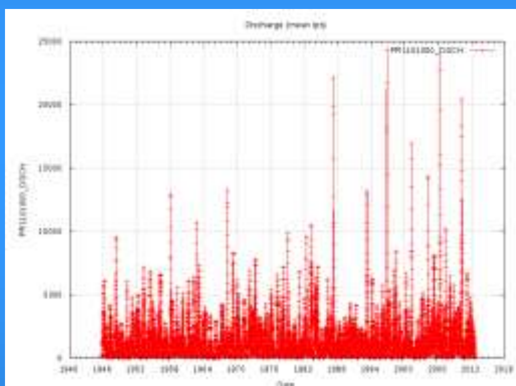
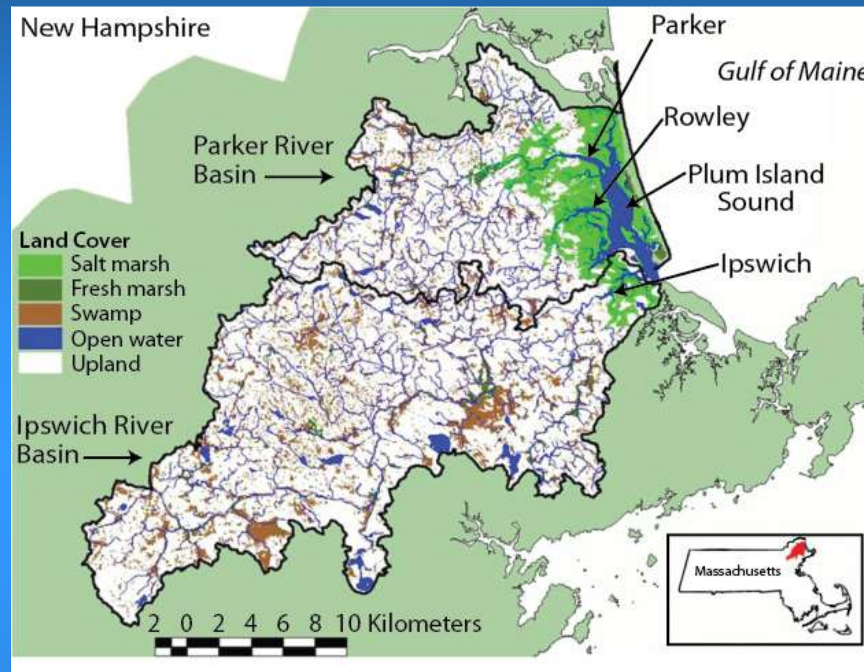
Plum Island Ecosystems (PIE) LTER

How do coastal ecosystems respond to changes in:

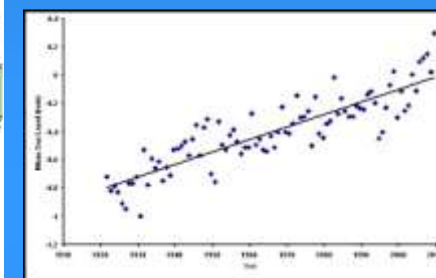
Climate

changes in precipitation patterns, stream discharge, storminess

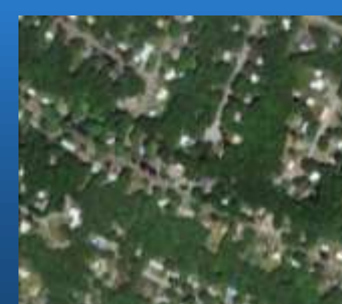




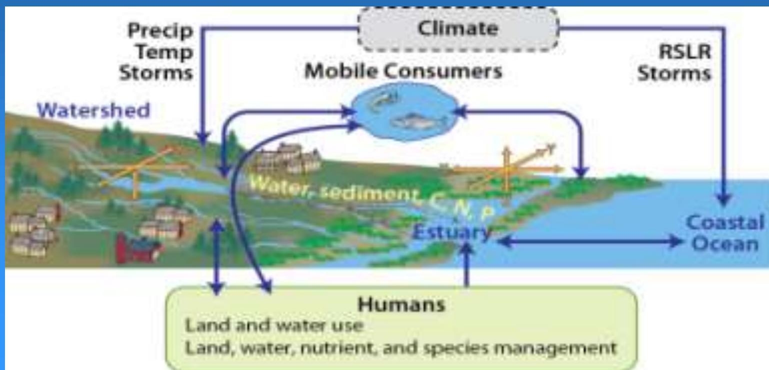
Sea Level



Human activities

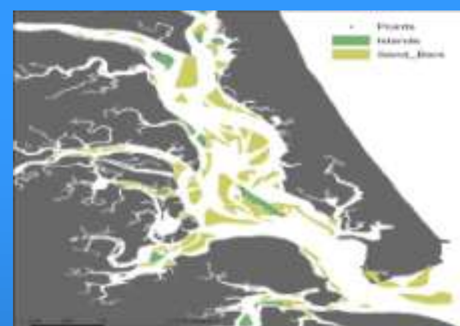


Changes in these drivers are not only changing rates of processes and biotic communities but also altering the geomorphology and connection between patches

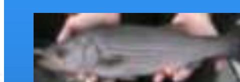


Flows and transformations of C, N, P, and S in areas with different geomorphology

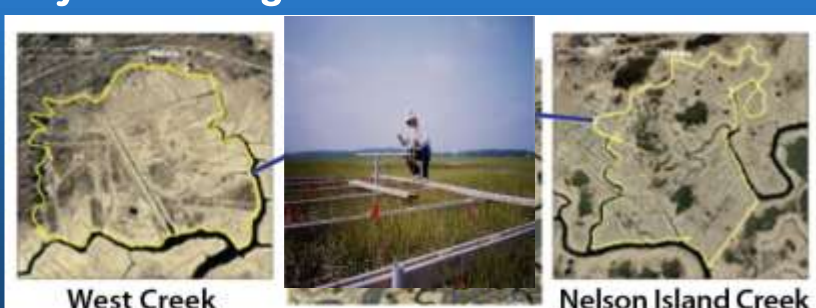
Changes in river flows , N and C export with urbanization and beaver ponds



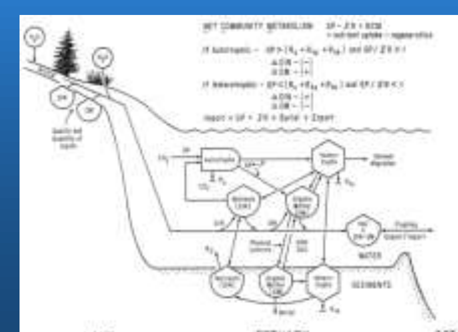
Controls on the distribution and abundance of organisms



Physical changes in marsh-creek structure



Experiments big and small, modeling

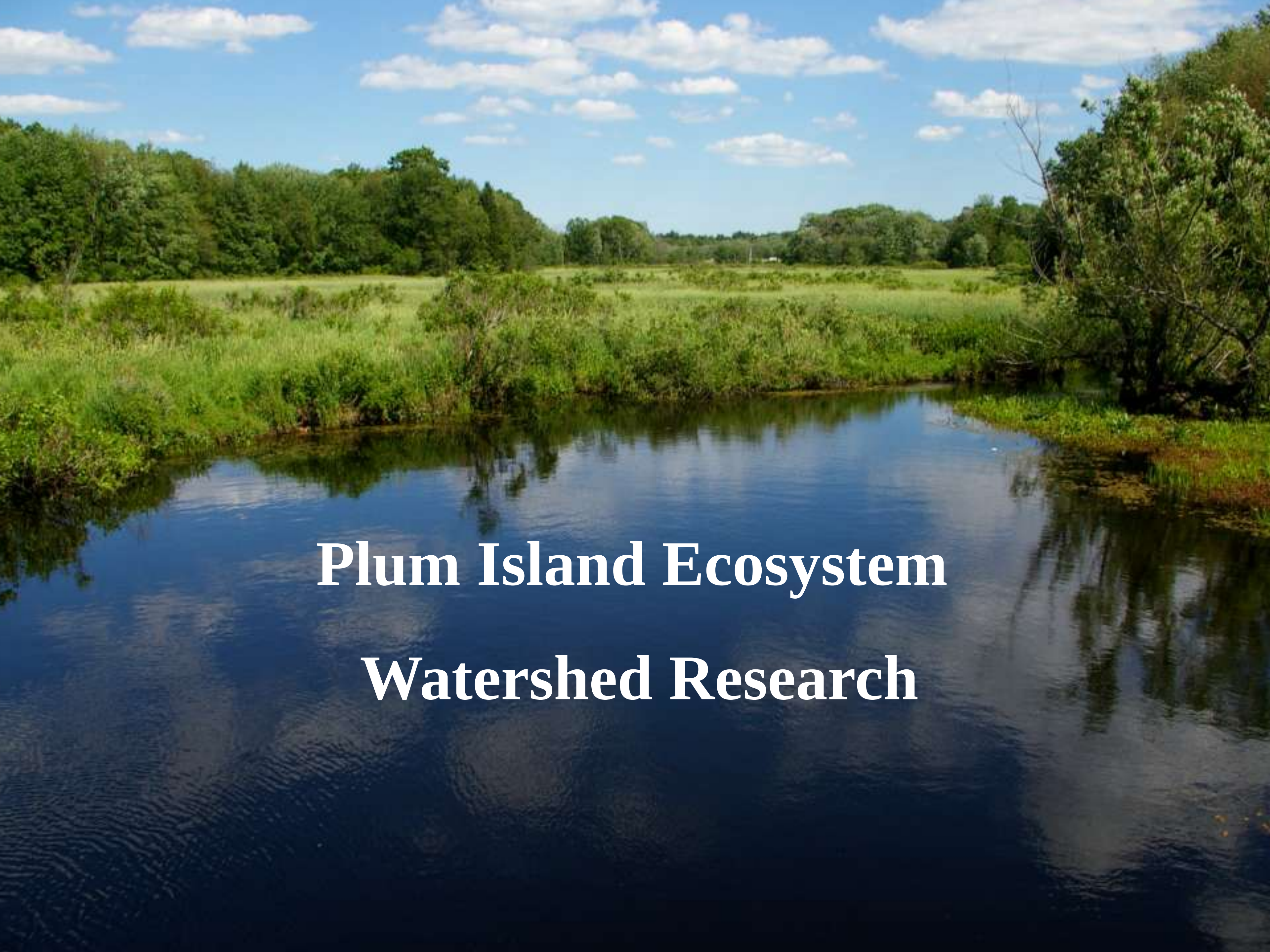


Watersheds and Coasts

- Watersheds determine the quantity and timing of water (salinity structure, fish passage, even nitrogen cycling)

- The amount of nutrients and pathogens delivered to the estuary (production, eutrophication, shell fish)

- Sediment delivery (light, marsh growth, benthic habitat)



Plum Island Ecosystem

Watershed Research


Wil Wollheim and UNH group
UNH

Human Dimensions of Land Use in the Plum Island Ecosystems LTER site

Gil Pontius, Colin Polsky, and a dozen students

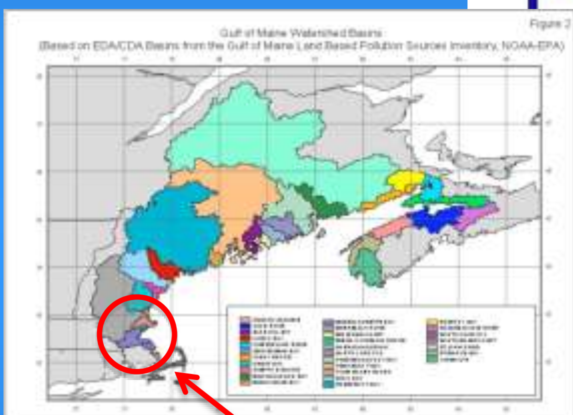
hero.clarku.edu

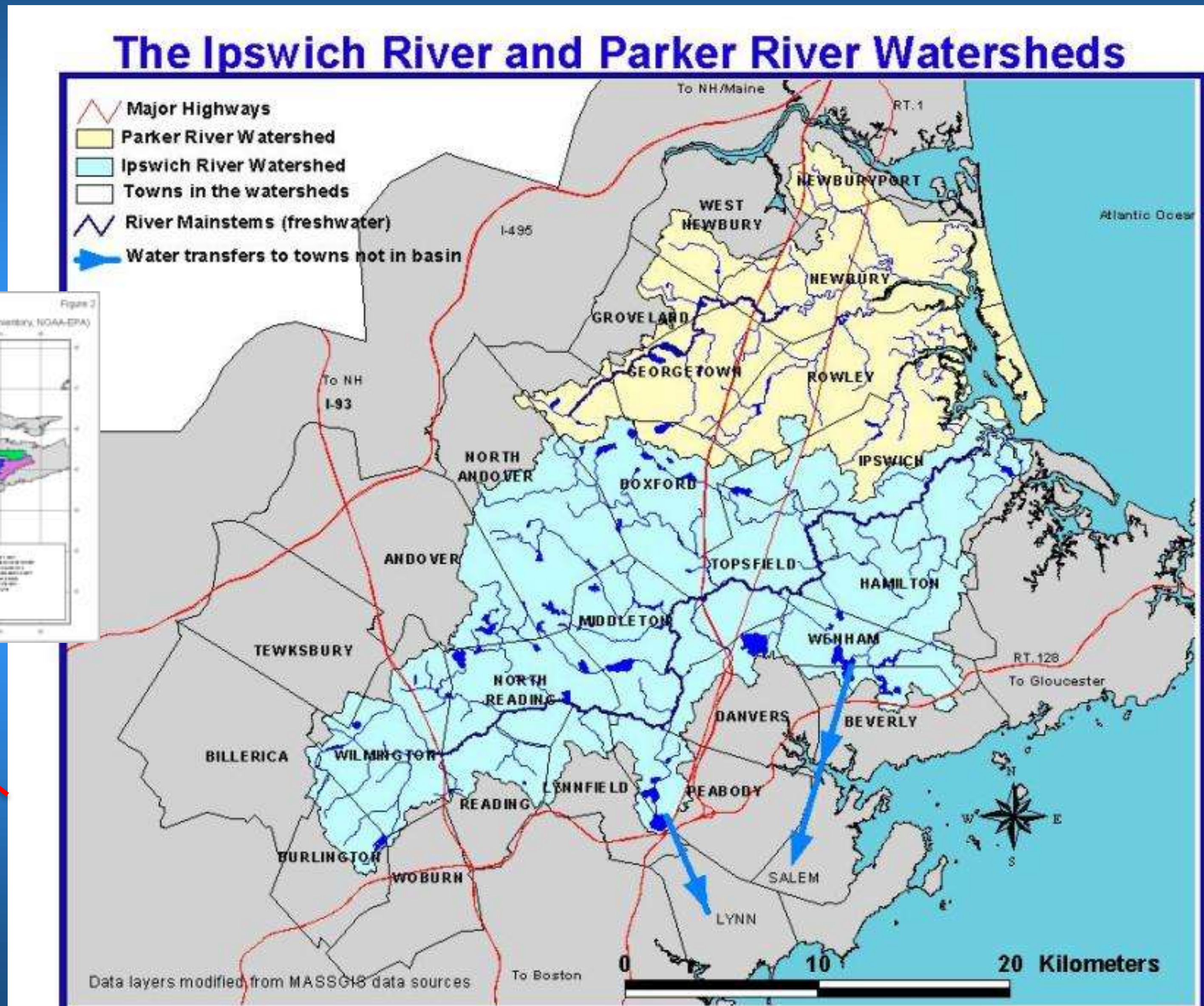
Watershed Questions

Humans alter watershed fluxes of material and water, change within-basin ecosystem connectivity, and alter geomorphology. When combined with climate change what will be the impact on water, organic matter, sediment and nutrient fluxes through the watershed to the estuary?

How do these changes feed back to human behaviors that further alter watershed function?

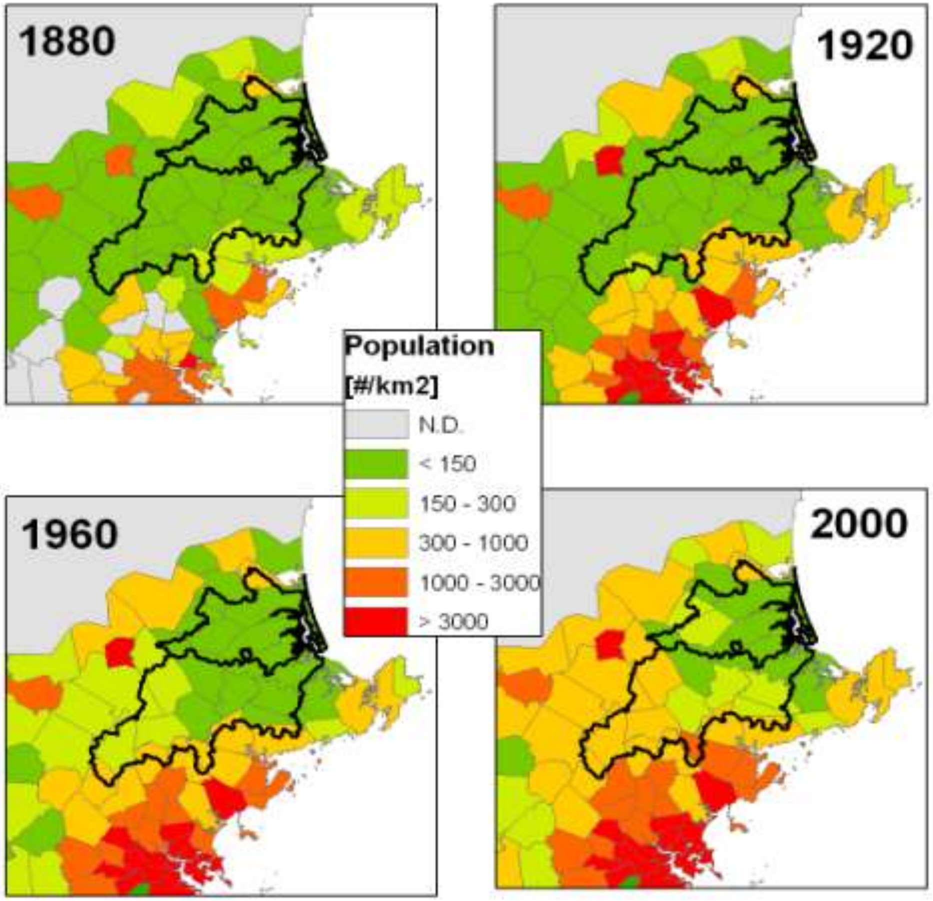
Study Domain



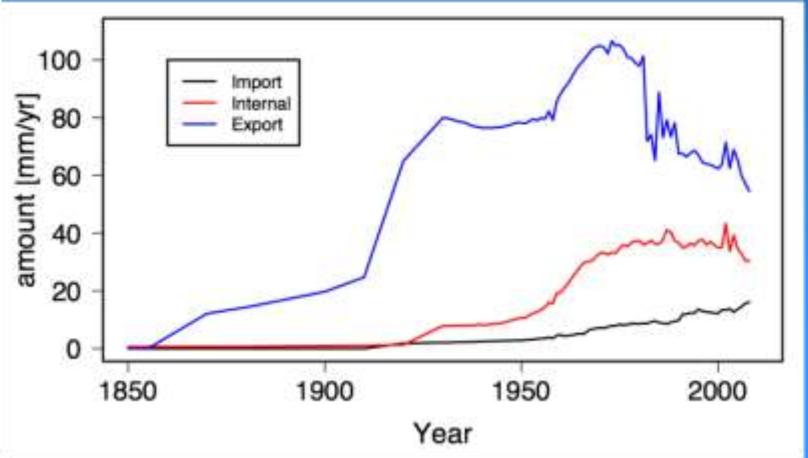


Watershed History and Impacts

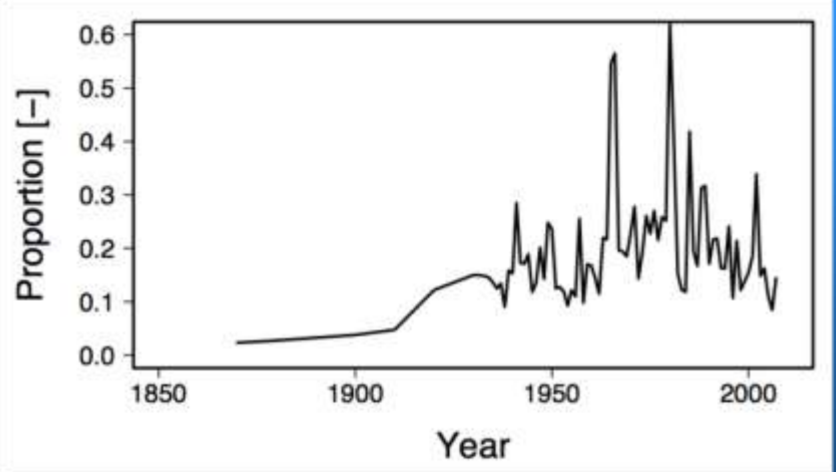
Population Density Through Time



Water Use: Local, Import, Export



Net Diversions

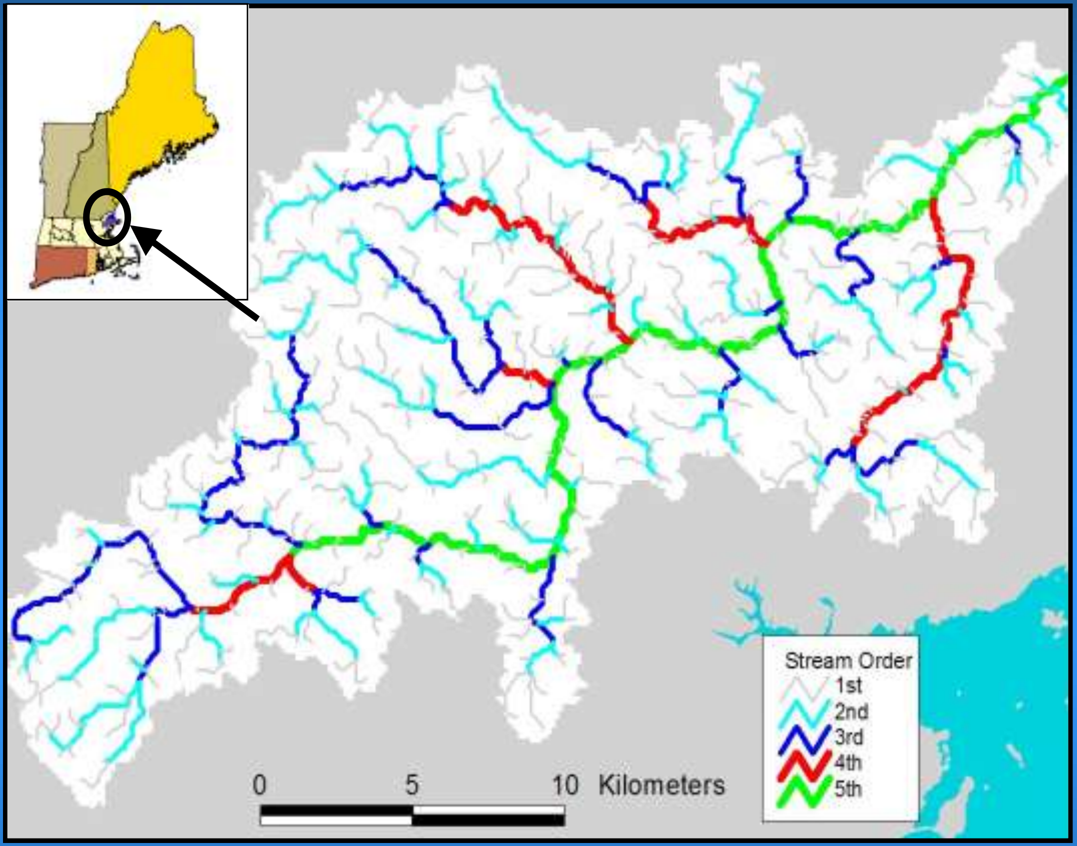


Claessens et al. 2005, Wollheim et al. In Prep.

What we do

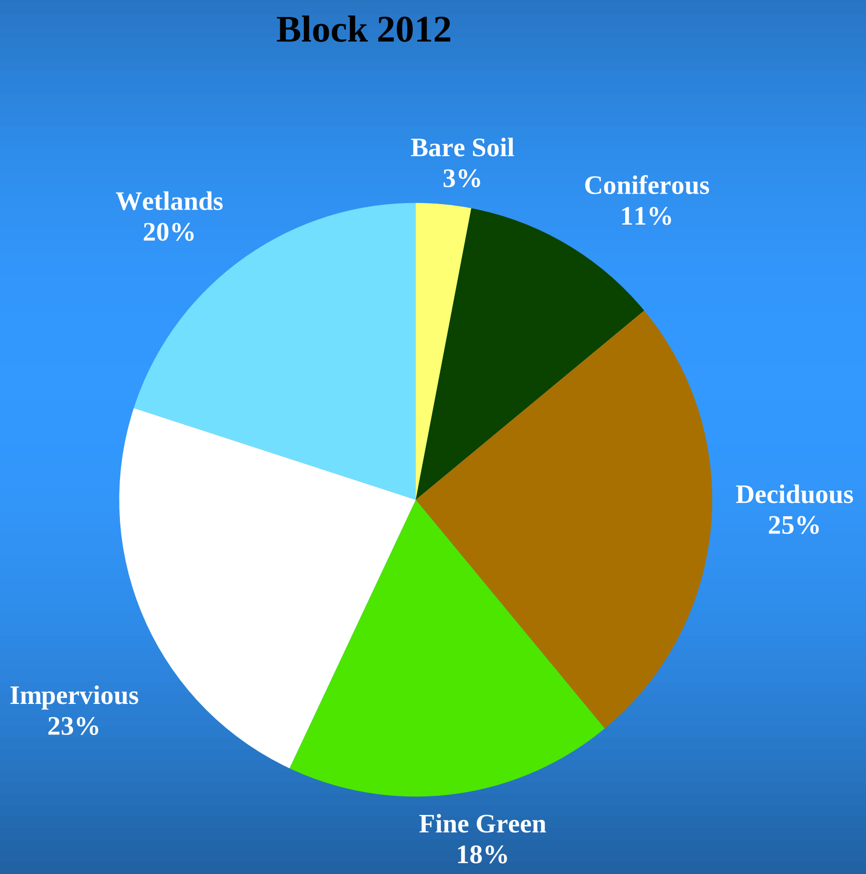
- Detailed Mapping - of features that influence water use, runoff and quality
- Models – especially interesting in predicting water quality, nitrogen concentrations, carbon export
- Monitoring and experiments

Mapping the River Network

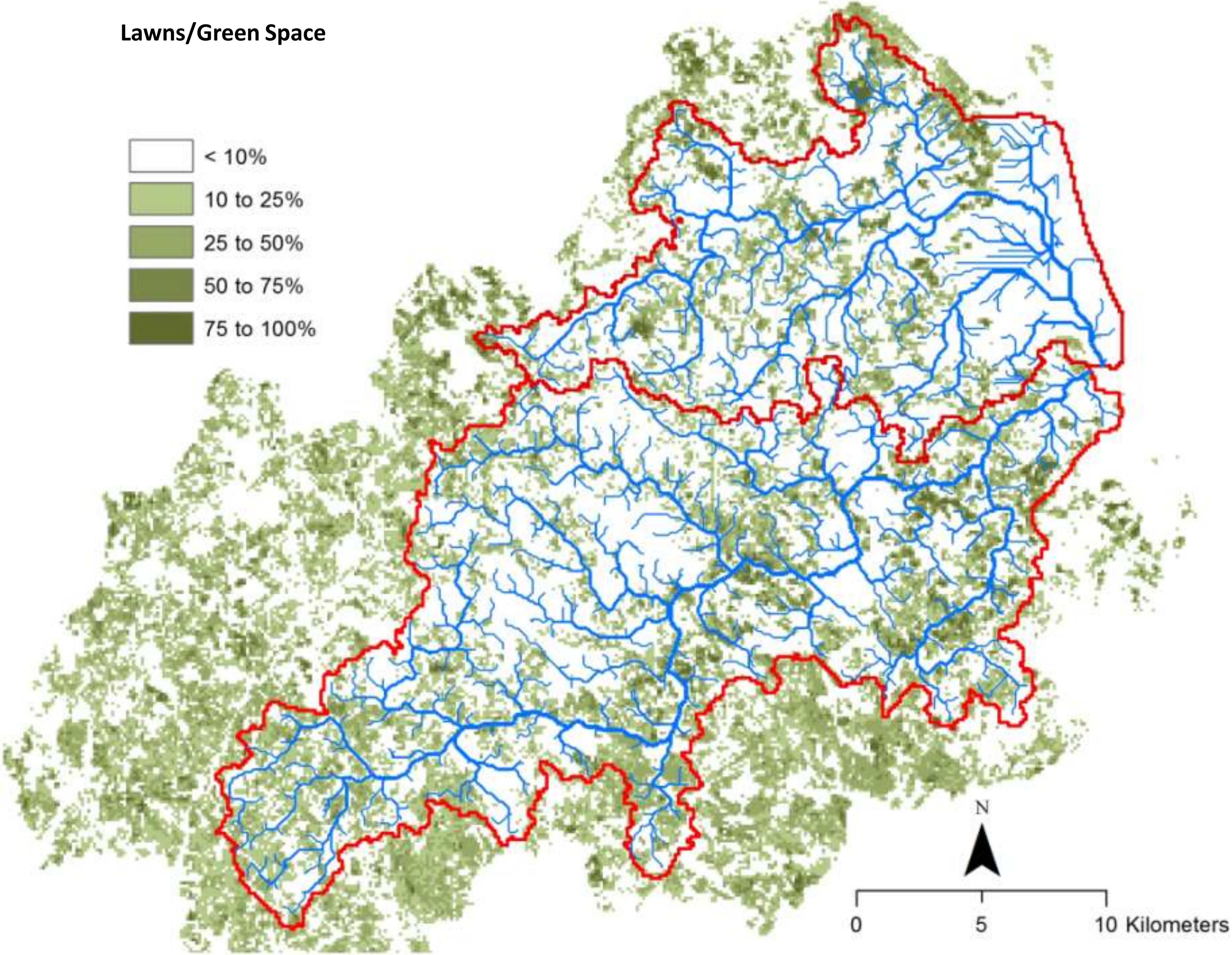


	Direct Drainage (km2)	Mean Area (km2)	Mean Length (km)	Numbers
1	0.52	0.52	0.65	432
2	0.81	2.35	1.33	103
3	1.77	9.6	2.77	28
4	3.39	34.5	5.62	6
5	25.3	404	41.9	1

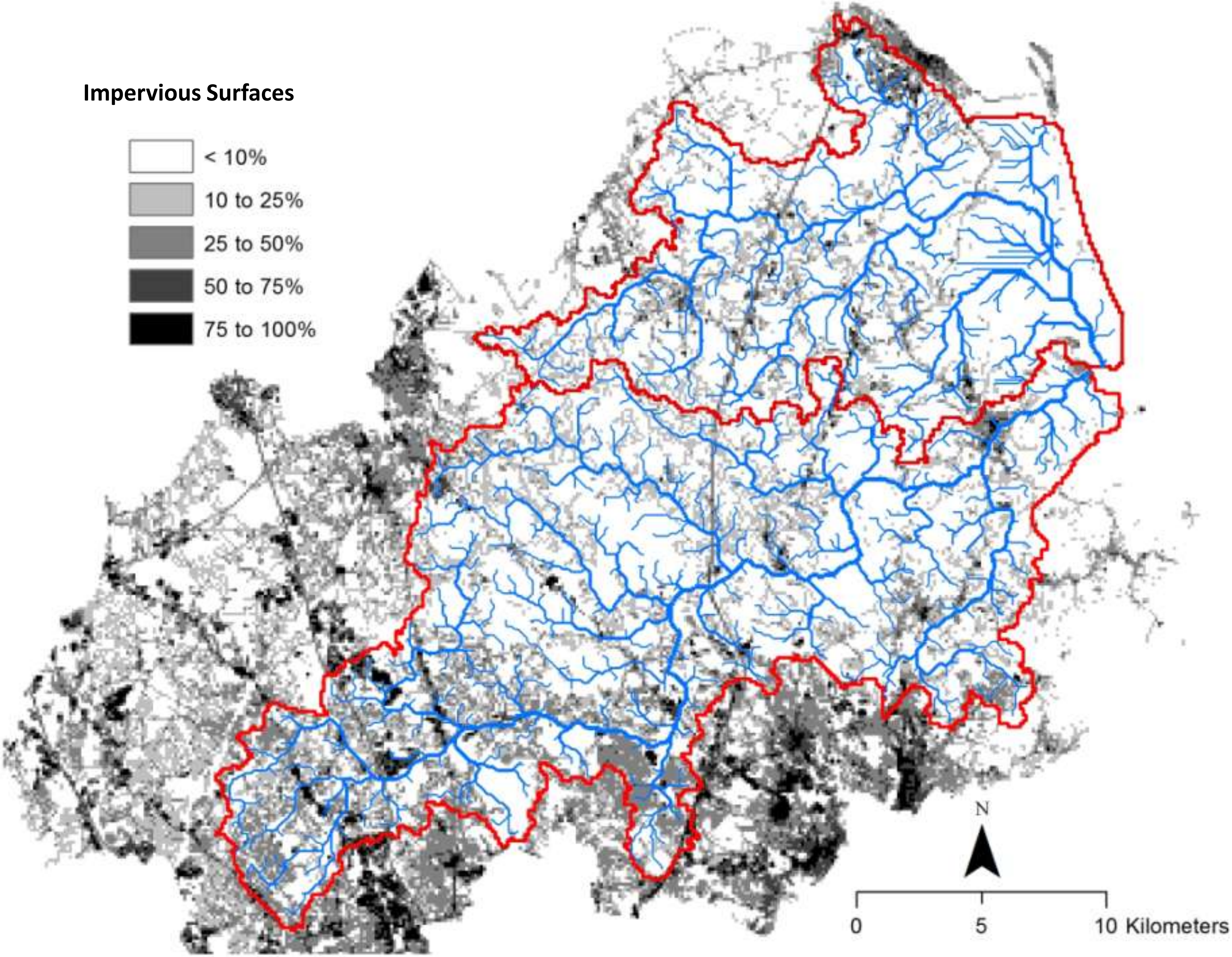
Census Block 2012 in Lynnfield, Massachusetts



Lawns/Green Space

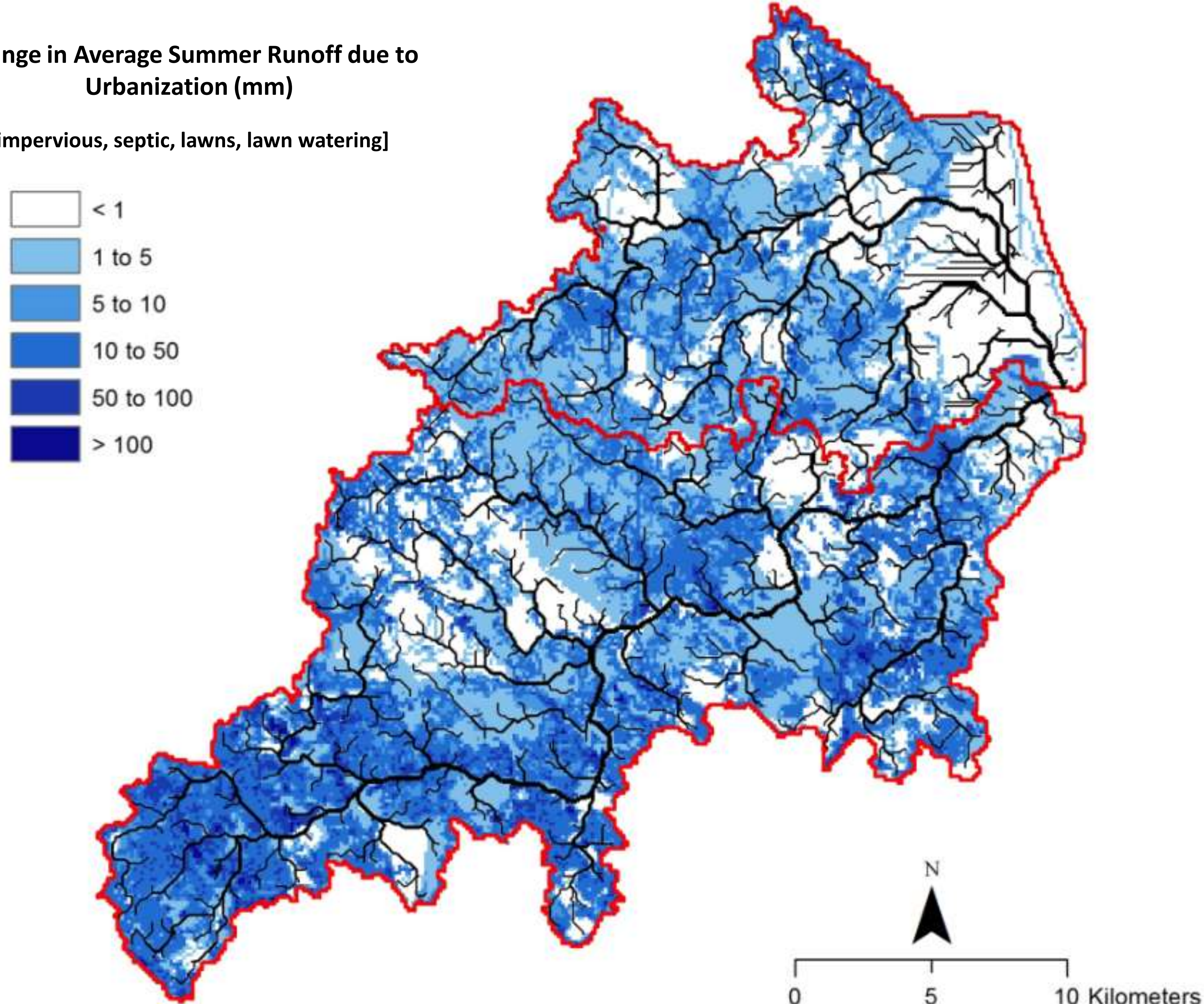


Impervious Surfaces



Change in Average Summer Runoff due to Urbanization (mm)

[impervious, septic, lawns, lawn watering]



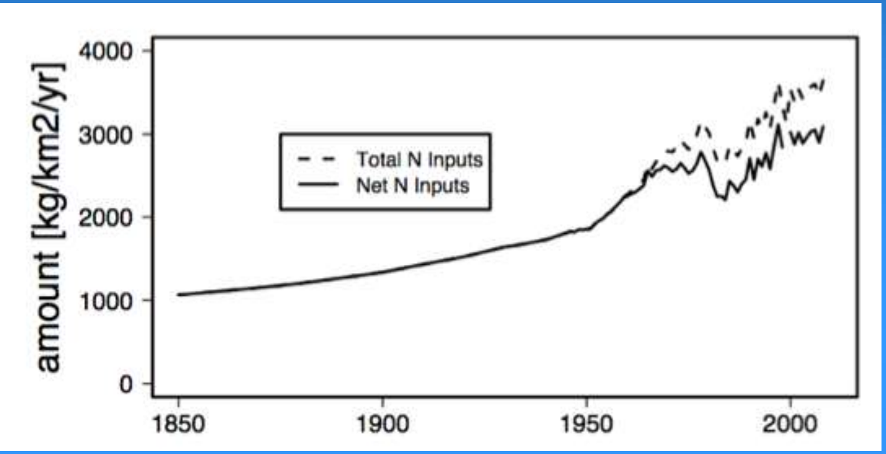
Research Focus:
Fate of N in river network

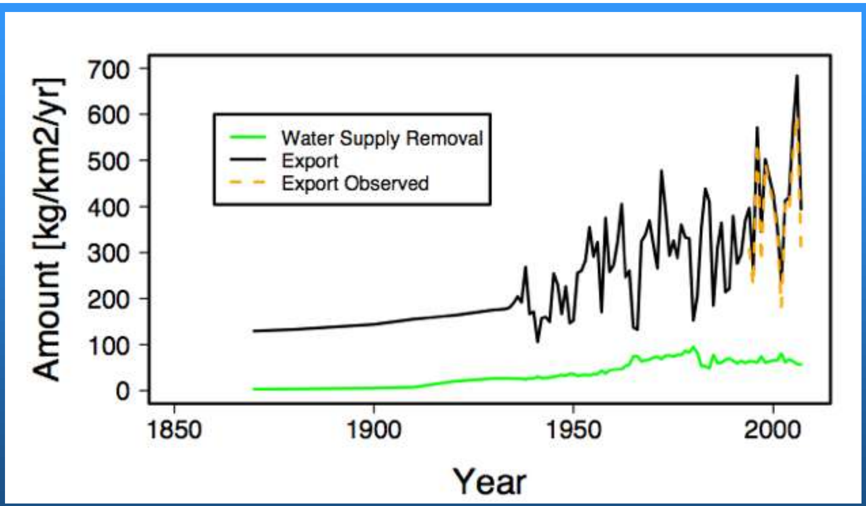
- What determines the effectiveness of the river system to regulate nitrogen fluxes?

  - How does flow condition influence effectiveness to regulate N removal?
  - How is N saturation expressed at network scales?
  - What is the role of different aquatic subsystems as influenced by connectivity and geomorphology?

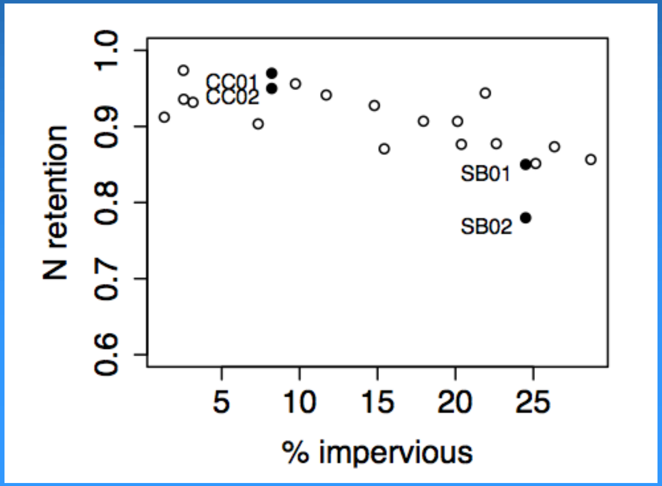
Anthropogenic N Changes

Trajectory of nitrogen loading and fluxes

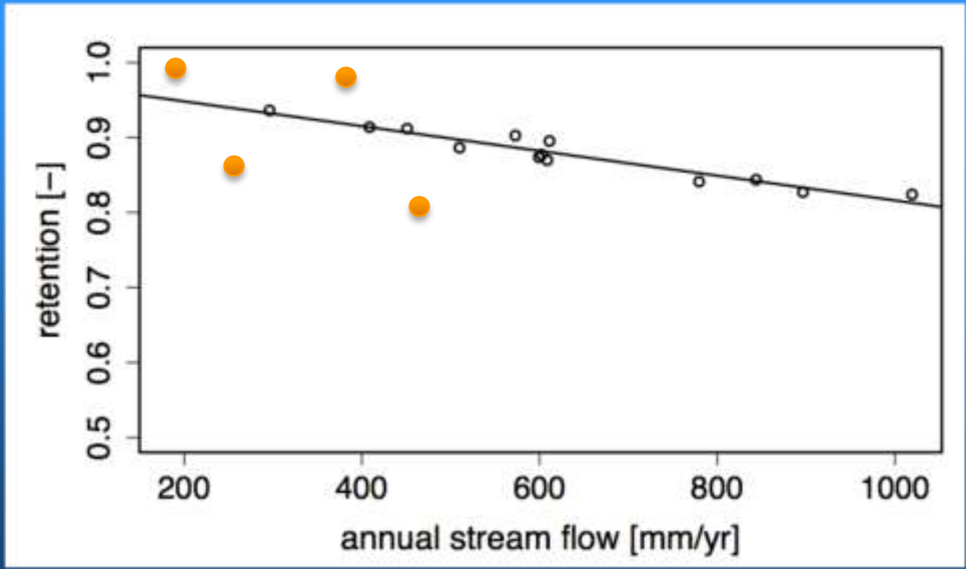




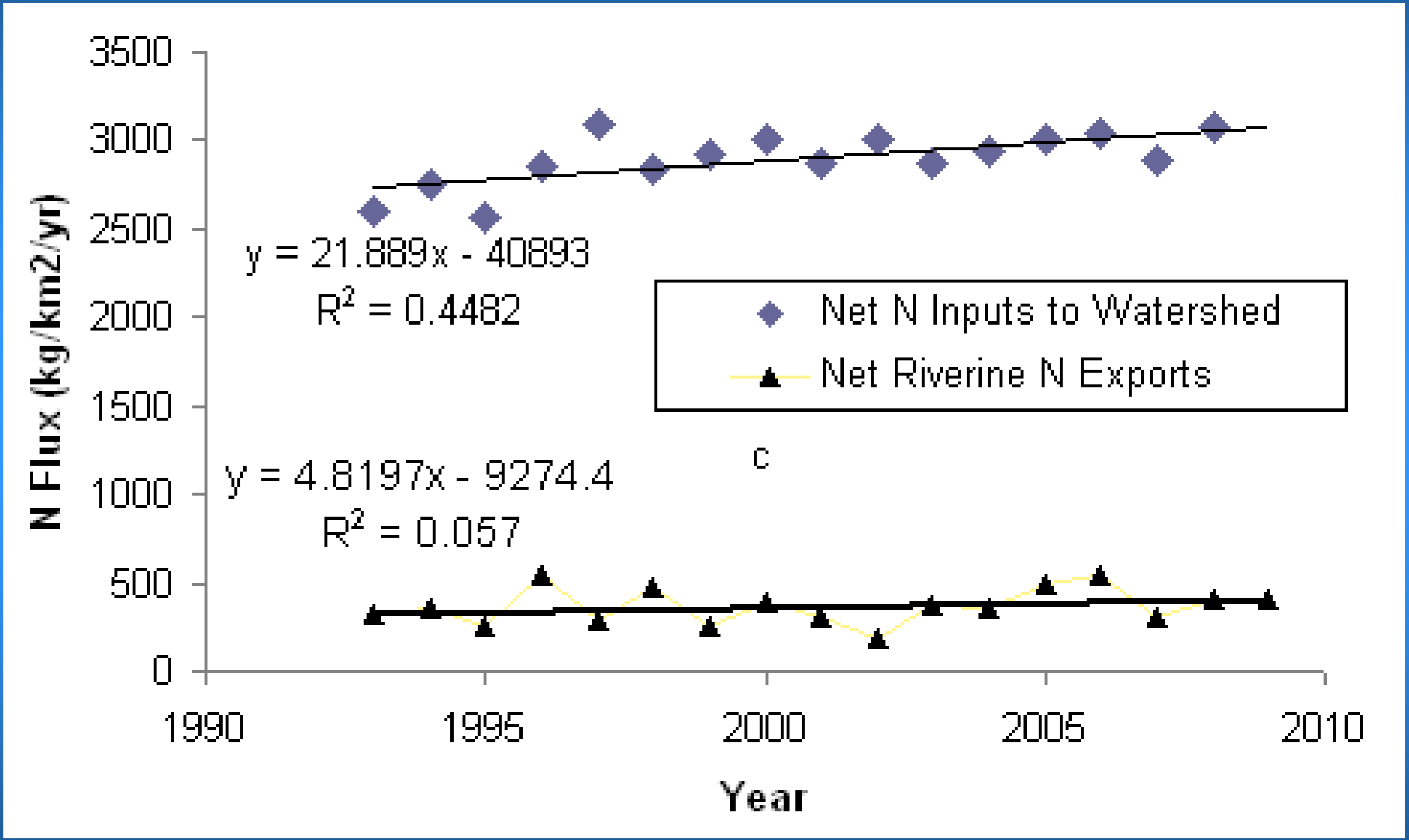
Decline in N removal in suburban watersheds



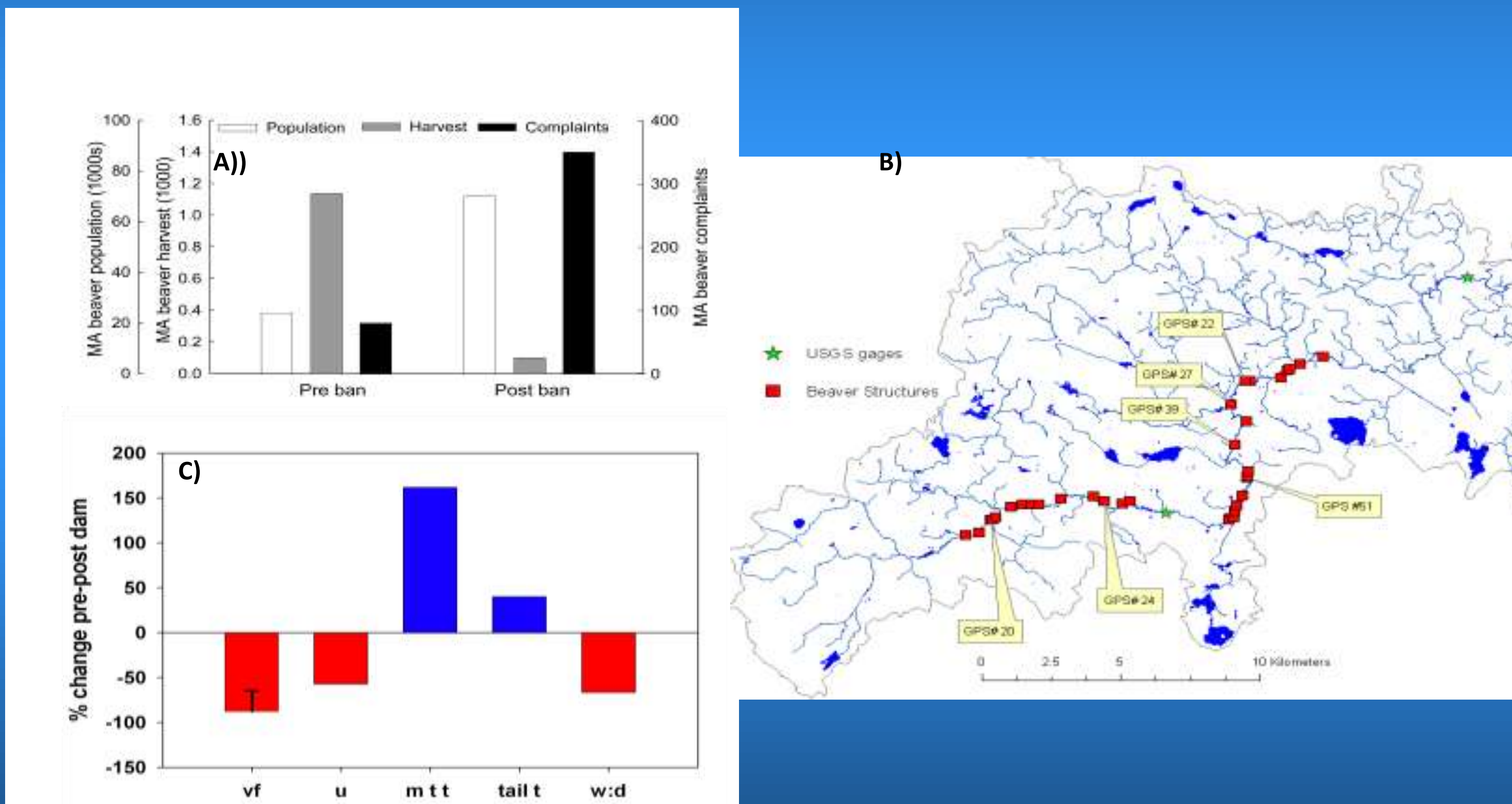
Decline in N removal with runoff

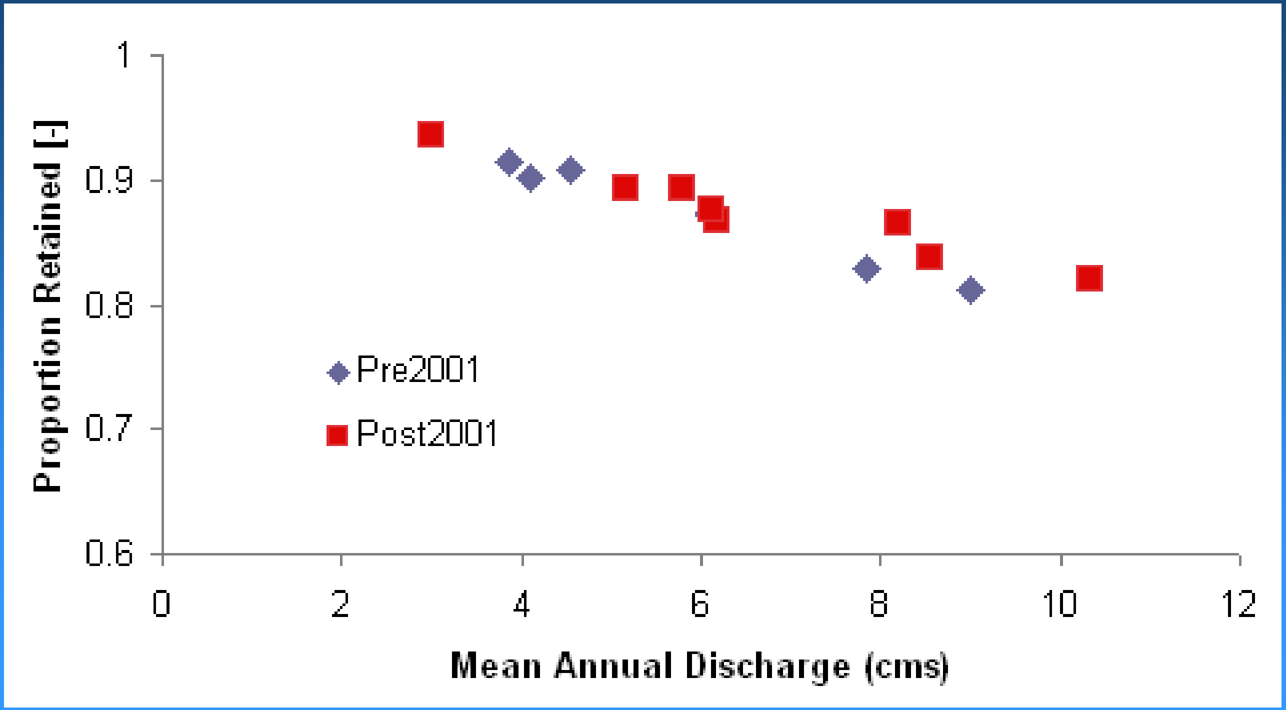


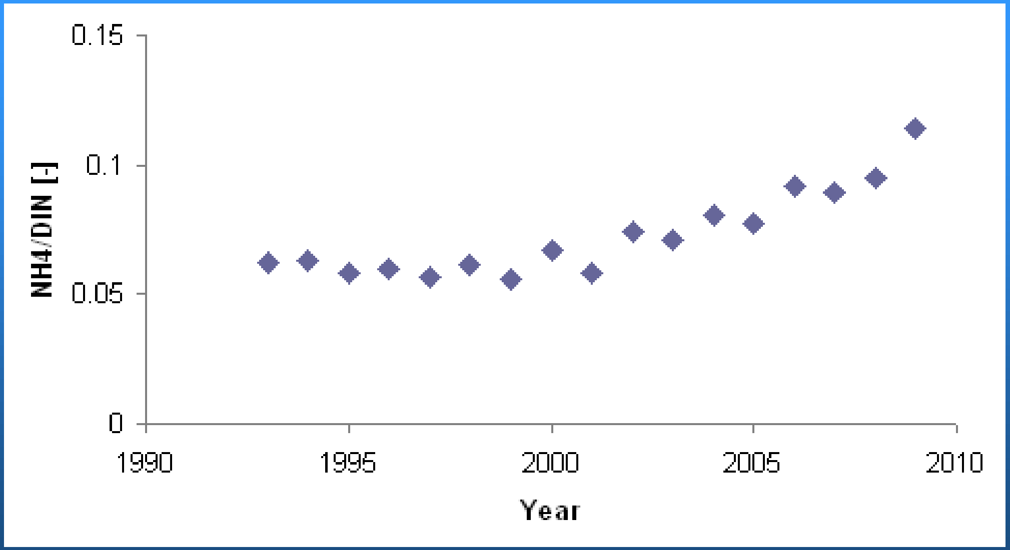
Williams et al. 2005, Wollheim et al. 2005, In Prep,



N Flux (kg/km2/yr)
3500
3000
2500
2000
1500
1000
500
0
1990
1995
2000
2005
2010
Year
y = 21.889x - 40893
R2 = 0.4482
y = 4.8197x - 9274.4
R2 = 0.057
Net N Inputs to Watershed
Net Riverine N Exports
c

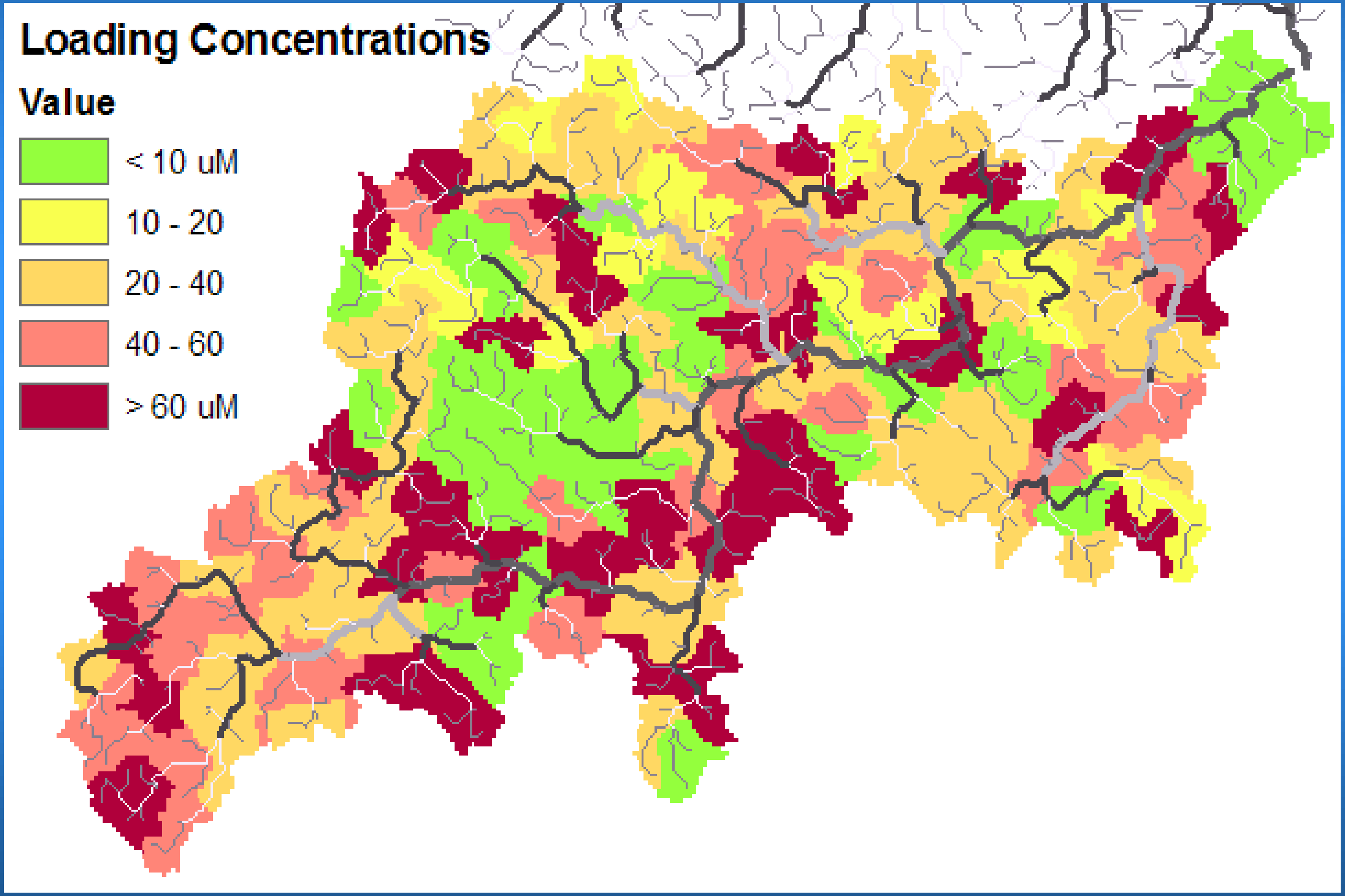

A))
MA beaver population (1000s)
MA beaver harvest (1000)
MA beaver complaints
Population
Harvest
Complaints
Pre ban
Post ban
B)
USGS gages
Beaver Structures
GPS# 22
GPS# 27
GPS# 39
GPS #51
GPS# 20
GPS# 24
0
2.5
5
10 Kilometers
C)
% change pre-post dam
vf
u
m t t
tail t
w:d





- Slight change in retention and % ammonium?

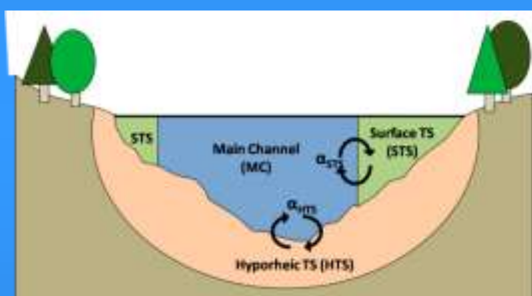
Ipswich River N loading

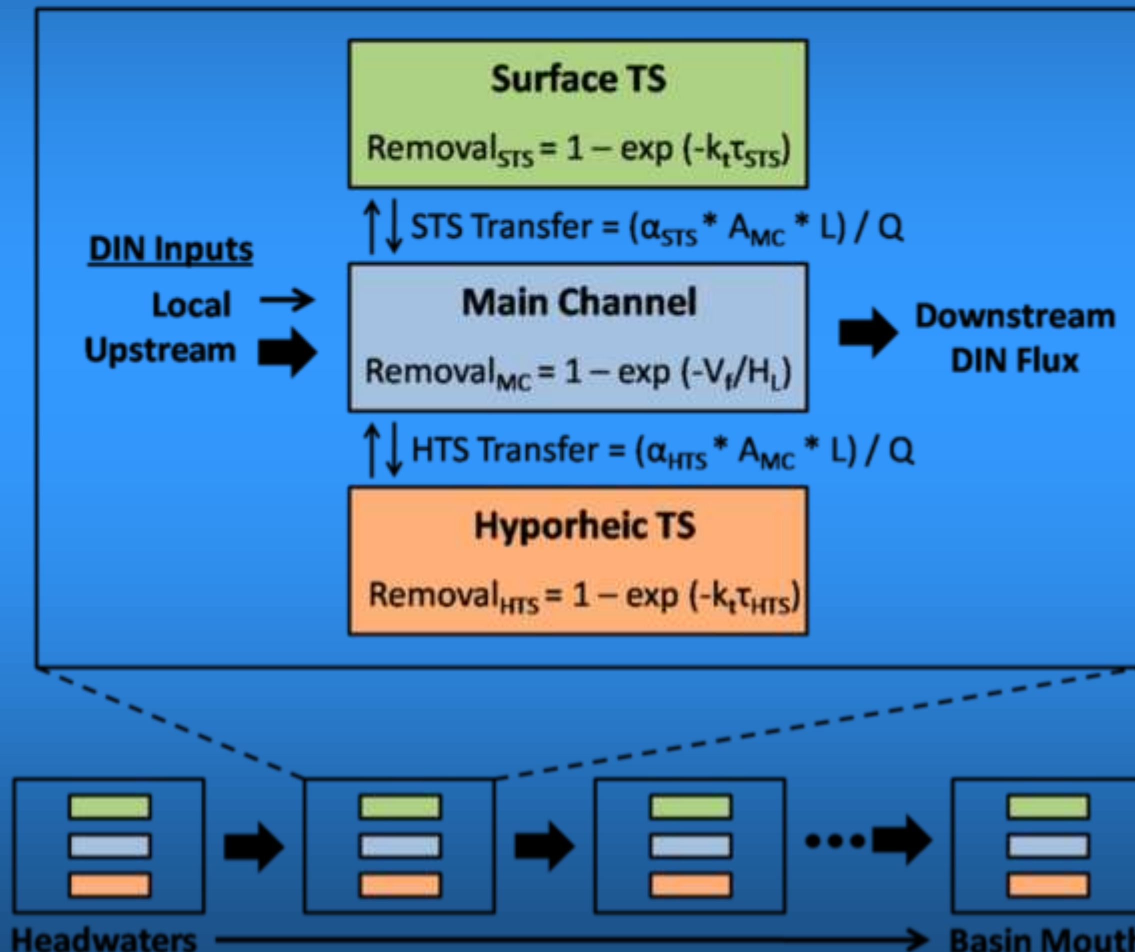


Incorporating connectivity of multiple habitats

Model derived from Mulholland and DeAngelis (2000)

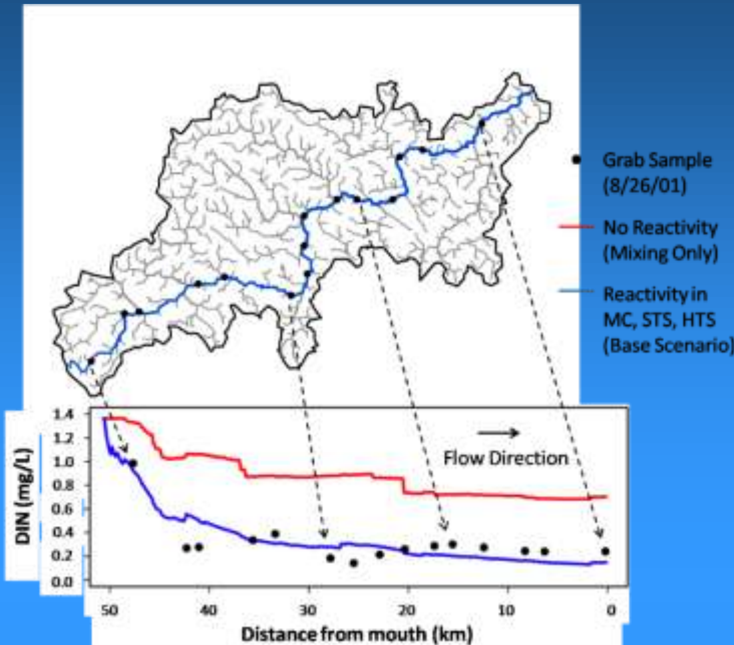
Cross-section

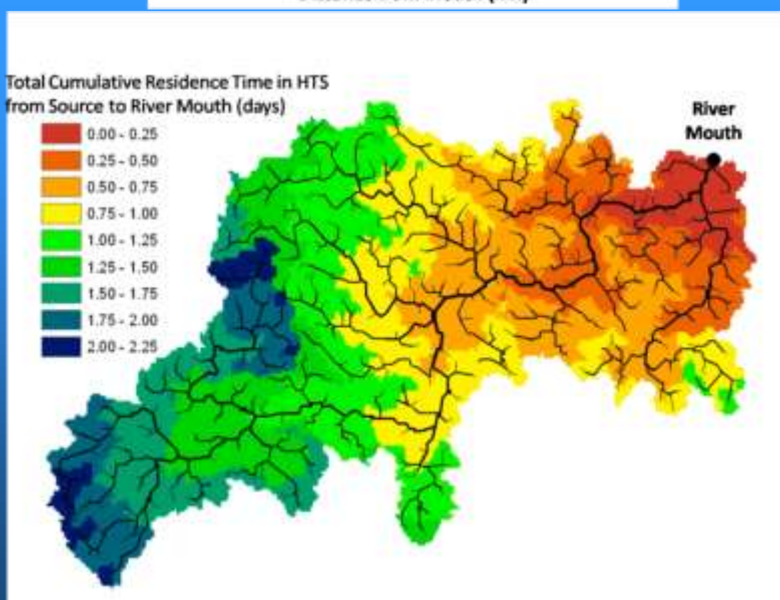


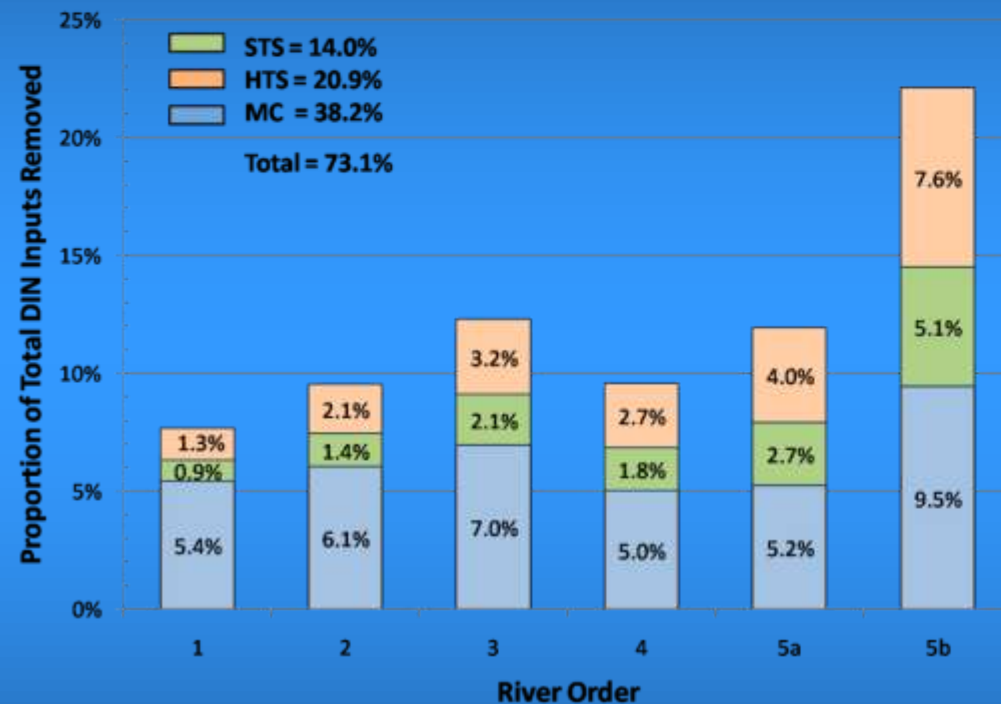


Stewart et al. In Review. WRR

Model Results - Baseflow





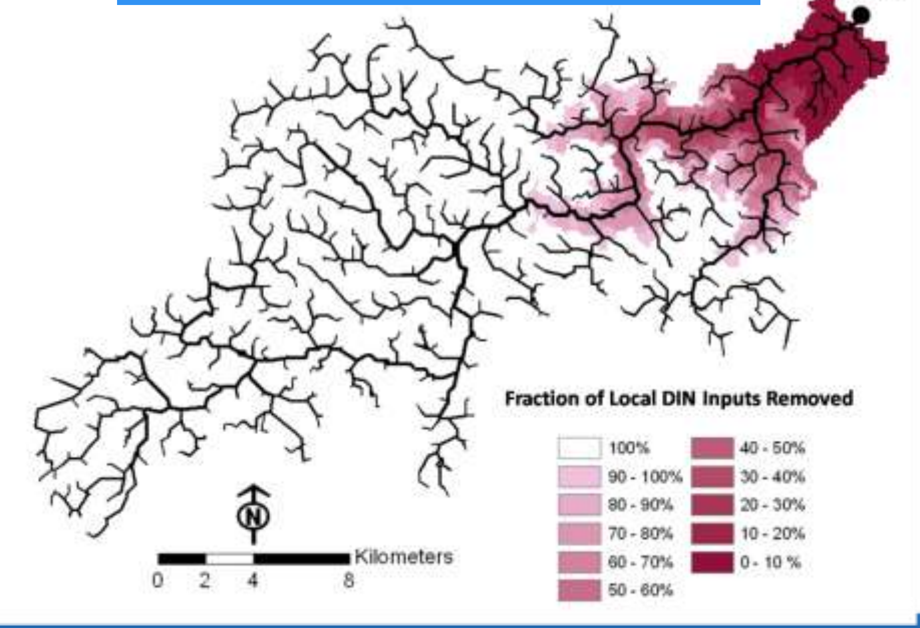


Stewart et al. In Review WRR

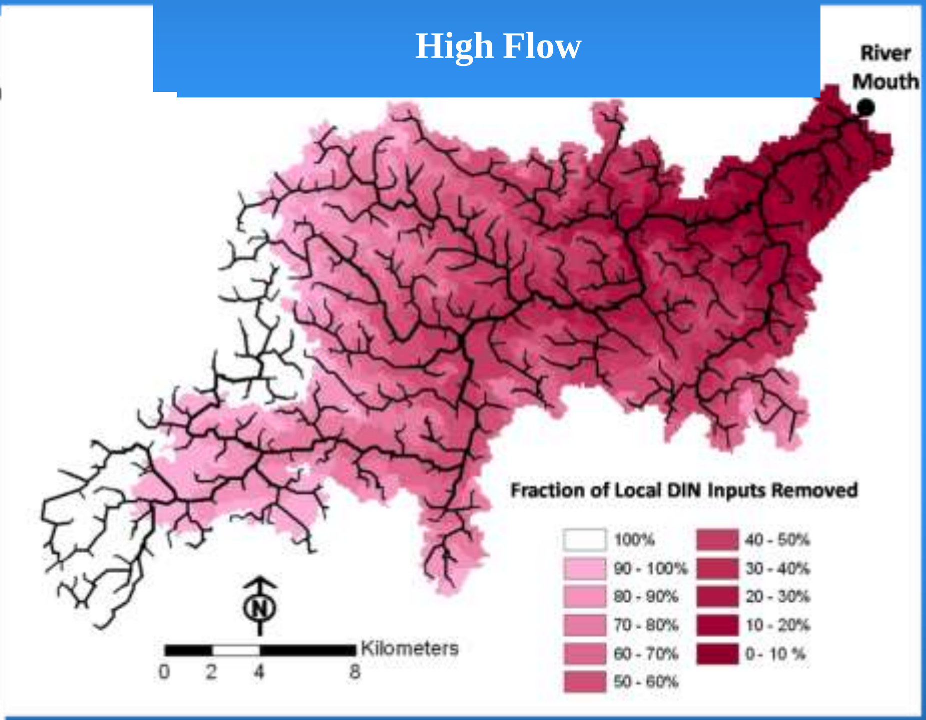
Management Relevance: Zone of Influence for Estuarine Health

Proportion of watershed contributing to coastal fluxes

Low Flow

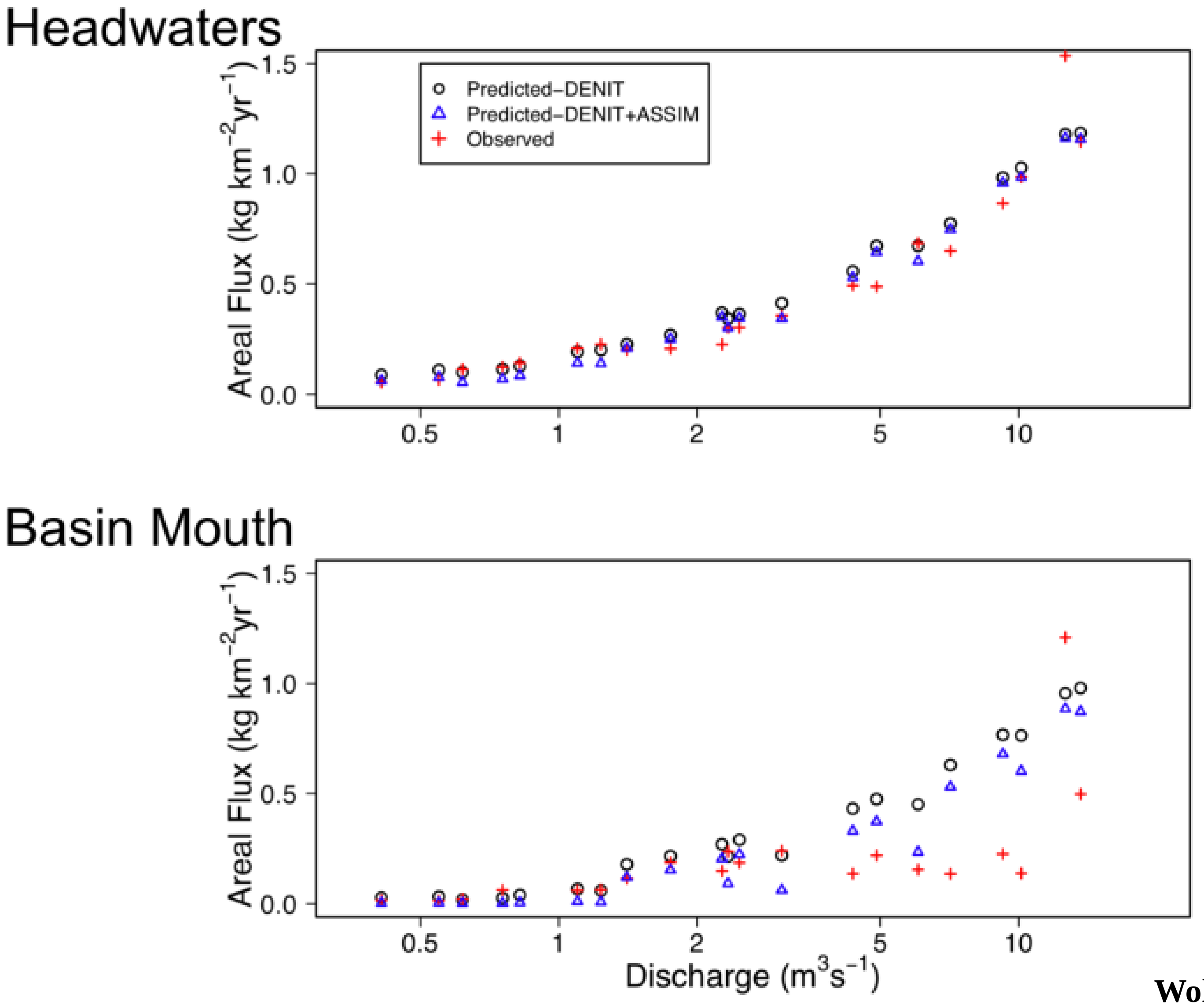


High Flow



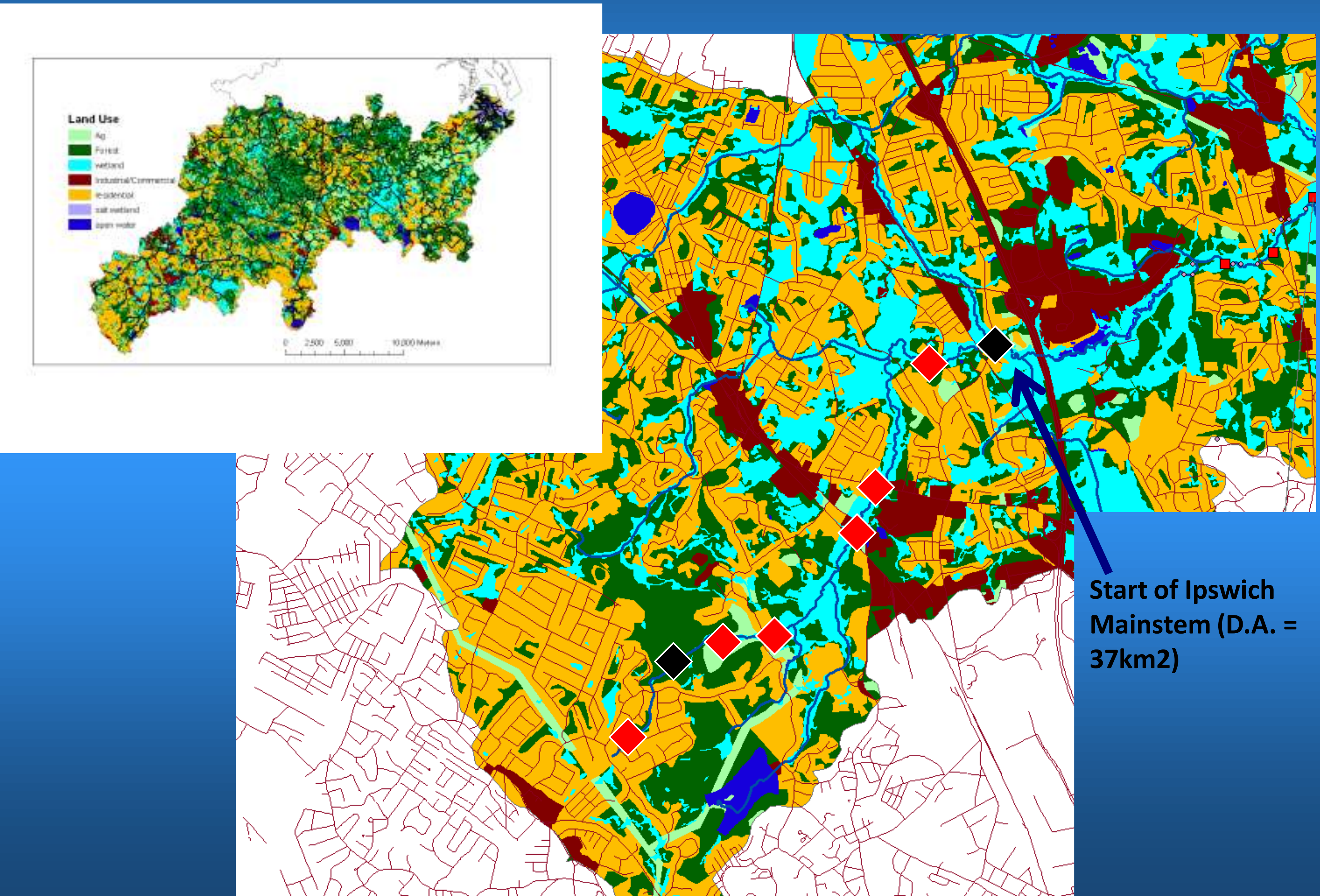
Stewart. 2009. UNH M.S. Thesis

Model does not match observations at high flows



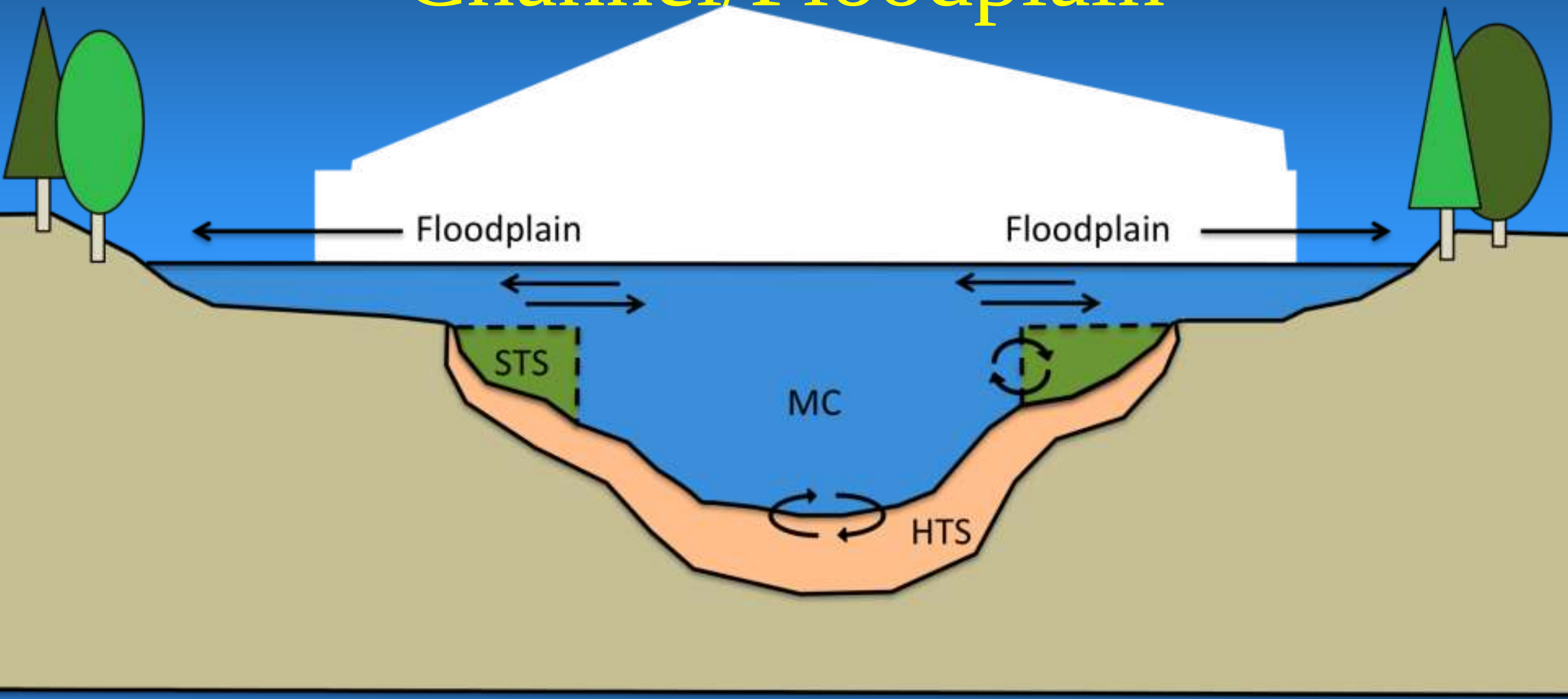
Wollheim et al. 2008

Role of Heterogeneity, Hot Spots, and Hot Moments: Wetlands and Floodplains



Start of Ipswich Mainstem (D.A. = 37km2)

Channel/Floodplain

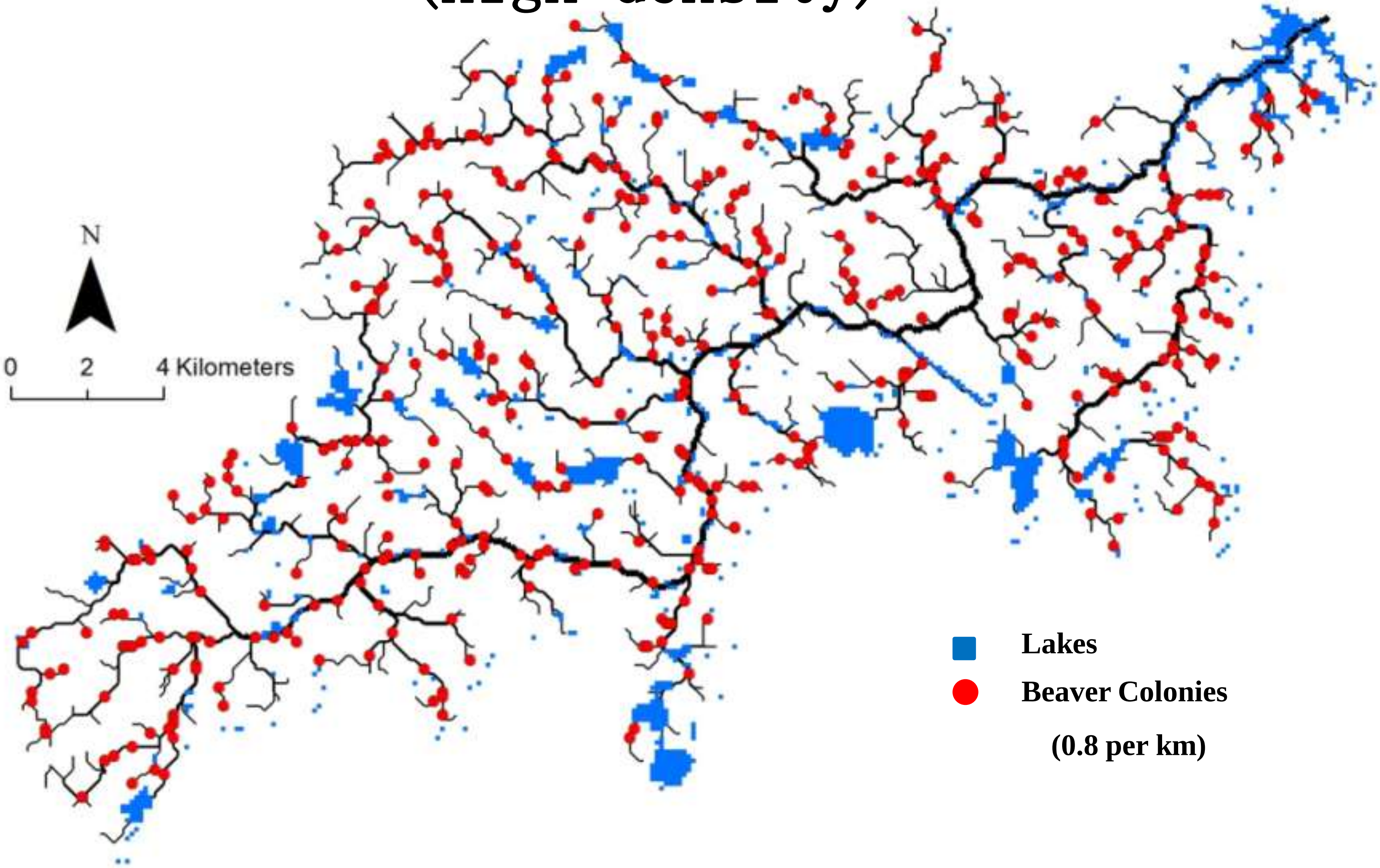


Assumptions: Floodplain in 4th/5th order only

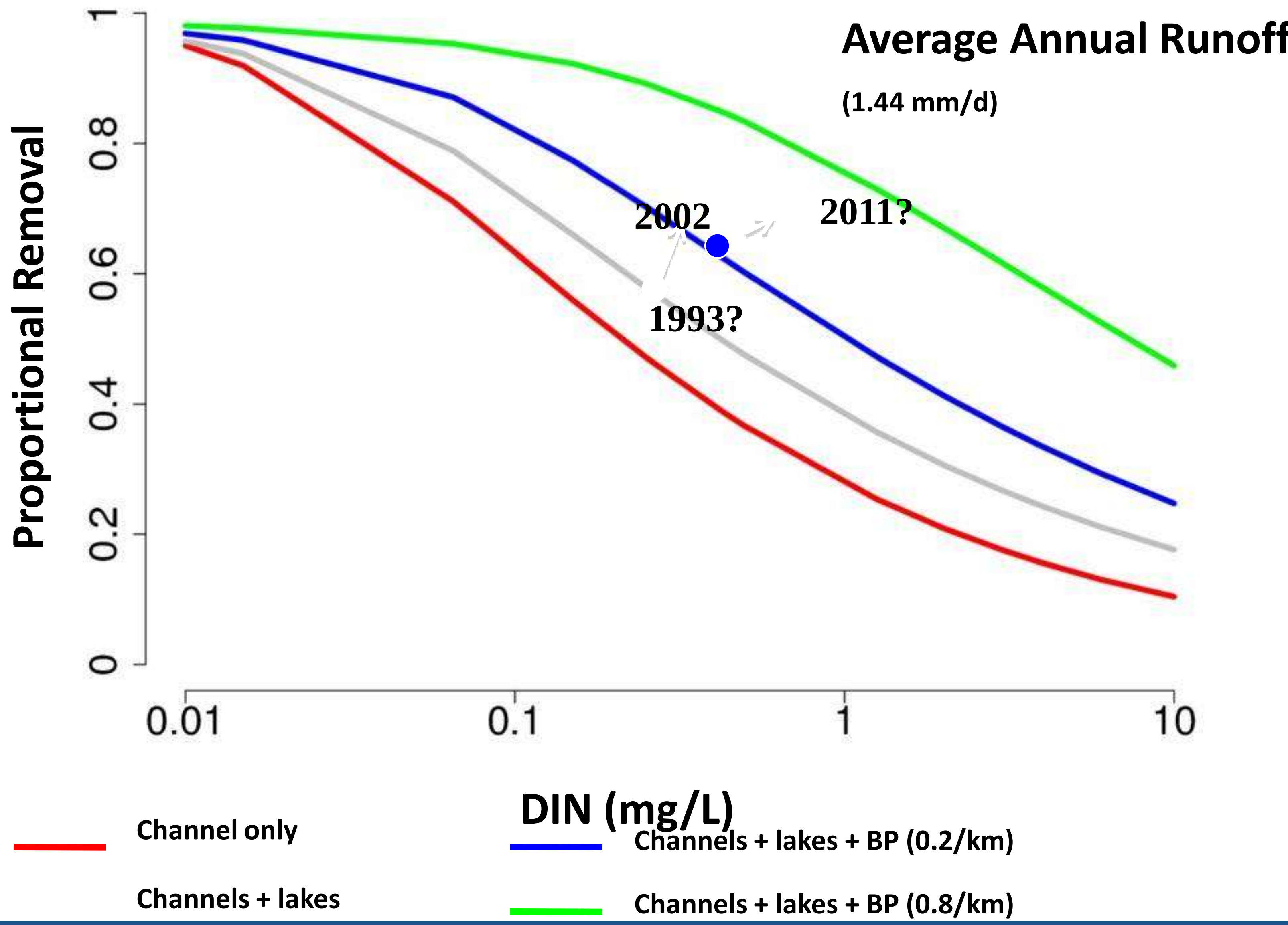
Well mixed with MC

Same reactivity as MC

Network with Lakes + Beaver Ponds (high density)



Network-scale N retention




Questions?