

Estimated Riverine Scour Under Future Climate Conditions

Modeling Workgroup Meeting – January 2020

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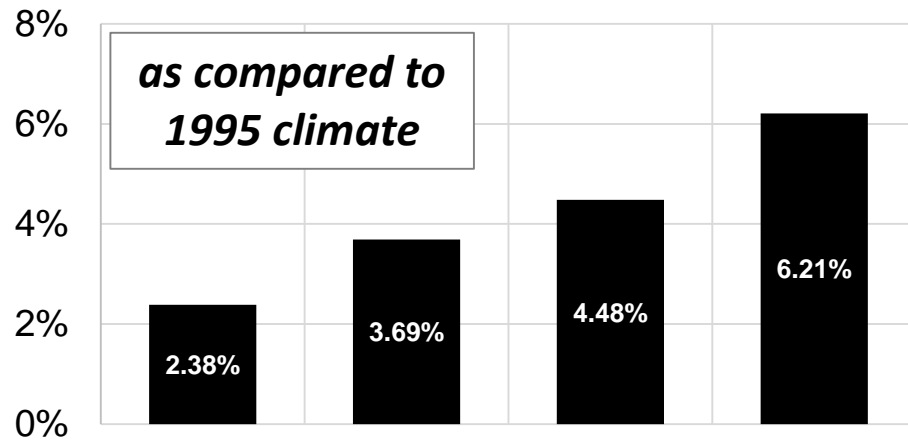
¹ Penn State, ² US EPA, ³ USGS – Chesapeake Bay Program Office

Presentation outline

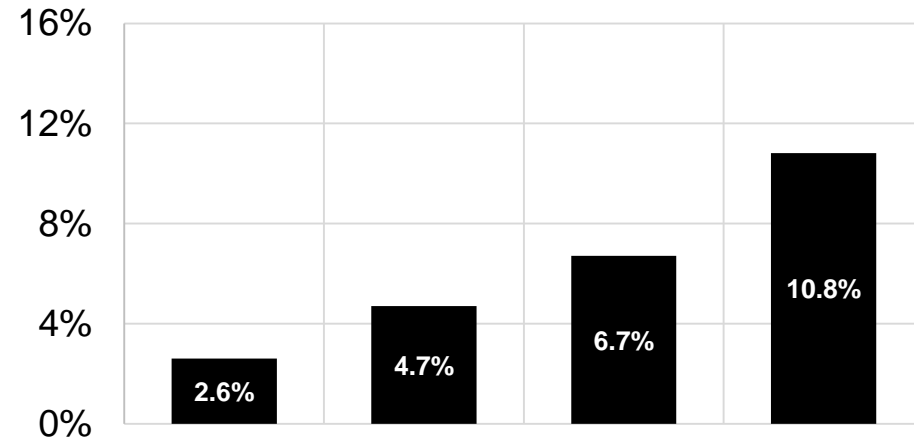
- 1. Summary of marginal changes in delivery for 2025, 2035, 2045, and 2055 climate scenarios**
- 2. Watershed processes impacting the changes in total nutrient delivery and speciation**
 - **Changes in Edge of River (EOR) loads**
 - **Nutrient budget for the rivers**
 - **Combined assessment of the watershed processes**

Estimated Water Quality Responses

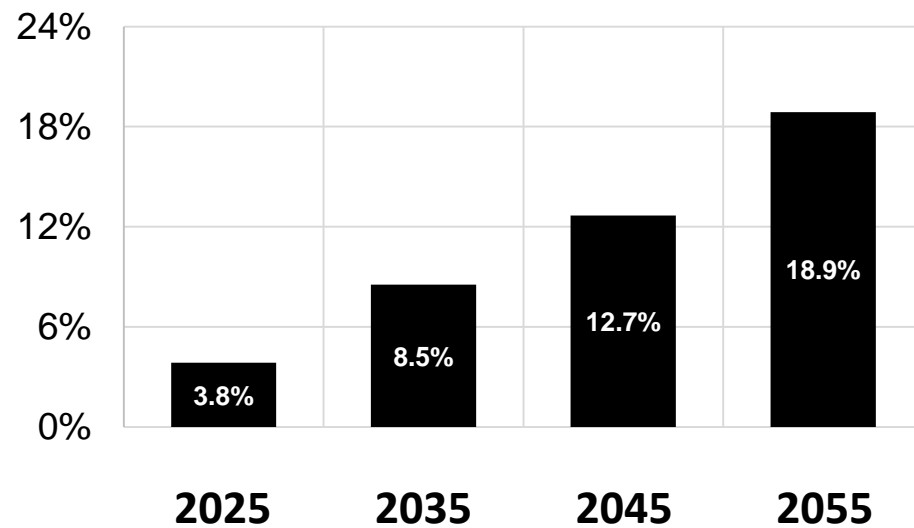
Marginal Differences in **Freshwater** Delivery



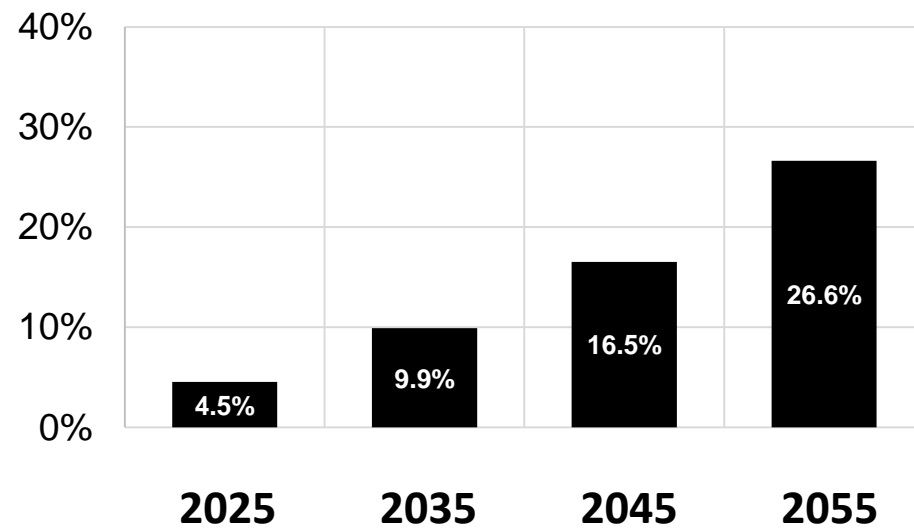
Marginal Differences in **Nitrogen** Delivery



Marginal Differences in **Sediment** Delivery

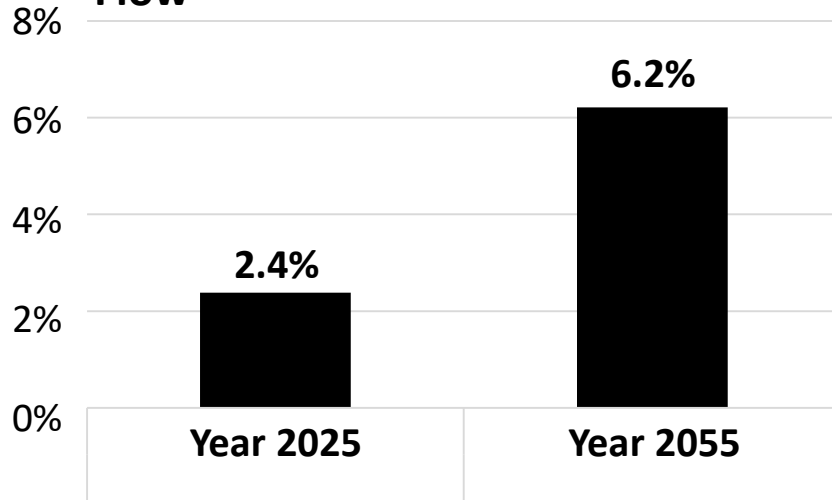


Marginal Differences in **Phosphorus** Delivery

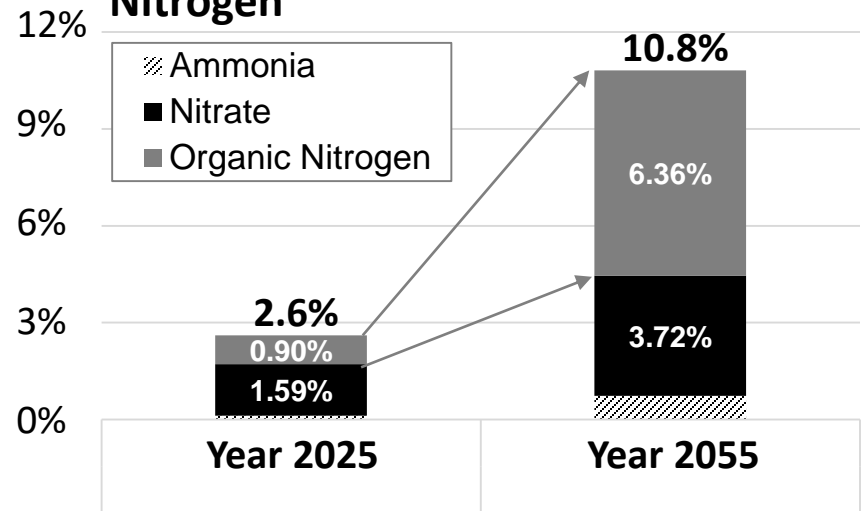


Nutrient Speciation – 2025 and 2055

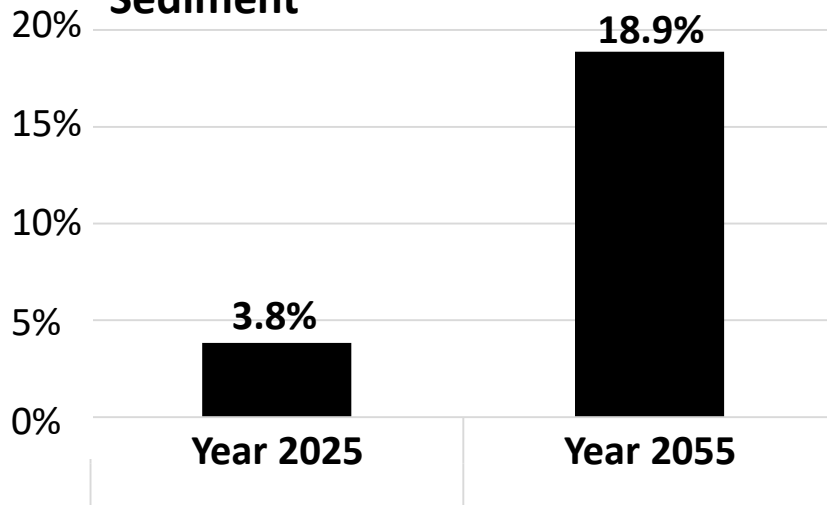
Flow



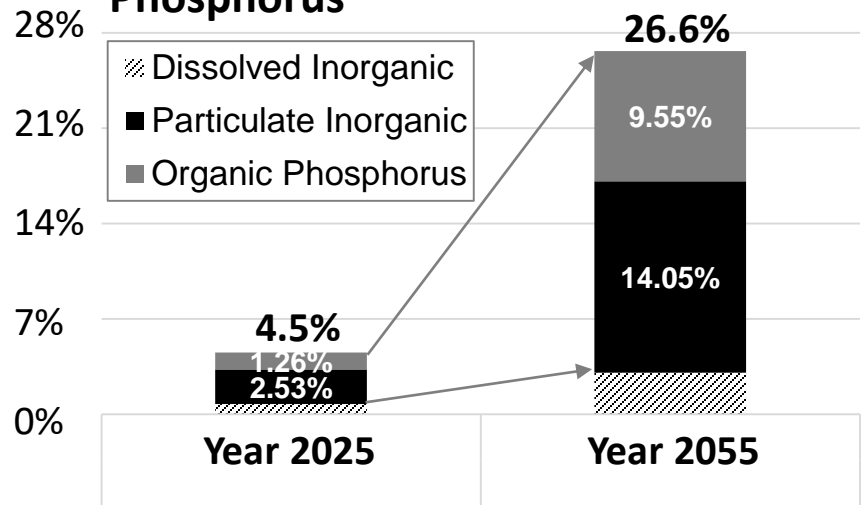
Nitrogen



Sediment

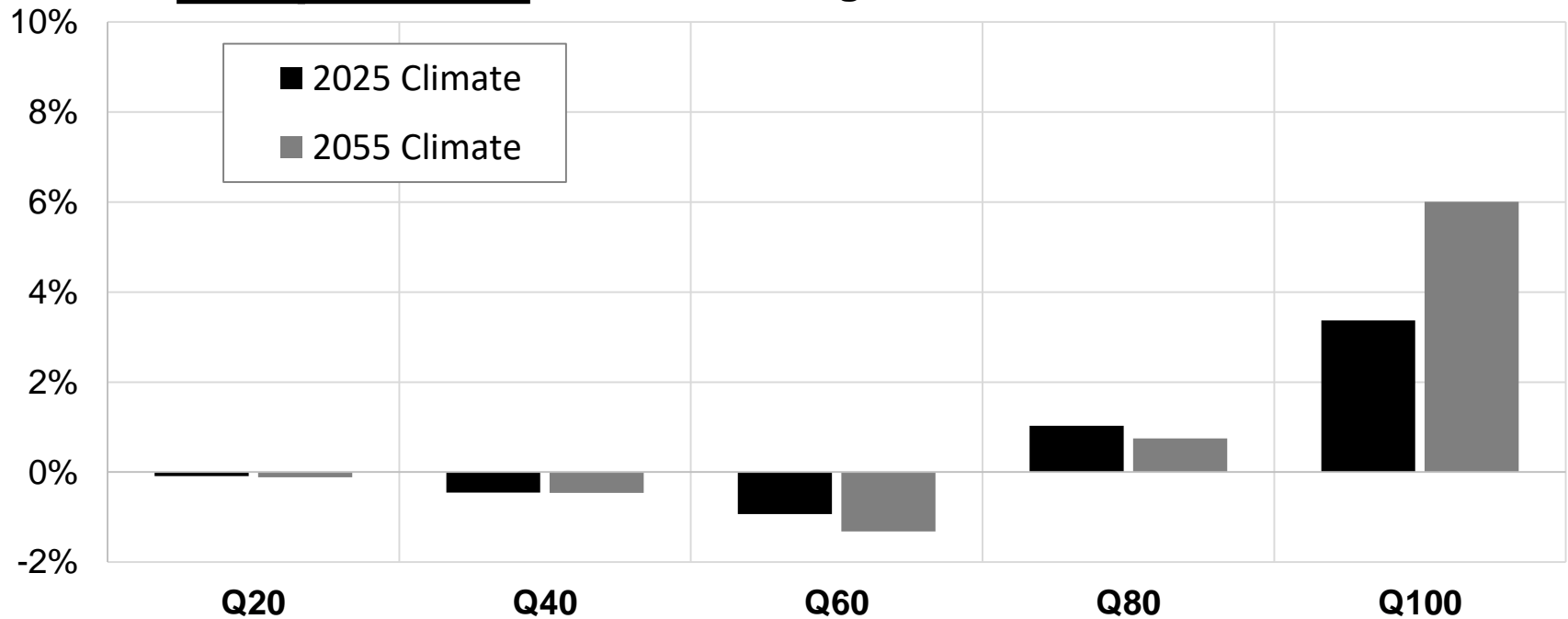


Phosphorus



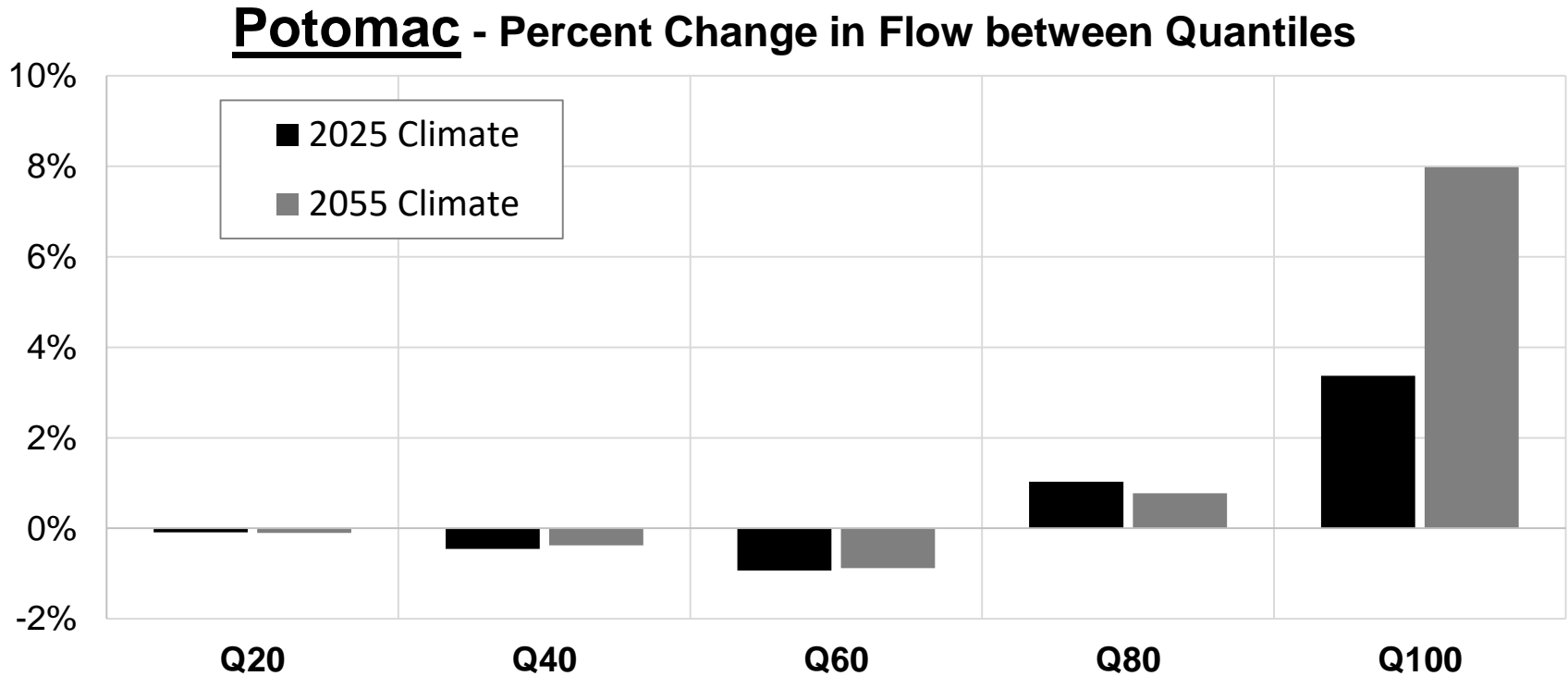
Changes in Flow Regime

Susquehanna - Percent Change in Flow between Quantiles



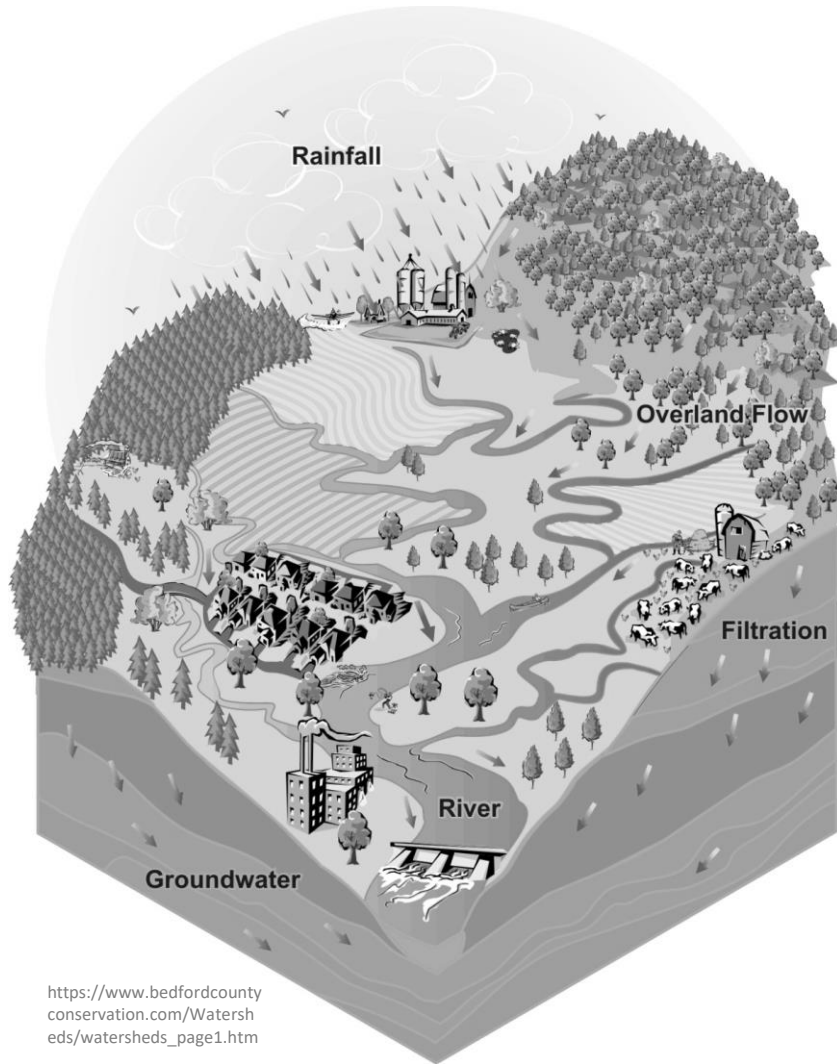
Increases in higher flow quantiles impact mobilization and transport of sediment and nutrients (in particulate form) – “*riverine nutrient competency*”.

Changes in Flow Regime



Increases in higher flow quantiles impact mobilization and transport of sediment and nutrients (in particulate form) – “*riverine nutrient competency*”.

Watershed Scale Budgets



https://www.bedfordcountyconservation.com/Watersheds/watersheds_page1.htm

↓ Δ Climate

Changes in
Land/Stream Response

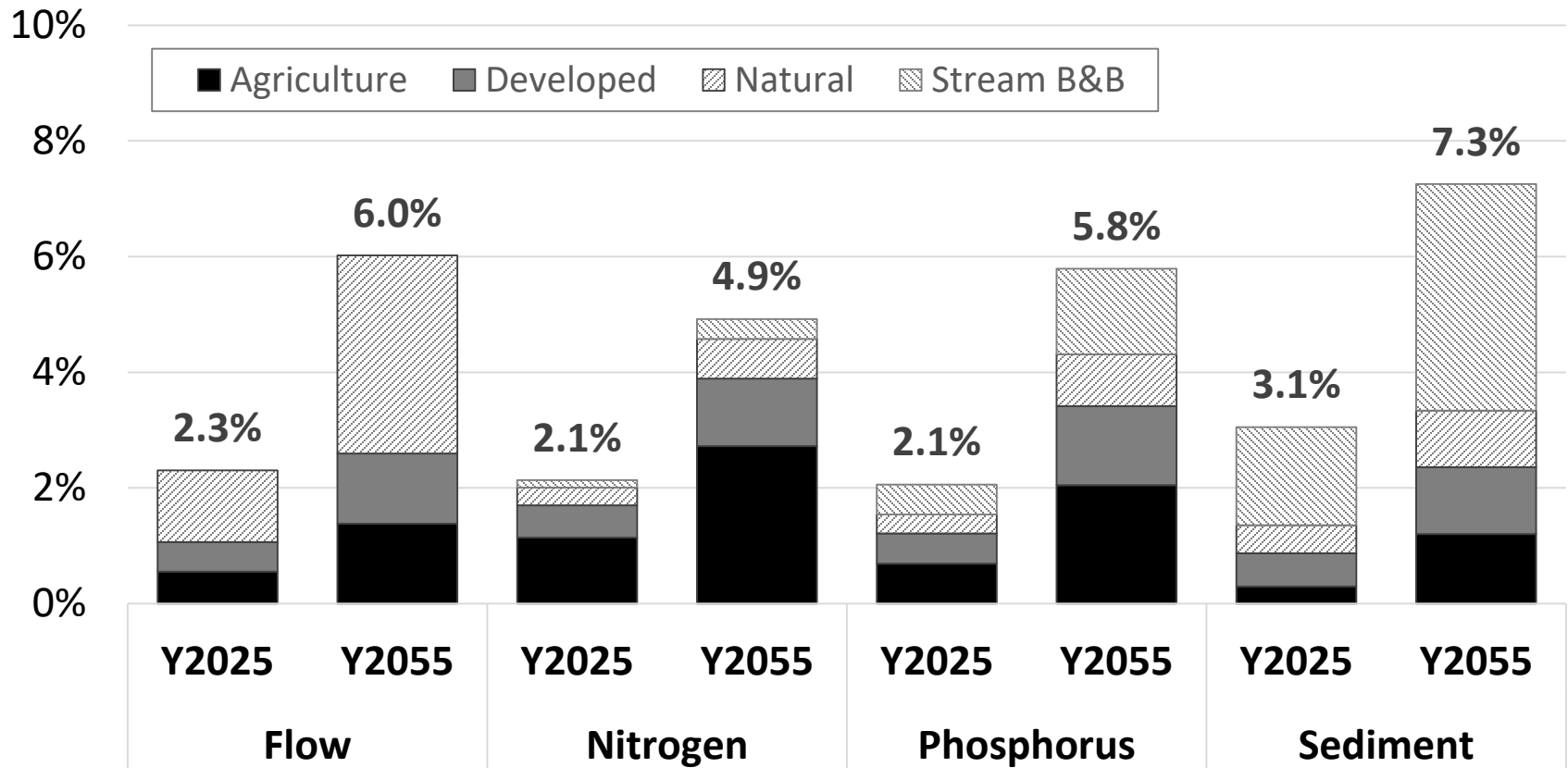
↓ Δ Edge of
River Loads

Changes in
Riverine Response

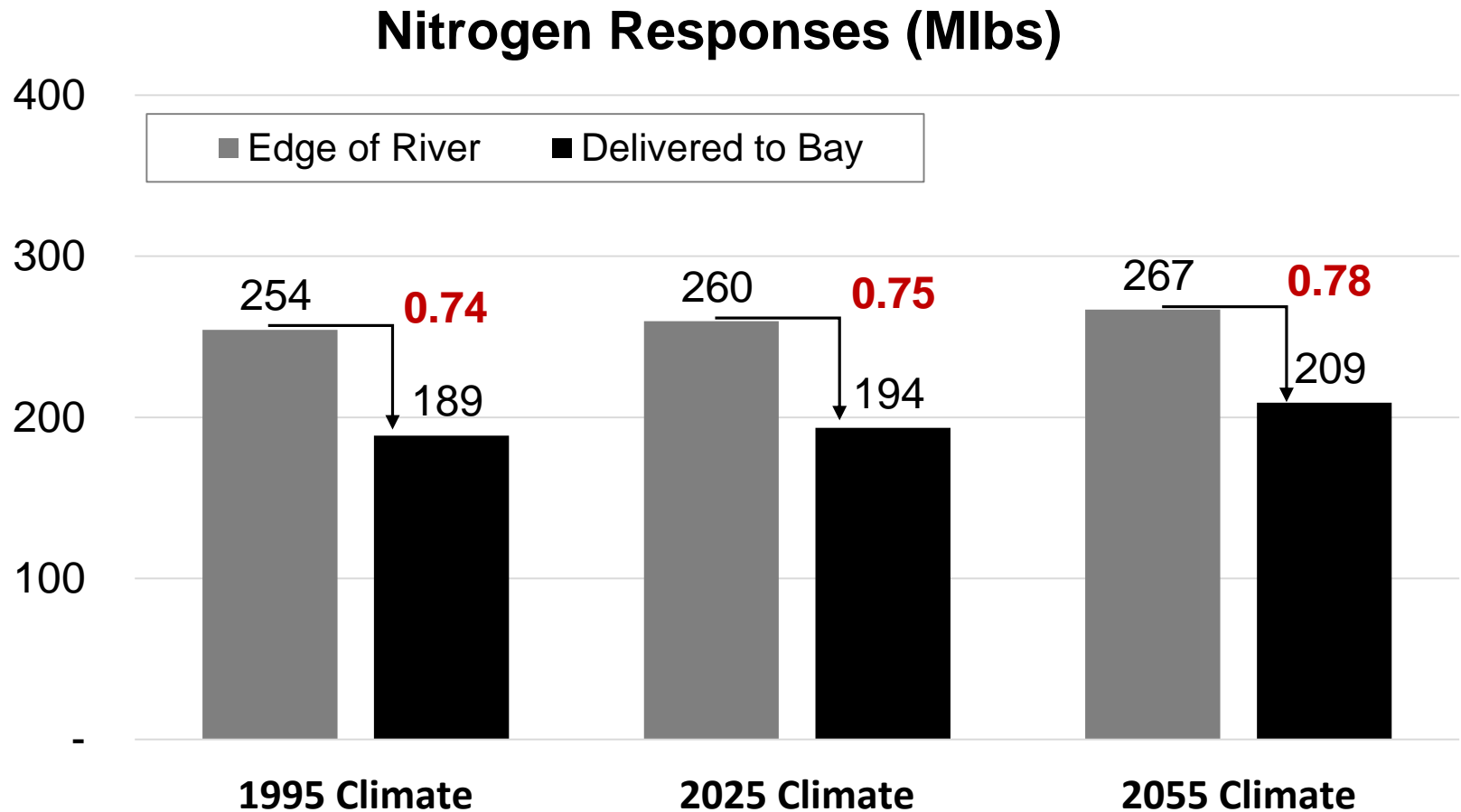
↓ Δ
Delivered
to Bay

Edge of River Loads

Changes in Edge of River Loads



(2a) NITROGEN: Edge of River and Delivery to Bay

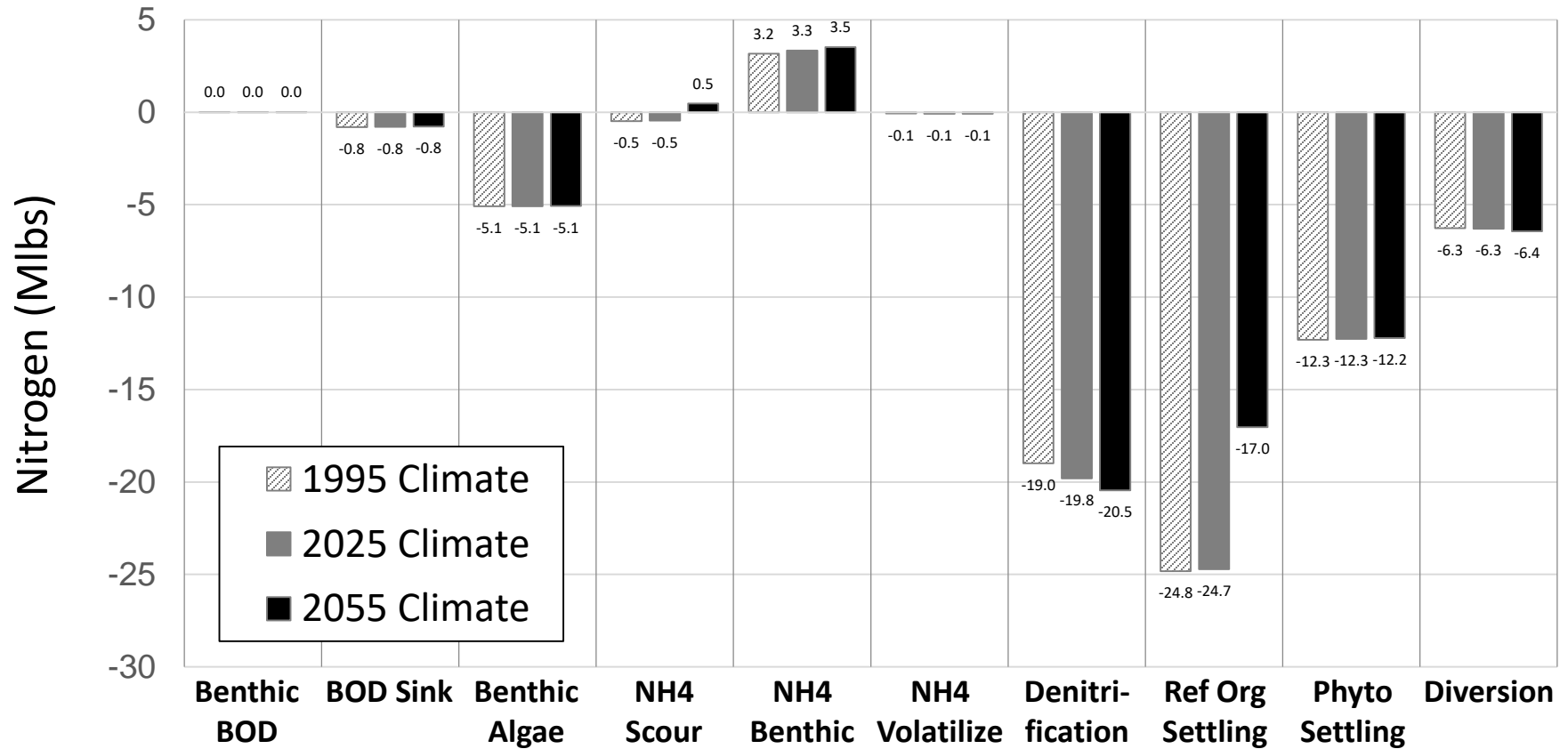


EOR: +5.4 Mlb-N for 2025, and +12.5 Mlb-N for 2055

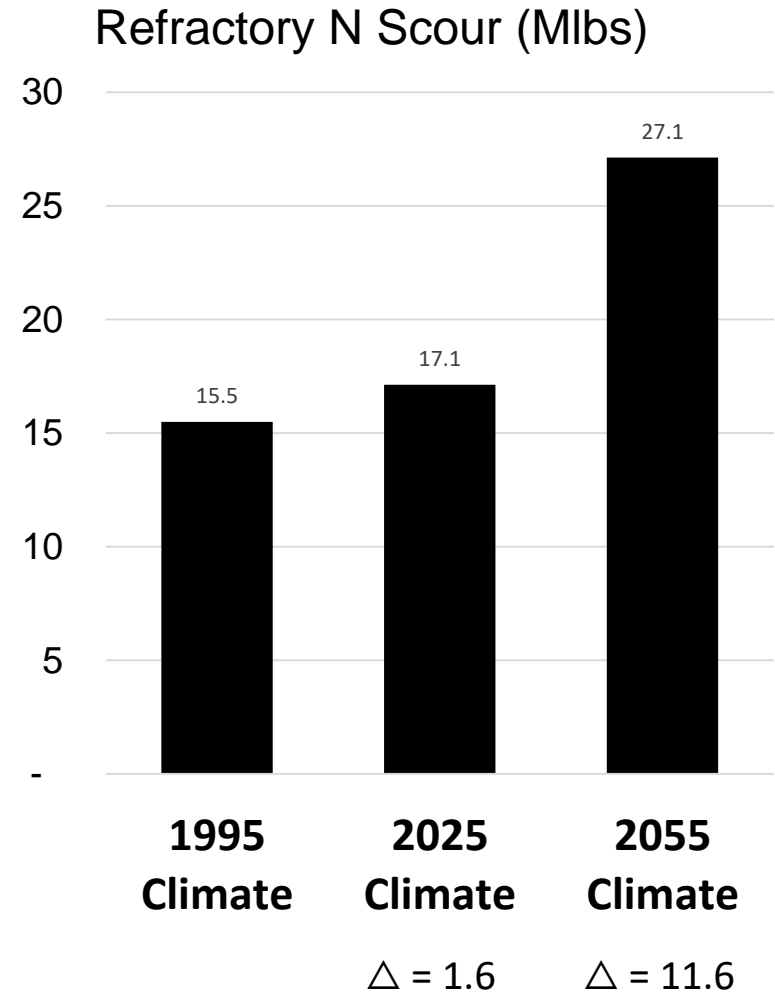
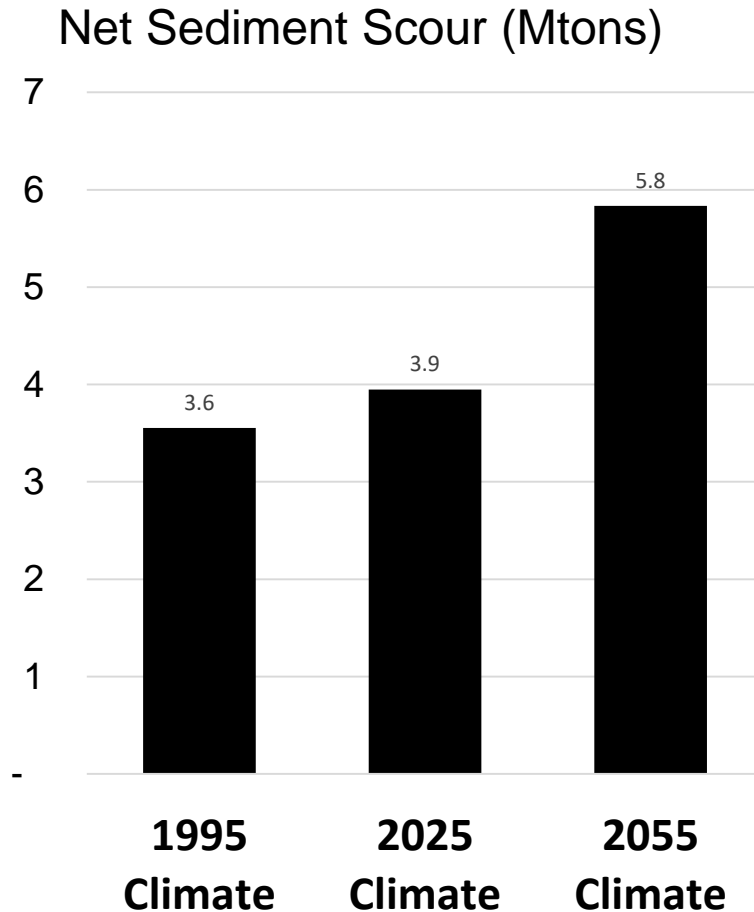
DEL: +4.9 Mlb-N for 2025, and +20.4 Mlb-N for 2055

Riverine Processes

Riverine Nitrogen Budget - Chesapeake Bay Watershed

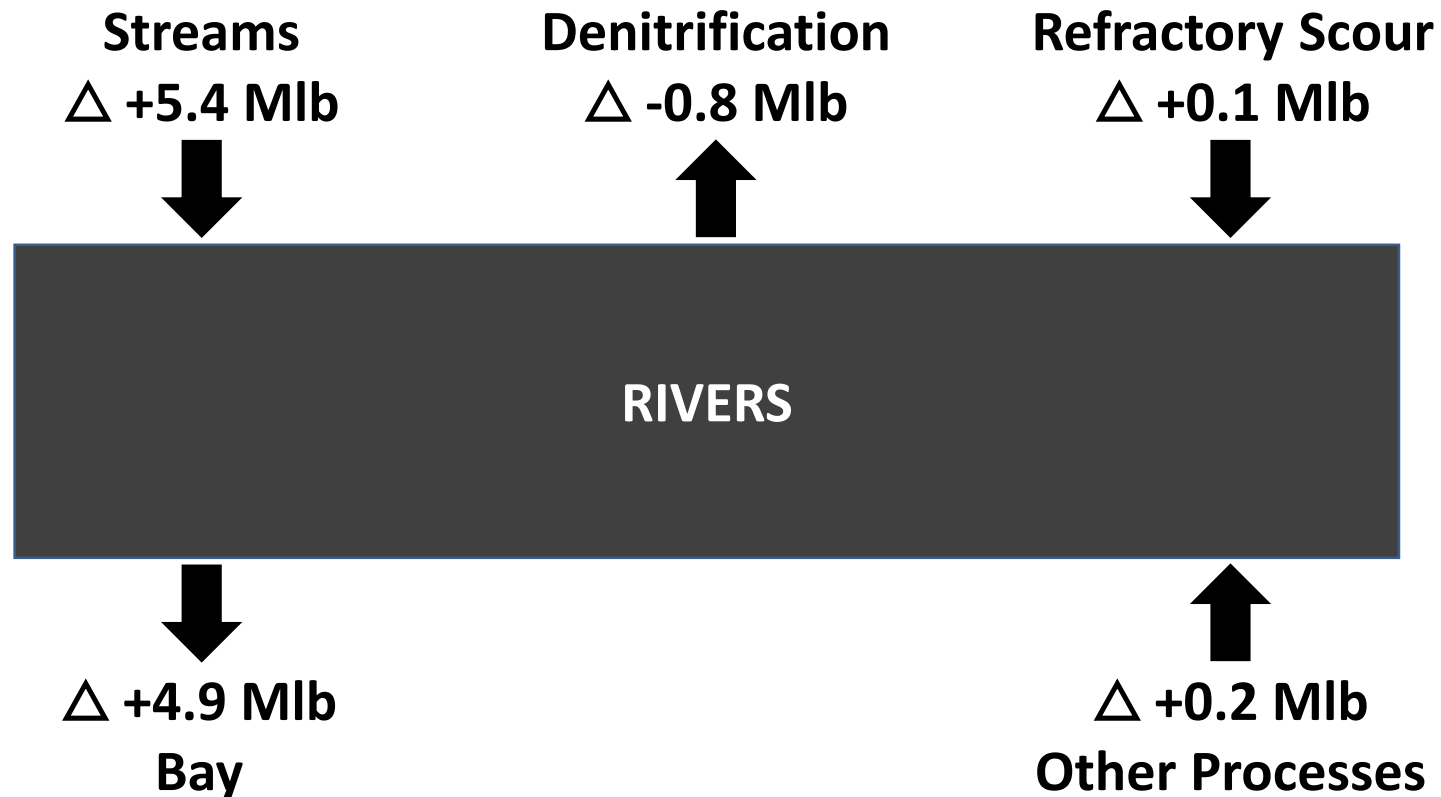


Riverine Processes – simulated refractory organic scour



Summary of Nitrogen Budget

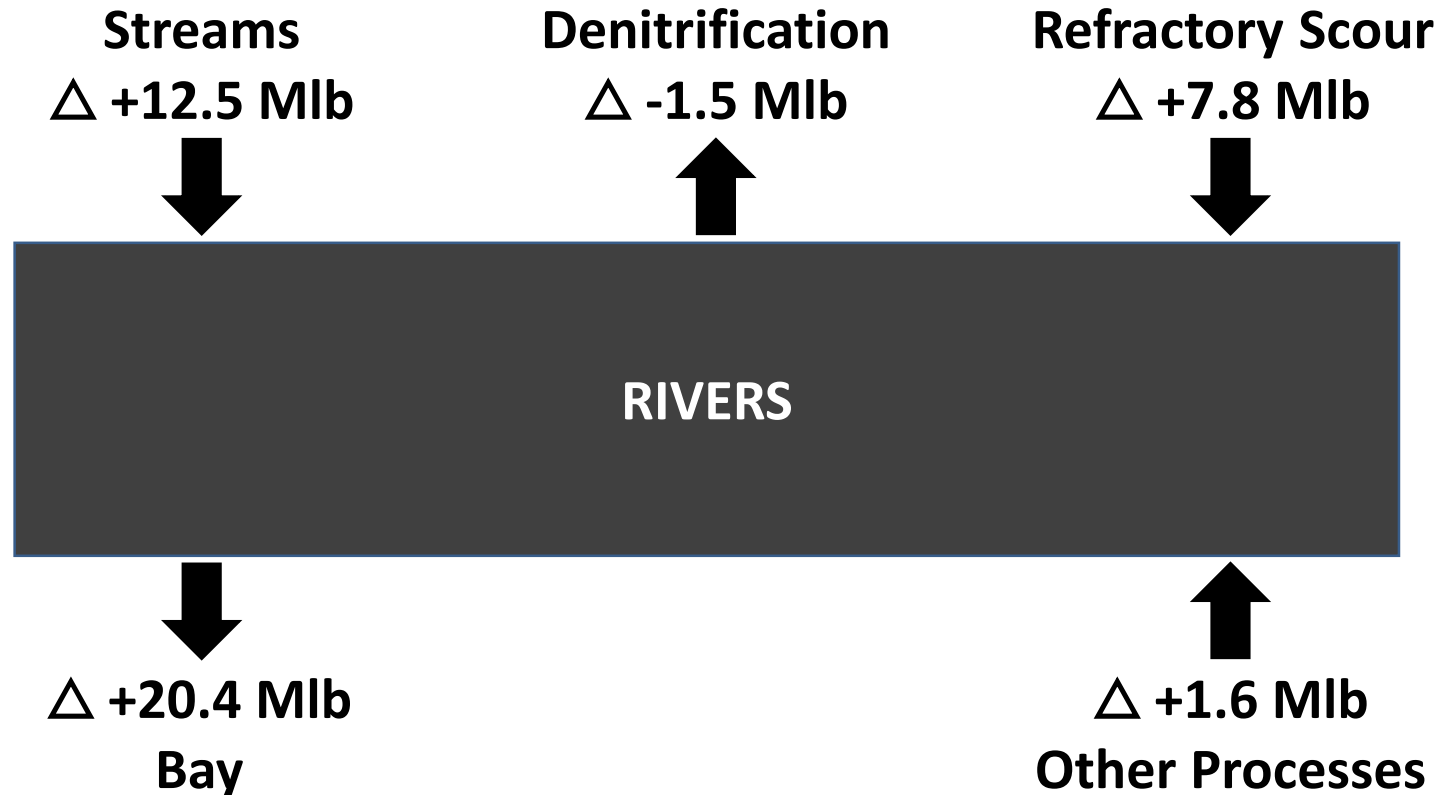
2025 Climate



Deltas (Δ) show change with respect to 1995 climate.

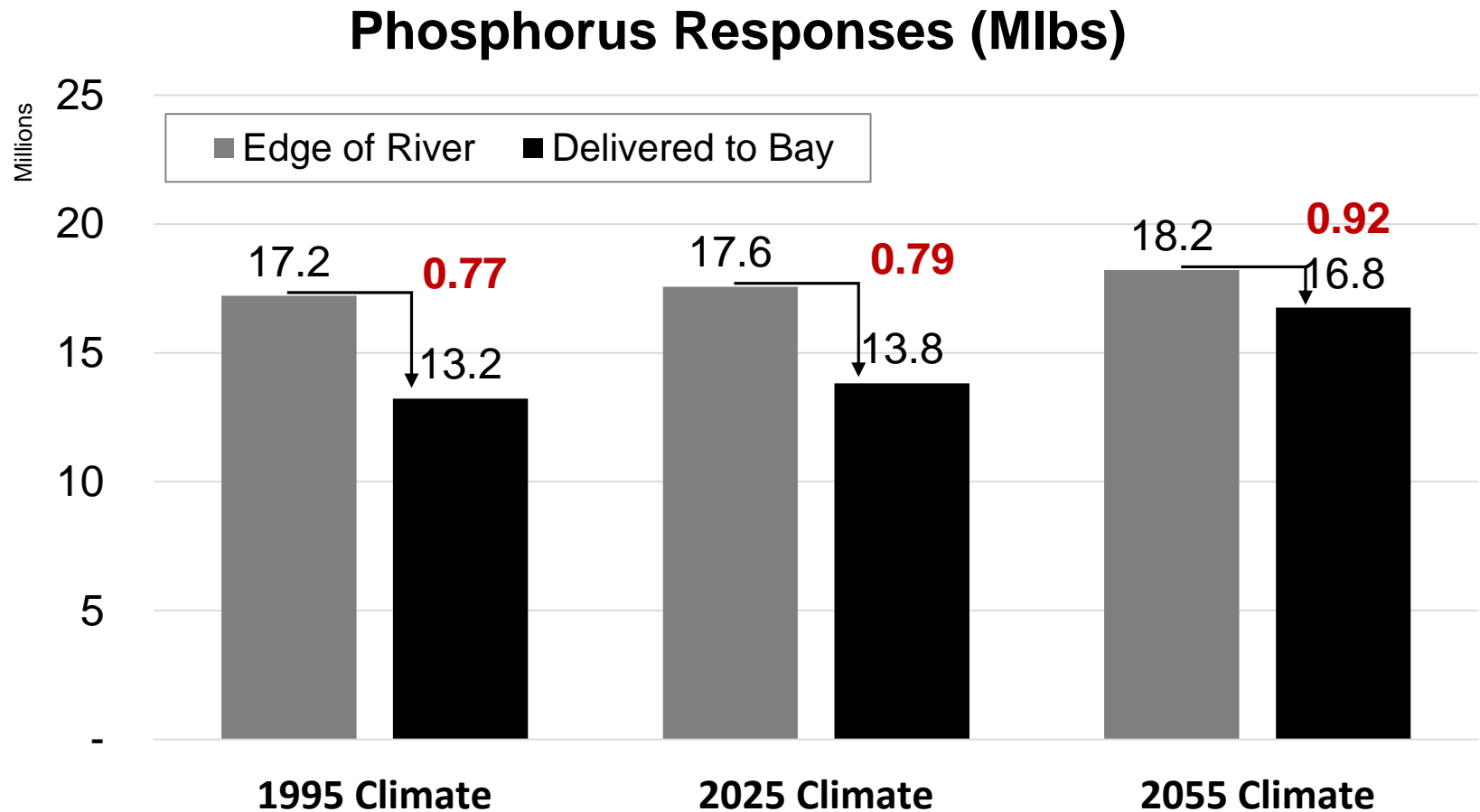
Summary of Nitrogen Budget

2055 Climate



Deltas (Δ) show change with respect to 1995 climate.

(2b) PHOSPHORUS: Edge of River and Delivery to Bay

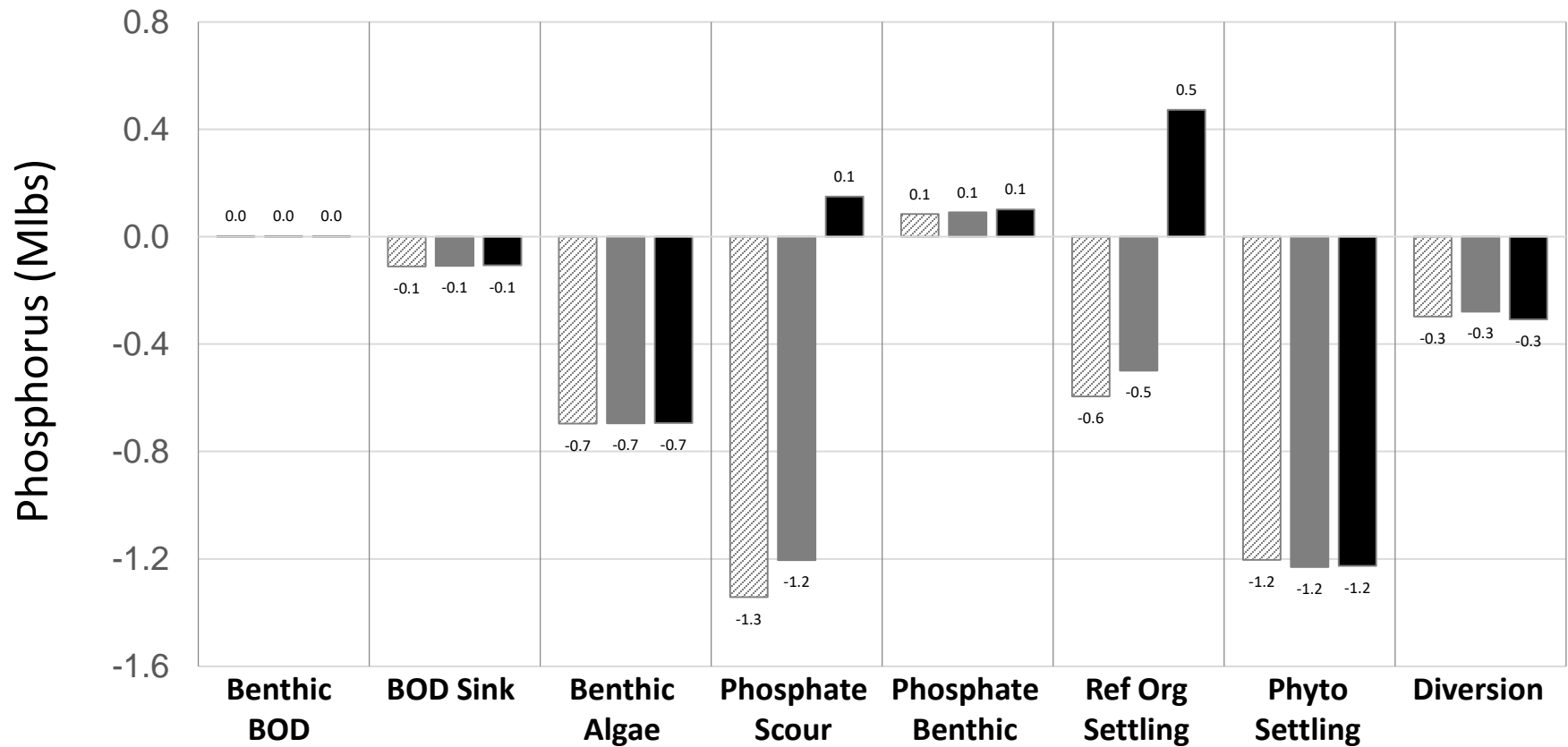


EOR: +0.35 Mlb-N for 2025, and +0.99 Mlb-N for 2055

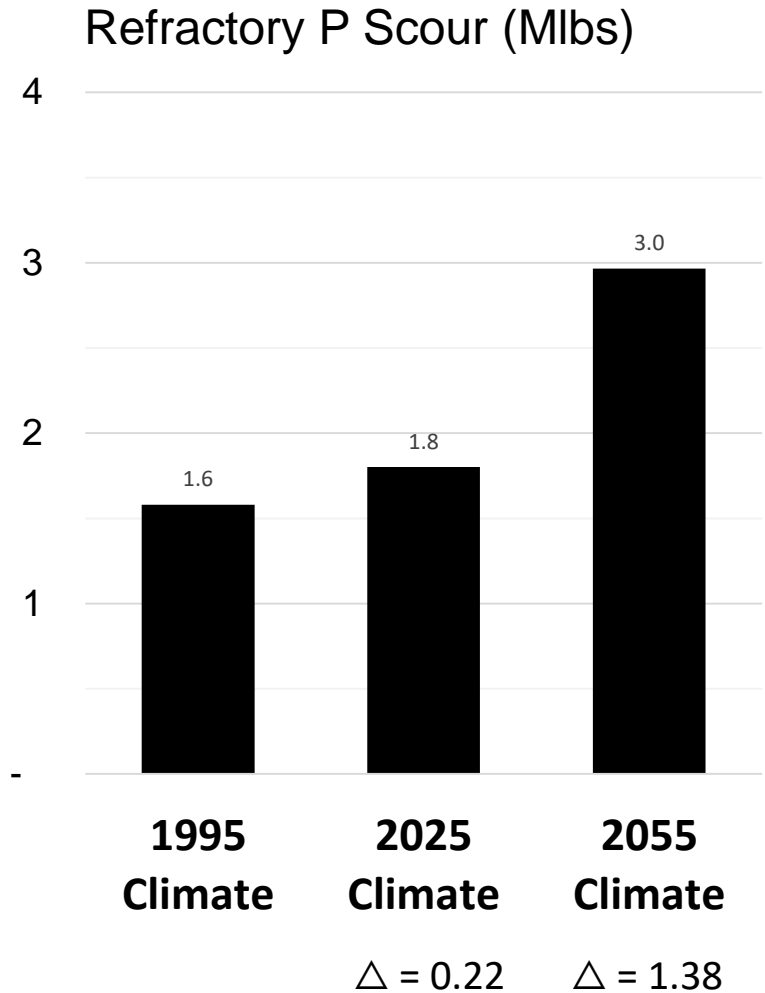
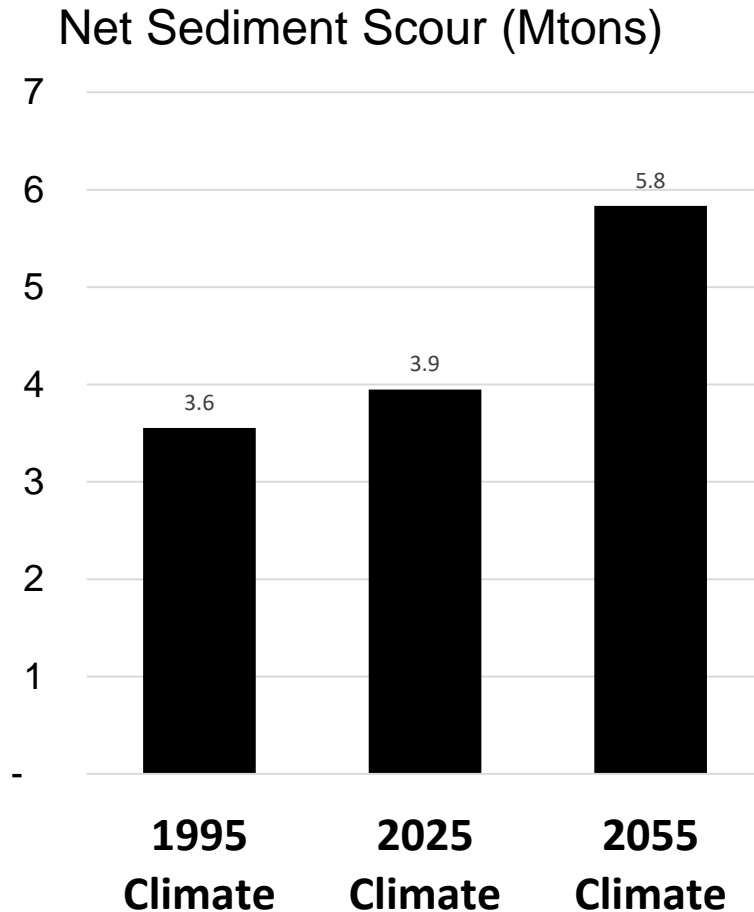
DEL: +0.60 Mlb-N for 2025, and +3.53 Mlb-N for 2055

Riverine Processes

Riverine Phosphorus Budget - Chesapeake Bay Watershed

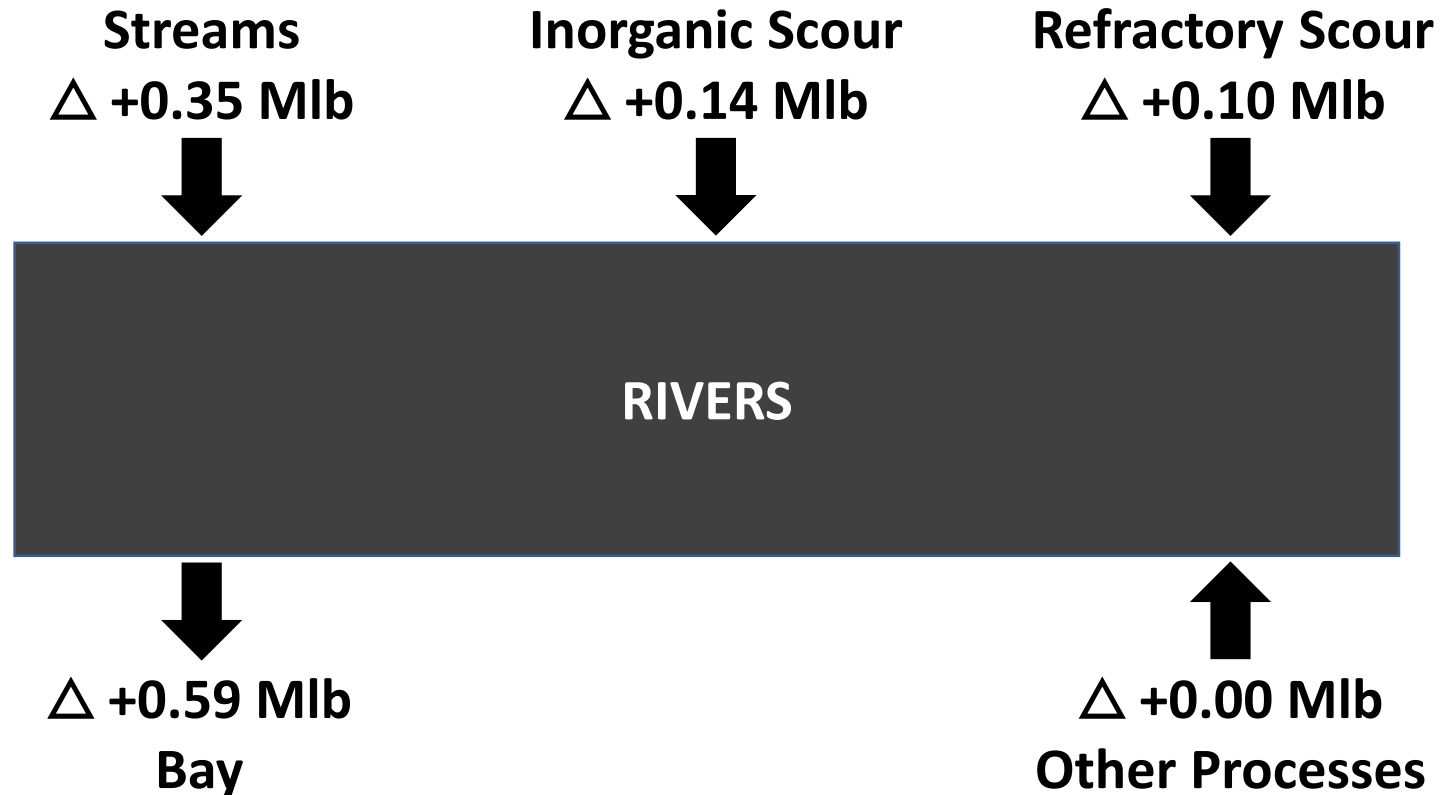


Riverine Processes – simulated refractory organic scour



Summary of Phosphorus Budget

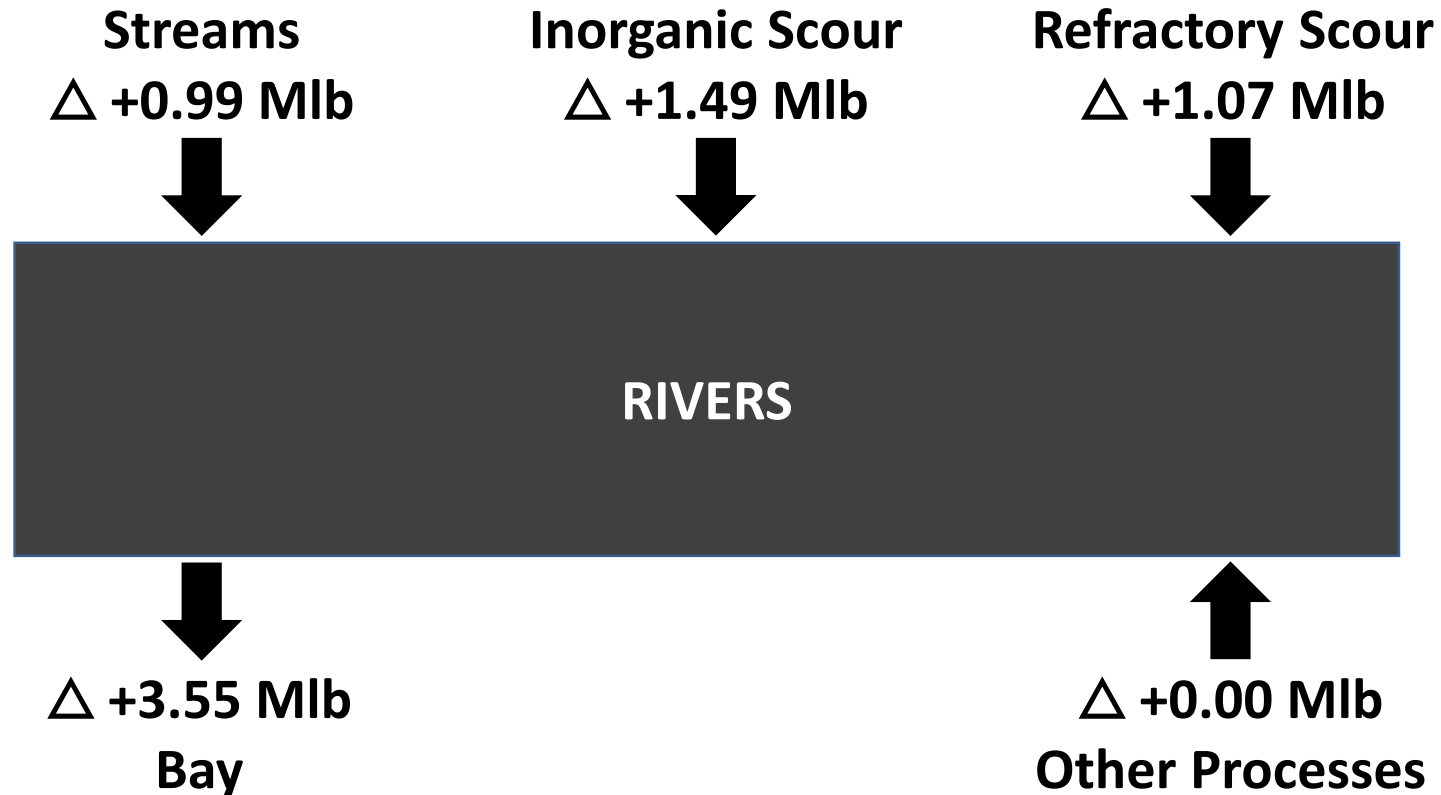
2025 Climate



Deltas (Δ) show change with respect to 1995 climate.

Summary of Phosphorus Budget

2055 Climate

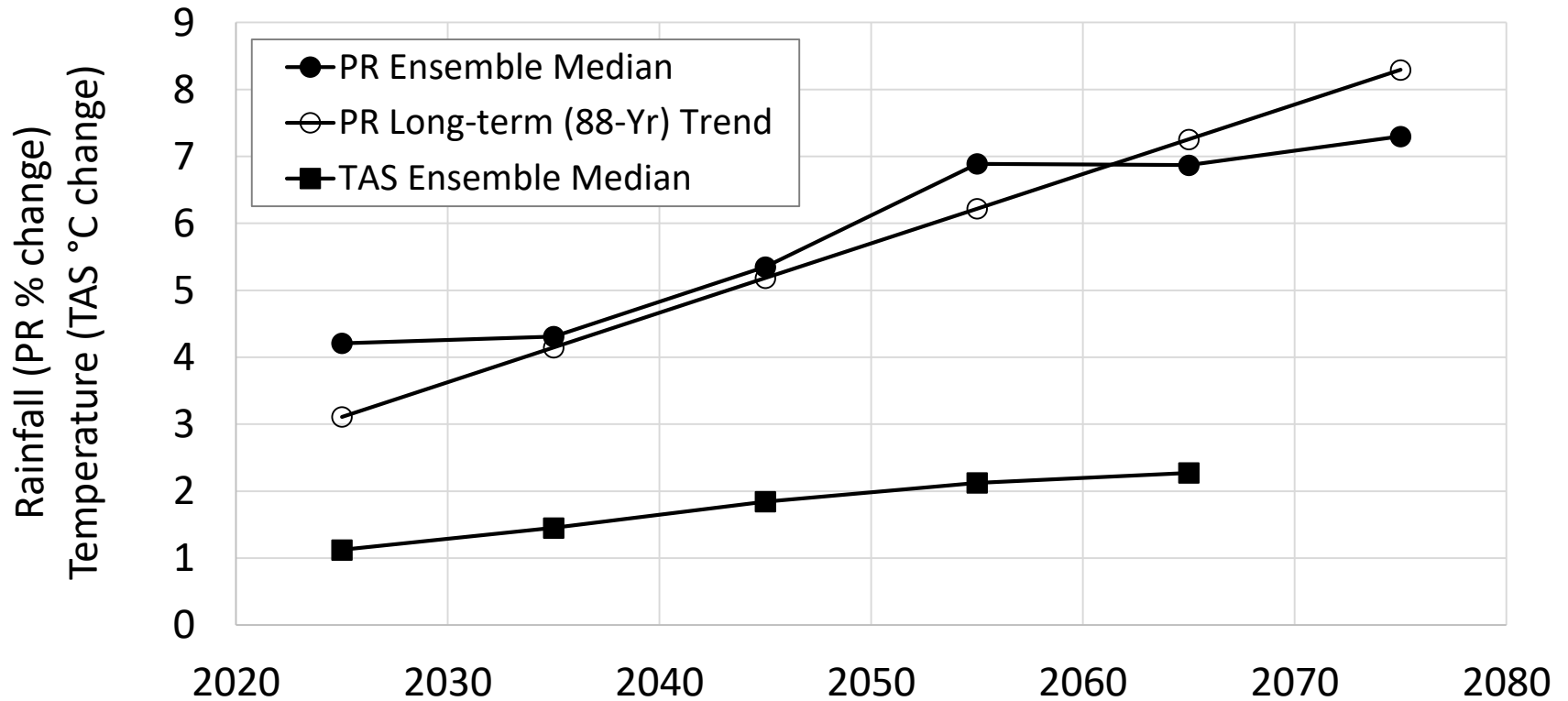


Deltas (Δ) show change with respect to 1995 climate.

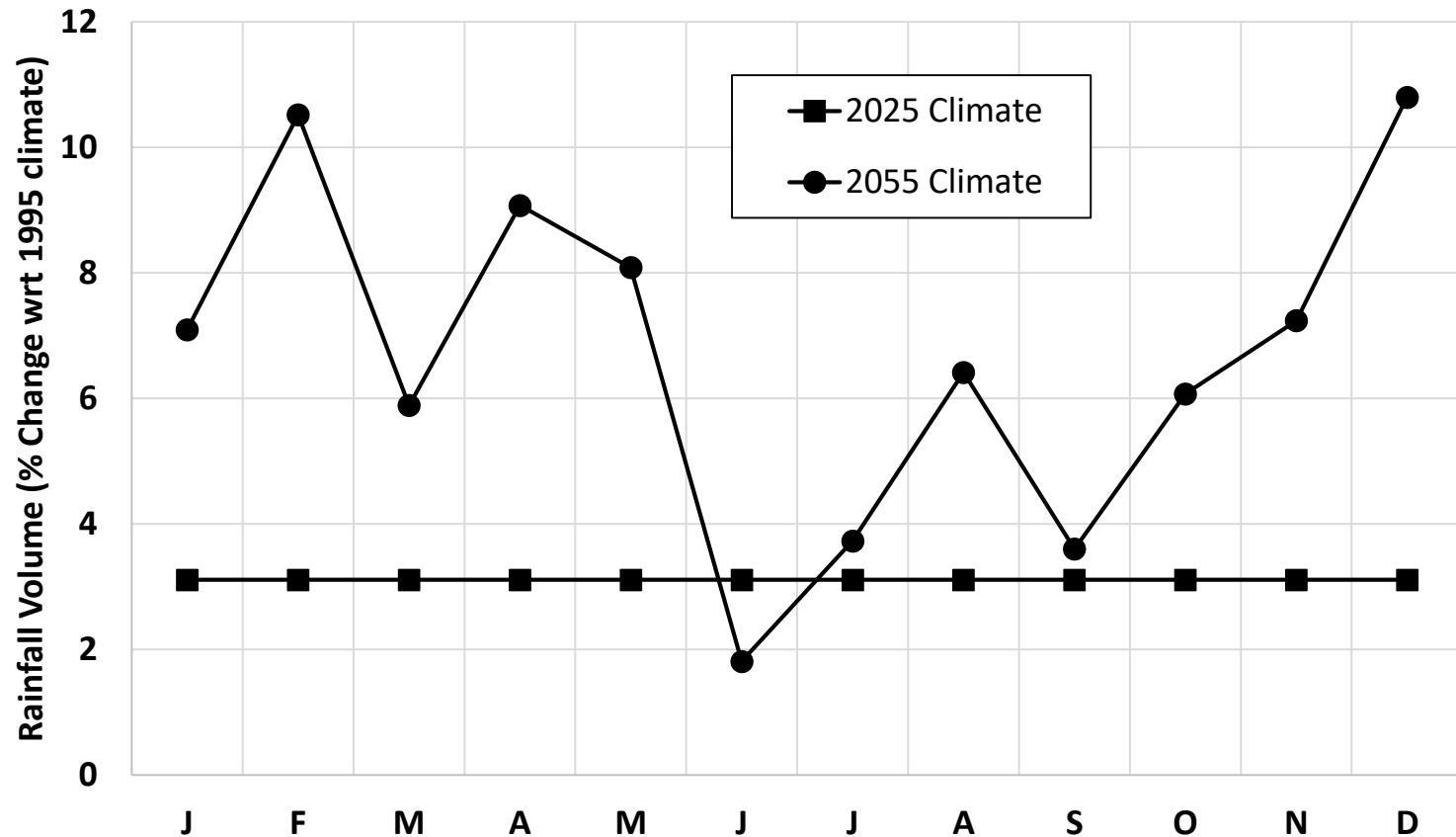
Summary

- **Both land and riverine processes contribute to changes in nitrogen and phosphorus deliveries.**
 - **More EOR loads with higher flow**
 - **An overall decrease in net trapping in the rivers**
- **Relatively higher proportions of particulate nitrogen and phosphorus with increasingly wetter climate are due to the mobilization and transport of refractory organics with sediment under higher flows.**

RCP 4.5 Ensemble Median vs. Trends



Chesapeake Bay Watershd Rainfall: 2025 vs 2055

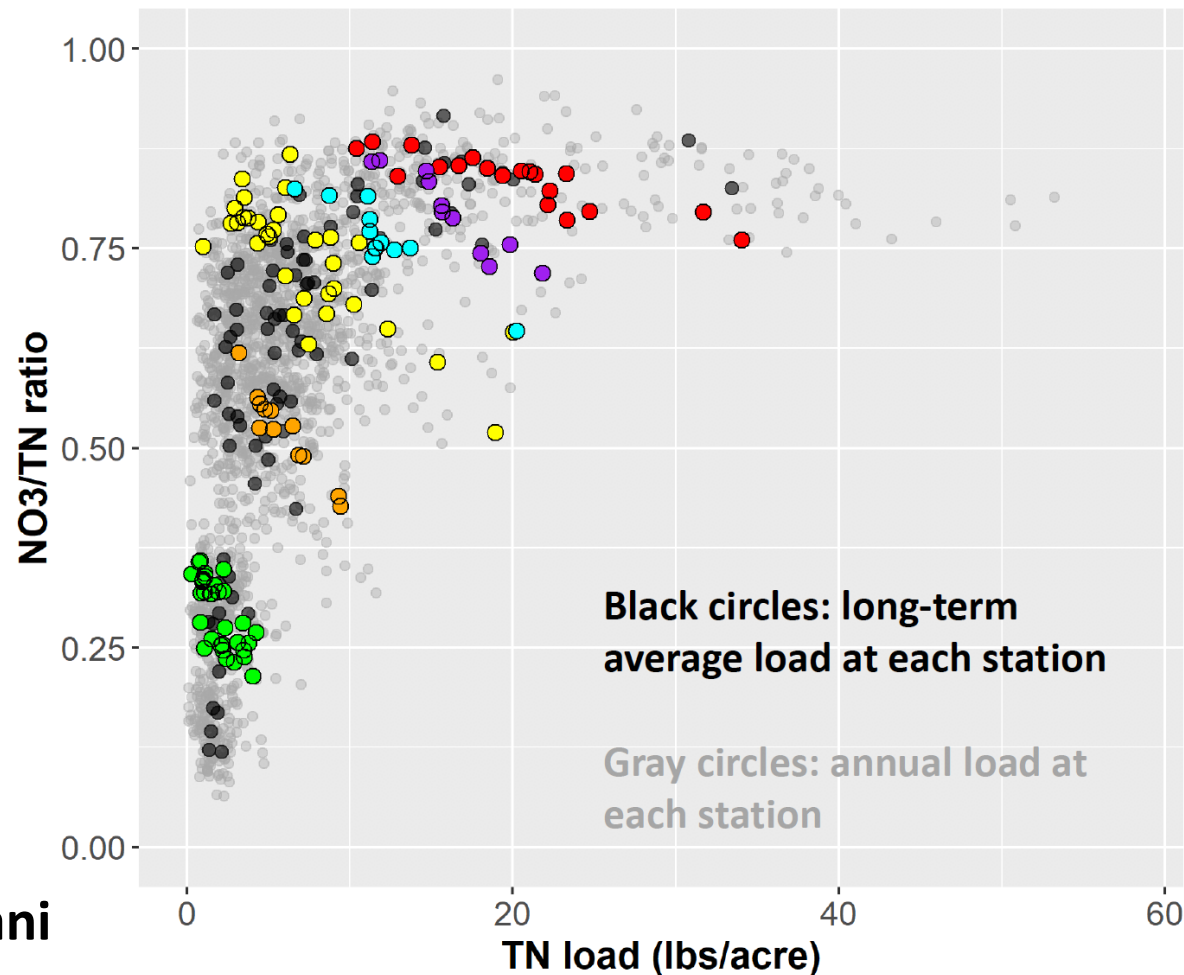


3.11% average annual increase for 2025

6.89% average annual increase for 2055

Edge of River Nitrogen Response

Across vs. within stations

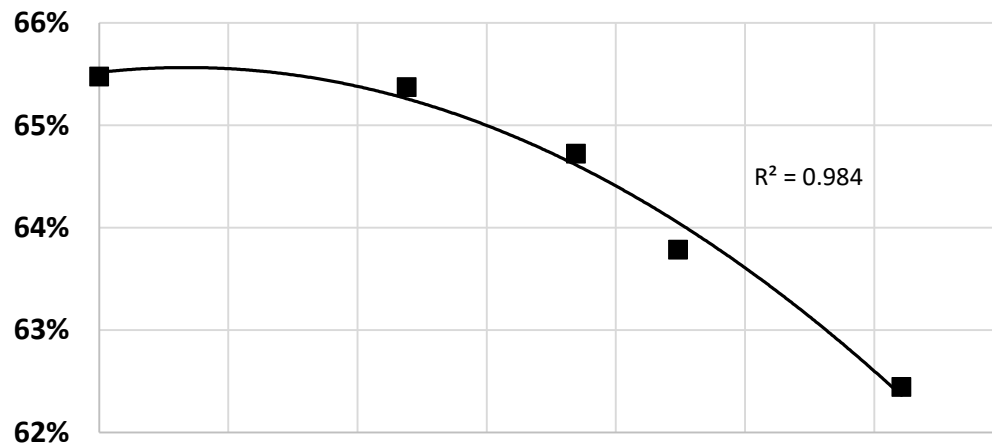


Isabella Bertani

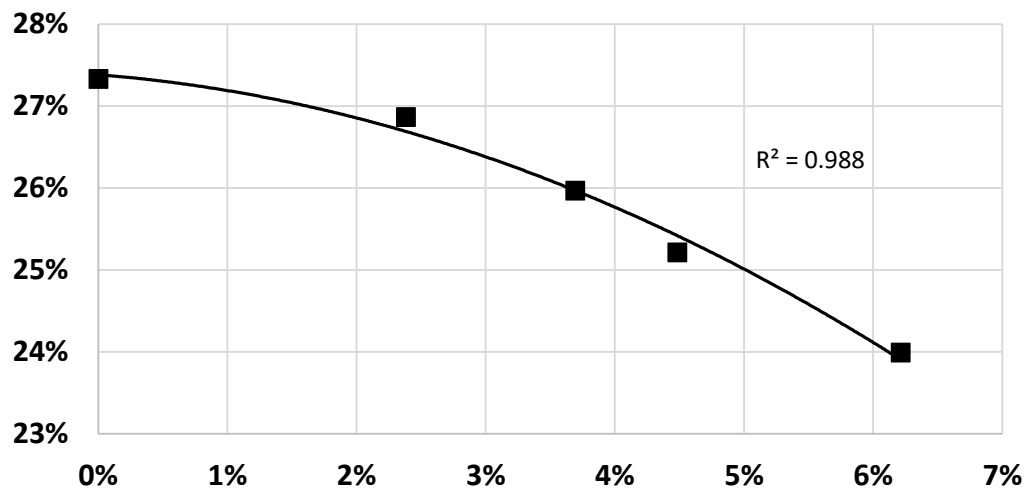
USGS data source: <https://doi.org/10.5066/F7RR1X68>

Nutrient Speciation

% Nitrate in Total Nitrogen



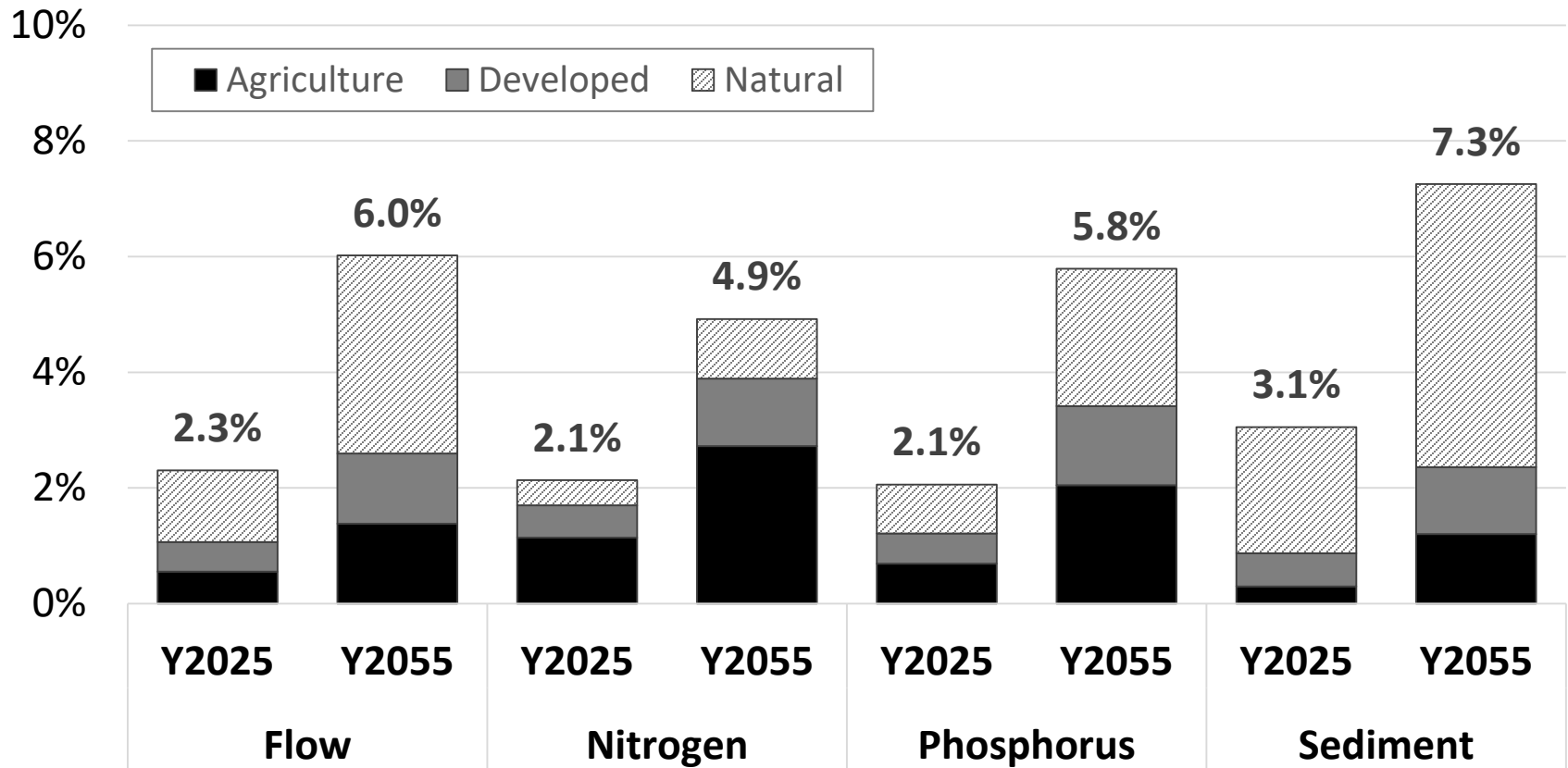
% Dissolved Inorganic in Total Phosphorus



Flow →


Edge of River Loads

Changes in Edge of River Loads




Summary of Nitrogen Budget

2025 Climate


EOR  $\Delta +5.4 \text{ Mlb-N}$

$\Delta \text{ TN} = -0.5 \text{ Mlb} [-66 \text{ Mlb-N}]$

{ $\Delta \text{ Refractory N} = +1.6 \text{ Mlb}$ }


DEL  $\Delta +4.9 \text{ Mlb-N}$

2055 Climate

 $\Delta +12.5 \text{ Mlb-N}$

$\Delta \text{ TN} = +7.8 \text{ Mlb} [-58 \text{ Mlb-N}]$

{ $\Delta \text{ Refractory N} = +11.6 \text{ Mlb}$ }

 $\Delta +20.4 \text{ Mlb-N}$

Deltas (Δ) show change with respect to 1995 climate.

Numbers in [square brackets] show the amount of nutrient processed in rivers.


Summary of Phosphorus Budget

2025 Climate


EOR  $\Delta +0.35 \text{ Mlb-P}$

$\Delta \text{ TP} = +0.23 \text{ Mlb} [-3.92 \text{ Mlb-P}]$

$\{ \Delta \text{ Refractory P} = +0.22 \text{ Mlb} \}$


DEL  $\Delta +0.59 \text{ Mlb-P}$

2055 Climate

 $\Delta +0.99 \text{ Mlb-P}$

$\Delta \text{ TP} = +2.55 \text{ Mlb} [-1.61 \text{ Mlb-P}]$

$\{ \Delta \text{ Refractory P} = +1.38 \text{ Mlb} \}$

 $\Delta +3.53 \text{ Mlb-P}$

Deltas (Δ) show change with respect to 1995 climate.

Numbers in [square brackets] show the amount of nutrient processed in rivers.