Early Look at Key 2025 and 2050 Climate Change Analysis Scenarios

Chesapeake Hypoxia Analysis and Modeling Program (CHAMP)

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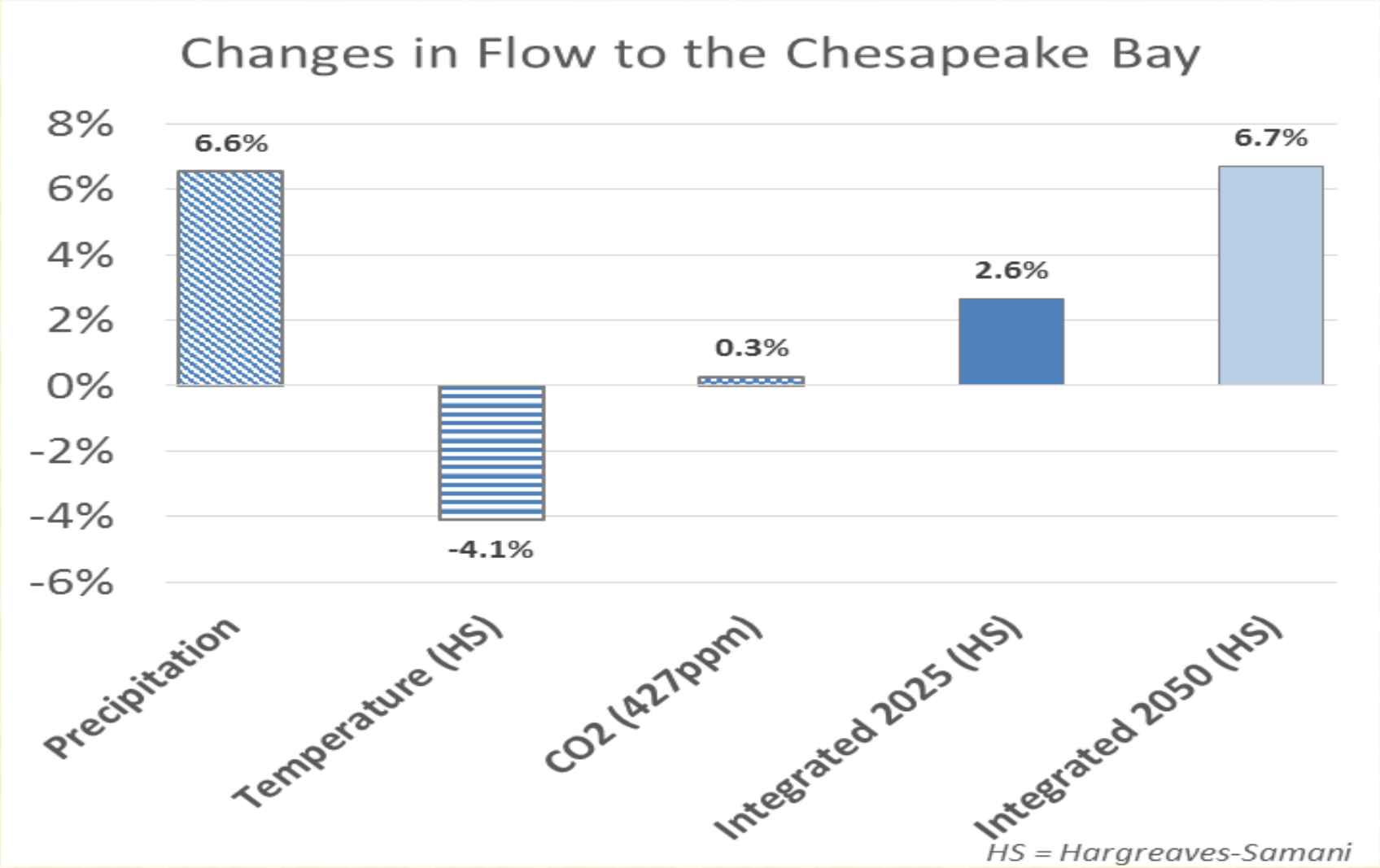
Chesapeake Bay Program
Science, Restoration, Partnership

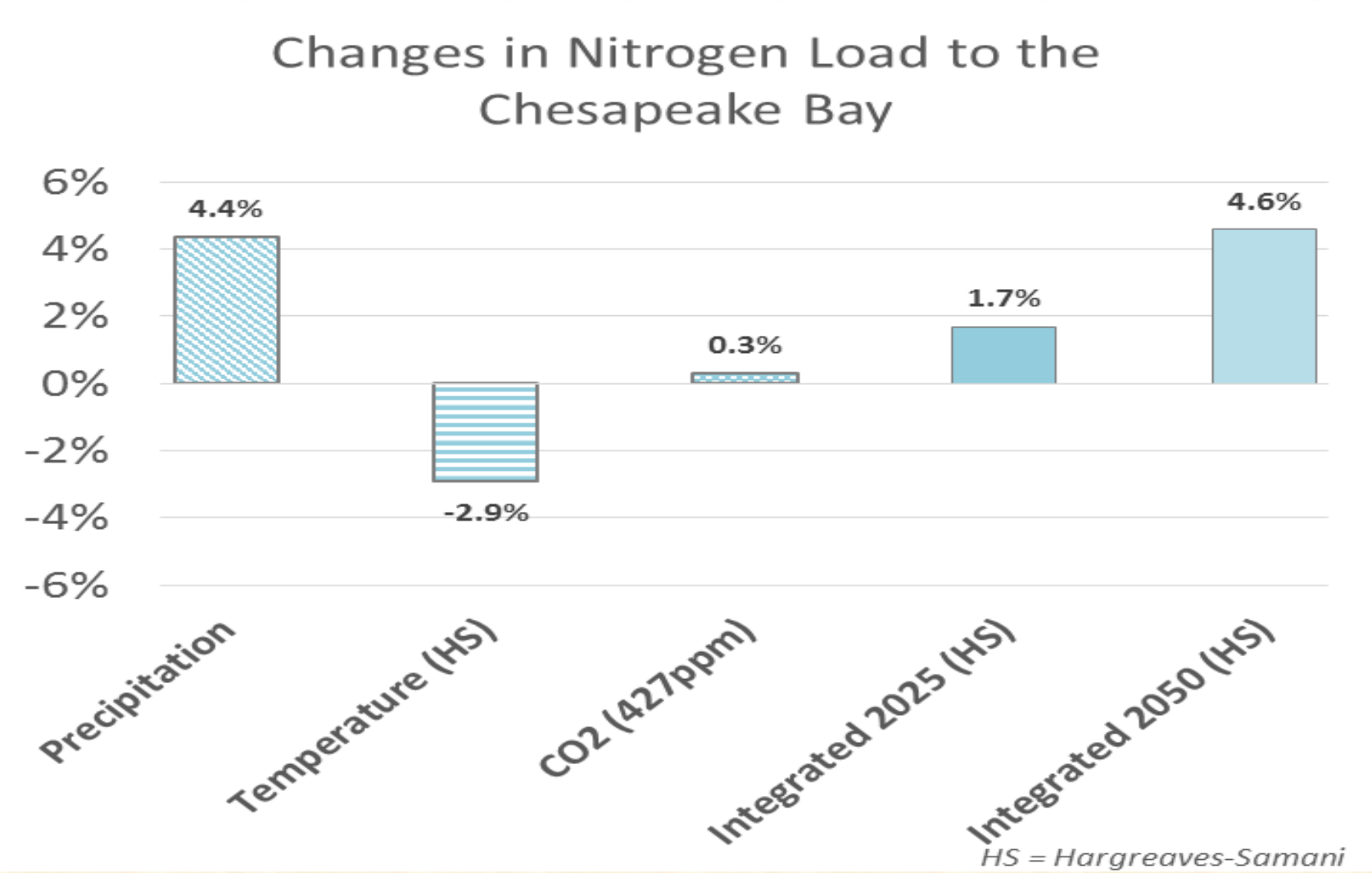
Overview:

- Preliminary estimates of 2025 & 2050 climate change influence on Chesapeake water quality.
- Current estimates include increases in precipitation, temperature, evapotranspiration, and stomatal resistance in the watershed.
- Current estimates in tidal water include temperature increases and changes hydrodynamics with sea level rise.

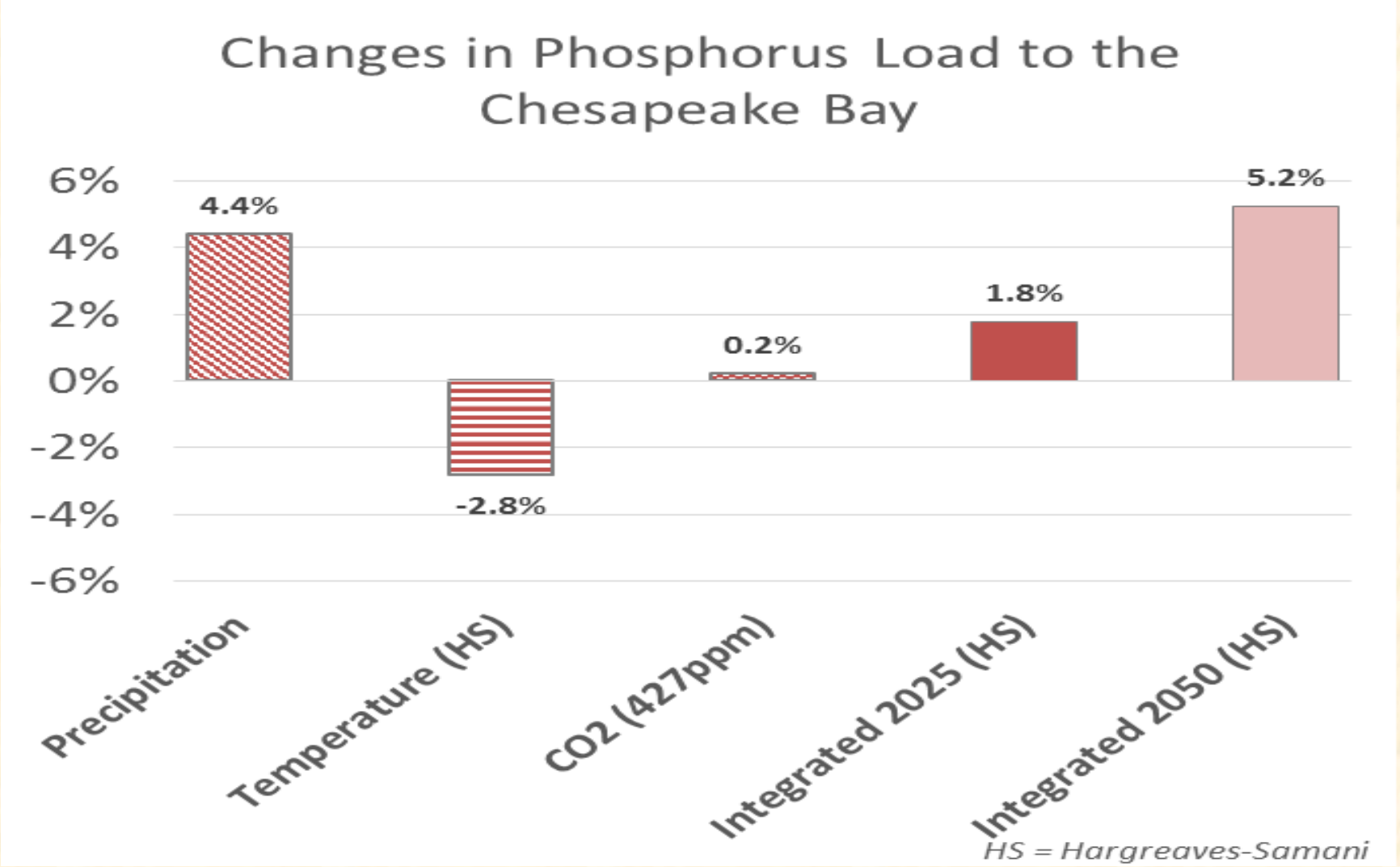
Climate Change 2025 Flow:



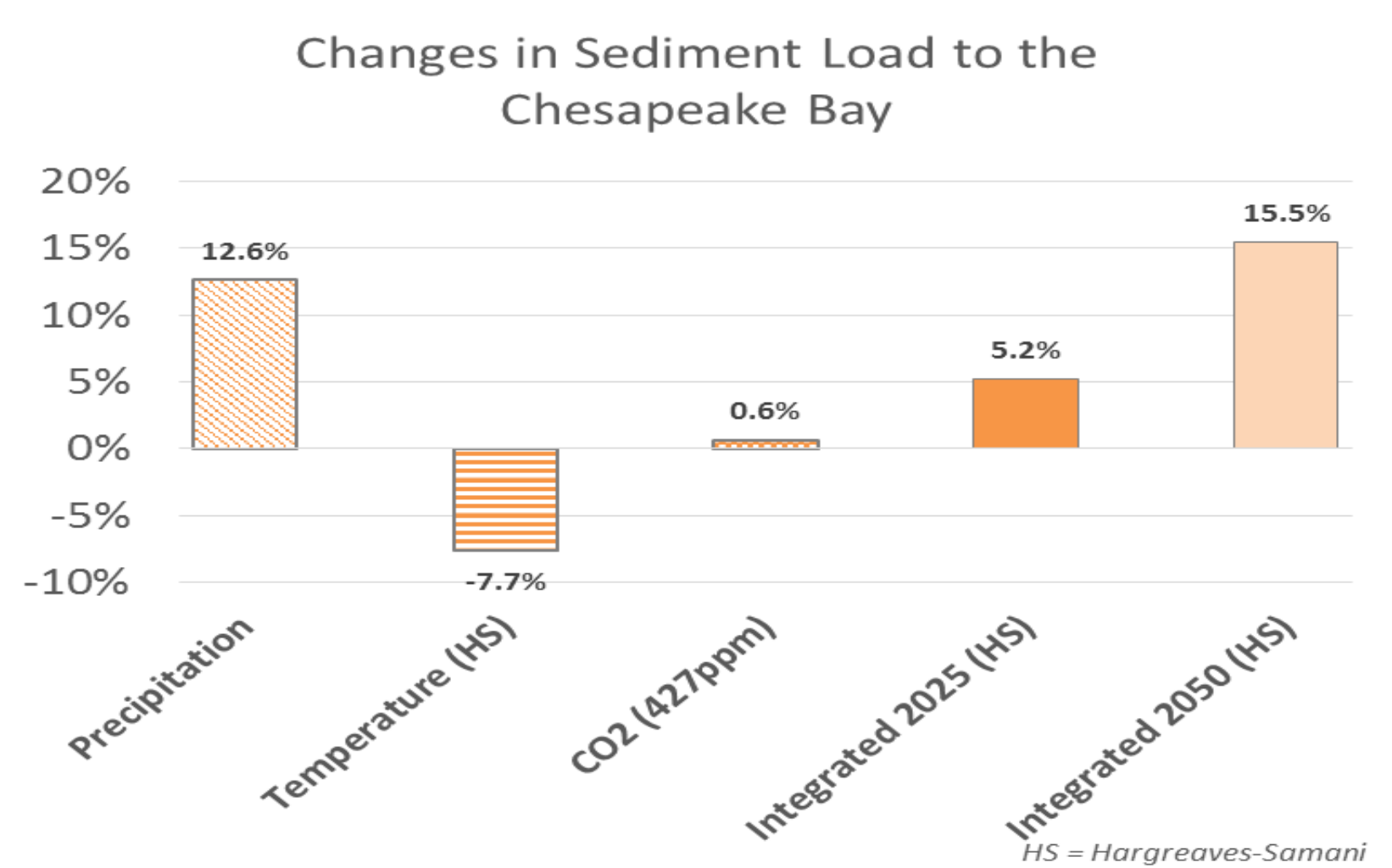
Climate Change 2025 Nitrogen:



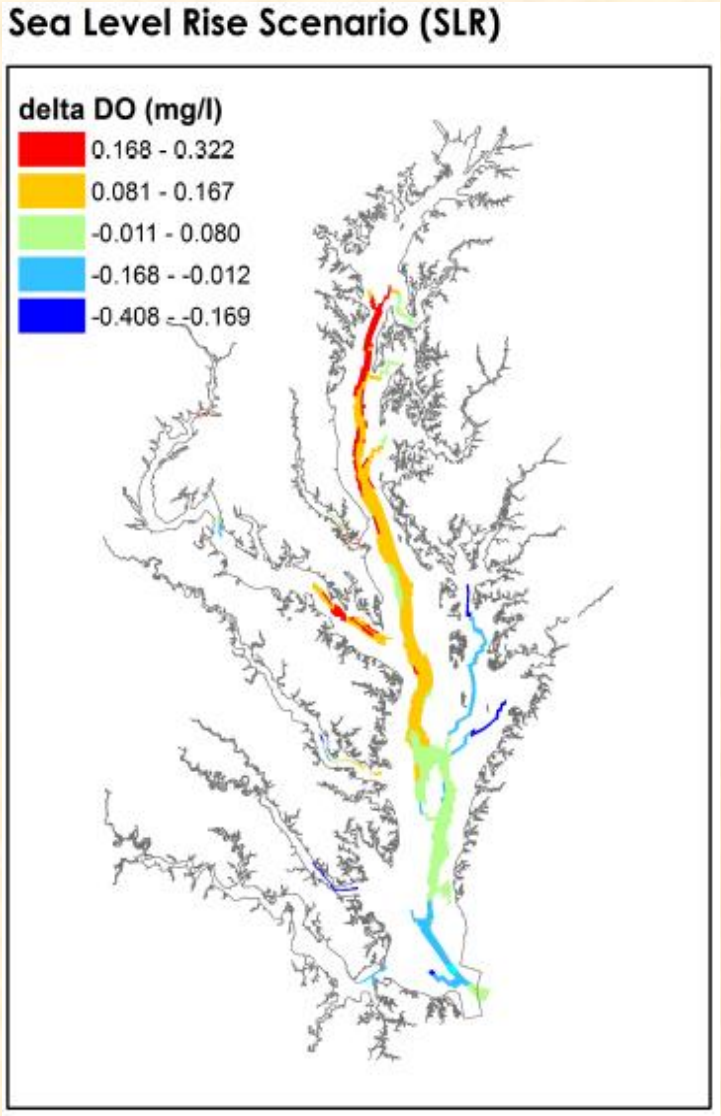
Climate Change 2025 Phosphorus:

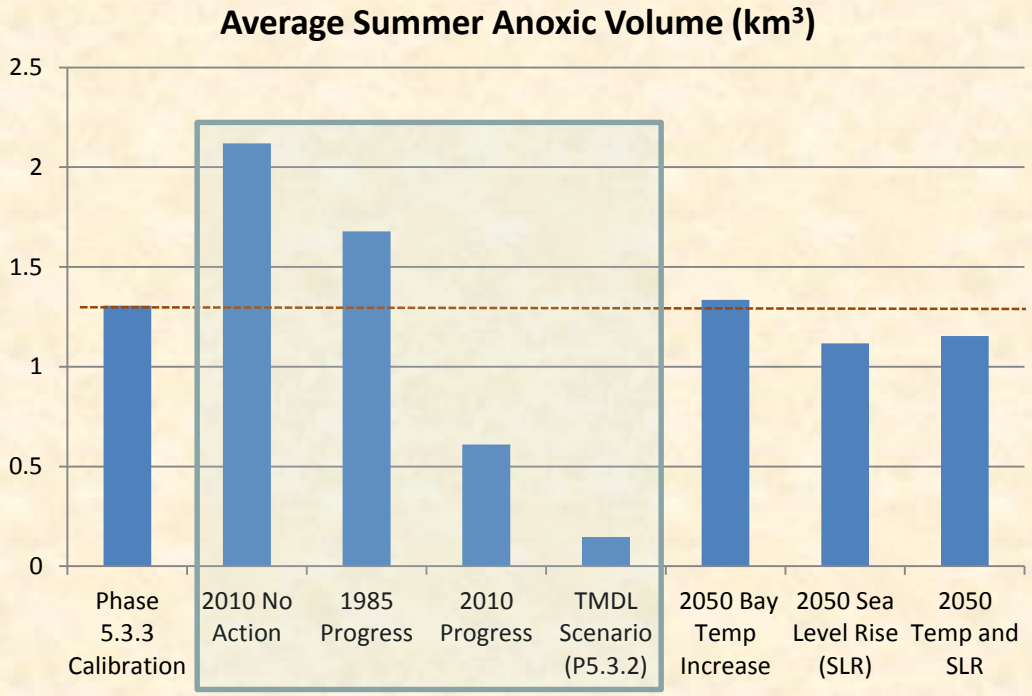


Climate Change 2025 Sediment:



Changes in Hydrodynamics due to Sea Level Rise





The influence of an 2050 estimated temperature and sea level rise on Chesapeake hypoxia is relatively small.

The estimated delta in Chesapeake hypoxia due to 2050 estimated sea level rise ranges from 0.3 to -0.4 mg/l.

Hypoxia decreases in the mid-Bay are due to increased ventilation of deep Chesapeake waters by high DO ocean waters and also to changes in vertical stratification.

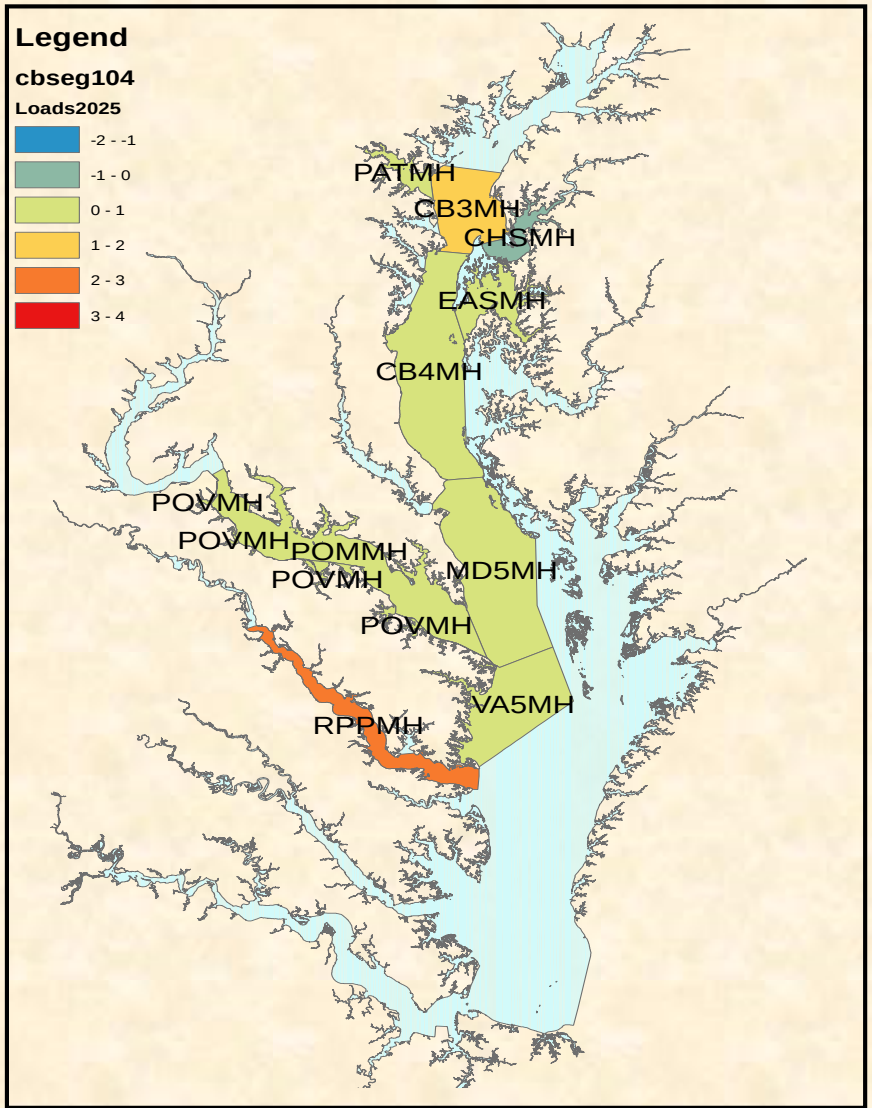
		Base Scenario 349TN 20.8TP 10.9TSS 1993-1995	2025 Climate Change Watershed Load 355TN 21.3TP 11.5TSS 1993-1995	2050 Climate Change Watershed Load 366TN 22.1TP 12.6TSS 1993-1995	2025 Watershed Load and Sea Level Rise (0.3m) 355TN 21.3TP 11.5TSS 1993-1995
CB Segment	State	Deep Channel	Deep Channel	Deep Channel	Deep Channel
CB3MH	MD	16.0%	17.1%	17.5%	17.0%
CB4MH	MD	46.0%	46.7%	48.0%	44.3%
CB5MH	MD/VA	14.2%	14.7%	15.7%	12.8%
CHSMH	MD	37.4%	37.4%	37.4%	37.2%
POTMH	MD/VA	20.2%	20.6%	21.7%	18.5%
POMMH	MD	20.4%	20.7%	21.8%	18.6%
RPPMH	VA	19.0%	21.7%	24.7%	22.4%
EASMH	MD	25.4%	25.9%	26.7%	24.8%
MD5MH	MD	21.7%	22.2%	23.2%	20.0%
VA5MH	VA	4.5%	4.9%	6.0%	3.4%
PATMH	MD	24.8%	25.5%	29.1%	28.7%

CB Segment	State	Base Scenario 349TN 20.8TP 10.9TSS 1993-1995 Deep Water	2025 Climate Change Watershed Load 355TN 21.3TP 11.5TSS 1993-1995 Deep Water	2050 Climate Change Watershed Load 366TN 22.1TP 12.6TSS 1993-1995 Deep Water	2025 Watershed Load and Sea Level Rise (0.3m) 355TN 21.3TP 11.5TSS 1993-1995 Deep Water
CB3MH	MD	2.1%	2.2%	2.3%	2.0%
CB4MH	MD	21.0%	21.4%	22.4%	19.6%
CB5MH	MD/VA	4.2%	4.3%	4.6%	3.6%
CB6PH	VA	0.0%	0.0%	0.1%	0.0%
CB7PH	VA	0.0%	0.0%	0.0%	0.0%
CHSMH	MD	25.7%	25.7%	29.7%	25.7%
EASMH	MD	5.9%	7.2%	12.6%	5.4%
PAXMH	MD	6.3%	6.8%	8.4%	6.8%
POTMH	MD/VA	4.1%	4.2%	4.5%	4.0%
POMMH	MD	4.1%	4.3%	4.5%	4.0%
RPPMH	VA	5.9%	6.2%	6.8%	6.1%
SBEMH	VA	0.0%	0.2%	2.5%	2.0%
YRKPH	VA	0.0%	0.0%	0.0%	0.0%
MD5MH	MD	8.5%	8.7%	9.1%	8.0%
VA5MH	VA	0.5%	0.5%	0.6%	0.1%
PATMH	MD	12.4%	12.4%	13.8%	14.4%
MAGMH	MD	51.0%	51.0%	51.0%	51.0%
SOUMH	MD	18.6%	18.6%	18.9%	18.6%
SEVMH	MD	6.1%	6.1%	6.1%	6.1%

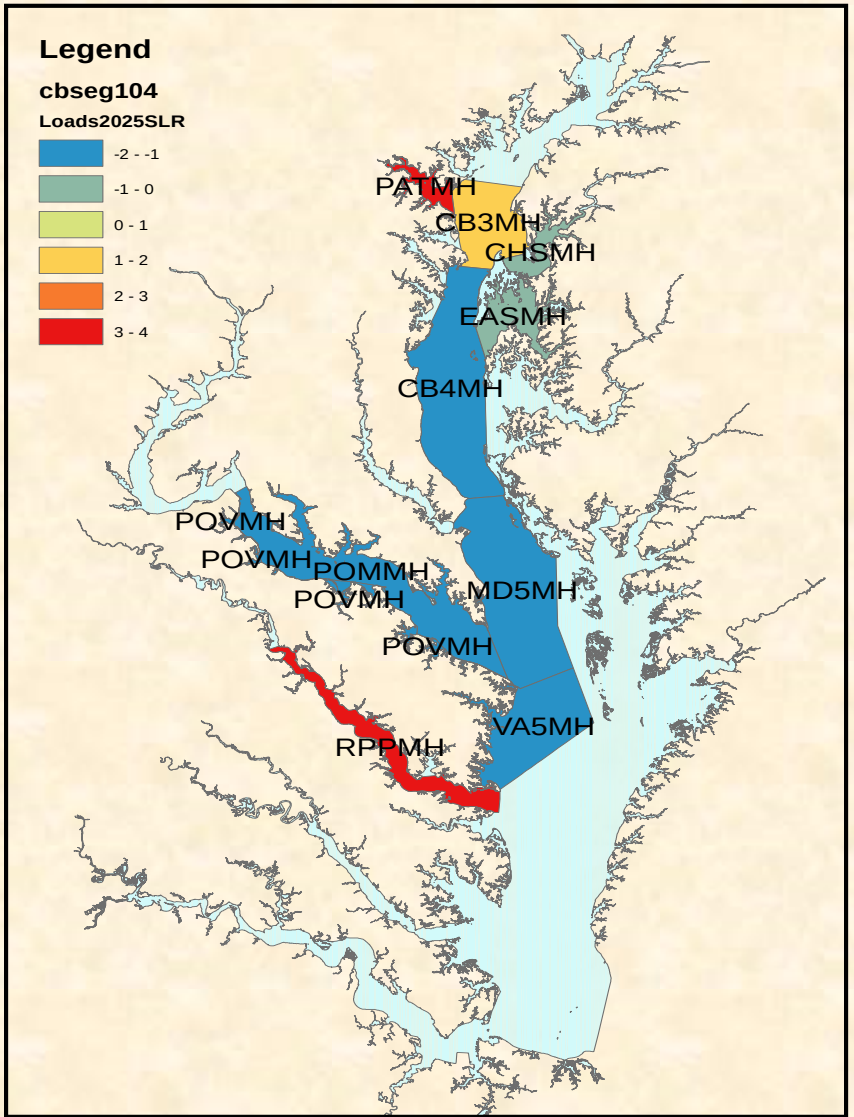
Estimated 2025 Changes in Deep Channel Nonattainment

With estimated 2025 watershed loads, which increased by 2% for both nitrogen and phosphorus, DO attainment degraded by <1% in the lower and middle portion of the mainstem, but by 1-2% in CB3 in the upper Bay and by 2-3% in Rappahannock. With estimated 2025 load and sea level rise (0.3m) combined, DO attainment improved by 1-2% in the low and middle portion of the mainstem, but degraded by 1-2% in CB3 in the upper Bay and by 3-4% in the Patuxent and Rappahannock mesohaline regions.

2025 nutrient load only



2025 nutrient load and 0.3 m sea level rise



Initial, Preliminary Conclusions:

• The current best estimate of the increase in nitrogen and phosphorus loads to Chesapeake tidal waters due to estimated 2025 and 2050 climate induced changes is 2 percent and 5 percent, respectively, for both nutrients. The detrimental influence of increased nutrient loads will be offset in 2025 by sea level rise and an associated increase in gravitational circulation.

• Efforts are underway to quantify the estimated increase in gravitational circulation with dissolved conservative tracers and flux transects in the model.

• Also underway are efforts to best resolve how to "scenario the data" in climate change scenarios based on the findings and contributions by Ike Irby.

Next Steps:

- Refine 2025 and 2050 hydrodynamic simulations of climate change.
- Add wetland loss with sea level rise as a sensitivity analysis.
- Add 2050 climate change atmospheric deposition estimates.
- Add 2025 and 2050 land use.
- Complete 2017 initial Midpoint Assessment climate change analysis in May-June 2017 for final review and application by Bay Program partners.