Understanding controls of watershed exports to Gulf of Maine as land use and climate changes.

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Gulf of Maine Monitoring and Research Symposium
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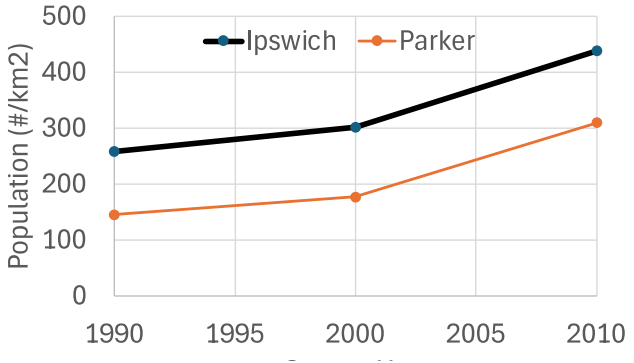
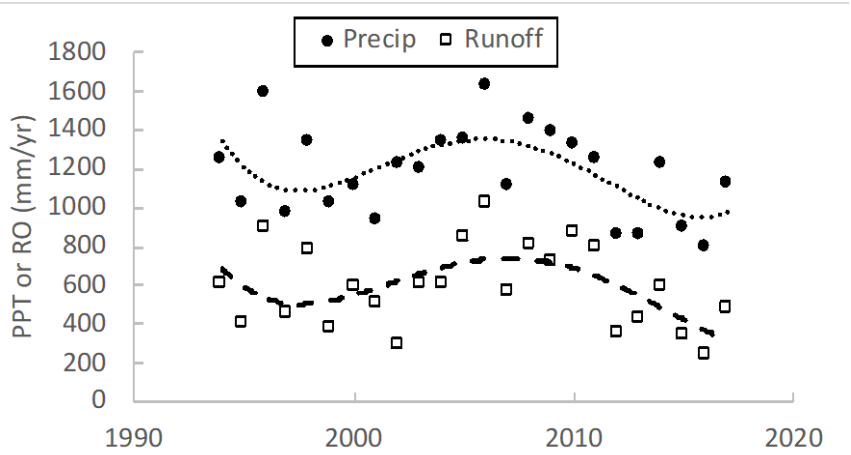
To understand how land use, population, climate, and hydrologic change are interacting to alter the location, timing, and form of material exports to the coast, and how communities view these changes.

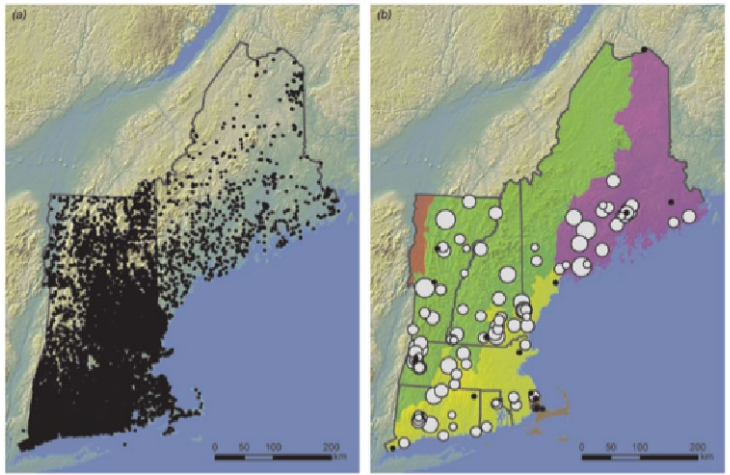
Flow, Temperature, Chloride, Nutrients, Pathogens





Current Dams

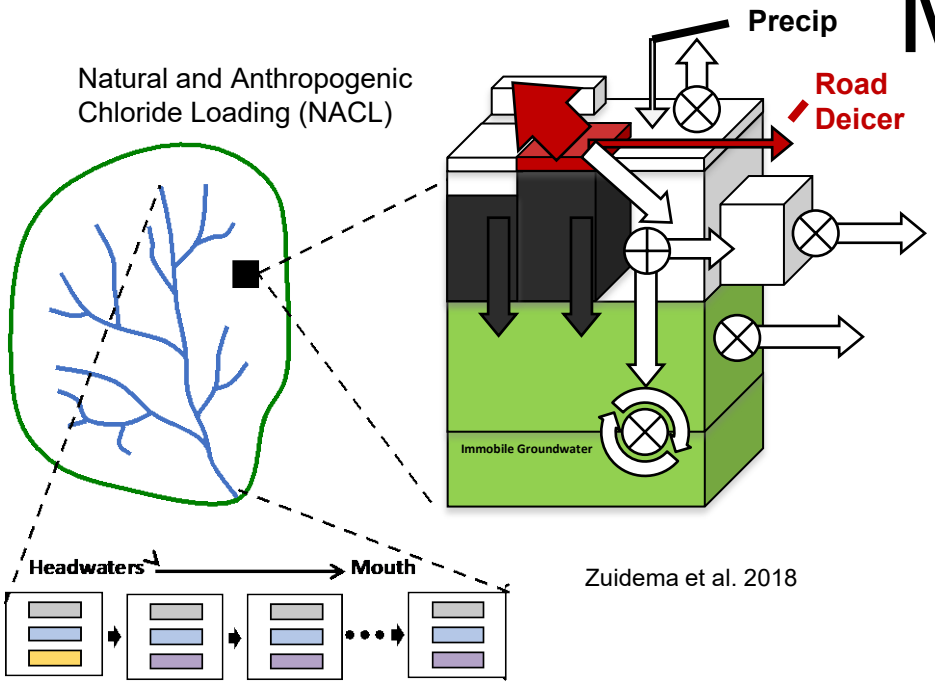
Dams Removed



Magilligan et al. 2016

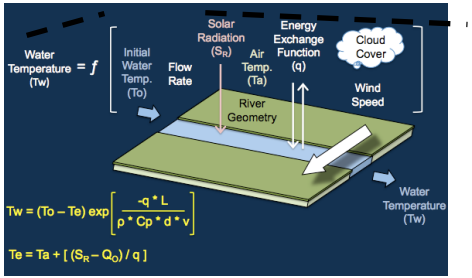
Modeling Approach

Natural and Anthropogenic Chloride Loading (NACL)



Zuidema et al. 2018

Water Temperature Module (WTM)



Stewart et al. 2013

WBM
The University of New Hampshire
Water Balance Model

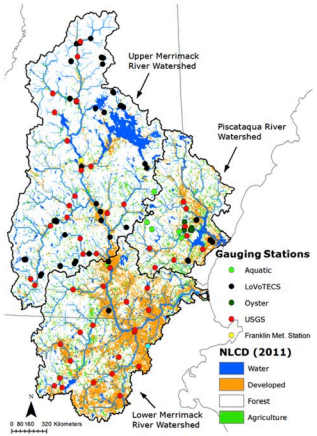
Open-source ***macro-scale*** hydrologic model (Grogan et al. 2022).

Rasterized, conceptual hydrology with a focus on human forcings.

Scenario based studies.
- Constrained by policy questions or by stakeholders.

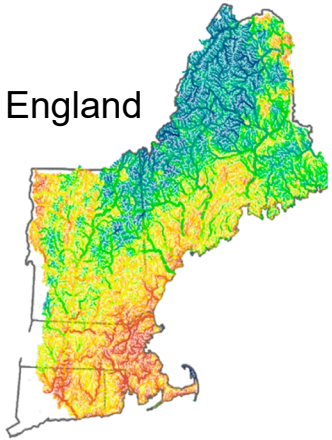
Model coupling.
- Other biophysical models, economic models, or ML.

Empirically parameterized.
- Minimal complexity biophysical processes.

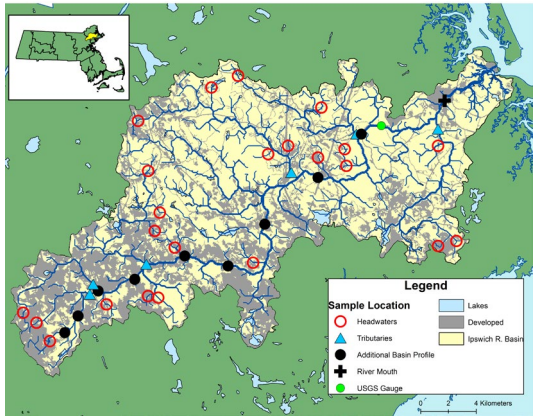


Large watershed
(Merrimack, Piscataqua)

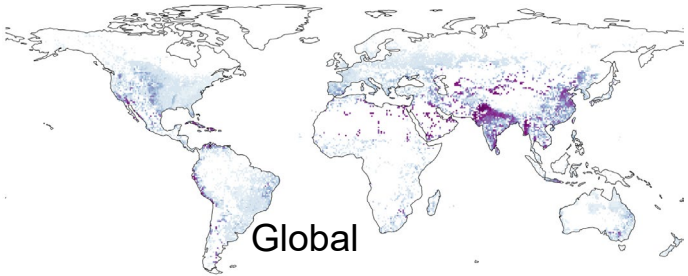
New England



Places, Scales, Networks

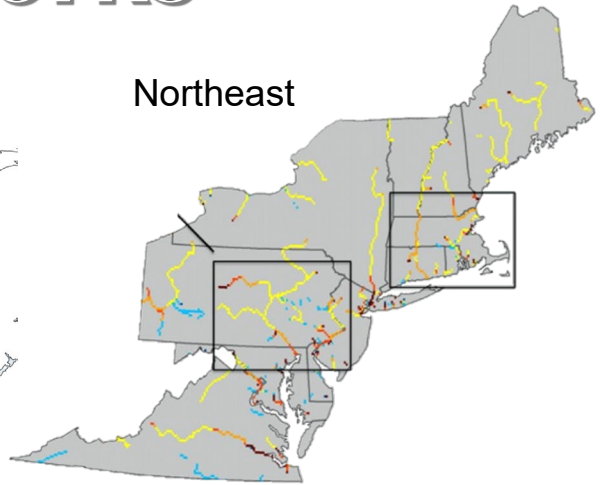


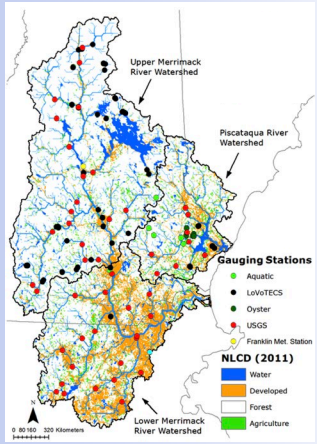
Small watershed (Ipswich, Parker)



Global

Northeast





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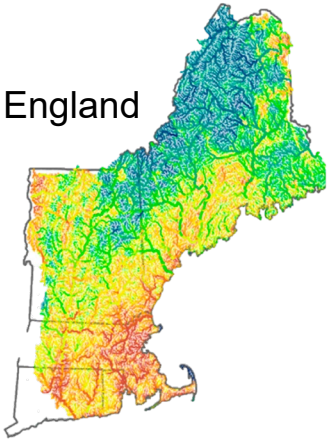

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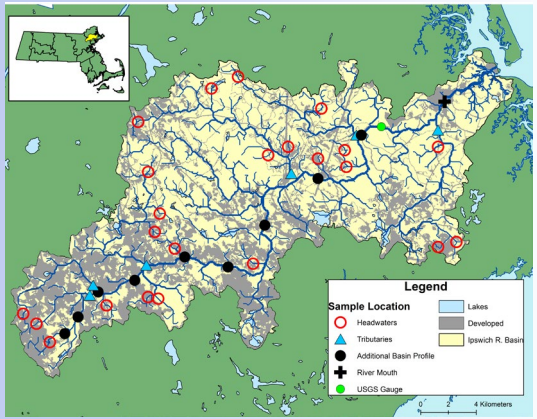

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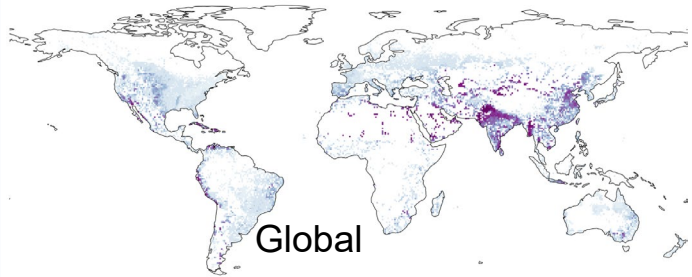

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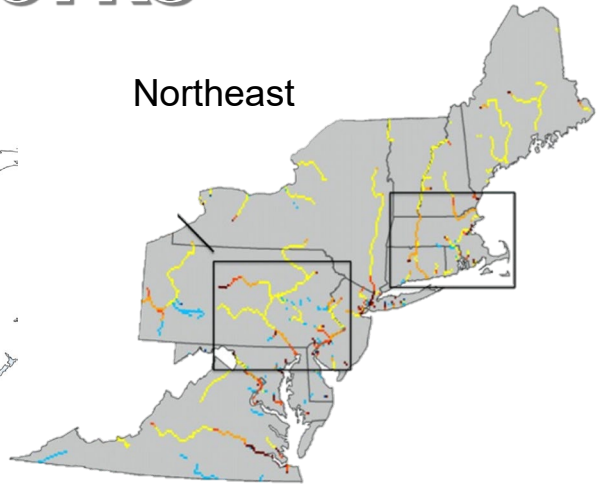

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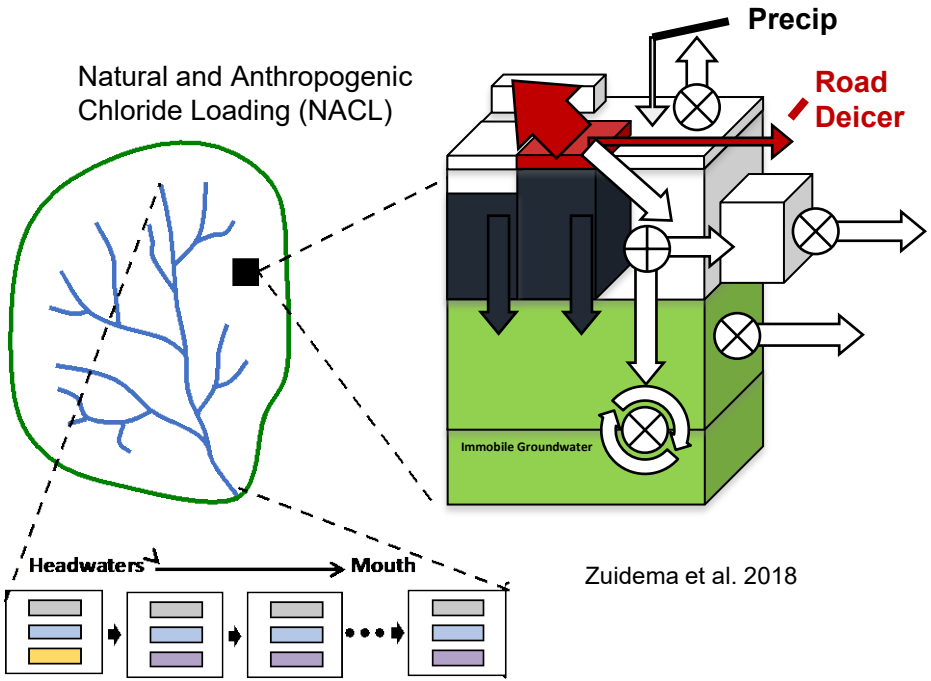

Zuidema et al. 2018

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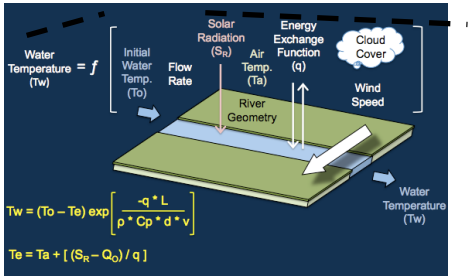
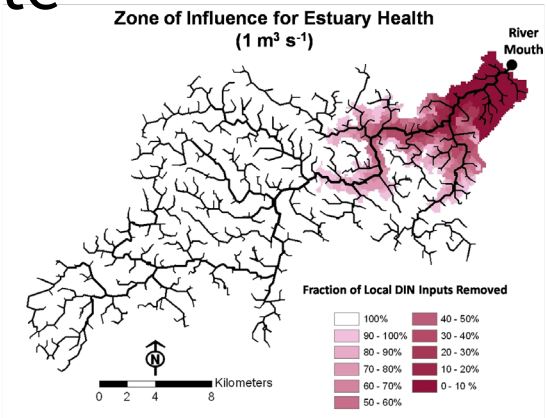


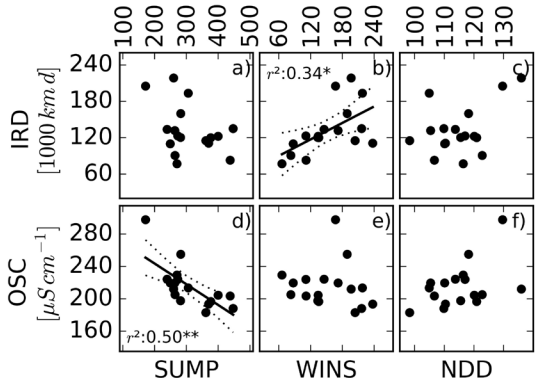
Stewart et al. 2013

Nitrate



Wollheim et al., 2008a,b, 2015; Stewart et al. 2011

Chloride



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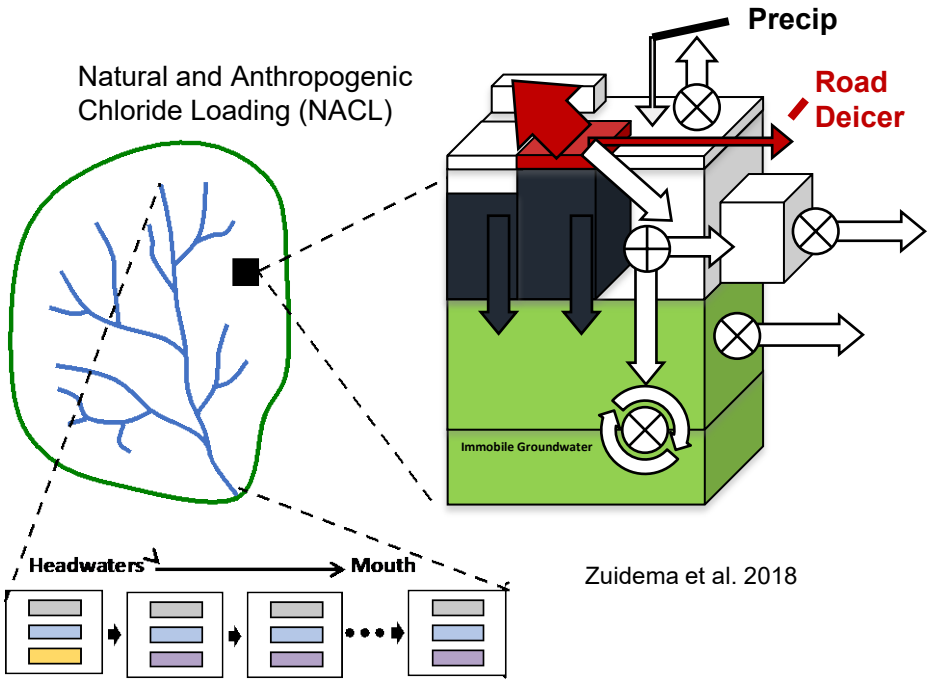

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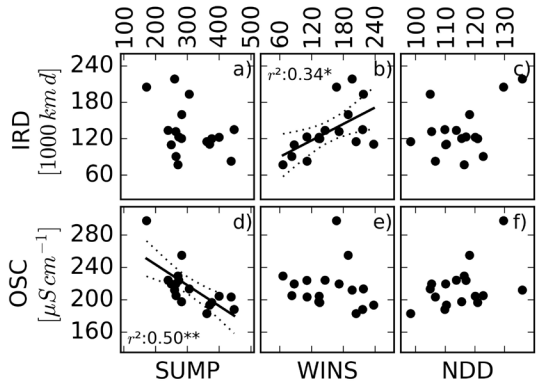
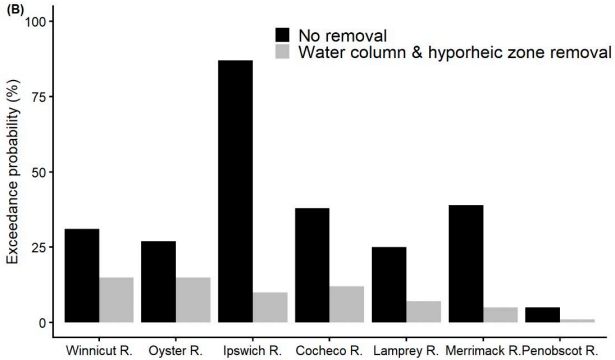


Zuidema et al. 2018

E.Coli



Huang et al. 2022

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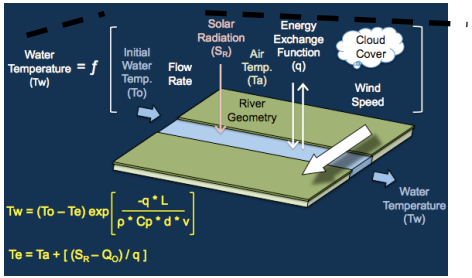

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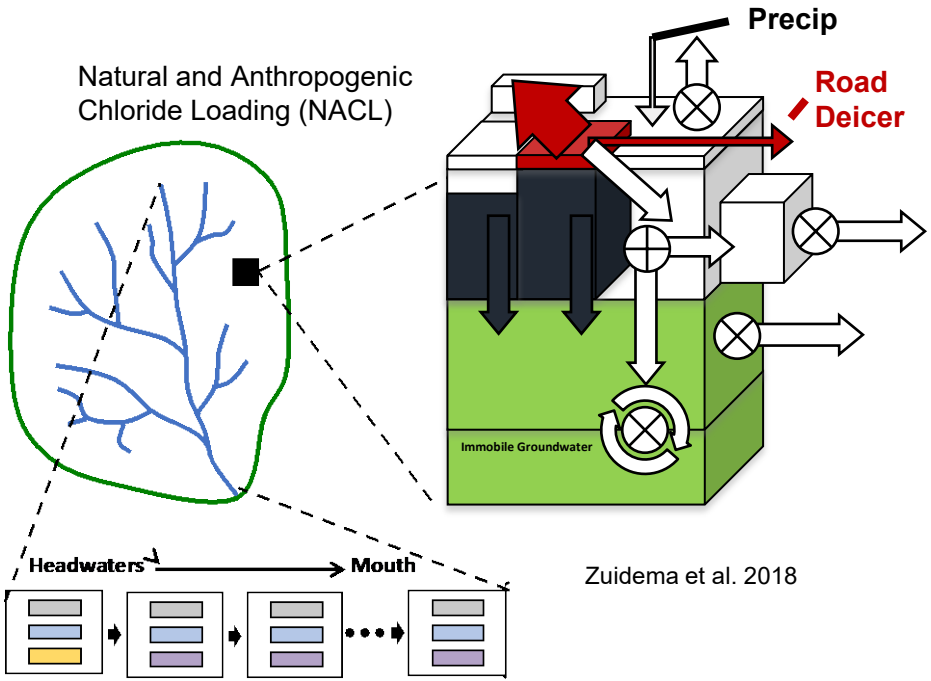

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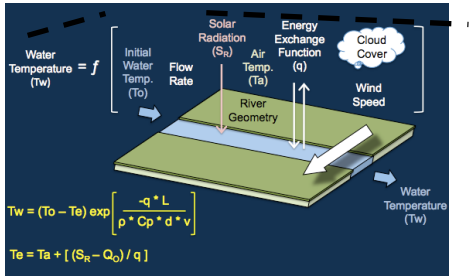

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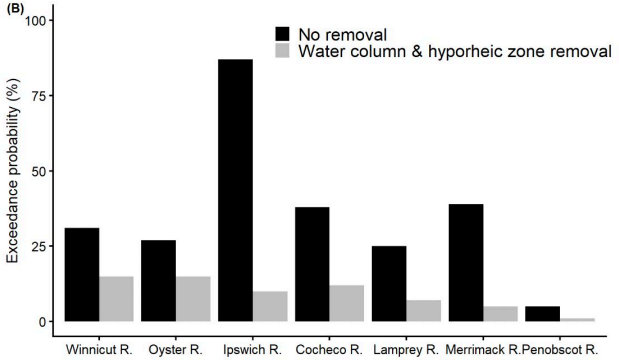
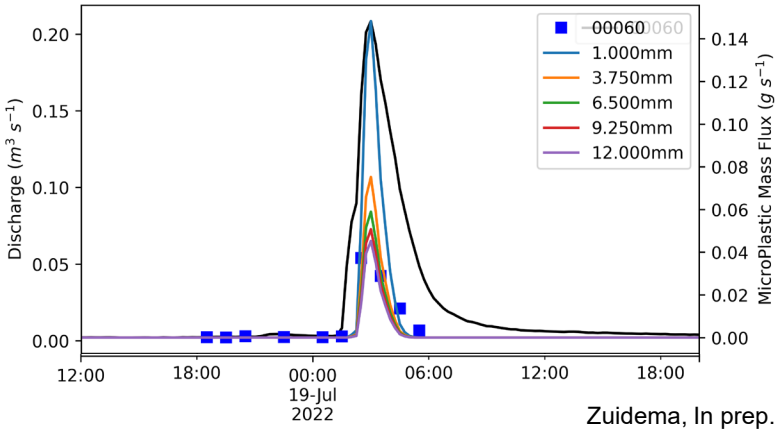
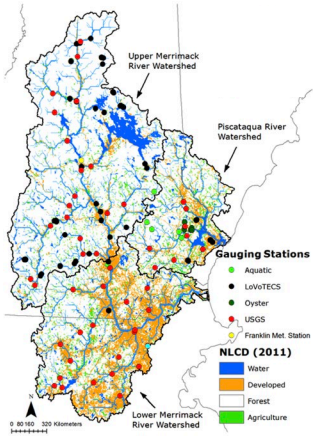


Huang et al. 2022

Microplastics



Zuidema, In prep.



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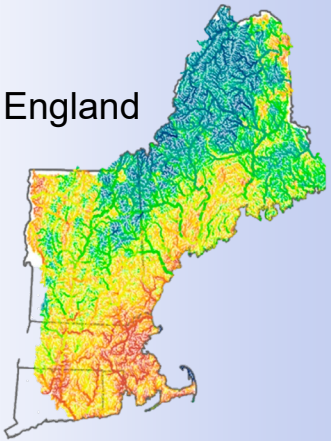

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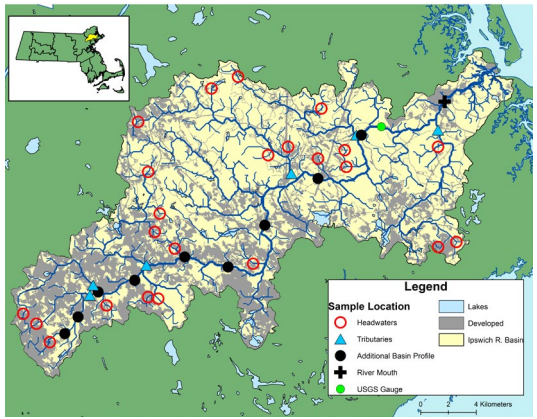

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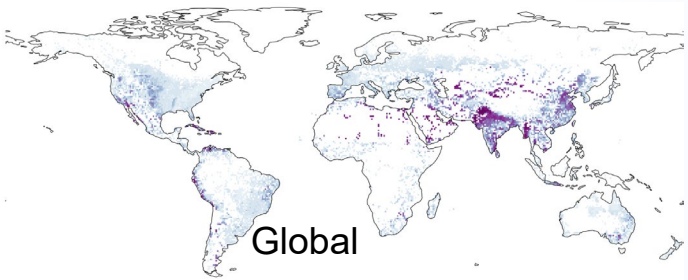

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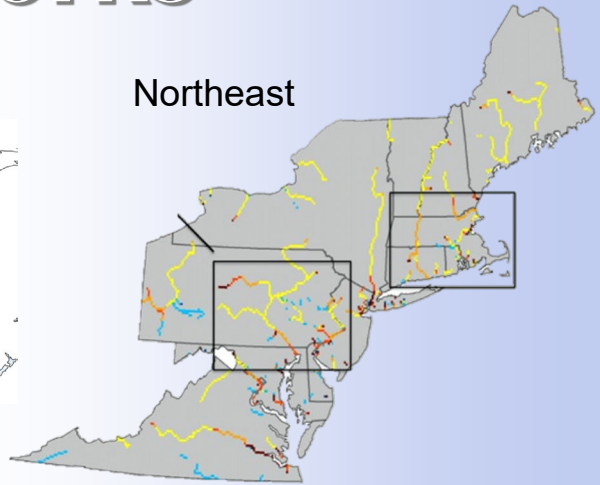
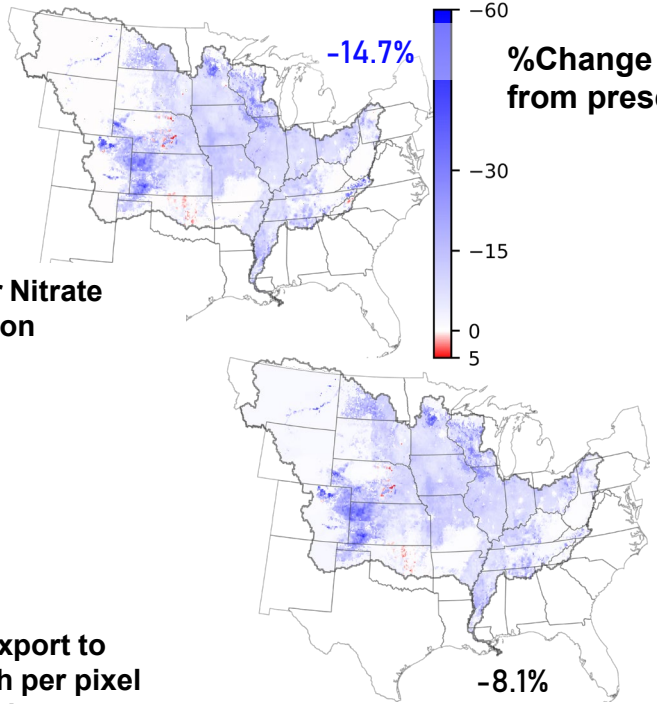


Policy and practices dictate exports

Nitrate export in response to natural gas prices increasing 50%

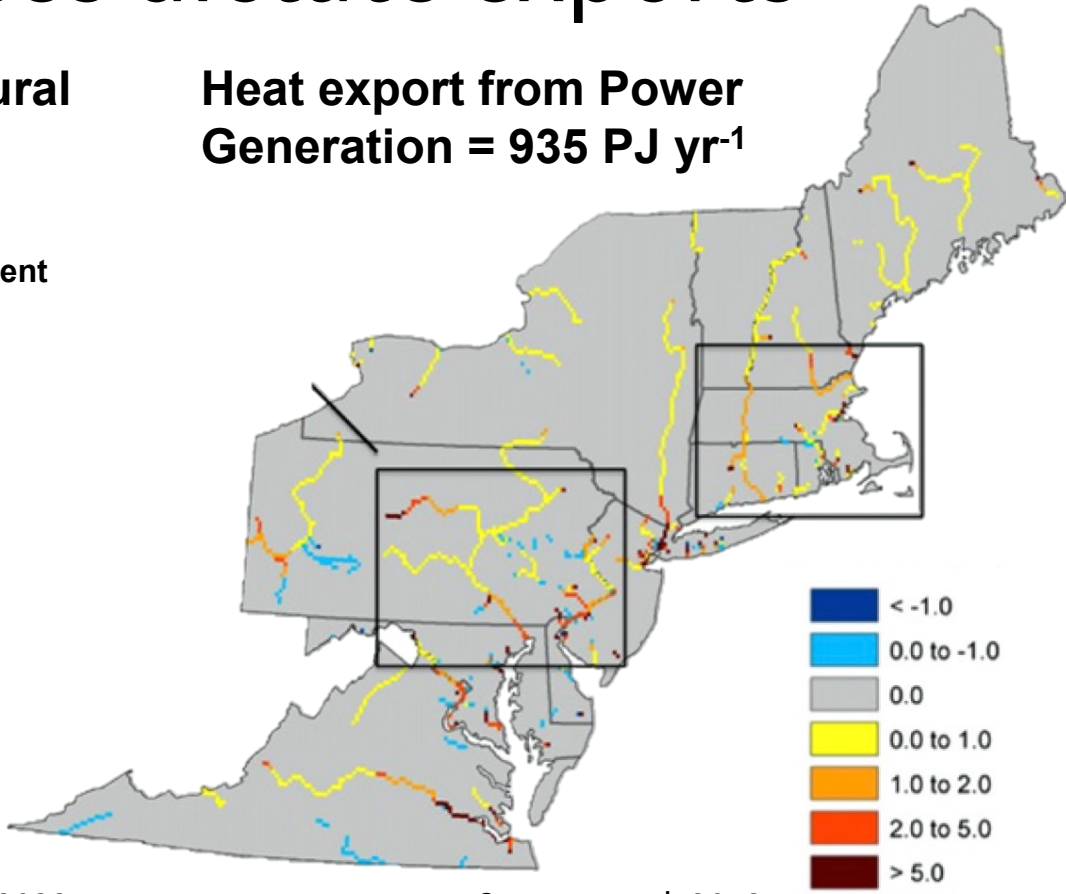


Fertilizer Nitrate application

Nitrate export to Gulf, with per pixel contribution.

Zuidema et al. 2023

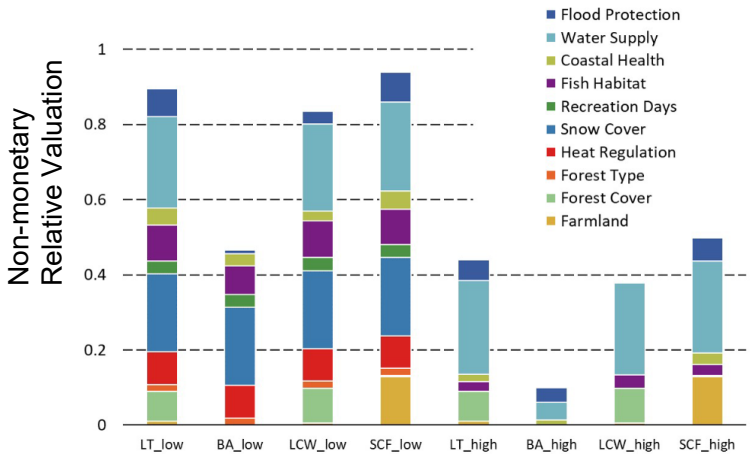
Heat export from Power Generation = 935 PJ yr^{-1}

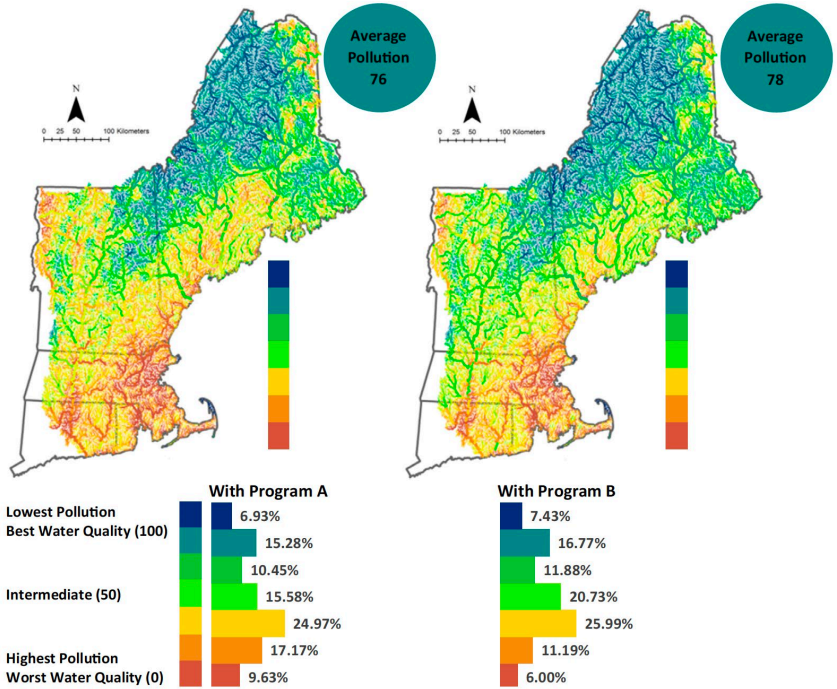


Stewart et al. 2013

Water quality is valued and is tied to place.

Quality **water supply** was the most valued service. Upstream residents placed less value on **health of coastal ecosystems**.



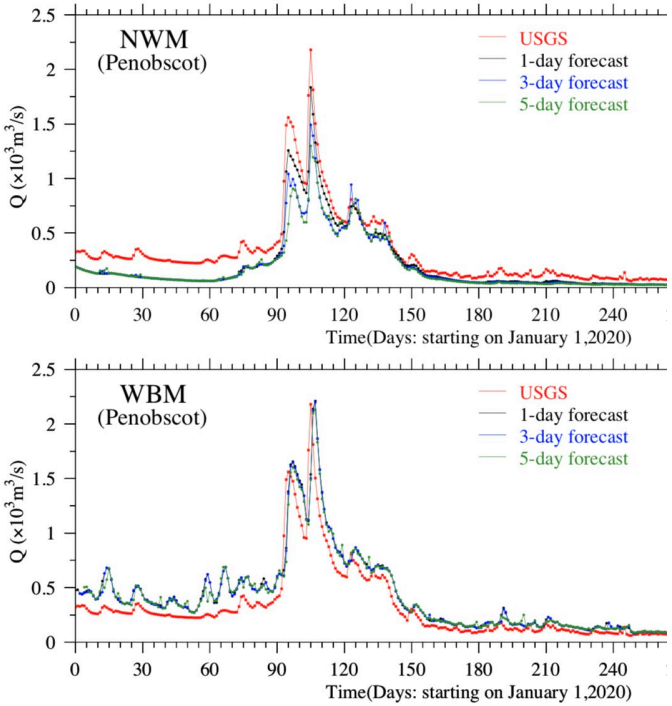


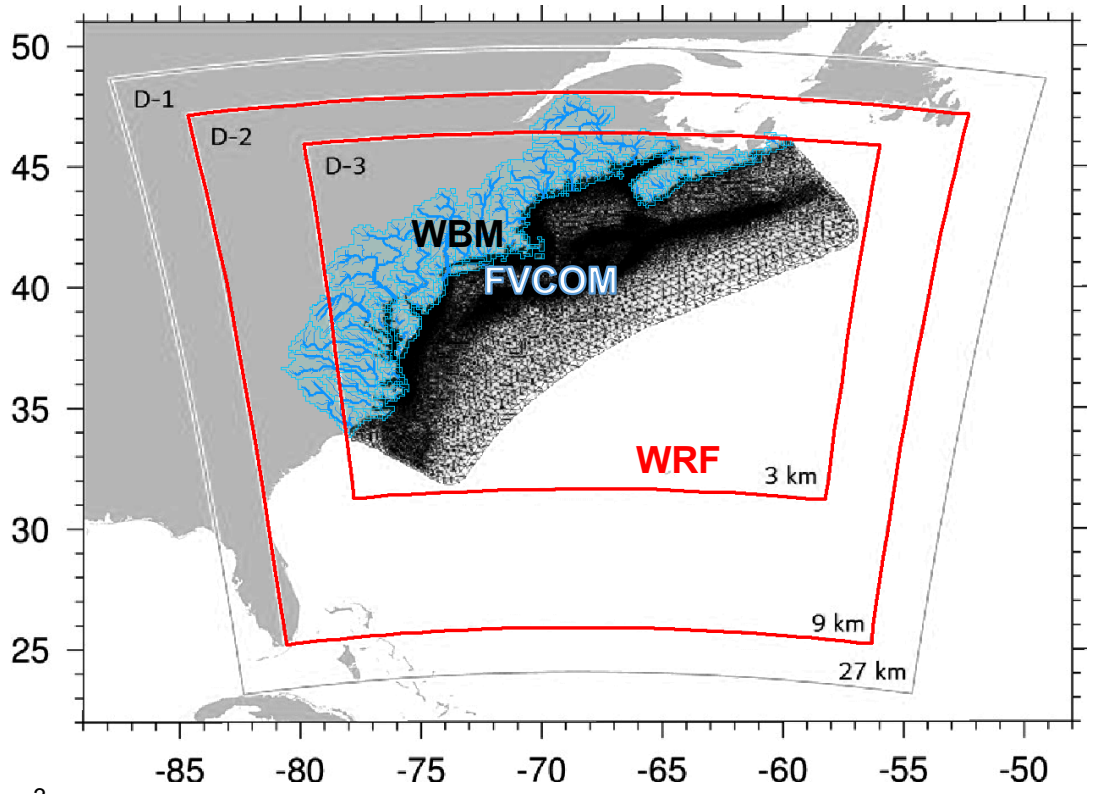
People stated a willingness to pay more for improved management

- $21 for each 1% improvement within 10 mi of home, $11 within 10-25 mi.
- An additional $8 for areas of interest (away from respondent's home)

Samal et al. 2017
Borsuk et al. 2019
Johnston et al. 2023.

Real-time Flow and Temperature to coast

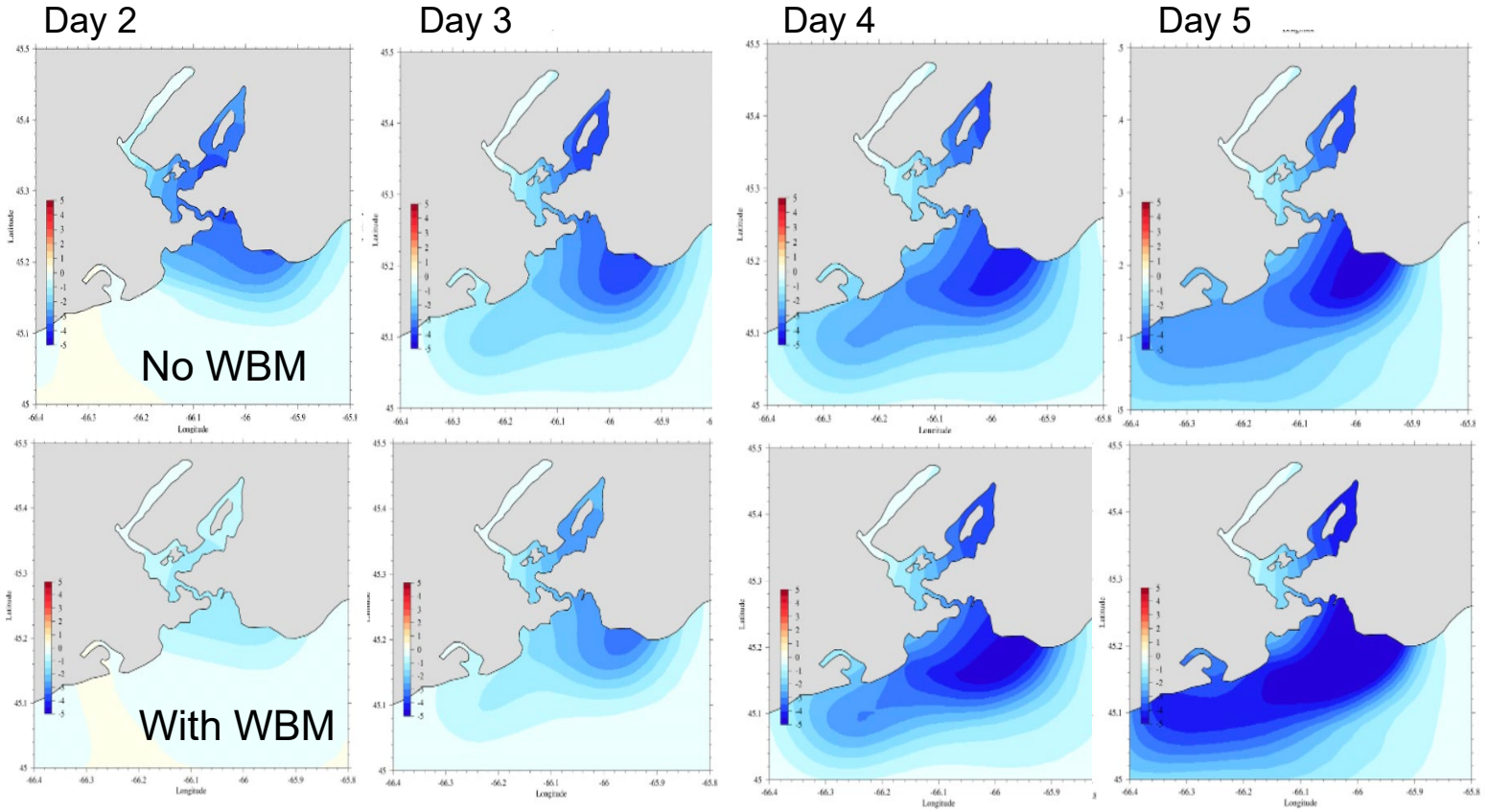




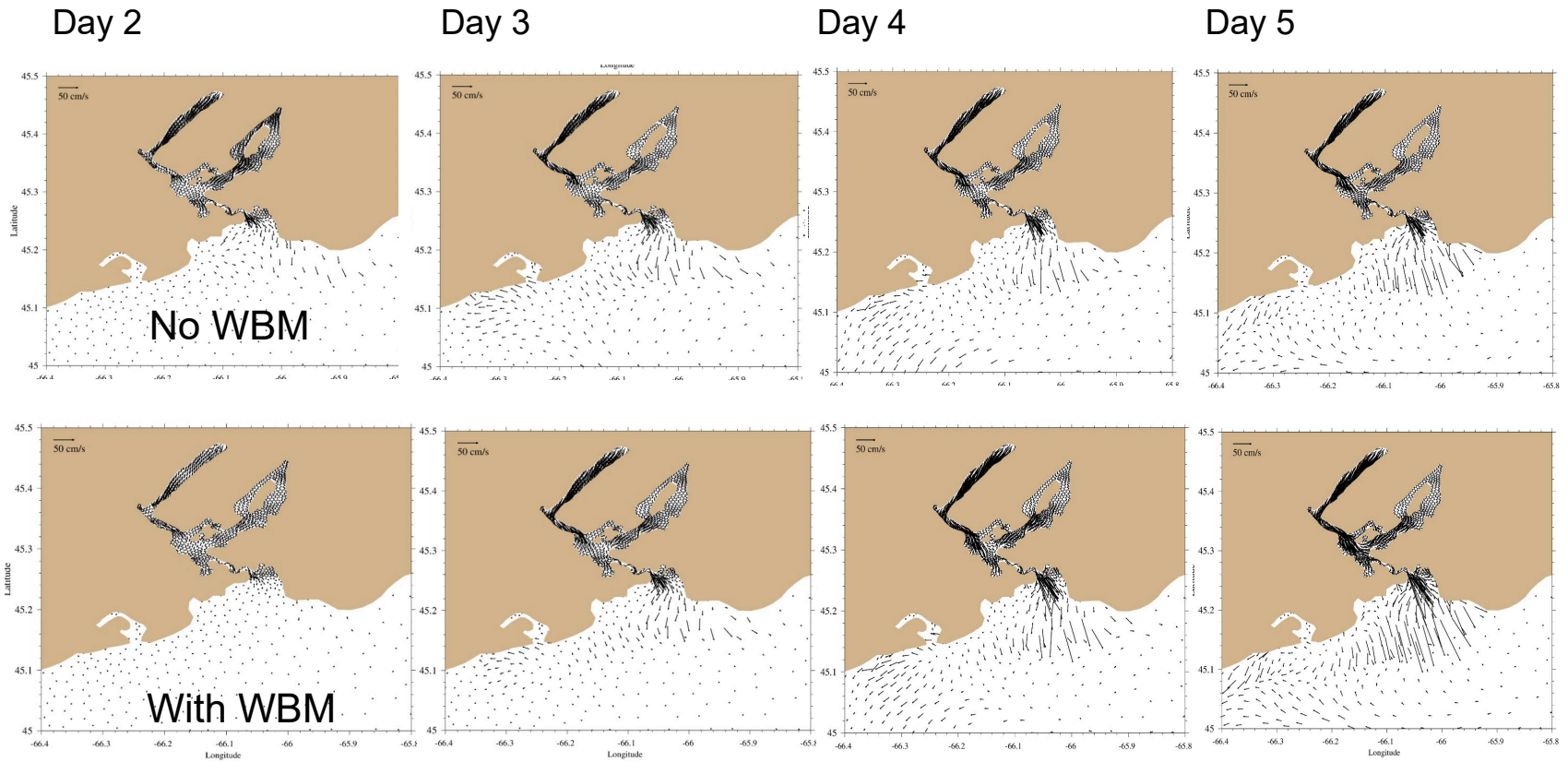
Q about 400 km^3 y^{-1} inflow to ocean

Dom + Ind use: ~60 km^3 y^{-1} Irrigation: 1-3 km^3

Coupling WBM→FVCOM meaningfully affects salinity forecasts



Coupling WBM→FVCOM meaningfully affects velocity forecasts



Paths we are trying to pursue in the GoM and its watersheds

1) Opportunities to integrate additional measures of water quality into our real-time forecasts.
   a) Richer integration of modeling frameworks
   b) Deeper insight into monitoring needs

2) Co-Develop model-based utilities or experiments that put communities and stakeholders in the driver-seat for watershed management.

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