Relating Management Practice Implementation and Modeled Load Reductions in the Chesapeake Bay Watershed

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Research Goal & Source Data

Research Goal: Describe changes in expected water quality with levels of management practice implementation. Assess the impact of other factors affecting water quality.

Source Data:

- Source Data
- Map Tools & Spatial Data
- Loads Per Unit Report
- BMP Submitted vs. Credited Report
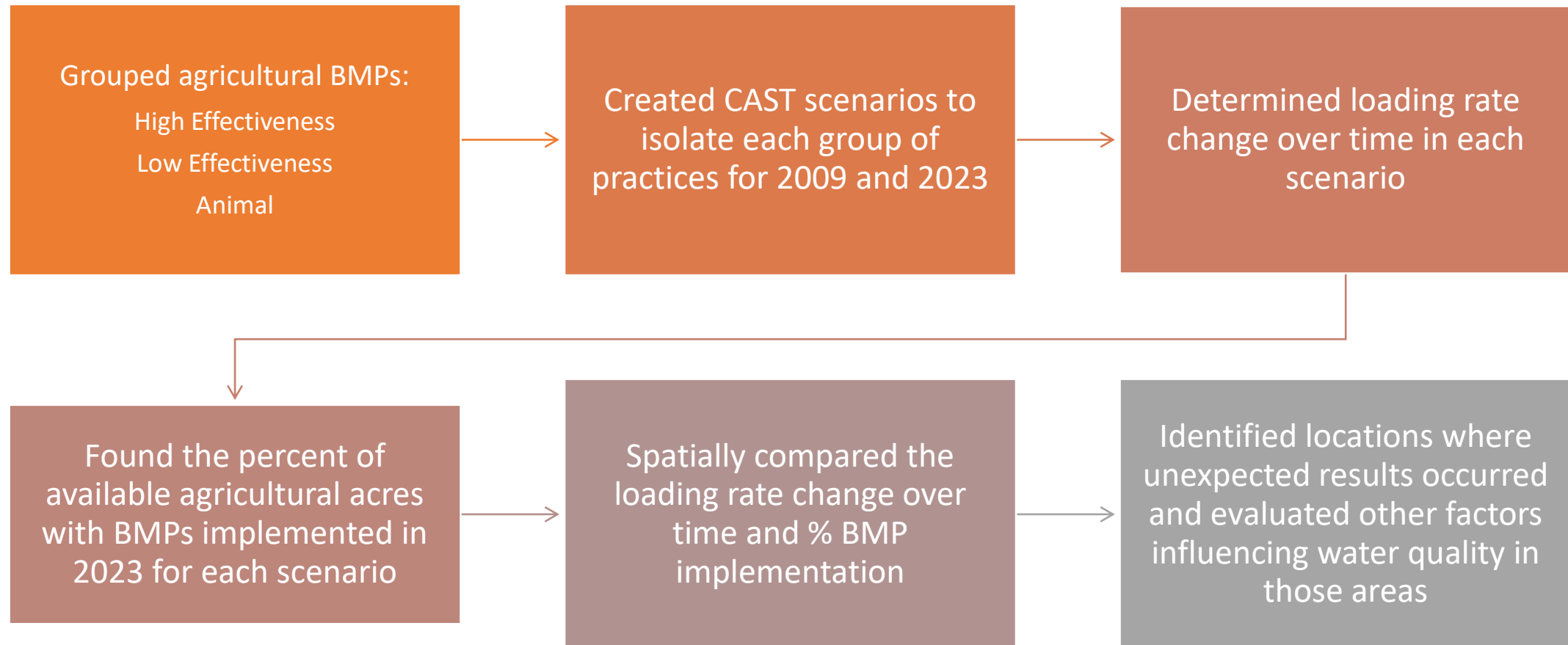- Nutrients Applied Report

Why It Matters

- Land managers want to know:
  - Where, and what types, of management practices are expected to have the most impact
  - Location of water quality changes that are inconsistent with management practice implementation
- The Scientific Technical Advisory Committee (STAC) 2023 Comprehensive Evaluation of System Response (CESR) report found that "existing implementation actions to reduce nonpoint sources of nutrients are insufficient to achieve the TMDL."
- Goal is to create a product that highlights opportunities by sector and geography

Methods

- All modeled data using CAST-23
- Total Nitrogen
- Change between 2009 and 2023

Grouped agricultural BMPs:

High Effectiveness

Low Effectiveness

Animal

Created CAST scenarios to isolate each group of practices for 2009 and 2023

Determined loading rate change over time in each scenario

Found the percent of available agricultural acres with BMPs implemented in 2023 for each scenario

Spatially compared the loading rate change over time and % BMP implementation

Identified locations where unexpected results occurred and evaluated other factors influencing water quality in those areas

Chesapeake Bay Watershed BMP Heat Map
High Effectiveness BMPs vs Nitrogen Loading Rate Change Over Time
(2009-2023)

Nitrogen Loading Rate Change Over Time
Low: -100% - 20%
Med: 20% - 140%
High: 140% - 260%

Ratio of BMP Acres to Total Available Acres
Low: 0% - 54%
Med: 54% - 108%
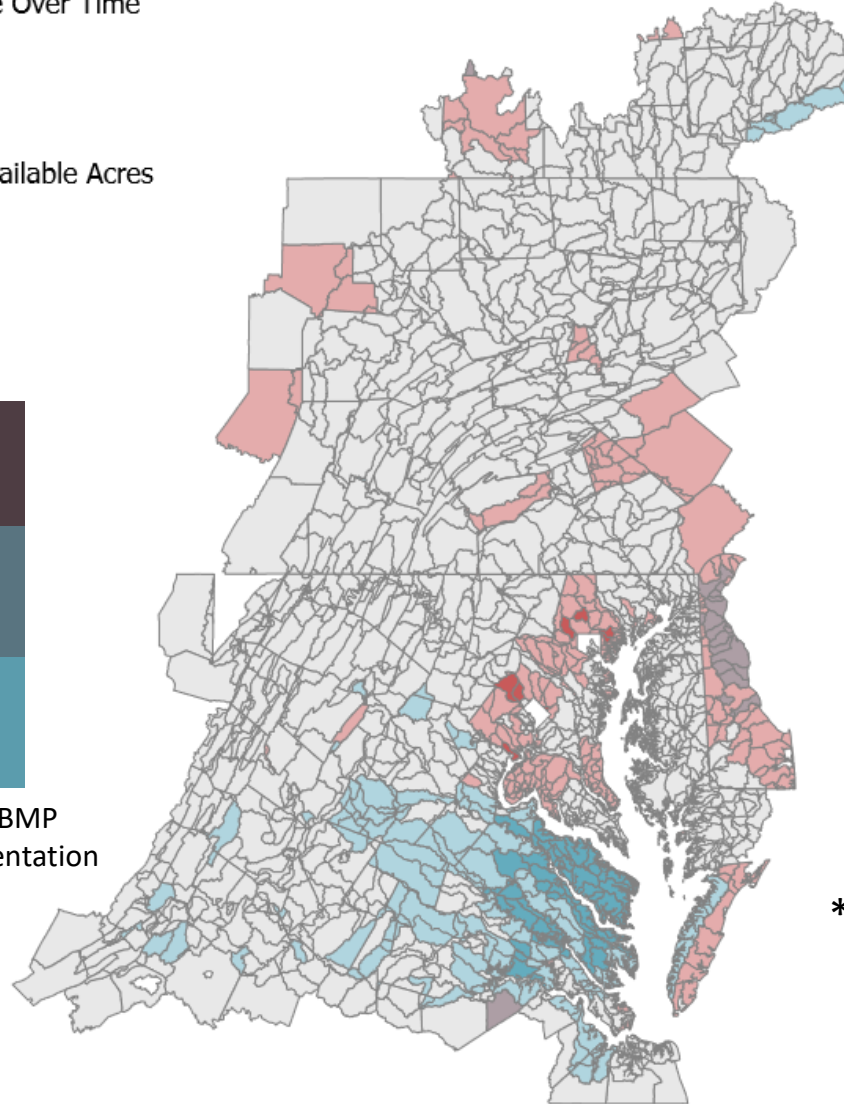High: 108% - 162%
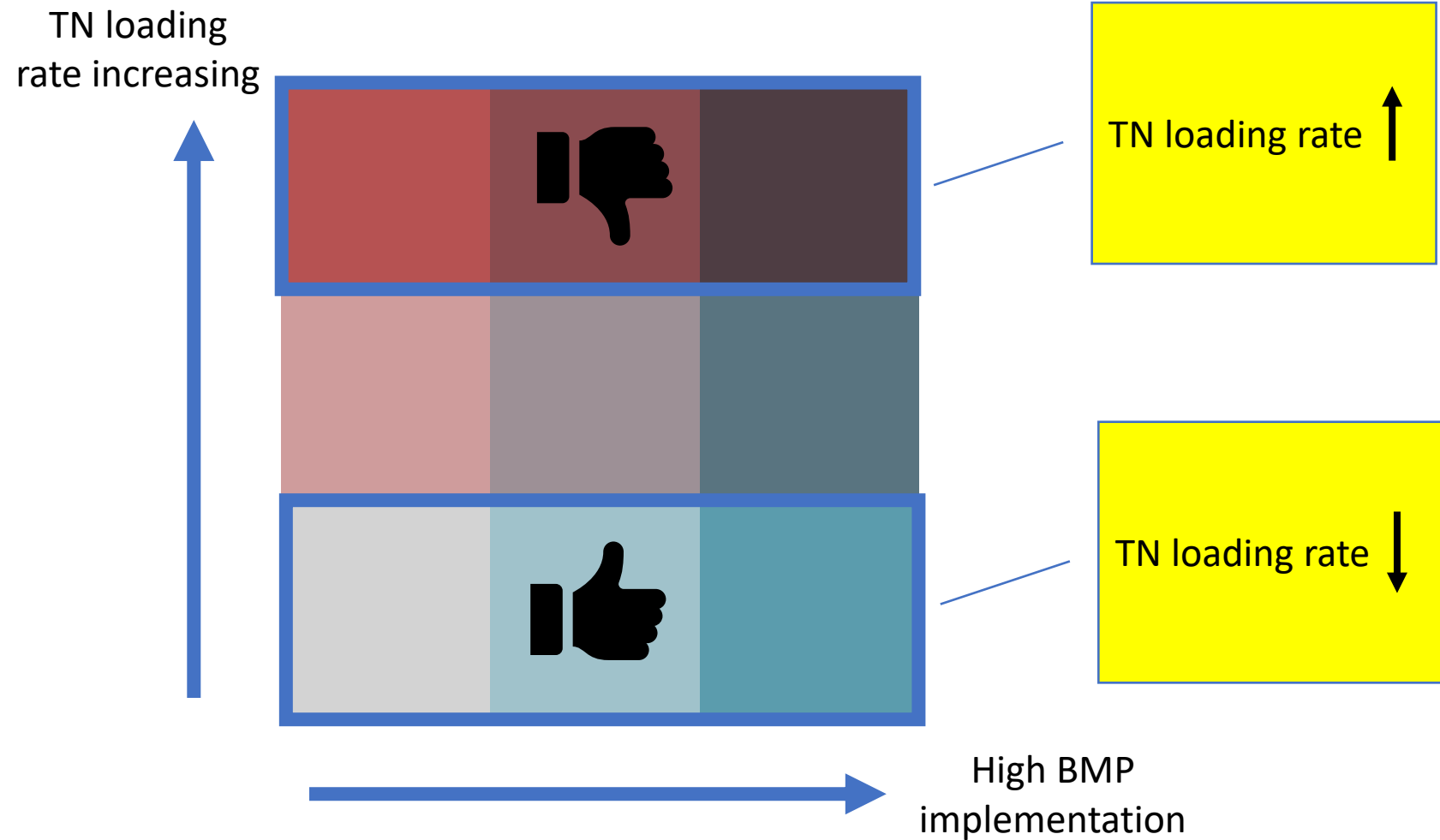
TN Loading Rate Increasing

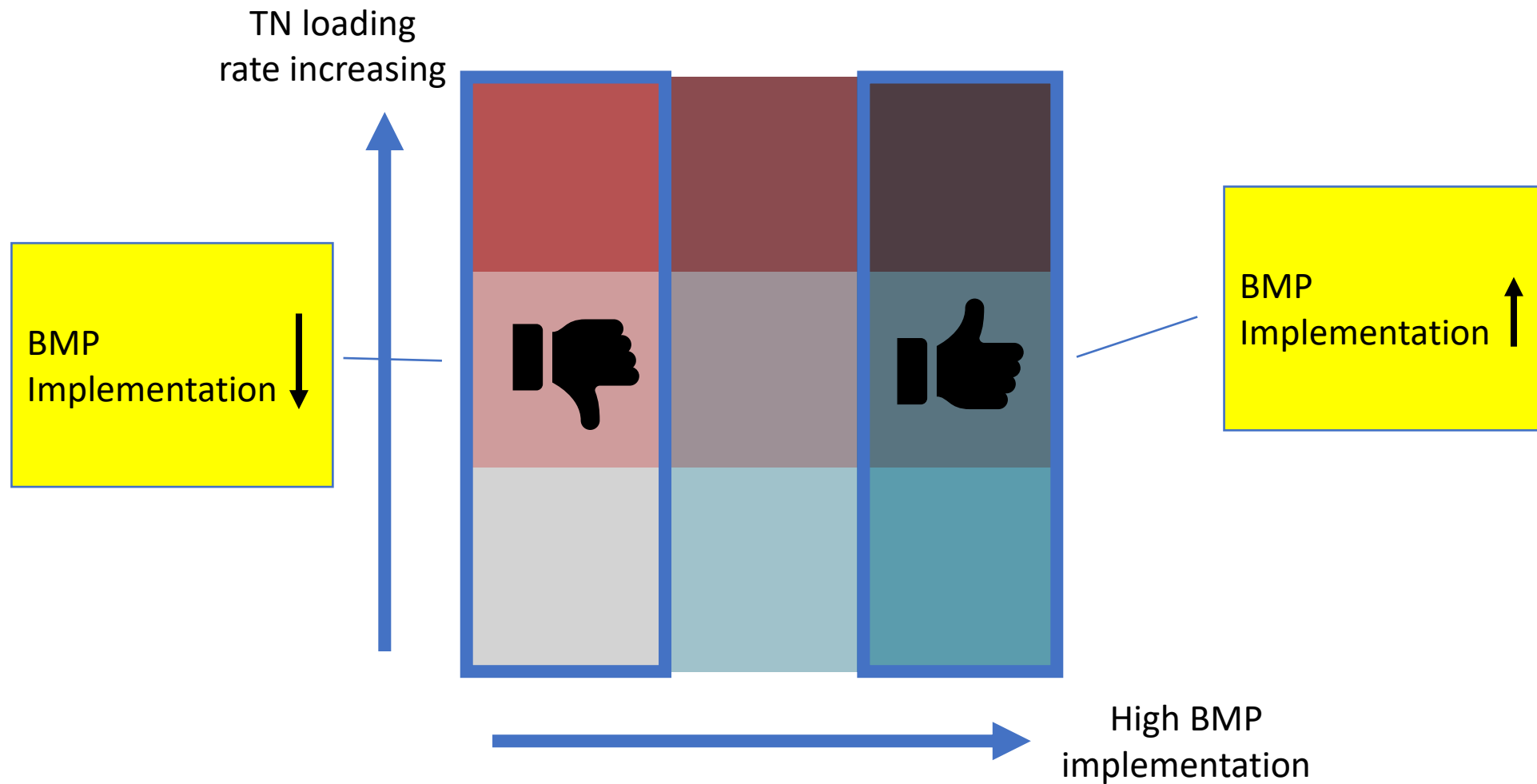High BMP Implementation

N

0   37.5   75   150 Miles

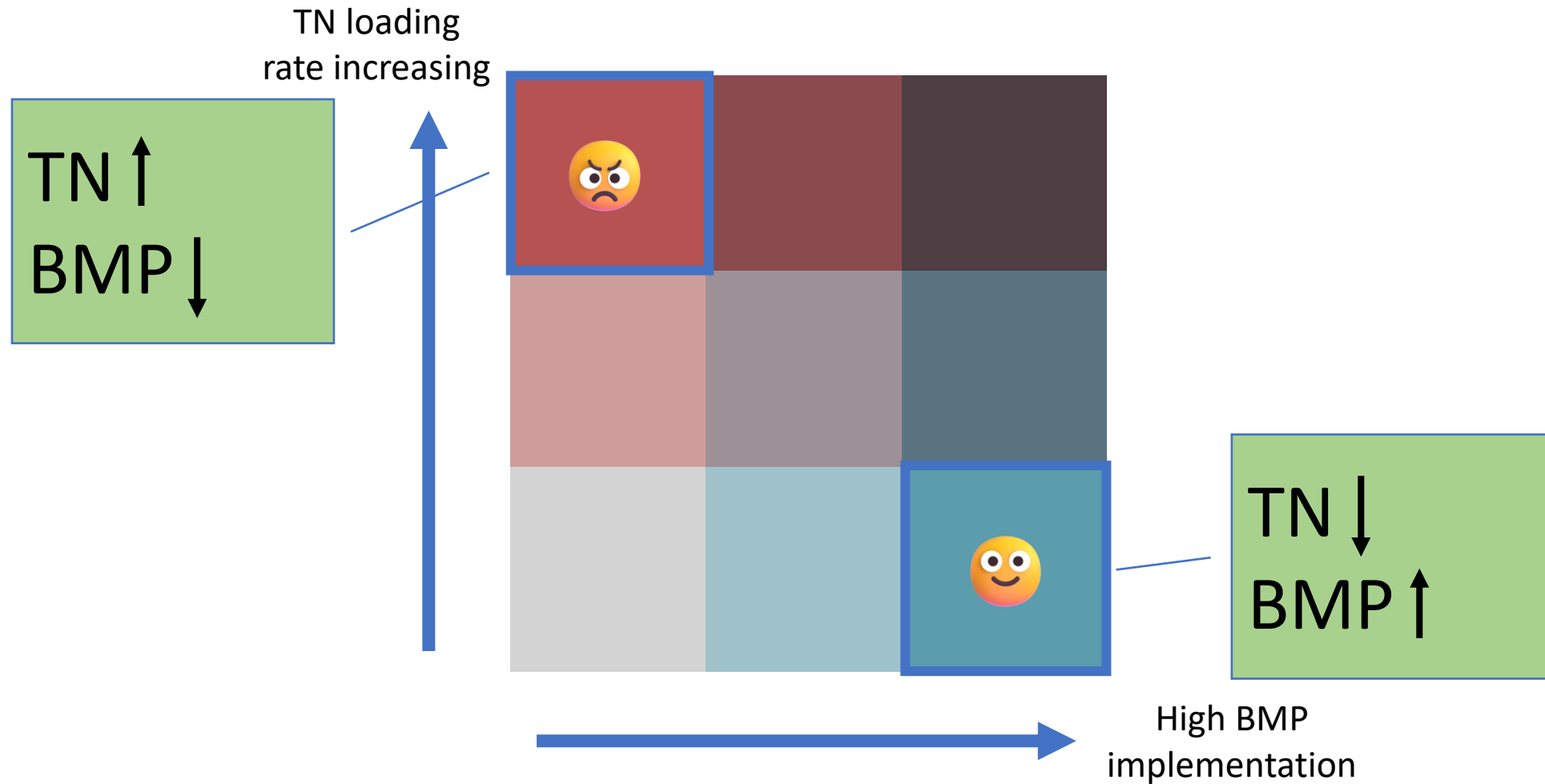*Preliminary Information – Subject to Revision
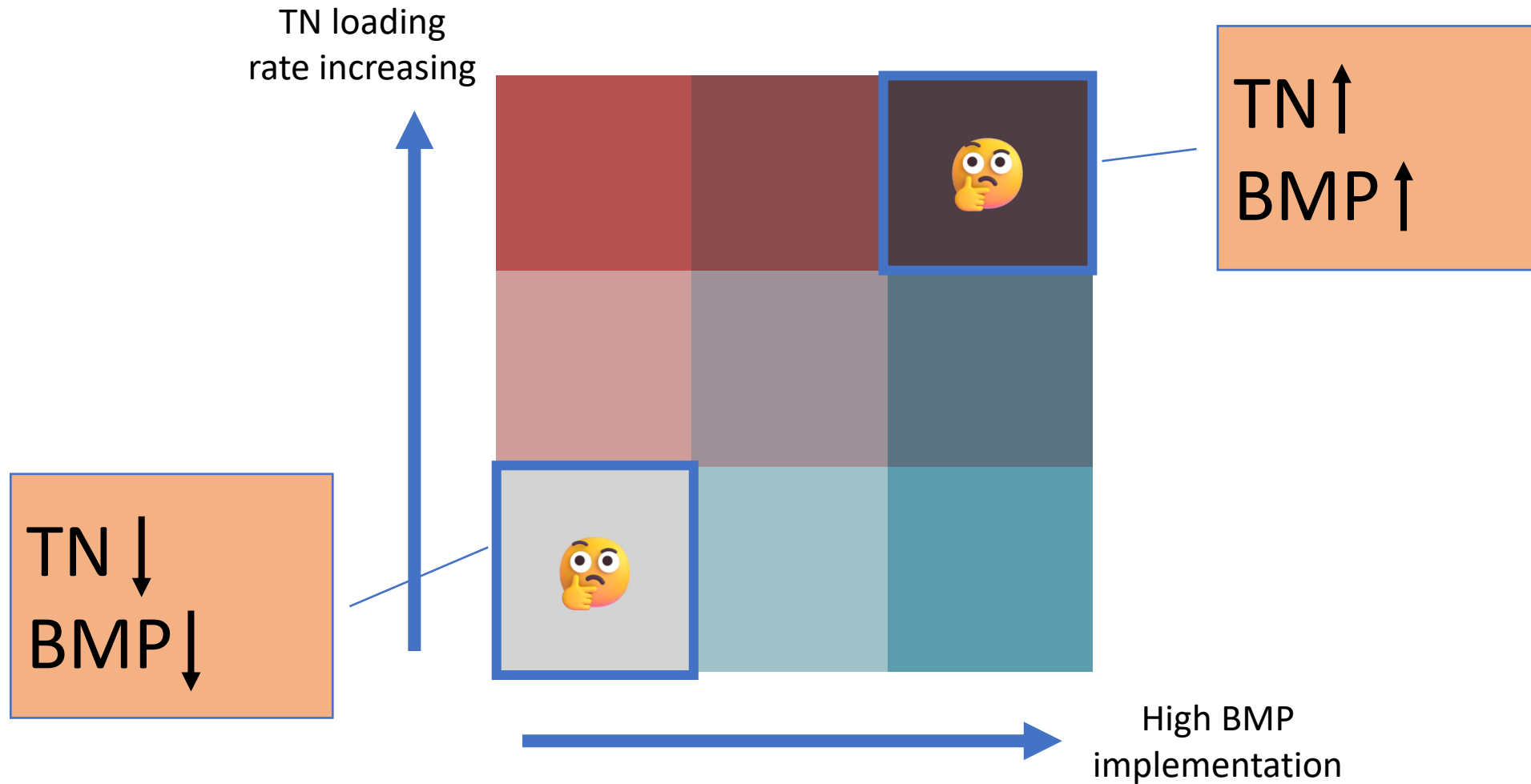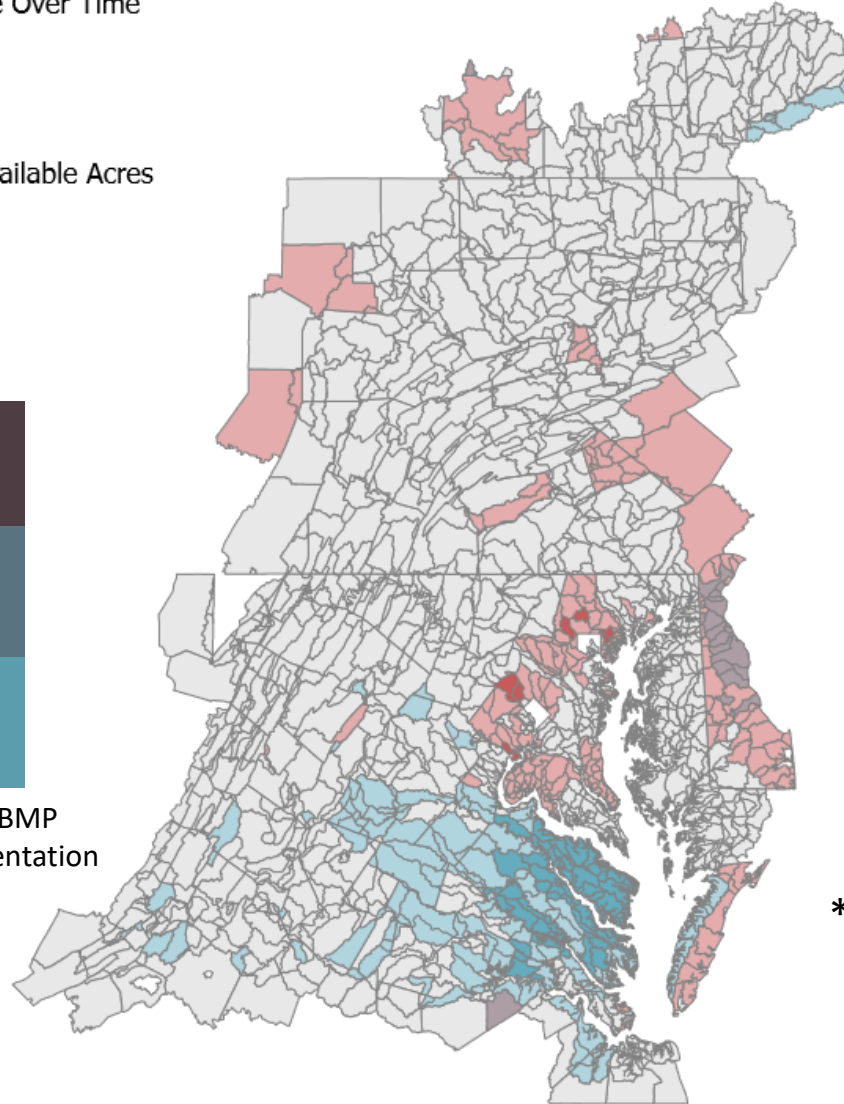
Source: CAST.ChesapeakeBay.net

Bivariate Legend

TN loading rate increasing

TN loading rate ↑

TN loading rate ↓

High BMP implementation

Bivariate Legend

TN loading
rate increasing

BMP
Implementation ↓

BMP
Implementation ↑

High BMP
implementation

Bivariate Legend – Expected Effects

TN loading rate increasing

TN ↑ BMP ↓

TN ↓ BMP ↑

High BMP implementation

Bivariate Legend – Unexpected Effects

TN loading rate increasing

High BMP implementation

TN ↑
BMP ↑

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BMP ↓

Chesapeake Bay Watershed BMP Heat Map
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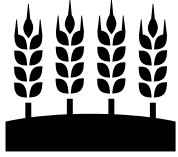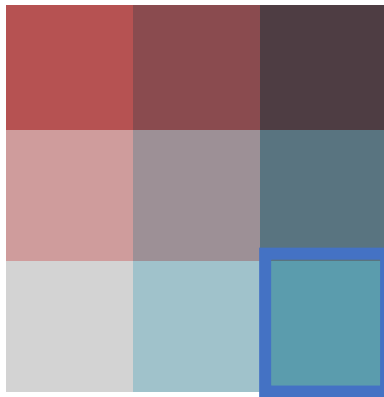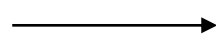Med: 54% - 108%
High: 108% - 162%

TN Loading
Rate
Increasing

High BMP
Implementation

N

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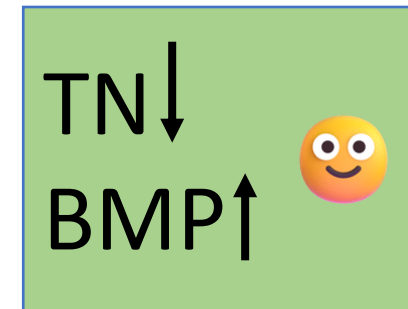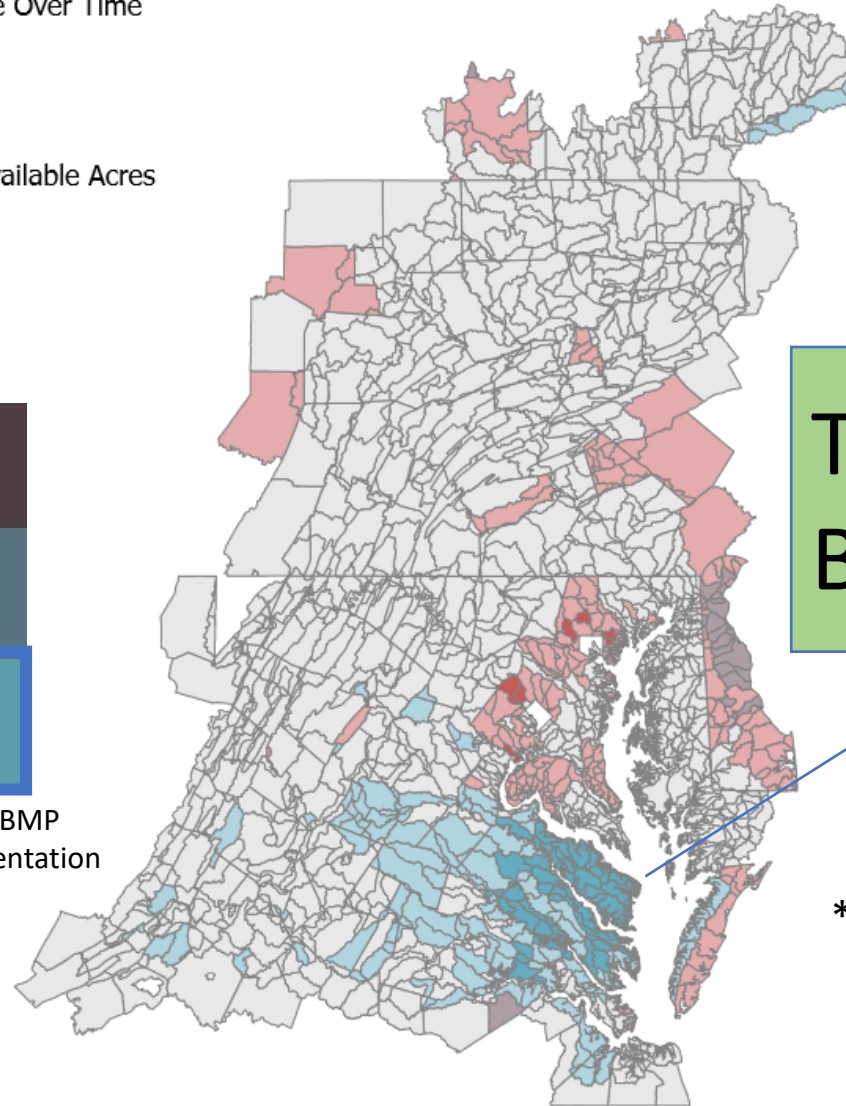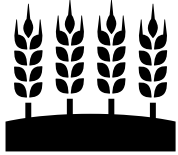High: 108% - 162%

TN Loading Rate Increasing

N

High BMP Implementation

0   37.5   75   150 Miles

TN↓
BMP↑ 😊

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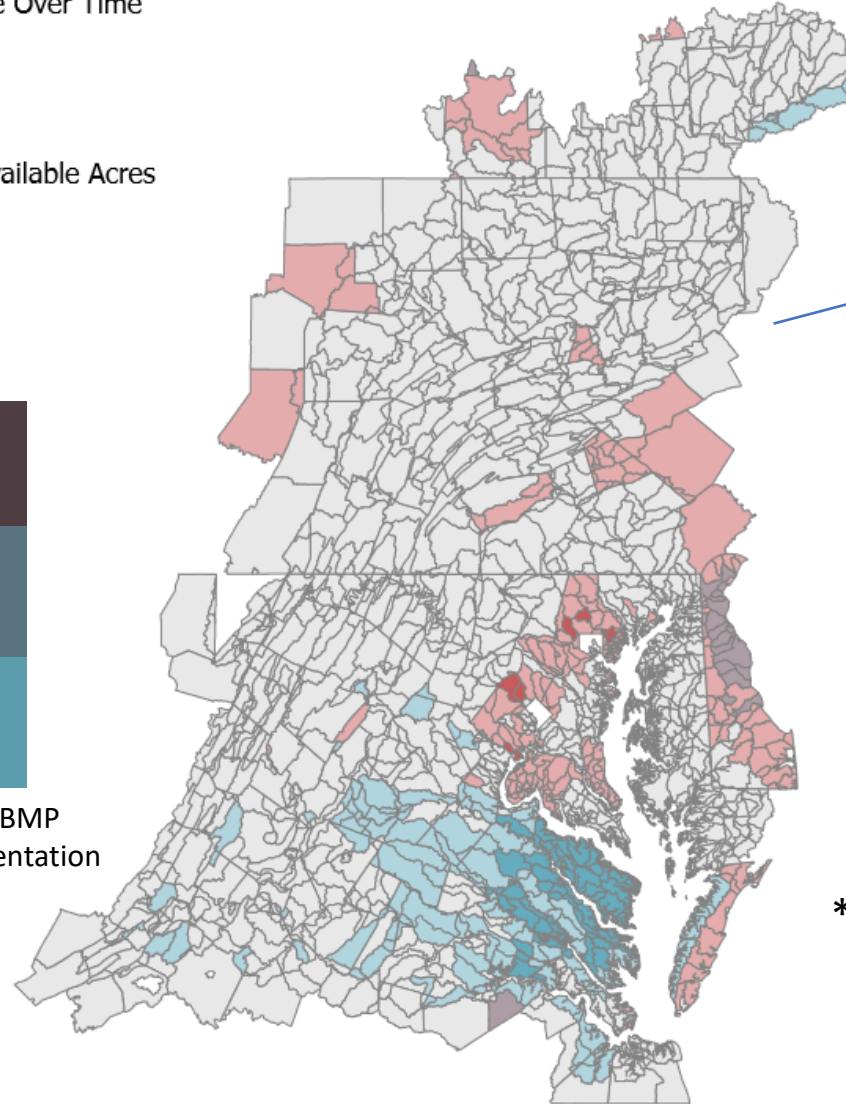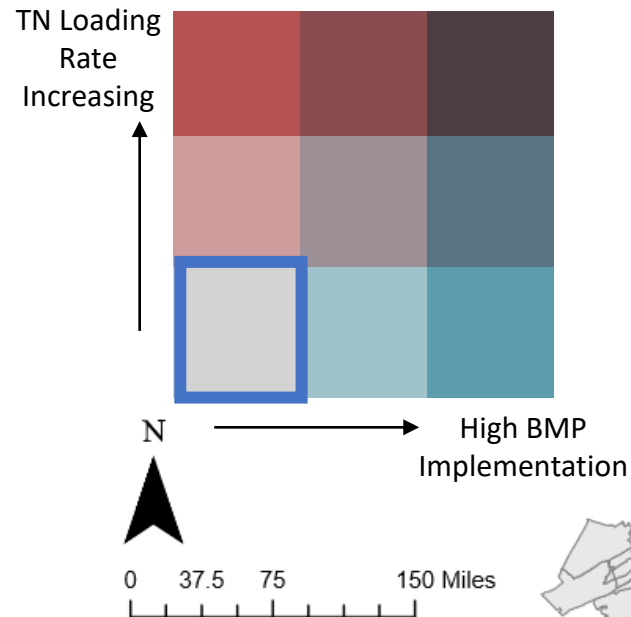Low: -100% - 20%
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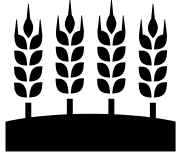Low: 0% - 54%
Med: 54% - 108%
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TN↓ 🧐
BMP↓

TN Loading Rate Increasing

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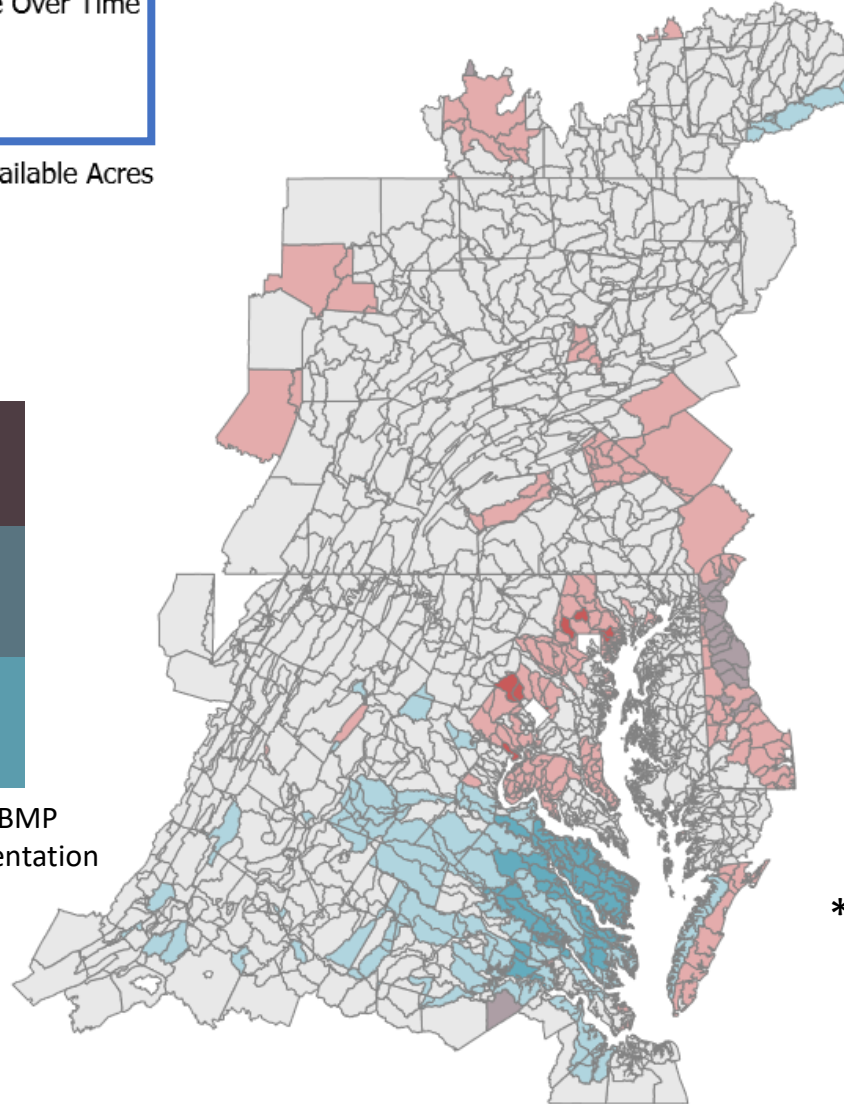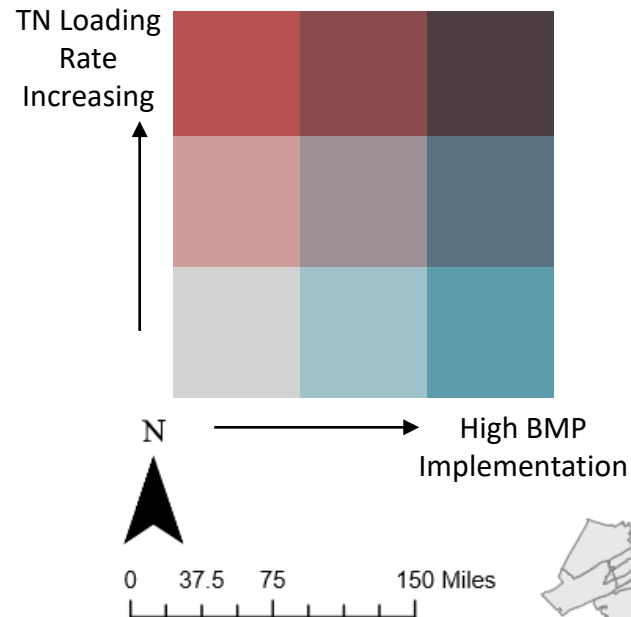
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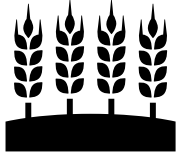Med: 20% - 140%
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Ratio of BMP Acres to Total Available Acres
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Med: 54% - 108%
High: 108% - 162%

TN Loading Rate Increasing

High BMP Implementation

N

0   37.5   75   150 Miles

- **5** modeling segments' TN loading rates **decreased 100%**
- **16** modeling segments TN loading rates **increased over 100%**

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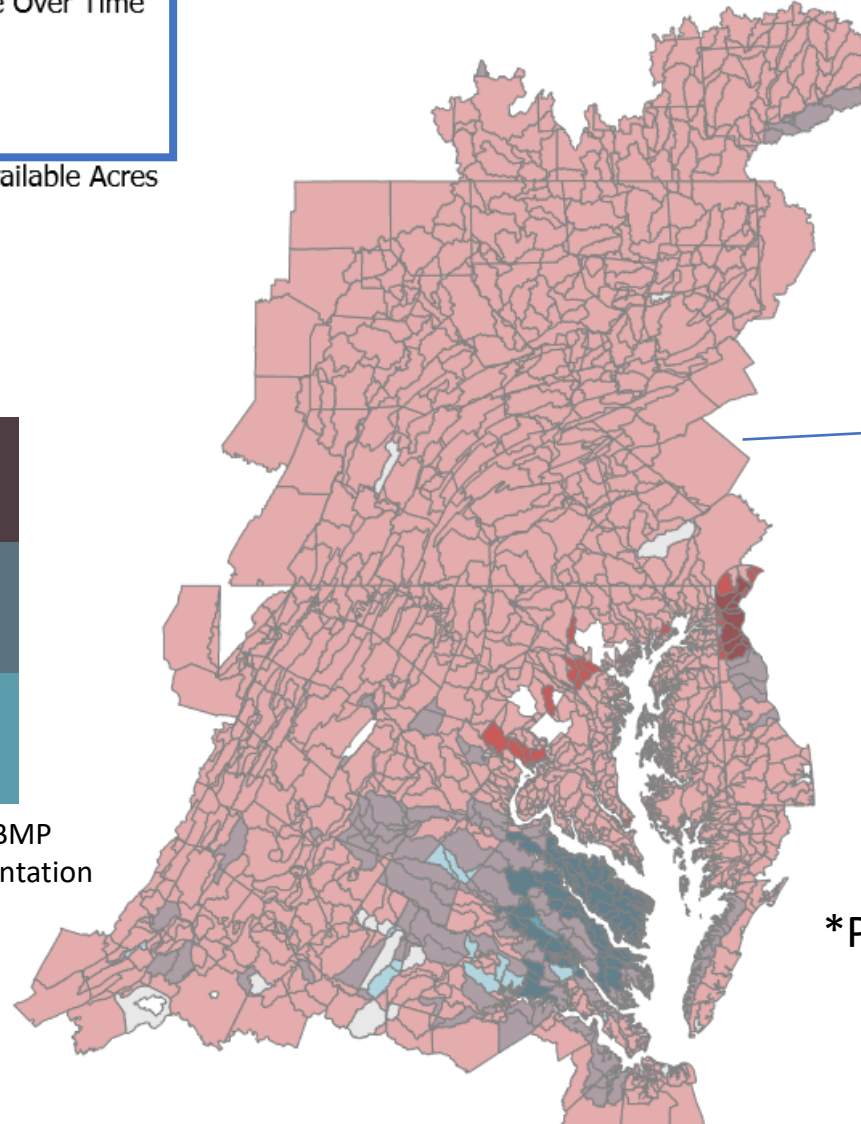
Source: CAST.ChesapeakeBay.net

Chesapeake Bay Watershed BMP Heat Map
High Effectiveness BMPs vs Nitrogen Loading Rate Change Over Time
(2009-2023)
NO OUTLIERS

Nitrogen Loading Rate Change Over Time
Low: -80% - -22%
Med: -22% - 37%
High: 37% - 95%

Ratio of BMP Acres to Total Available Acres
Low: 0% - 54%
Med: 54% - 108%
High: 108% - 162%

TN Loading Rate Increasing

High BMP Implementation

N

0   37.5   75   150 Miles

TN ↔ 😠
BMP↓

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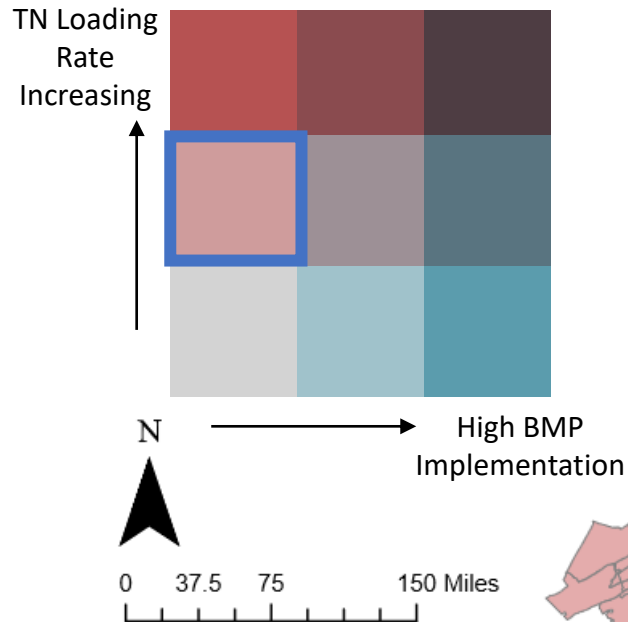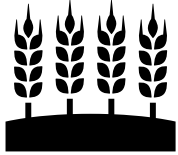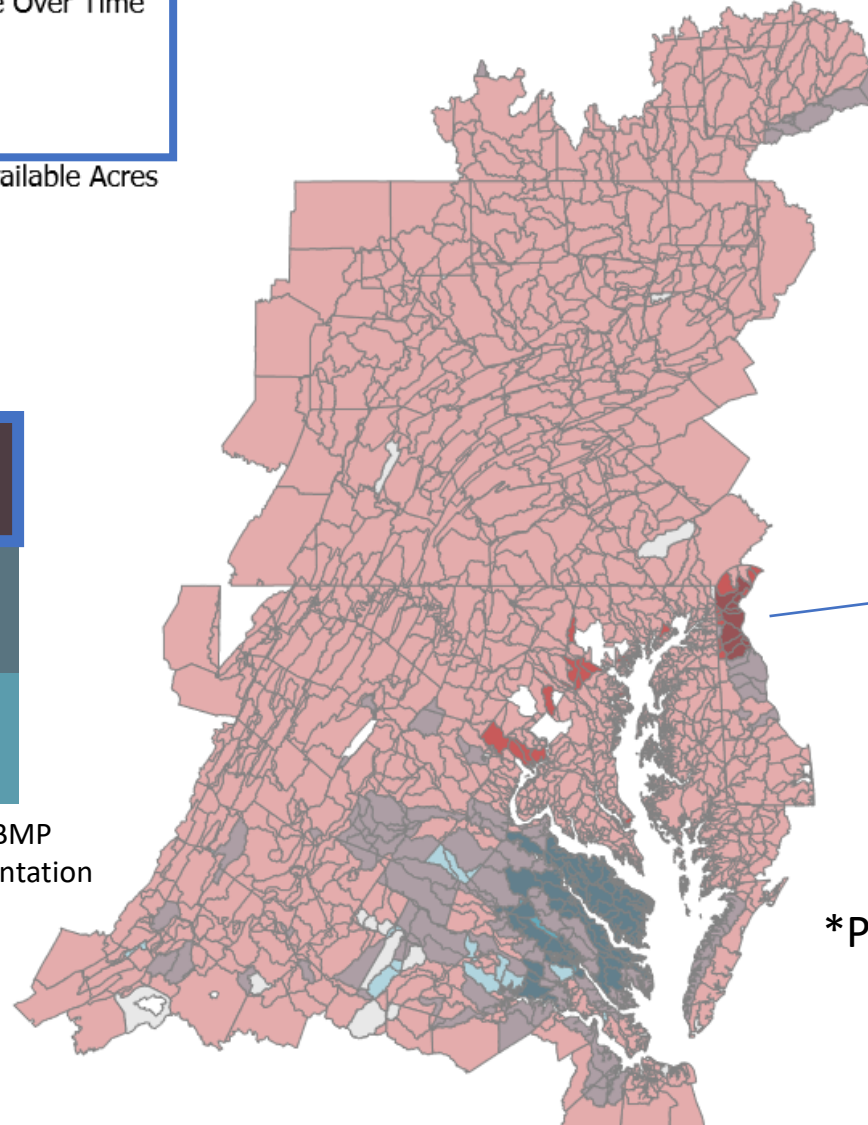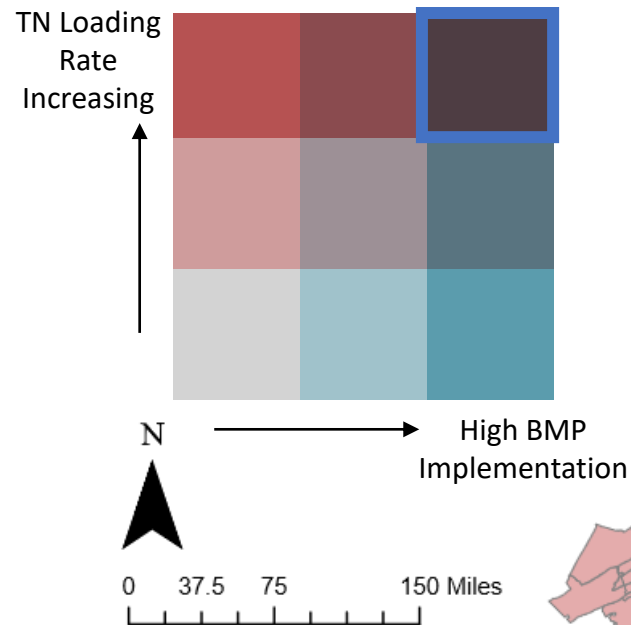Source: CAST.ChesapeakeBay.net

Chesapeake Bay Watershed BMP Heat Map
High Effectiveness BMPs vs Nitrogen Loading Rate Change Over Time
(2009-2023)
NO OUTLIERS

Nitrogen Loading Rate Change Over Time
Low: -80% - -22%
Med: -22% - 37%
High: 37% - 95%

Ratio of BMP Acres to Total Available Acres
Low: 0% - 54%
Med: 54% - 108%
High: 108% - 162%

TN Loading Rate Increasing

High BMP Implementation

N

0   37.5   75   150 Miles

TN↑
BMP↑ 🧐

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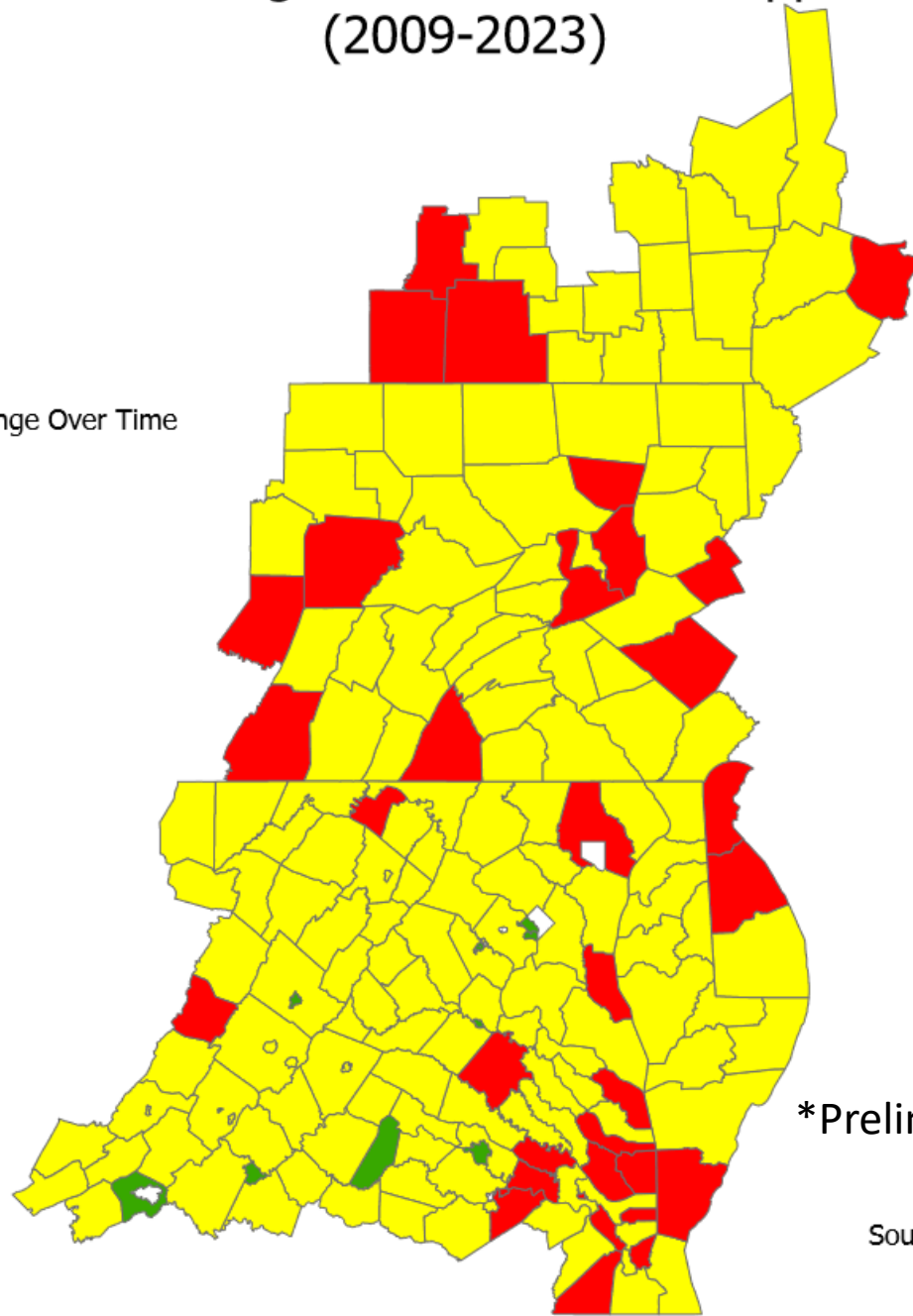
Source: CAST.ChesapeakeBay.net

Chesapeake Bay Watershed Agricultural Nutrients Applied Change Over Time (2009-2023)

Ag Nitrogen Applied % Change Over Time (2009-2023)
- ■ -100% - 24%
- ■ 24% - 52%
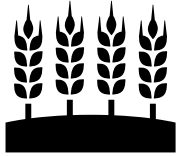- ■ 52% - 128%

N

0   37.5   75   150 Miles

*Preliminary Information – Subject to Revision
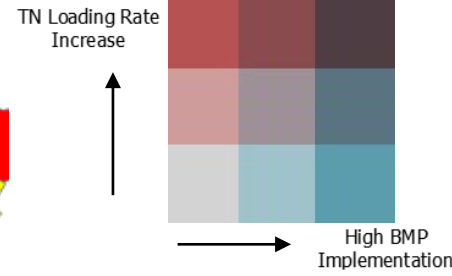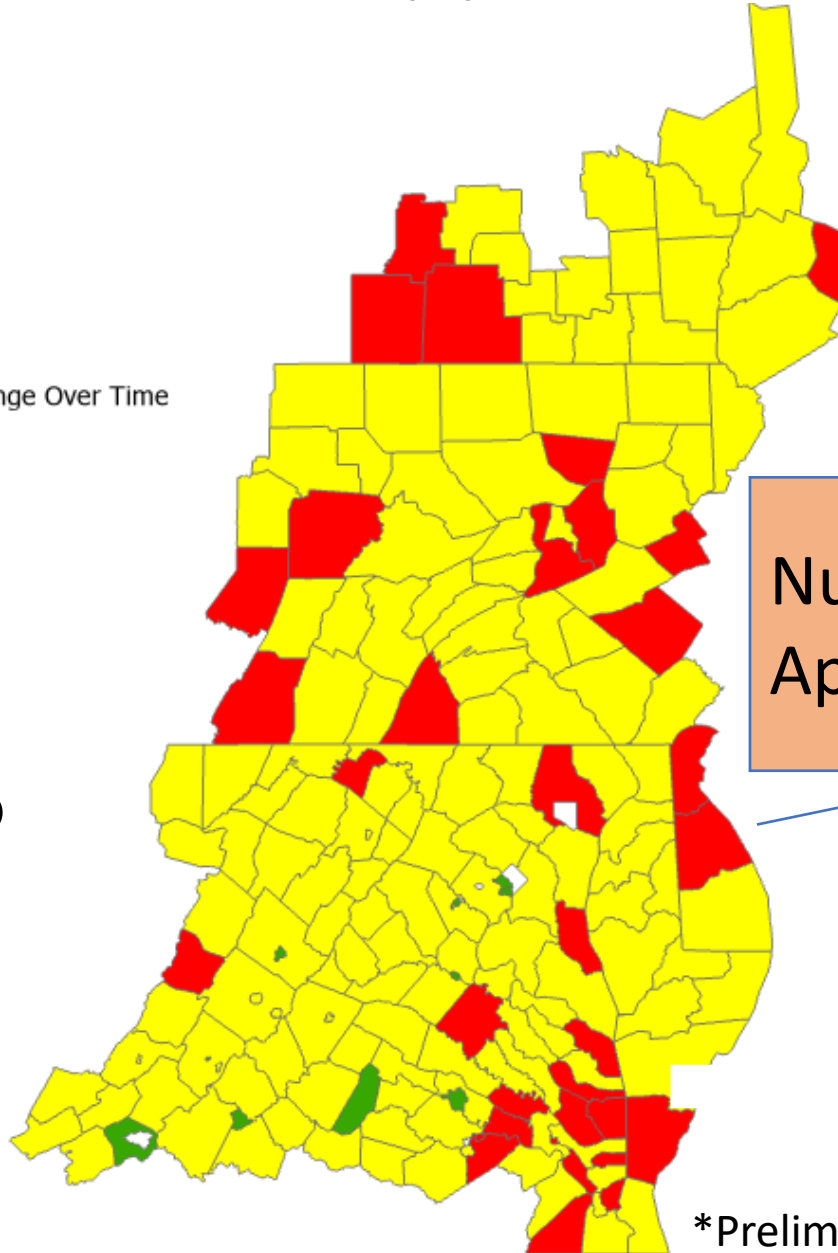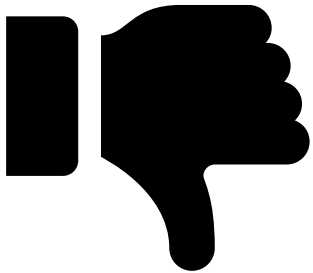
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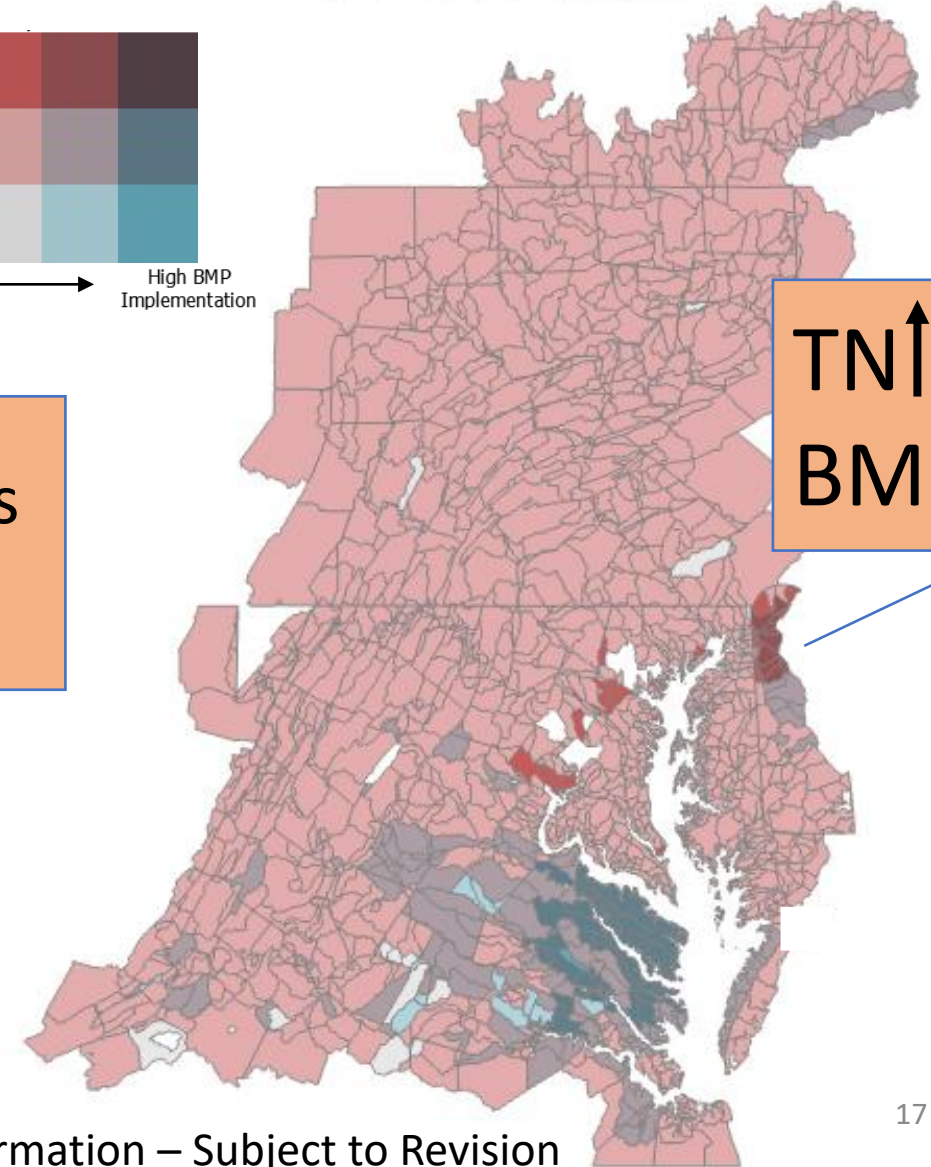
Nutrients Applied vs High Effectiveness BMPs

NO OUTLIERS

Ag Nitrogen Applied % Change Over Time (2009-2023)
- 🟩 -100% - 24%
- 🟨 24% - 52%
- 🟥 52% - 128%

TN Loading Rate Increase

High BMP Implementation

Nutrients Applied ↑

TN↑ 🤔
BMP↑

*Preliminary Information – Subject to Revision

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Chesapeake Bay Watershed BMP Heat Map
Low Effectiveness BMPs vs Nitrogen Loading Rate Change Over Time
(2009-2023)
NO NUTRIENT MANAGEMENT

Nitrogen Loading Rate Change Over Time
Low: -6% - -1%
Med: -1% - 3%
High: 3% - 7%

Ratio of BMP Acres to Total Available Acres
Low: 0% - 16%
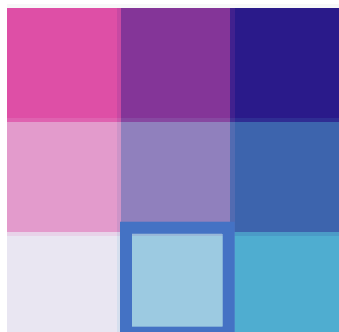Med: 16% - 32%
High: 32% - 48%

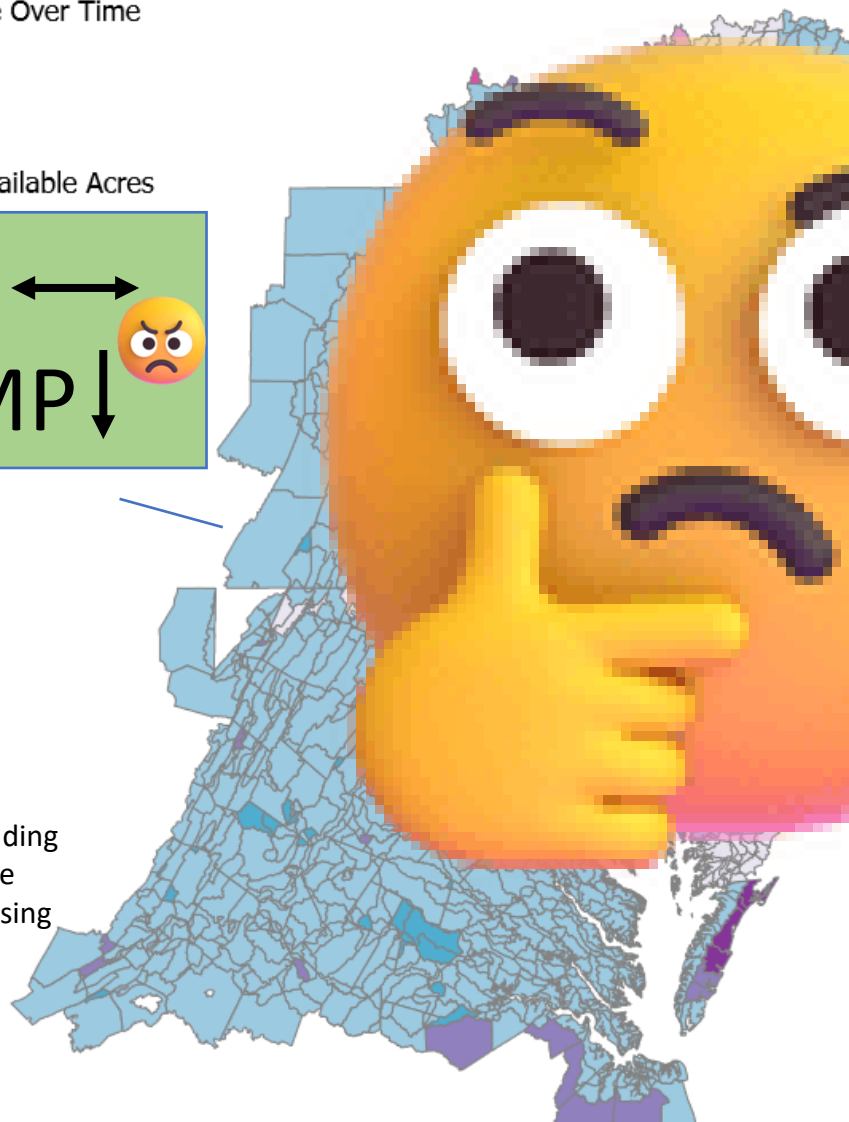Including nutrient management

High BMP Implementation

N

TN Loading Rate Increasing

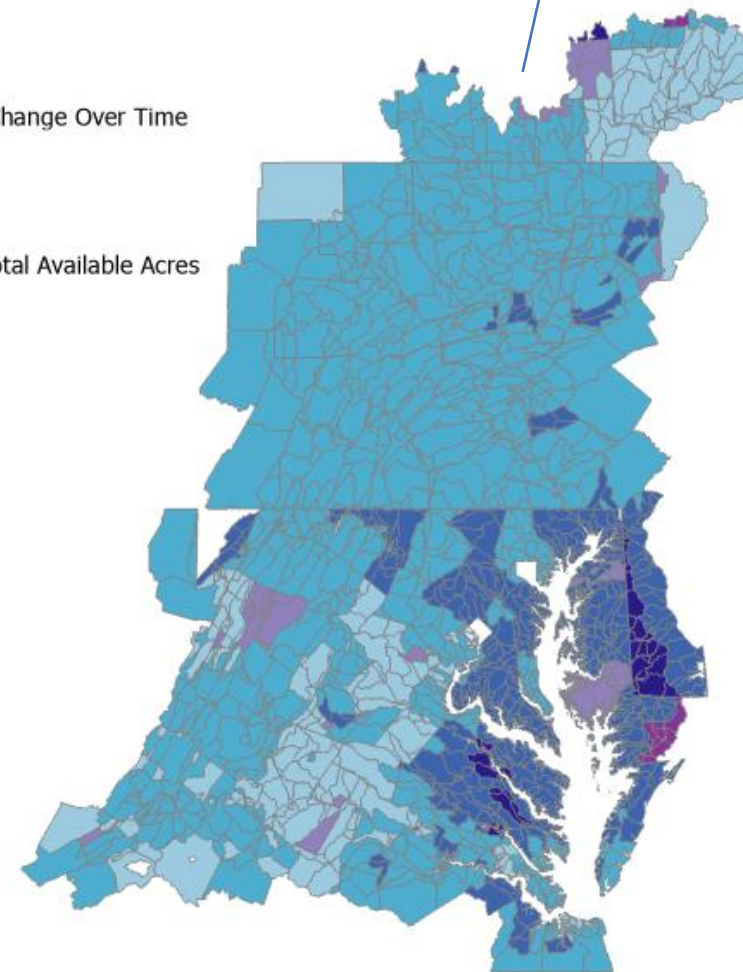0   37.5   75   150 Miles

*Preliminary Information – Subject to Revision

Summary

- Using BMP implementation and TN change over time, we identify areas where practices are not having the expected effects

- Modeled nutrient applications may explain some unexpected results – despite high management practices implementation, loading rates are increasing

- Modeled nutrient management practice may explain some unexpected results—the *modeled* practice does not explain load changes

- Analysis can be repeated for phosphorus and in the urban sector

Outliers

100% TN Loading Rate **Decrease**

- Arlington, VA
  - N51013PL7_4911_0000
  - N51013PL7_4941_0000
  - N51013PL7_4962_0000
  - N51013PL7_4964_0000
- Falls Church City, VA
  - N51610PL7_4962_0000

High TN Loading Rate **Increase**

- Baltimore, MD
  - N24005WM0_3650_0001
  - N24005WM0_3741_0000
  - N24005WM1_3660_3910
  - N24005WU0_3670_0001
  - N24005WU1_3490_3480
- Calvert, MD
  - N24009WL0_4925_0000
- Montgomery, MD
  - N24031PL1_4540_0001
  - N24031PM0_4640_4820
  - N24031PM1_4252_4250
  - N24031PM7_4580_4820
- Prince Georges, MD
  - N24033PL2_4810_0000
  - N24033PL2_4811_0000
- Somerset, MD
  - N24039EL0_5765_0000
- Fairfax, VA
  - N51059PL0_5251_0000
- Shenandoah, VA
  - N51171PS4_5080_4380
- Waynesboro City, VA
  - N24039EL0_5765_0000

Explanation of Outliers

- The **100% TN decreases** were due to the small amount of agricultural land present in those LRsegs in 2009 dropping to 0 in 2022

- The **high TN increases** are difficult to explain:

  - Agricultural acres decreased in all LRsegs except the Calvert, MD LRseg (15 acres to 17 acres)

  - Animal units decreased in all counties except Somerset, MD (30% increase) and Shenandoah, VA (15% increase)

  - TN application per acre increased in some areas of the entire counties but also decreased in others

Chesapeake Bay Watershed
Developed Loading Rate vs Population Change Over Time (2010-2017)

Population Change Over Time
Low: -100% - 11,162%
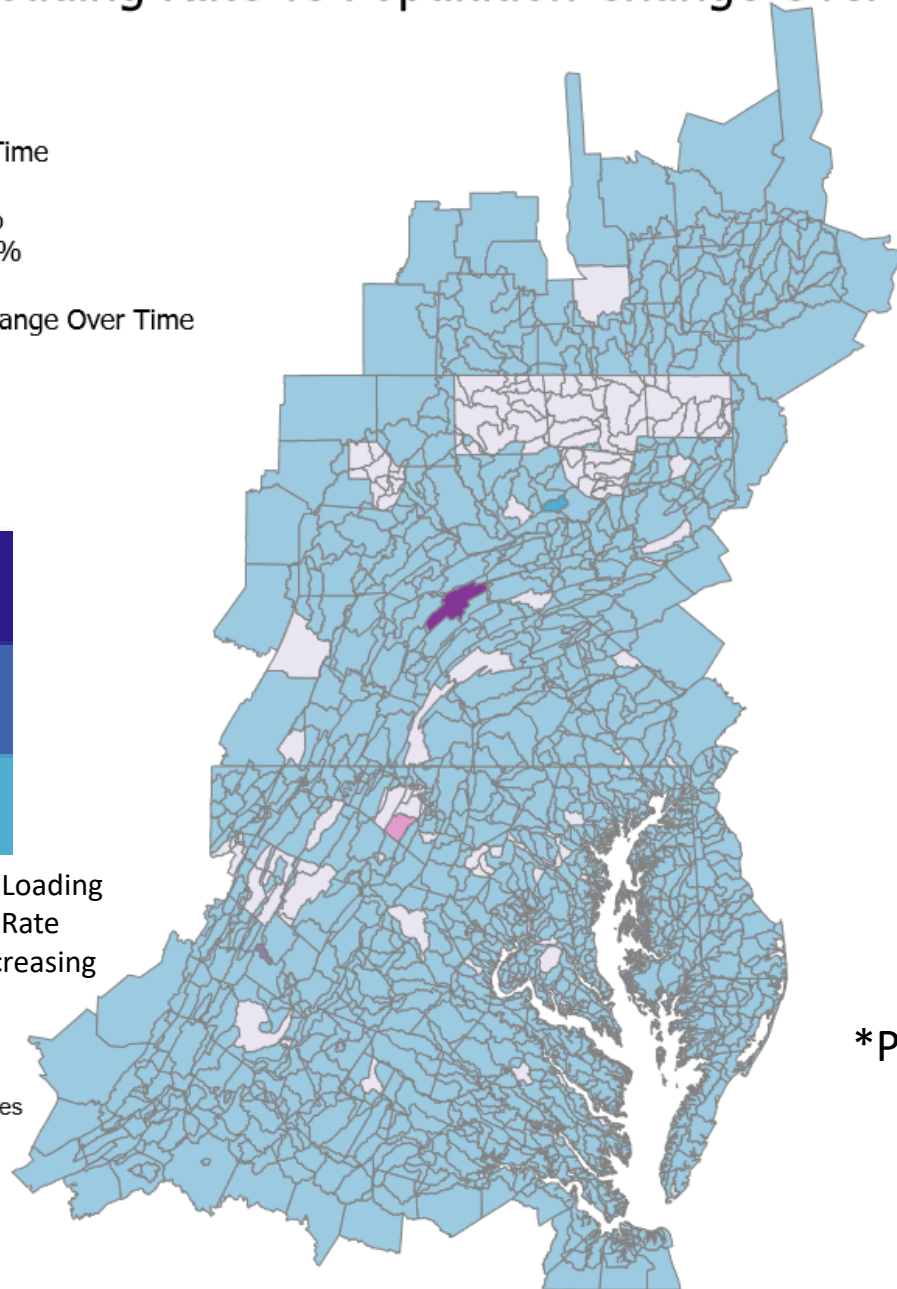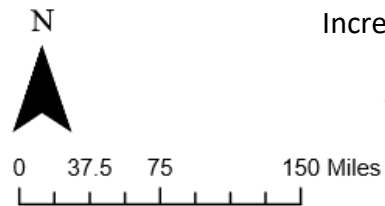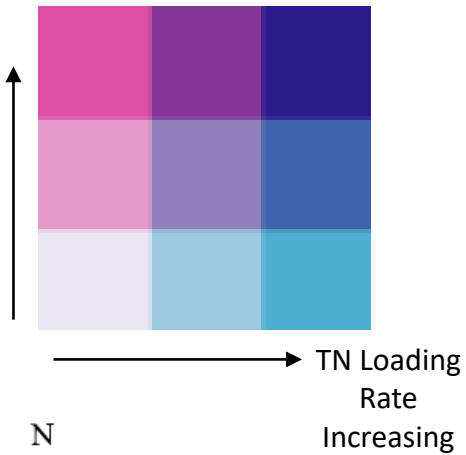Med: 11,162% - 40,636%
High: 40,636% - 407,250%

Nitrogen Loading Rate Change Over Time
Low: -51% - -6%
Med: -6% - 168%
High: 168% - 412%

Population Increasing

TN Loading Rate Increasing

N

0   37.5   75   150 Miles

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Source: CAST.ChesapeakeBay.net