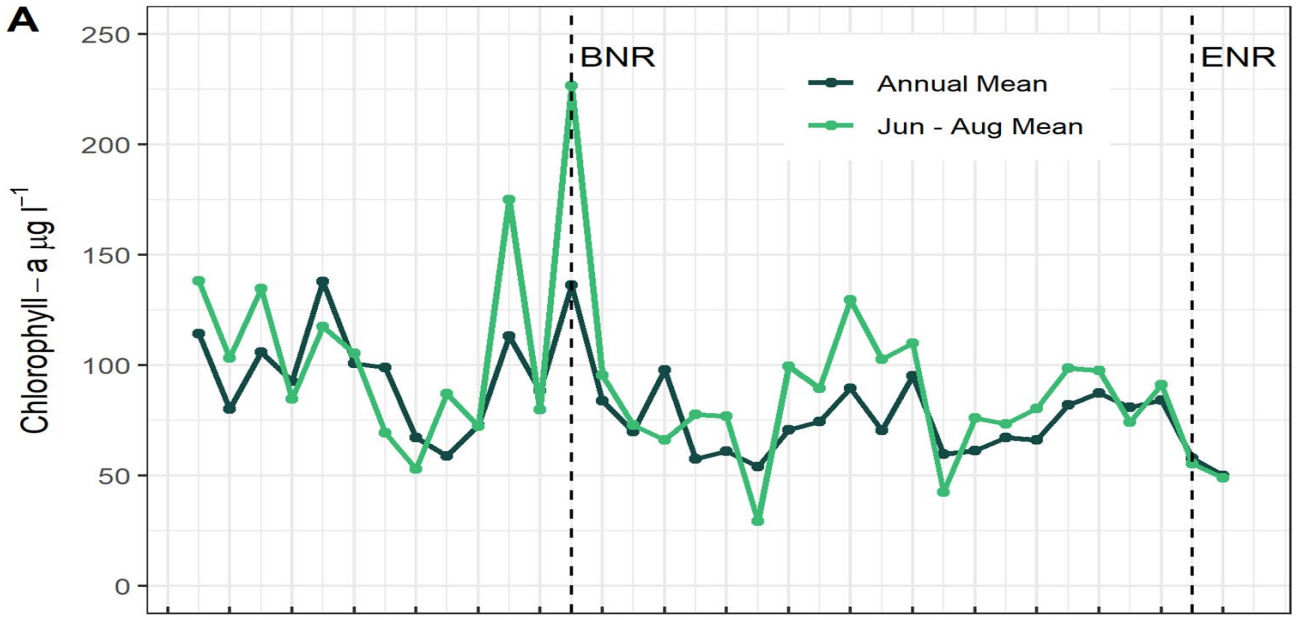


Our Most Basic Model of Bay Water Quality



Water Quality Response at Local Scales: Back River

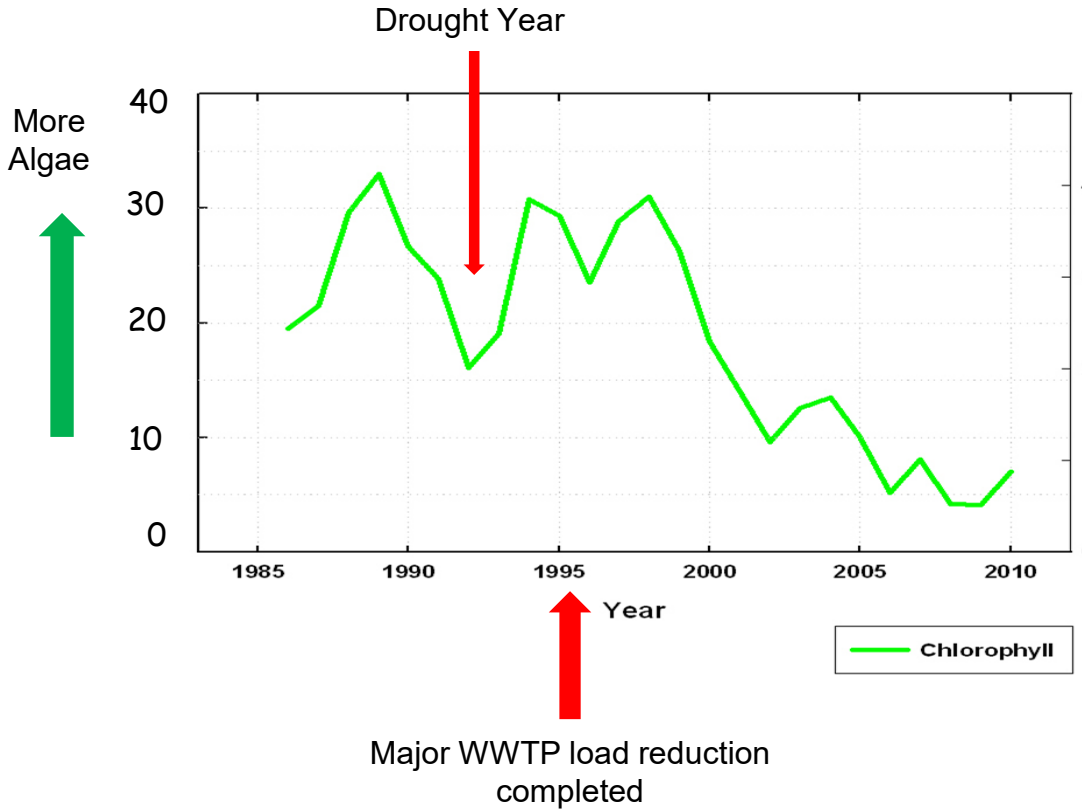




Water Quality Response at Local Scales: Mattawoman Creek

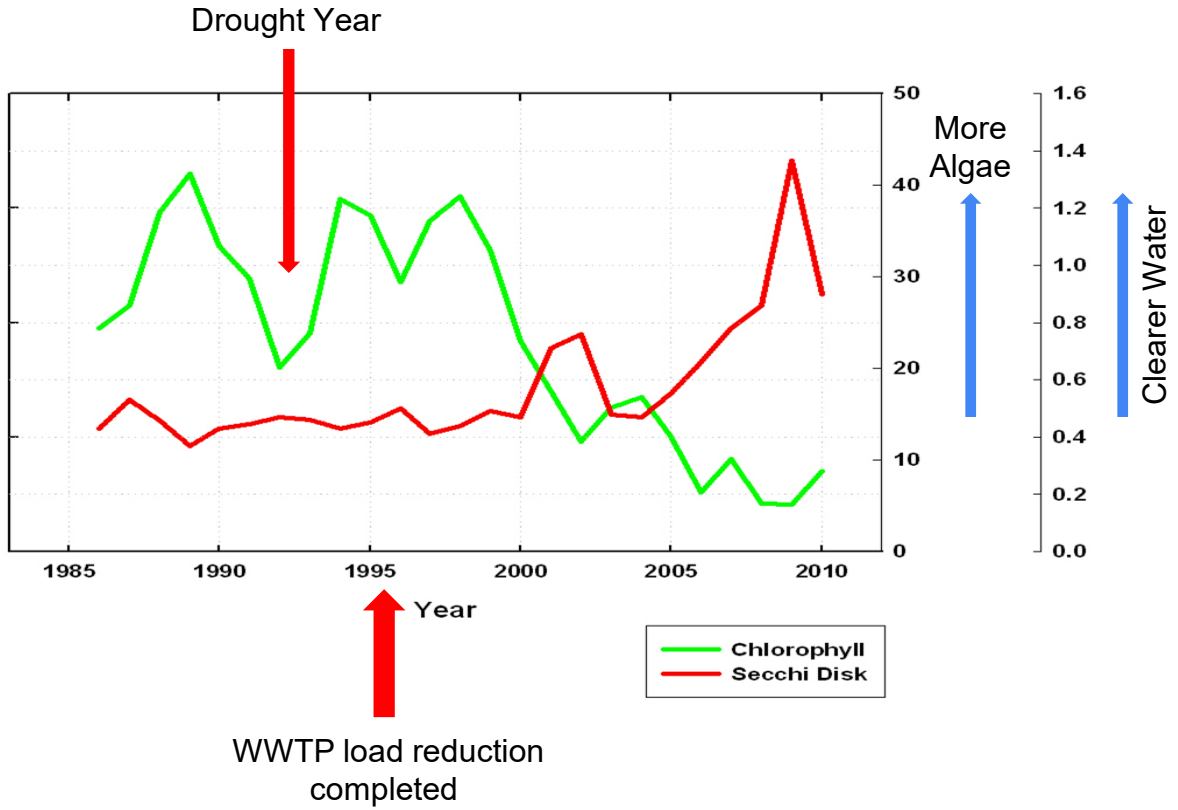
Photo from Elena Gilroy

Algal Biomass Decreased …with Substantial Lag Time



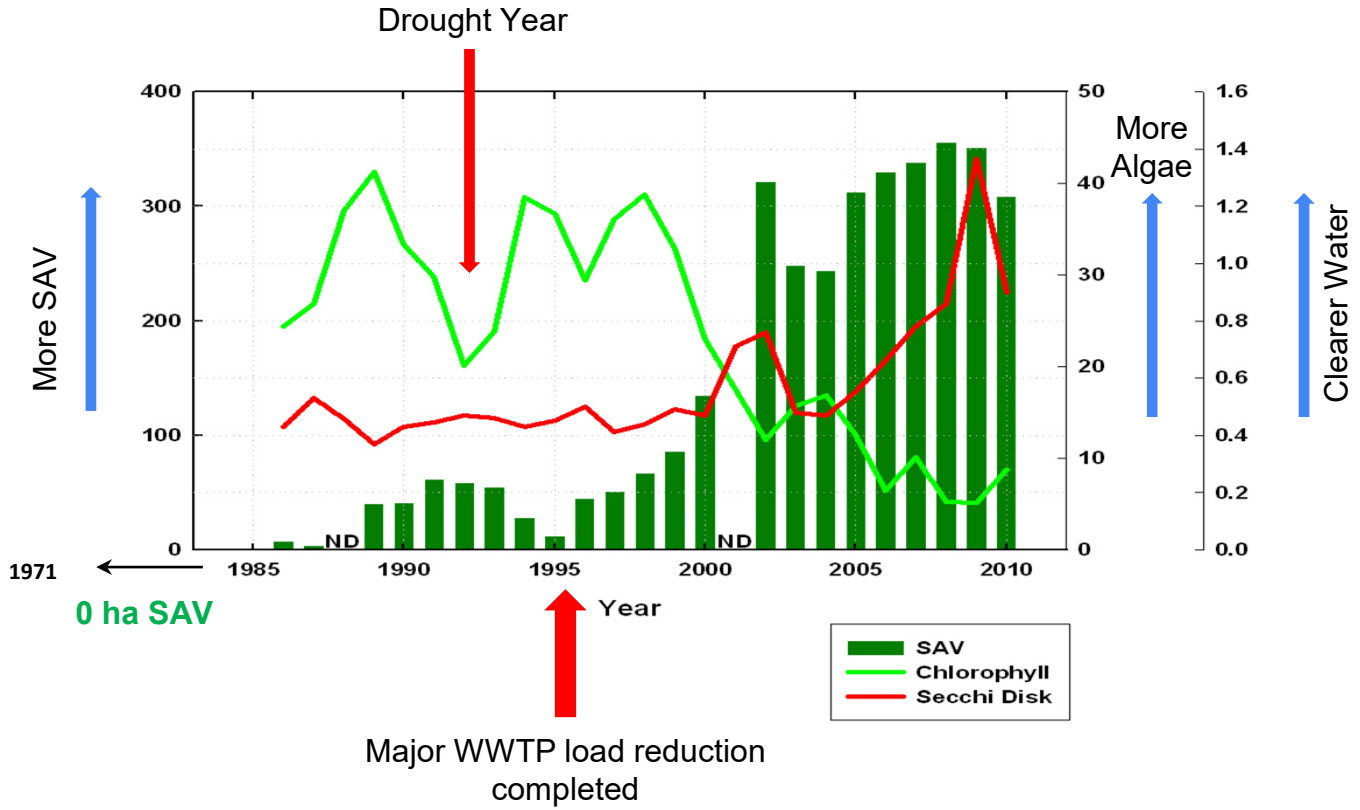
- No clear response for about 4 years followed by sharp decline in algae
- After 2005 low levels of algae became normal

Water Clarity Increased …Also with a Lag Time



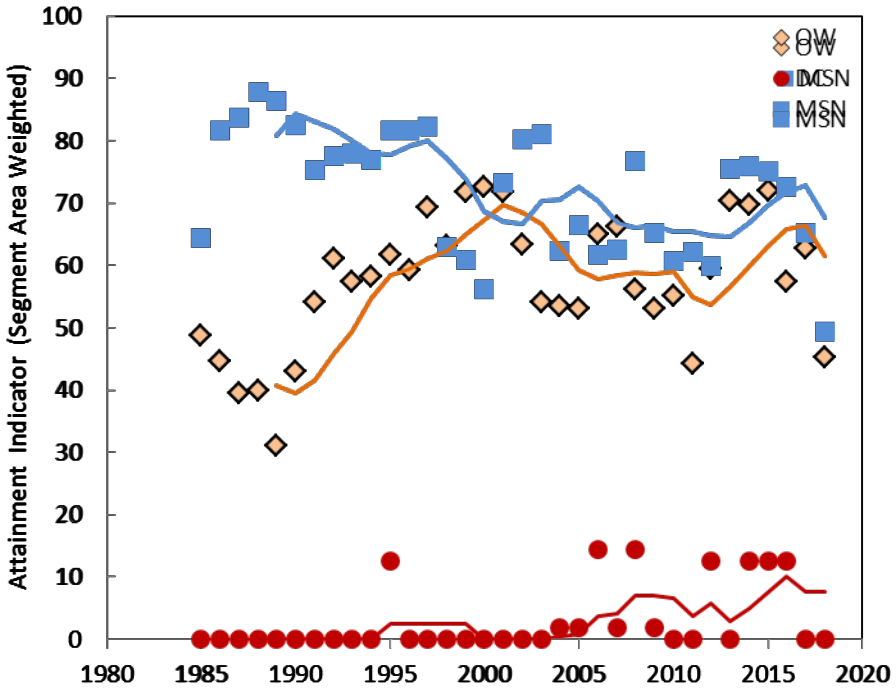
- No clear increase for about 8 years followed by sharp increase in clarity
- Water clarity and algae highly correlated in shallow Chesapeake Bay systems

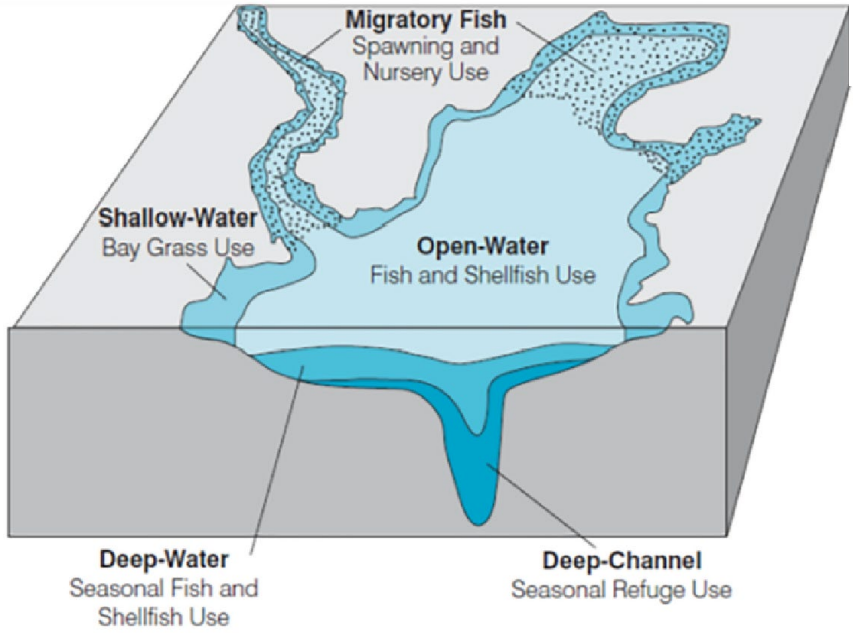
SAV Increased …Shorter Lag with Threshold Response



- Very low levels of SAV were present prior to nutrient load reductions
- Major expansion of SAV in 2002, a severe drought year
- SAV relatively stable after 2002; lag in SAV relatively short

Breaking Down WQC Attainment

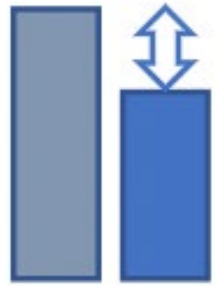




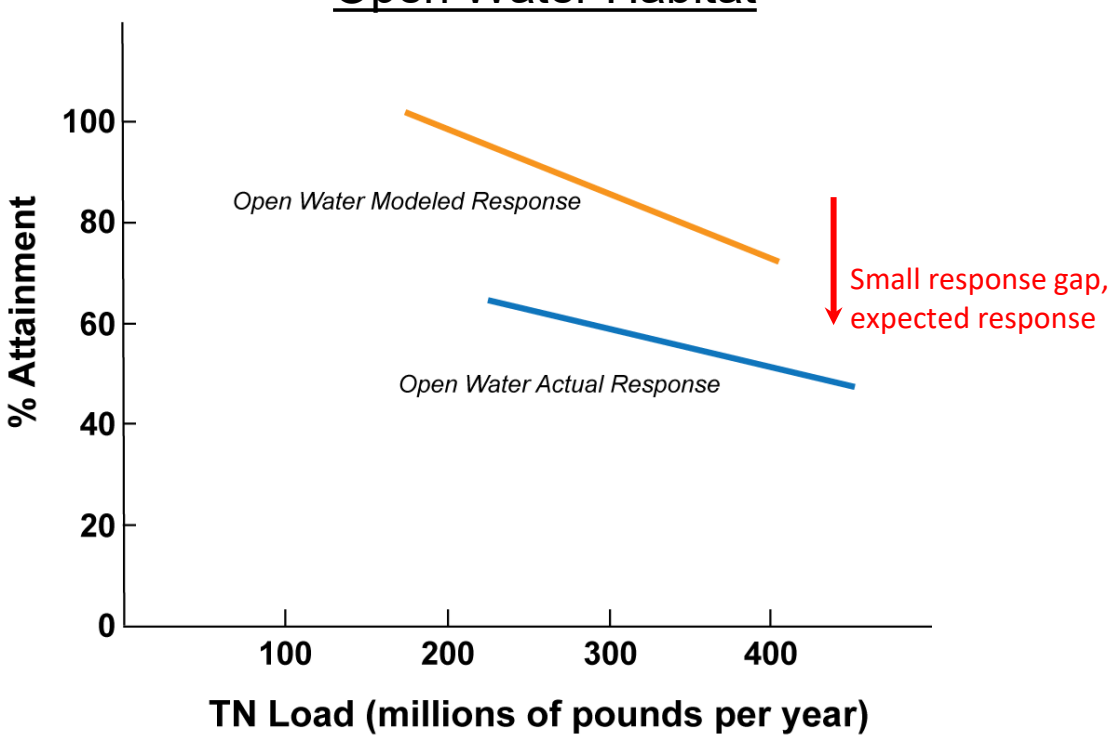
We have estimates of Baywide water quality criteria over the period in which nutrient load reductions have been made.

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

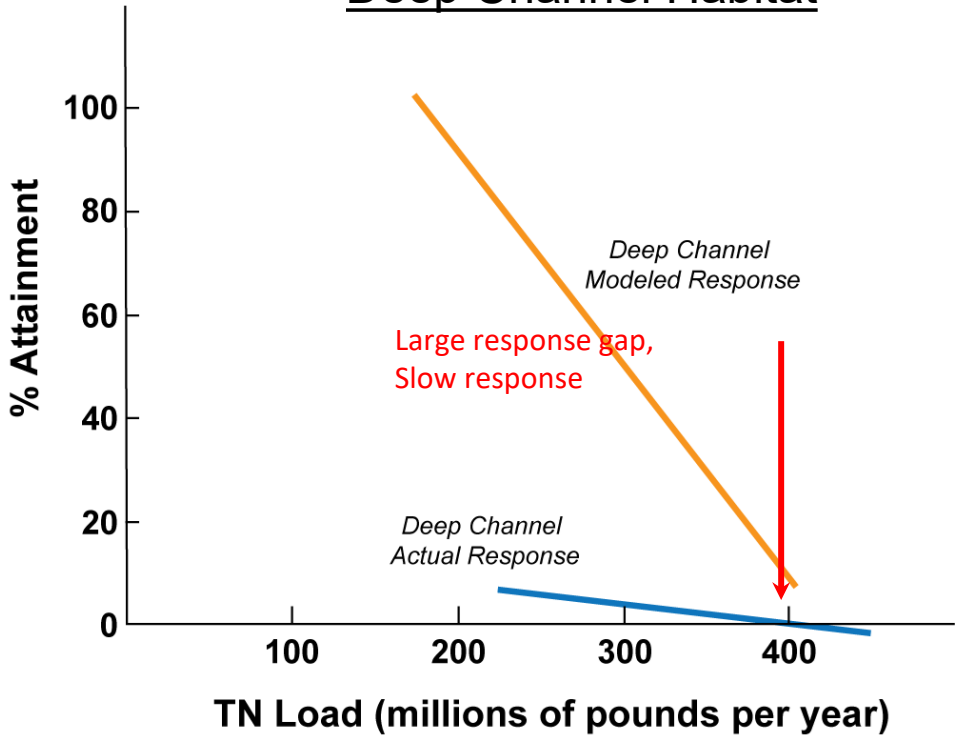
We have observed a response gap for some habitats for dissolved oxygen.



Open Water Habitat



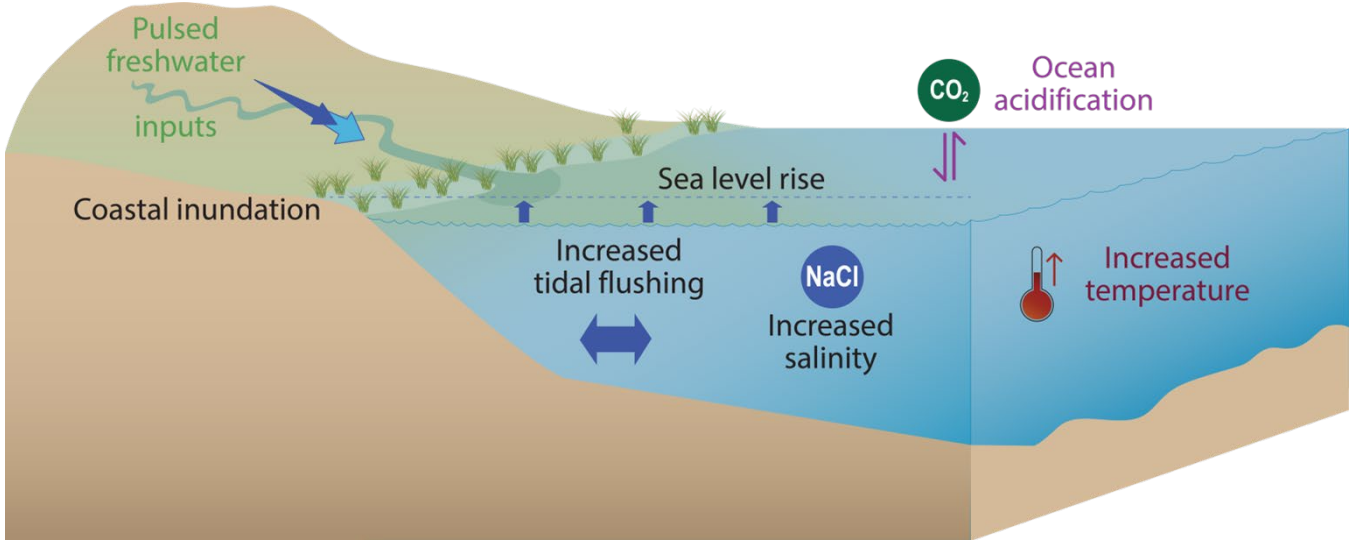
Deep Channel Habitat



Why Do We have Response Gaps?

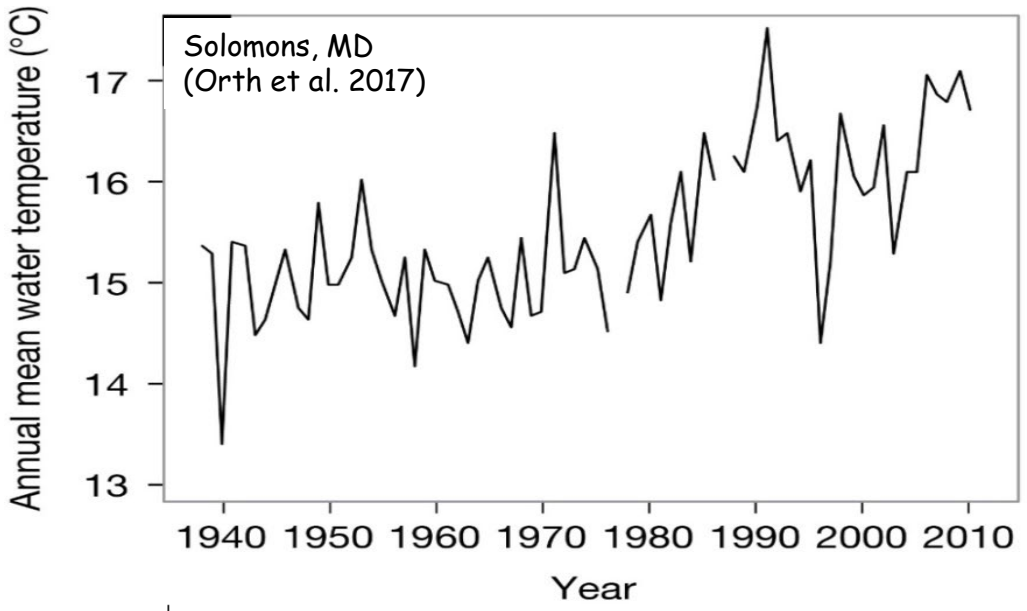
Some Answers (all have uncertainties):

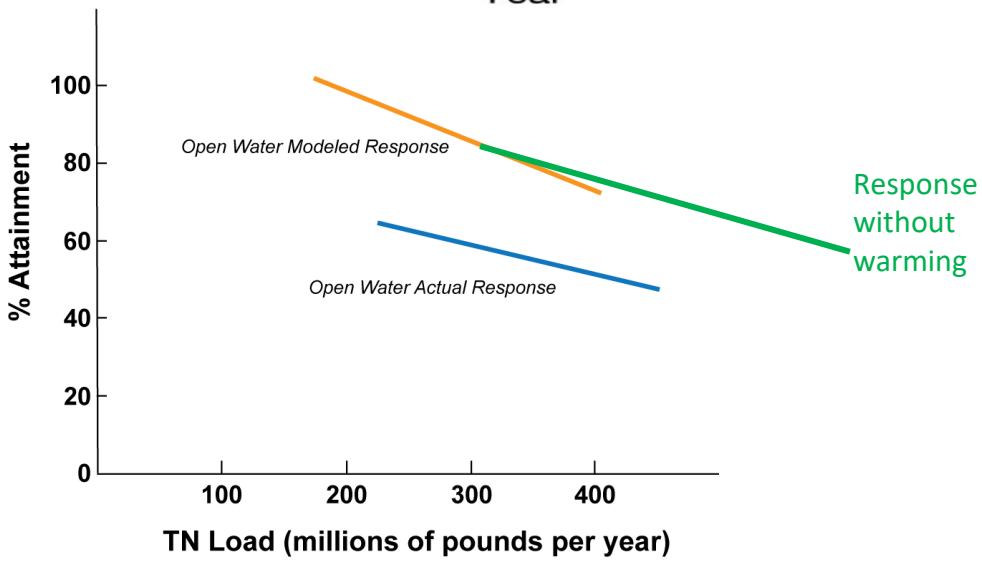
(a) **Climate change**: warming, sea level rise, precipitation

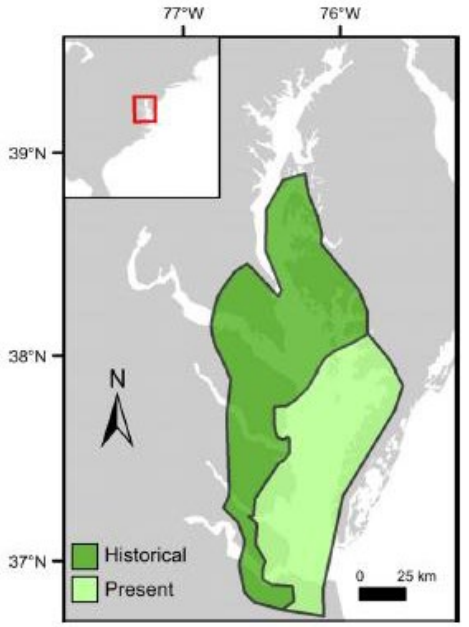


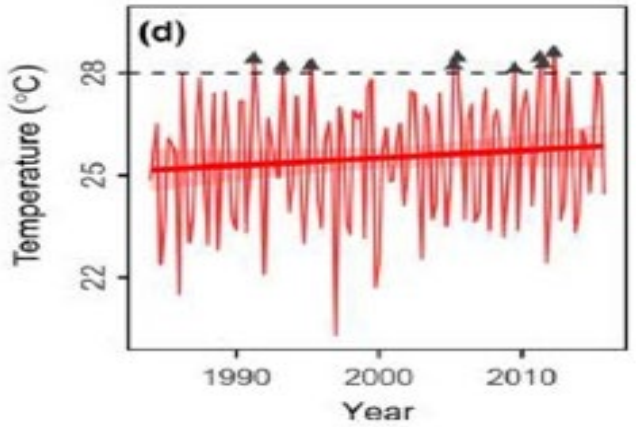
(b) **Tipping points and associated feedbacks**: Features that make Bay changes not always immediately available

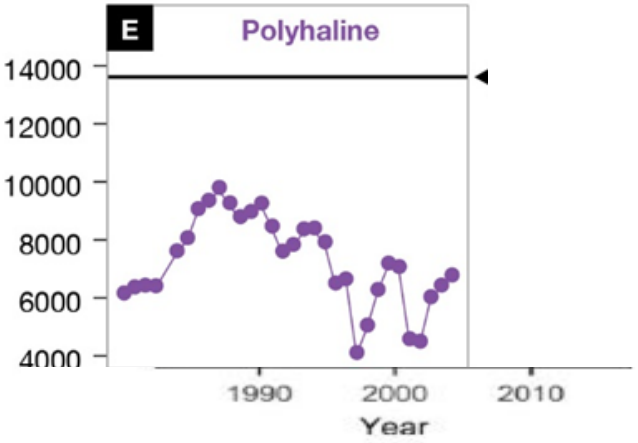
Climate change has already impacted the Bay. We can't control this.



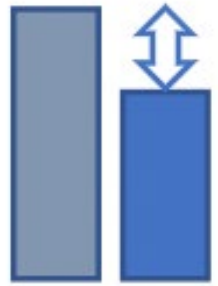


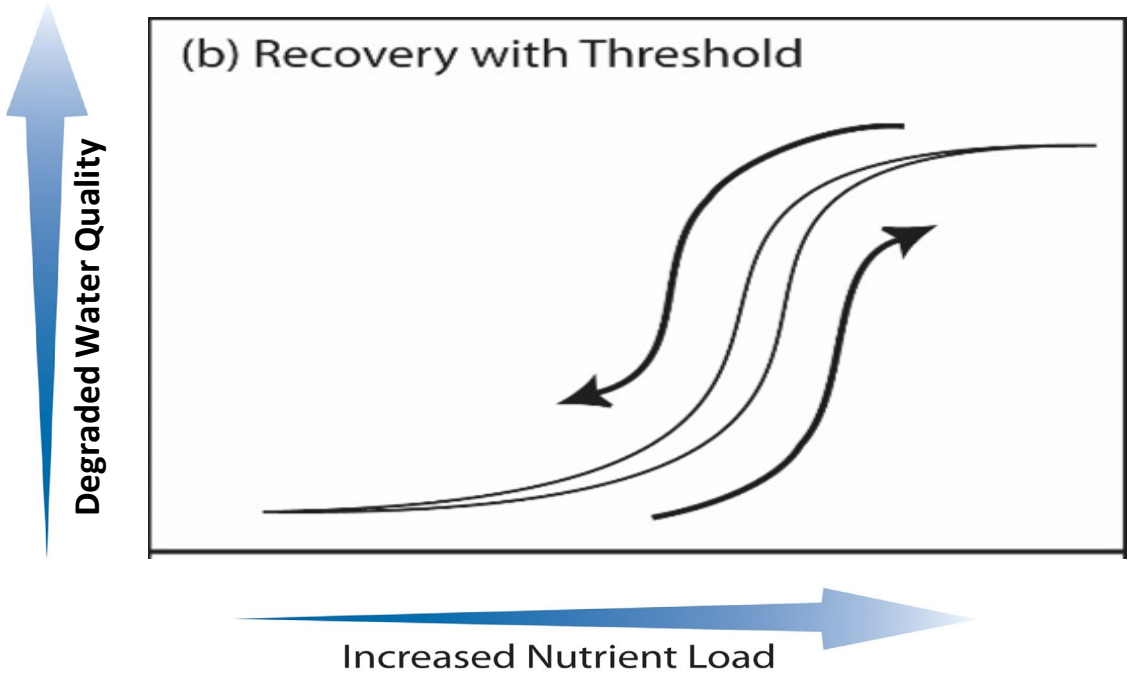


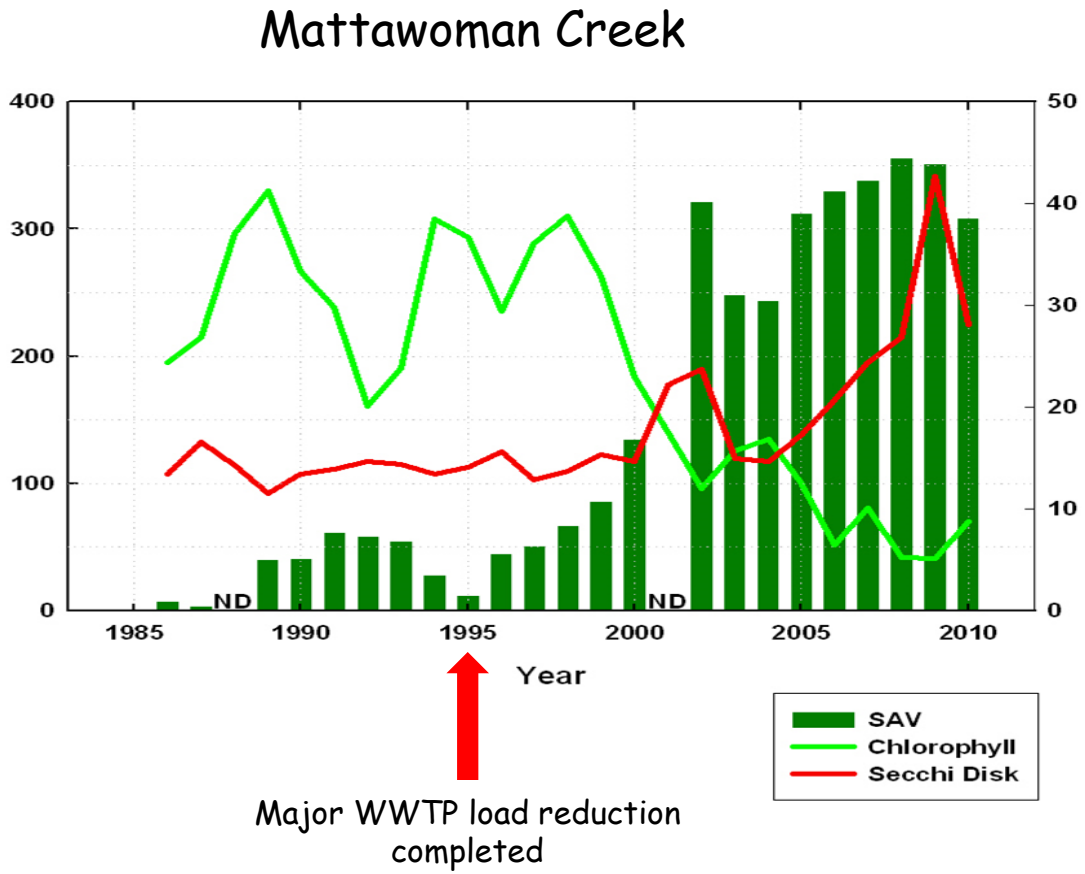




Tipping Points and Feedbacks:
Where Restoration Stalls, or Takes off

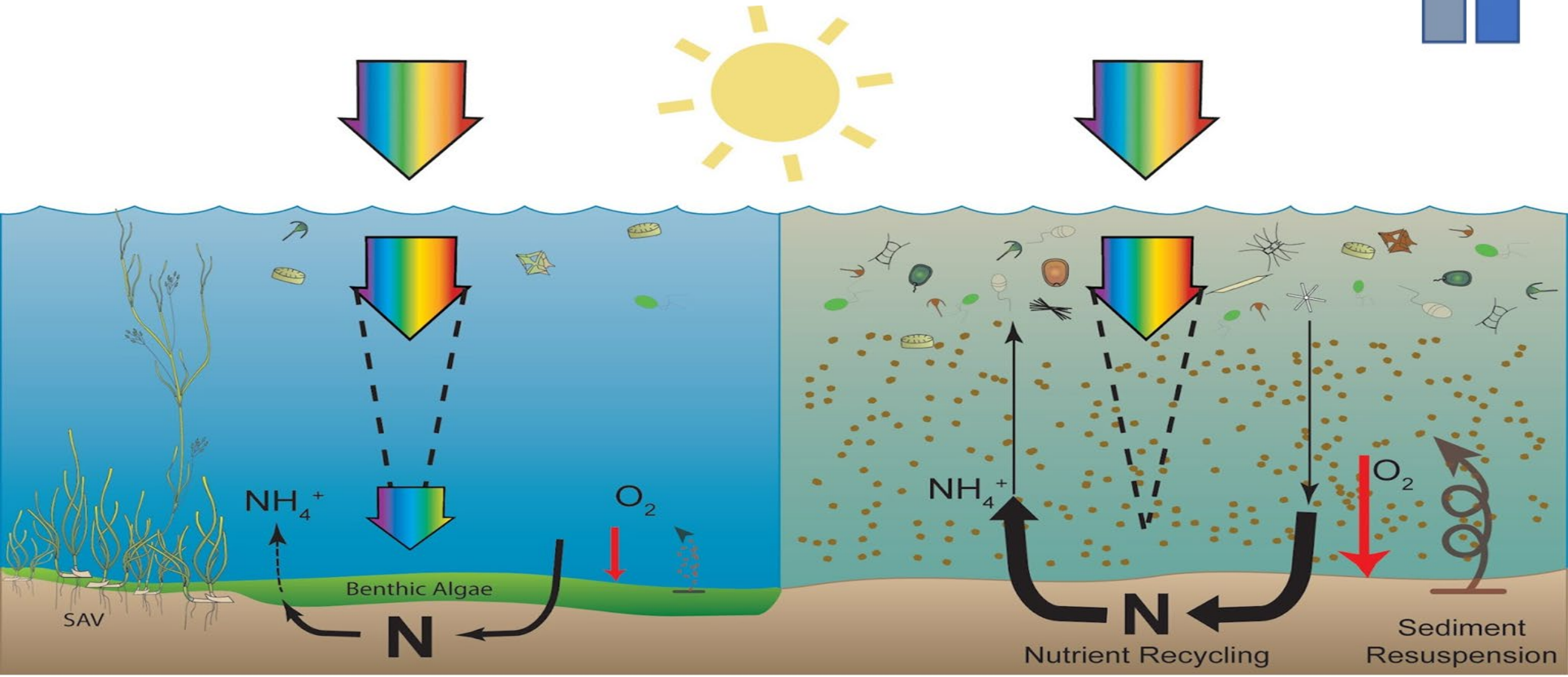




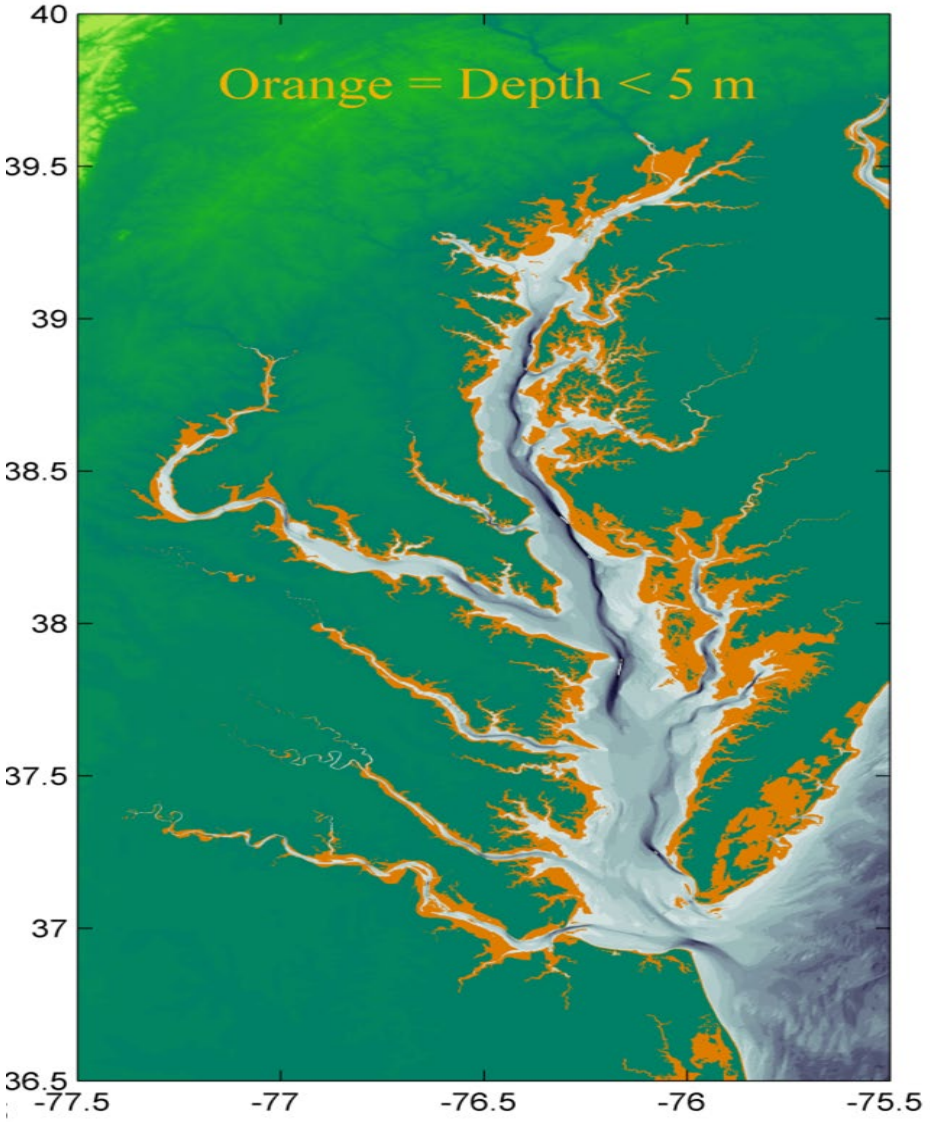


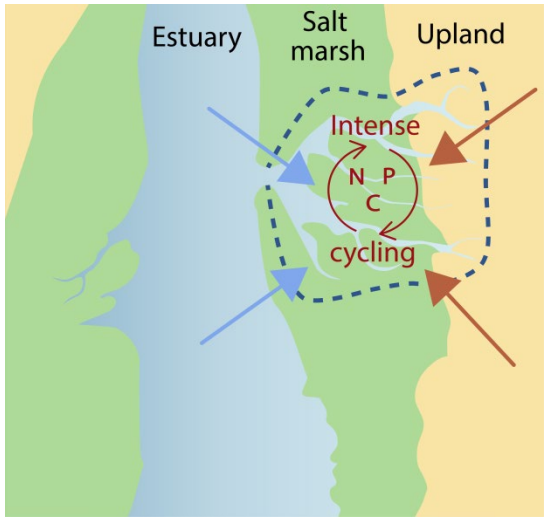
SAV off Poplar Island in late summer 2015

Sediments That Receive Light Trap Nutrients



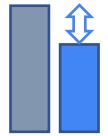
Opportunities For Shallow Water Restoration

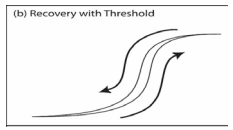




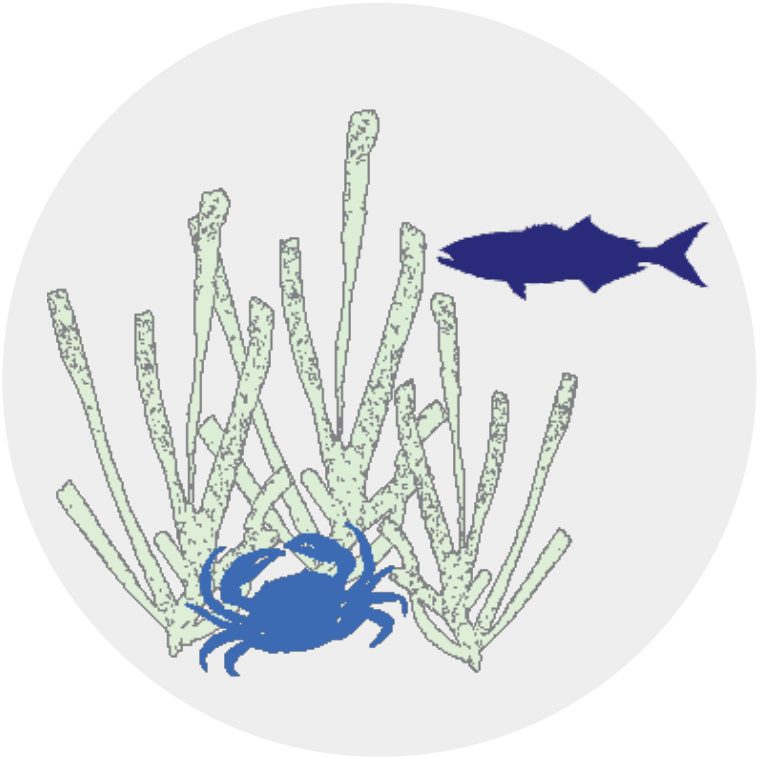
FINDING: Uncertain if it is possible to achieve water quality criteria (DO, SAV), **but** efforts have stemmed further declines in water quality.

- 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.





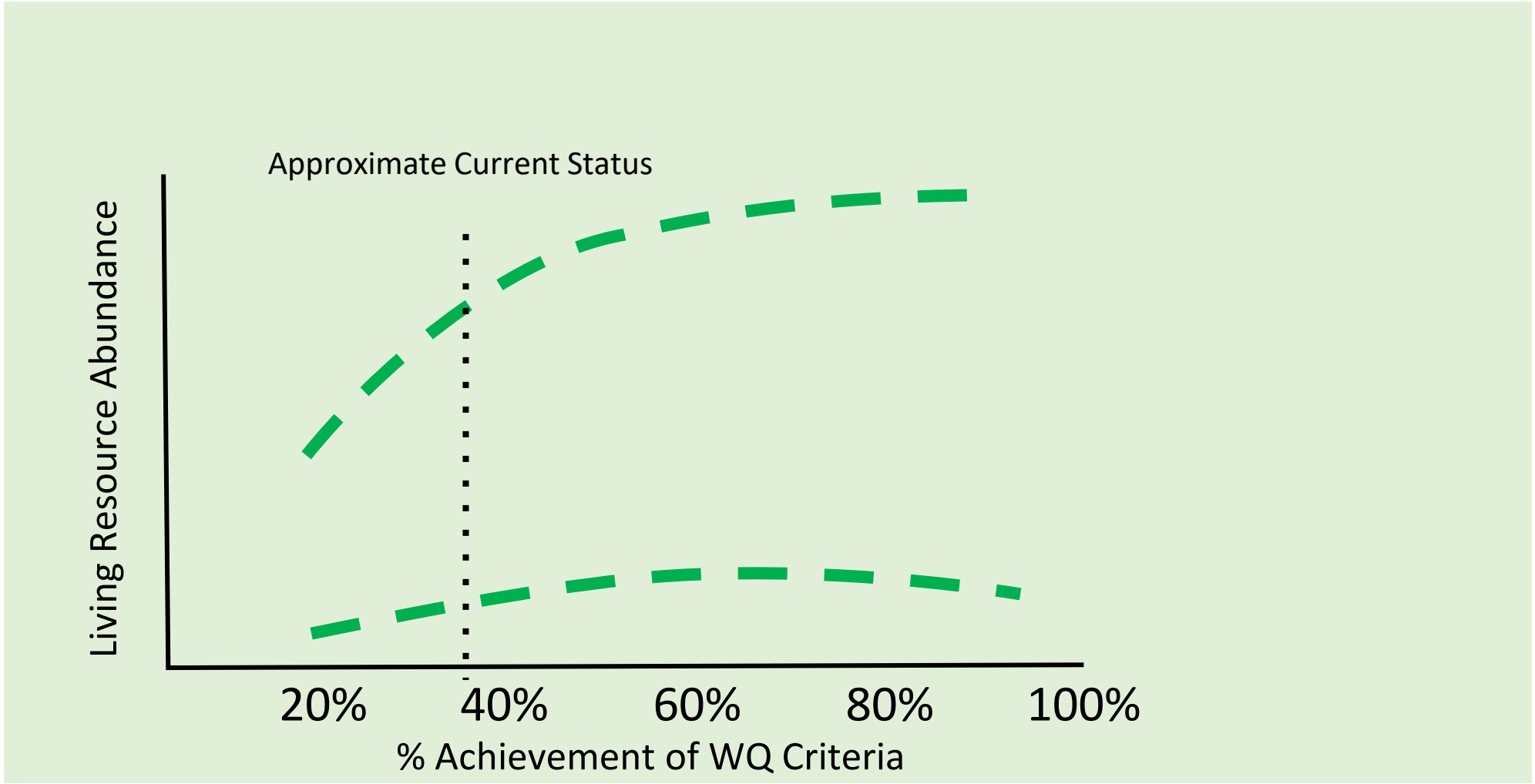
Living Resources



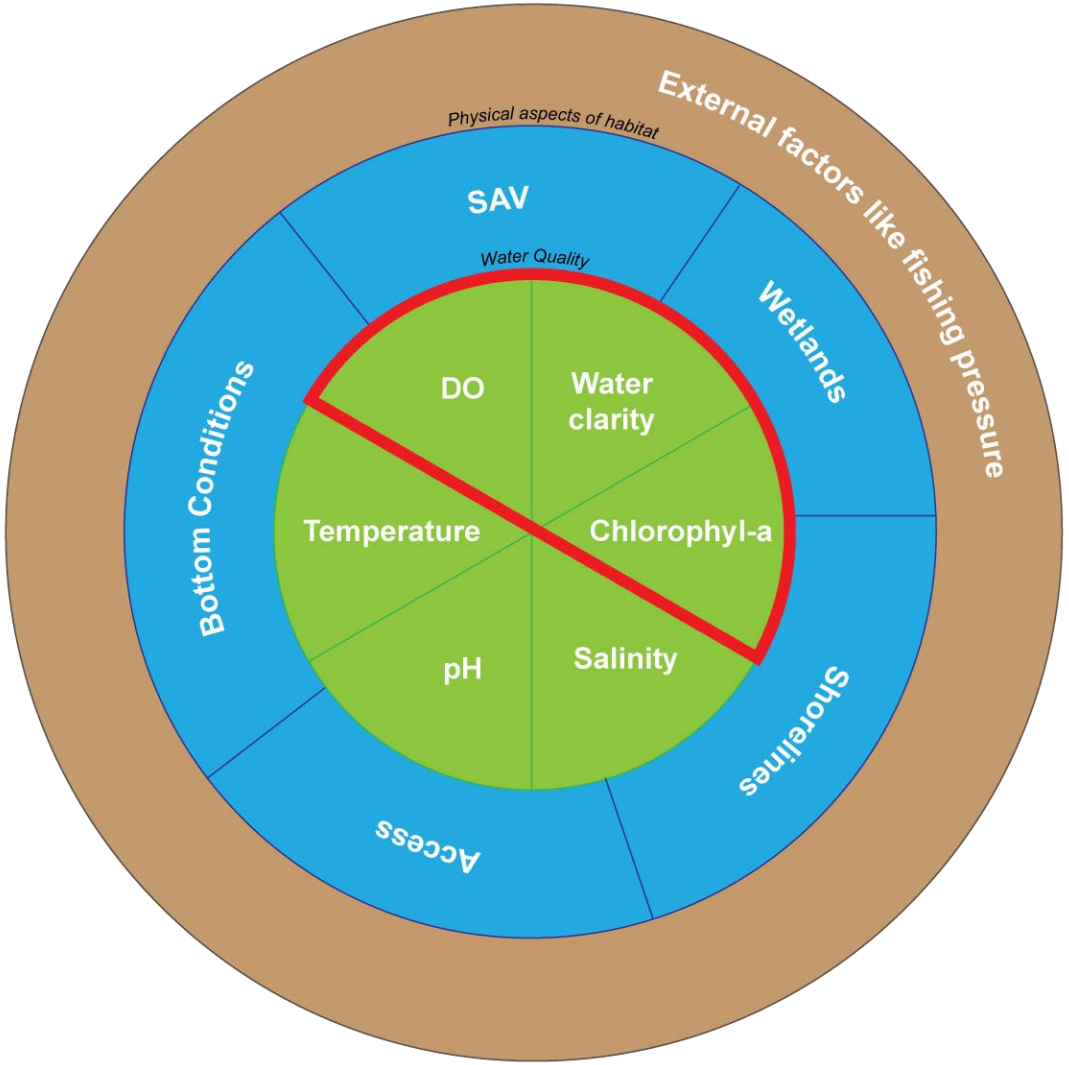
Living Resources Response

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)?

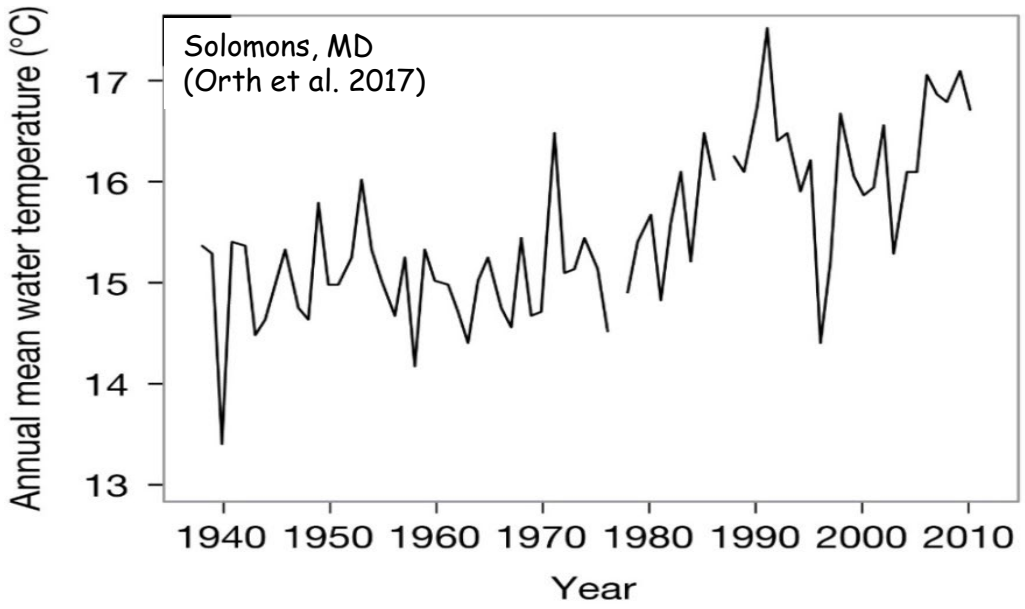

Approximate Current Status
Living Resource Abundance
20%
40%
60%
80%
100%
% Achievement of WQ Criteria

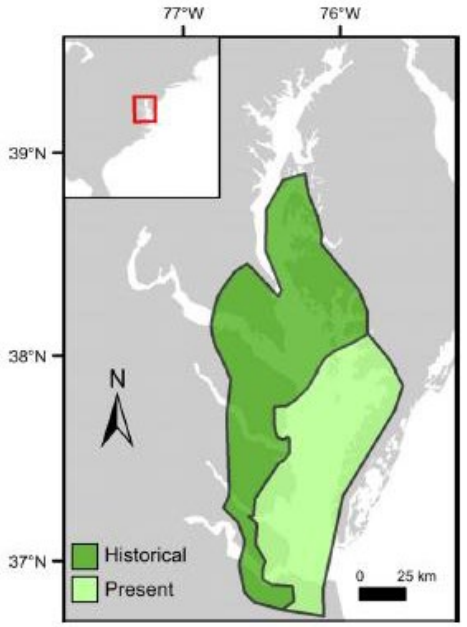
Many Knobs of Living Resource Response

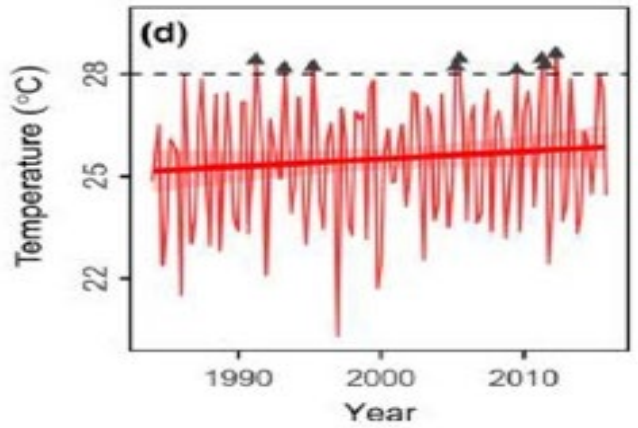


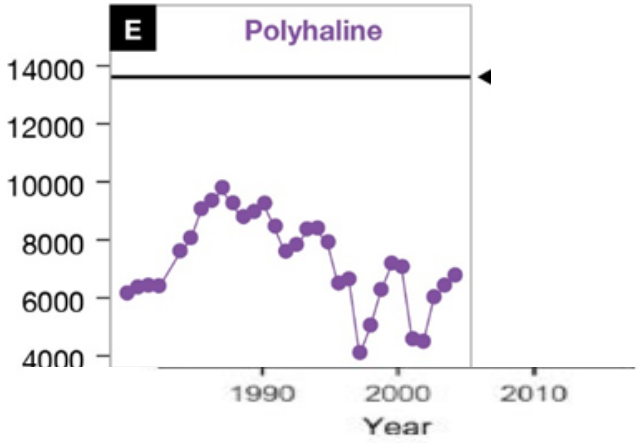
Managed by Bay water quality standards

Climate change has already impacted the Bay. We can't control this.

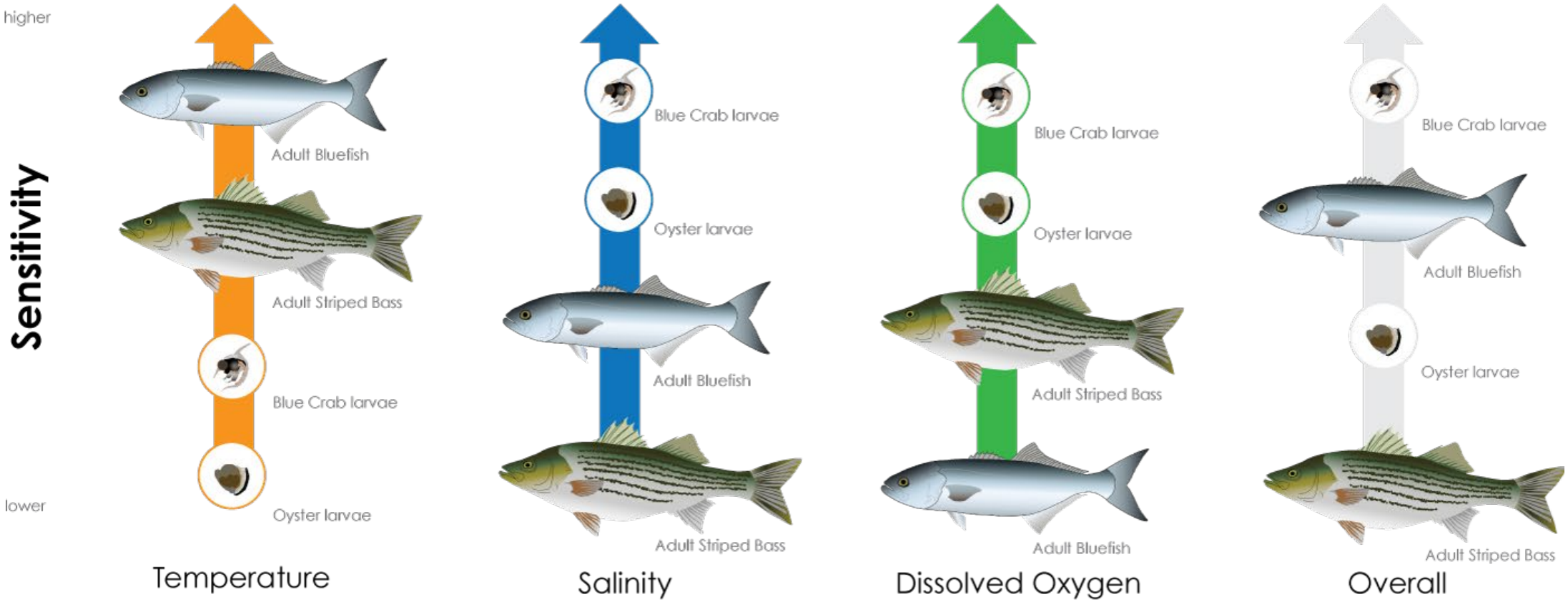


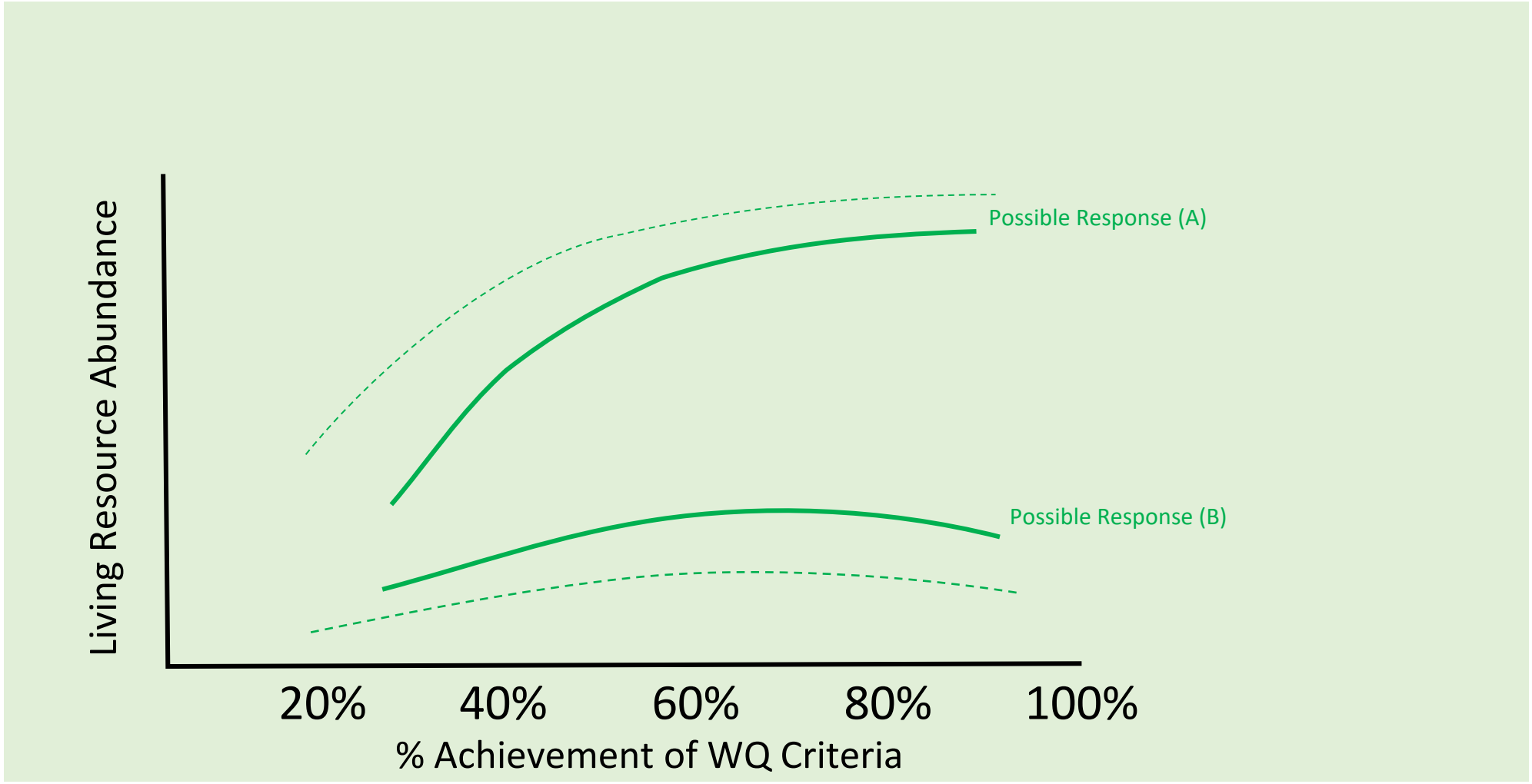




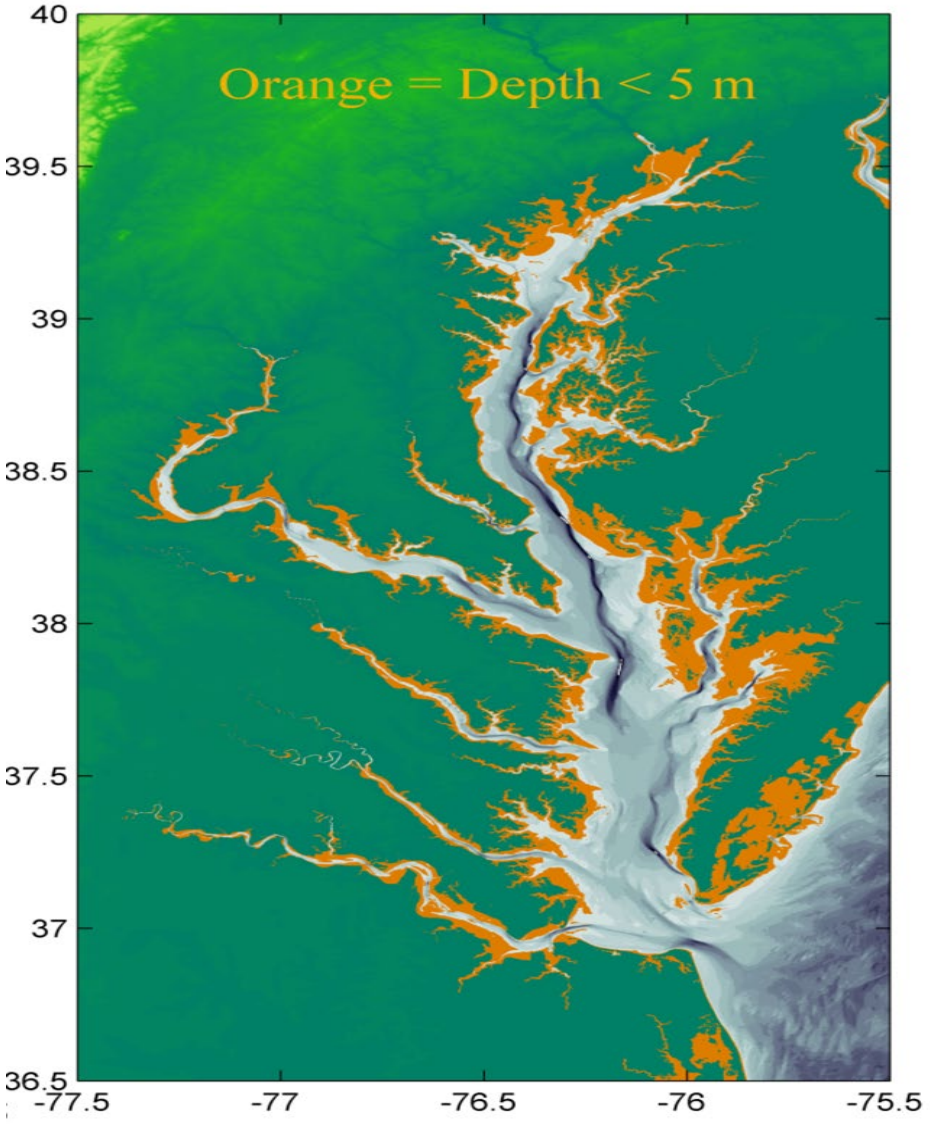


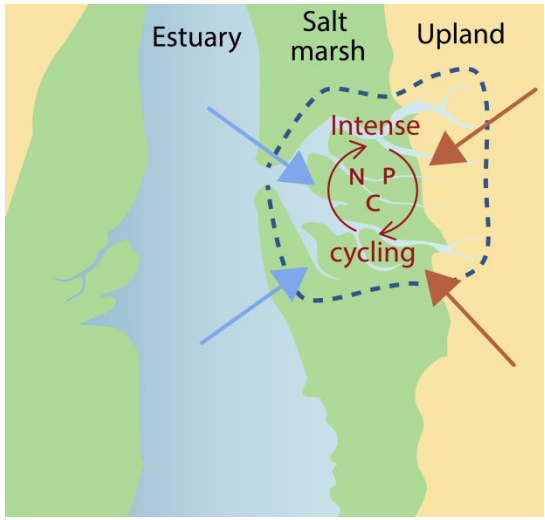
Many Knobs of Living Resource Response




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

Opportunities For Shallow Water Restoration

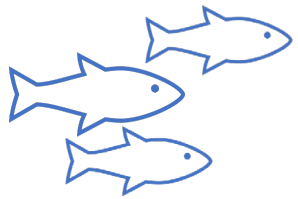




Living Resources

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.

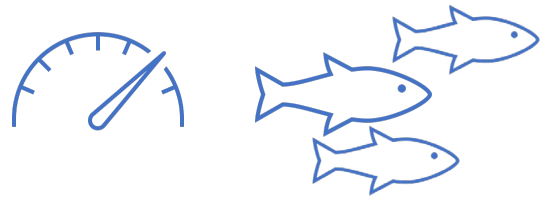


- Water quality alone does not guarantee improvements in Living Resources. There are other factors!

Living Resources

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

- Prioritize nutrient reduction where you will get a living resource response sooner.



- Bay Program should be willing to shift investments to efforts that increase Living Resources for the water quality gains that are achieved.

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.