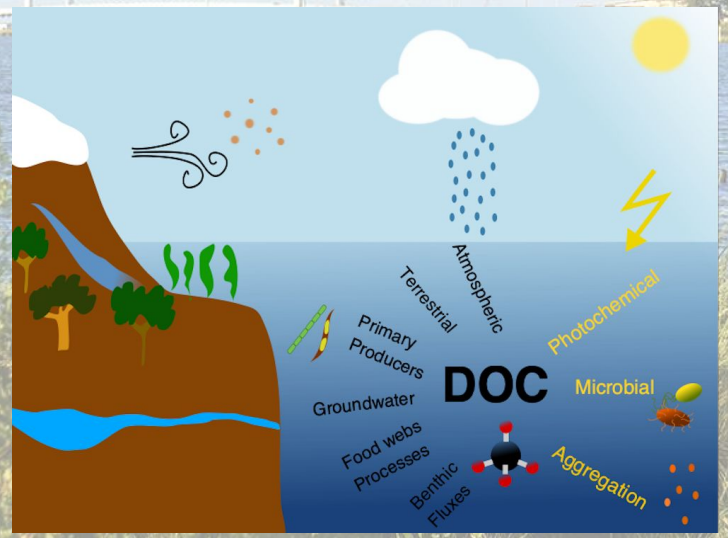
PROJECT WiCCED
WATER in the CHANGING COASTAL ENVIRONMENT of DELAWARE

Assessing sources and factors that impact carbon and nutrient cycles in the Indian River Bay, Delaware

Tianyin Ouyang
CAC Meeting
February 13, 2025



DELAWARE CENTER FOR THE INLAND BAYS
Research. Educate. Restore.

UNIVERSITY OF DELAWARE

Agenda

- Why do we care about the Inland Bay in Delaware?
- What are sources and factors that impact Inland Bay chemistry/ water quality?
- What projects have we done to understand chemical cycles of the Bay and help to solve the water quality problems?
- What did we find based on our preliminary data?
- Future steps & How will our project impact the Inland Bay community?

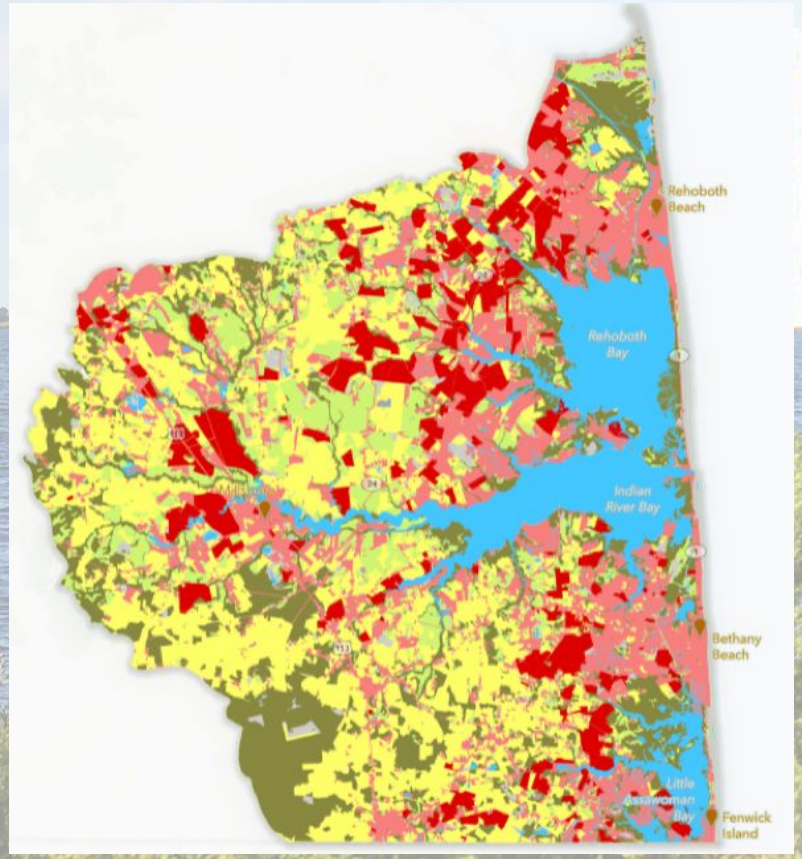
Why do we care about the Inland Bays in Delaware?

The Inland Bay water bodies and its surrounding habitats are valued over $22 billion per year and provide over 20,000 jobs for Delawareans (Kauffman 2016).

Water security challenges (Grade D): 1) unidentified chemical sources, 2) factors that cause depletion of oxygen levels, and 3) consequences triggered via tidal flushes and saltwater intr

What are sources and factors that impact Inland Bay water quality?

Runoffs from lands – fertilizers, plants/ soils, and human wastes.



- 28.9% agricultural, 22.3% developing, and 13.9% forested lands (Walch & McGowan 2023)
- Wastewater Treatment Plants

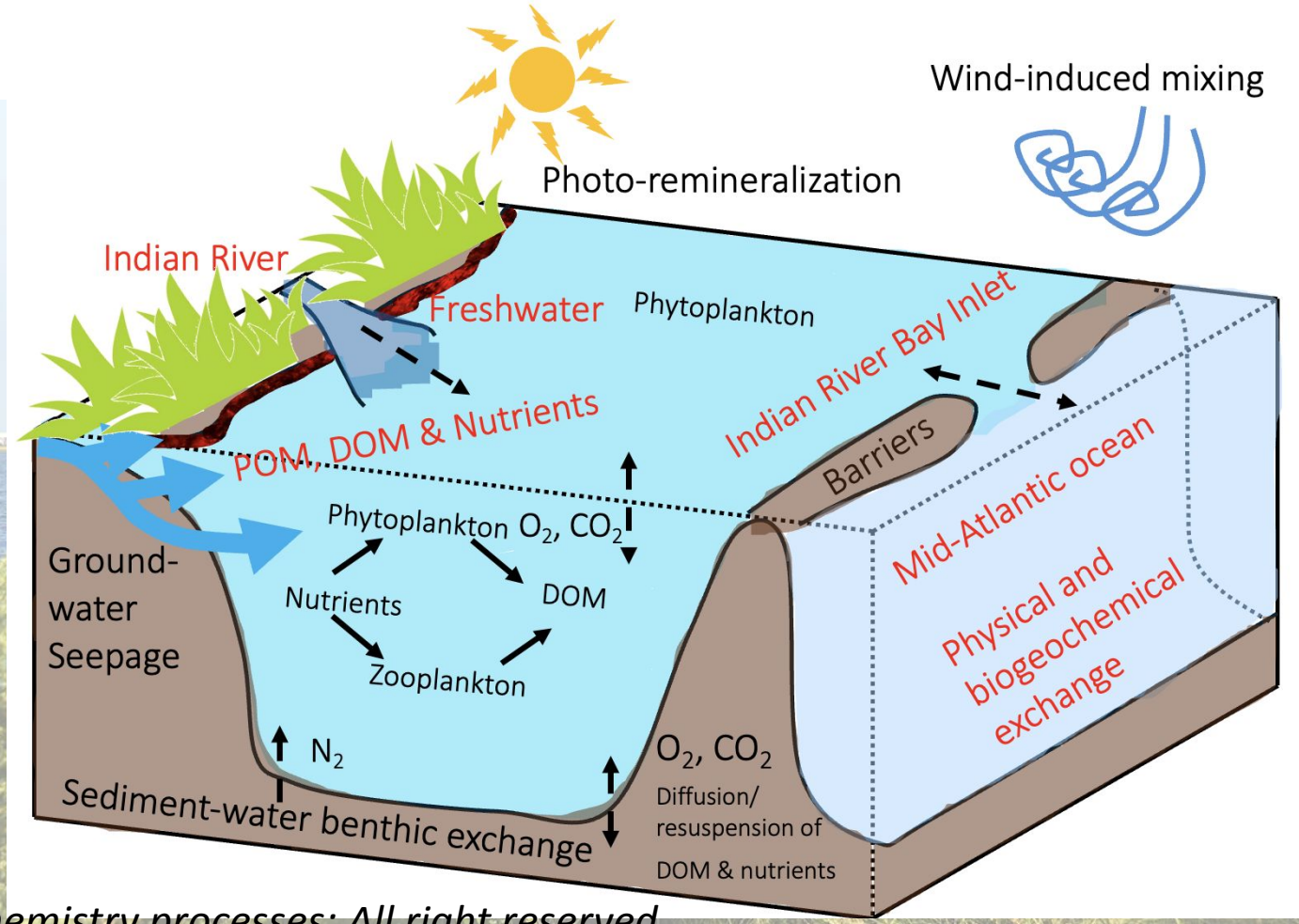
What are sources and factors that impact Inland Bay water quality?

Runoffs from lands – fertilizers, plants/ soils, and human wastes.

- Study sites: the Love Creek and its tributaries
- Septic and wastewater are major pollution sources

What are sources and factors that impact Inland Bay water quality?

- Microbes and algae from rivers and coastal oceans
- light & temperature
- Storms
- wind-induced mixing



Biogeochemistry processes; All right reserved.

What are sources and factors that impact Inland Bay water quality?

Groundwater inputs to the Inland Bays: accounts for 70-80% of freshwater inputs, large amounts of accumulated nutrients and labile organic carbons

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Contents lists available at ScienceDirect

Journal of Hydrology

journal homepage: www.elsevier.com/locate/jhydrol

Hydrogeologic controls on groundwater discharge and nitrogen loads in a coastal watershed

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- Study sites: Holts Landing State Park
- Hydrological model that emphasizes the importance of groundwater

What are sources and factors that impact Inland Bay water quality?

All these can induce eutrophication (or algae bloom), depletion of oxygen (hypoxia), and related water quality problems (impaired fish pools, decreased ecosystem diversity, etc.)

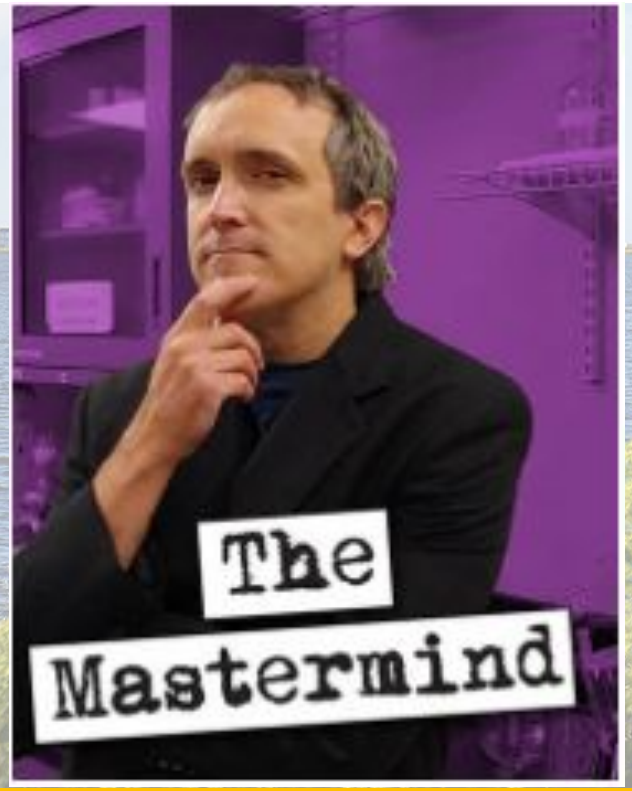
Eutrophication & toxic algae blooms

Dead zones

Crab Hypoxic Migration

What projects have we done?

The Wozniak Marine Organic Geochemistry Lab (WozMOG)



PI of the project

Dr. Andrew S. Wozniak

Assistant professor,
University of Delaware,
School of Marine
Science & Policy

Study Sites: the Indian River Bay

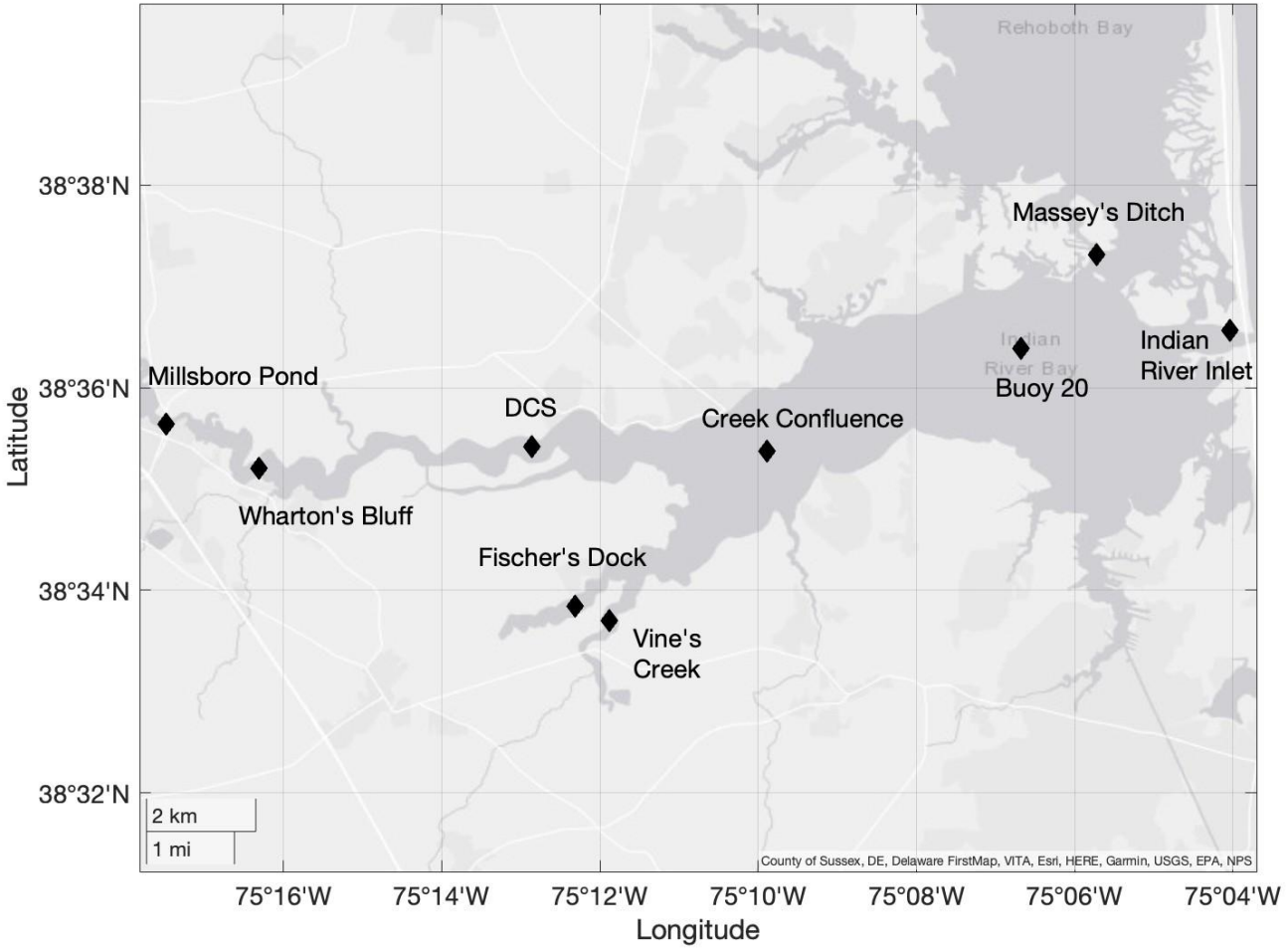
Goals:

1) investigate sources of nutrients and organic carbons
2) Relationship between oxygen and organic carbons
3) Study kinds of nutrients and organic carbons exported via groundwater
4) Model biogeochemistry processes

Funding sources:

NSF EPSCOR Award# OIA – 1757353 & UD doctoral fellowship for excellence

What projects have we done?



From July 2021 to May 2023

We collected water samples monthly at

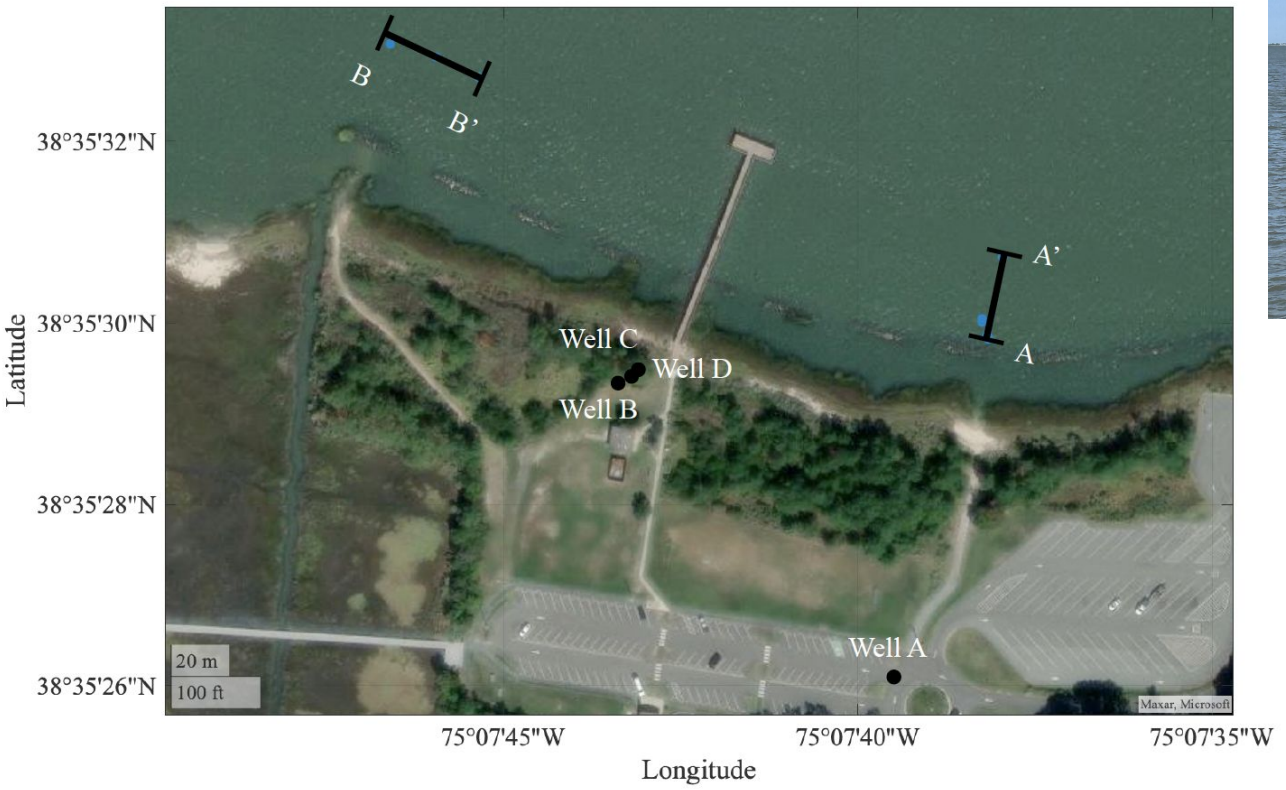
9 locations in the Indian River Bay

What projects have we done?

Thanks Zach, faculty of CIB, for driving the sampling boat

What projects have we done?

Holts Landing State Park

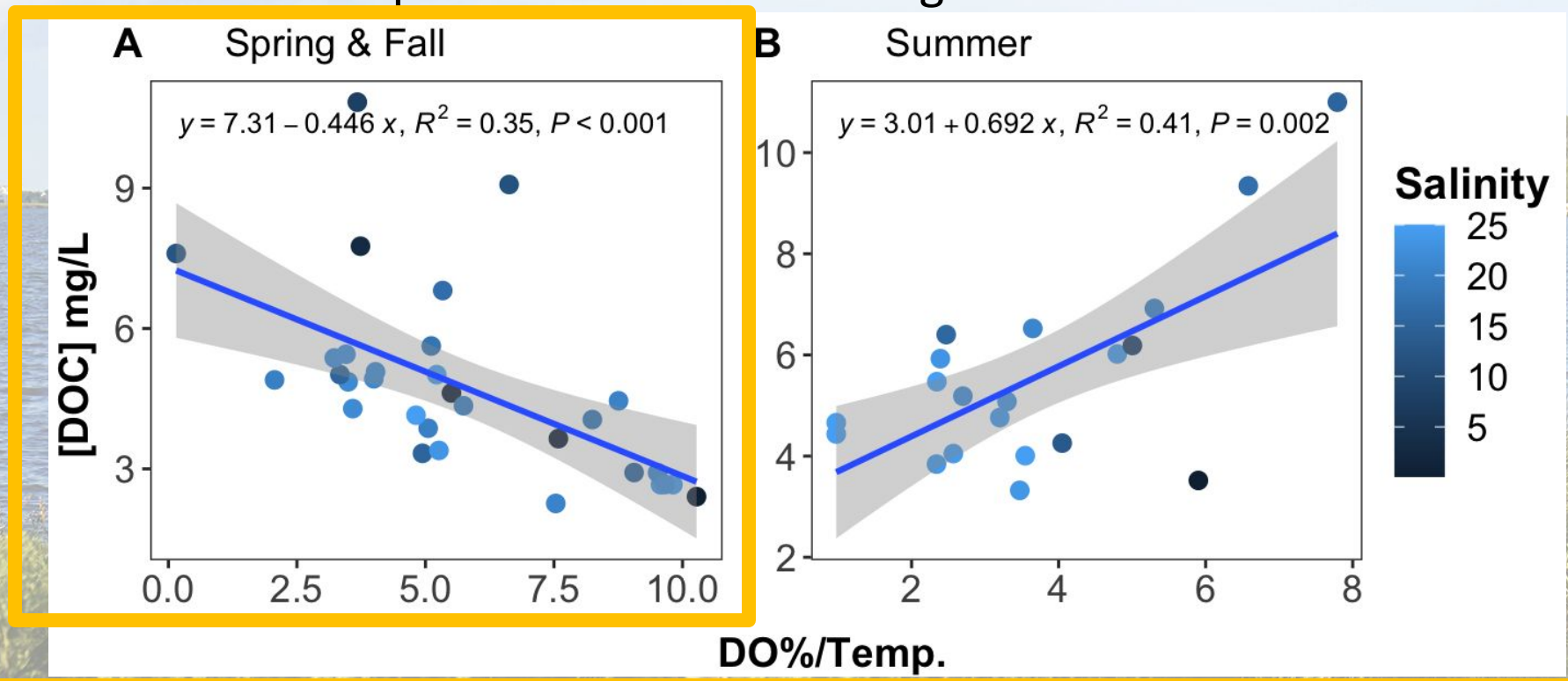


In August 2023

We collected submarine groundwater along the salinity transect in muddy and sandy sites

What did we find based on the preliminary data?

- Temperature (more nutrients in winter & more organic carbons in spring and summer) and salinity control the Bay chemicals
- Relationships between DO% and organic carbon differ across various seasons

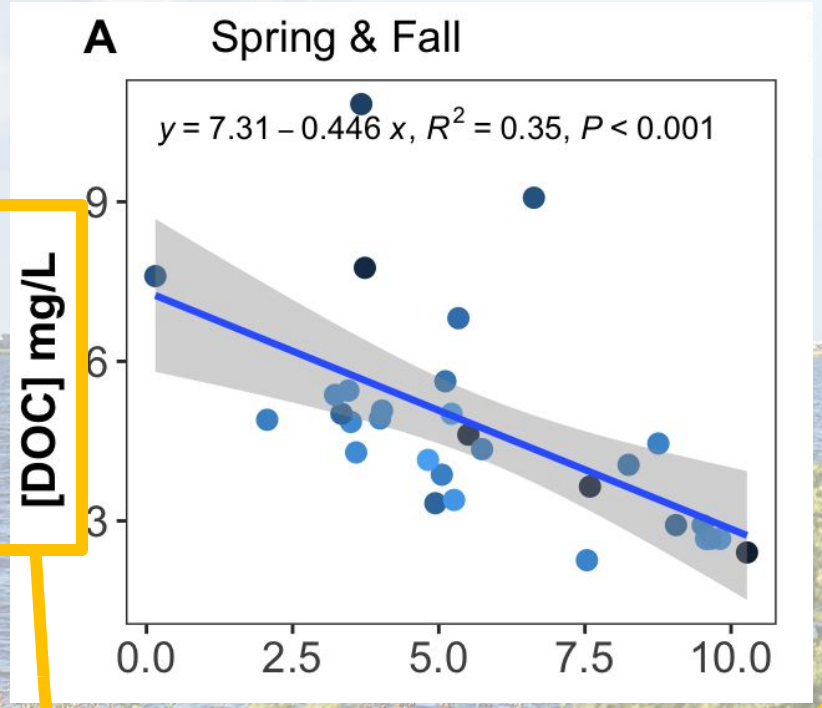


Biological activities matter!

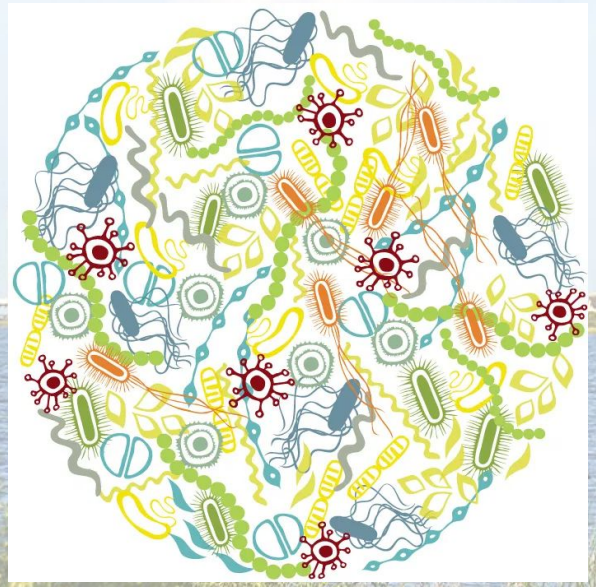
Bowen et al. 2024 - human wastes can trigger heterotrophic activities

What did we find based on the preliminary data?

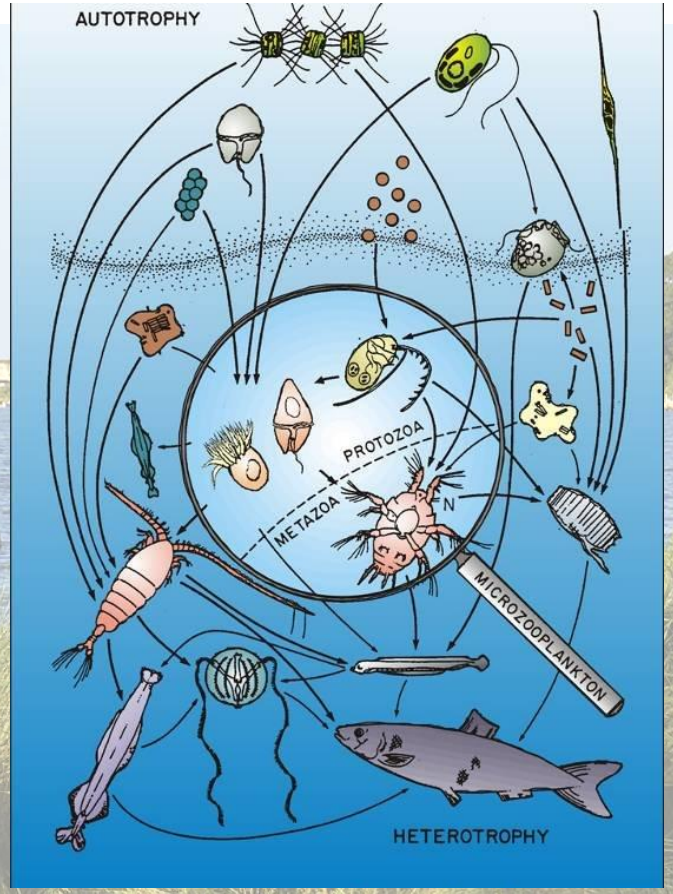
Optimum temperature



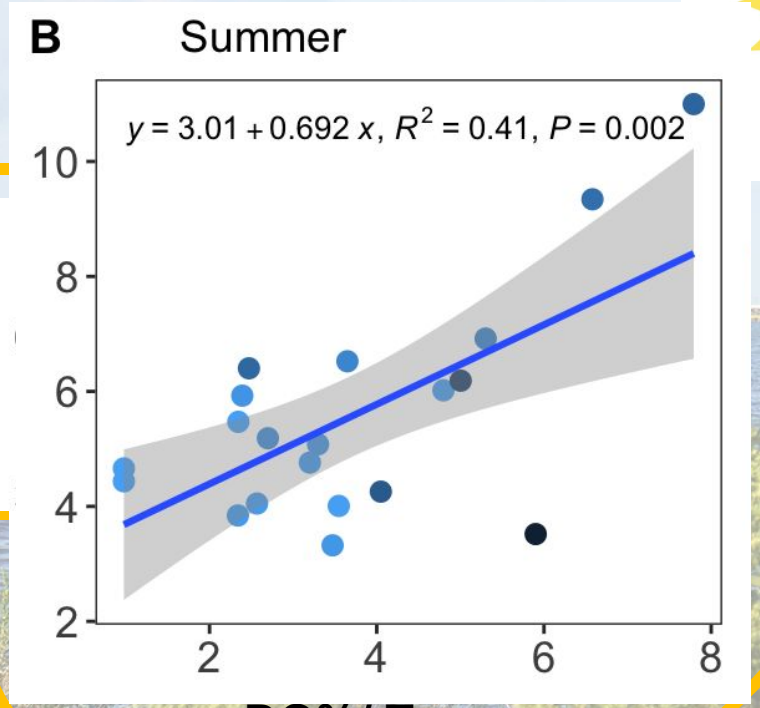
DO%/ Temp.

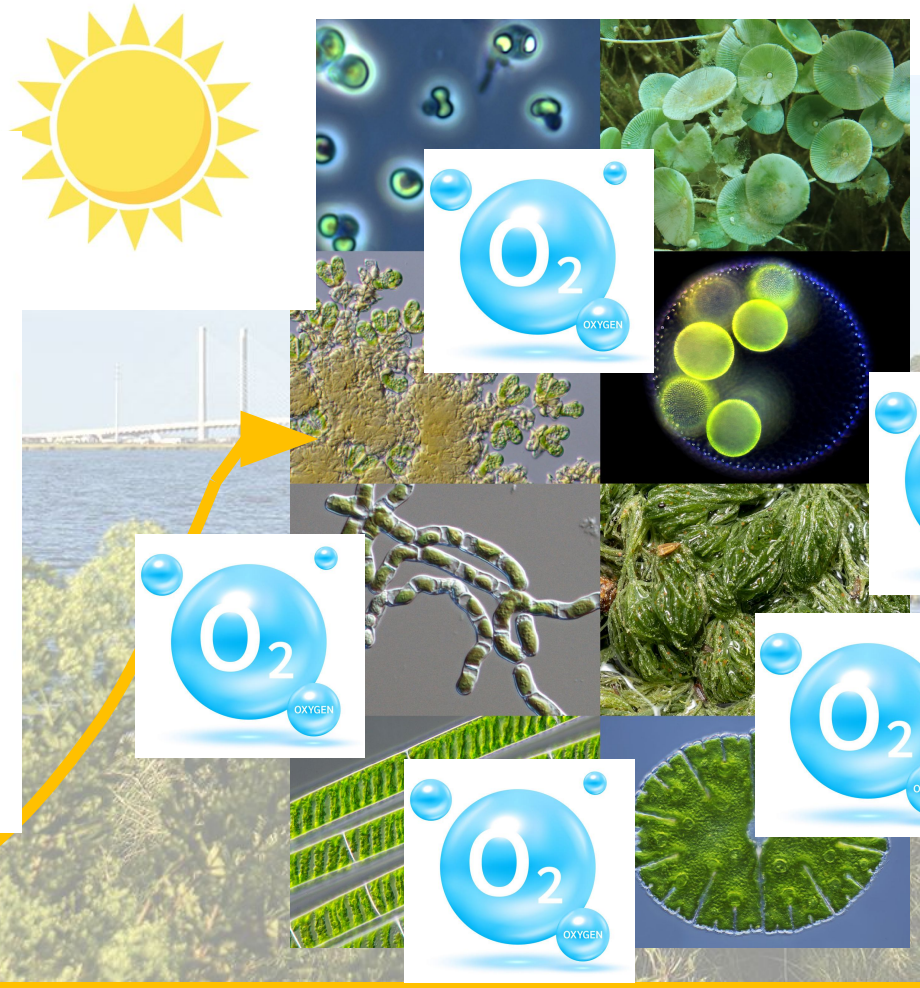


Microbes (i.e., bacteria) or derivatives from heterotrophic activities



What did we find based on the preliminary data?

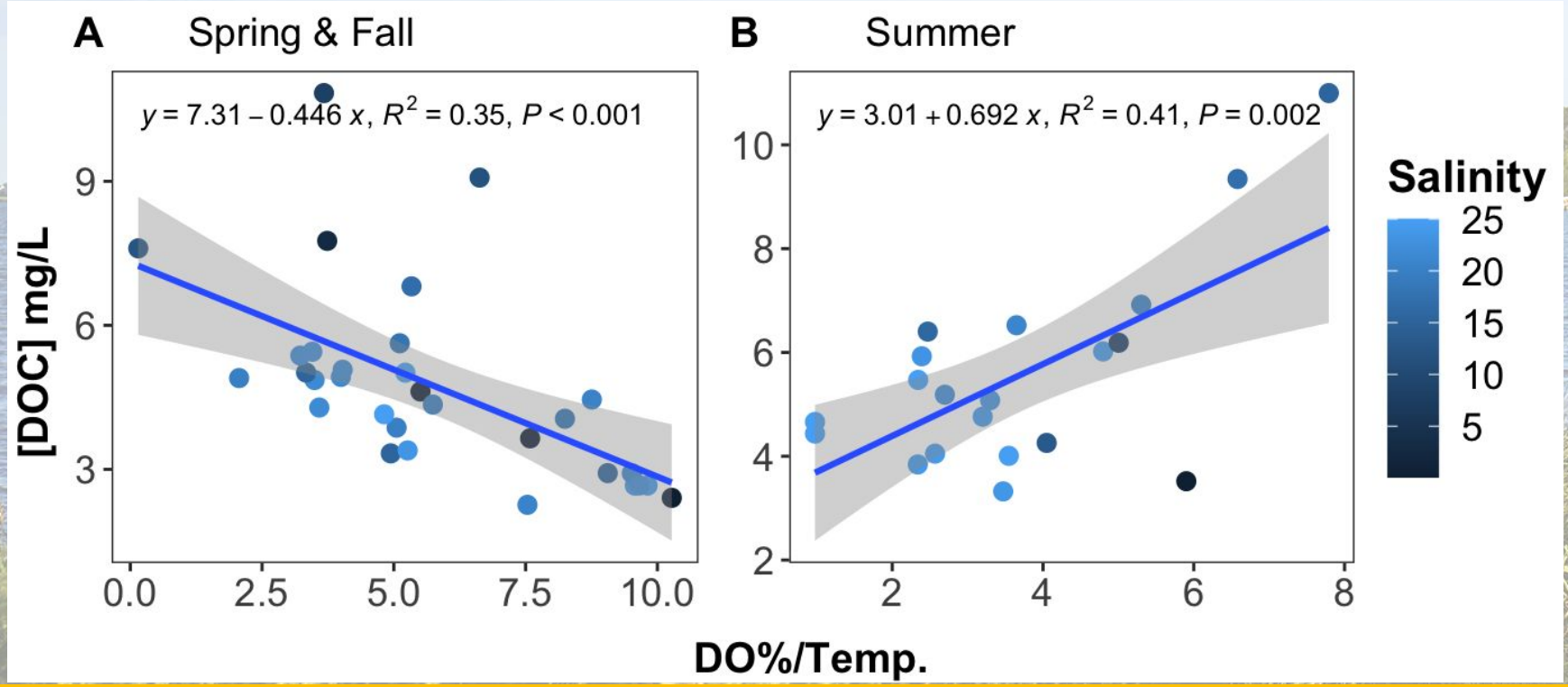




- Sufficient nutrients & light – dominated by phytoplankton species
- Primary production – yielding oxygens

What did we find based on the preliminary data?

- Temperature (more nutrients in winter & more organic carbons in spring and summer) and salinity control the Bay chemicals
- Relationships between DO% and organic carbon differ across various seasons

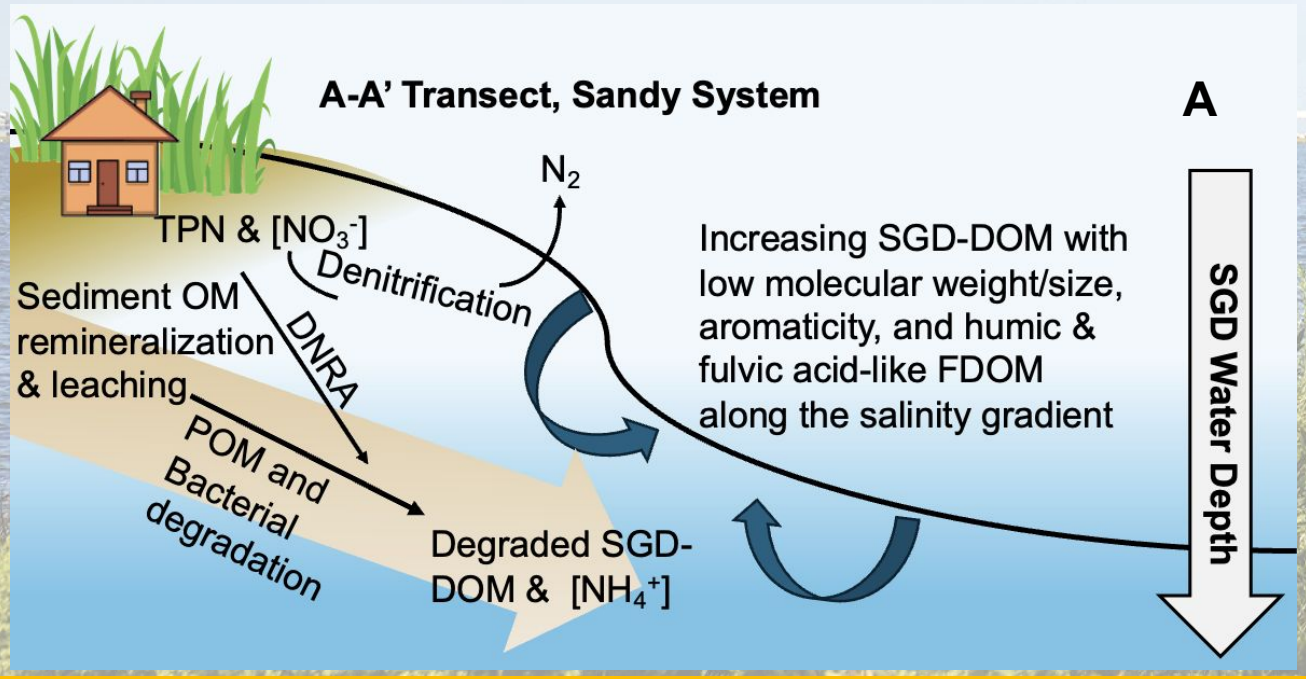


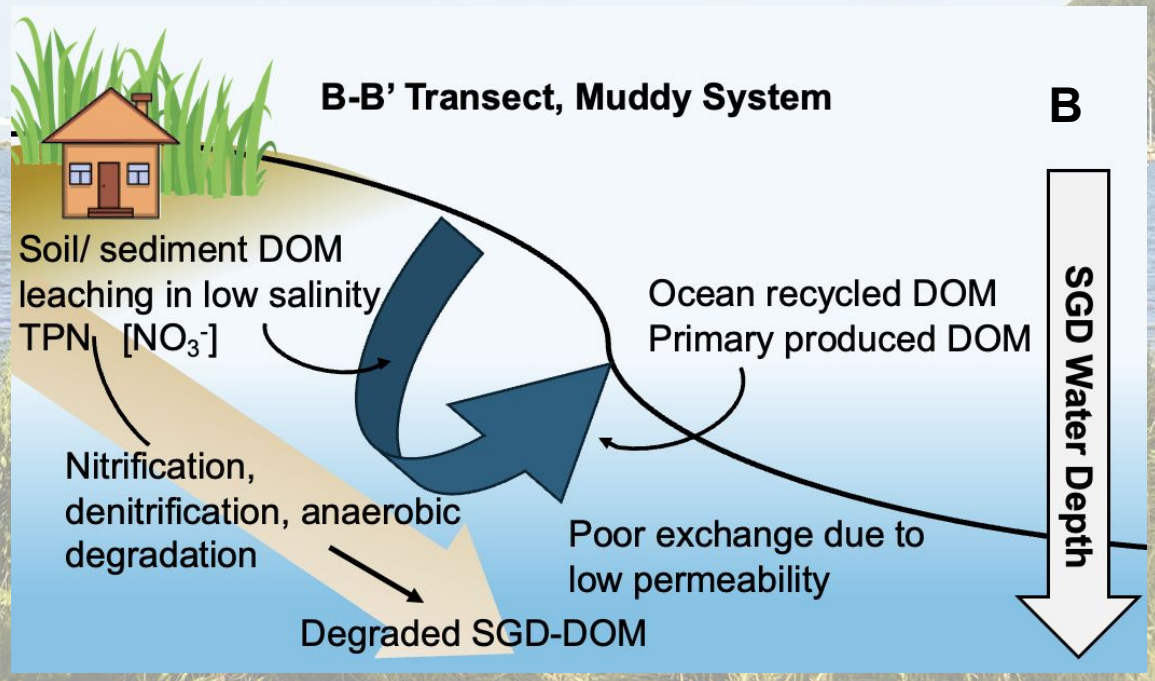
Biological activities matter!

Bowen et al. 2024 - human wastes can trigger heterotrophic activities

What did we find based on the preliminary data?

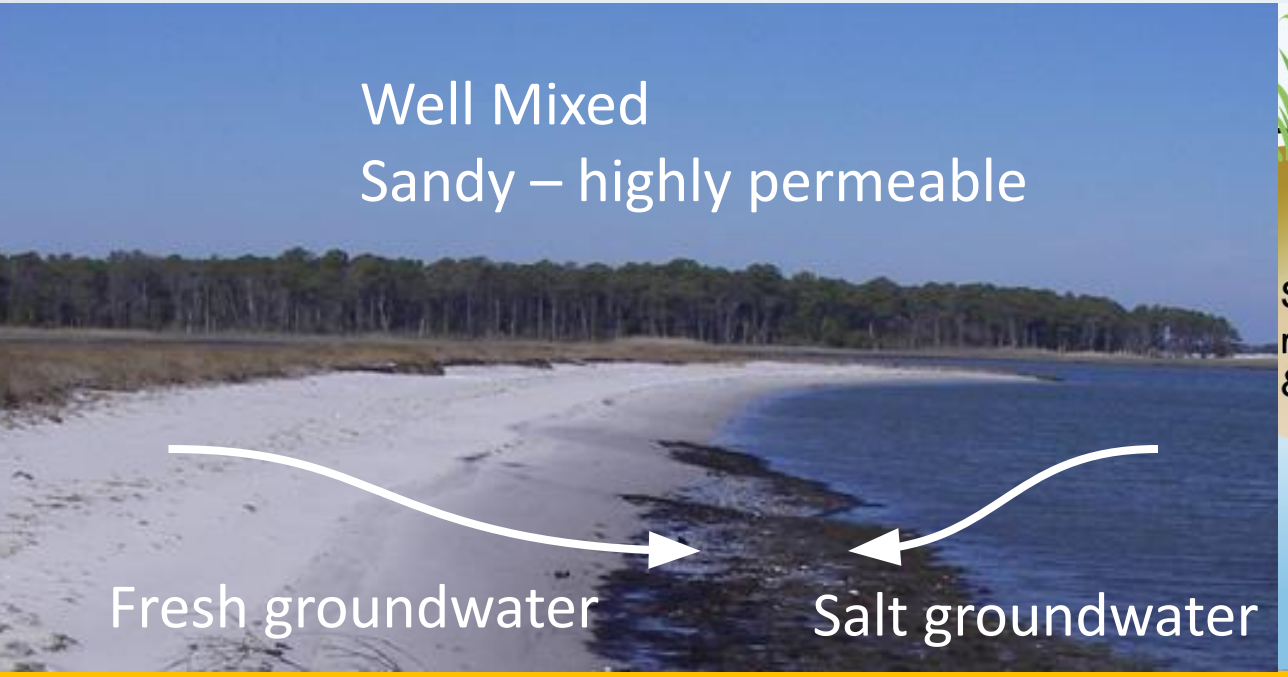
Wetland matters in the context of the biogeochemistry of submarine groundwater discharge!

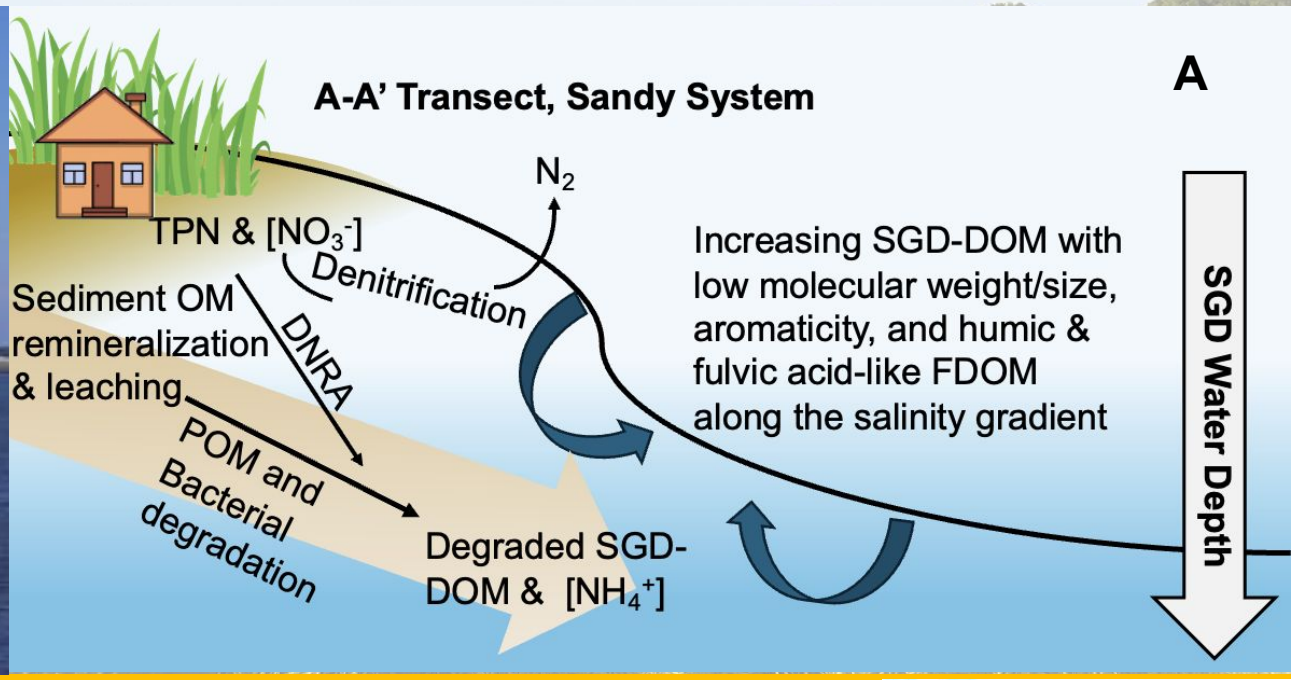




What did we find based on the preliminary data?

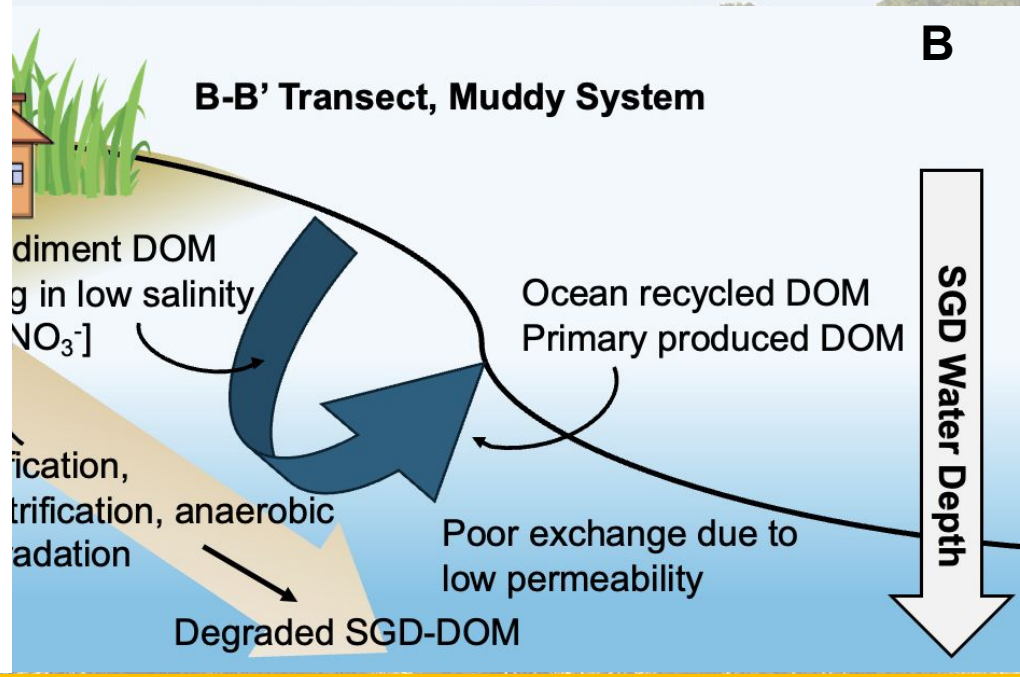
Outcomes from well-mixed sandy areas: yummy organics, soil derivatives, nutrients & nitrogen gas



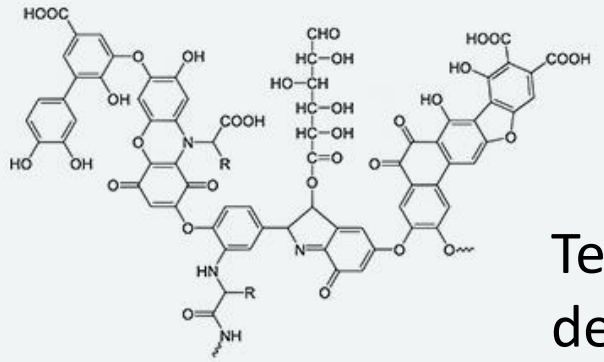


What did we find based on the preliminary data?

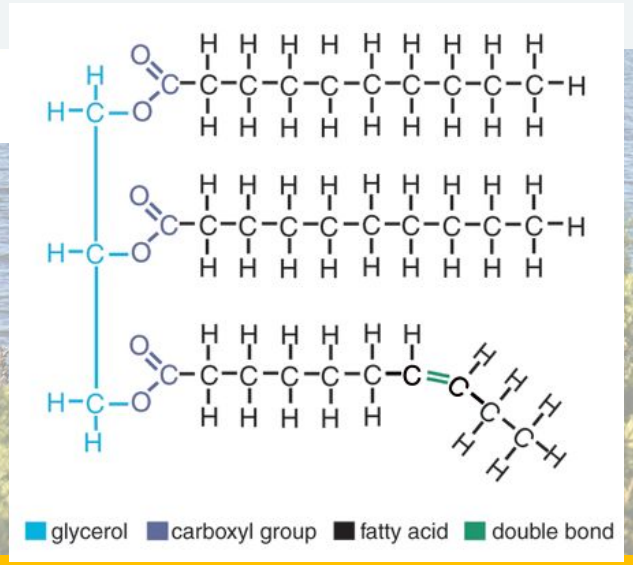
- Deep mixing
- Surface outcomes: recycled bay waters through bay sediments & primary productions



Future Steps – analyze samples at molecular levels!



Terrestrial derivatives



Biological derivatives

FTICR MS Instrument at Florida State University

How will our project impact the community?

- Contributing valuable data to guide the establishment of shellfish farms (i.e., oysters)
- Helping to maintain habitat health and water sources redemption efforts
- Follow NSF Track and threat III of Project WiCCED, support the development of Delaware water management plans
- Model inputs for estuarine and coastal water studies
- Provide insight about the variability and mobility of chemicals in response to climate change and human activities

Thank You and Any Questions?

References

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