COMPREHENSIVE EVALUATION OF SYSTEM RESPONSE (CESR) to Water Quality Management Efforts, Part 2

Management Board Meeting
10 November 2022

Significant progress in the face of change

1982

- Population in the watershed: 12.7 million
- Number of chickens: 160,763,080
- Between 1990 and 2007, impervious surfaces associated with growth in single-family homes are estimated to have increased about 34 percent, while the region's population increased by 18 percent.

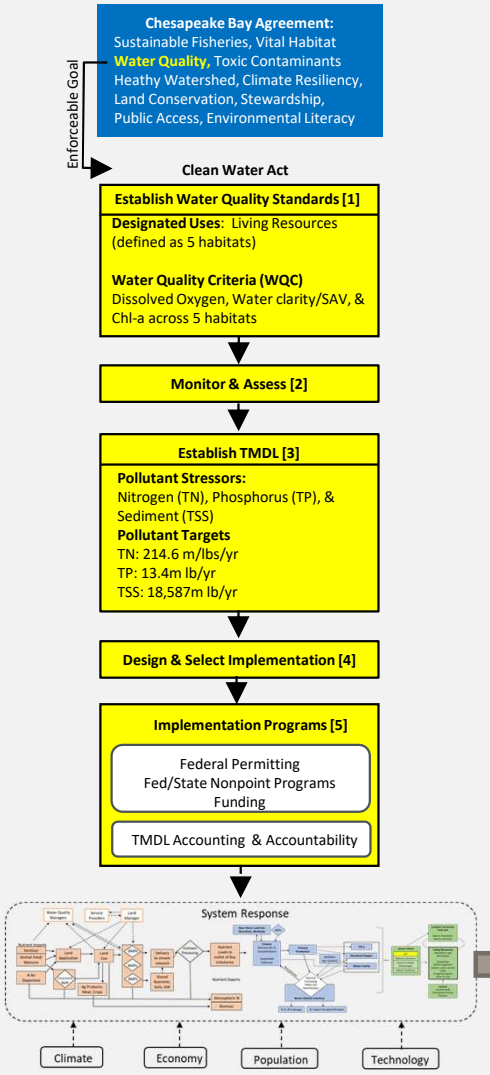
2017

- Population in the watershed: 18.2 million
- Number of chickens: 1,141,466,636
- Since 2007, Pennsylvania, Maryland, and Virginia have been losing about 28,000 acres of farmland annually, much of it to development
- Since the mid-1980s, the bay has warmed by about 2 degrees Fahrenheit or about .07 degrees each year

Section 6 Tentative Findings and Implications

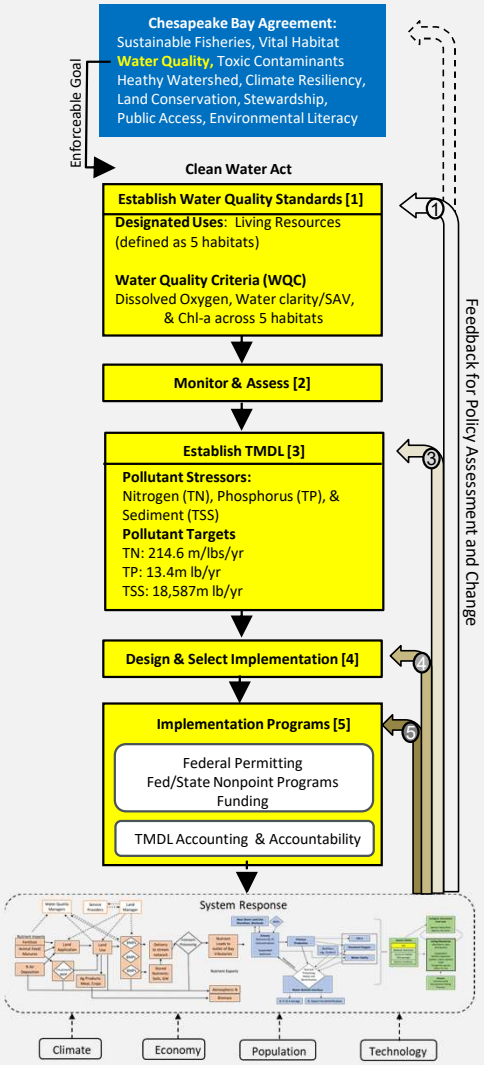
Two Premises

- The Chesapeake Bay system observed in the past will not be the same system we will have in the future.
- What defines success and the programs to achieve success will require reexamination and change



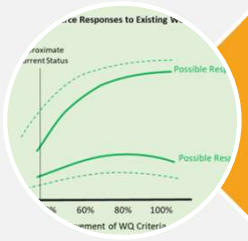
SUMMARY OF FINDINGS

- ***Overall, the rate of progress in ambient water quality outcomes suggests that achievement of existing water quality criteria is uncertain and remains in the future.***
- ***Existing water quality planning and programs are likely to be insufficient to achieve the nonpoint source reductions called for under the TMDL.***
- ***Improving water quality alone, as measured by existing Bay water quality criteria, may be The current CBP adaptive insufficient to generate desired changes in the composition and abundance of Bay living resources.***
- ***The existing adaptive management process has limited capacity to effectively address the uncertainties and response gaps described in this report.***



Implications

Improving effectiveness of nonpoint source management programs

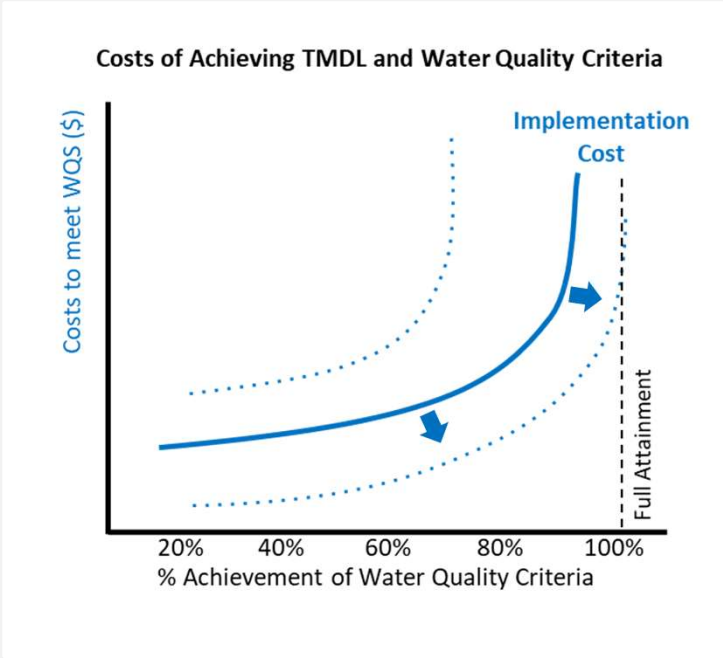


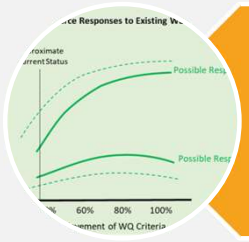
Improving living resource response to water quality management efforts

Expand adaptive management

Improving effectiveness of nonpoint source management programs

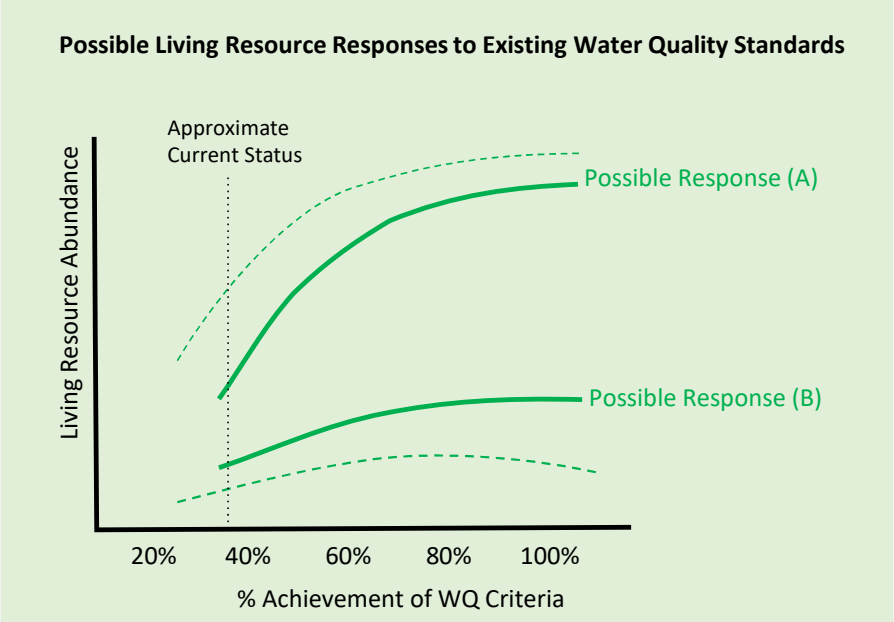
- Spatial targeting
- Outcomes-based Incentive Programs
- Targeted Requirements
- Facilitating policy innovation through "sandboxing"

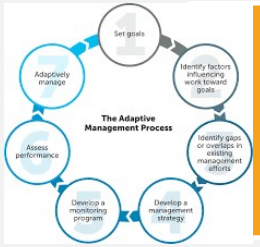




Improving living resource response to water quality management efforts

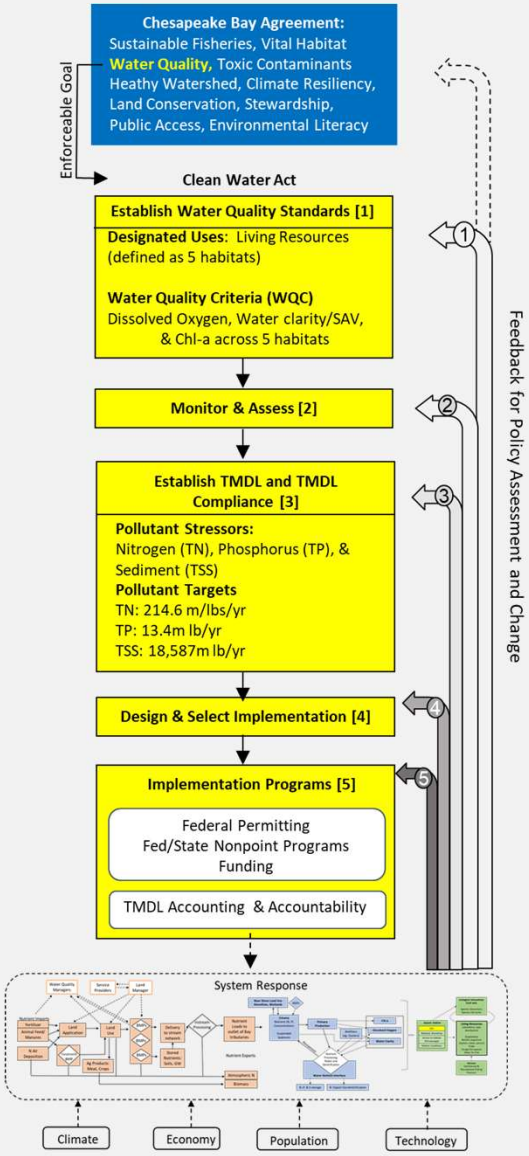
- Expression of the criteria can be shifted to more accurately reflect necessary conditions for habitat suitability (value, mode, how and where measured)
- Achievement of TMDL targets could be prioritized according to location (segments) or habitat type
- Addition of management actions to elevate LR response to WQ management efforts.





Expand adaptive management

- Expanded AM will need to include all levels of policy feedback and learning in the existing CWA approach (arrows 1 through 4).
  - Commitment throughout the organization
  - Processes to support decision-making under uncertainty
  - Addition of analytical tools
  - Targeted monitoring to support adaptive management
- Now is an opportunity to developed expanded adaptive management processes



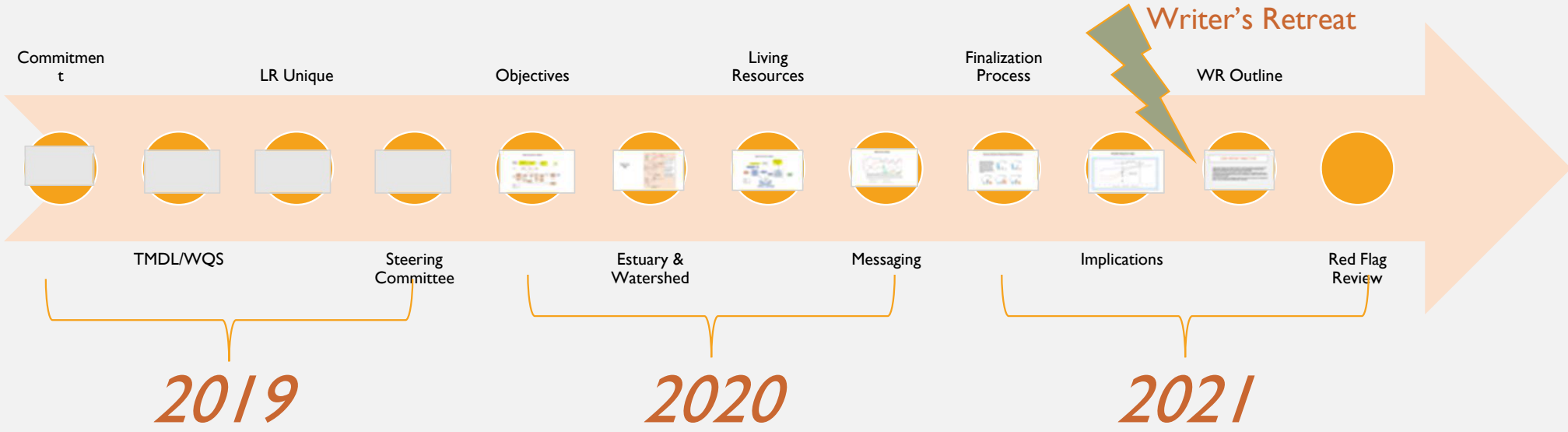
CESR REPORT OBJECTIVES

- Identify gaps between the expected physical, chemical, biological, and socioeconomic responses to management actions and their current realization, and identify recent scientific developments that can advance efforts to attain WQS;
- Characterize the critical uncertainties in system response to management actions and recommend research strategies that improve understanding of system response relevant to the attainment of WQS.
- Recommend strategies for integrating scientific and technical analysis into management efforts in order to aid decision-making under uncertainty.

Who is CESR?

- What it's not:
  - A report card on the restoration effort
  - A list of specific recommendations
- What it is:
  - An extraction of learnings after 30 years of water quality efforts
  - An identification of some opportunities for increasing program effectiveness

CESR Timeline
March 2019 – December 2021



Responsible science brokerage

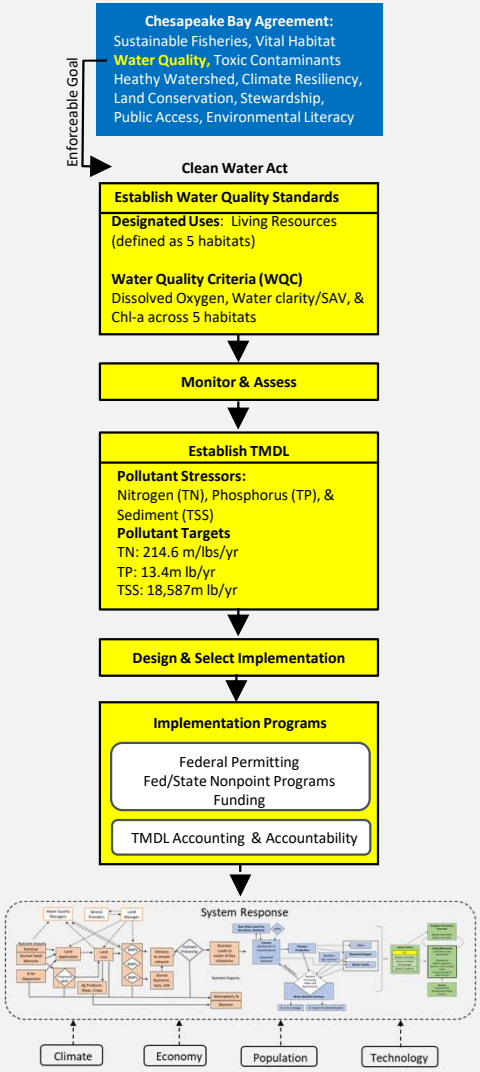
- Alignment of synthesis of evidence with policy needs
- Robust, transdisciplinary, with appropriate expert inputs
- Implications are articulated
- Choices and options instead of recommendations
- Communicates limitations and unavoidable biases
- Does not take a role in the policy choice process

Gluckman, P.D., Bardsley, A. & Kaiser, M. Brokerage at the science–policy interface: from conceptual framework to practical guidance. Humanit Soc Sci Commun 8, 84 (2021). https://doi.org/10.1057/s41599-021-00756-3

The Structure of the Report

"If I had an hour to solve a problem I'd spend 55 minutes thinking about the problem and five minutes thinking about solutions" *Albert Einstein*

Section 2: Policy Context and Report Organization



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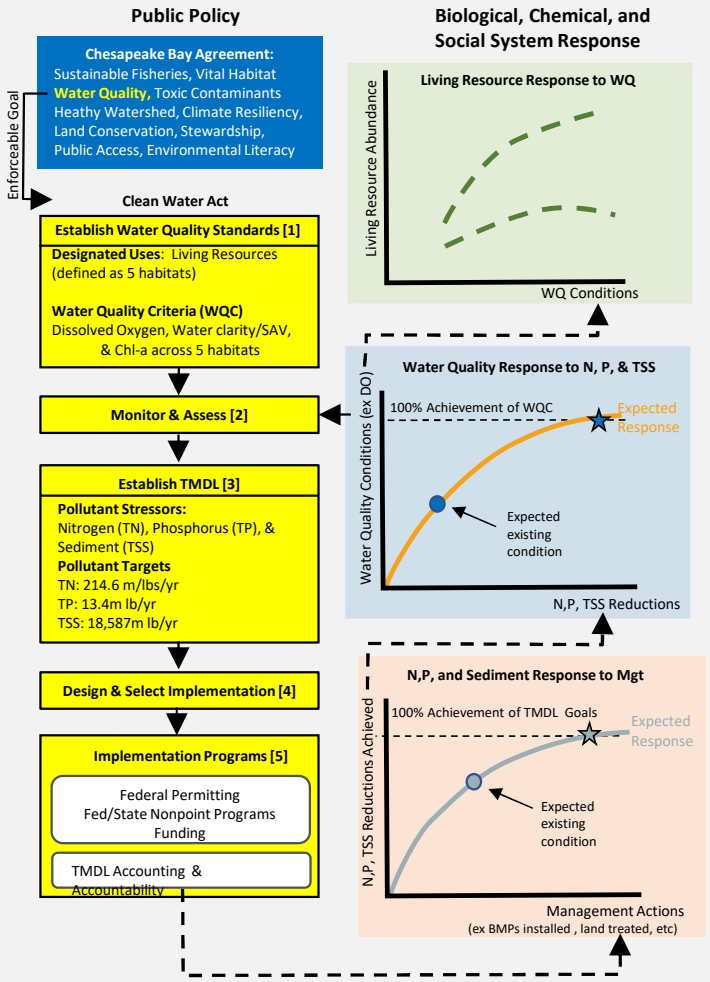
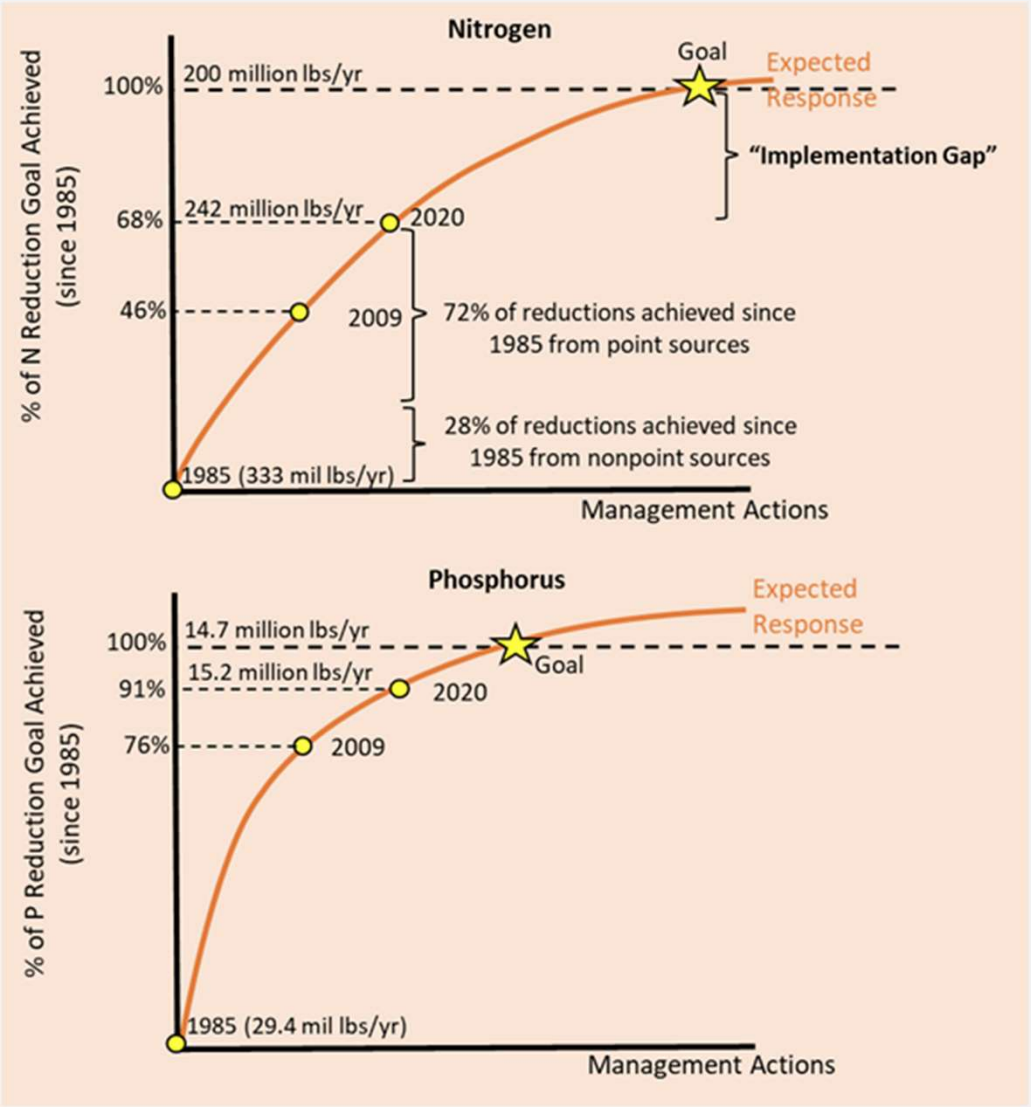
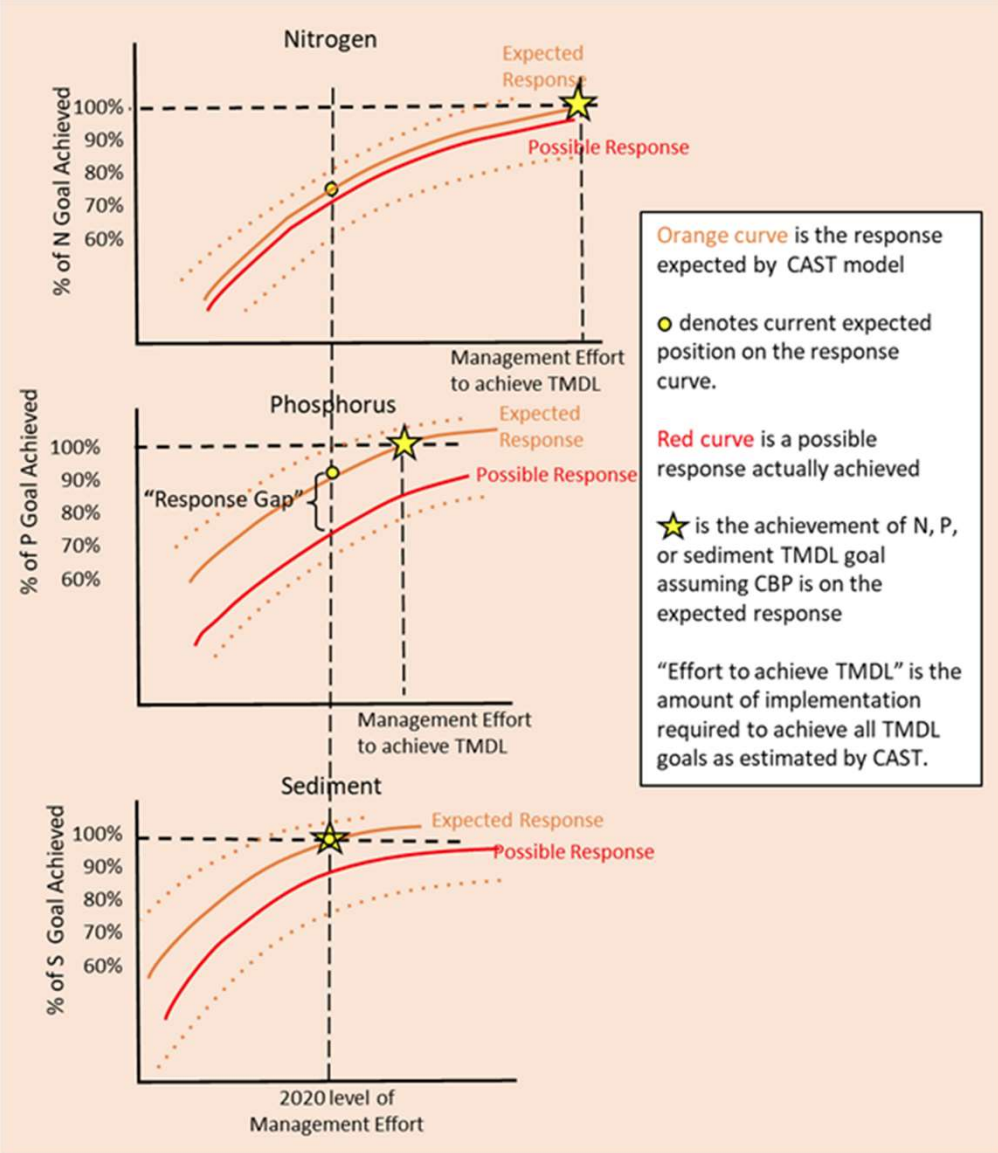


Section 3: Nutrient and Sediment Response to Management Efforts

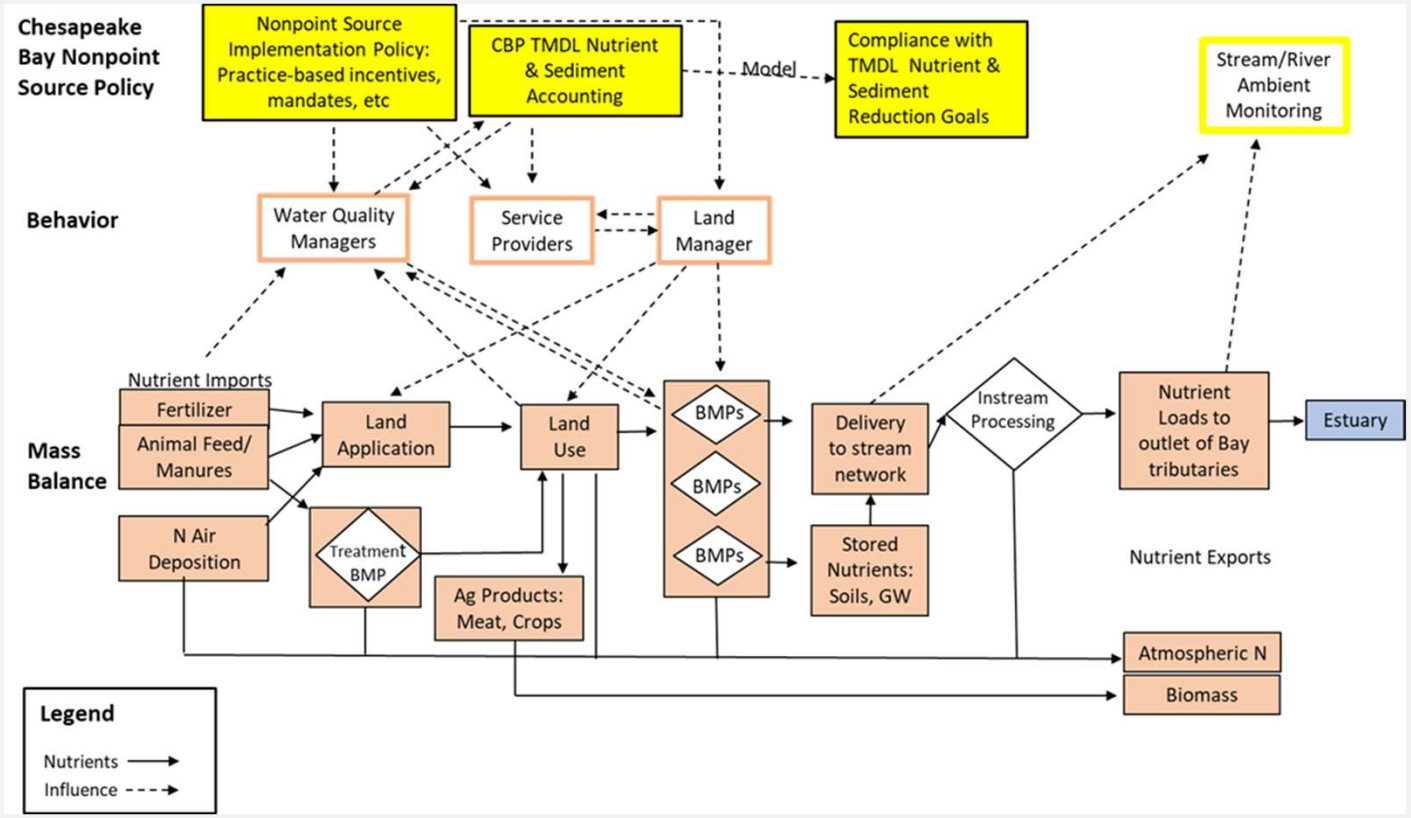
Implementation Gap



Response Gap

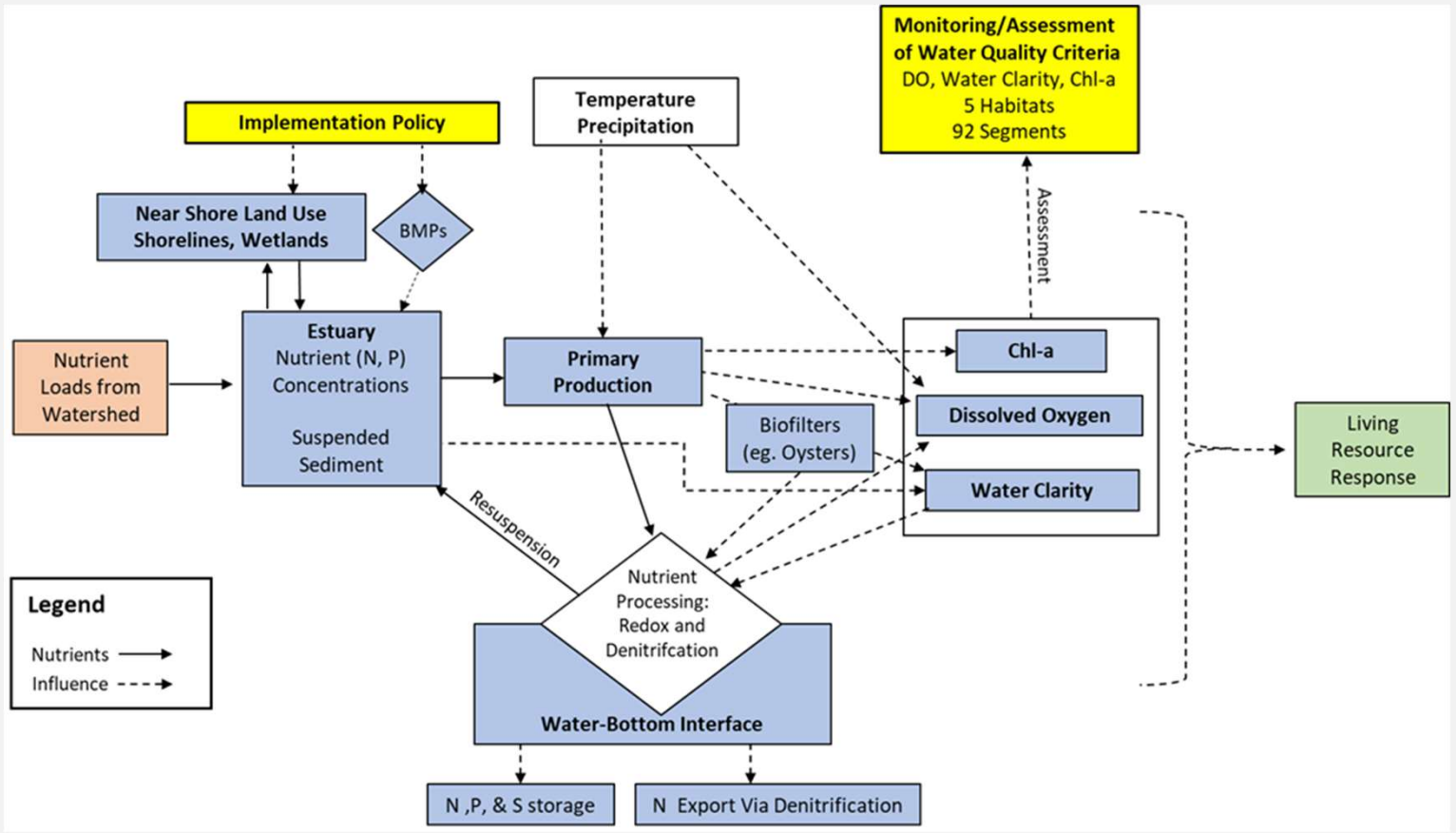


Organizing System Diagram

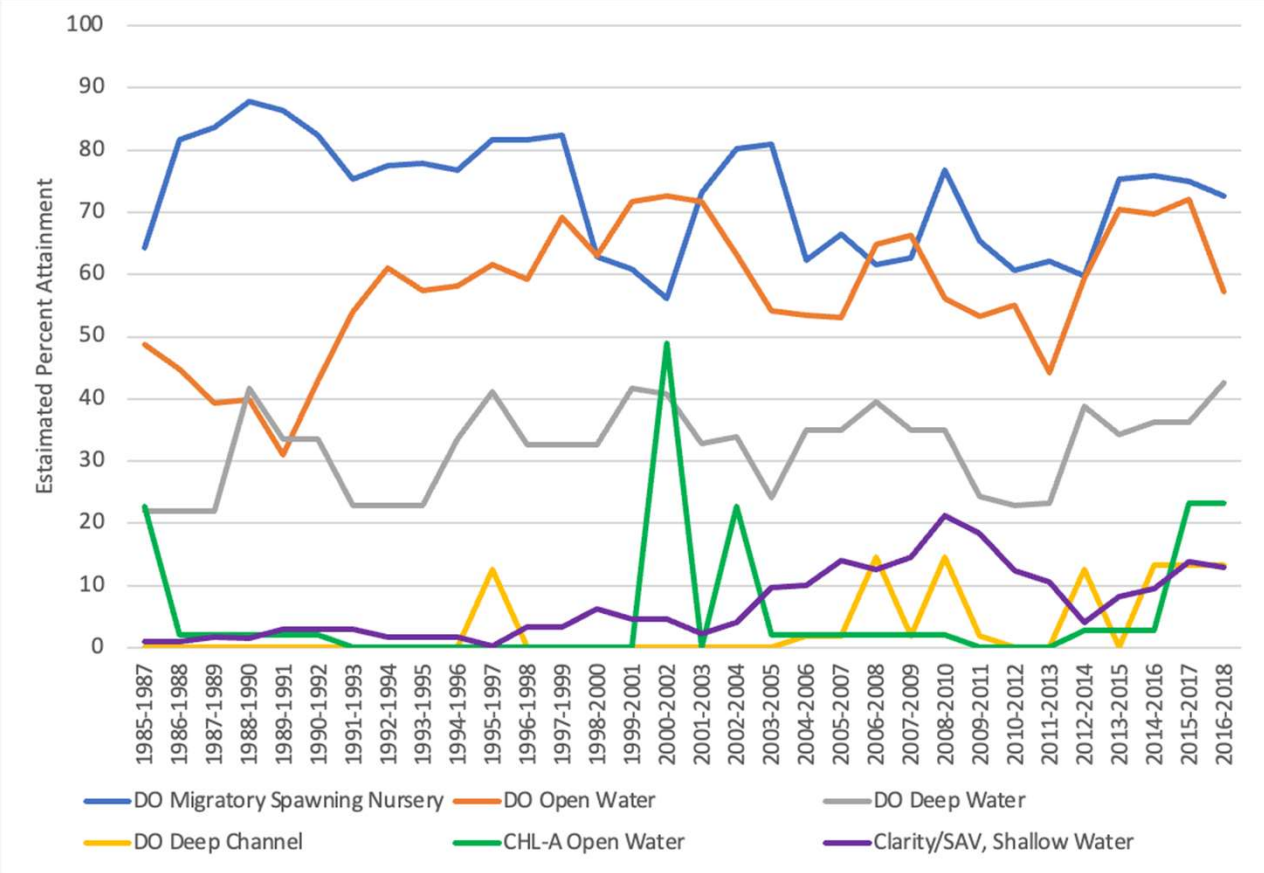


Section 4: Water Quality Response to Nutrient and Sediment Reductions

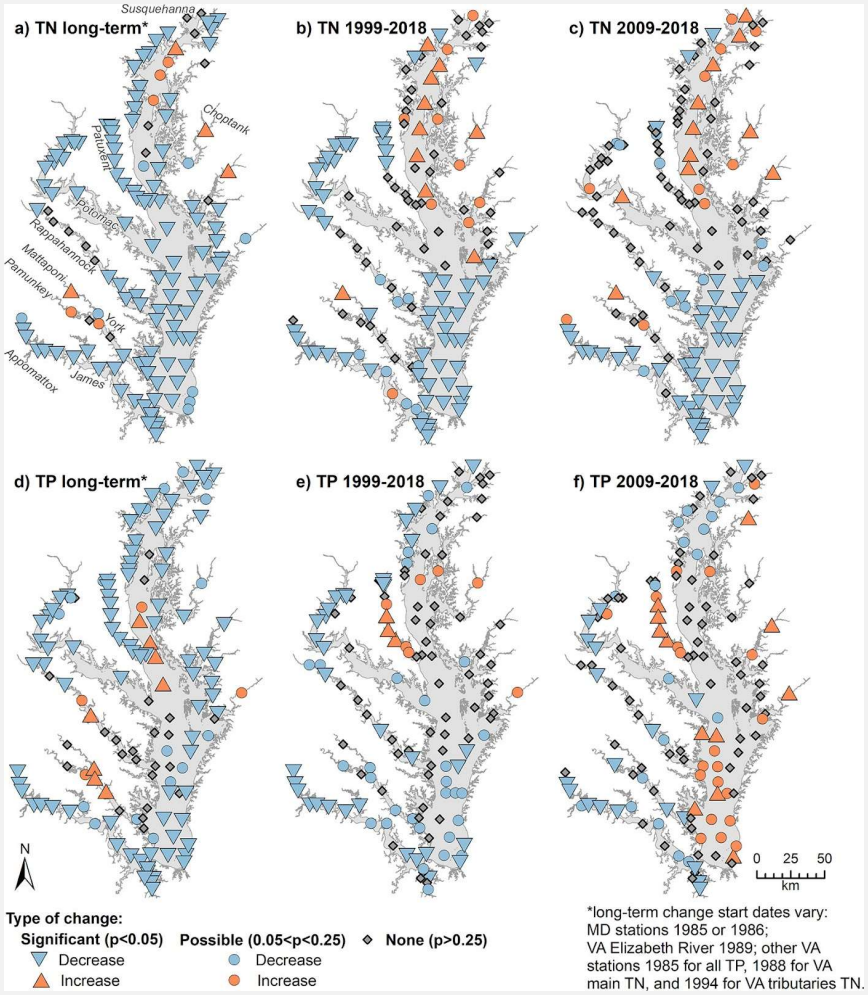
Organizing System Diagram



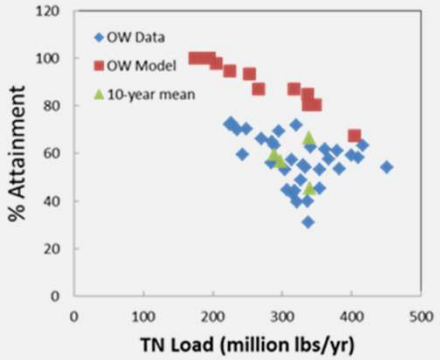
Attainment by Designated Uses

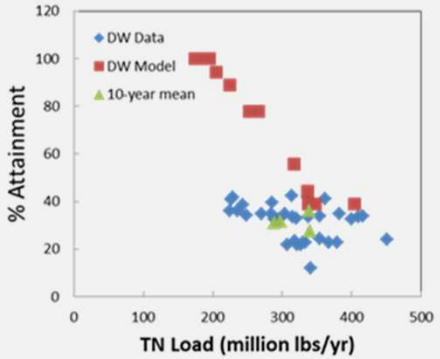


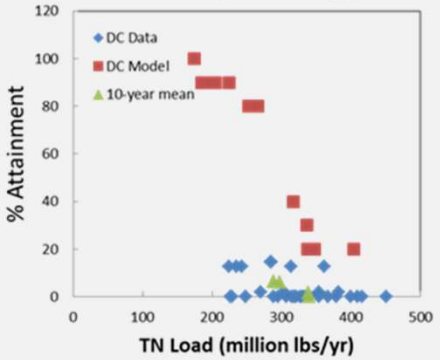
Are load reductions resulting in lower N, P, & S?



Chesapeake Bay tidal station categorical results for mean change in surface TN (a–c) and TP (d–f) over three time periods computed using temporal GAM fits (eqs 2 and 3) but not filtering for flow or any other explanatory variable. From Murphy et al., 2022.





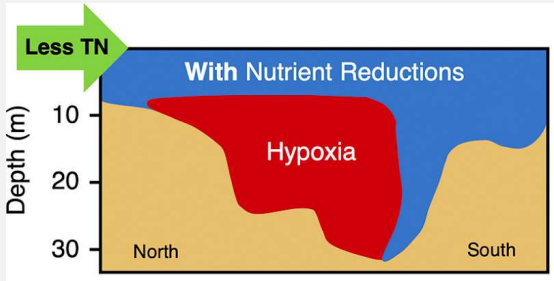


Translating load reductions to attainment

Graph of below fall line WSM+RIM TN loads and DO criteria attainment, calculated as three year running mean criteria versus the 3-year running mean RIM+WSM TN for the same time period. Red squares represent expected responses from the 2017 Mid-point Assessment. Green triangles are 10-year means of the observations. Graph by Jeremy Testa, based on data from Qian Zhang.

Why?

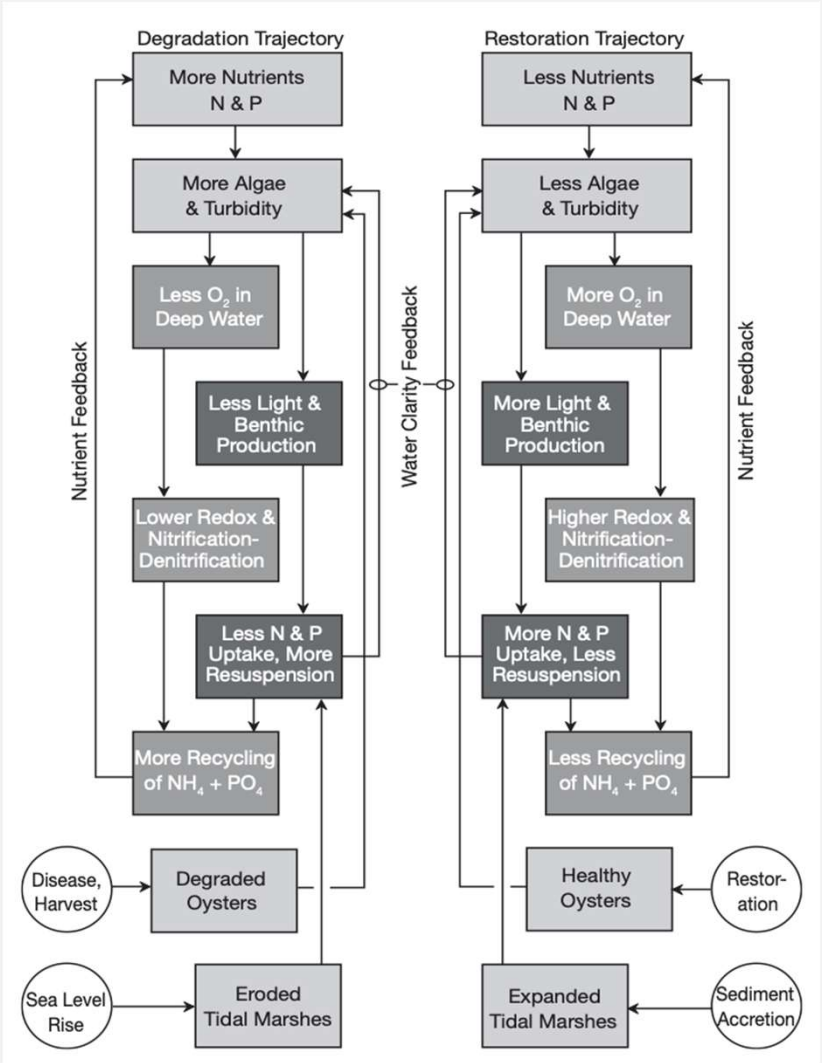
Non-linear Interactions and Climate Change



If 35 years of nutrient reductions had not occurred, hypoxia would have:

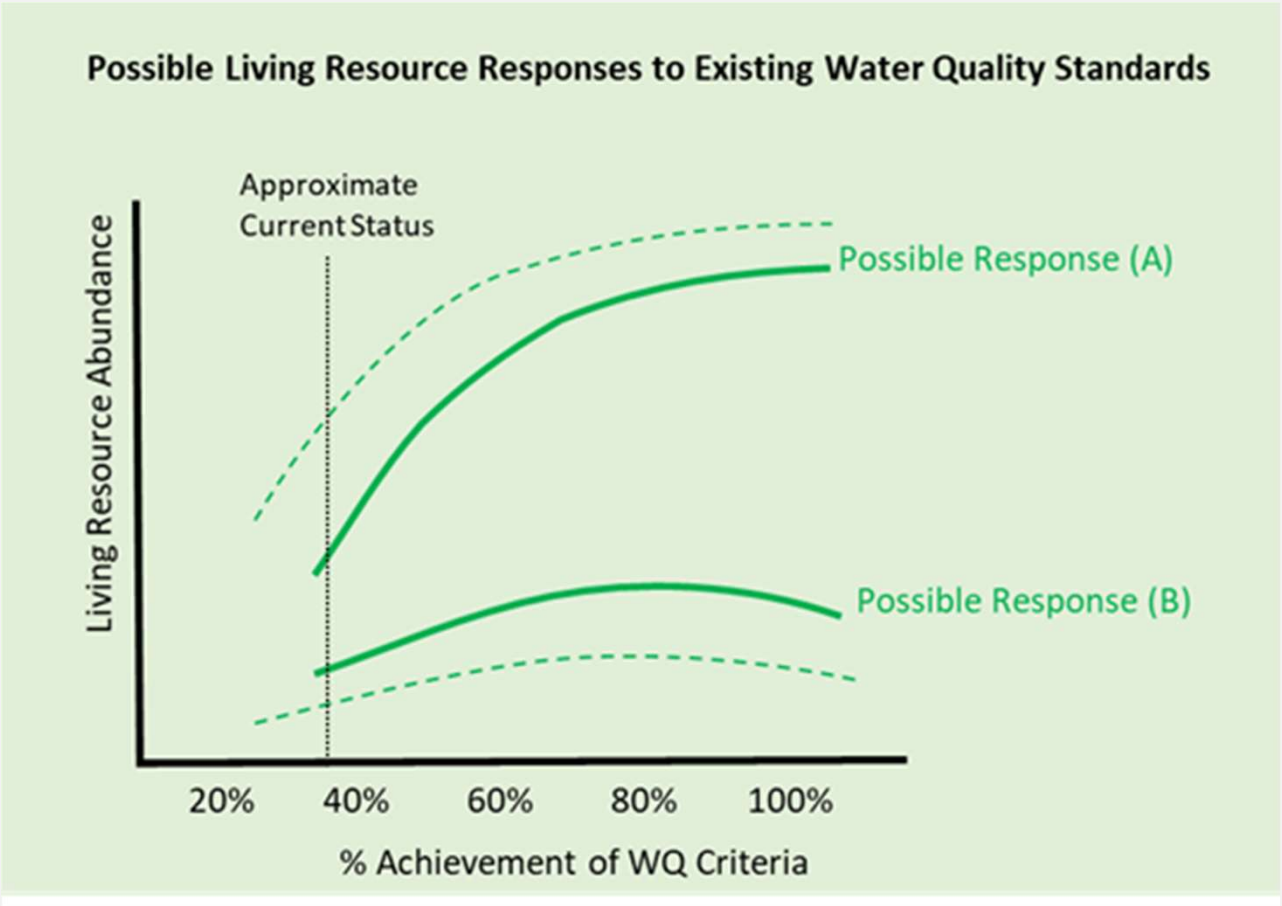
- Been **20-120% larger** for $O_2 < 3$ mg L^{-1}
- Been **30-280% larger** for $O_2 < 1$ mg L^{-1}
- Extended **further south** in the Bay
- Lasted **longer** during dry years

From Frankel et al., 2022



From Kemp et al., 2005

Section 5: Living Resource Response to Water Quality Conditions


Possible Living Resource Responses to Existing Water Quality Standards
Approximate
Current Status
Possible Response (A)
Possible Response (B)
Living Resource Abundance
20%
40%
60%
80%
100%
% Achievement of WQ Criteria

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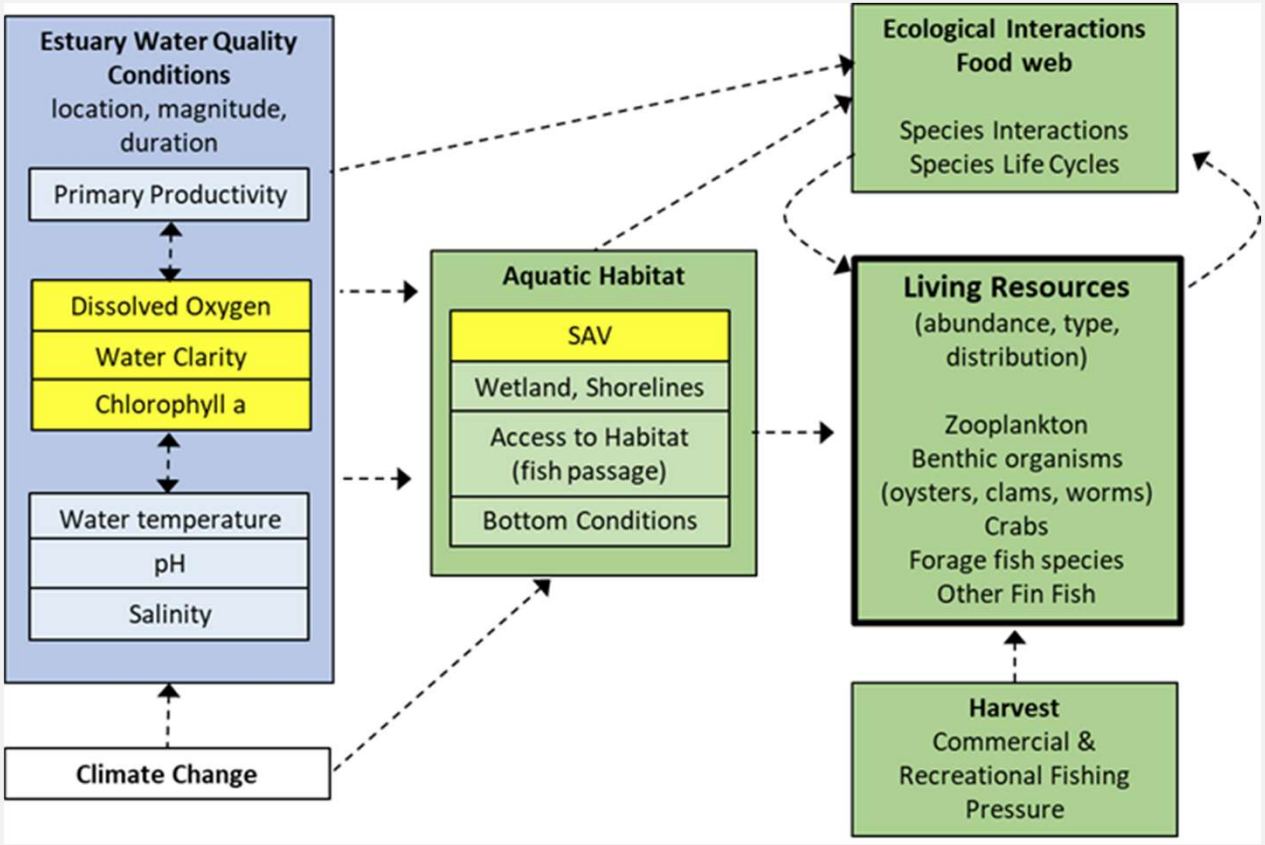

Evidence and Effort to Explain Observed Patterns