Achieving Water Quality Goals in the Chesapeake Bay: A Comprehensive Evaluation of System Response (CESR)

Choose Clean Water Coalition
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June 6, 2023
“CESR” Report

- 2 editors
- 8 members of a writers group
- 11 steering committee members
- 50+ contributing members of Scientific and Technical Advisory Committee (STAC)
Achieving Bay Water Quality Standards

Why?

Goal

How to

Improve

response?
Cesar Conclusions

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

Opportunities to improve program effectiveness exist but require programmatic change (not just spending more on doing the same things).
Chesapeake Bay Agreement:

**Restoration Goals**
- Sustainable Fisheries
- Vital Habitat
- **Water Quality**
  - Toxic Contaminants
  - Heathy Watershed
- Climate Resiliency
- Land Conservation
- Stewardship
- Public Access
- Environmental Literacy

**Water Quality Standards**

**Designated Uses**

**Water Quality Criteria**
- Dissolved Oxygen, Water clarity/SAV, & Chl-a across 5 habitats

**TMDL: Stressor Reduction Goals**
- Targets: Nitrogen, phosphorus, sediment
  - TN: 214.6 m/lbs/yr
  - TP: 13.3 m lb/yr
  - TSS: 18,587 m lb/yr

**Implementation Policies**
- Federal permitting
- Fed/State nonpoint programs
- Funding
- TMDL accounting & accountability

**Public Policy**

- Numeric criteria for:
  - Dissolved Oxygen
  - Water Clarity/Submerged vegetation
  - Chlorophyll a
Public Policy

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Biological, Physical, and Social System Response

Living Resource Response
- How are living resources responding to changing water quality conditions?

Achieving Water Quality Standards
- Are nutrient & sediment reductions producing expected water quality response?

Achieving TMDL:
- Are implementation policies and management actions sufficient to achieve nitrogen, phosphorus and sediment goals in the TMDL?
System Response to Meeting Bay Water Quality Standards
Findings and Implications:

Pollutant Response to Management Efforts
**FINDINGS:** Achieving TMDL dependent on significant reductions agricultural & urban nutrient runoff (nonpoint).

Existing nonpoint source water quality programs are insufficient to achieve the nonpoint source reductions required by the TMDL
1. Not generating enough implementation
2. Implementation not as effective as expected
Are nonpoint source programs generating enough adoption/change ("implementation gap")?

Controllable N Loads to the Chesapeake Bay, 2021 (CAST Model)

- Urban
- Agricultural (Ag)
- Wastewater
- Atmospheric
- Septic

Millions of lbs/yr
Possible reasons for the limited implementation progress?

- Nutrient Mass Imbalances
- Limits to current voluntary financial incentive programs ("cost-share")
Point #2: Nonpoint source practices may not be as effective as expected
Possible reasons our nonpoint source efforts may not be as effective as we think (response gap)?

- Lag times/Legacy sources (efforts are effective but not yet realized)
- BMP Effectiveness
- Behavior/Implementation (who, what, where)
- Data Limitations (e.g. nutrient inputs)
Opportunities for improving nonpoint source effectiveness
Improving Nonpoint Source Program Effectiveness: Practices v Outcomes

- Pay for Performance/Success
- Incentives for demonstrated outcomes (greater certainty)

- Cover crops: Low upfront installation costs, Private benefits.
- Livestock Exclusion Fencing: High up front installation costs, No private benefits.
- Denitrifying Bioreactor: Public benefits: Pollutant removal benefits?
Improving Nonpoint Source Program Effectiveness: Targeting Outcomes

- Finer scale modeling & monitoring
- Incentives to find & address high load area
- Alternatives to TMDL accounting/crediting

Large variation in nonpoint source loads and BMP effectiveness across landscape and land managers
Improving Effectiveness: Addressing Mass Balance

Mass Balance:

\[ A = B + C + D \pm \text{Storage} \]

- **A**: Mass of Nutrient Import (N or P in fertilizer, feed)
- **B**: Nutrient Export to Water
- **C**: Nutrient Export in Materials/biomass
- **D**: Nutrient Export to Air
- **Watershed**
- **Storage**
Nutrient Mass Balance

Moyer et al. 2017, Webber, 2017

Source: USGS Sparrow Model Output
Over past 3 decades, the number of animal units increasing.

Well designed and maintained riparian buffer (BMP).

Livestock manure.

Net Result:
Monitored N loads increasing over time.

Over past 3 decades, 4x increase in # of BMPs installed.
Improving Nonpoint Source Program Effectiveness: New Opportunities for Technological & Institutional Innovation

The Sandboxing Process (Figure adapted from Higgins and Male, 2019)
Findings:
Bay Water Quality Response to Nutrient Reductions
FINDING: Load reductions have produced water quality improvements in some areas but often not at levels expected. Full achievement of WQS is distant & unlikely, particularly for deep water habitats.
Expected and observed dissolved oxygen response

- Potential response gap across habitats
- Response gap largest for deep channel
- Response gap largest at low loads
- No expected response for shallow waters
Why response gaps?

- Climate change (ex. warming waters)
- “Tipping points”
Examples of rapid recovery in regions of the Bay

Mattawoman Creek

Major WWTP load reduction completed
Implications
Findings: Living Resource Response to Water Quality Improvement
Living resource response to changes in water quality criteria
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
Many Knobs of Living Resource Response
Implications

Full attainment of current water quality criteria may not be necessary to improve and support living resources goals.
CESR Implications for Water Quality Goals & Living Resources

Additional nutrient reductions needed to maintain and improve water quality.

Opportunities to improve living resource response without achieving full attainment of water quality criteria

Prioritize management actions that improve living resource response
- Example: targeted attention in shallow water habitats through tiered approach to TMDL implementation