PROJECT SUMMARY:

Nitrogen (N) loading exerts profound effects on the functions and values of coastal estuaries. Local decision makers and landowners can affect a number of watershed processes that control N export from coastal watersheds. **The goal of our proposed project is to develop an environmental spatial decision support system (ESDSS) for local watershed managers to evaluate the extent and location of nitrogen (N) sinks within specific stream reach ecosystems.**

Within N sinks, biogeochemical processes transform inorganic N, especially nitrate, into organic N in plant and/or microbial biomass or into N gases via denitrification, preventing movement of N into receiving waters. Key watershed N sinks include: the "zero order" network of seasonally saturated swales and ephemeral flowages constituting the expanded stream network in wet weather conditions; the riparian zone; the stream and its sediments (e.g., the hyporheic zone that exchanges water with the stream); lakes; and reservoirs. Water residence time may be the controlling factor for reducing N loading in all these settings; hydrology and geomorphology strongly influences residence time.

Our ESDSS will permit decision makers and landowners to target best management practices (BMPs; e.g., intensive source controls or stream reach ecosystem restoration) in subwatersheds that lack stream reach ecosystem N sinks. In subwatersheds with important N sinks, the tool will provide guidance to protect critical areas. ESDSSs, based on geographic information systems (GIS), geographic visualization, exploratory data analysis tools, and spatial statistical analysis and modeling, hold the potential to connect scientists with decision makers because of the power of vision to aid problem solving.

We hypothesize that county scale geospatial data (1:5000 to 1:24,000) can depict critical hydrologic and geomorphic attributes of stream reach ecosystem N sinks in lower order watersheds. Our specific objectives are:

1. To develop a ranking system for the N sink capacity of lower order stream reach ecosystems. The evaluation will reflect N retention resulting from both the individual and cumulative effects of each N sink within drainage networks.
2. To translate our insights into an ESDSS to improve the capacity of local decision makers in targeting BMPs and planning efforts to areas with the greatest potential to affect watershed N export.
3. To transmit our ESDSS to Extension (e.g., NEMO - Nonpoint Education of Municipal Officials - Program staff and eXtension) and NRCS (Natural Resources Conservation Service) professionals to enhance their capacity to train local decision makers.
4. To create new curricula and training opportunities for graduate and undergraduate students that provide new insights into watershed N dynamics and expand their understanding of the rigor required to develop accessible decision support tools for coastal decision makers.

Our team encompasses researchers, Extension staff, and educators with considerable experience in working on integrated programs that translate research into outcomes for

local stakeholders and students. Our evaluation tool will be tailored to the geographic and political conditions prevailing within most rural communities in coastal New England and New York; however, the tool will be built in modular format and easily adaptable to other regions if they possess critical differences in ecosystem structure influencing N sinks along drainage networks. Because our approach focuses on sink areas that enhance retention times and biogeochemical processing, the tool will have additional value for stakeholders concerned with other water quality issues.

To develop a ranking system (Objective 1) we will focus on four watersheds in Southern New England that have high resolution spatial data on soils, geomorphology, land cover and land surface elevation – as well as water quality data. We will engage in an iterative process that starts with published relationships between landscape attributes and N sink function. We will strengthen our ranking system through mass balance assessments and core studies on stream, hyporheic and reservoir function. The classification will focus on individual N sinks and the cumulative stream reach ecosystem. Sensitivity analysis and other approaches will be used to assign levels of certainty (high and low) to each estimate.

Drawing on our experience with developing graphical user interfaces (GUIs) and visualization formats for local decision makers, our ESDSS will be developed (Objective 2) in a modular format for each of the N sinks as well as for the whole stream network. Our ESDSS will be an interactive system where trained users will be able to define initial conditions, establish geographic parameters as inputs to the model, generate maps, manipulate maps, connect instantaneously from the maps to data, and repeat selected steps under different scenarios. It will use different colors to display the different tiers of N sink capacity and will display uncertainty in specific stream reach ecosystems by altering shading or patterns. We will assess and refine our ESDSS's GUI and visualization format through an iterative process with sequential feedback from four different audiences: GIS students, NEMO Extension professionals, NRCS staff and local decision makers.

Our ESDSS and related educational materials will be disseminated (Objective 3) to NEMO Network participants via the "train the trainer" Extension programs with individuals versed in the range of effectiveness of different GIS platforms for addressing the constraints and capacities of local decision makers. NRCS staff will receive targeted training at separate venues. We will also make our work available to the Map@Syst Community of Practice in eXtension.

We will focus our educational efforts (Objective 4) on: i) curriculum development and engagement in University of Rhode Island's (URI) NSF-funded IGERT (Integrative Graduate Education and Research Traineeship) Ph.D. training grant; ii) doctoral level research training at Arizona State University; iii) involvement of undergraduate URI Coastal Fellows in experiential learning; and iv) inclusion of components stream reach assessment tool into two undergraduate courses. Both the IGERT and Coastal Fellows programs have outcome assessment structures that we will use to assess educational value from these efforts.