Water Quality Monitoring Program in the Ipswich and Parker River Watersheds

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Plum Islan ems LTER

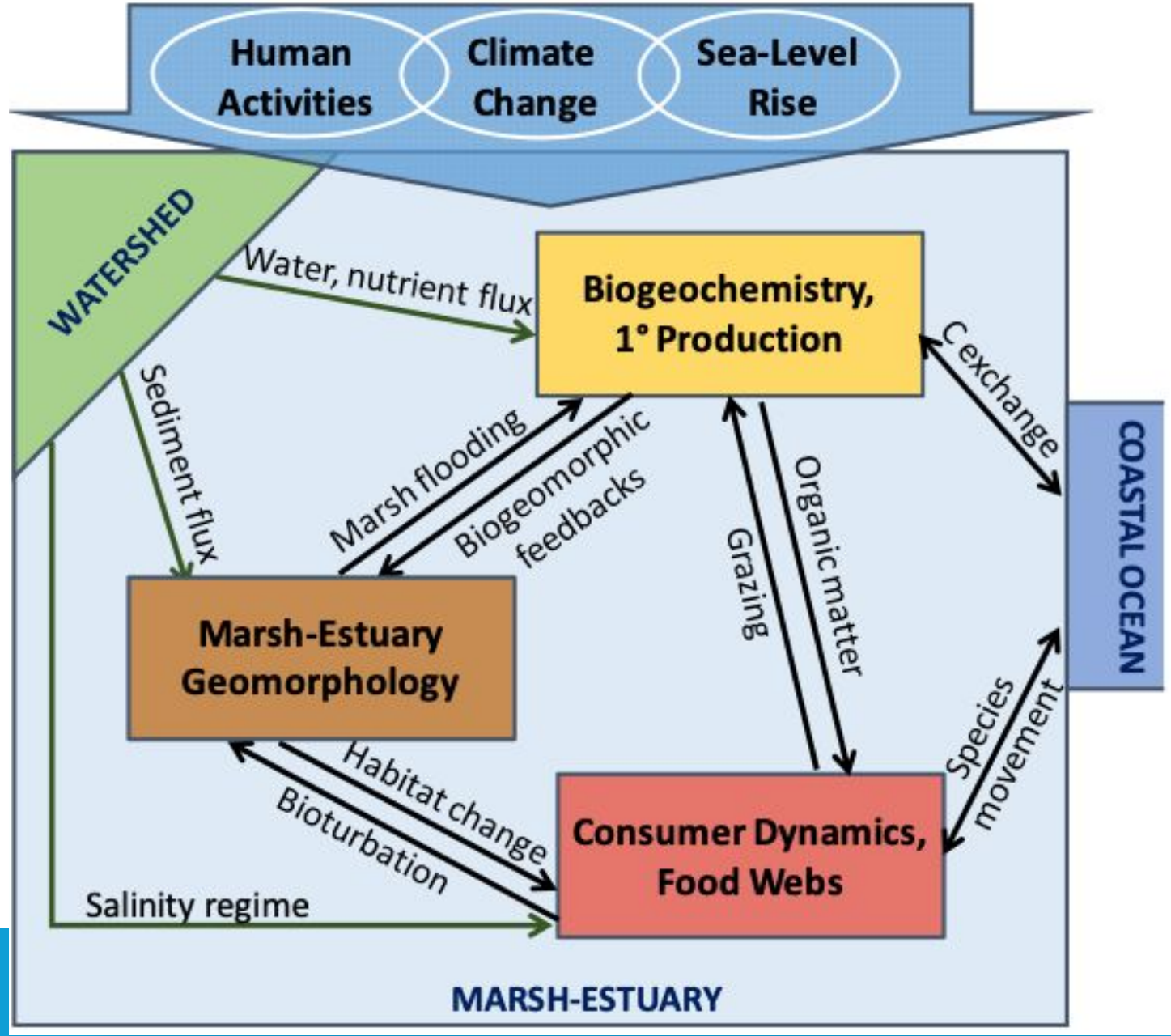
University of New Hampshire

Plum Island Ecosystems Long Term Ecological Research

NSF

Overview of Plum Island Ecosystems LTER

- Established in 1998 with a mission to predict long-term responses in coupled land-marsh-estuary-ocean systems
- Key drivers: climate change, sea-level rise, and human activities
- Emphasis on integrated monitoring across spatial scales



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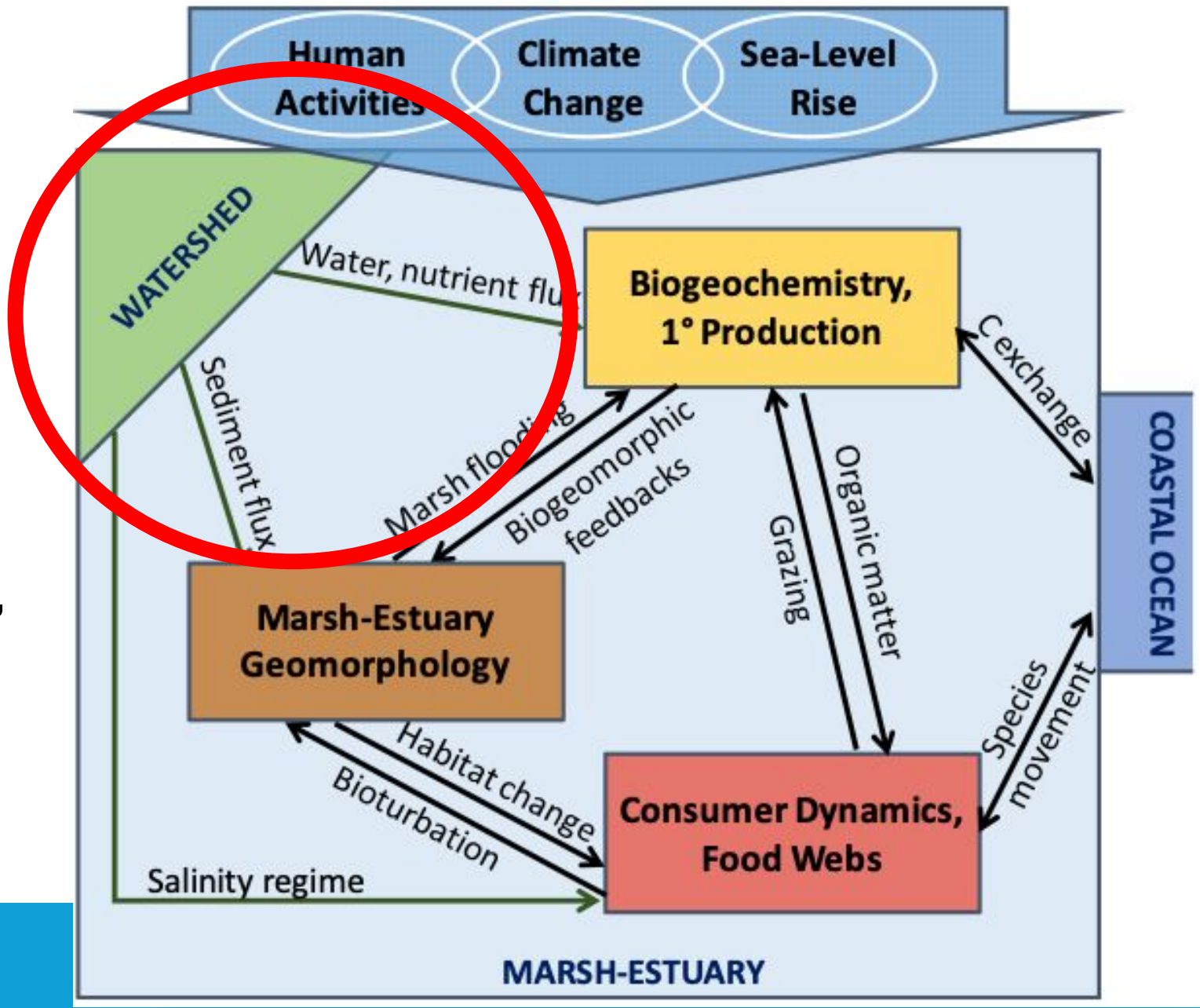
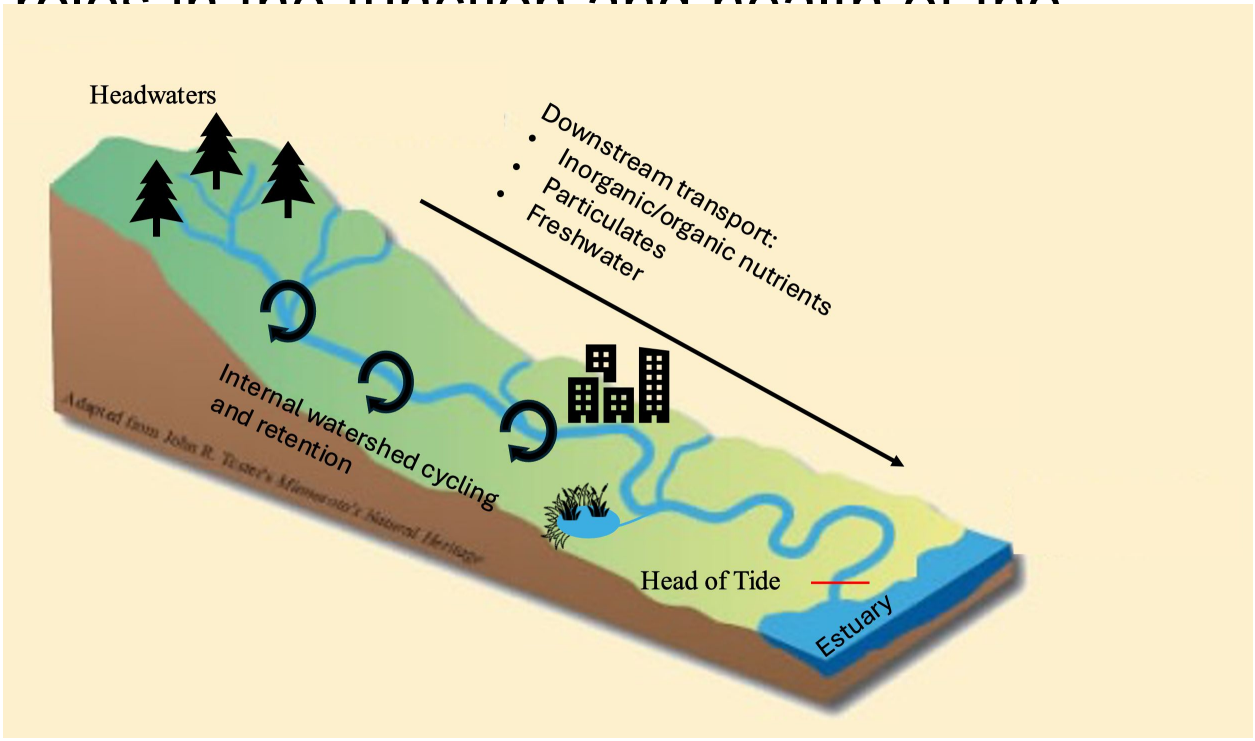


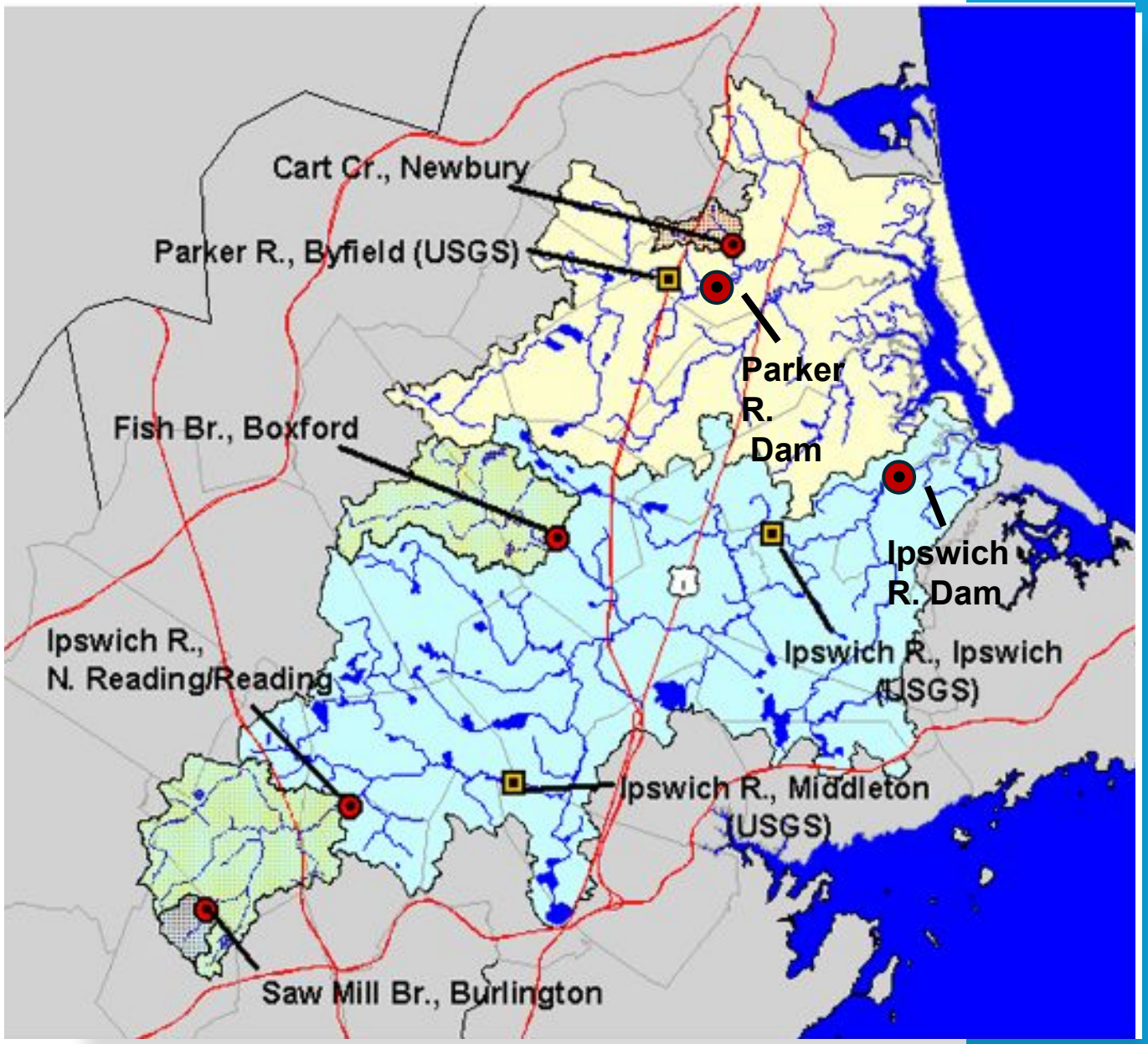
Research Motivation & Objectives

- **Motivation:** To understand the impact of climate change, sea-level rise, and land-use on freshwater biogeochemistry
- **Key linking question:** How are watershed inputs and geomorphic changes influencing nutrient cycling and organic matter fate?
  - What we measure: NO3, NH4, Cl, SO4, PO4, Si, DOC, DON, TDN, TDP, TSS, POC/PON, fDOM
- **Why:** all these factors play important roles in the function and health of the estuary
  - Macro nutrients (N/P) influence primary production
  - Silica influence algal production and food webs
  - TSS is critical for a marsh to keep pace with sea level rise
  - DOC exports impact the browning of coastal waters



Study Area & Watersheds

- Location: North shore of MA; focuses on Ipswich and Parker River watersheds
- Description of site diversity: Two dam/mouth sites vs. three headwater sites
- Land-use differences affecting water quality



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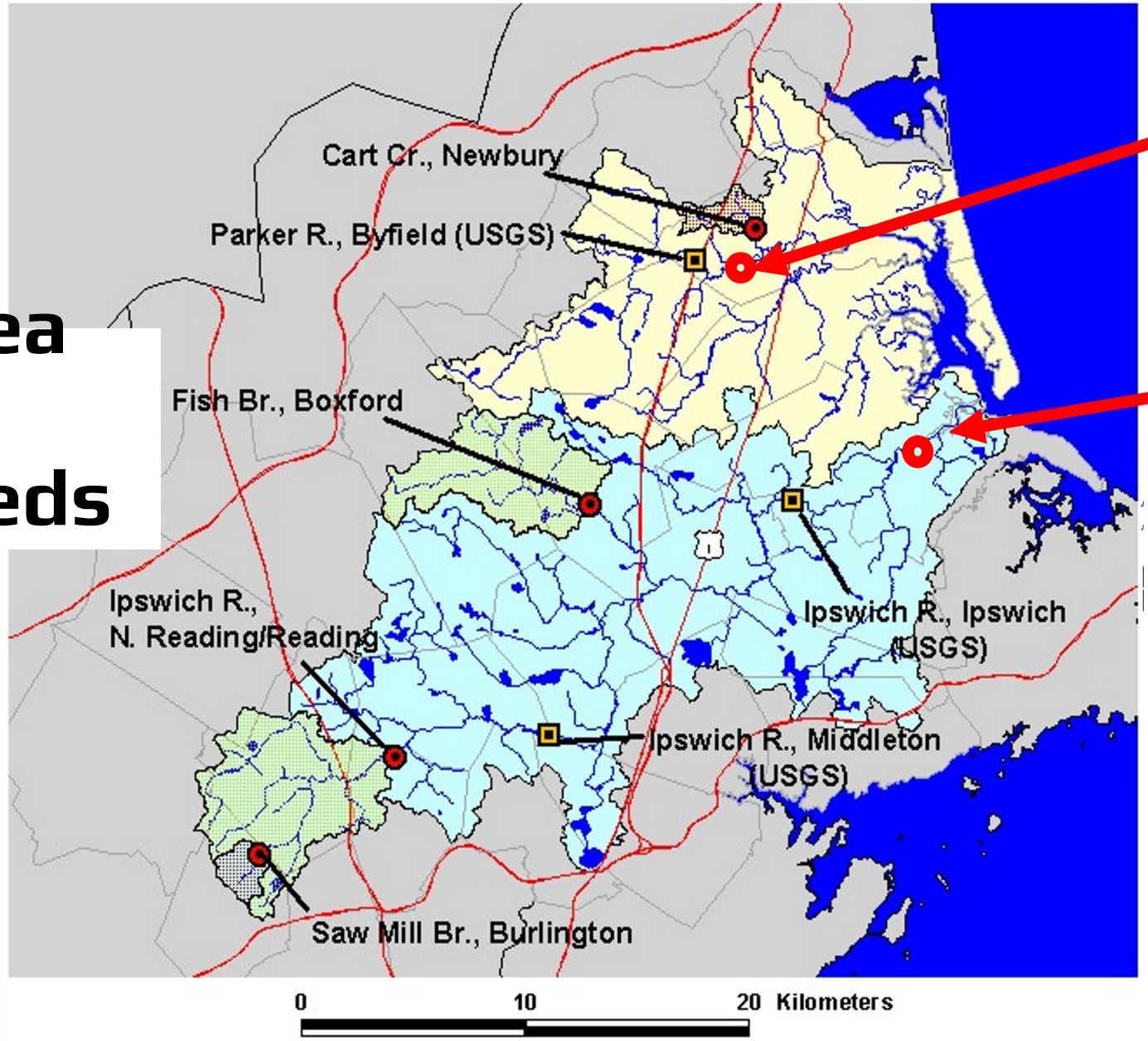
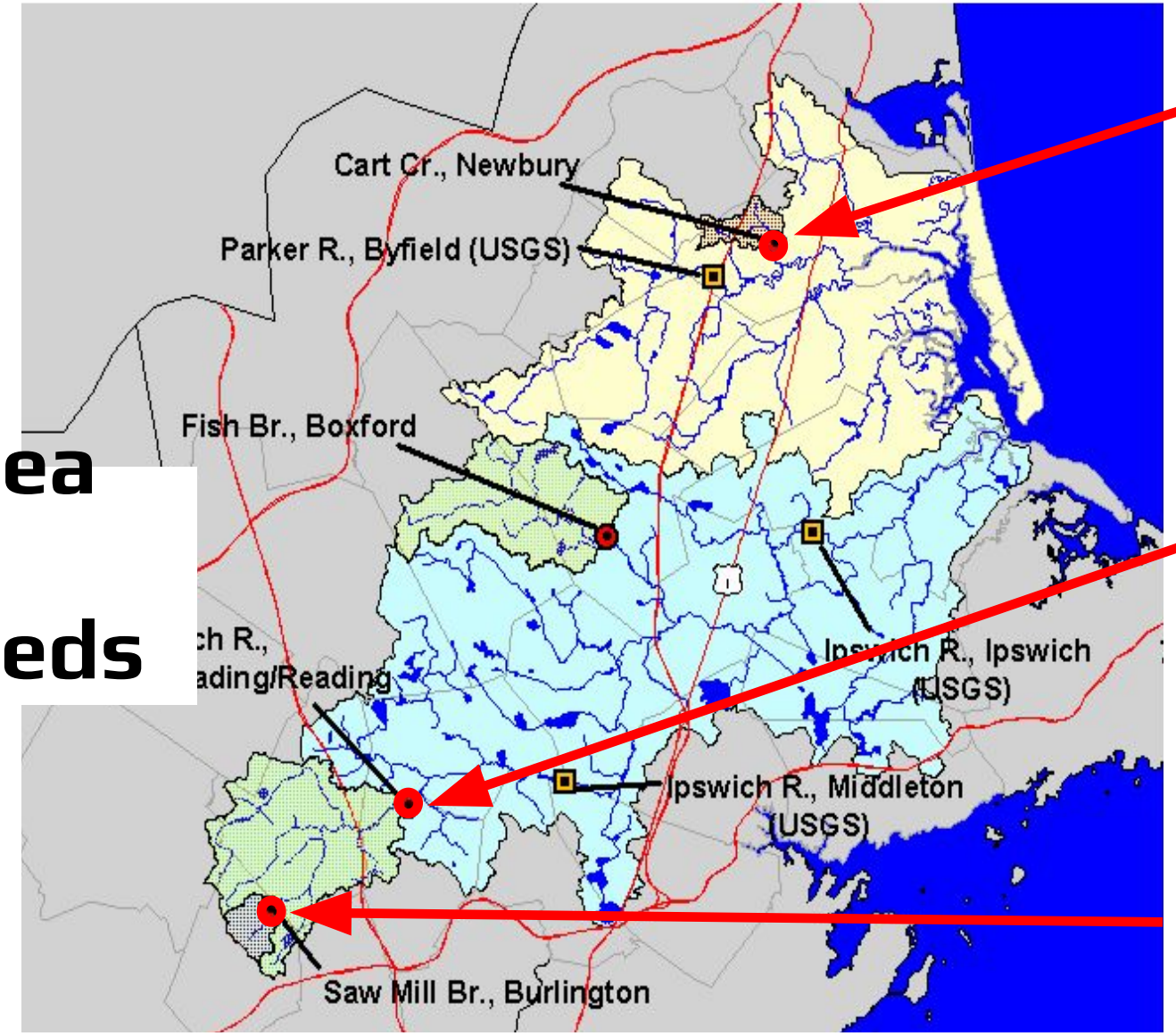


Parker Dam

Ipswich Dam

Study Area & Watersheds



Forested (2001)

Wetland (2005)

Suburban (2001)

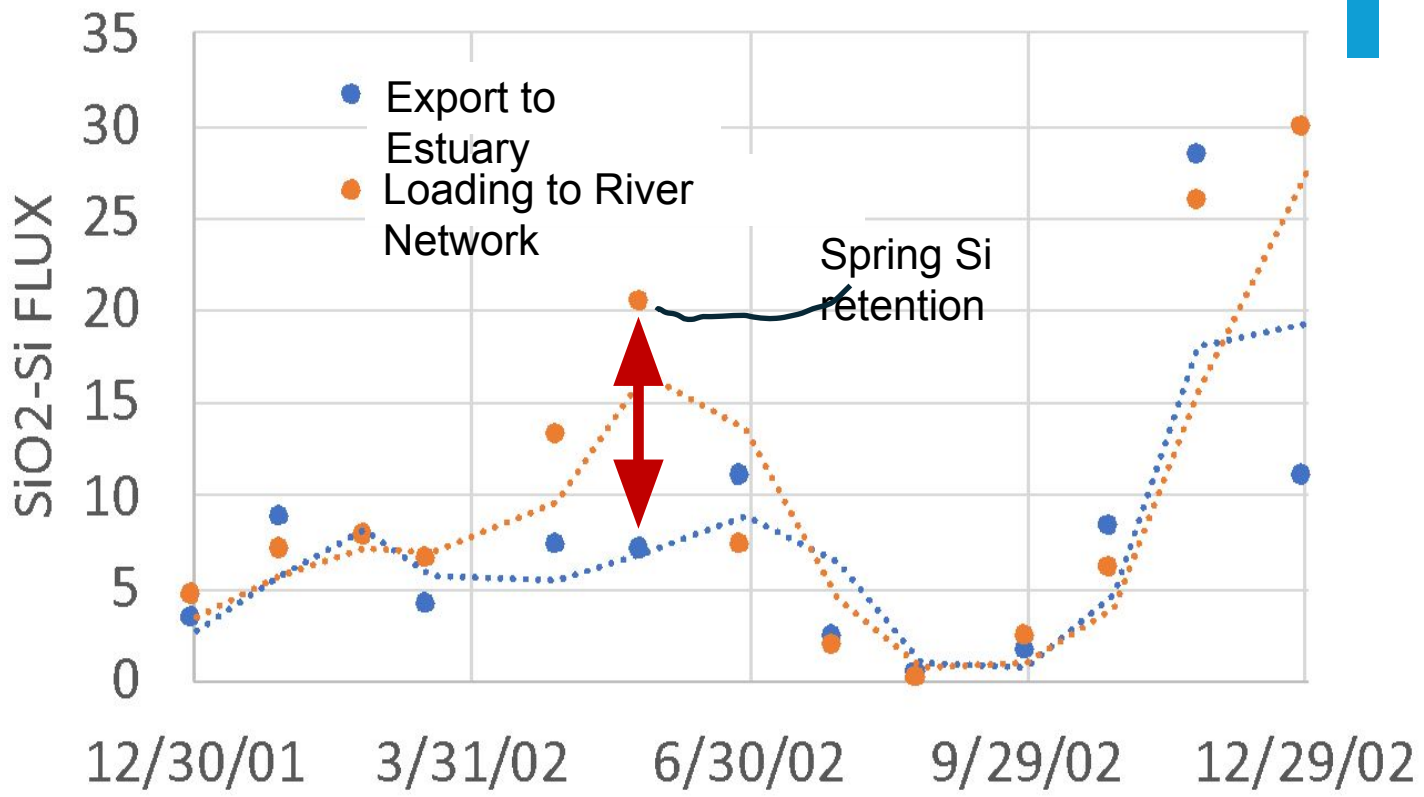
Basin	Area (Km^2)	% Agr.	% Forest	% Wetland	% Ind.	% Resid.
Cart Creek	3.96	8	57	19	5	11
Saw Mill Br.	4.02	4	17	4	2	72
Cedar Swamp	1.40	6	36	49	0	9

Monitoring Program Overview

- Integrated approach:
  - 21-day grab sampling routine
  - in situ high-frequency sensors (recent)
  - long-term autosamplers
  - regular stream discharge gaging and site inspections
- Multi-scale sampling across 5 diverse sites
- Coordination with broader LTER and local initiatives

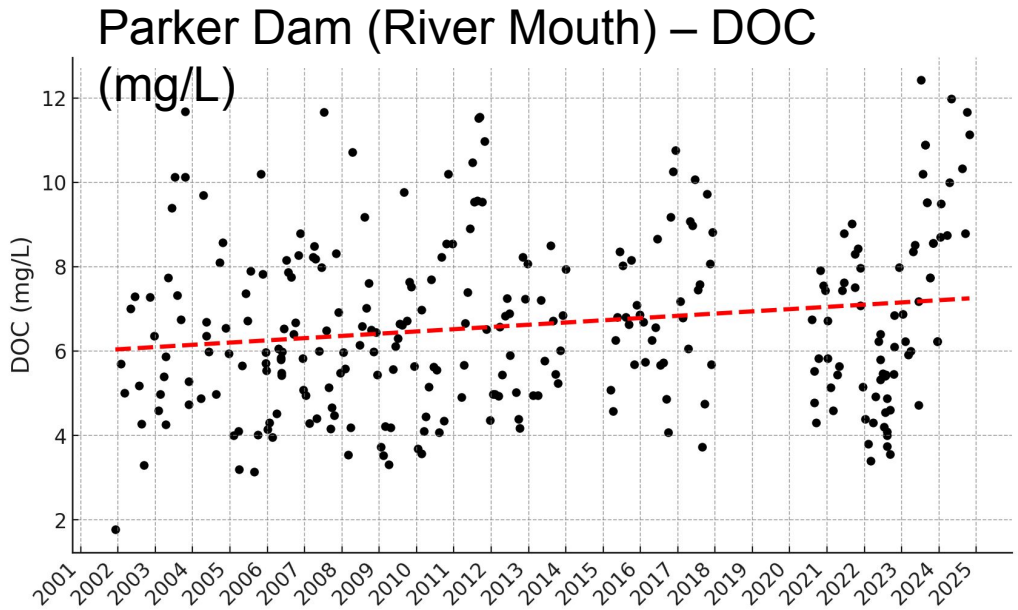
Understanding Role of River Network in Export to Estuary

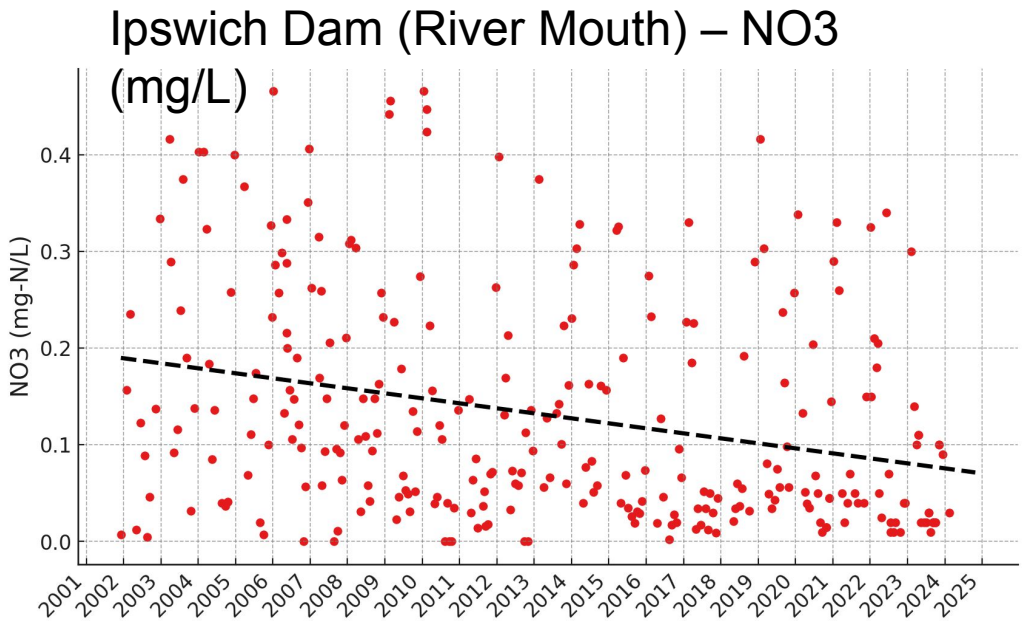
- **Integrated Approach:** Focus on paired sampling at headwater sites and corresponding mouth-of-river sites
- **Key Transition Zone:** Permanent dam sites serve as the head of tides where th estuarine influence begins
- **Dynamic Processes:** Assess how biogeochemical signatures evolve from headwater generation to transformation the river mouth
- **Coupled Fluxes:** Evaluate nutrient, organic matter, and sediment export across the river network



Water Quality Trends

- **DOC increasing:** all sites, showing increased input or reduced degradation, wetland site highest rate
- **DIN decreasing:** most sites, including forest and wetland, possibly indicating less deposition or improved pollution control
- **DON:** increasing only at forest site, possible influence of beaver activity
- **Cl:** significantly increasing at the urban site, likely due to road salt applications





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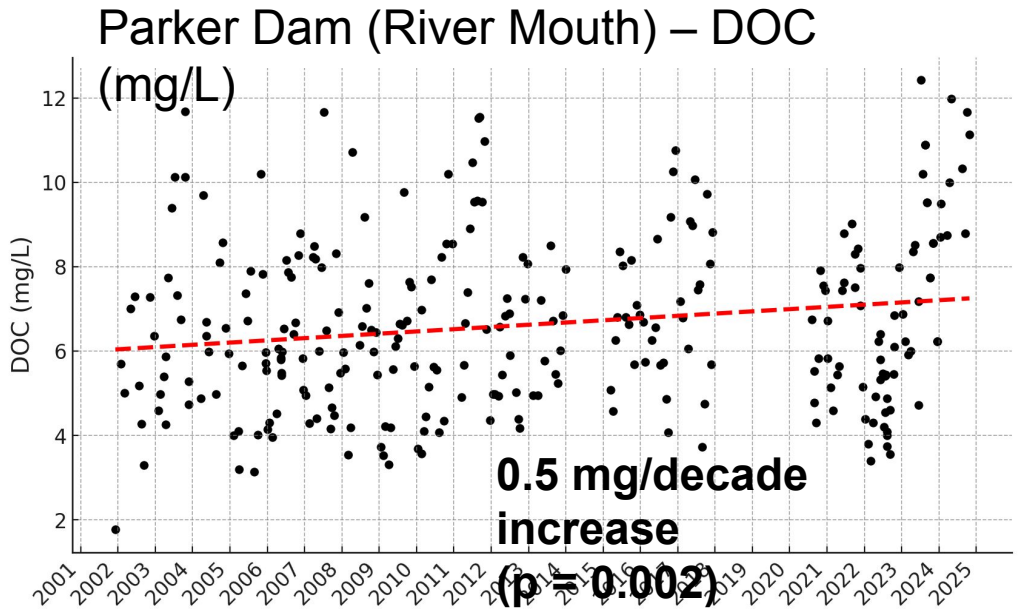

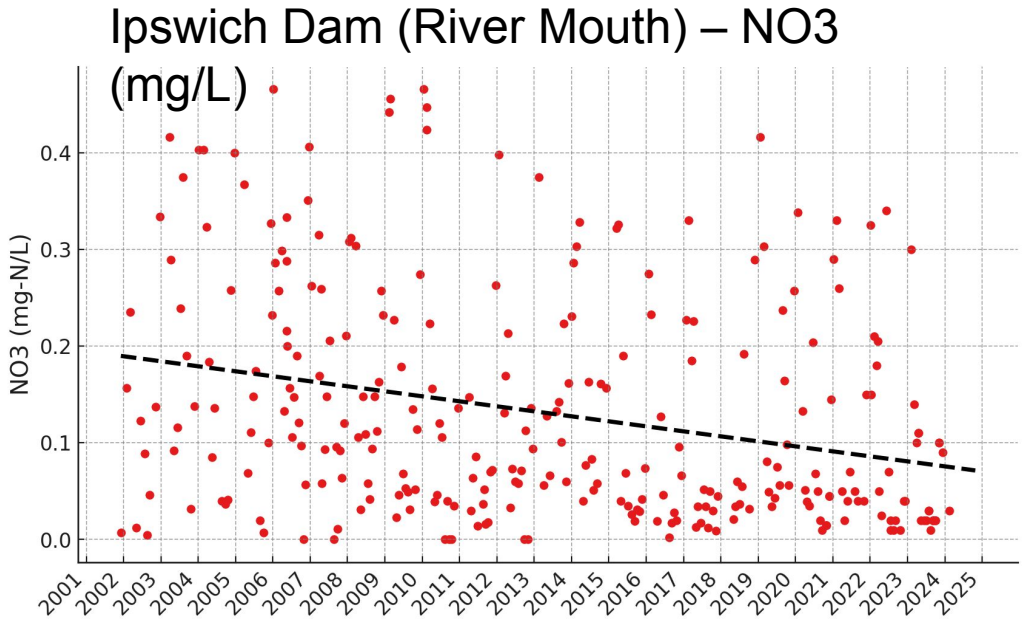

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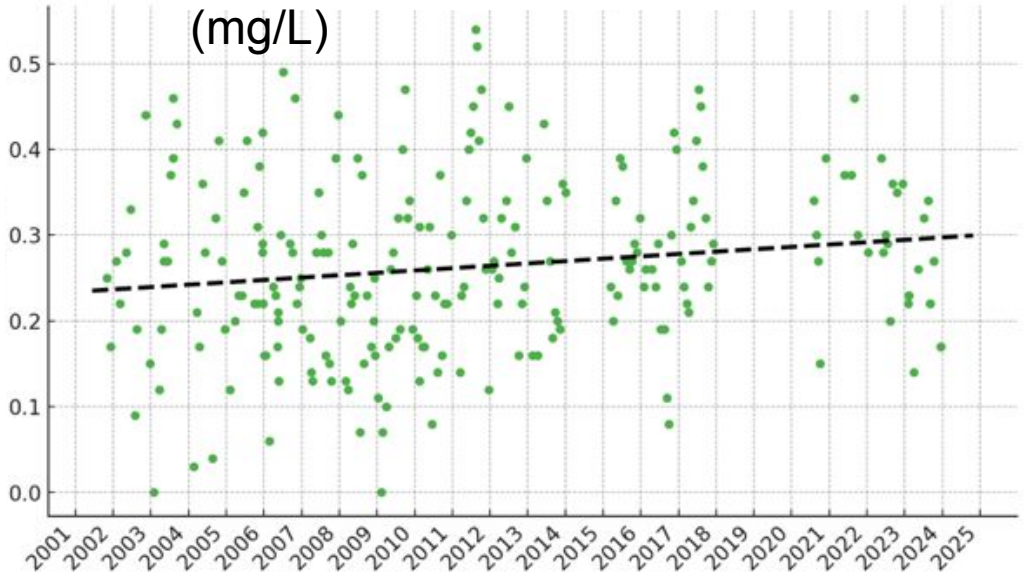
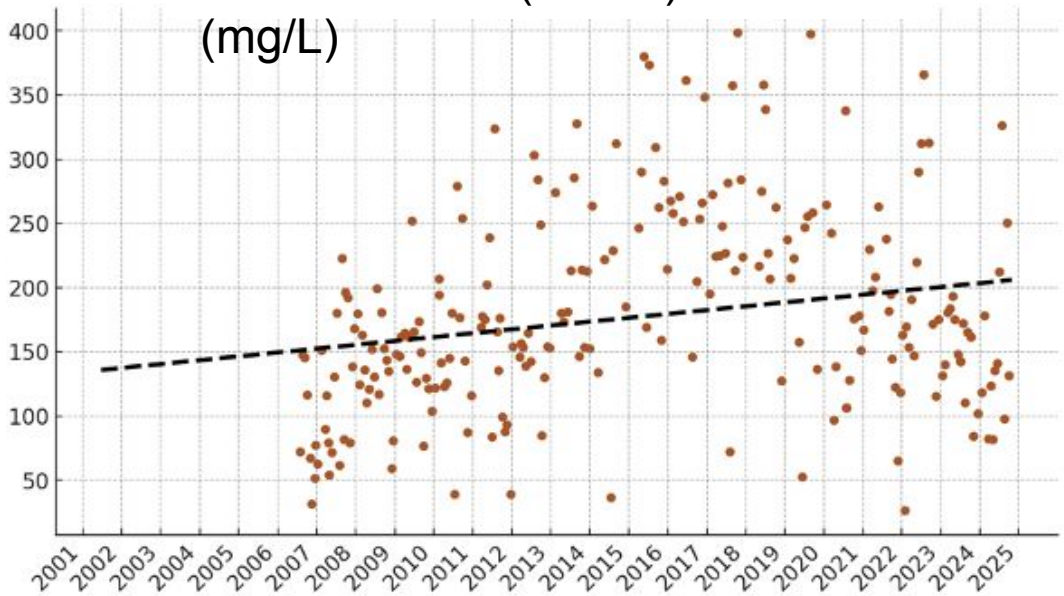
Cart Creek (Forest) – DON (mg/L)

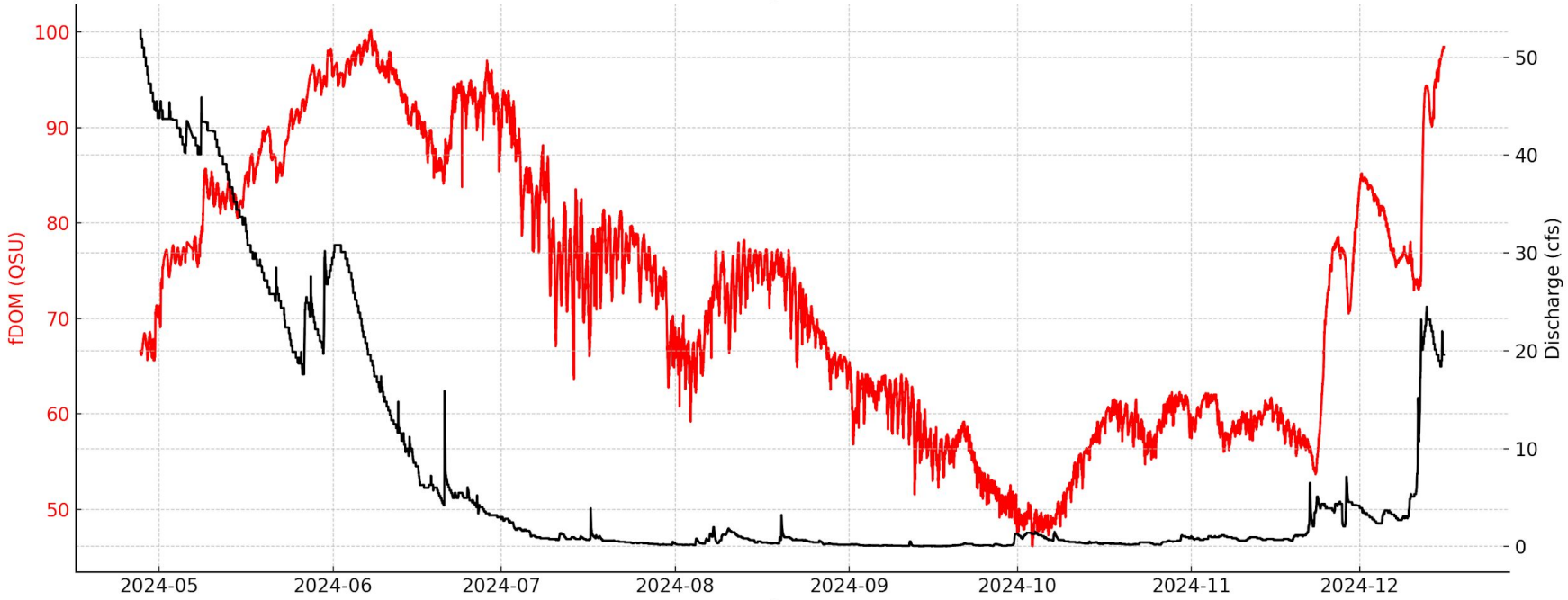


Sawmill Brook (Urban) – Cl (mg/L)



High-Frequency Monitoring Data

- **Measurements:**
  - TSS: Daily resolution for sediment dynamics
  - fDOM, NO3 & Turbidity**:** 15-minute resolution capturing rapid biogeochemical and optical changes
- **Objective:** To better understand how storms (and their characteristics) are impacting export of NO3, fDOM, TSS



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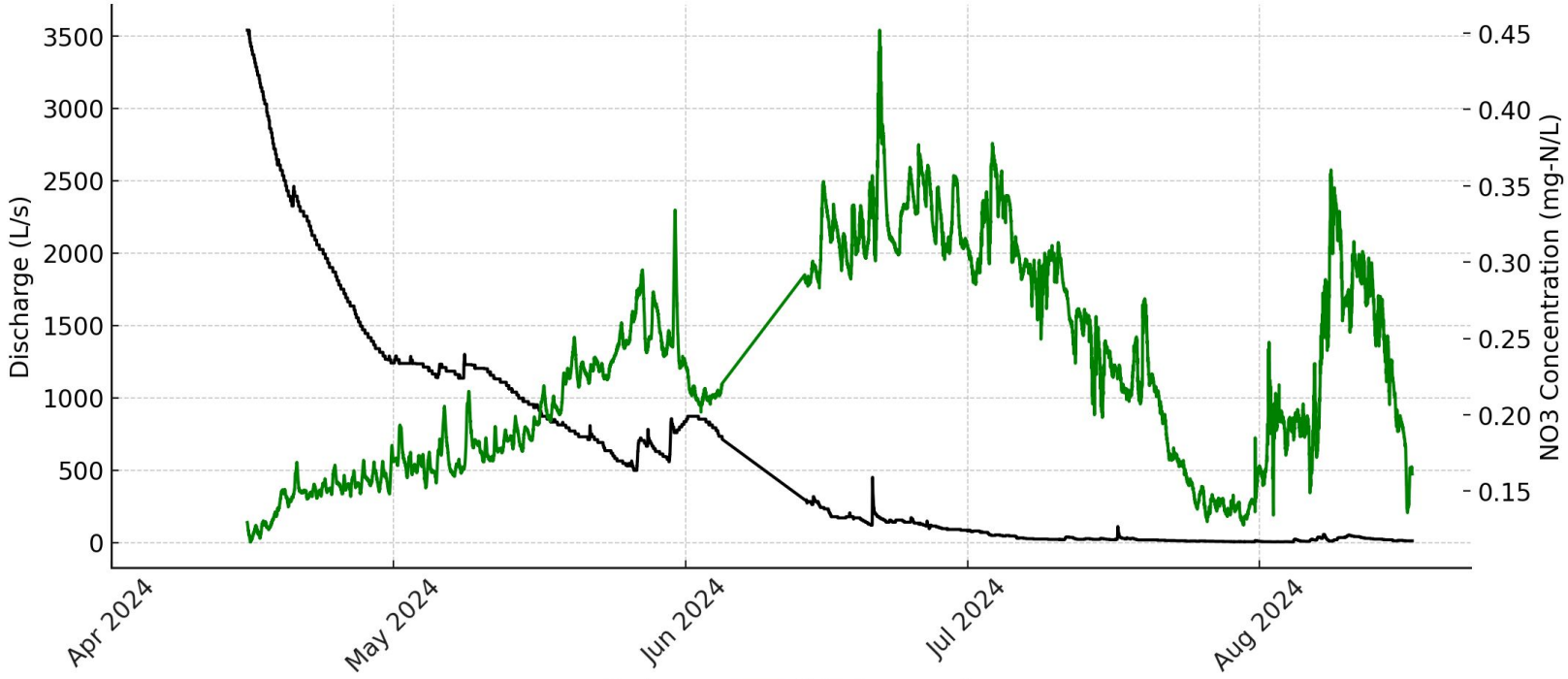

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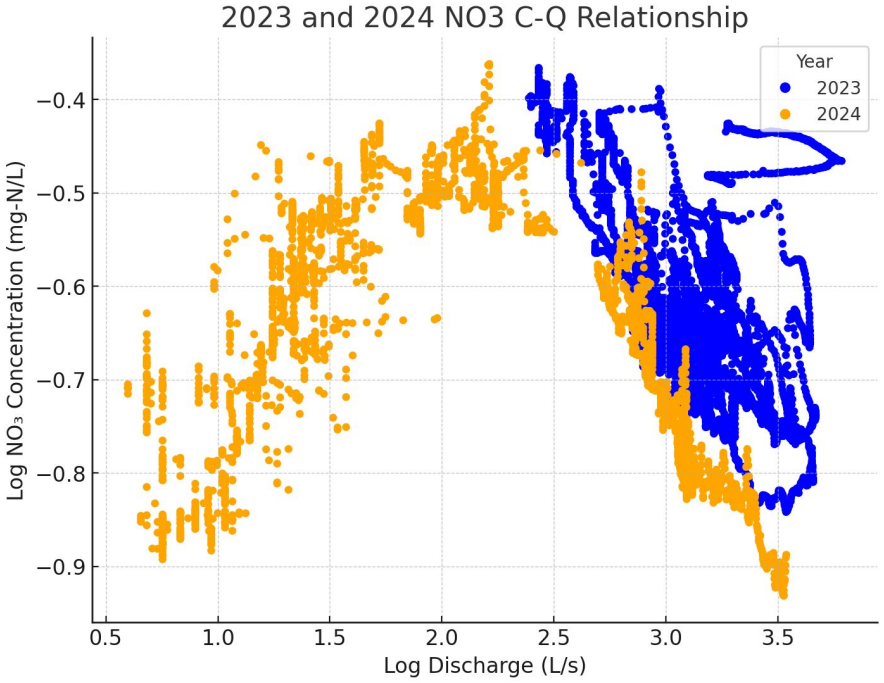
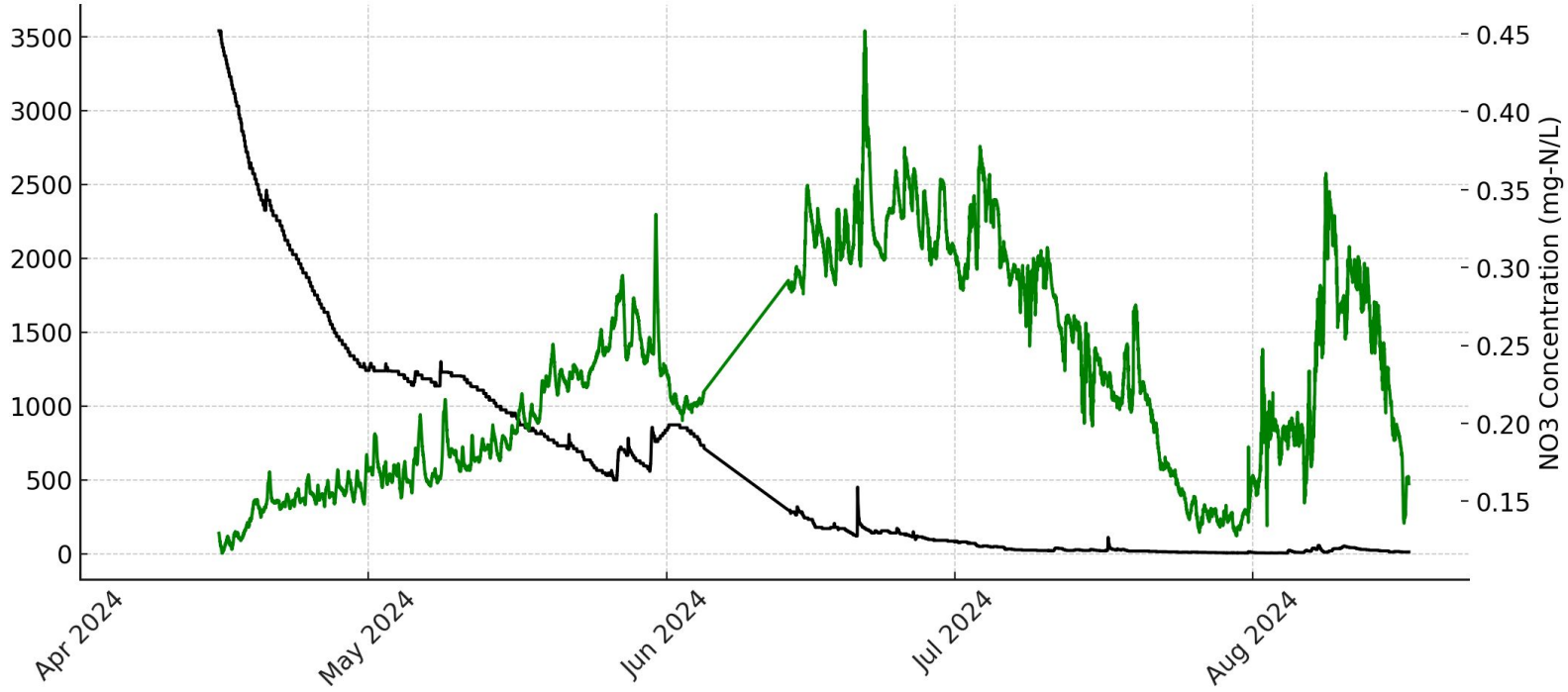




Conclusions & Implications for Watershed Dynamics

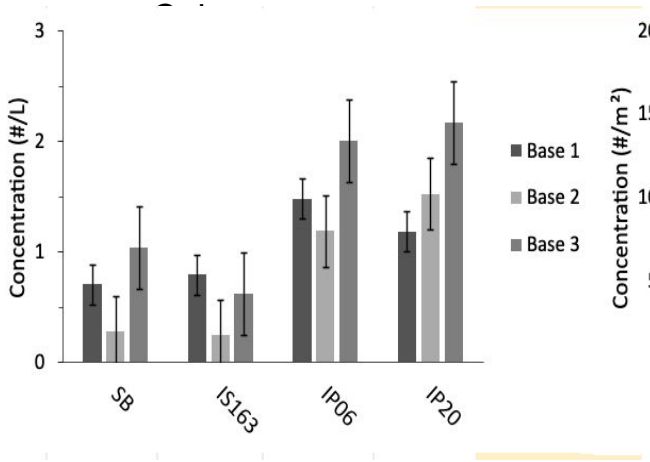
- **Integrated Monitoring Outcomes:**
- Paired headwater and mouth-of-river sampling reveals clear biogeochemical transformations along the river network
- Observed temporal trends in nutrient concentrations, organic matter, and physical parameters serve as critical indicators of watershed influences

- **Informing Estuarine Drivers:**
- Watershed monitoring provides insight into potential drivers (e.g., land use, hydrologic modifications, dam operations) that may impact downstream estuarine processes
- Data serves as a baseline to forecast changes in river-to-estuary transfers under variable climatic and anthropogenic conditions
- Continued collaboration is essential to integrate watershed findings with broader coastal monitoring efforts

Other Work

- Microplastic study investigating flux to the estuary and modeling
- Detailed beaver pond study looking at metabolism, nutrient balance, nitrogen enrichment, and greenhouse gas fluxes
- Looking into detailed storm classification and the role of hydrologic variability on biogeochemical responses
- Further work to do on beaver ponds, organic lability, small pond storm response

Water



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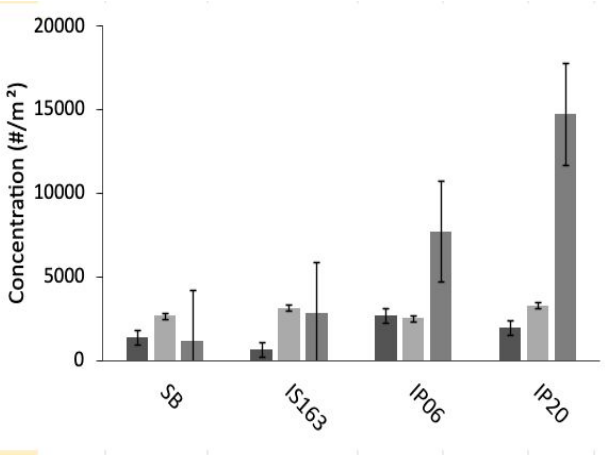
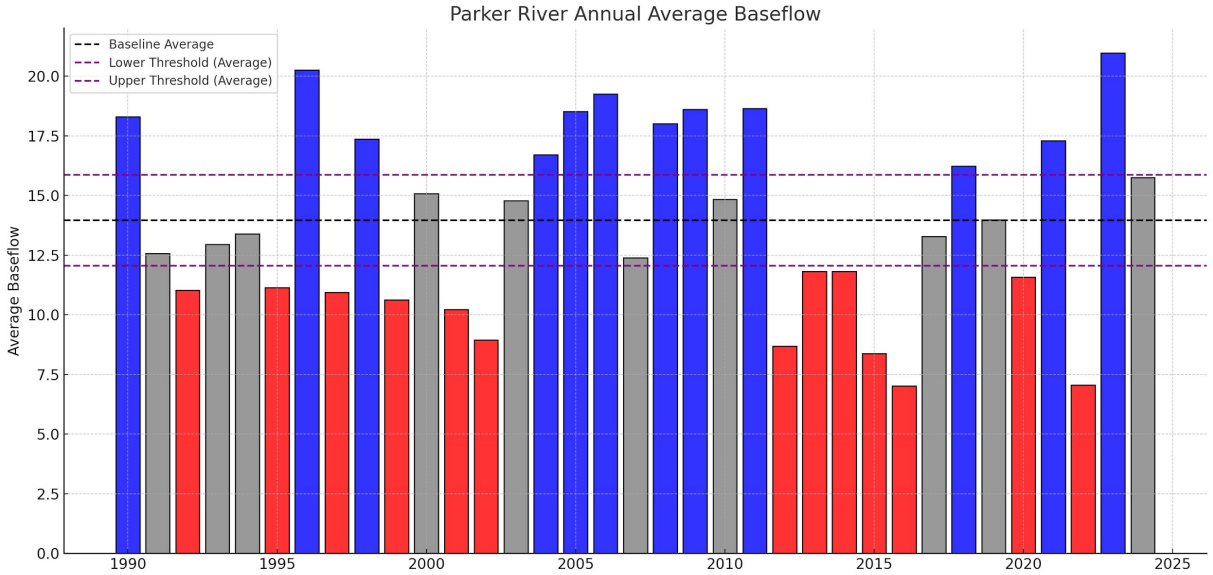
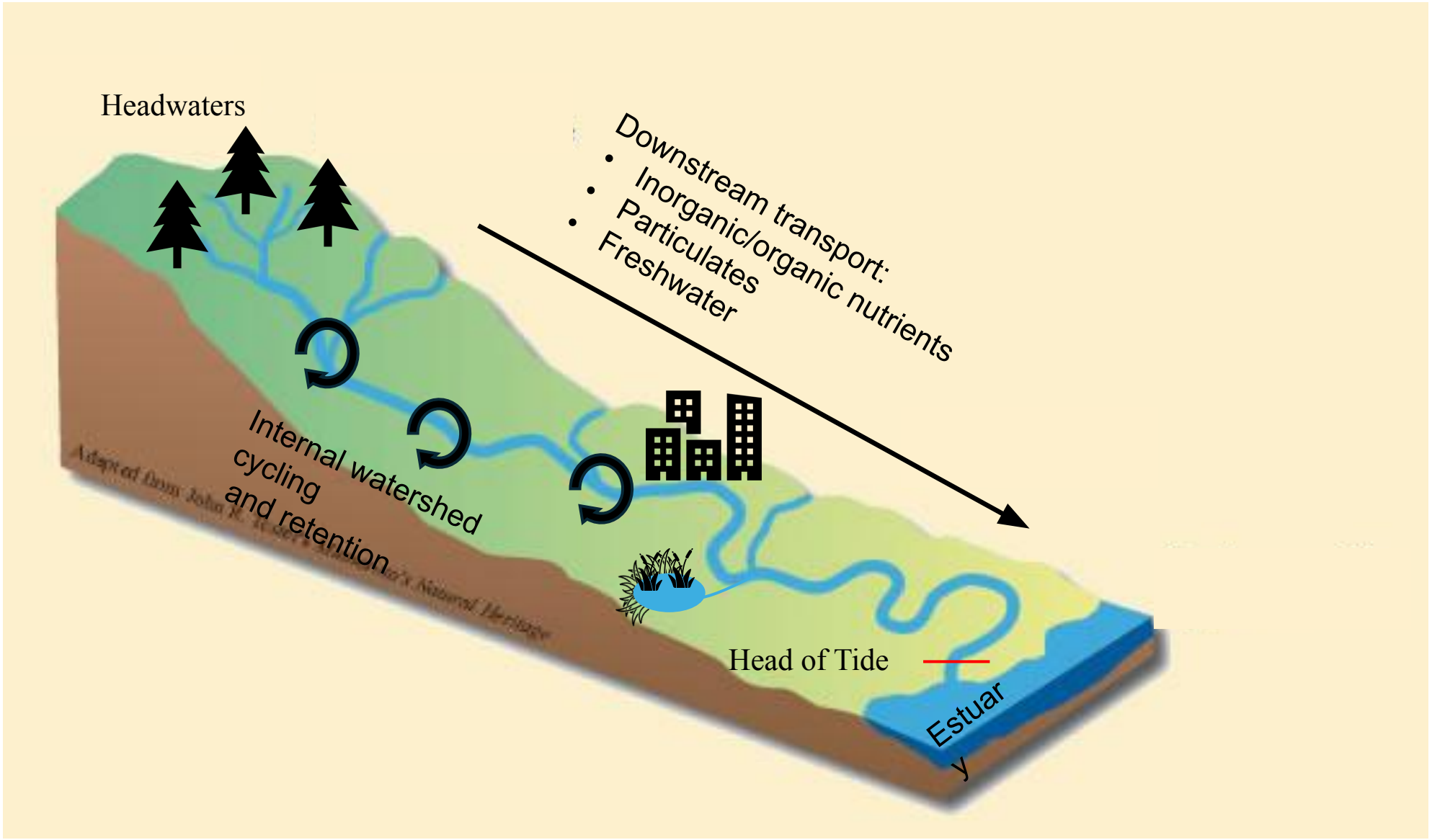




Acknowledgements

- NSF - Longterm Ecological Research network
- NSF – Hydrology
- EPA
- New Hampshire Agricultural Experiment Station


Headwaters
Downstream transport:
• Inorganic/organic nutrients
• Particulates
• Freshwater
Internal watershed cycling and retention
Head of Tide
Estuary