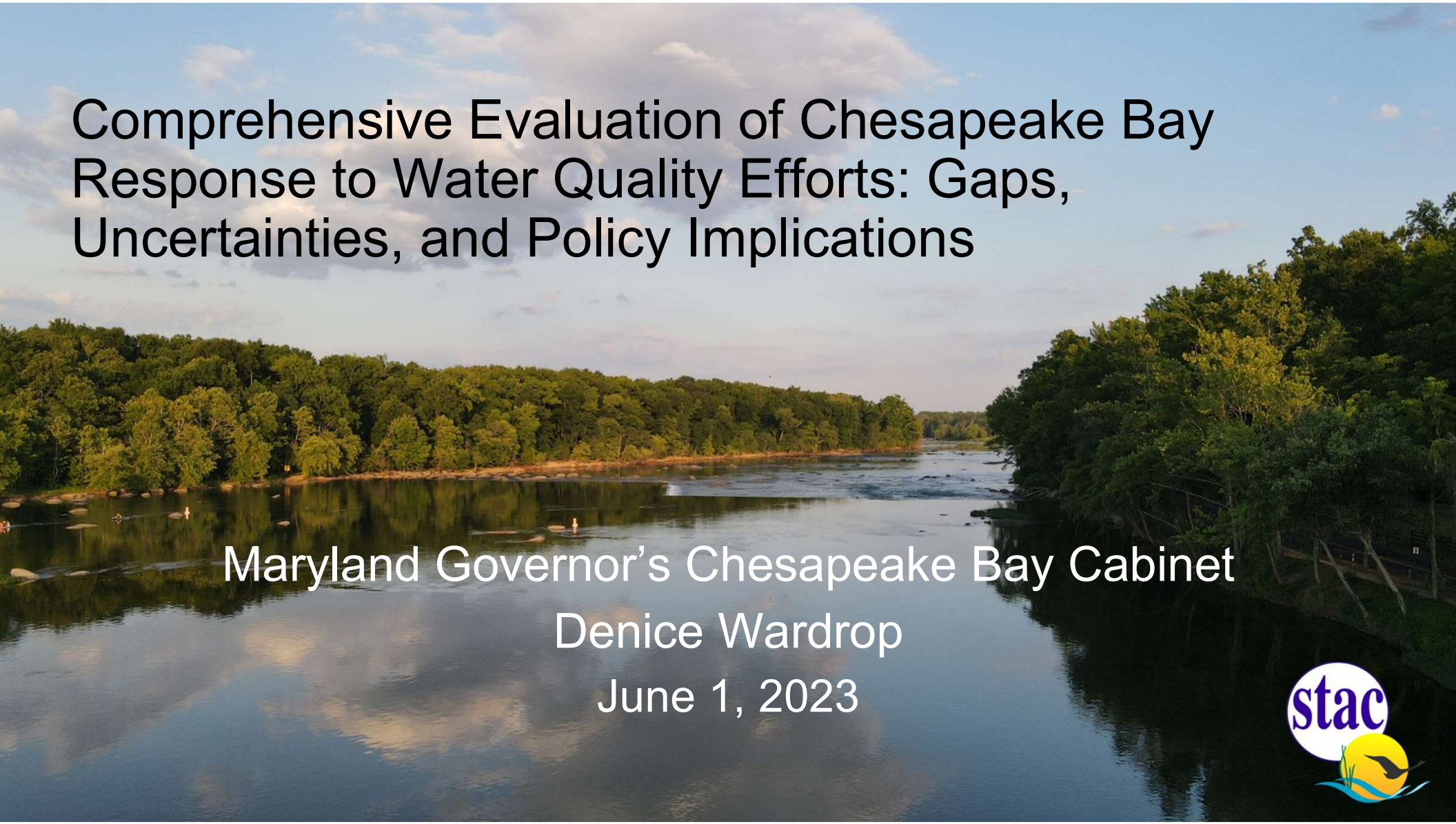
Comprehensive Evaluation of Chesapeake Bay Response to Water Quality Efforts: Gaps, Uncertainties, and Policy Implications

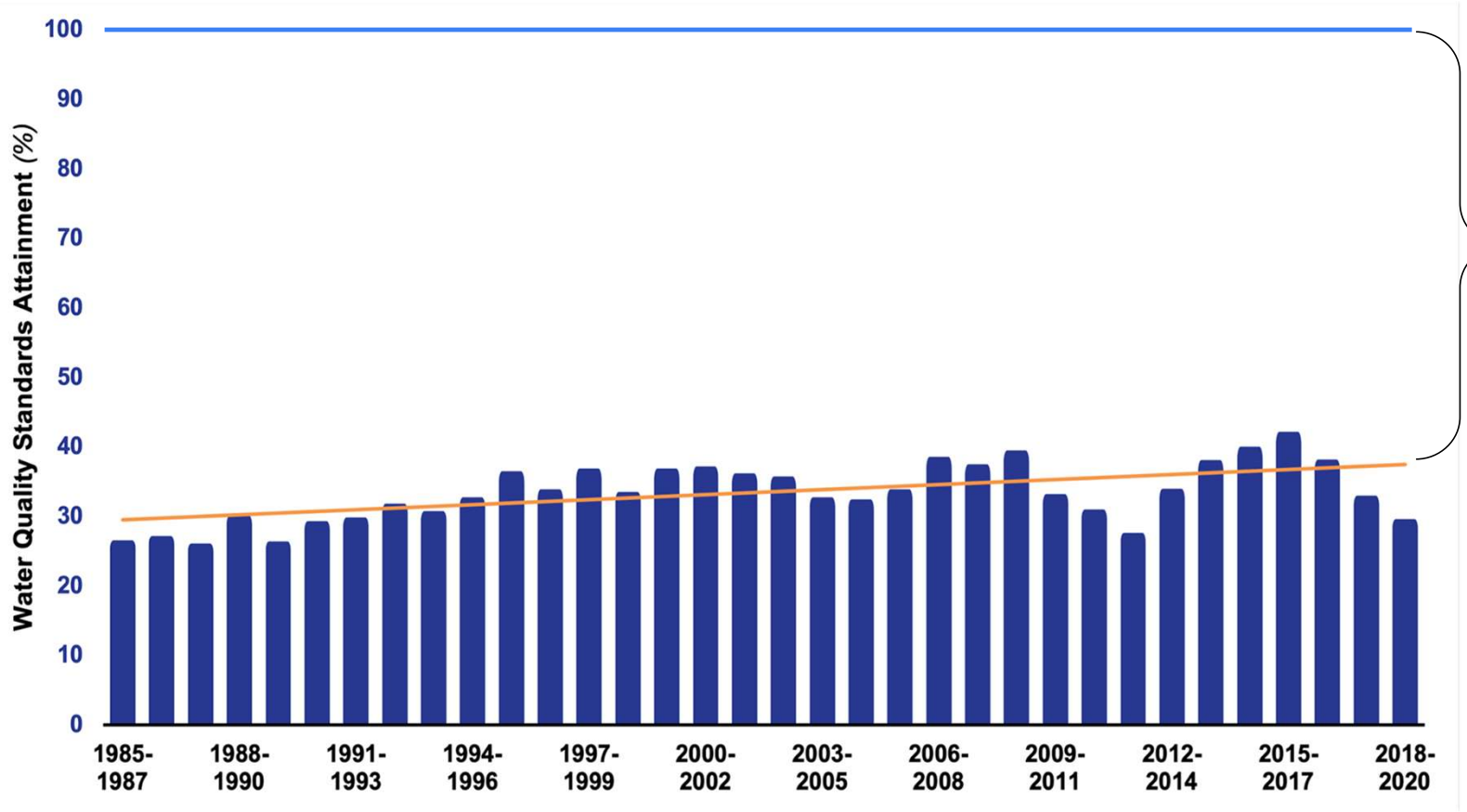


Maryland Governor's Chesapeake Bay Cabinet

Denice Wardrop

June 1, 2023

Achieving Bay Water Quality Standards

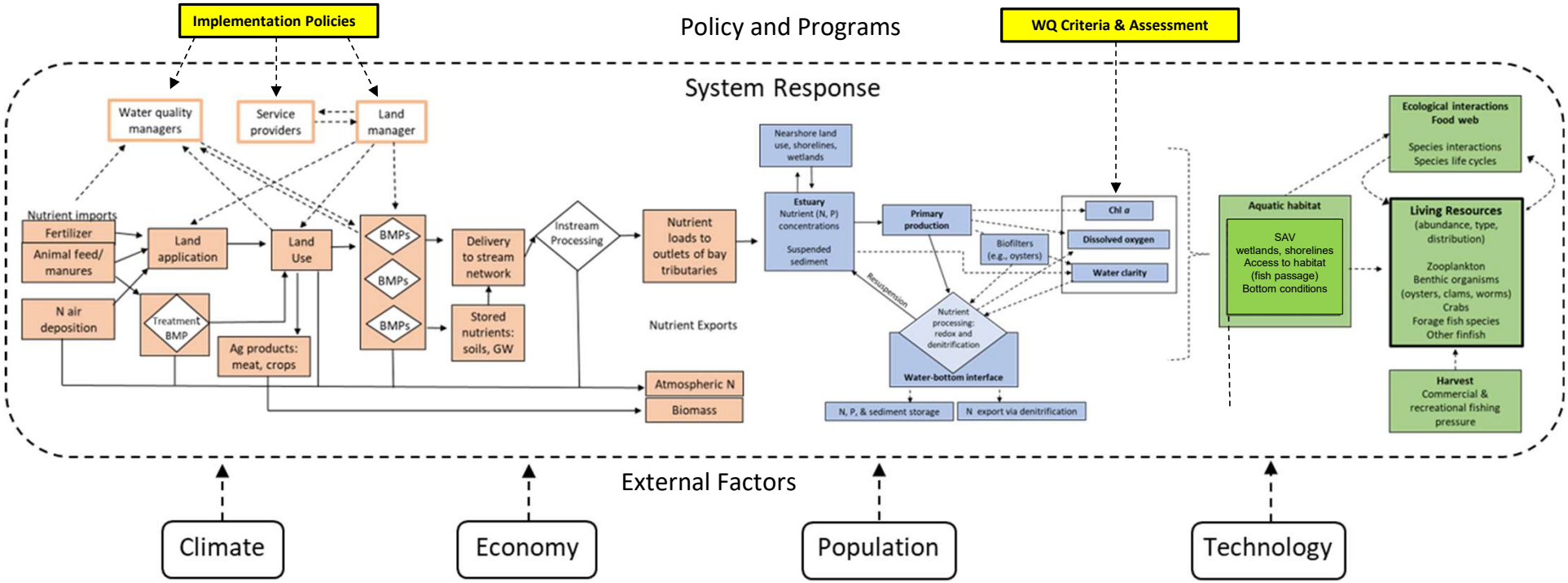


CESR Conclusions

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

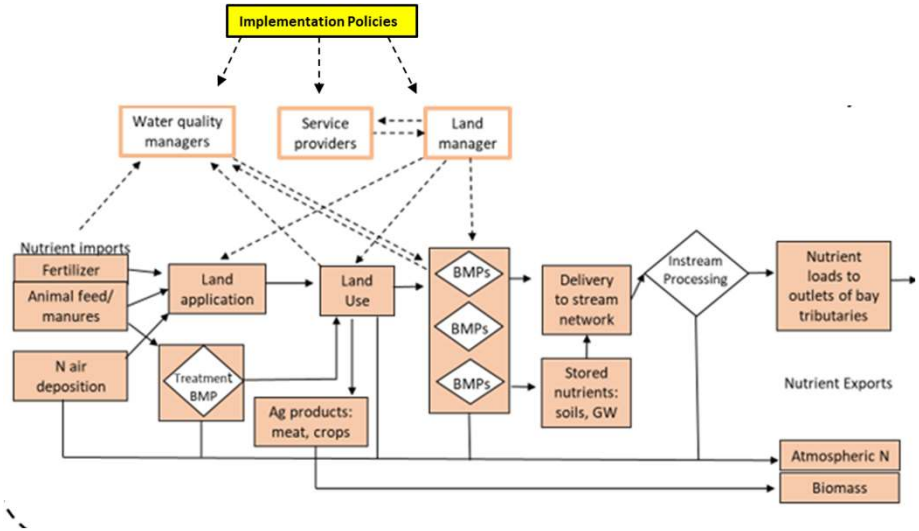
Opportunities to improve program effectiveness exist but require programmatic change (not simply doing more of the same).

System Response to Meeting Bay Water Quality Standards



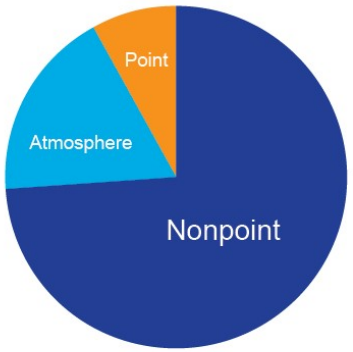
Findings:

Pollutant Response to Management Efforts

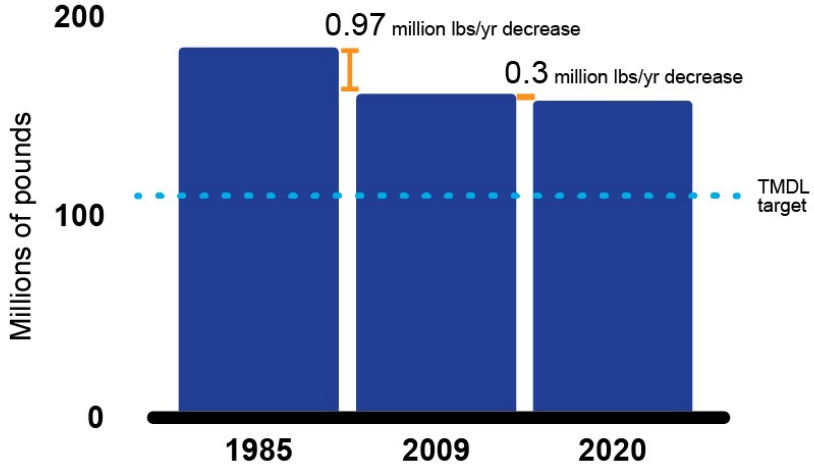


Are nonpoint source programs generating enough adoption/change (“implementation gap”)?

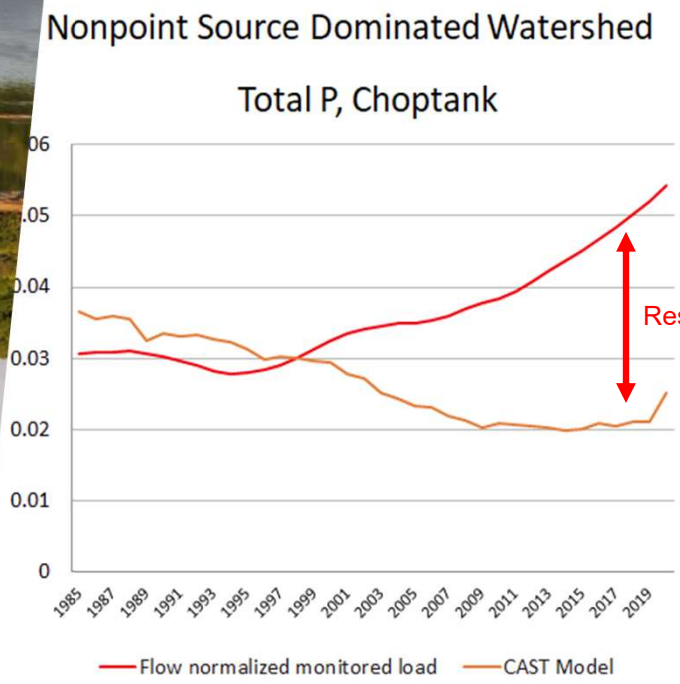
Nonpoint sources (NPS) represent 74% of the controllable nitrogen load to the Chesapeake Bay.

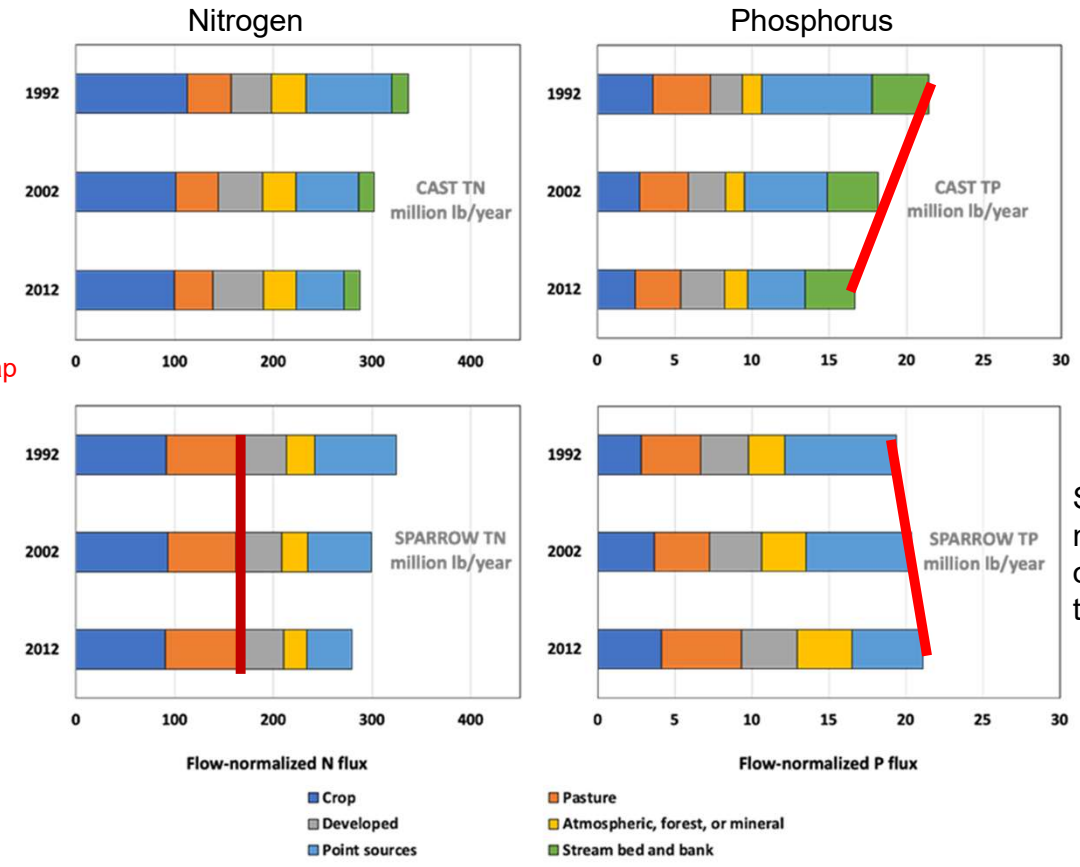


To reach the target for nitrogen, we would need to multiply the current rate of annual NPS decease by 167 times.



Are nonpoint source programs generating the expected response ("response gap")?





CAST Model Predictions

Statistical model of observed trends

Ator, et al., 2020

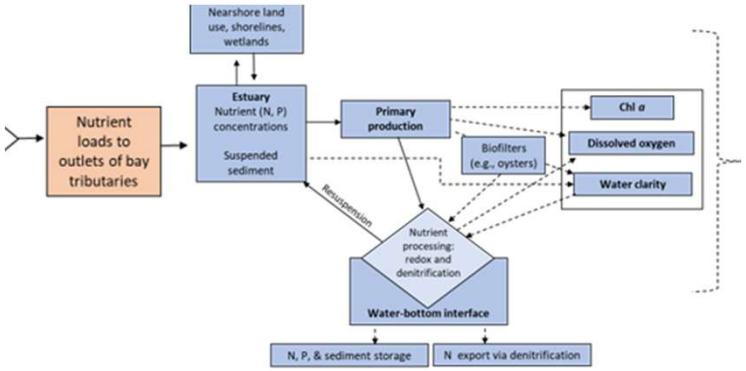
Why Response/Implementation Gaps?

- Lag times/Legacy sources
- Behavior/Implementation (who, what, where)
- BMP Effectiveness
- Nutrient Mass Imbalances
- Data/Monitoring Limitations (model inputs [nutrient inputs, etc], monitoring cannot detect signal)

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

Findings:

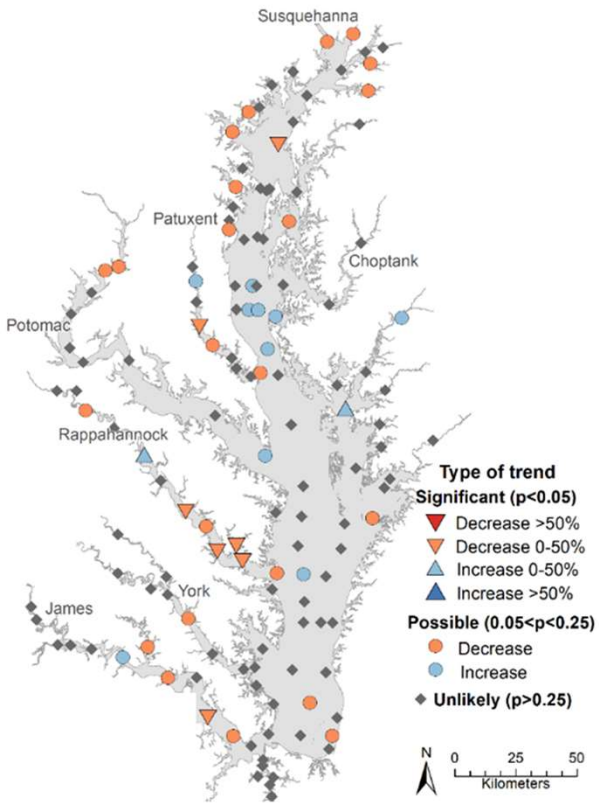
Bay Water Quality Response to Nutrient Reductions



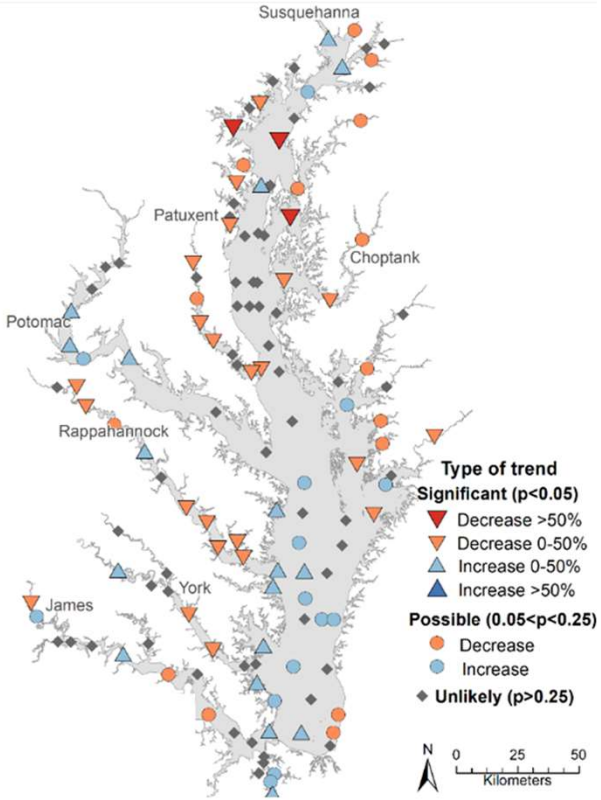
Water Quality Response at Bay Scale; DO

Chesapeake Bay bottom summer (June-Sept) dissolved oxygen

Short term change (2012 to 2021)



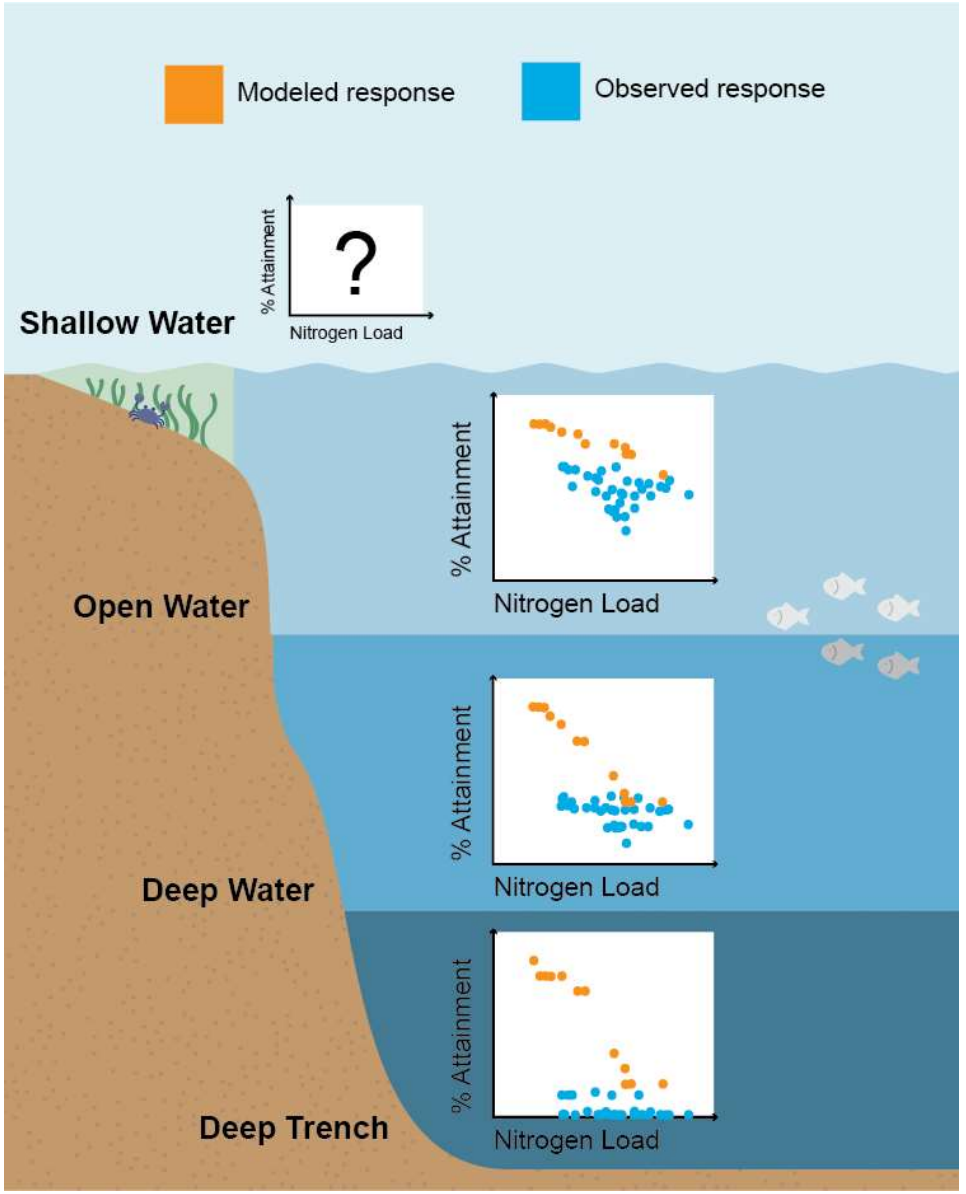
Long term change (1985/6 to 2021)



(Source: CBP)

Response Gaps for DO across Habitats

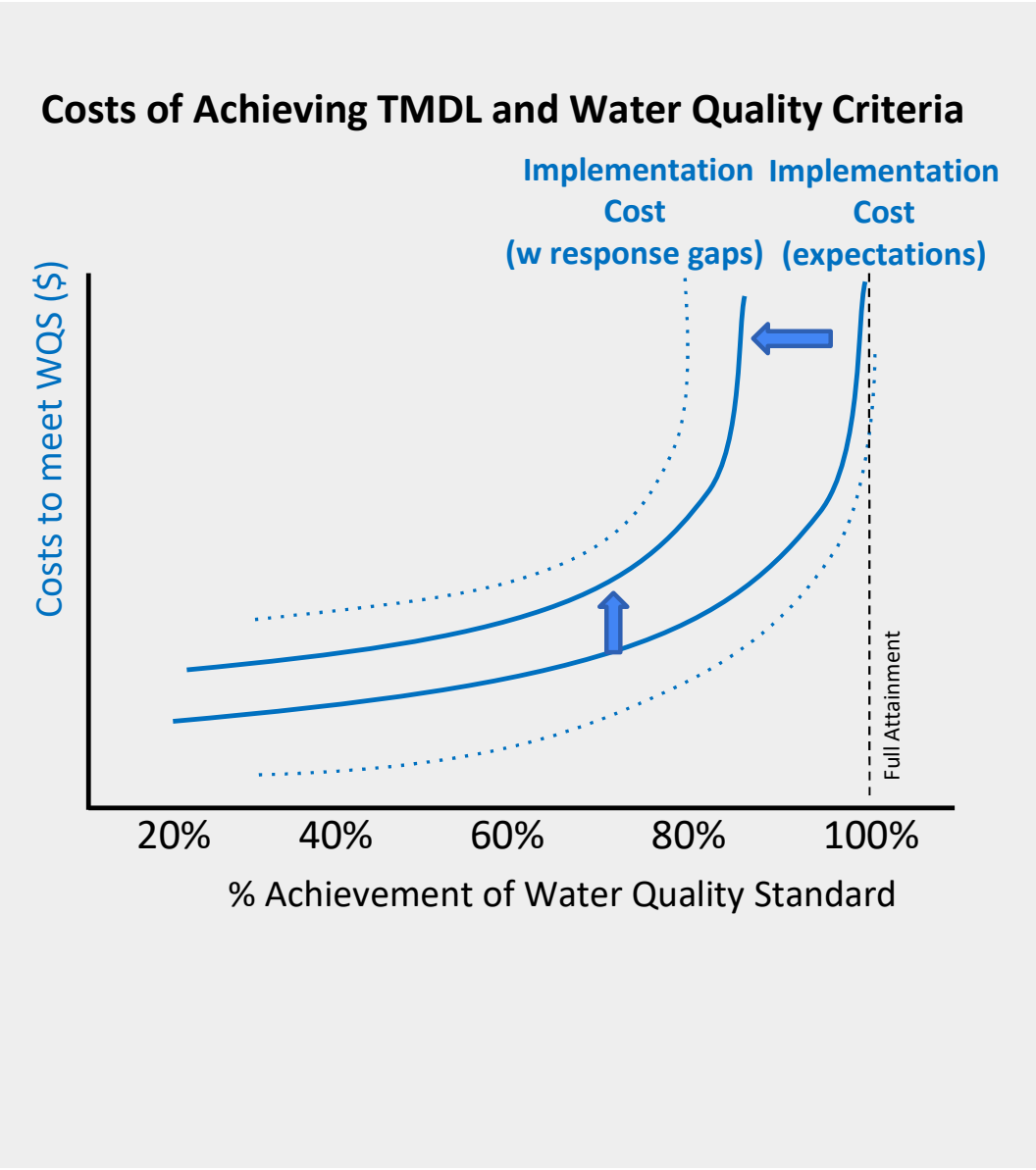
- Potential response gap across all habitats
- Response gap largest at low loads
- Response gap largest for Deep Channel
- No expected response for shallow waters



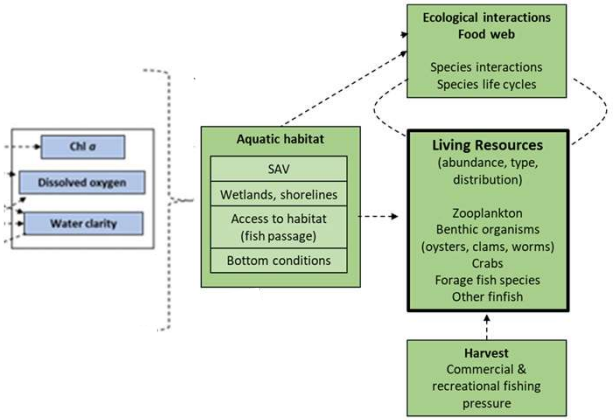
FINDING: Load reductions have not produced expected level of WQ response. Full achievement of WQS is is distant and unlikely, particularly for deep water DO

Implications

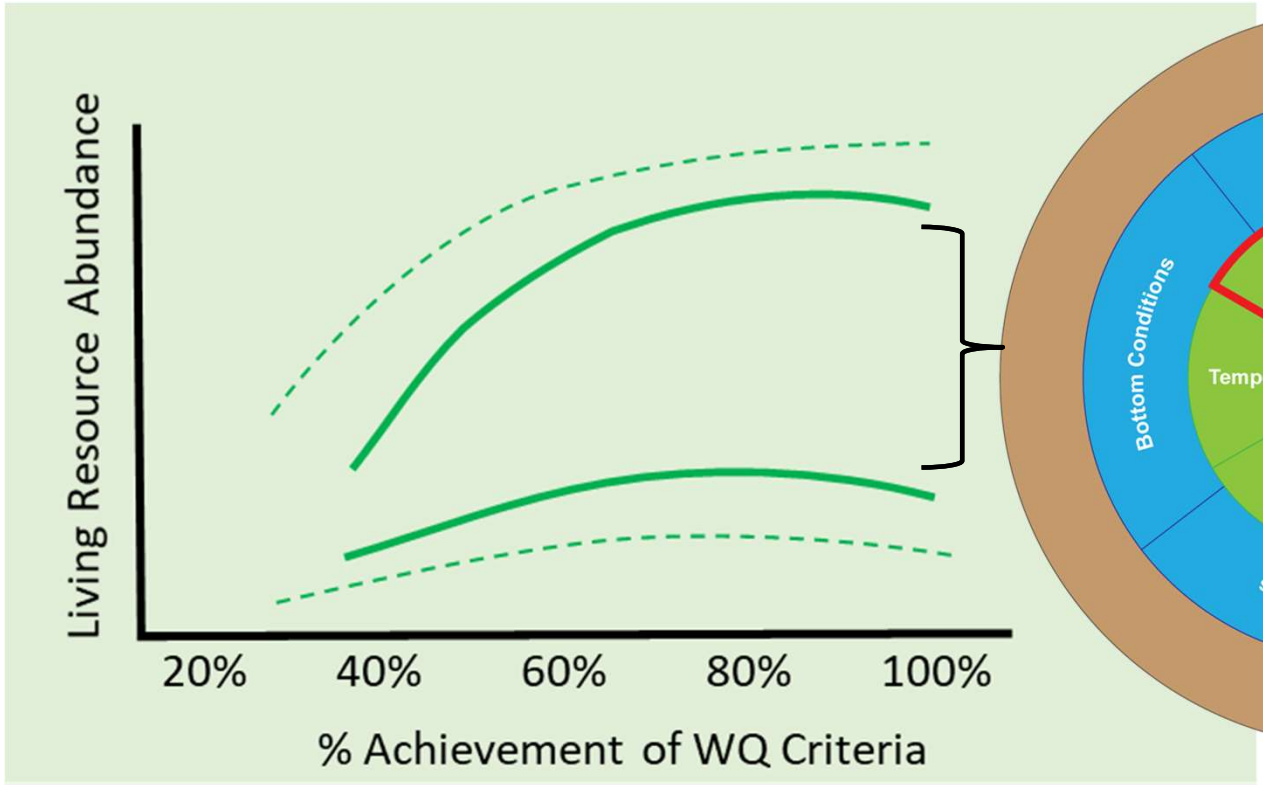
The Bay of the future is not the Bay of the past

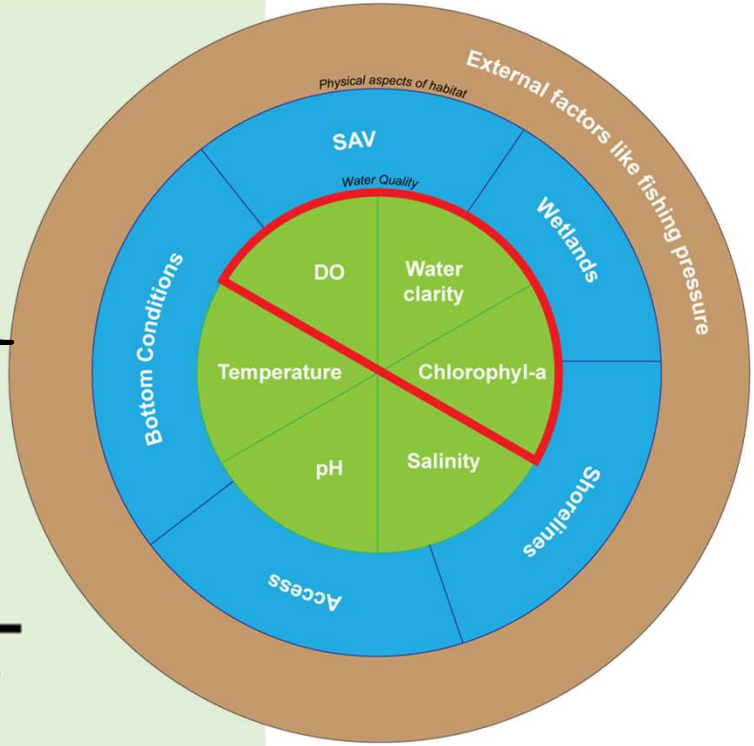


Findings: Living Resource Response to Water Quality Improvement



Boosting Living Resource Response

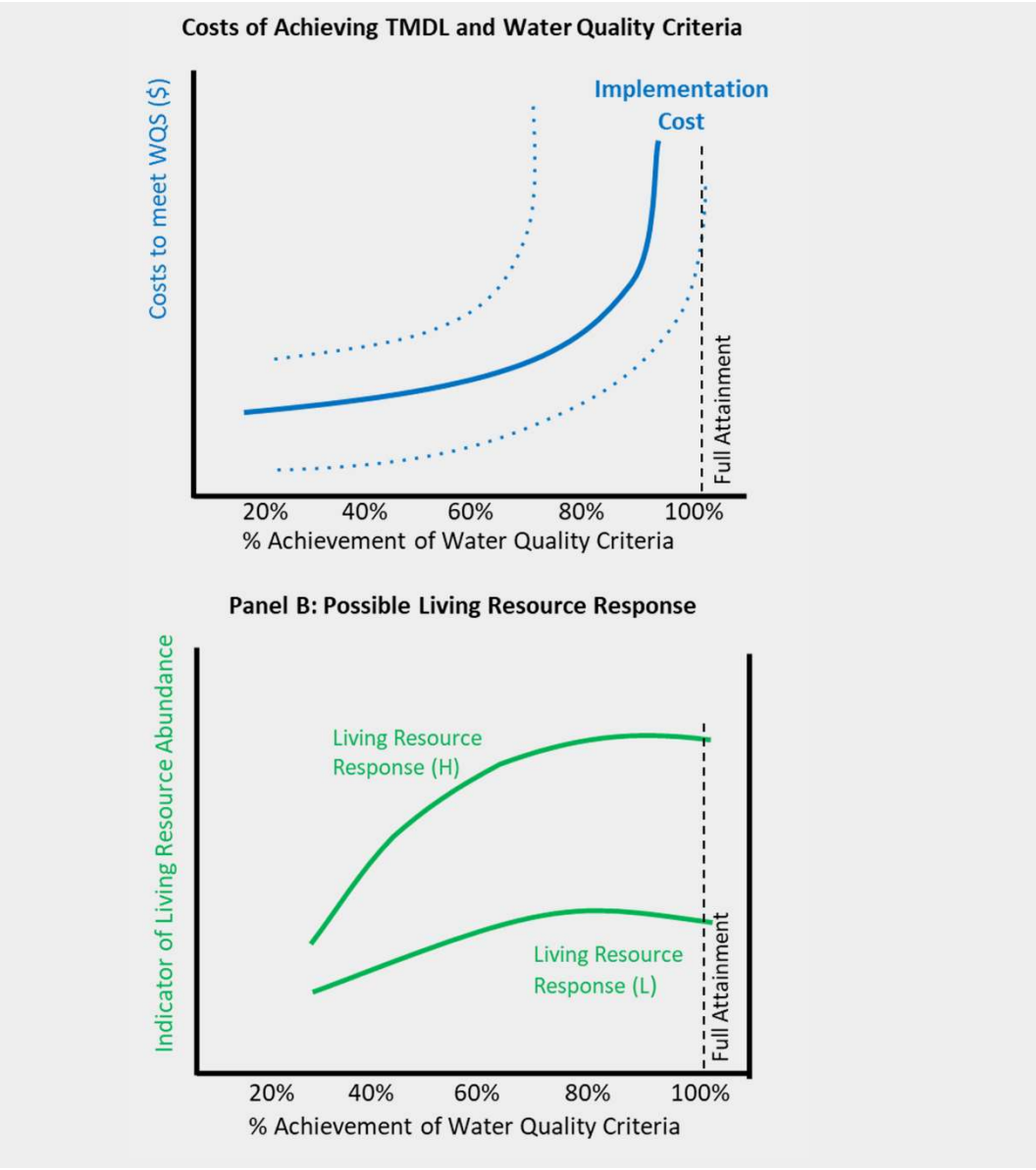




Managed by Bay water quality standards

Implications

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



CESR Implications and Opportunities

- Improving WQ outcomes
  - Incentives
  - Attention to mass imbalances
  - Innovation/Sandboxing
- Improving living resource outcomes
  - Prioritizing attainment in different habitats (shallow waters)
  - Status of other factors to boost response
- Improving decision-making under uncertainty

Photo by Will Parson/Chesapeake Bay Program

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

Cover crops

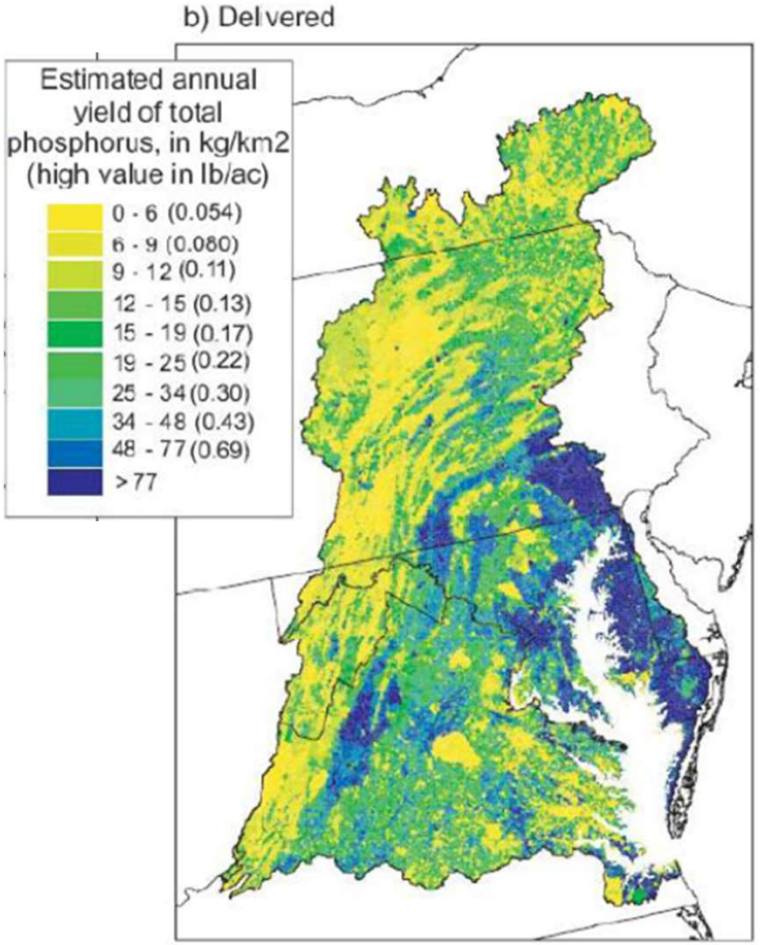
Livestock Exclusion Fencing

Denitrifying Bioreactor

Low upfront installation costs
Private benefits

High up front installation costs
No private benefits

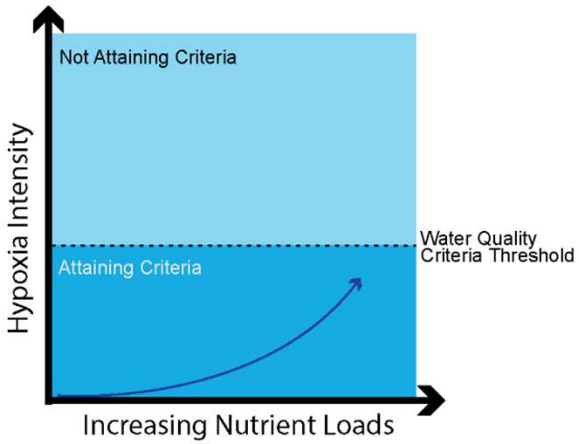
Nutrient Mass Balance



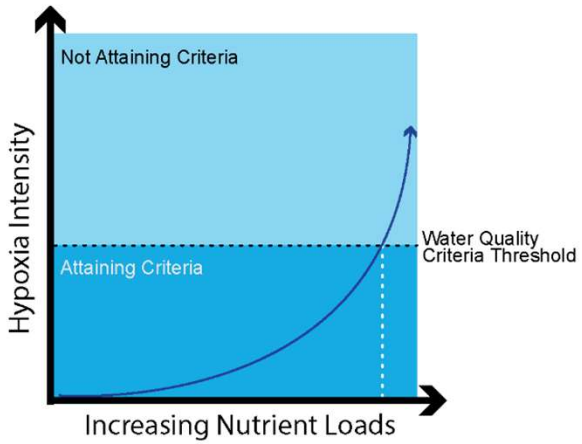
Source: USGS Sparrow Model Output

Improving Nonpoint Source Program Effectiveness:
New Opportunities for Technological & Institutional Innovation

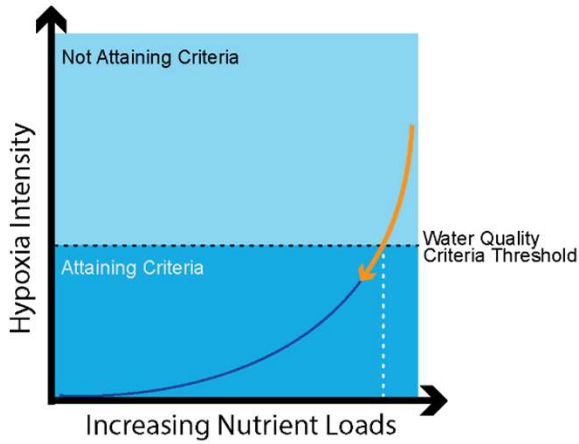
The Sandboxing Process (Figure adapted from Higgins and Male, 2019)



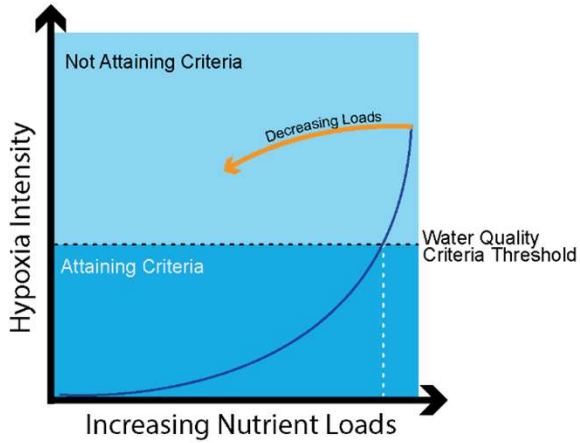
1 It is generally understood that as nutrient loads to the Bay increased over time, the intensity of hypoxia also increased.



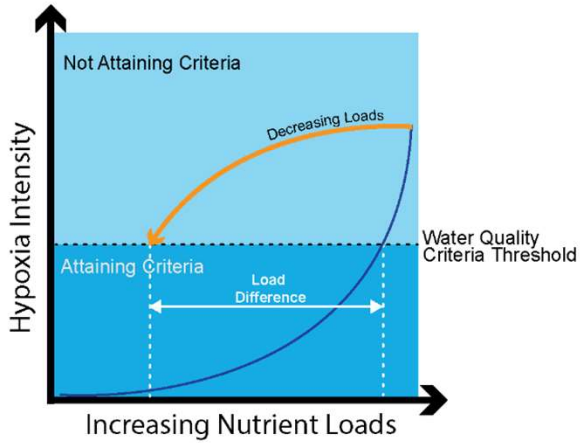
2 Loads enventually reached a level where the amount of hypoxia exceeded the water quality criteria threshold and the bay is now in non-attainment.



3 It has been assumed that by simply reducing loads below the point that resulted in exceedance of the criteria threshold, the Bay would be in attainment.



4 However, because of changing Bay conditions (like warmer temperatures) and differing responses across habitats, reducing loads will not result in a simple reversal of hypoxic intensity.



5 The shifted curve means that loads will have to be reduced far below the level initially causing non-attainment.