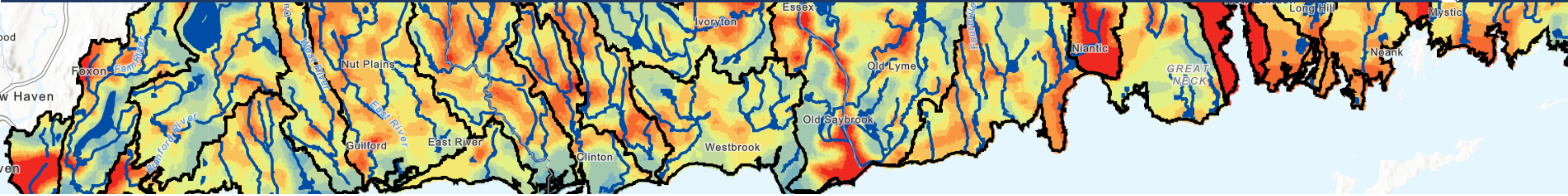

The N-Sink Tool: Tracking Nitrogen Through Coastal Watersheds

Chet Arnold
Qian (Rachel) Lei-Parent
UConn CLEAR

April 21, 2021

UCONN COLLEGE OF AGRICULTURE, HEALTH AND NATURAL RESOURCES Extension

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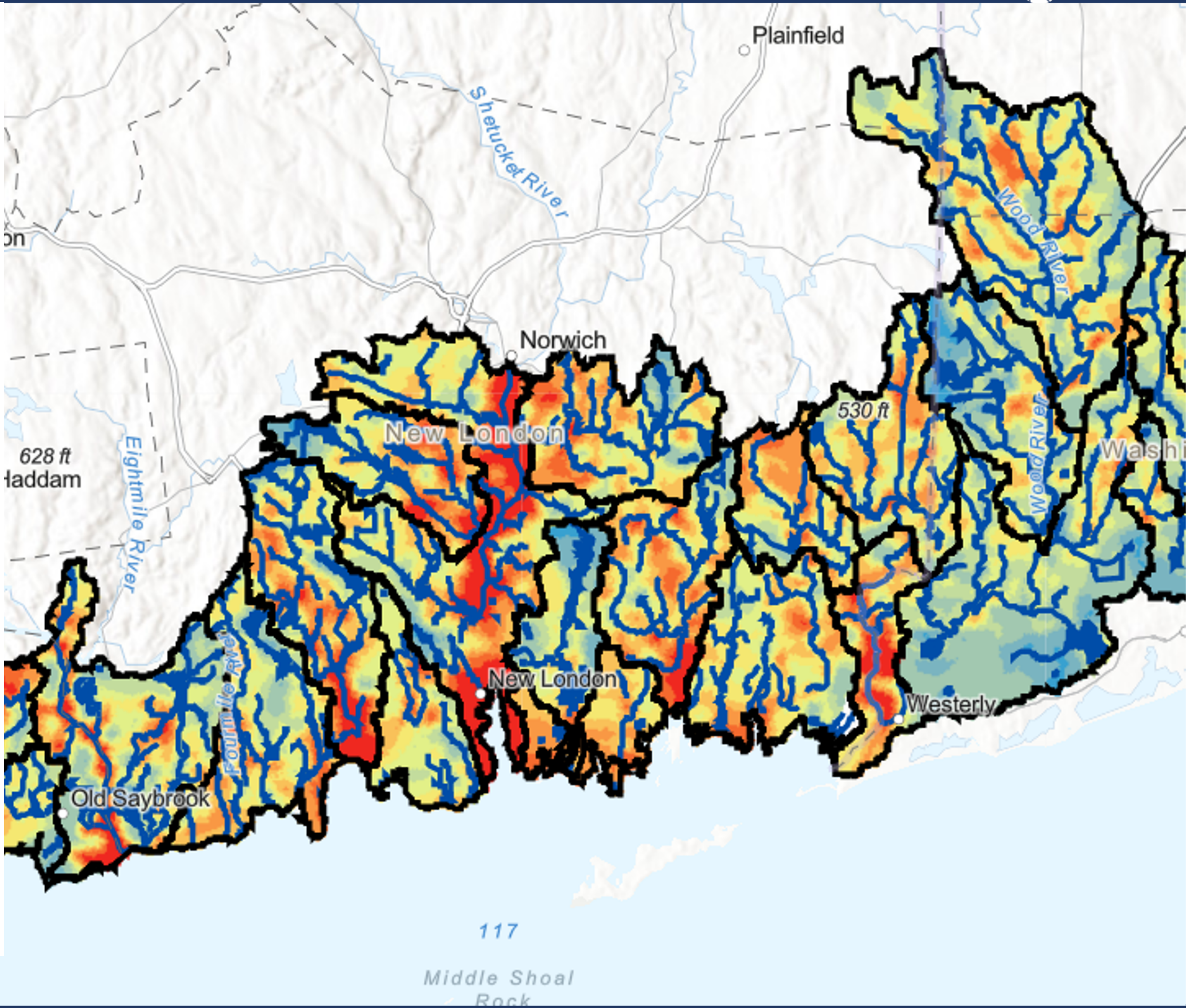
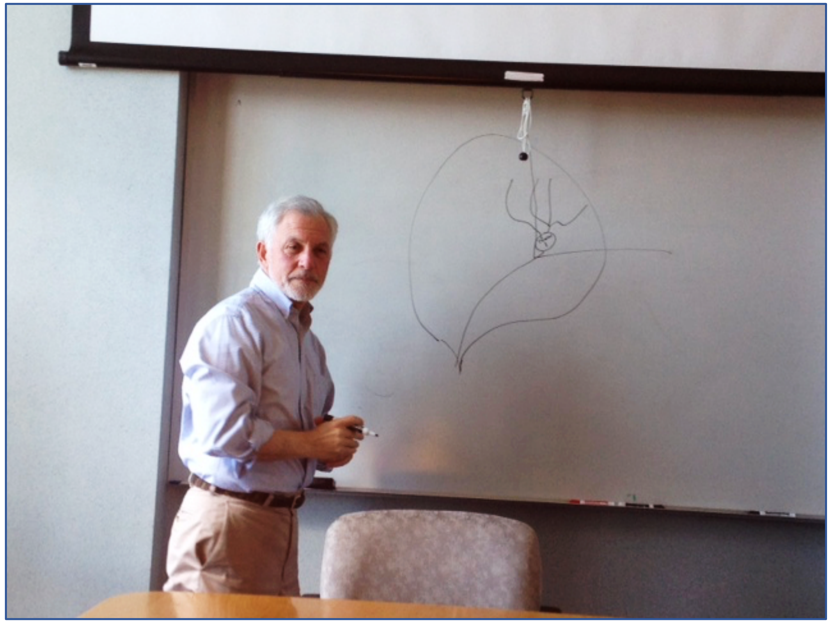
Today's Mini-Session

- Introduction
- Goals & Methods
- N-Sink maps
- Interactive Web tool



Unindicted Co-Conspirators

- University of Rhode Island Dept. of Natural Resources Science
  - *Art Gold, Q Kellogg*
- UConn Center for Land Use Education & Research
  - *Chet Arnold, Cary Chadwick, Rachel Lei, Emily Wilson, Dave Dickson*
- EPA Office of Research & Development (Ada, OK and Narragansett, RI)
  - *Ken Forshay, Jeff Hollister*
- EPA Region 1
  - *Mark Voorhees, Ian Dombroski*



Art Gold diagrams the game-winning play (Hollister to the post) at a recent N-Sink team meeting…

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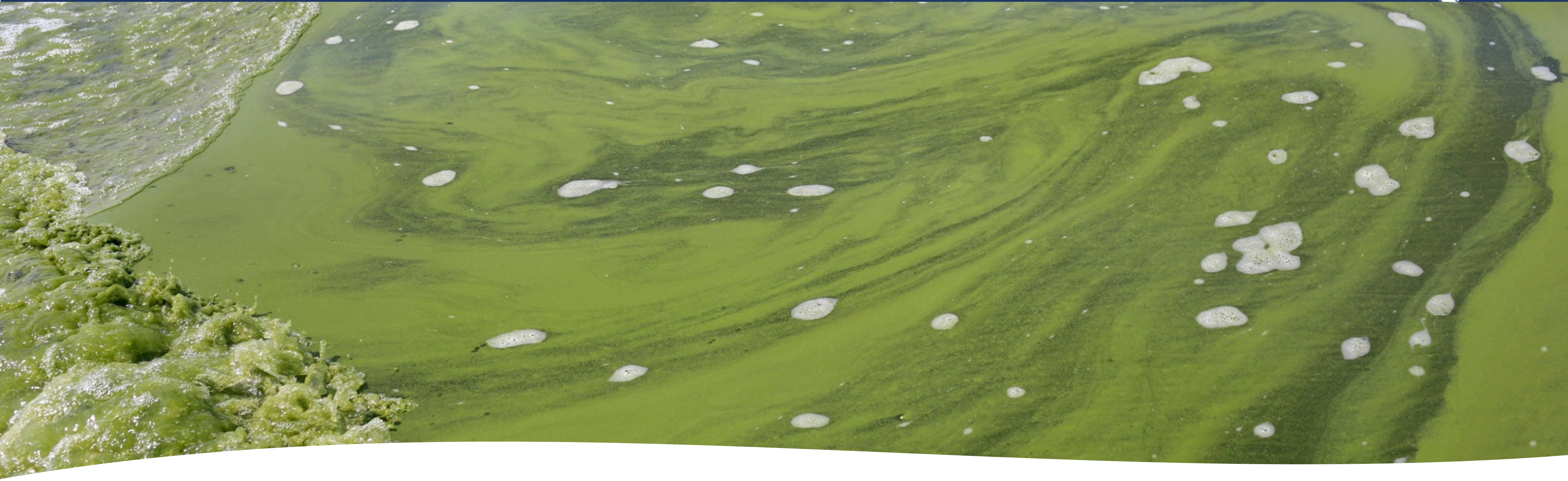


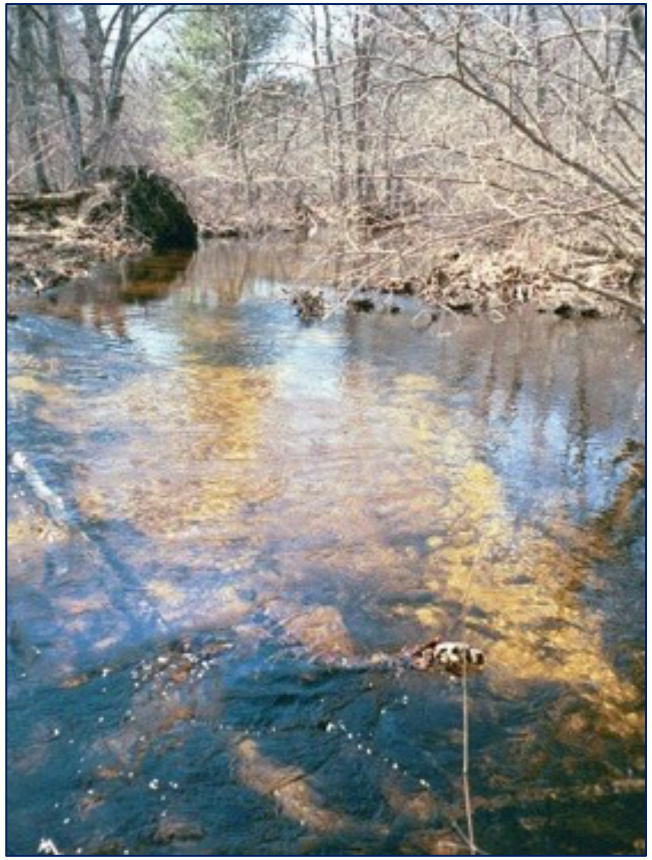
Background

- Nitrogen (N) pollution is a growing problem in coastal waters and the watersheds/communities that drain to them.
- Decision makers need a better understanding of the relationships between land use and the fate and transport of N.

Our goals

- Create a planning and visualization tool for users to explore the relationship of land use to N pollution of their coastal waters
  - ✓ broad applicability
  - ✓ easy to use/understand
  - ✓ accessible online

- Anchor the tool in a land use context by identifying specific areas in watersheds important to N pollution management.
  - ✓ sink areas (wetlands, riparian areas, ponds & lakes)
  - ✓ areas with high likelihood of efficient N transport



Caveats, explanations, disclaimers

N-Sink:

- is a decision support tool, not a rigorous model
- uses widely available national datasets rather than field data
- focuses on sinks and their importance rather than calculations of sources/loadings

→ Shifts attention to the watershed, rather than the receiving waters

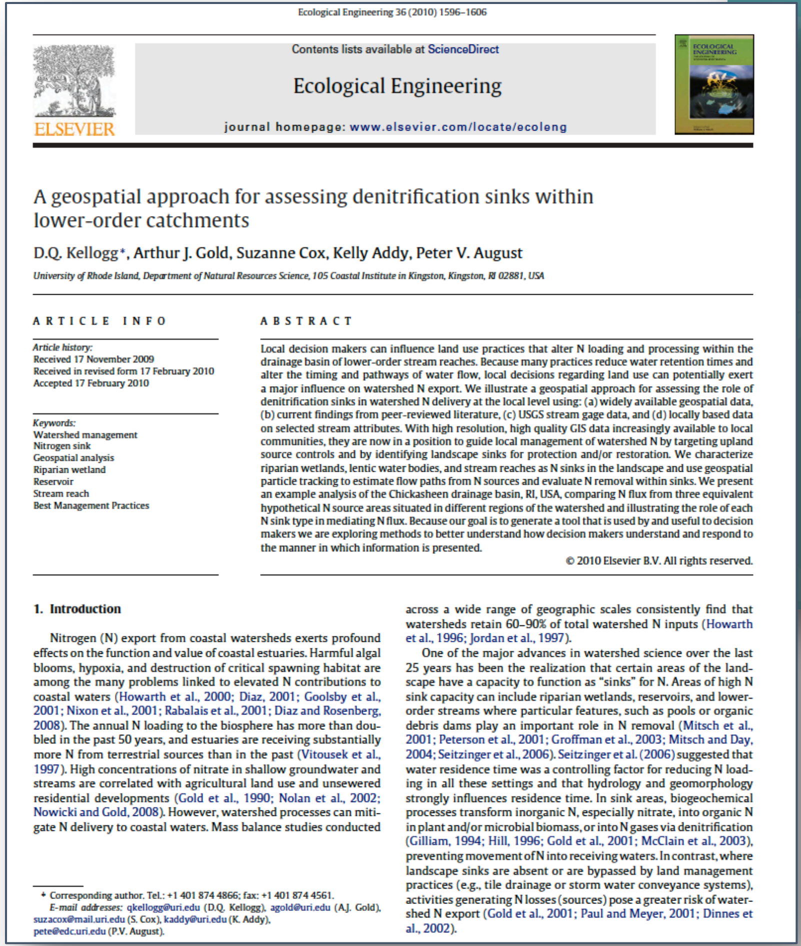
Geospatial Data Sources

Uses widely available (national) spatial datasets

1. **Hydrography (NHD-Plus V2)**
   a. NHD, NED, WBD
   b. Catchment characteristics, cumulative drainage area characteristics, flow direction, flow accumulation, elevation grids
   c. Flow rate & velocity for each reach in the stream network
2. **Soils** from USDA/NRCS Soil Survey Geographic (SSURGO) Database
3. **Land cover** from 2016 National Land Cover Data (NLCD 2016)

Methods

- Uses Particle Tracking to estimate N pathway from source to receiving water
- Estimates N removal based on characteristics of landscape sinks along that pathway



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A geospatial approach for assessing denitrification sinks within lower-order catchments

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ABSTRACT

Local decision makers can influence land use practices that alter N loading and processing within the drainage basin of lower-order stream reaches. Because many practices reduce water retention times and alter the timing and pathways of water flow, local decisions regarding land use can potentially exert a major influence on watershed N export. We illustrate a geospatial approach for assessing the role of denitrification sinks in watershed N delivery at the local level using: (a) widely available geospatial data, (b) current findings from peer-reviewed literature, (c) USGS stream gage data, and (d) locally based data on selected stream attributes. With high resolution, high quality GIS data increasingly available to local communities, they are now in a position to guide local management of watershed N by targeting upland source controls and by identifying landscape sinks for protection and/or restoration. We characterize riparian wetlands, lentic water bodies, and stream reaches as N sinks in the landscape and use geospatial particle tracking to estimate flow paths from N sources and evaluate N removal within sinks. We present an example analysis of the Chickasheen drainage basin, RI, USA, comparing N flux from three equivalent hypothetical N source areas situated in different regions of the watershed and illustrating the role of each N sink type in mediating N flux. Because our goal is to generate a tool that is used by and useful to decision makers we are exploring methods to better understand how decision makers understand and respond to the manner in which information is presented.

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1. Introduction

Nitrogen (N) export from coastal watersheds exerts profound effects on the function and value of coastal estuaries. Harmful algal blooms, hypoxia, and destruction of critical spawning habitat are among the many problems linked to elevated N contributions to coastal waters (Howarth et al., 2000; Diaz, 2001; Goolsby et al., 2001; Nixon et al., 2001; Rabalais et al., 2001; Diaz and Rosenberg, 2008). The annual N loading to the biosphere has more than doubled in the past 50 years, and estuaries are receiving substantially more N from terrestrial sources than in the past (Vitousek et al., 1997). High concentrations of nitrate in shallow groundwater and streams are correlated with agricultural land use and unsewered residential developments (Gold et al., 1990; Nolan et al., 2002; Nowicki and Gold, 2008). However, watershed processes can mitigate N delivery to coastal waters. Mass balance studies conducted across a wide range of geographic scales consistently find that watersheds retain 60–90% of total watershed N inputs (Howarth et al., 1996; Jordan et al., 1997).

One of the major advances in watershed science over the last 25 years has been the realization that certain areas of the landscape have a capacity to function as "sinks" for N. Areas of high N sink capacity can include riparian wetlands, reservoirs, and lower-order streams where particular features, such as pools or organic debris dams play an important role in N removal (Mitsch et al., 2001; Peterson et al., 2001; Groffman et al., 2003; Mitsch and Day, 2004; Seitzinger et al., 2006). Seitzinger et al. (2006) suggested that water residence time was a controlling factor for reducing N loading in all these settings and that hydrology and geomorphology strongly influences residence time. In sink areas, biogeochemical processes transform inorganic N, especially nitrate, into organic N in plant and/or microbial biomass, or into N gases via denitrification (Gilliam, 1994; Hill, 1996; Gold et al., 2001; McClain et al., 2003), preventing movement of N into receiving waters. In contrast, where landscape sinks are absent or are bypassed by land management practices (e.g., tile drainage or storm water conveyance systems), activities generating N losses (sources) pose a greater risk of watershed N export (Gold et al., 2001; Paul and Meyer, 2001; Dinnes et al., 2002).

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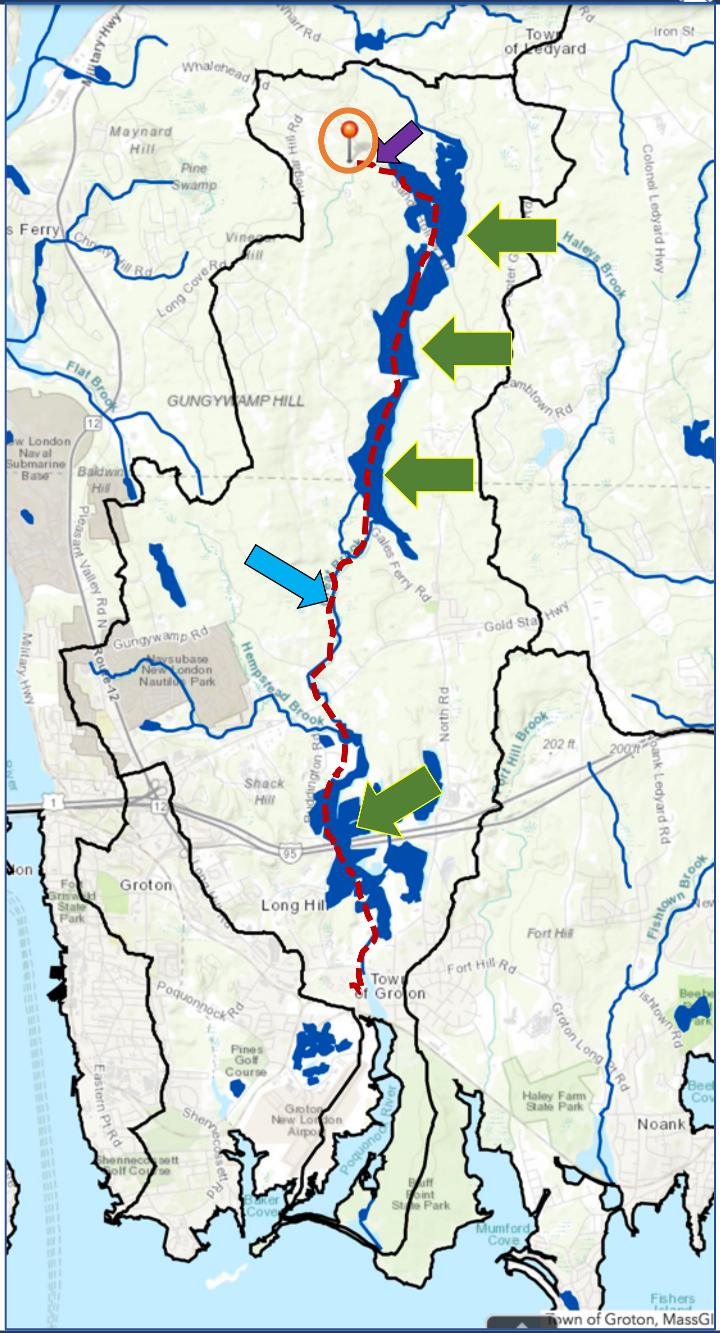
https://clear.uconn.edu/projects/nsink/about.htm

A focus on retention time

- **Wetlands (hydric soils)**
  - **Based on % hydric in soil mapping units (SSURGO)**
  - **Use NLCD to exclude impervious cover**

- Ponds/lakes/reservoirs
  - Based on Pond area/Catchment area (NHD Plus V2)

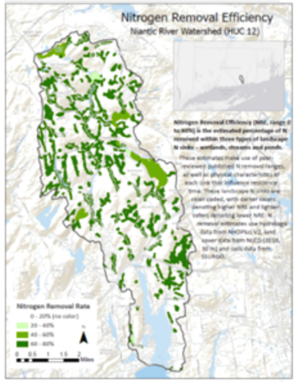
- Stream reaches
  - Based on velocity in stream reach (NHD Plus V2)



The N-Sink Maps

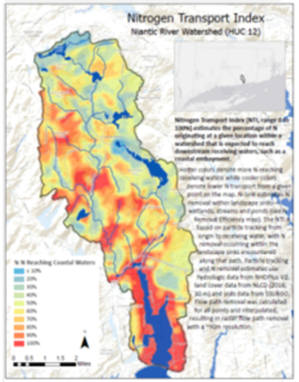
Watershed Maps

The original version of N-Sink was vector-based and built using ArcGIS API for Adobe Flex (which is no longer available). We are upgrading the tool but the analytical outputs – the maps produced by the model – have not changed. Here are sample maps for our two pilot watersheds, the Niantic River Watershed in southeast Connecticut and the Palmer River Watershed in Massachusetts. Brief descriptions of the three analytical outputs.



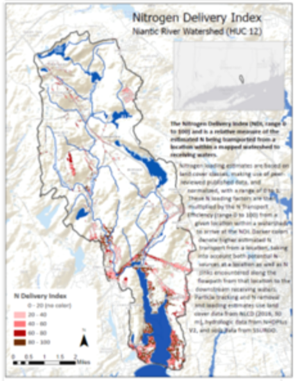
Niantic River N Removal Efficiency

VIEW MAP



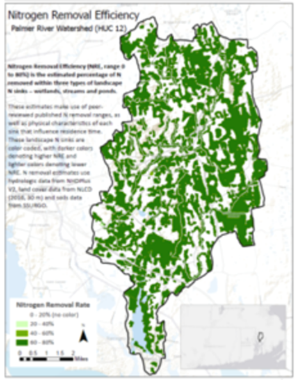
Niantic River N Transport Index

VIEW MAP

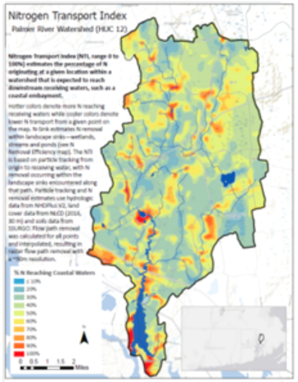


Niantic River N Delivery Index

VIEW MAP

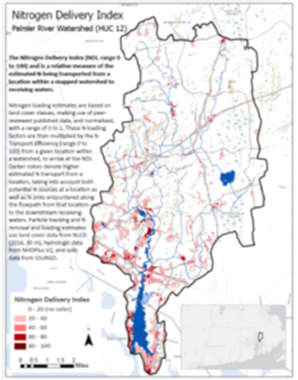


Palmer River N Removal Efficiency



Palmer River N Transport Index

VIEW MAP



Palmer River N Delivery Index

VIEW MAP

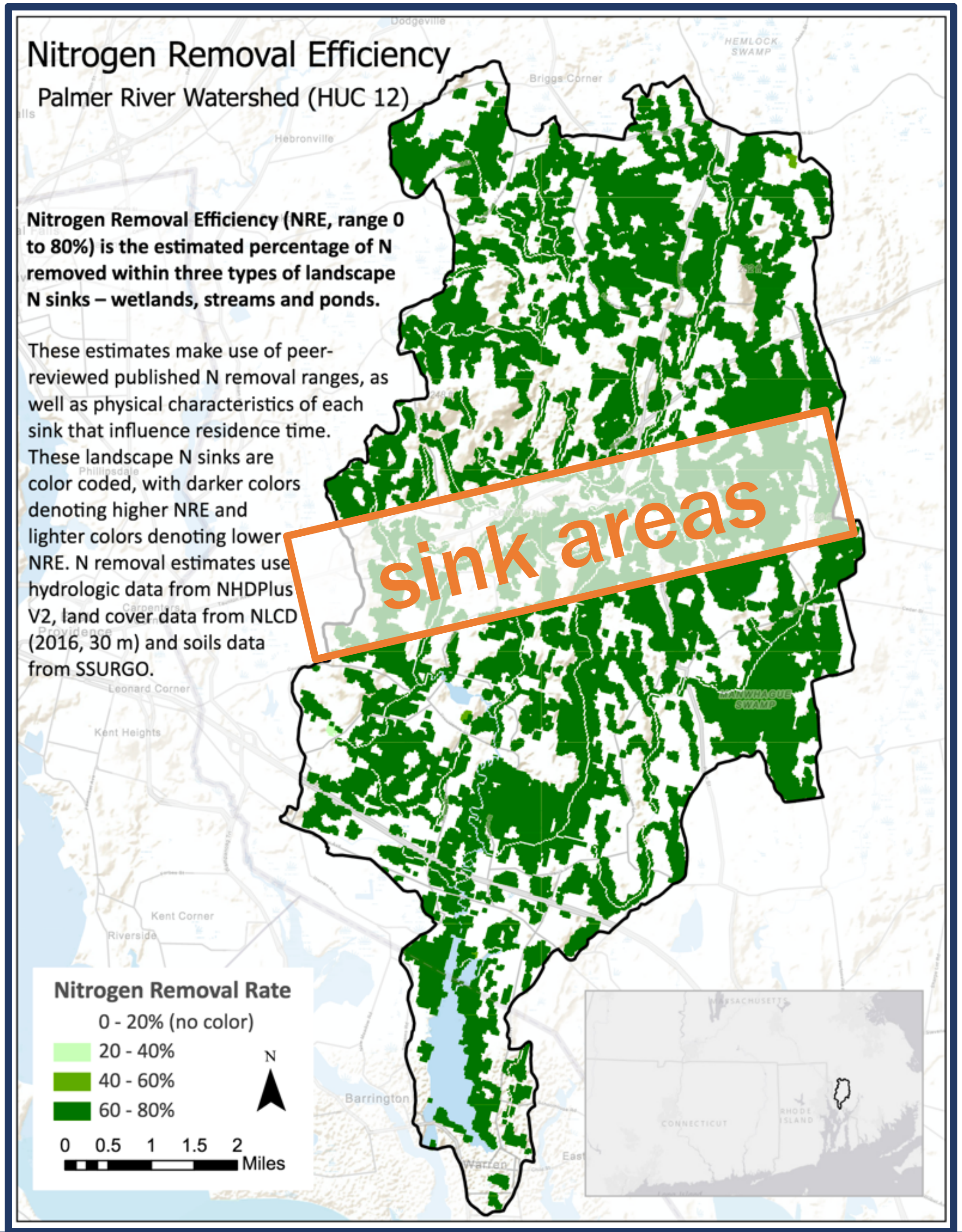
1. Removal Efficiency

➢ Estimates percent of N removal in landscape sinks

- Removal rates are based on research results from the literature

- Darker green color indicates higher percent of N removal.

Implications: IWWC operations, riparian corridor protection/restoration, open space acquisitions

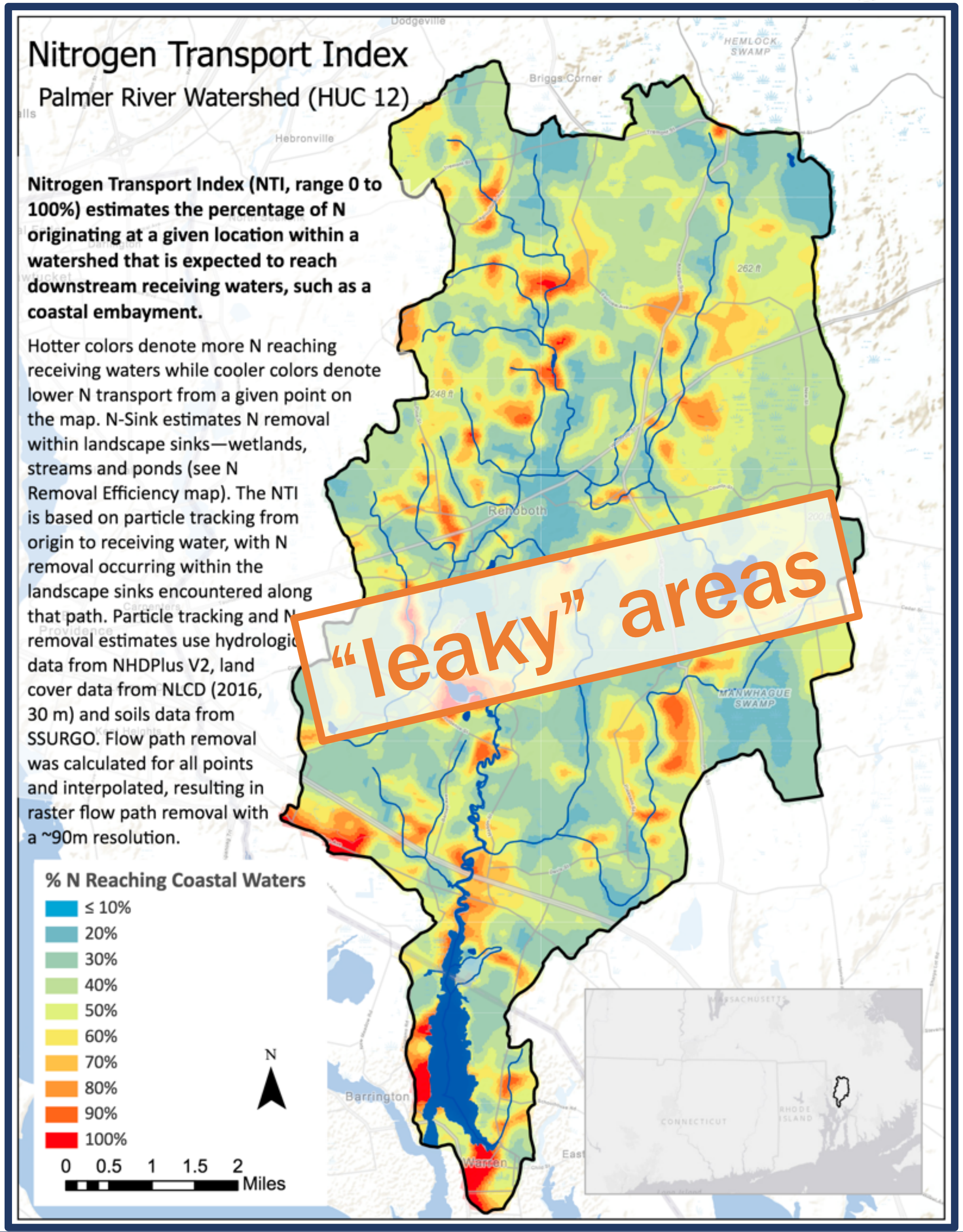


2. Transport Index

- ➢ Estimates cumulative N removal along a pathway originating at a given location

- Uses particle tracking
- Estimates percent of N reaching downstream receiving water
- Warmer color indicates higher efficiency of N transport

<u>Implications</u>: controls for existing land uses, zoning review for future land uses

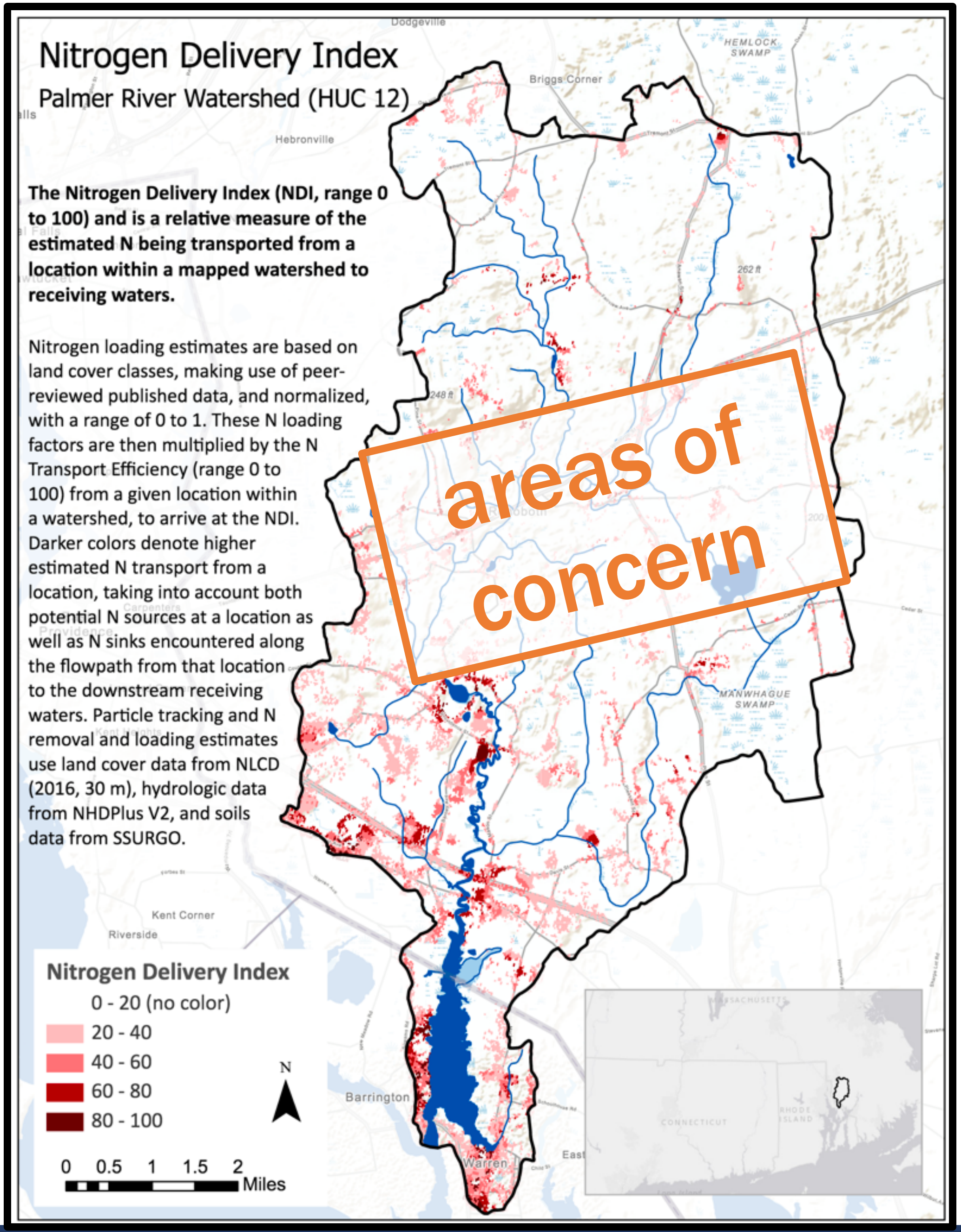


3. Delivery Index

➢ Estimates relative amount of N being transported from a given location to receiving water

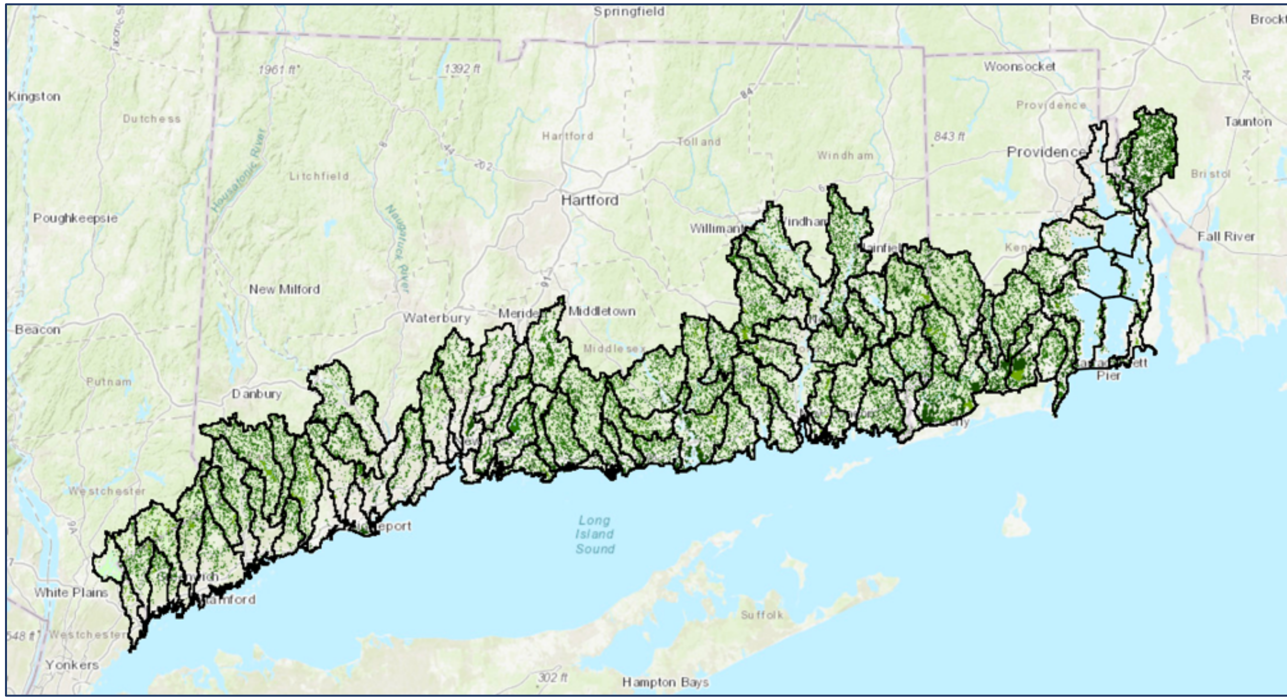
- Calculates N loading rates based on NLCD & literature values
- Multiplies loading rate by Transport Index
- Darker red color indicates combination of high loading and high delivery efficiency

Implications: source controls, monitoring(?), focus on loading estimates

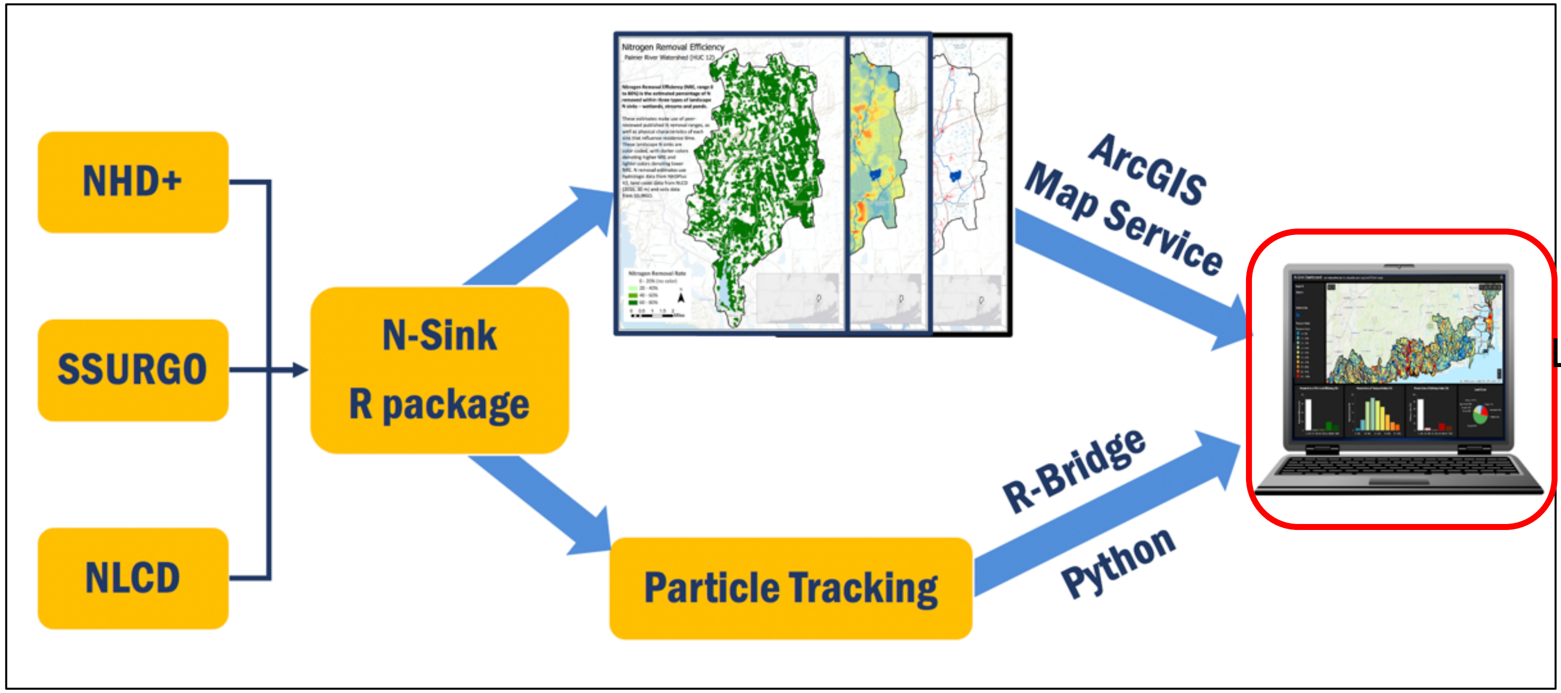


Extent of the web tool

- HUC-12 level of organization
- Covers all of CT and RI coastlines
- 76 (!) coastal watersheds!



Workflow: from R to Arc



explained (kind of)

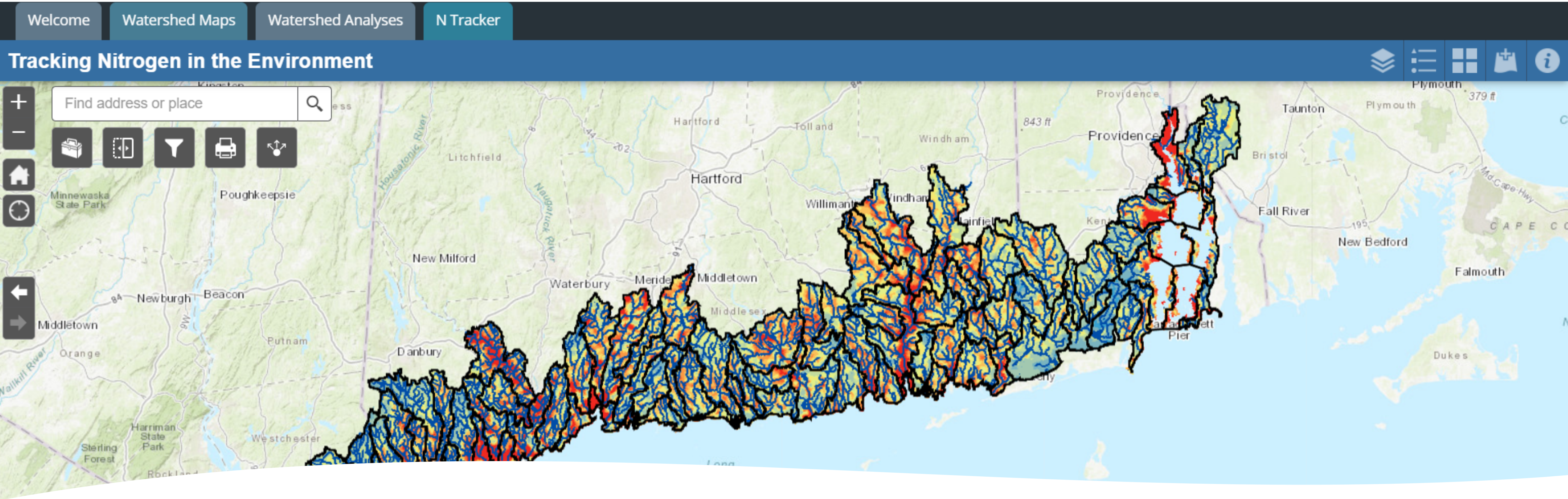
get thee to github

not today!

not today!

https://s.uconn.edu/nsink

https://github.com/jhollist/nsink



N-Sink Web Tool

An interactive decision support tool to visualize, explore and analyze N-Sink maps online