# Watershed Findings and Implications of the STAC CESR Report

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June 29, 2023

Presentation to CBP STAR

## “CESR” Report

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

An Independent Report from the Scientific and Technical Advisory Committee (STAC)
Chesapeake Bay Program
Annapolis, MD

May 2023

Scientific and Technical Advisory Committee (STAC)

## Watershed Resource Document

**Scientific and Technical Advisory Committee:**
**Evaluation of Management Efforts to Reduce Nutrient and Sediment Contributions to the Chesapeake Bay Estuary**

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**May 2023**

**STAC Publication 23-003**

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## Public Policy

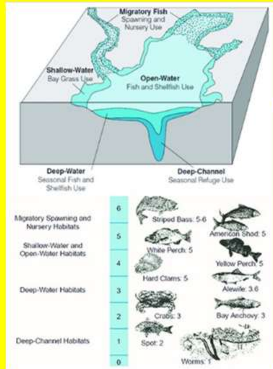
**Chesapeake Bay Agreement: Restoration Goals**

- 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: 13.4m lb/yr
TSS: 18,587m lb/yr

→

**Implementation Policies**

Federal permitting
Fed/State nonpoint programs
Funding

TMDL accounting & accountability

## Biological, Physical, and Social System Response

**Living Resource Response**

**How are living resources responding to changing water quality conditions?**

←

**Achieving Water Quality Standards**

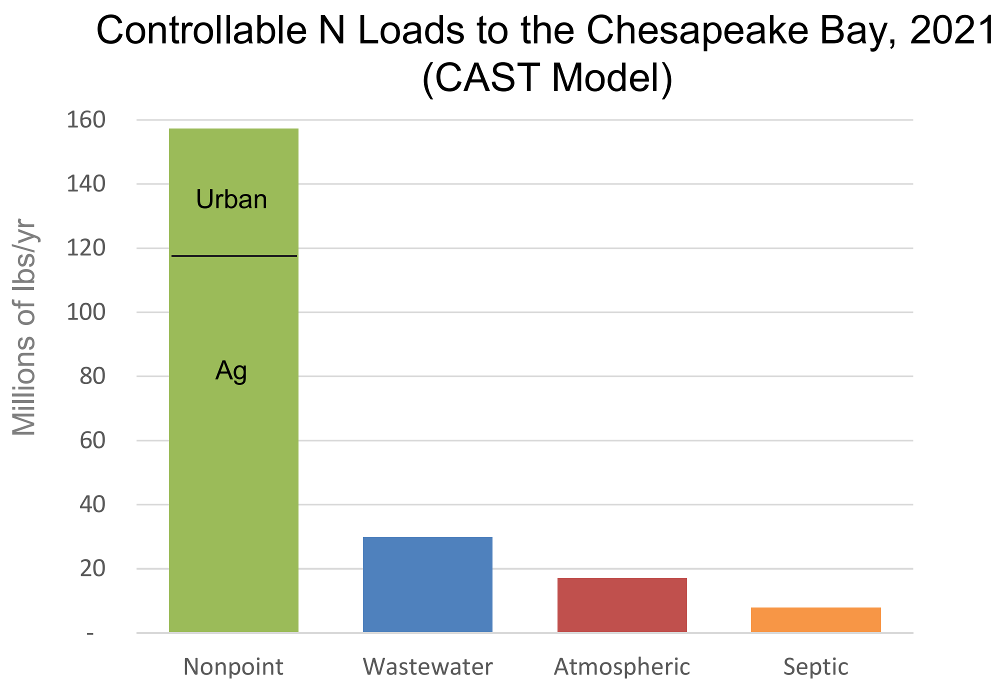
**Are nutrient & sediment reductions producing expected water quality response?**

←

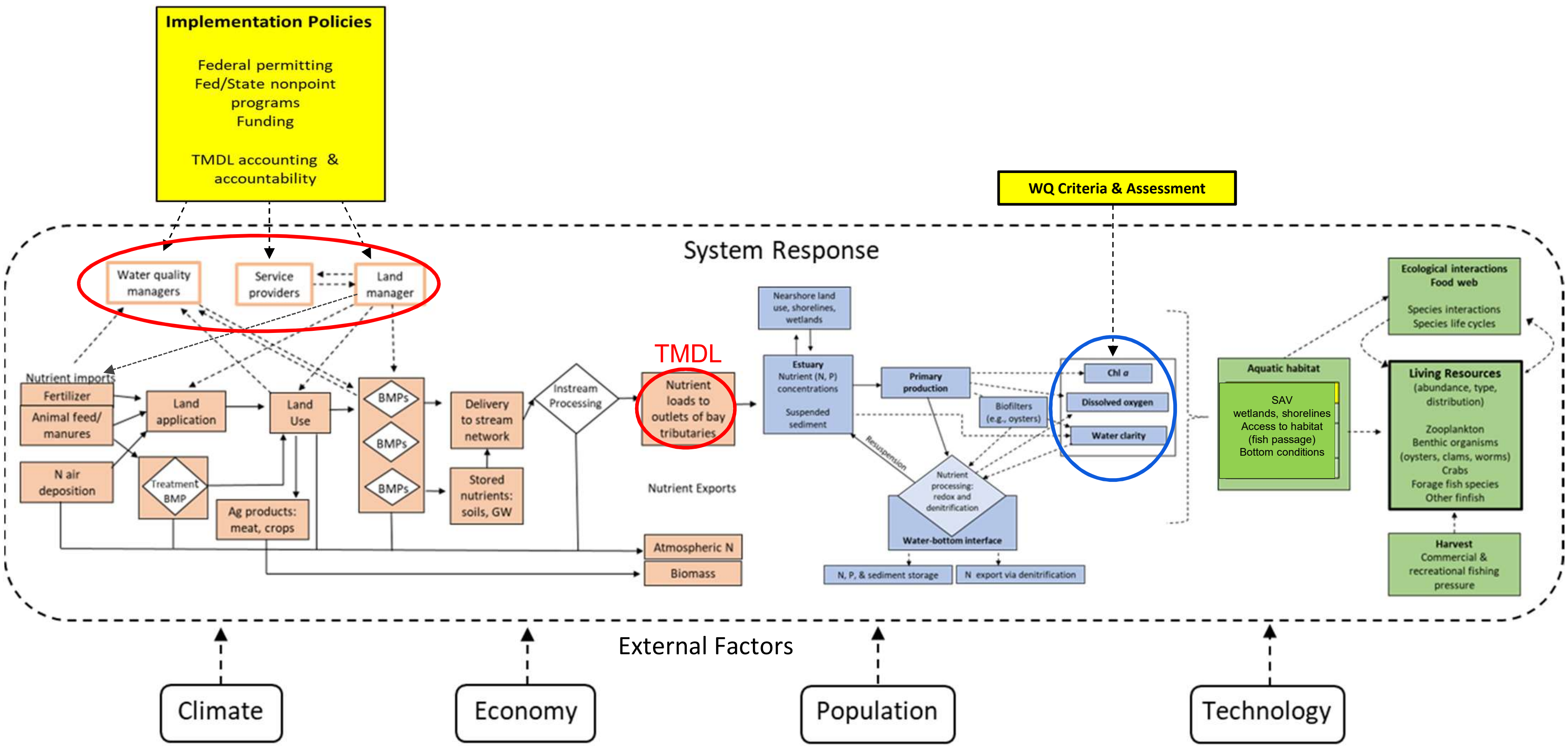
**Achieving TMDL:**

**Are implementation policies and management actions sufficient to achieve nitrogen, phosphorus and sediment goals in the TMDL?**

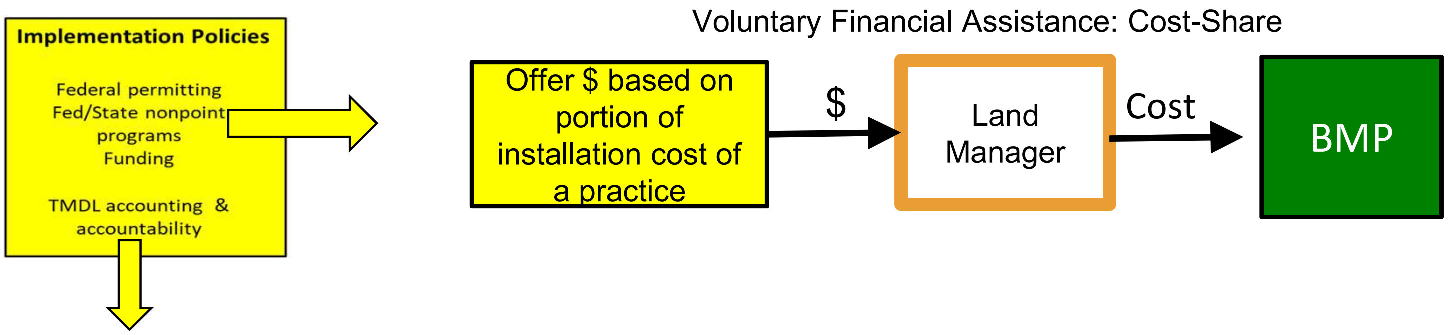
# Focus of CESR Watershed Discussion: Nonpoint Sources



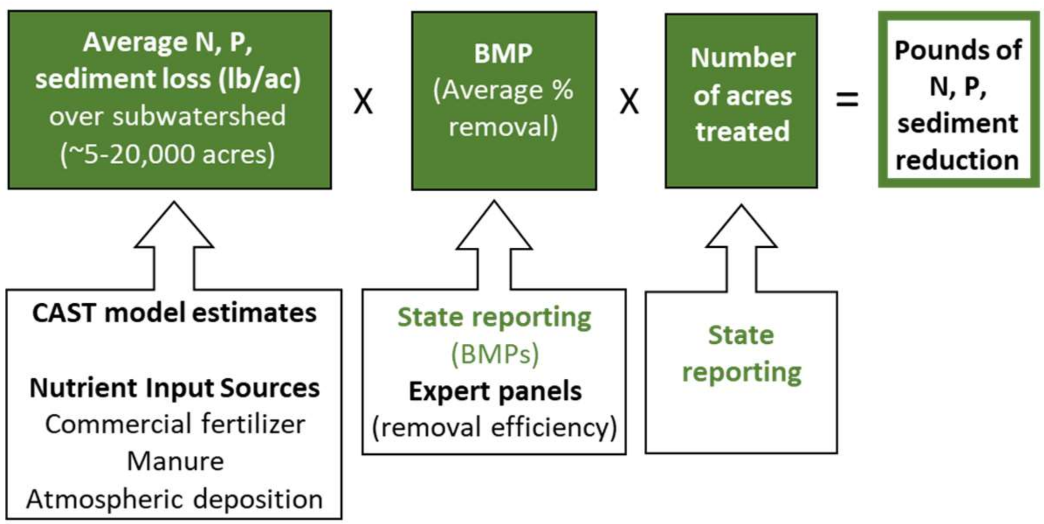
# System Response to Meeting Bay Water Quality Standards



# Basics of Bay TMDL Implementation Policy

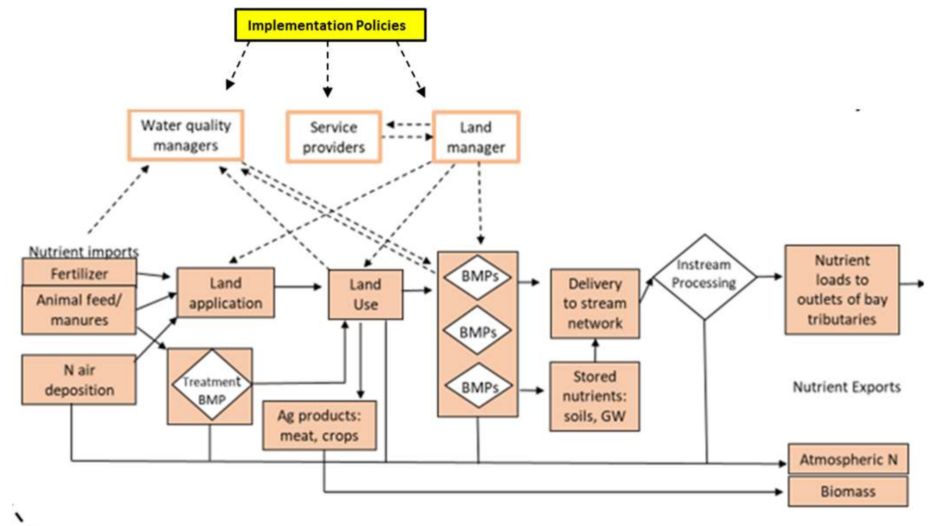



## Crediting nonpoint source reductions & the CAST model



# Findings and Implications:

## Pollutant Response to Management Efforts

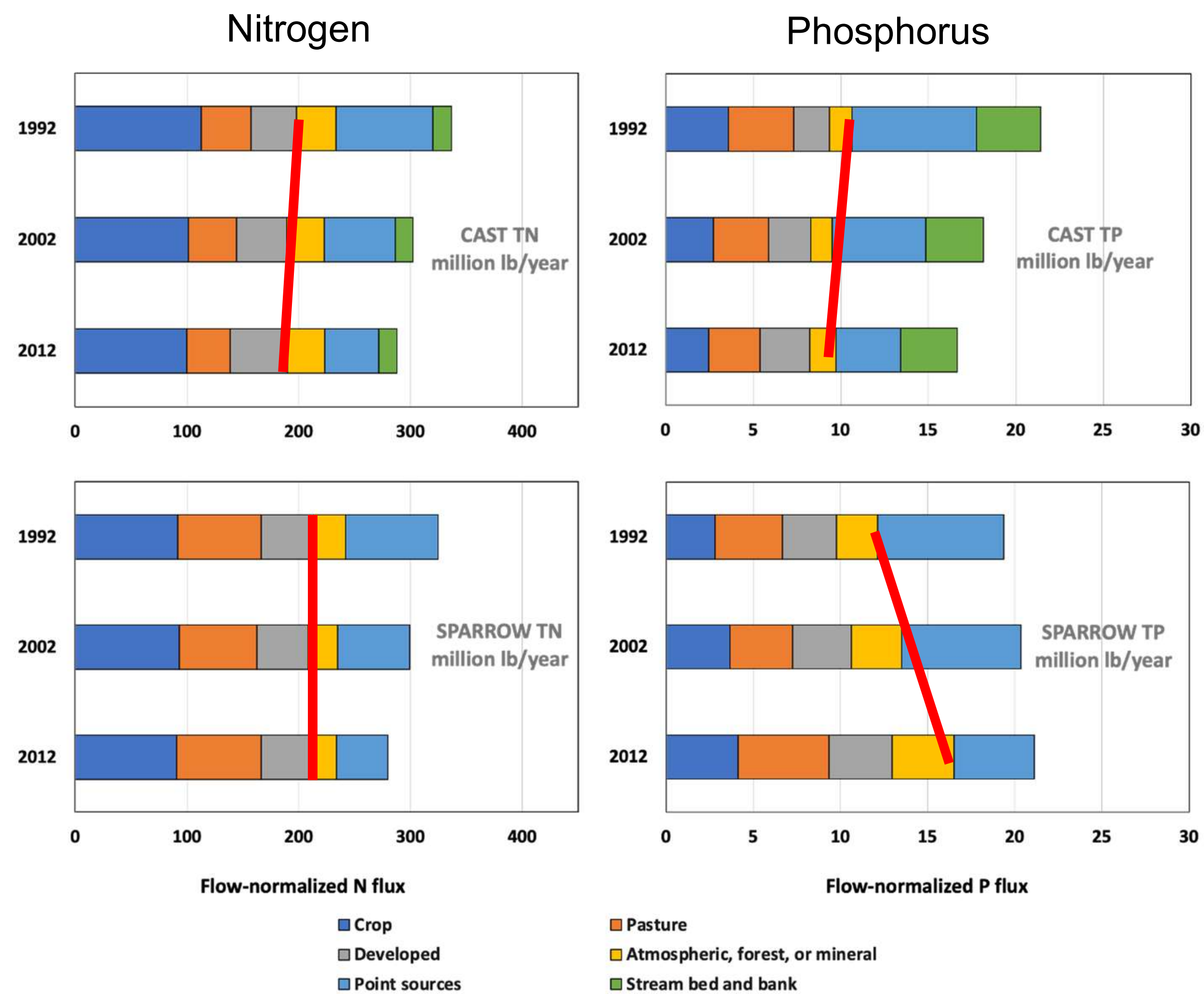


## FINDINGS:

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

1. NPS programs not generating scale of behavioral change needed (implementation gap)
2. Implementation may not be as effective as expected (response gap)

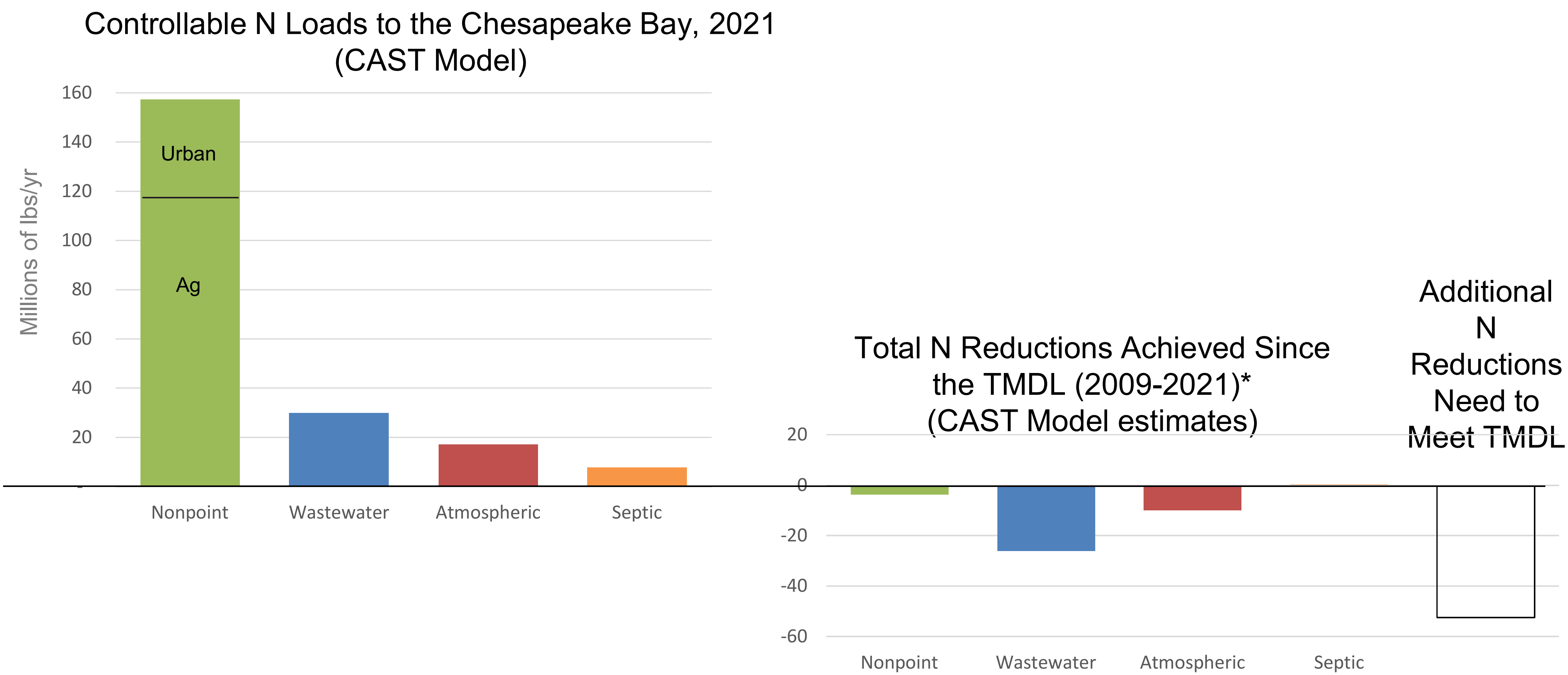
# Progress on reducing nonpoint source nutrient loads




Estimated flow-normalized total and source sector TN and TP fluxes to the Chesapeake Bay for the CAST and SPARROW models

Ator et al. 2020

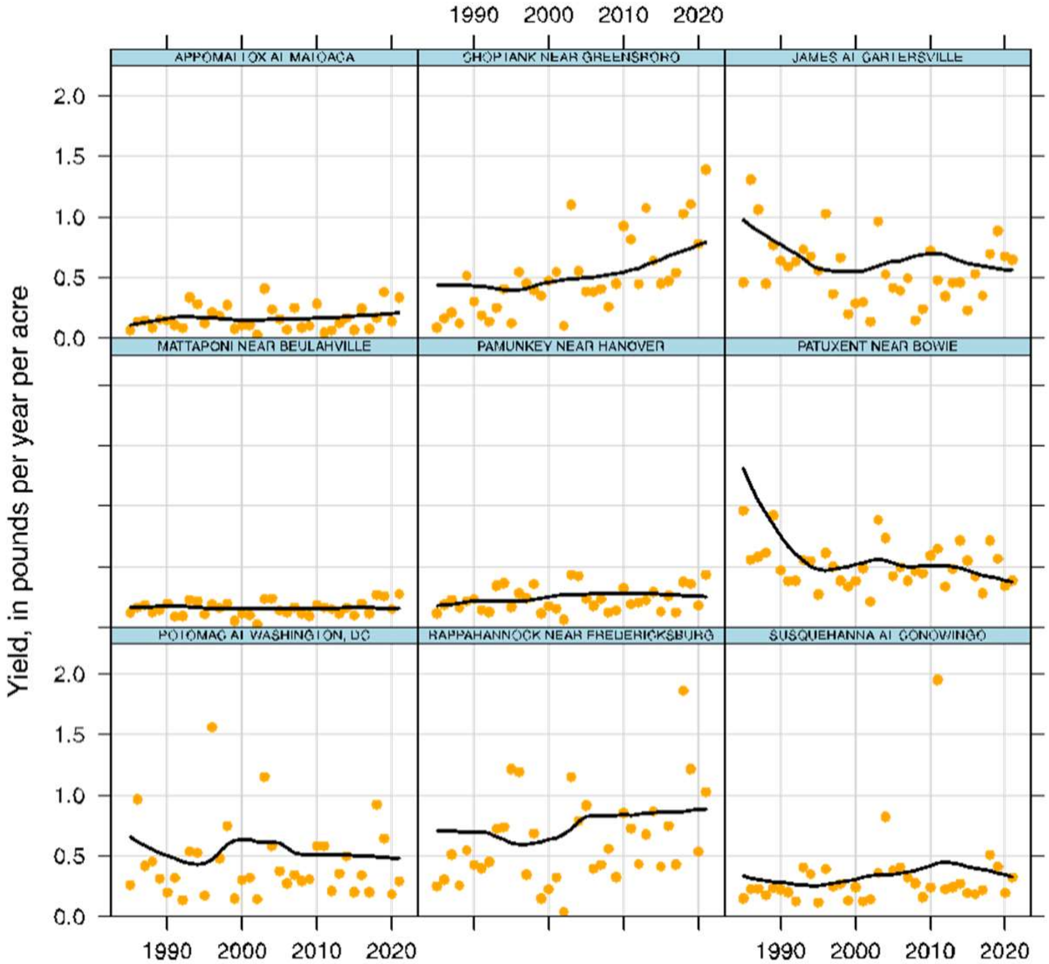
# Are nonpoint source programs generating enough adoption/change ("implementation gap")?



# Effectiveness of Nonpoint Source Management Efforts

Monitoring data shows mixed signals of NPS management effectiveness. Several studies have found relatively little change in NPS loads between 1990 and today.

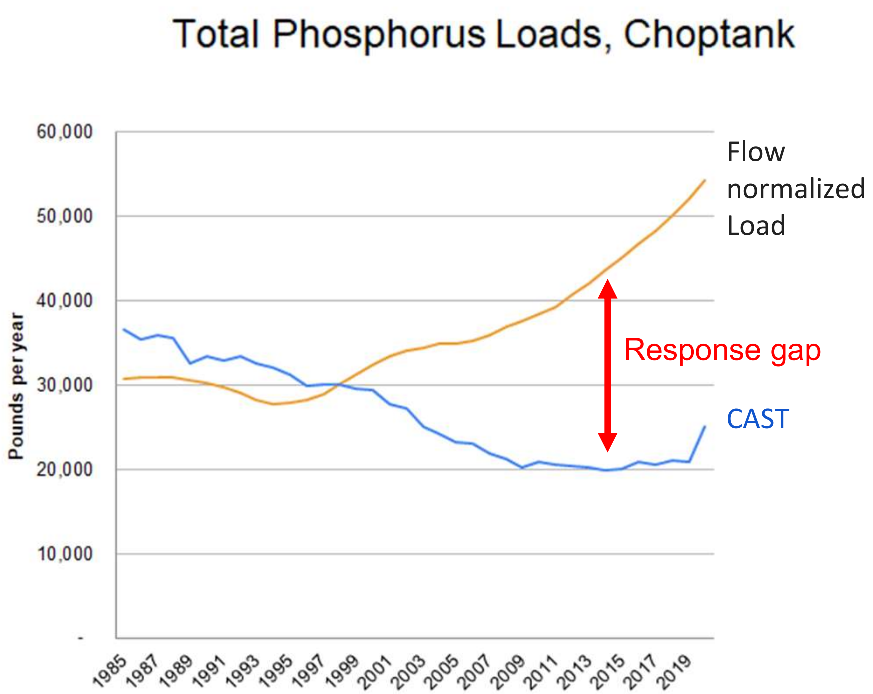
Keisman et al 2018; Ator et al. 2019; 2020

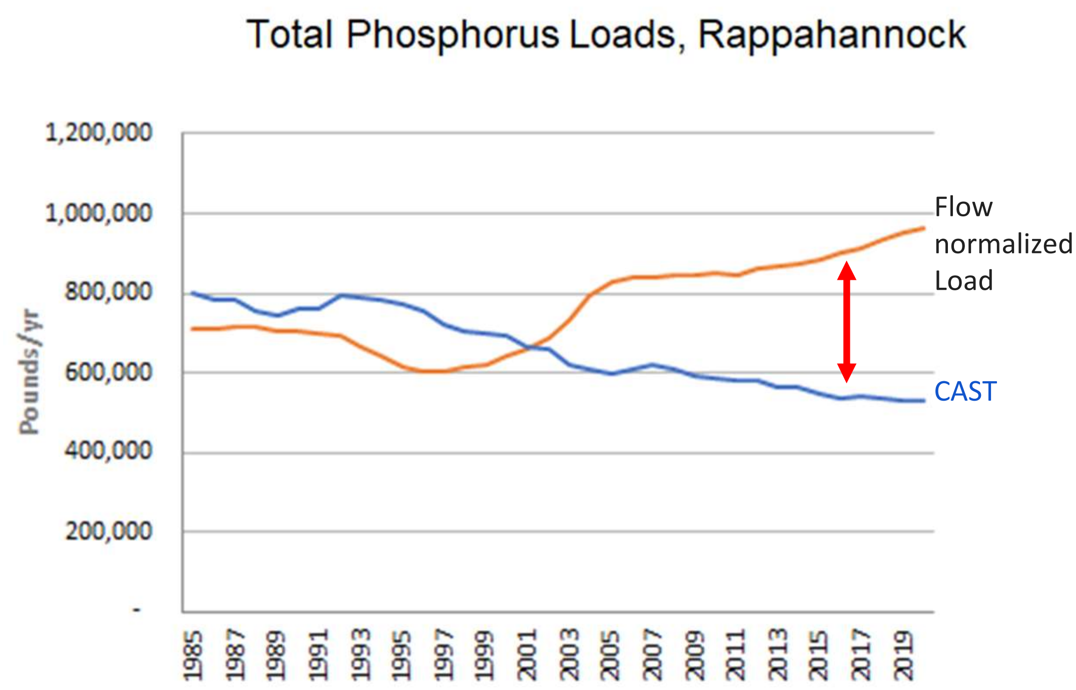



**Total Phosphorus Yields at the RIM sites**
**Black Line is flow Normalized Yield, 1985-2021**

Mason and Soroka, 2022

# Illustrations of the NPS phosphorus response gap: Difference between expected and observed outcomes

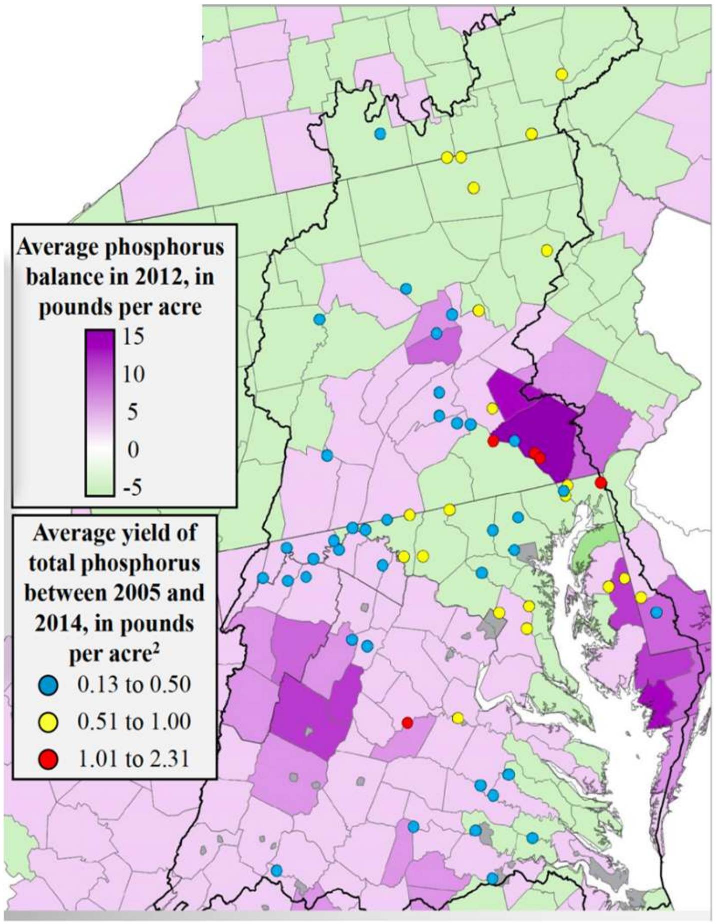


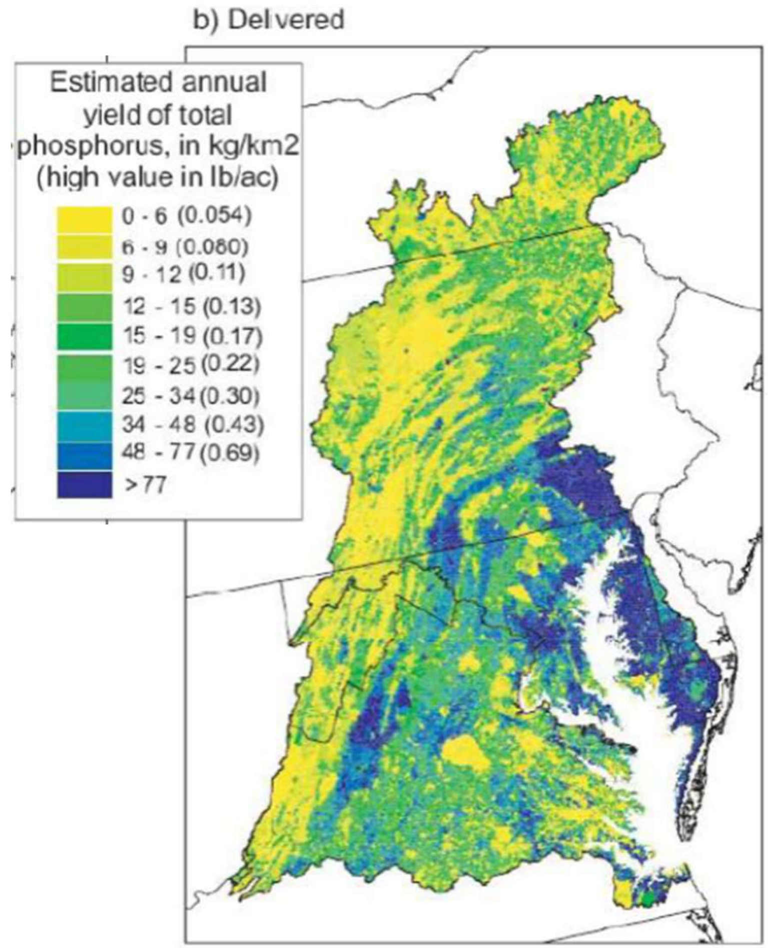
# Possible reasons for the limited progress in implementation

- Nutrient mass imbalances
- Limits to current voluntary financial incentive programs (“cost-share”)

# Nutrient Mass Balance




Moyer et al. 2017, Webber, 2017




Source: USGS Sparrow Model Output

# Illustration of a CBP showcase watershed: Smith Creek

Livestock manure

Over past 3 decades, the number of animal units increasing

Well designed and maintained riparian buffer (BMP)

Over past 3 decades, 4x increase in # of BMPs installed.

Net Result:

Monitored N loads increasing over time

# Scaling Adoption: Limits of Cost-Share

Cover crops

Livestock Exclusion Fencing

Denitrifying Bioreactor

Low upfront installation costs
Private benefits

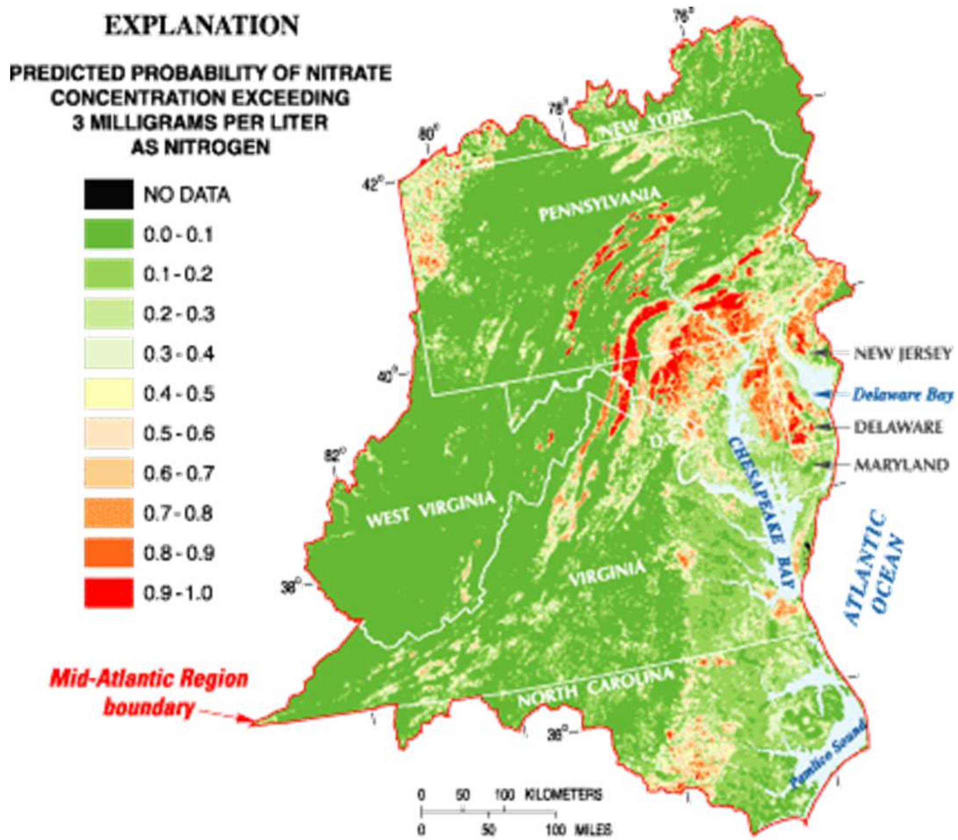
High up front installation costs
No private benefits

# Possible reasons our nonpoint source efforts may not be producing expected response

- Lag times/Legacy sources (efforts are effective but not yet realized)
- BMP Effectiveness
- Behavior/Implementation (who, what, where)
- Data Limitations (e.g. nutrient inputs)

Predicted probability of groundwater nitrate levels exceeding 3 mg/L.

Legacy nutrient sources delay and obscure pollutant reduction outcomes




Source Greene et al. (2004).

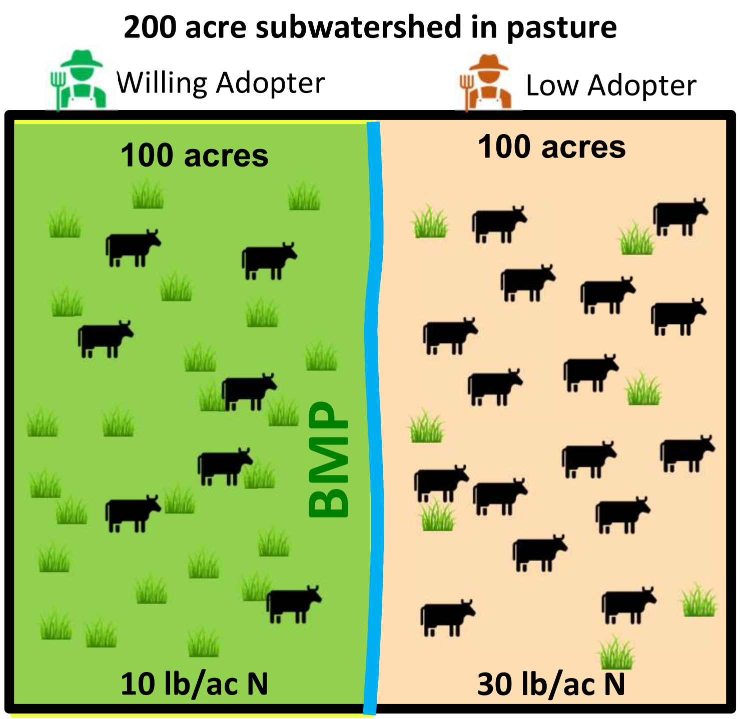
# Uncertainty in BMP Effectiveness

- Uncertainty in removal effectiveness
- Incomplete literature on loss pathways
- Performance over time
- Maintenance (expected vs realized)

# Uncertainty in BMP Effectiveness

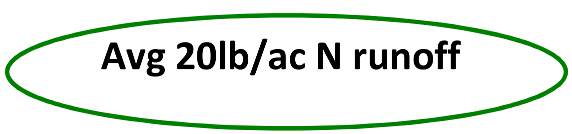
- Complex cropping systems/practices
- Tradeoffs between pollutant objectives

# Behavior




BMP with 50% removal efficiency. Land manager most likely to adopt?

Which land managers will a service provider most likely work with?




Modeled average condition

# Diversity Across Land managers

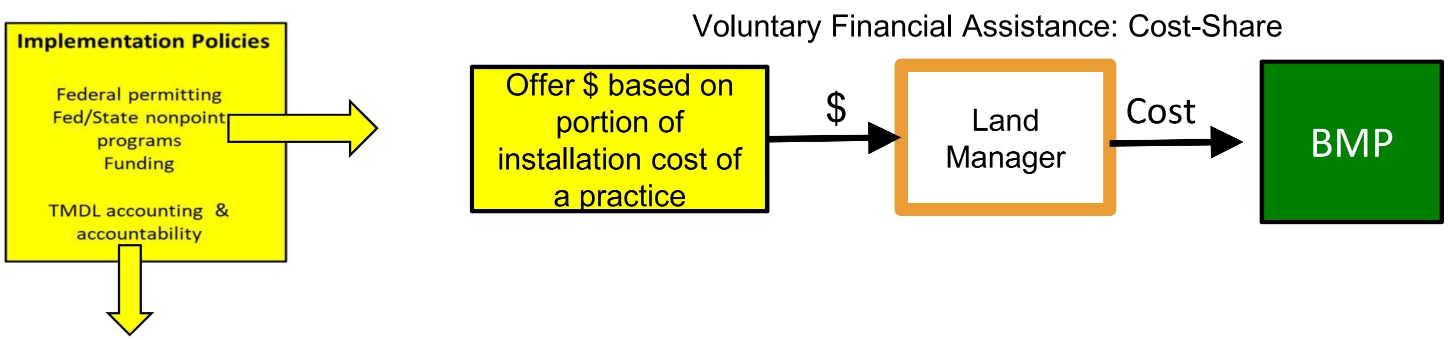
Total phosphorus balance across 58 dairy farms in Shenandoah Valley Virginia, 2018

| Quartile | Total P balance (kg/ha) |
|---|---|
| Minimum | -30.9 |
| 1st Quartile | 1.5 |
| Median | 12.4 |
| 3rd Quartile | 18.7 |
| Maximum | 97.6 |

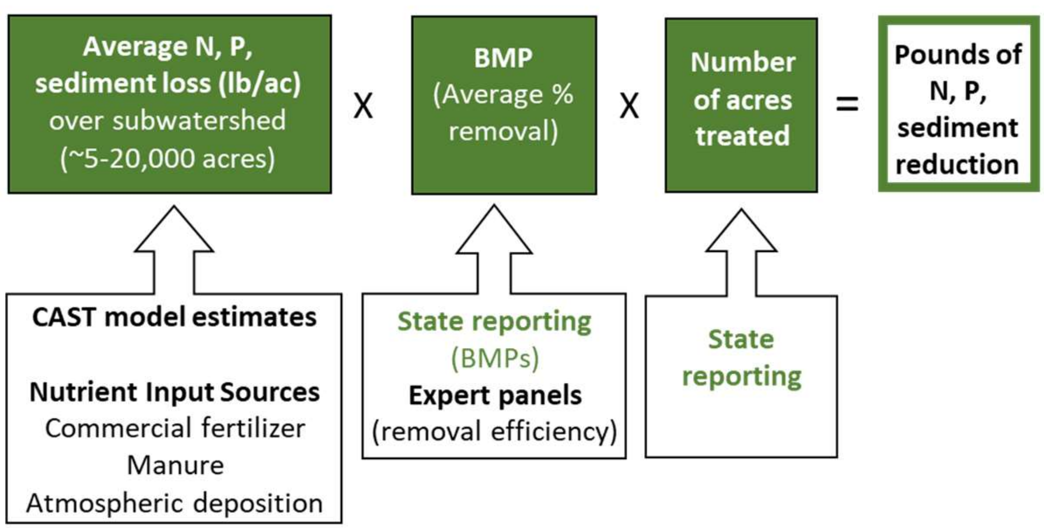
(Source: Pearce & Maguire 2020)

# Implications

# Basics of Bay TMDL Implementation Policy




**Crediting nonpoint source reductions & the CAST model**

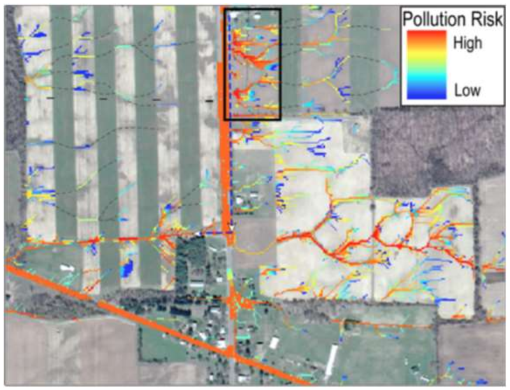



There are opportunities to improve program effectiveness, but it will require policy change

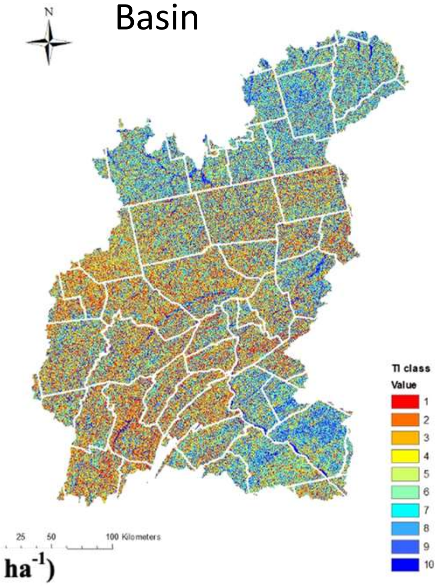
## *Summary of Possible Policy Options*

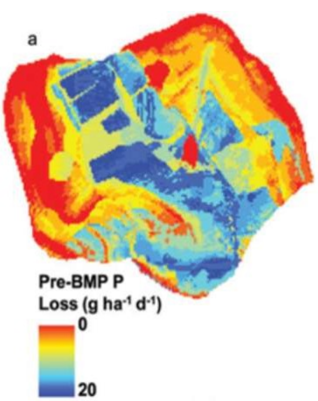
- Shift the focus to **achieving outcomes,** less emphasis on counting practices.
  - Outcome based incentives
  - Incentives for targeting and improved targeting tools
  - Targeted outcome-based requirements
- Additional emphasis/focus on addressing mass imbalances
- Willingness to experiment with policy reform/innovations
- More explicit acknowledgement and evaluation of uncertainty

25 acre parcel

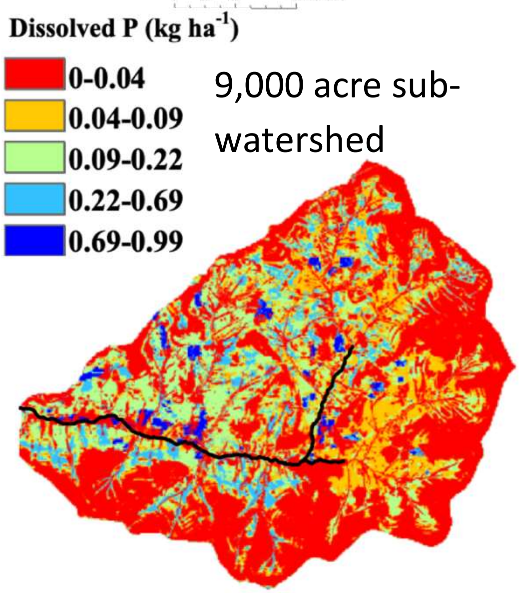



Basin




400 acre farm

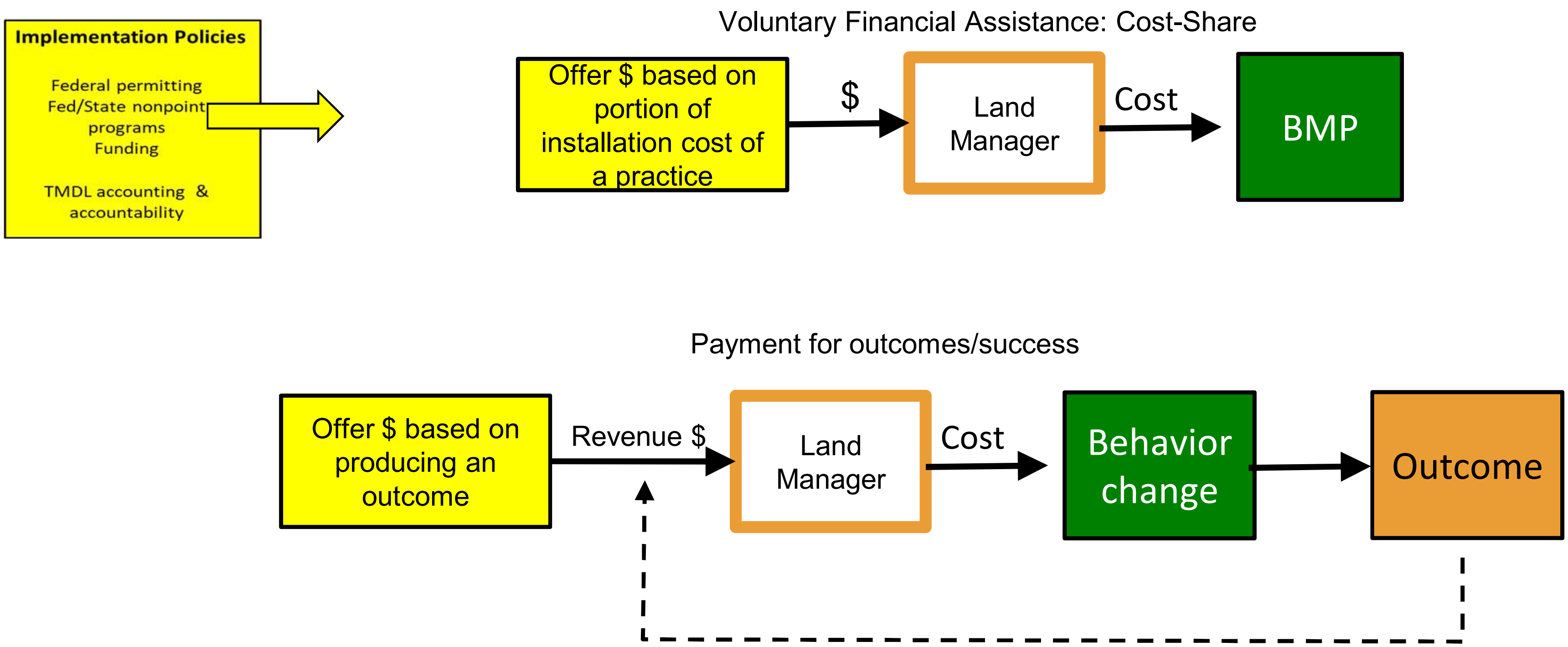



9,000 acre sub-watershed

**Nutrient loads are highly variable across the landscape across multiple scales**

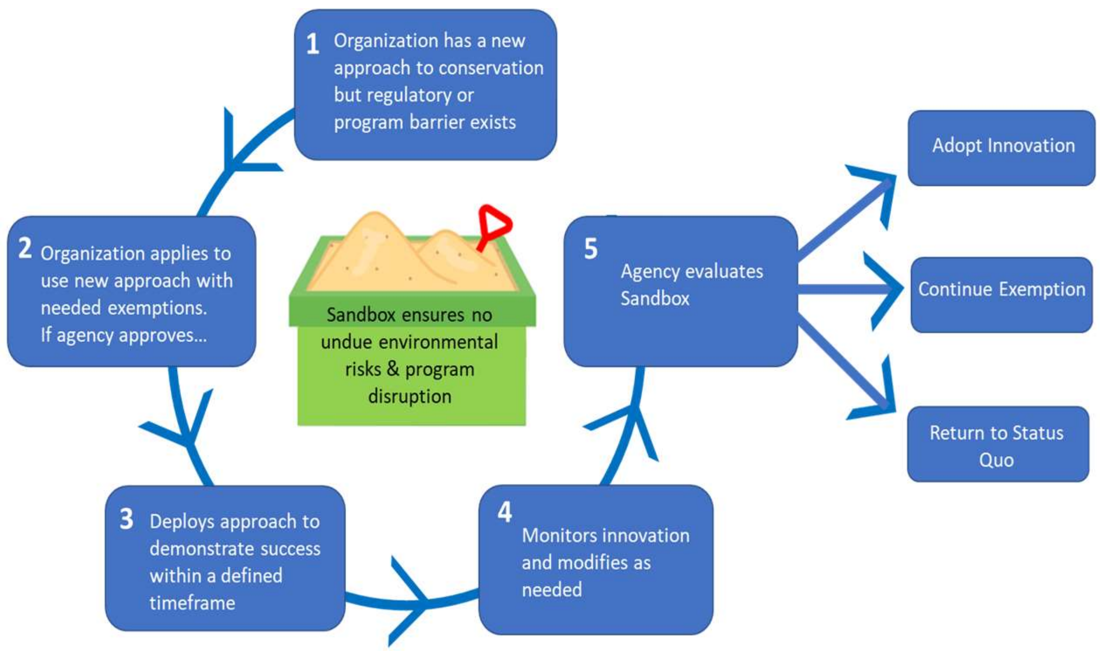
**Improve tools and incentives for targeting**

# Outcome based Incentive Systems



# Improving Nonpoint Source Program Effectiveness:

## Encourage Institutional/policy Innovation




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