

Nitrogen Research in the Lamprey River Watershed and the Great Bay Estuarine Ecosystem

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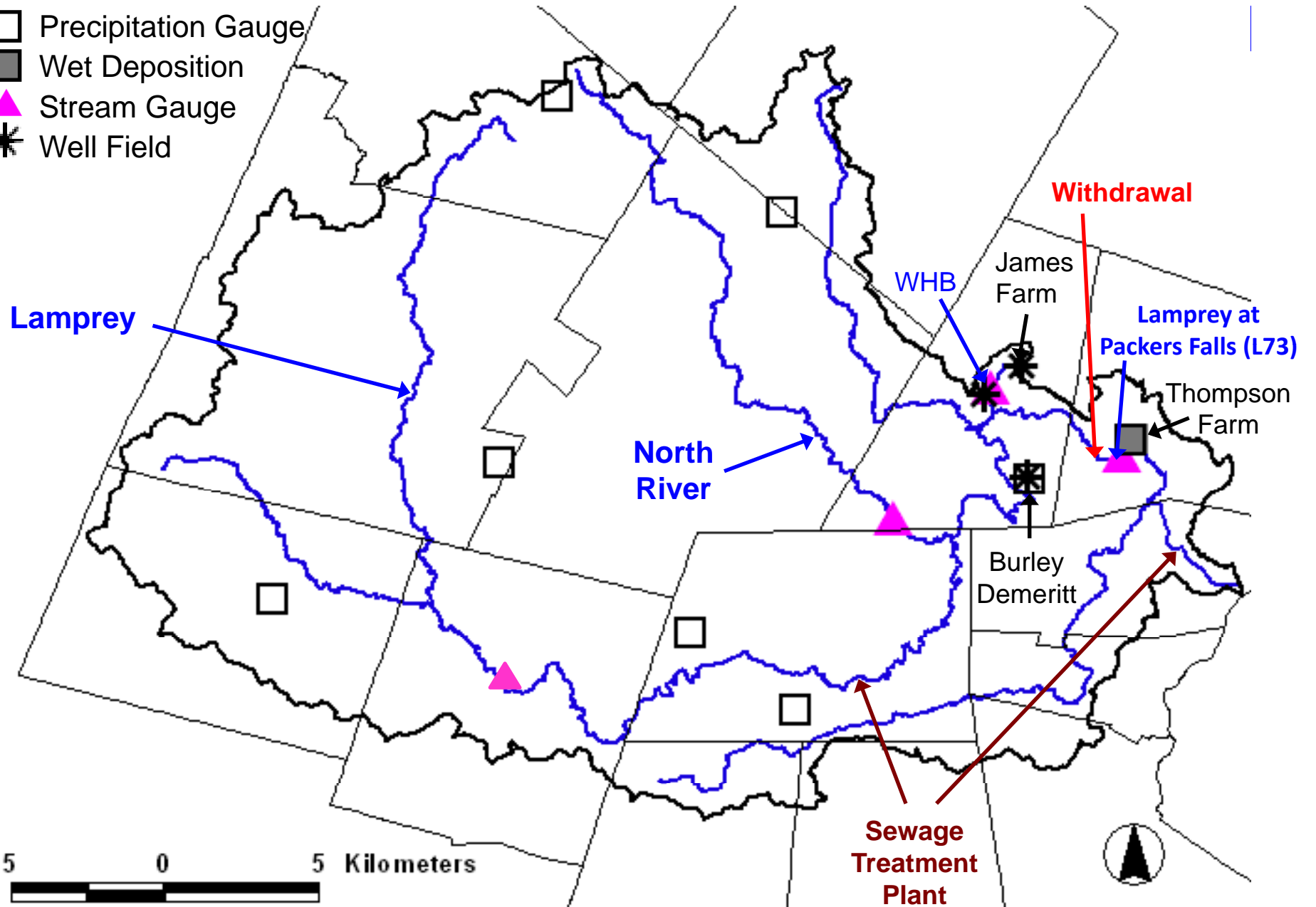


University of
New Hampshire



Lamprey River Hydrologic Observatory

- Precipitation Gauge
- Wet Deposition
- ▲ Stream Gauge
- * Well Field



The Lamprey River is the Largest Tributary to Great Bay

LR Watershed = 550 km²





Nitrogen Research Questions

- Are there *long-term trends* in LRHO stream chemistry?
 - Weekly, storm event stream water N since 1999 at L73
- What is the *N budget* for the LRHO?
 - Quantify N inputs, outputs and retention from 2000-2009
- How do N outputs and retention vary for Lamprey and Oyster *sub-basins with different landscape attributes and levels of inputs*?
 - Quantify N budgets, population density, land use and impervious surfaces for various sub-basins



Forms of Nitrogen (N)

Particulate N
(Measured Since Oct 2002)

Dissolved N
(Measured since Sept. 1999)

Dissolved Inorganic
Nitrogen (DIN)

Dissolved Organic
Nitrogen (DON)

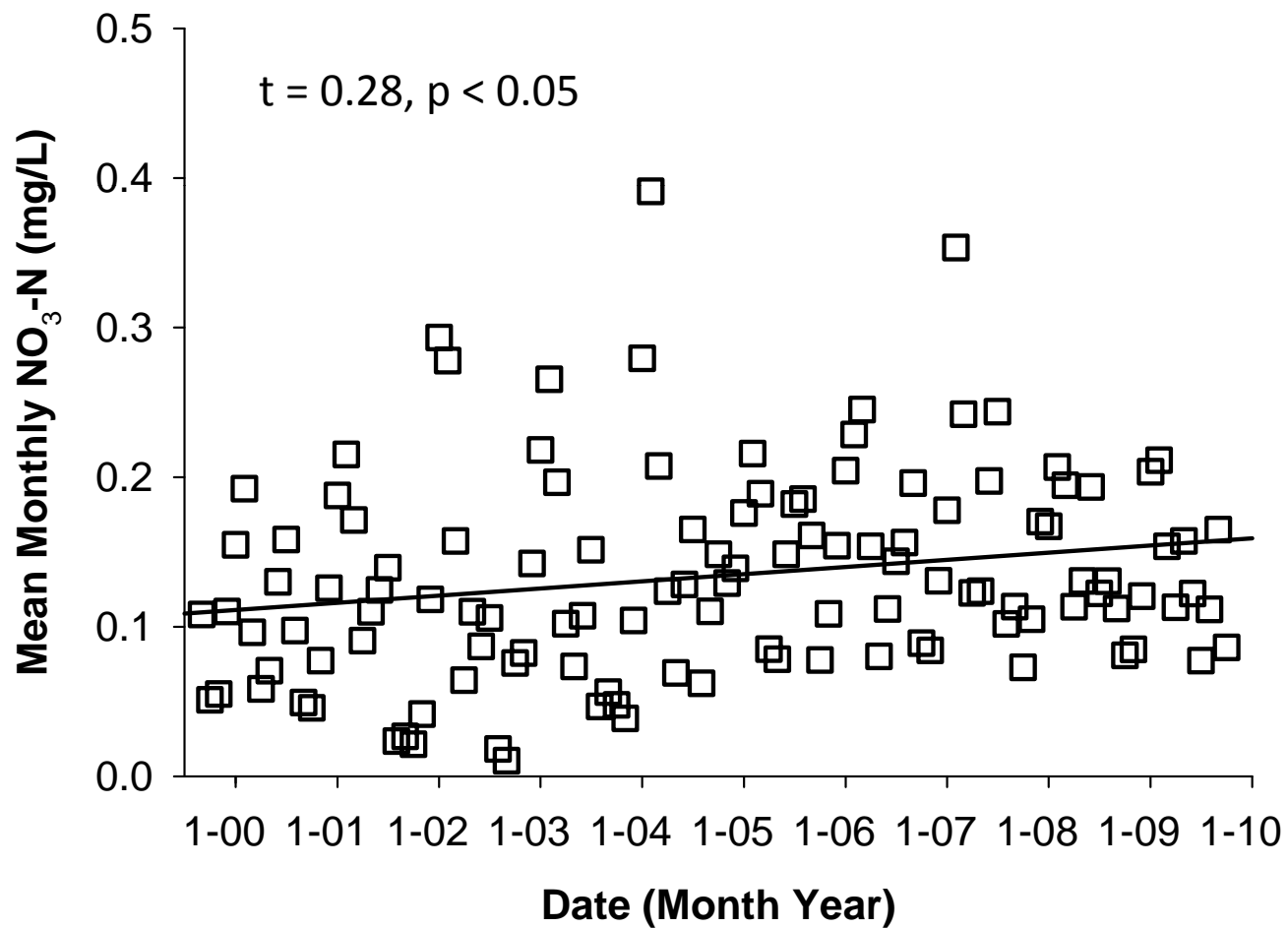
Nitrate
(NO_3^-)

Ammonium
(NH_4^+)

Use 10 years of data to examine trends in dissolved N at L73

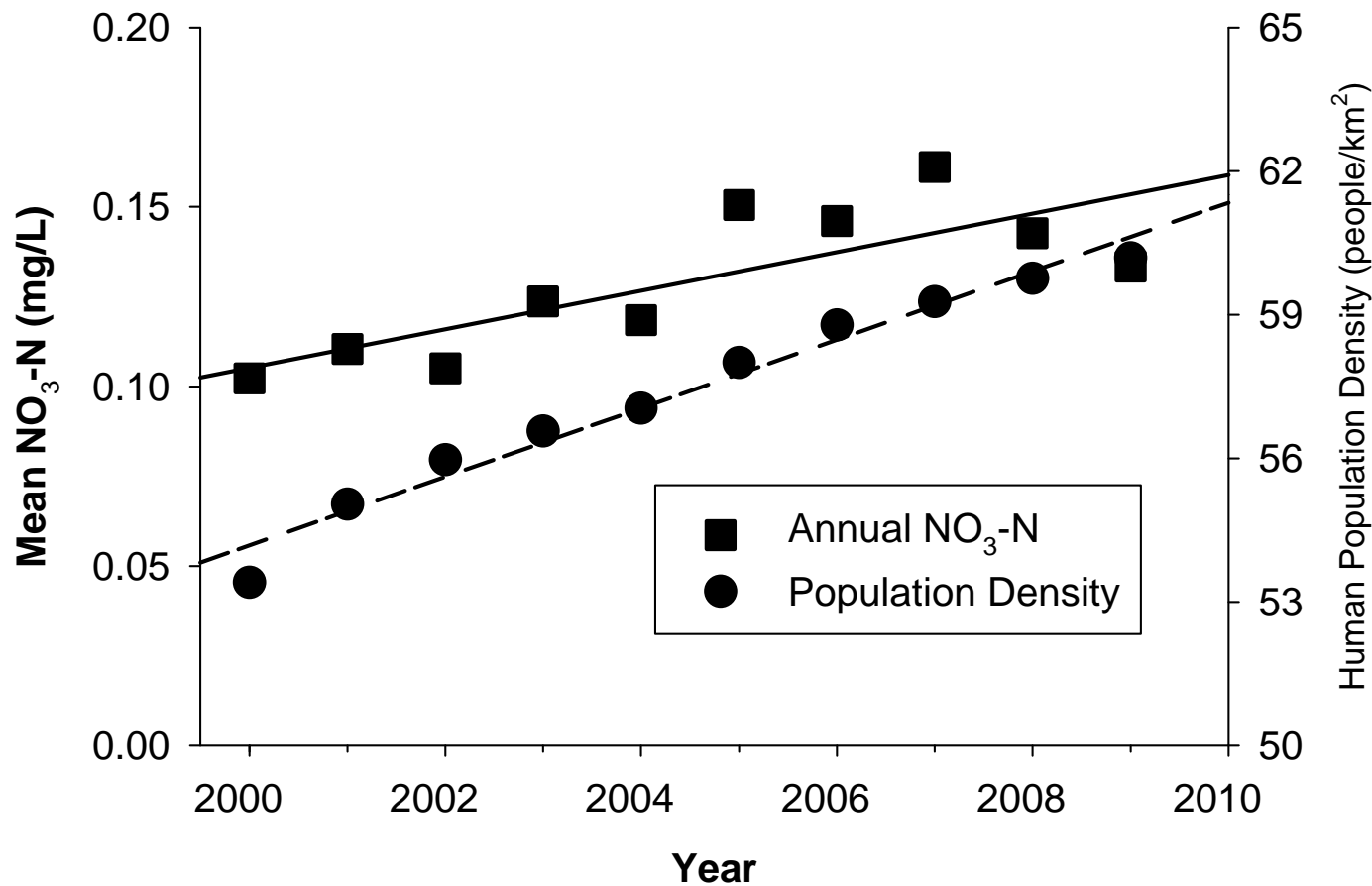


Nitrate (NO_3^-) is increasing at L73





Increase is associated with increasing human population density



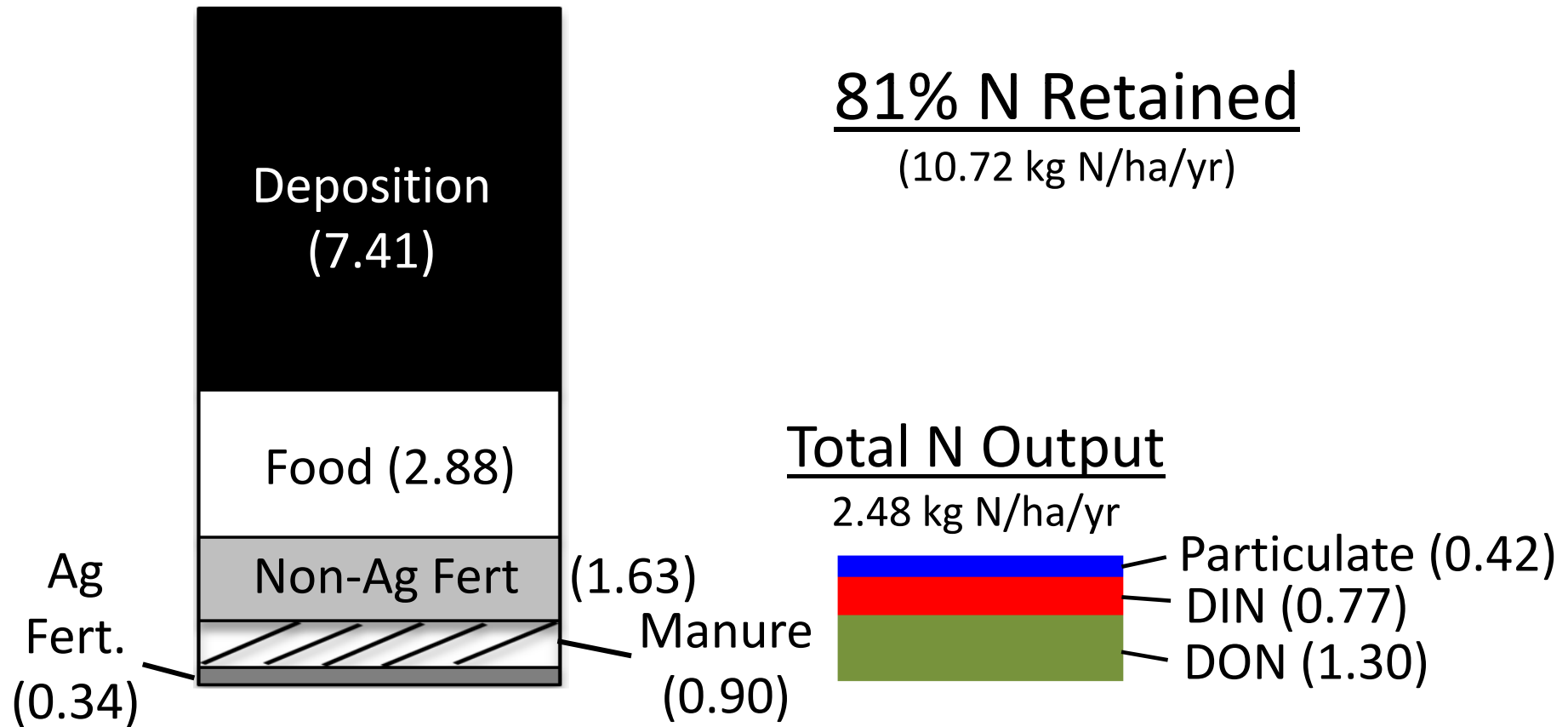


Nitrogen budget for the Lamprey watershed (L73)

Total N Input
13.2 kg/ha/yr

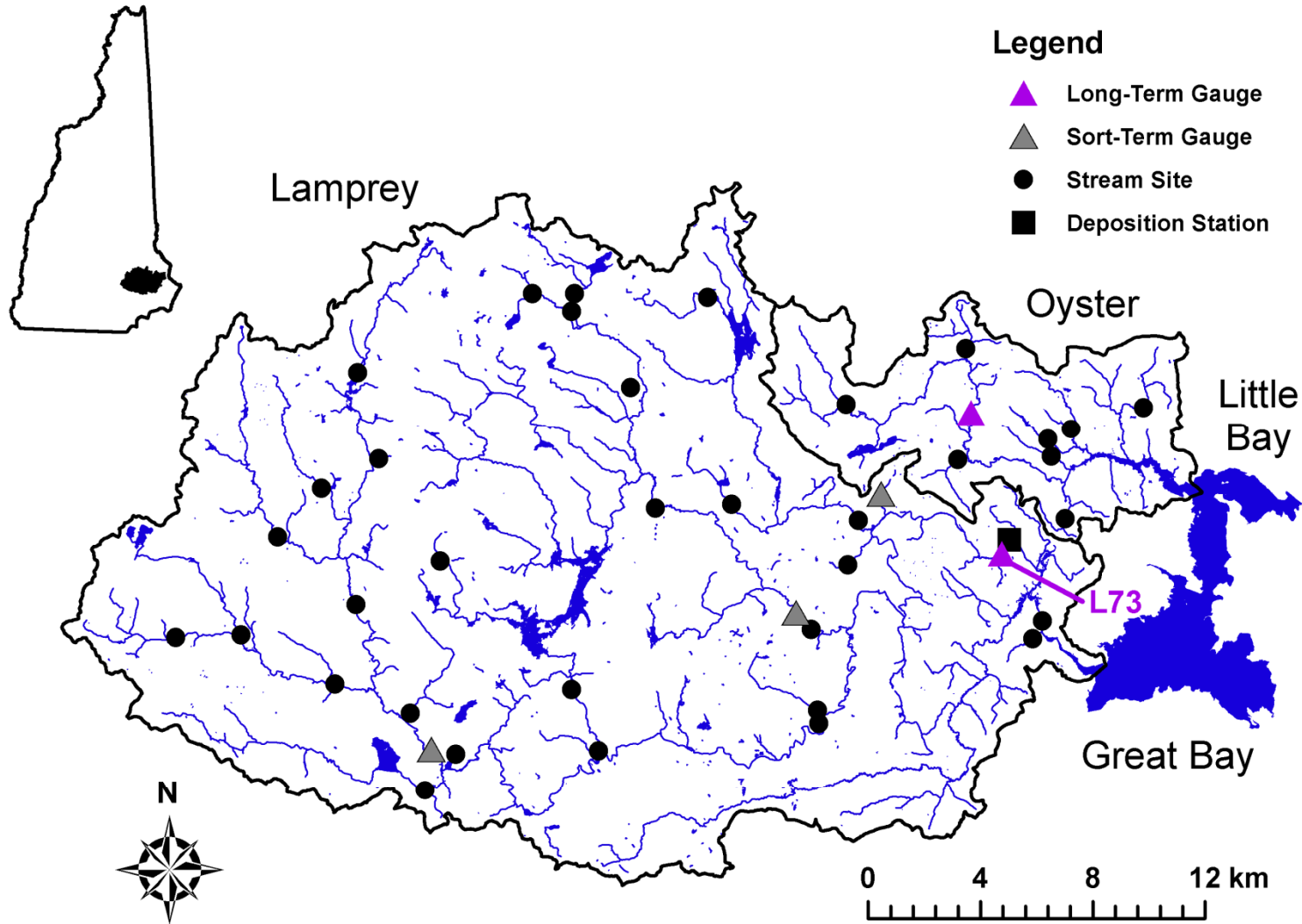
(Median 2000-2009)

81% N Retained
(10.72 kg N/ha/yr)



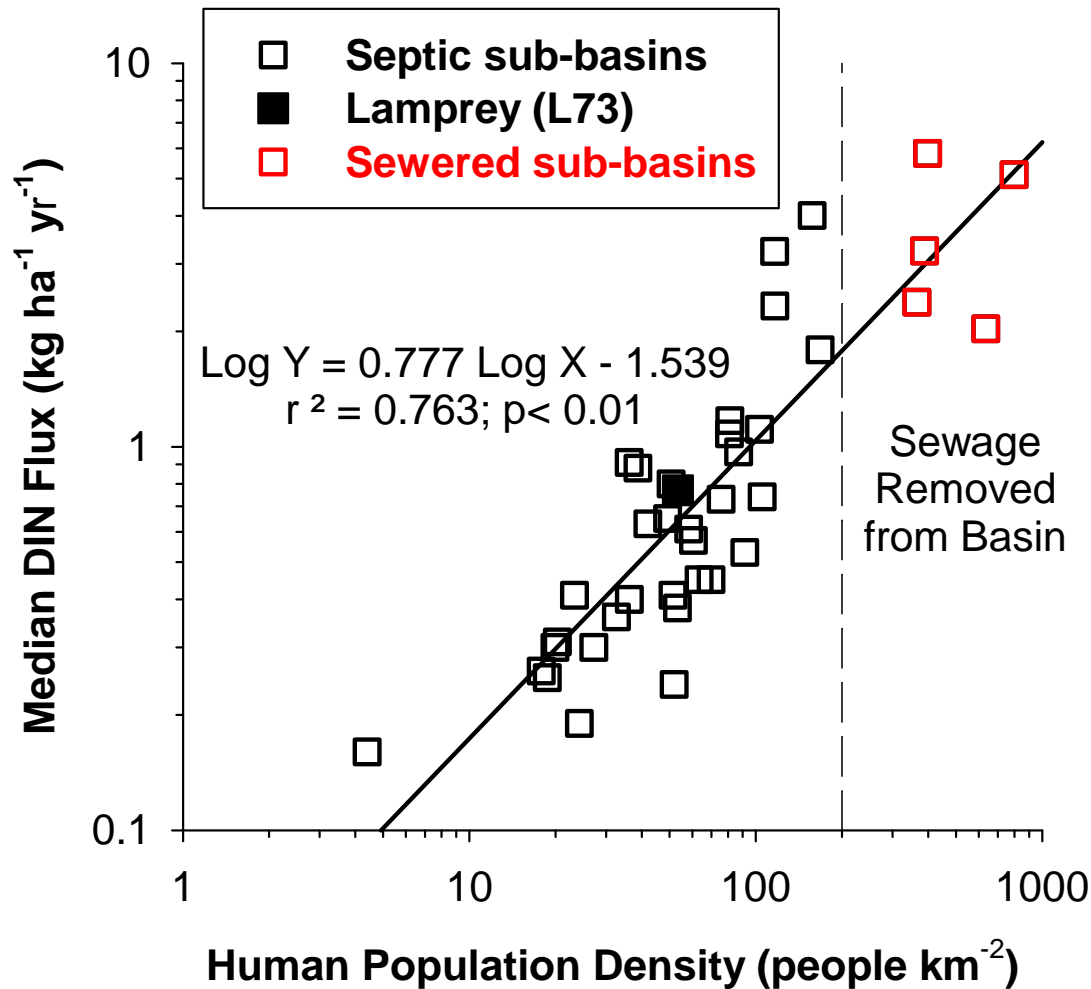


Sites in the Lamprey and Oyster watersheds





DIN related to sub-basin population density

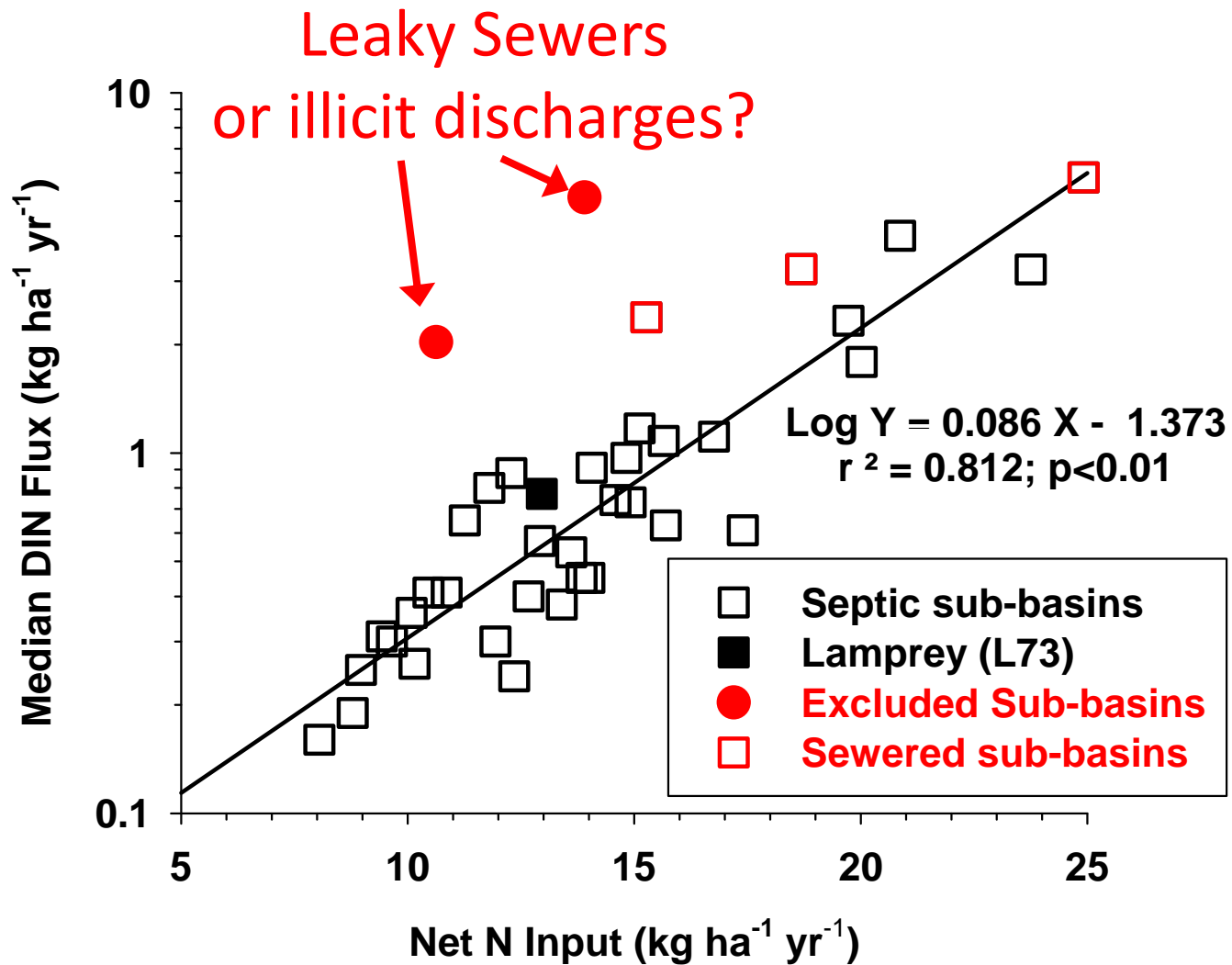


Potential Sources:

- Septic Systems
- Leaky sewers
- Pet waste
- Fertilizers
 - Residential
 - Commercial
 - Recreational
- Deposition delivered from impervious surfaces
- Interspersed agriculture
 - Fertilizers
 - manure

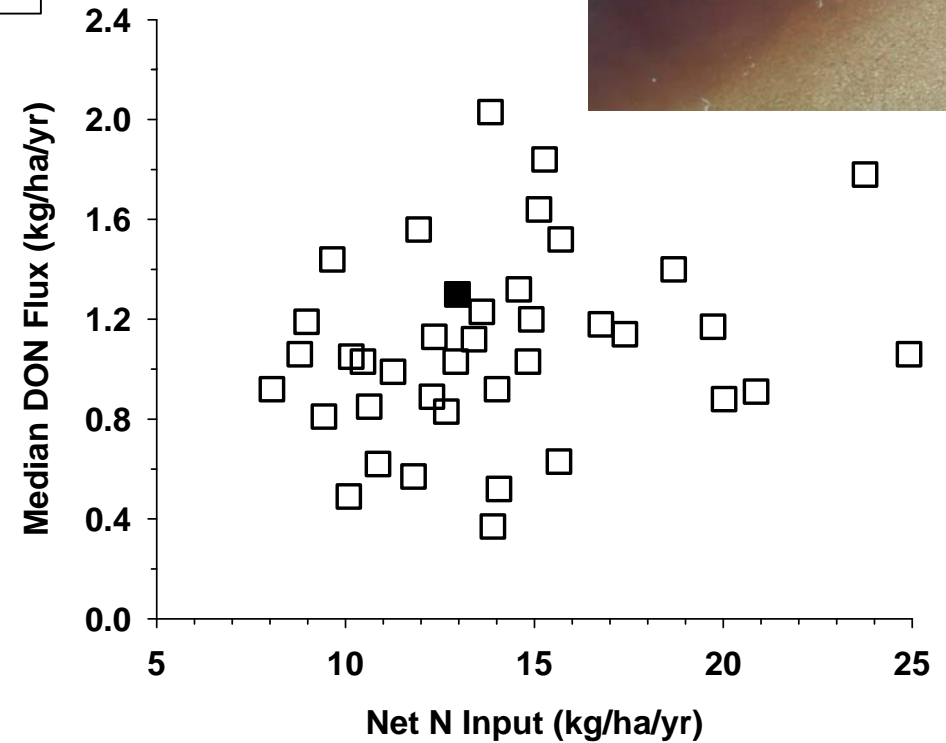
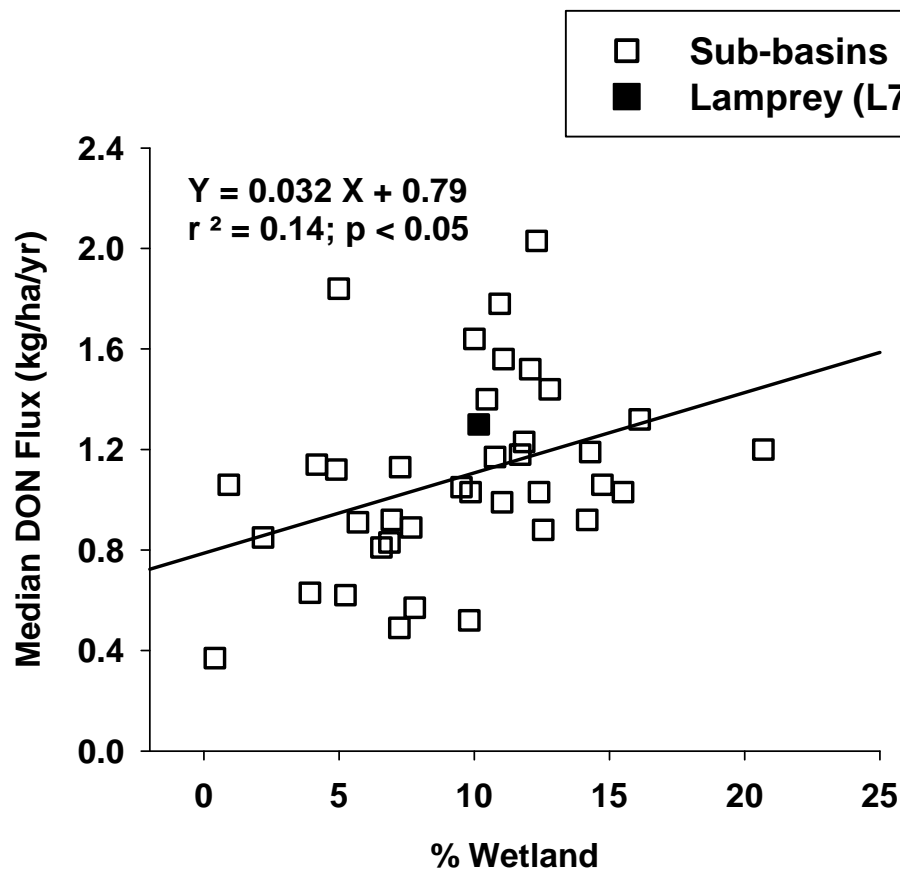


DIN also related to N inputs (Note Log Scale)





DON is related to natural features not human activity





Simple lessons from input-output analysis

- **Good news** is that the LRHO is efficient (better than many NE watersheds) in retaining and/or removing N
- **BUT** there is no guarantee it will continue to do so, given evidence of possible N saturation, elevated groundwater N and unknown groundwater residence times in the basin
- **Bad news** is that all inputs are big enough to matter
- Must understand drivers of stream chemistry to be confident in the best approaches to reduce N loads from watersheds to Great Bay

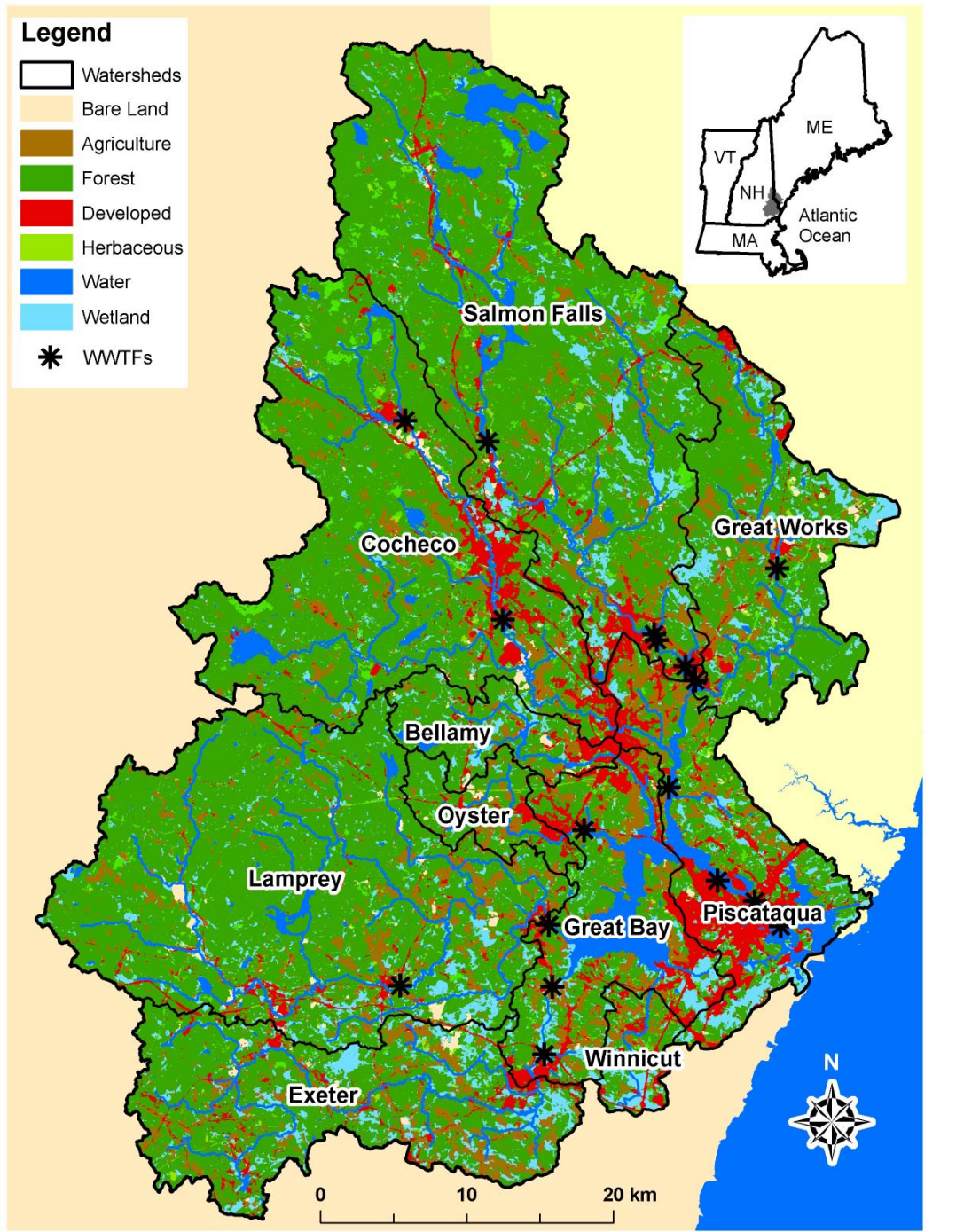


All forms of N are not equal!

- Not equal in their *impacts*, and not equal in their *susceptibility to management*
- DIN ($\text{NH}_4 + \text{NO}_3$) most biologically available to algae and microbes, and most susceptible to increases driven by humans = **HIGH PRIORITY**
- PN (Particulate N) somewhat biologically available, smallest fraction of total N load, no data on land use effects but high during storms = **MEDIUM PRIORITY**
- DON (Dissolved organic nitrogen) somewhat biologically available, correlated only with amount of wetlands in a sub-basin = **LOW PRIORITY**

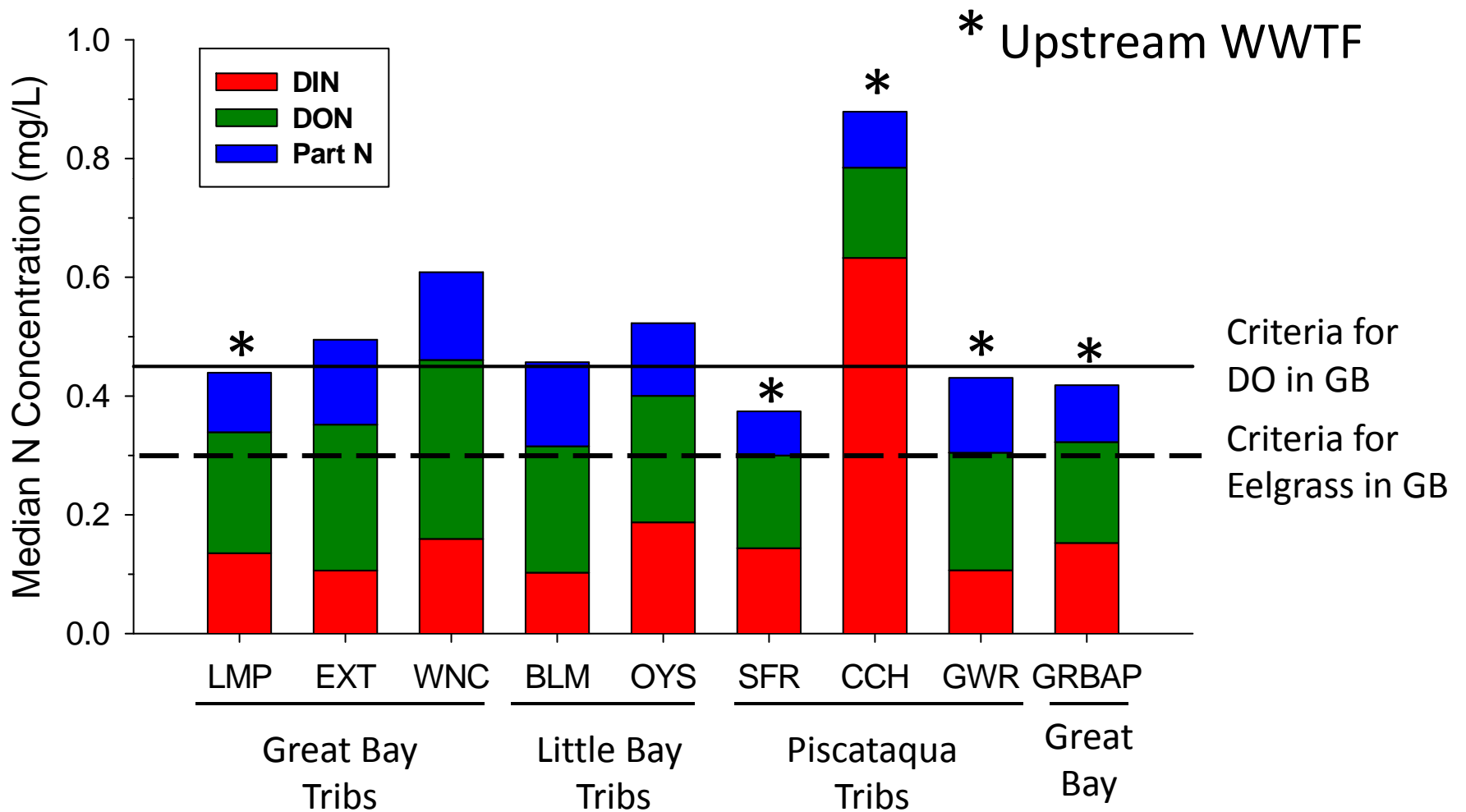


Watersheds in the Great Bay Estuary System





All tributary watersheds are not equal!





Nitrogen Sources and Transport Pathways Objectives

➤ NERRS Science Collaborative Project funded by NOAA

Objectives:

1. Integrate scientific investigations with stakeholders to ensure results are useful and accessible to environmental managers and other stakeholders
2. Identify, model and map N concentrations in surface waters throughout the Great Bay Watershed
3. Identify non-point sources of N that reach surface waters
4. Quantify N attenuation in large river reaches by modeling N inputs and outputs and inferring N attenuation



Closing Thoughts

- Point sources contribute 27% and non-point sources contribute 73% of the overall N load.....**BUT not all non-point N is manageable!**
- Less than half of the non-point N entering Great Bay is manageable
- Uncertainty as to which non-point sources to target, and costs to do so
- Costs to upgrade WWTFs are known but high
- Can we think outside the box to reduce costs....
 - Land apply treated effluent....during summer months?
 - Use effluent to generate biofuel
 - Reuse grey water to reduce waste, install composting toilets



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A River, Estuary or Lake is a
Reflection of its Watershed

Questions?

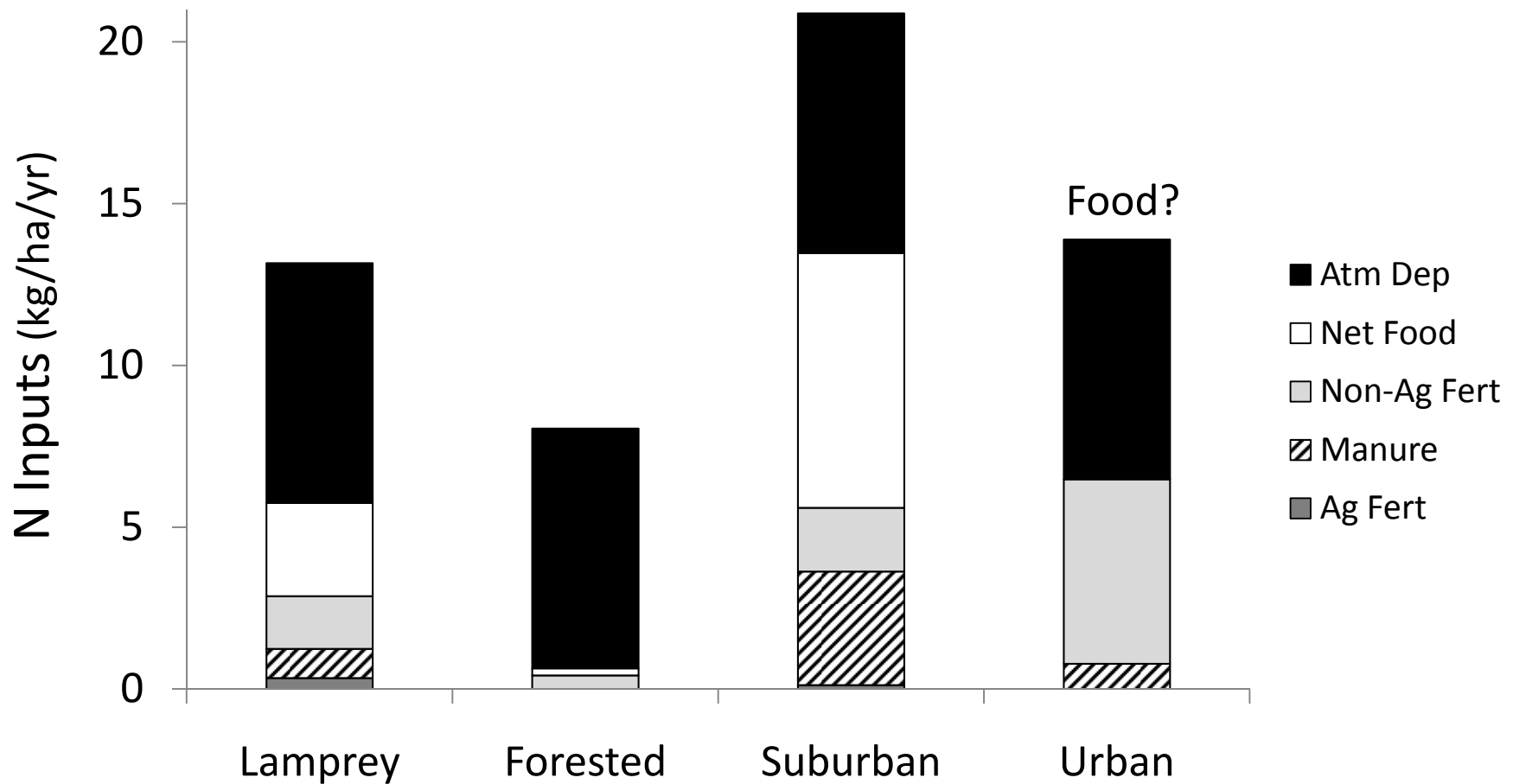
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Nitrogen Inputs Vary Among Sub-basins





Nitrogen Outputs Vary Among Sub-basins

