

Carbon Sources and Impacts in the Delaware River Estuary

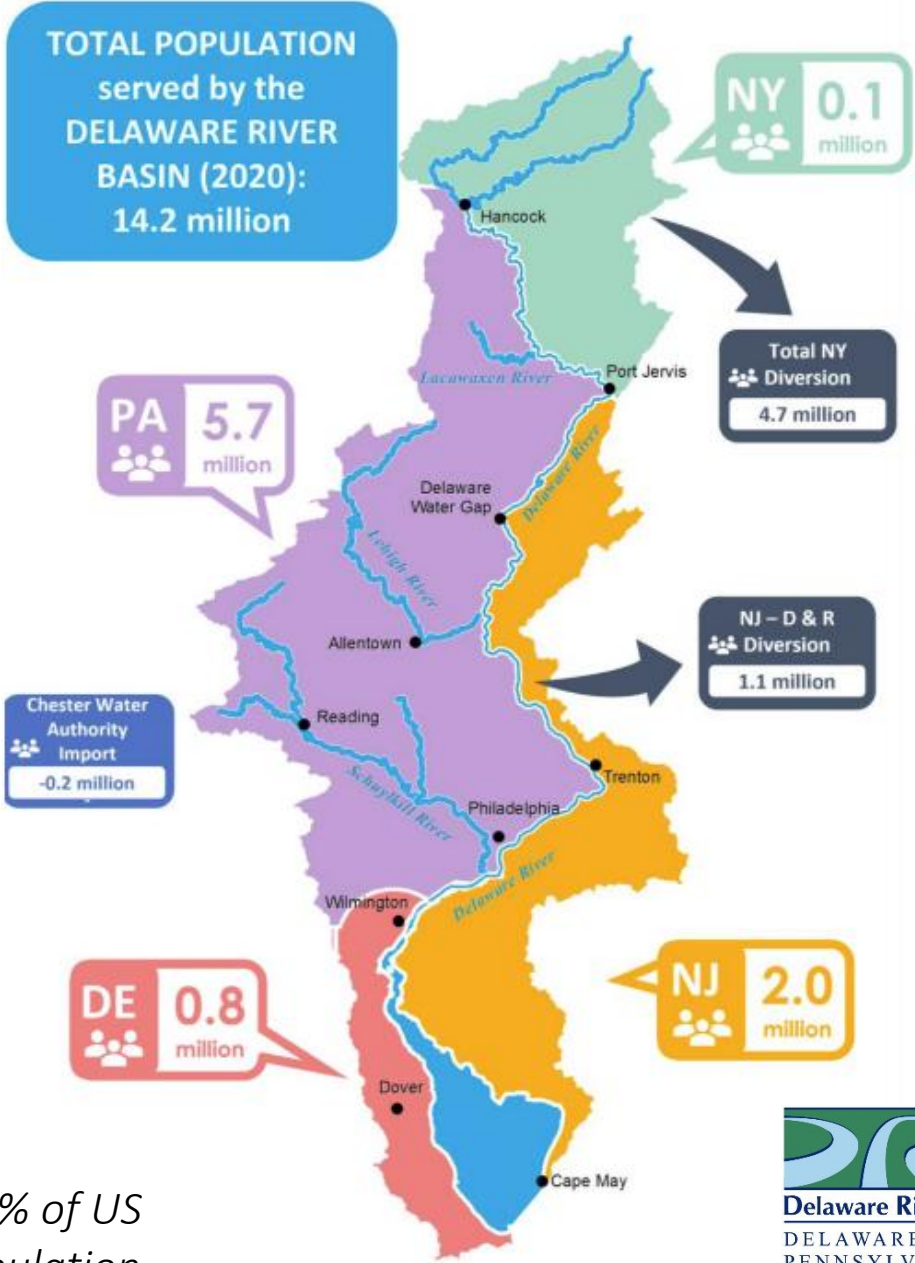
Pinelands Research Institute Science Summit
June, 2026

Matthew T. Amato, PhD
Li Zheng, PhD
Joseph Fogarty, PhD
Thomas Amidon, BCES
Namsoo Suk, PhD



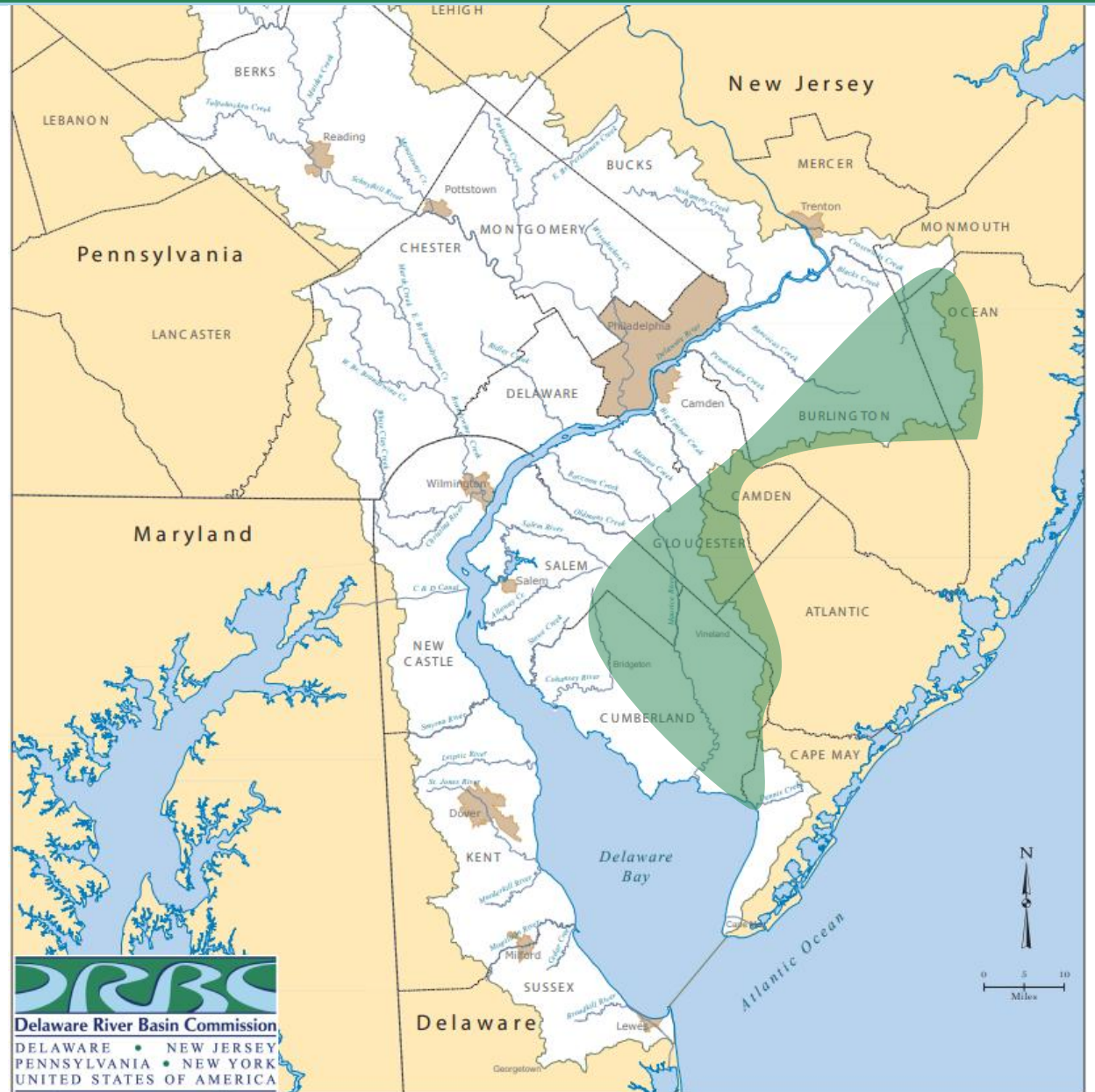
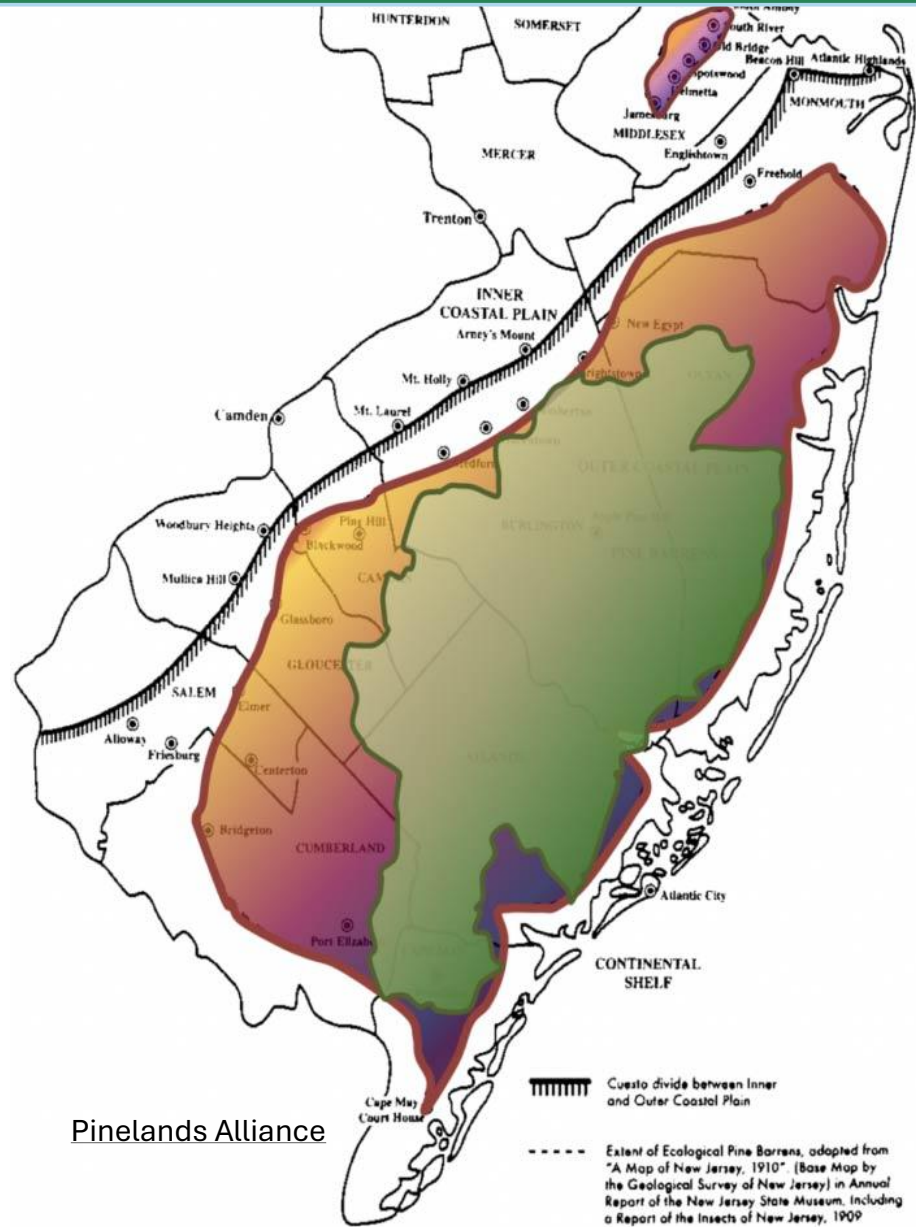
Who is the DRBC and
what do we do?

DRBC is a government organization that manages, monitors, and regulates the quality and quantity of water resources within the Delaware River Basin



4-5% of US population

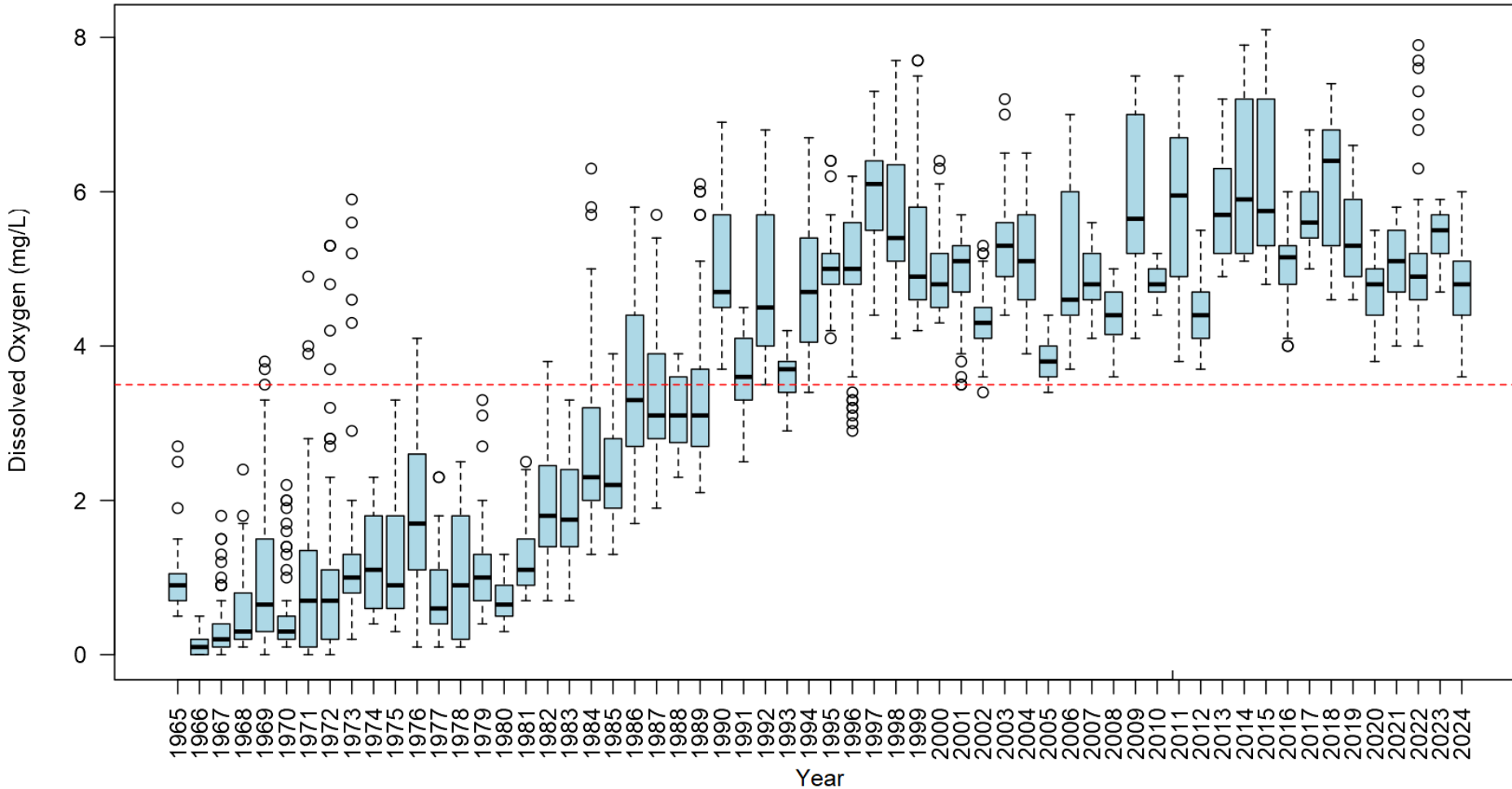
Our systems do intersect...



But wait, why is a water
agency interested in
carbon?

A Comeback Story...

July & August Dissolved Oxygen by Year
USGS Monitor 01467200, Delaware River at Penns Landing (formerly Ben Franklin Bridge)



Historical dissolved oxygen recovery driven by carbon reductions

- DRBC wastewater CBOD allocations in 1968

“DO sag” still persists

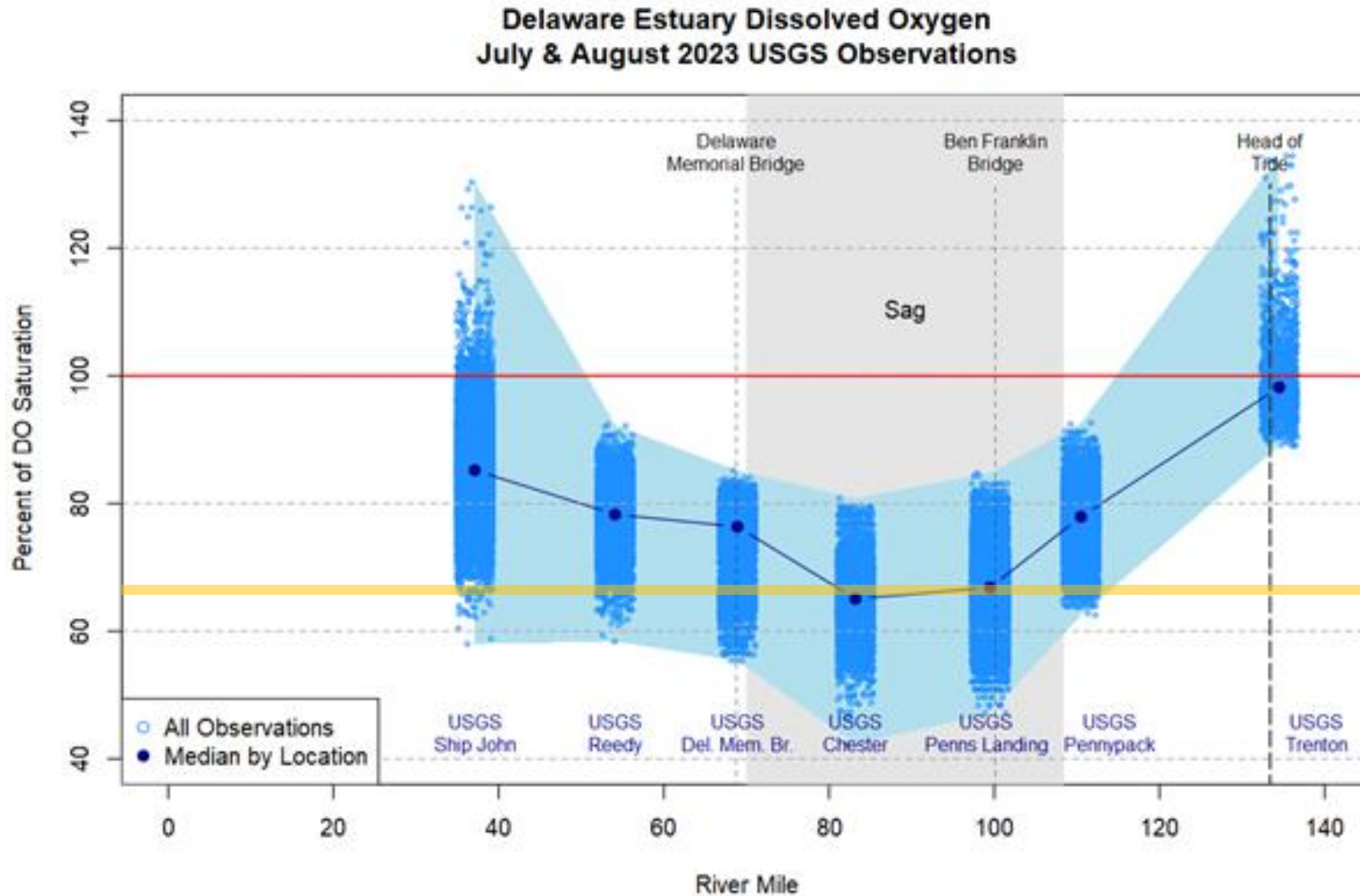
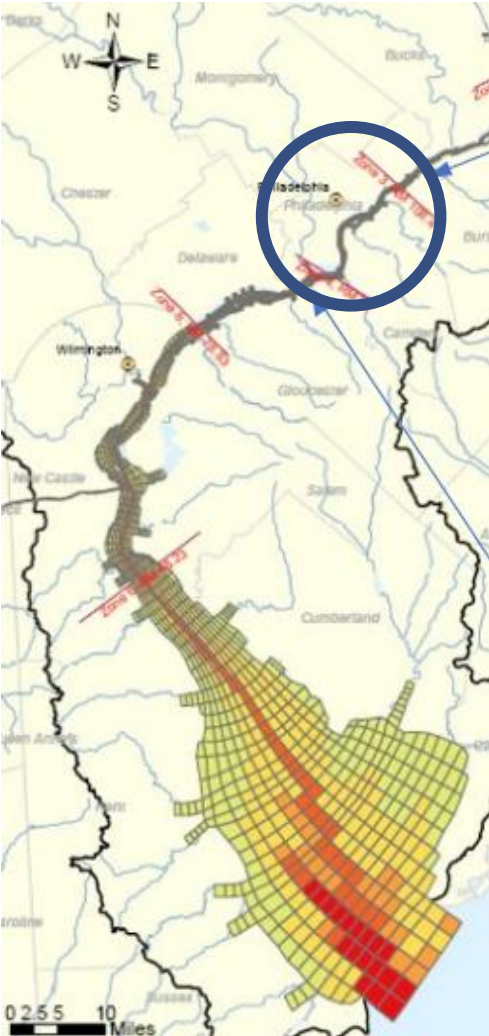


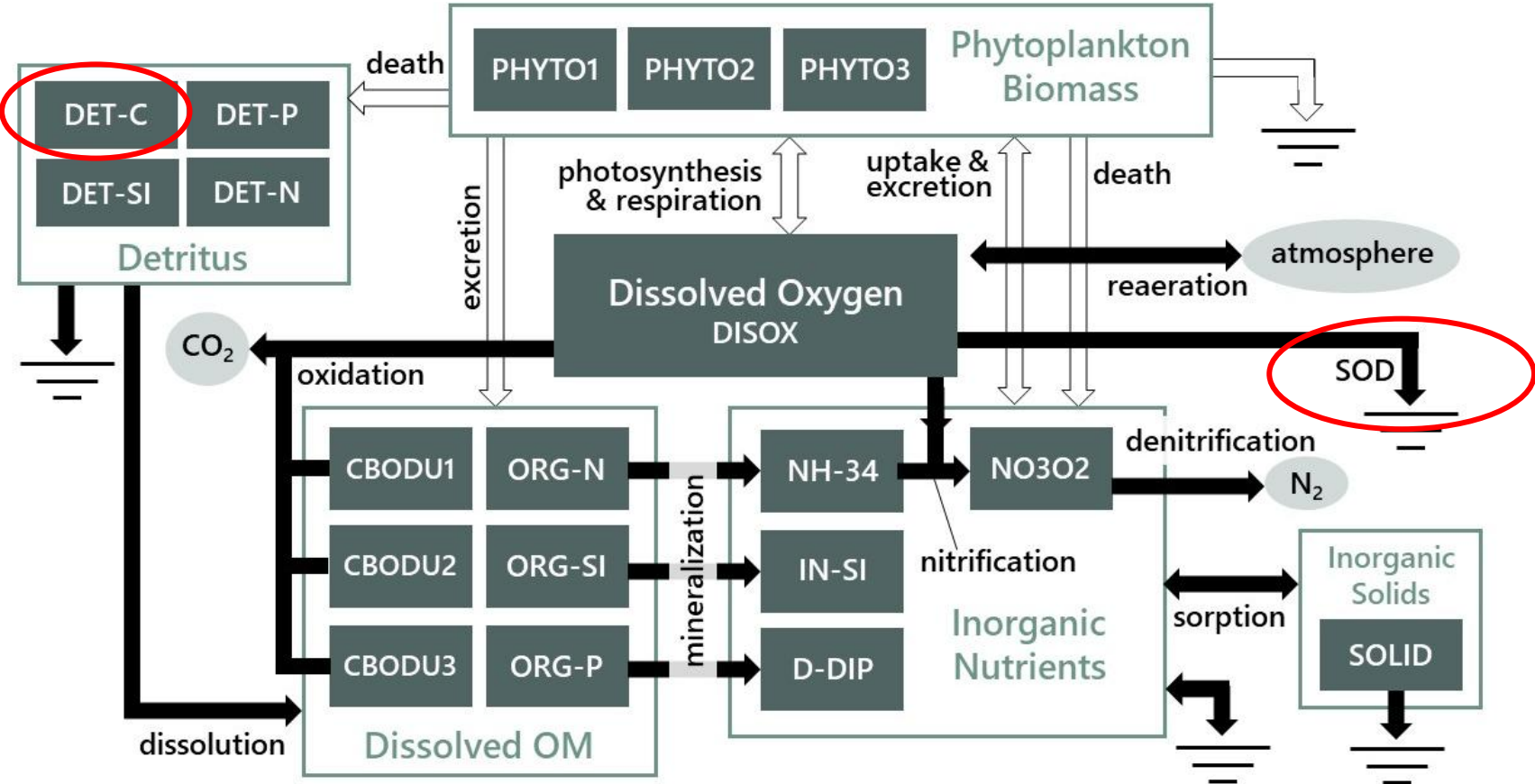
Photo by Vladimir Dinets (May 2026)

*EPA's new criteria
as of Sept. 2026*

DRBC developed a 3D dissolved oxygen model to predict load responses



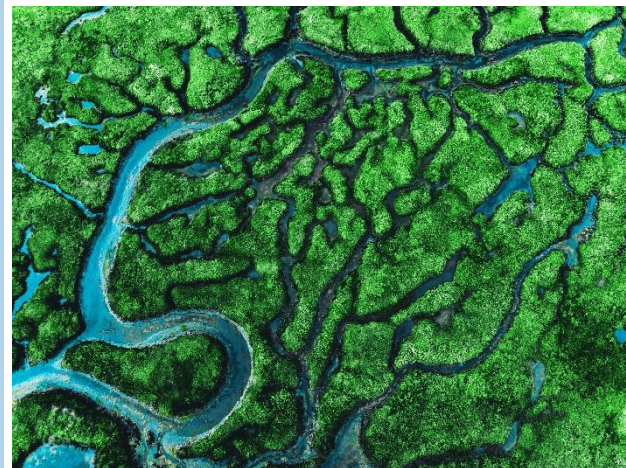
Dissolved Oxygen Model Kinetics (WASP)



Where does the C come from?

Autochthonous (*internal*) sources:
phytoplankton, SAV, periphyton

Allochthonous (*external*) sources:
tributaries, tidal marshes,
atmospheric deposition



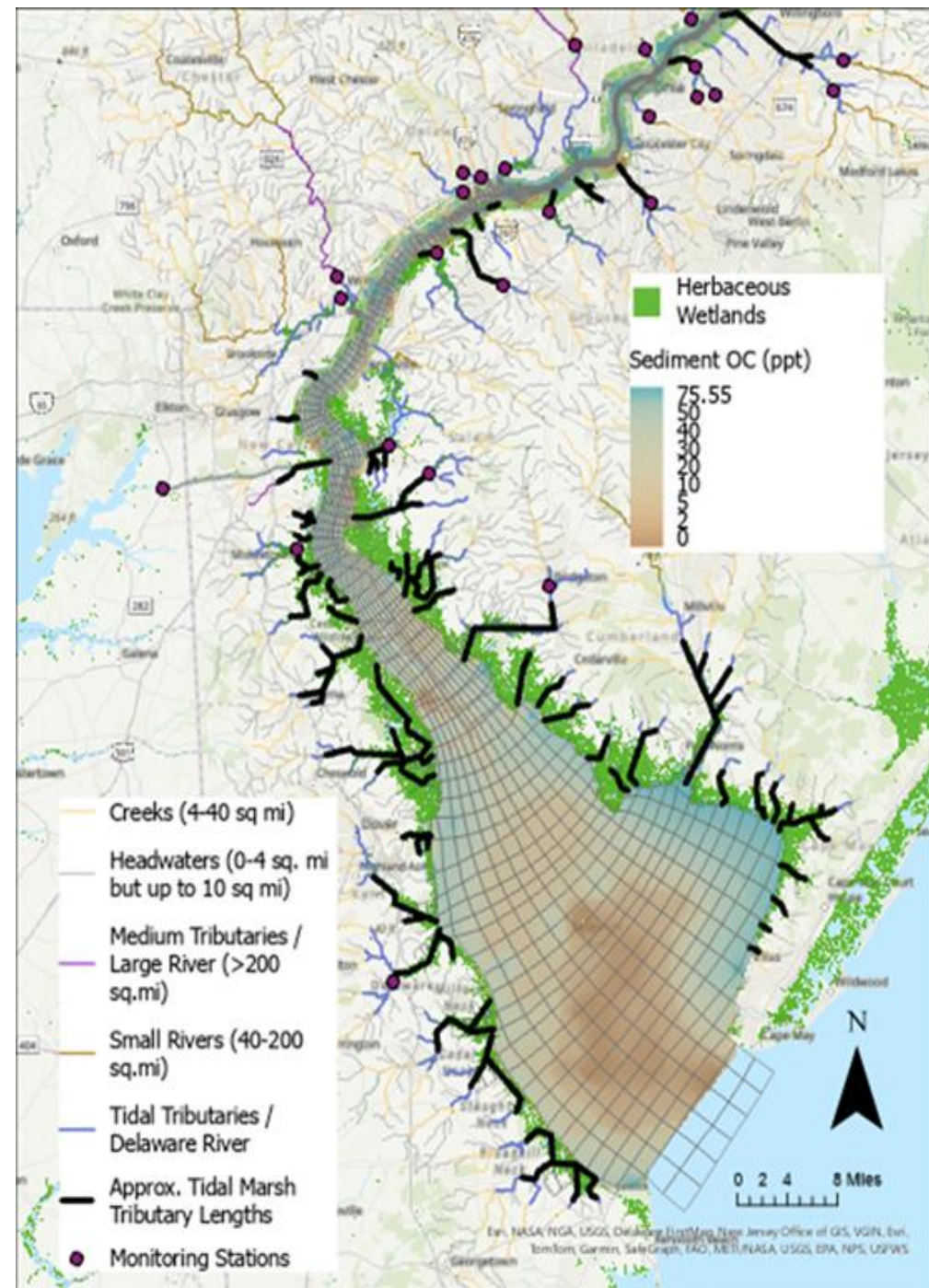
Marsh Loads

Most tidal marshes are not directly in contact with the mainstem but are hydraulically connected through networks of tidal tributaries/creeks

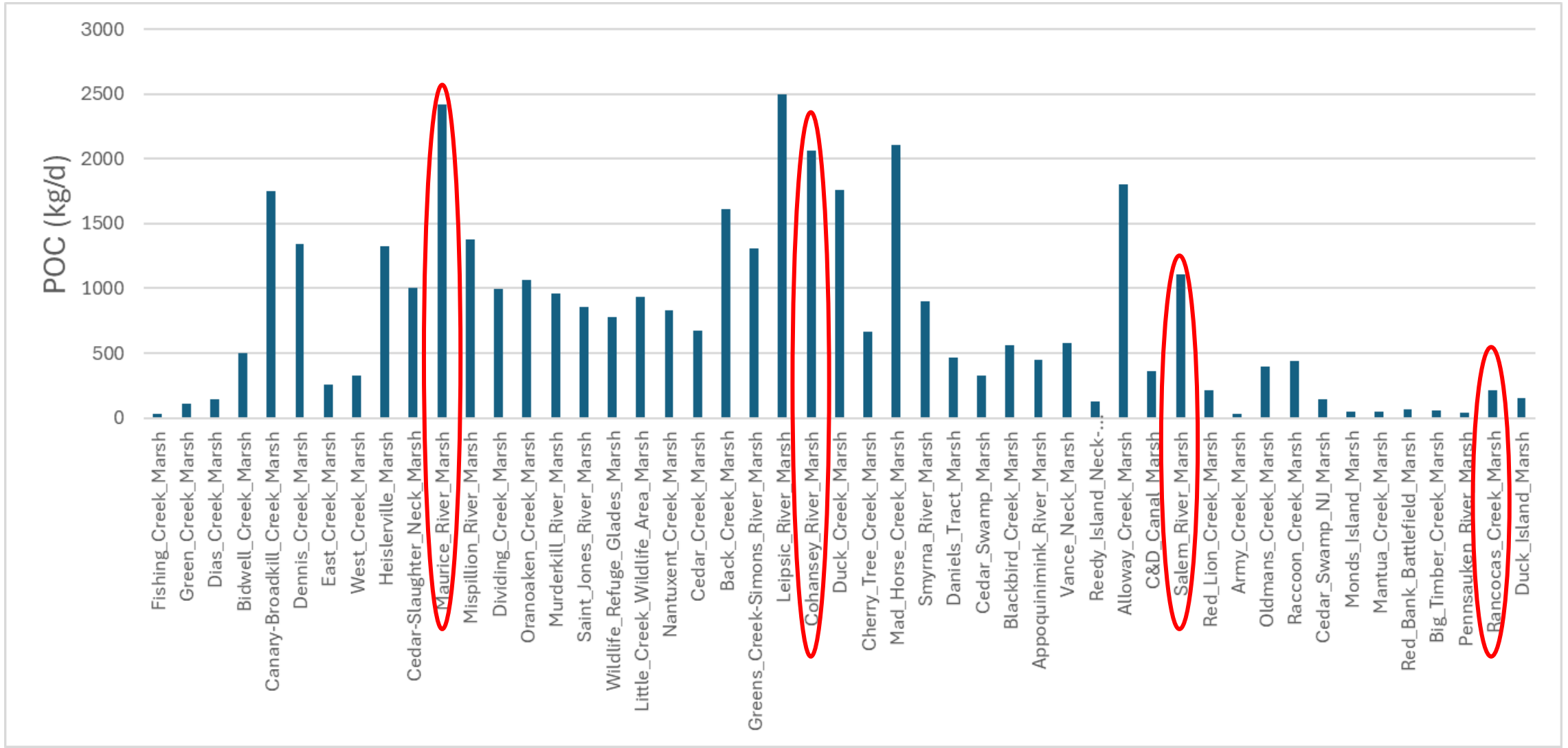
Seasonal loads were calculated proportional to marsh area

Season	DRE Marsh POC Exports (mg C/m ² /d)
Winter	-33.9
Spring	220.6
Summer	274.8
Fall	43.5
Avg.	126.3

Based on literature estimates (Cifuentes, 1987; Roman and Daiber, 1989)



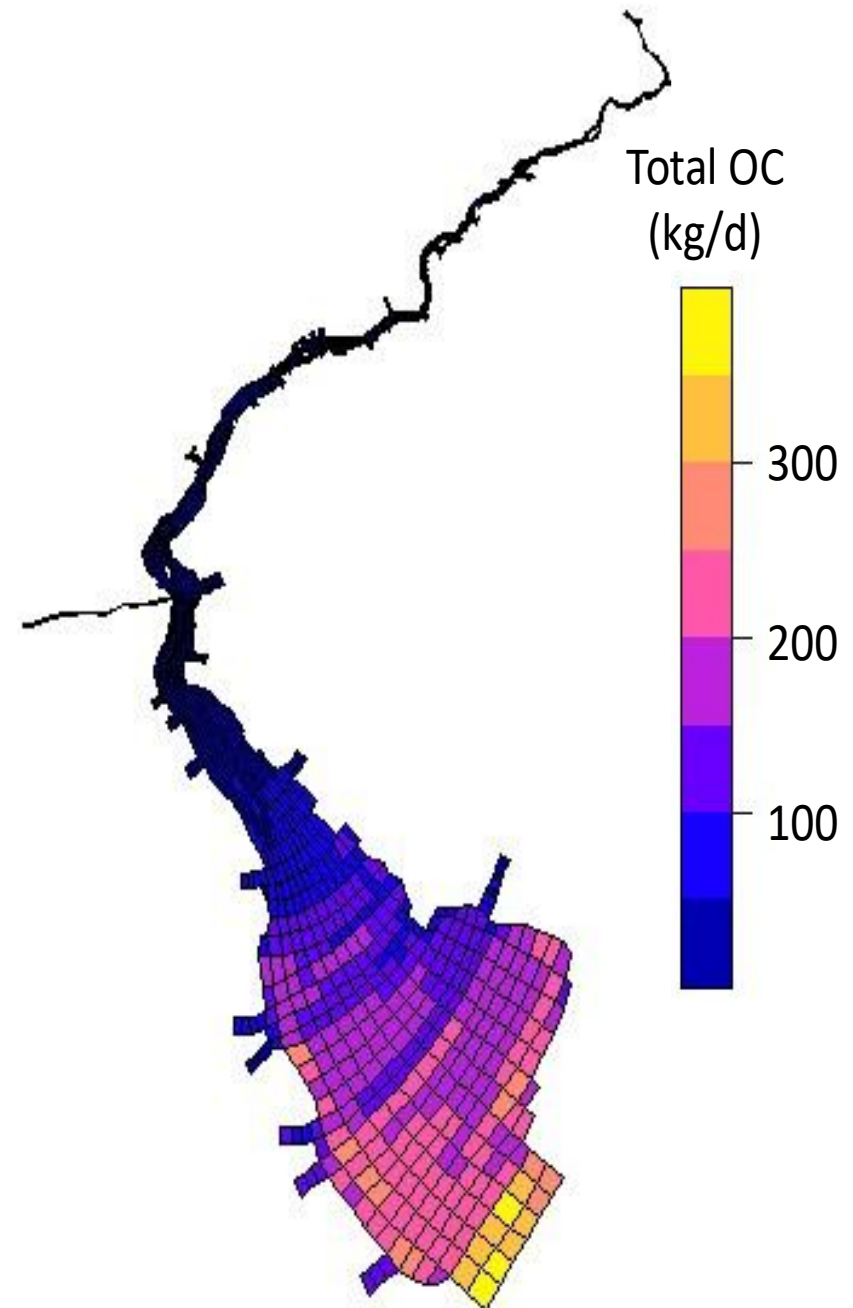
Tidal marshes contribute ~38,000 kg of particulate organic C per day to the DRE!



Similarly, atmospheric deposition accounts for ~35,000 kg POC/d

This is assuming an annual atmospheric deposition rate of TOC is 11.3 g C/m²/yr for Chesapeake Bay Region (Velinsky et al., 1986)

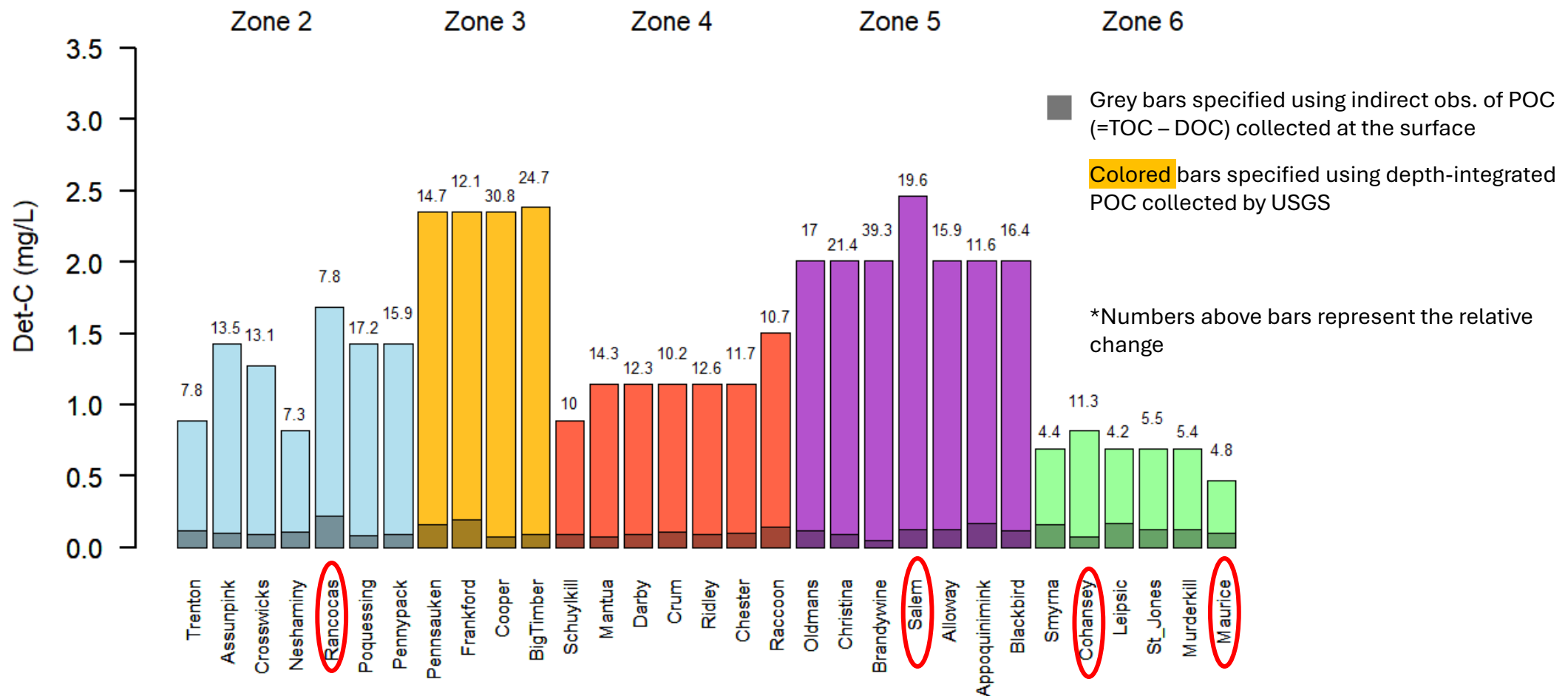
Measurements suggest annual wet and dry deposition are approximately equivalent



Tributaries contribute almost 80,000 kg of particulate organic C every day to the DRE

DR @ Trenton

Mouth of Bay

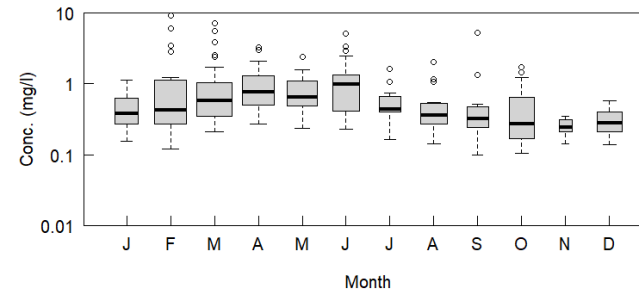
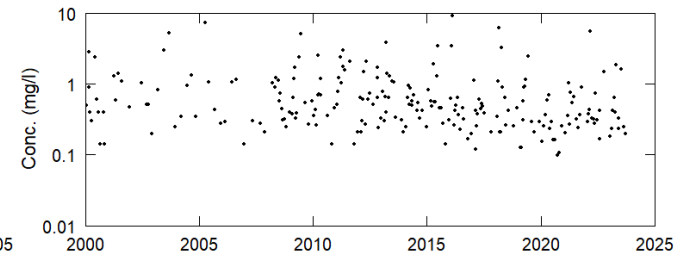
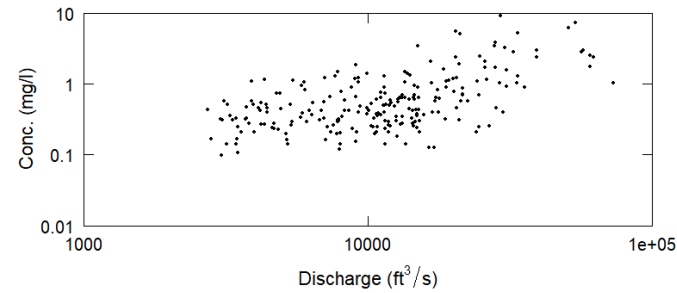


The DR @ Trenton delivers half the entire tributary POC load to the DRE

Approach:

1. Compile a database of POC measurements across the DRE using EPA's WQP and USGS' Water Data API
2. Fit a weighted regression model to predict daily POC loads for the Delaware River at Trenton, NJ and Schuylkill Rivers, which account for nearly 75% of freshwater discharge into the estuary
3. Add POC from sloughed off periphyton using continuous fluorometry data
 - This step was required because field samples are rarely taken after extreme discharge events

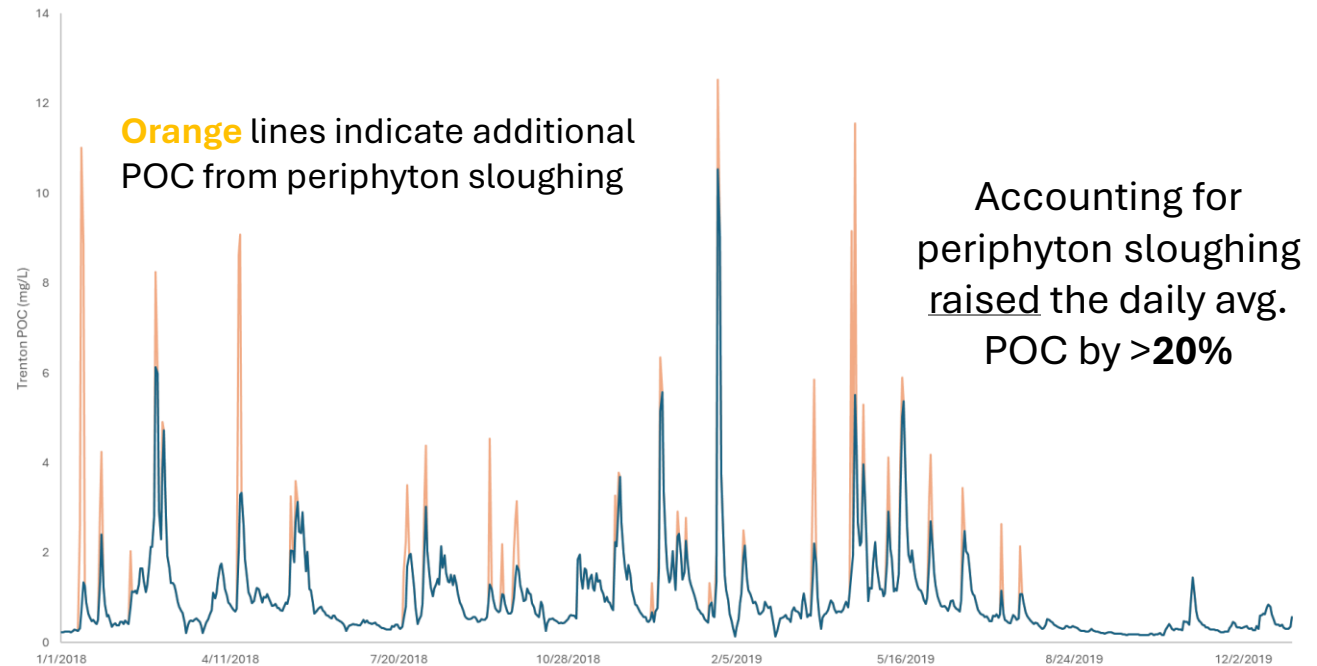
Delaware River @ Trenton



✓ *Flow trend*

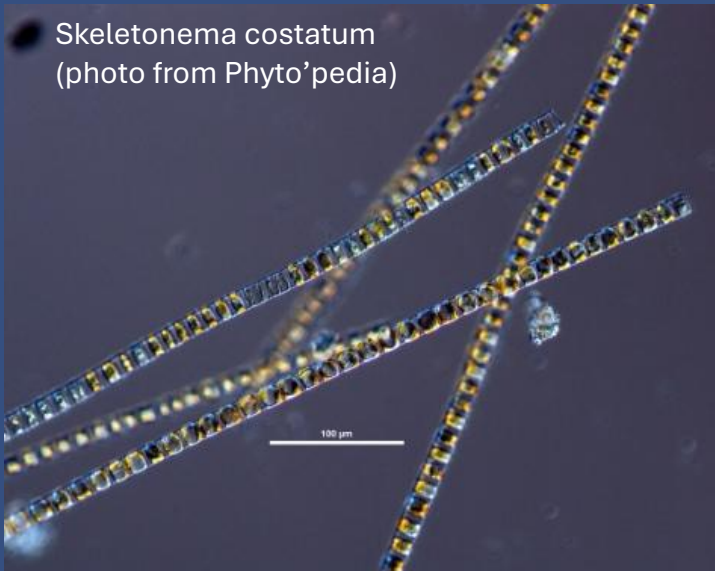
✗ *Long-term trend*

✓ *Seasonal trend*

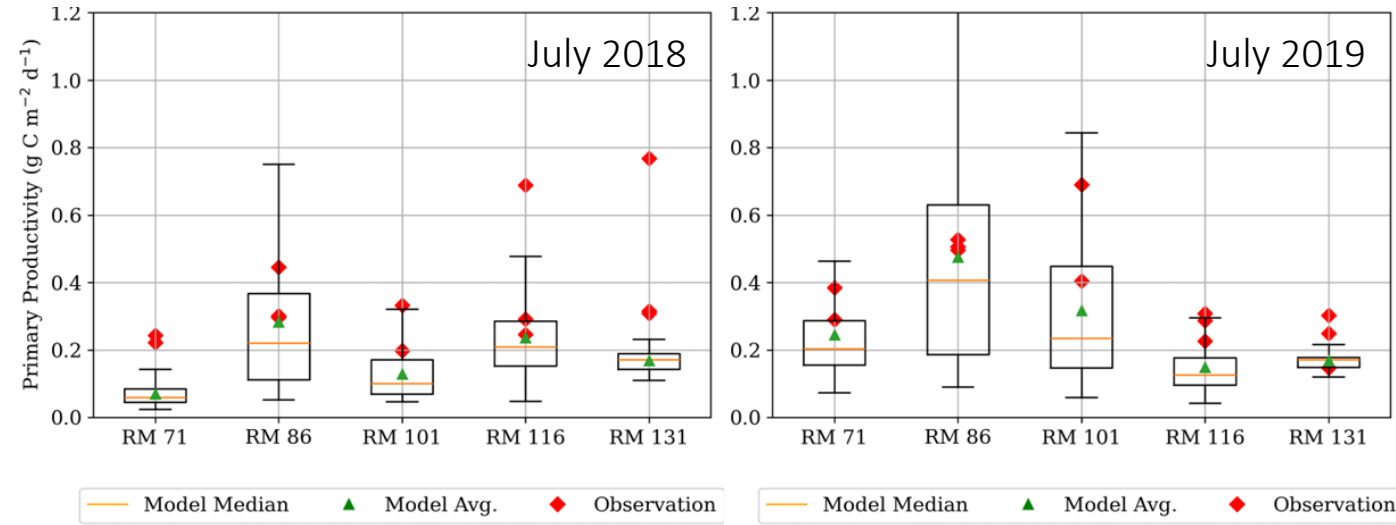


Phytoplankton are the primary source of POC to the DRE (~395,000 kg/d)

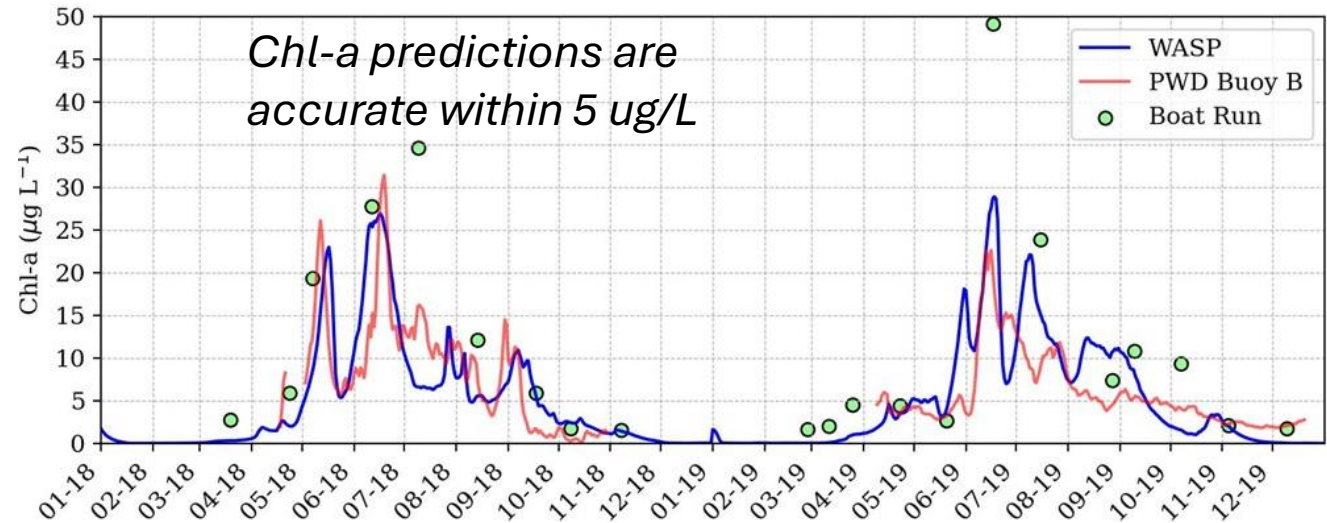
Based on model predictions of winter-marine, summer-marine and summer-fresh phytoplankton bloom dynamics



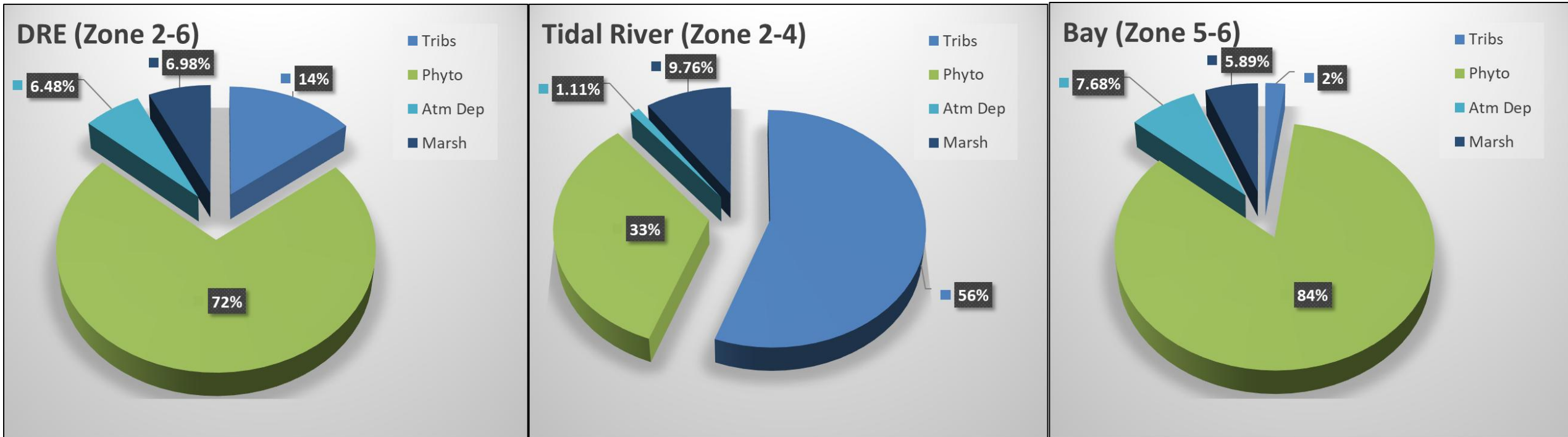
Algal Primary Productivity in the Tidal Delaware River



Simulated and Observed Chl-a at PWD Buoy B, RM 93.5: 2018 to 2019



The origin of estuarine POC varies by region



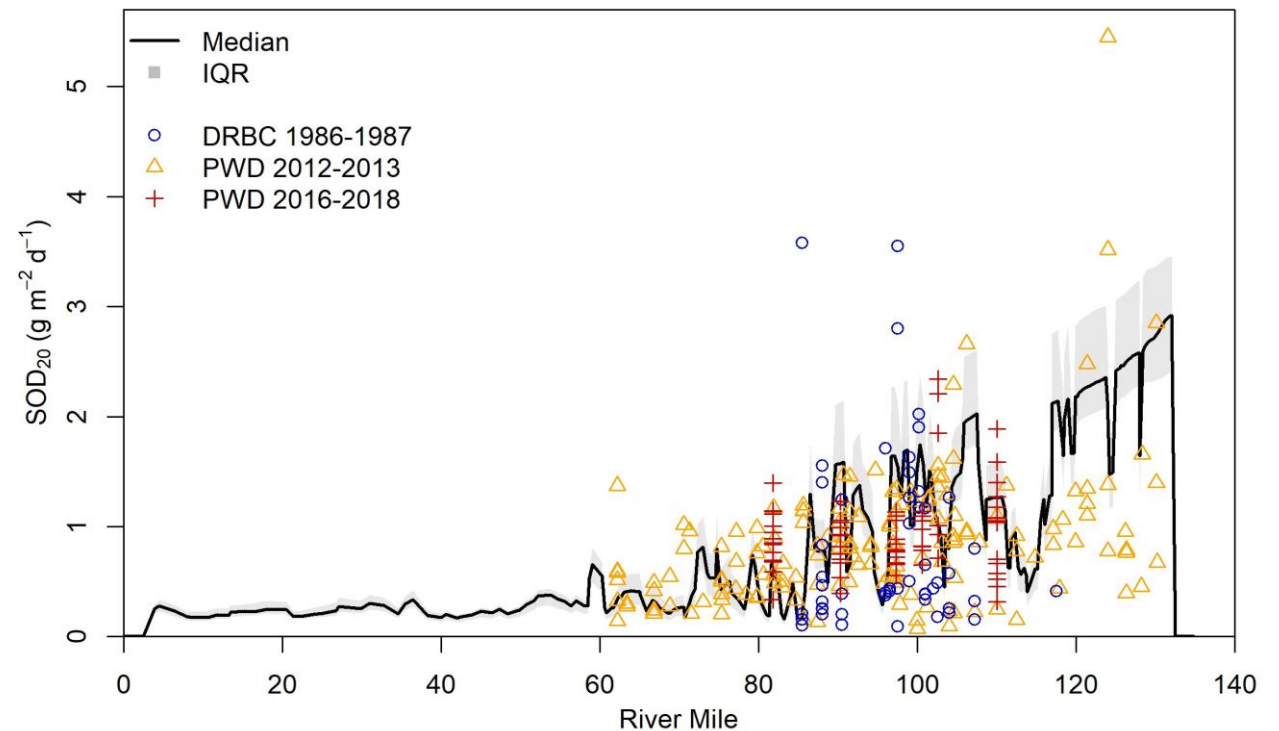
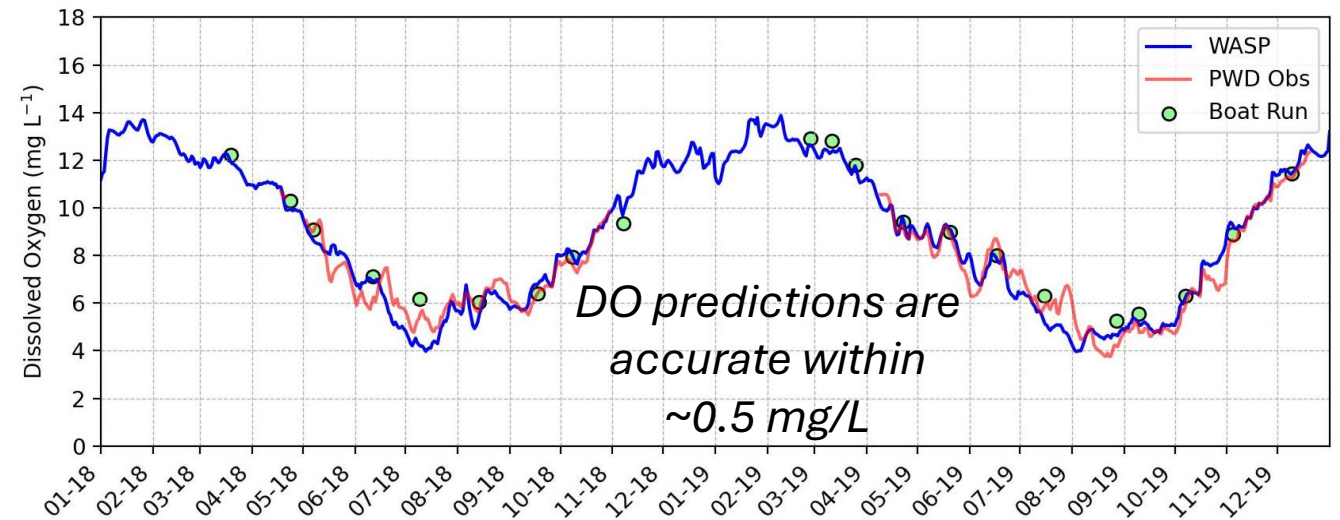
In the bay, most POC is from internal algal production (due to the size of the bay!)

In the tidal river, external production is the primary source of POC

Closing the POC budget for the DRE enabled....

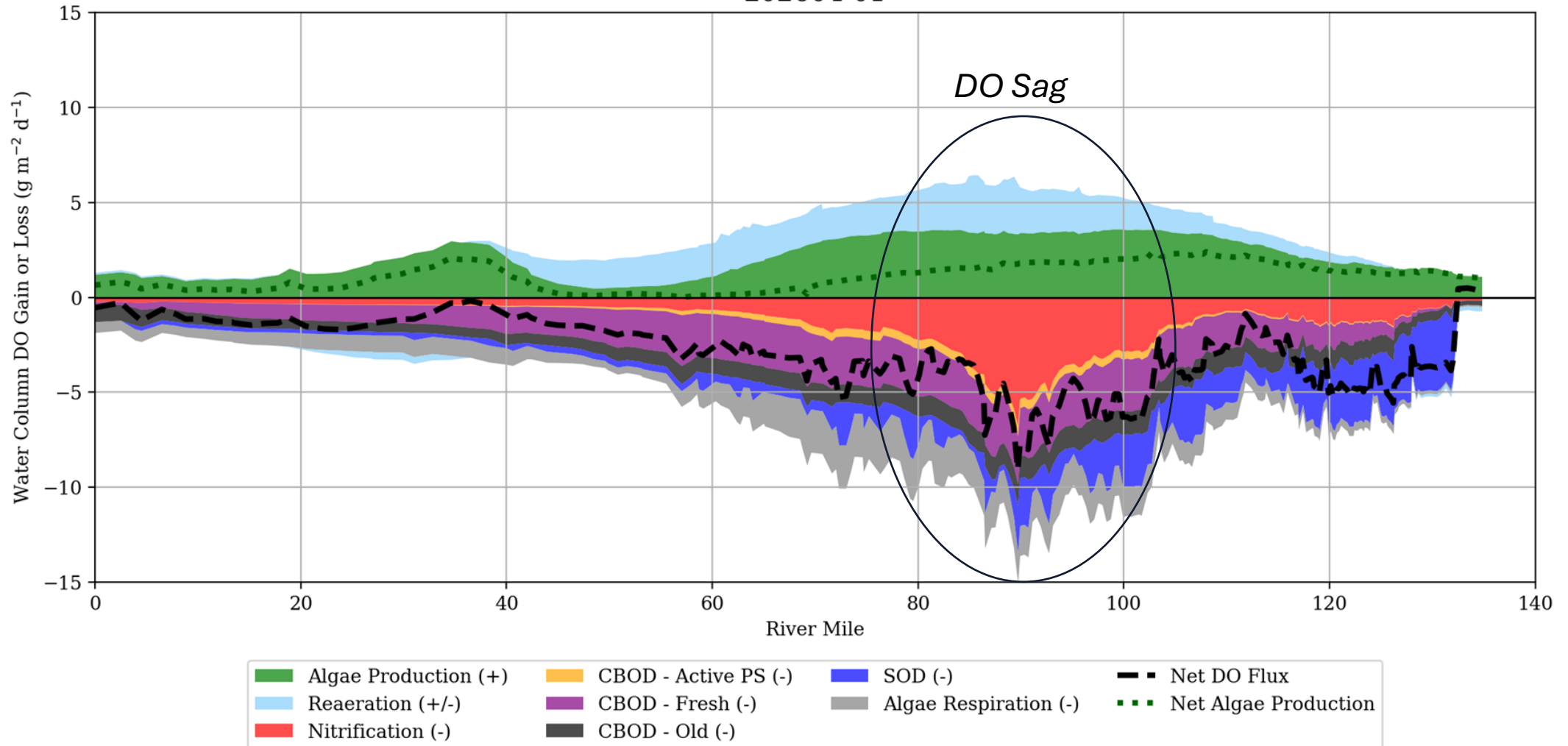
- Better representation of carbonaceous biological oxygen demand of freshly dissolved detritus
- Precise spatiotemporal prediction of sediment oxygen demand and benthic nutrient fluxes
- Enhanced capacity to predict DO load responses to future changes in water quality
- A more scientifically defensible framework for evaluating DO dynamics when implementing the EPA's new DO criteria

Simulated and Observed Dissolved Oxygen at PWD Buoy B, RM 93.5: 2018 to 2019



Natural POC inputs have a significant influence on DO, but the main cause of the sag is nitrification

Simulated DO Gain (+) and Loss (-) from Different Processes, June 2019
202604-01



Stay tuned!

- Technical report to be published late summer/fall
- We are hosting a session at the upcoming AWRA Conference Nov, 2026

Pinelands Research Institute
Science Summit, June 2026
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