

A Northeastern North America Environmental Sensor Network: A New NERC Working Group

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This project launched a new initiative to develop infrastructure, share methodologies, and ultimately link researchers and sites deploying environmental sensor networks in eastern North America.

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<http://www.nsrcforest.org>

Project Summary

Electronic environmental sensors and associated data logging have been with us for nearly three decades. They have become standard in environmental monitoring and research but remain a challenge to deploy and "do right." Within the past decade, the selection and capabilities of sensors has advanced rapidly, and transmission of data to the world in real time has become commonplace. To keep abreast of this quickly shifting electronic landscape, NSRC researchers have started a new Northeastern Ecosystem Research Cooperative (NERC) working group on environmental sensors. The goal of this group is to inform, assist, and support NERC researchers on basic to advanced sensor deployment, data acquisition, and real-time transmission. In addition to this "clearinghouse" function, researchers will team up to advance understanding of environmental processes and response to global change through integrated planning and deployment of state-of-the-art sensor systems. The working group held an initial planning workshop in fall 2011, and has co-sponsored several training sessions, a paper on quality assurance of environmental sensor data, and a follow up proposal. Ultimately, the vision of this project is to establish -or contribute to- *a regionally distributed, long-term multi-site, multi-sensor platform for detection of short- and longer-term environmental change for northeastern North America.*

Background and Justification

1. An increasing number of studies are using advanced sensor technology to better understand and/or monitor a wide variety of ecosystem physical and chemical properties.
2. Examples of such applications include: continuous monitoring of stream flow, water quality, groundwater table, sap flow, and trace gas flux; installation of web cams to improve quality and frequency of phenological measurements and observations of avian behavior; and installation and use of radio collars for tracking fish and wildlife movements across the landscape.
3. Only a few sites, however, have these data available to the public online in real or near-real time.
4. A need exists to further the access to and development of environmental sensors and wireless sensor networks.

Methods

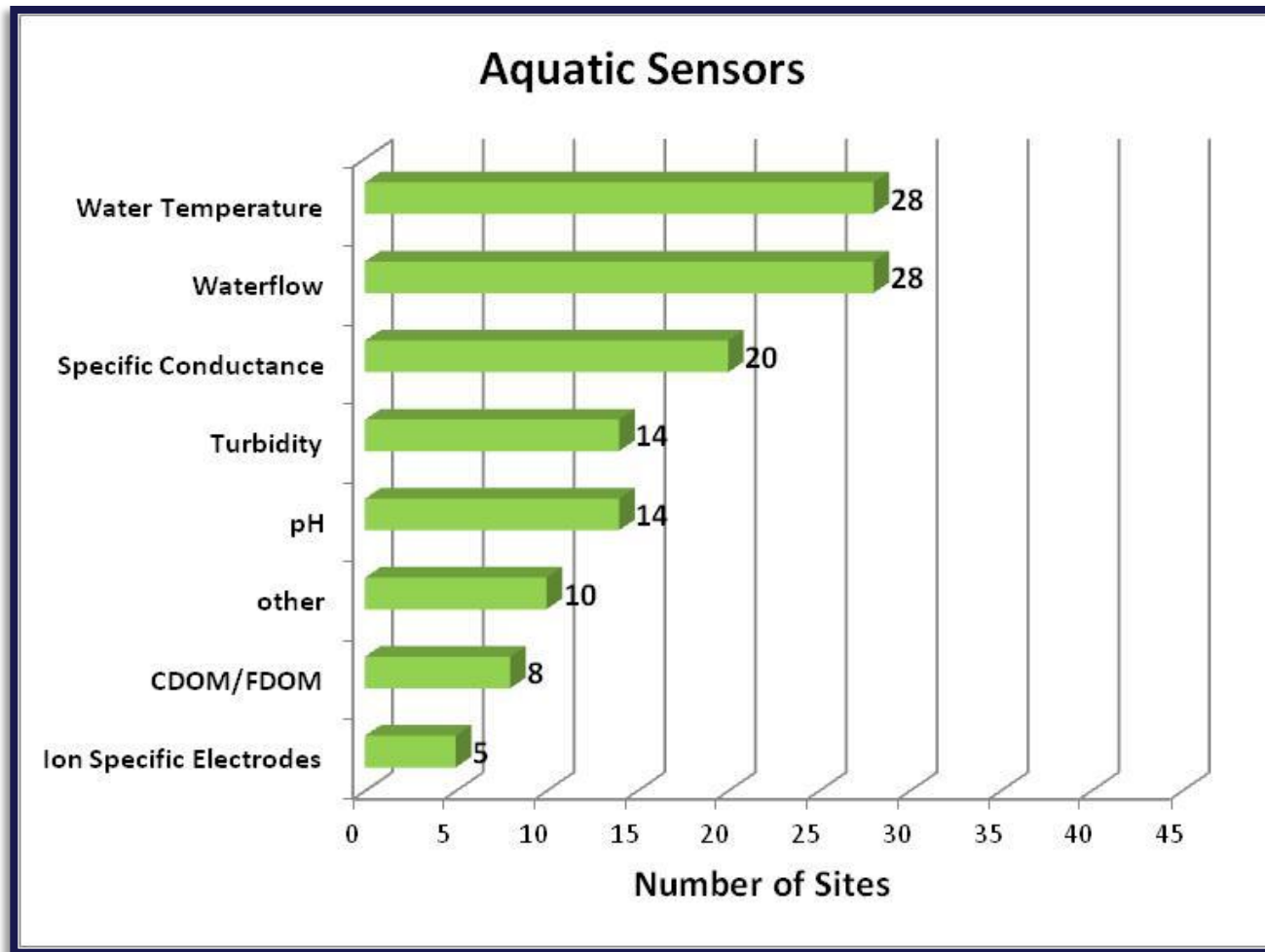
- Survey – We conducted a survey of northeastern researchers to ascertain what types of sensors they were currently using and what they planned to use in the future.
- Workshop – We held a 2 day workshop for 78 participants at the Hubbard Brook Experimental Forest, NH in October 2011. The goals of the workshop were to:
 - share knowledge, insights and 'lessons learned' on hardware and software technology,
 - discuss novel applications and understanding that can be gained from such a network,
 - *develop a vision for a regionally distributed, long-term multi-site, multi-sensor platform for detection of short- and longer-term environmental change for northeastern North America.*

Results: Survey

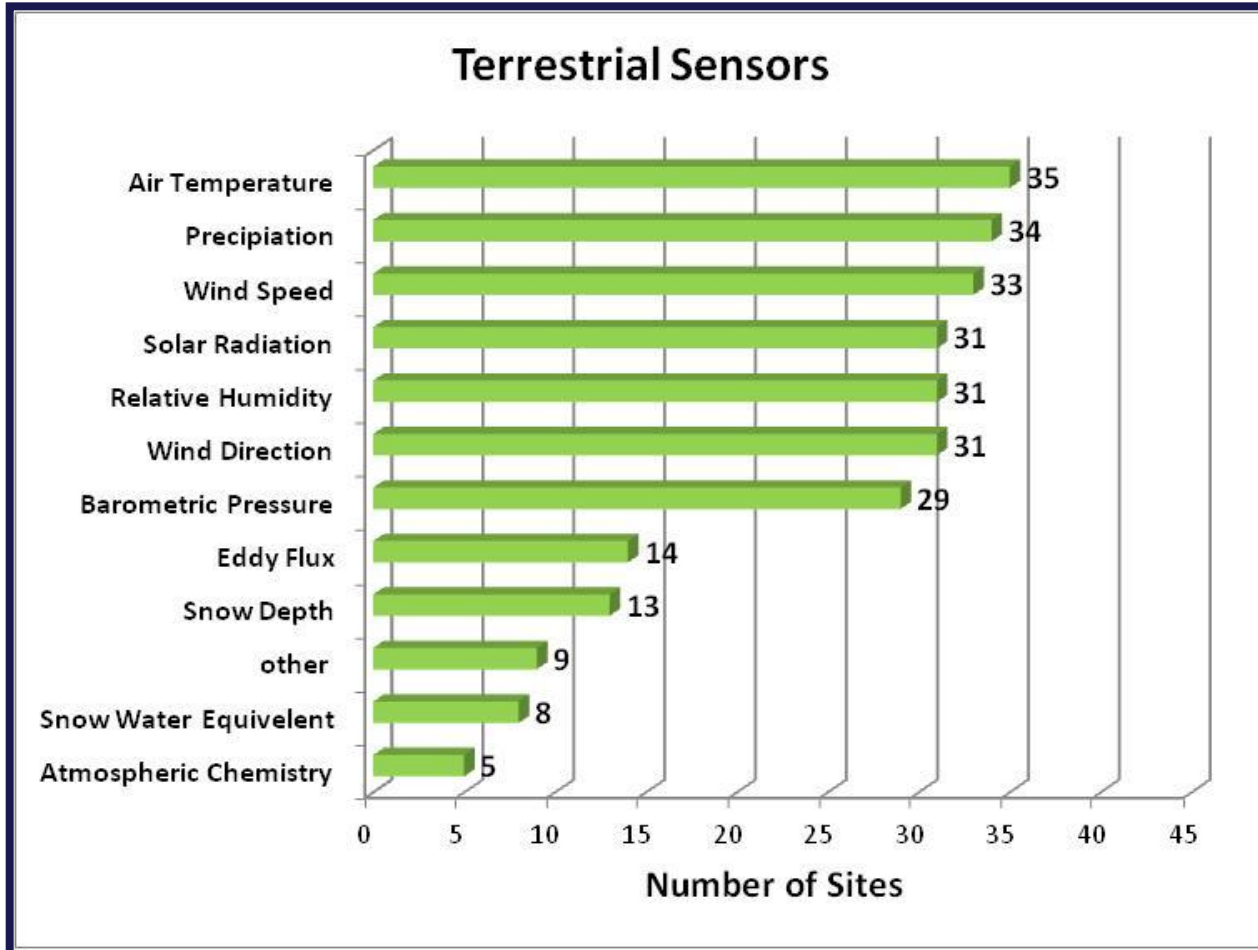
- The survey was filled out by 47 respondents, representing the sites in the table below.

EFR	LTER	Other
<ul style="list-style-type: none">• Bartlett• Bonanza• Coweeta• Glacier Lakes• H.J. Andrews• Héén Latinee• Howland• Hubbard Brook• Luquillo• Marcell• Silas Little• Wind Rivers	<ul style="list-style-type: none">• Arctic• BES• Bonanza Creek• Coweeta• Florida Coastal Everglades• Georgia Coastal Ecosystem• H.J. Andrews• Harvard Forest• Hubbard Brook• Jornada• Jornada• Konza• Luquillo• Moorea Coral Reef• Niwot Ridge• North Temperate Lakes• Plum Island• Sevelita• The Baltimore Ecosystem Study	<ul style="list-style-type: none">• Amot Forest, NY• Black Rock Forest, NY• Central MA• Guanica Forest, PR• Hudson River Estuary, NY• Huntington Wildlife Forest, NY• James Bay Region, Ontario• Lake Giles, PA• Lake Lacawac, PA• Lamprey River, NH• Macleish Field Station, MA• McLaughlin Natural Reserve, Canada• NEPCCMN, New England• Seacoast, NH• Sleepers River, VT• Vermont Monitoring Coop, VT

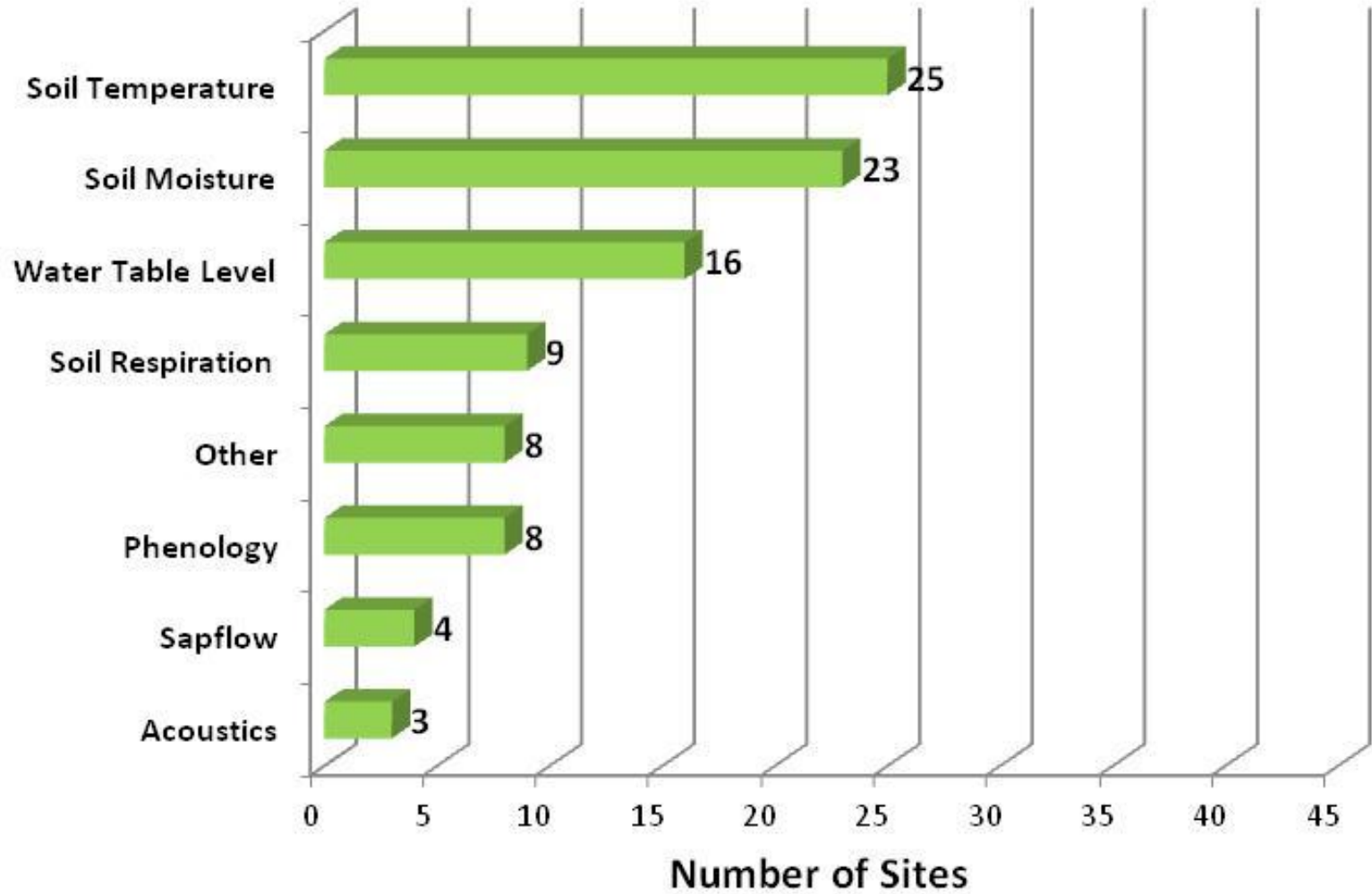
Number of sites deploying aquatic sensors:



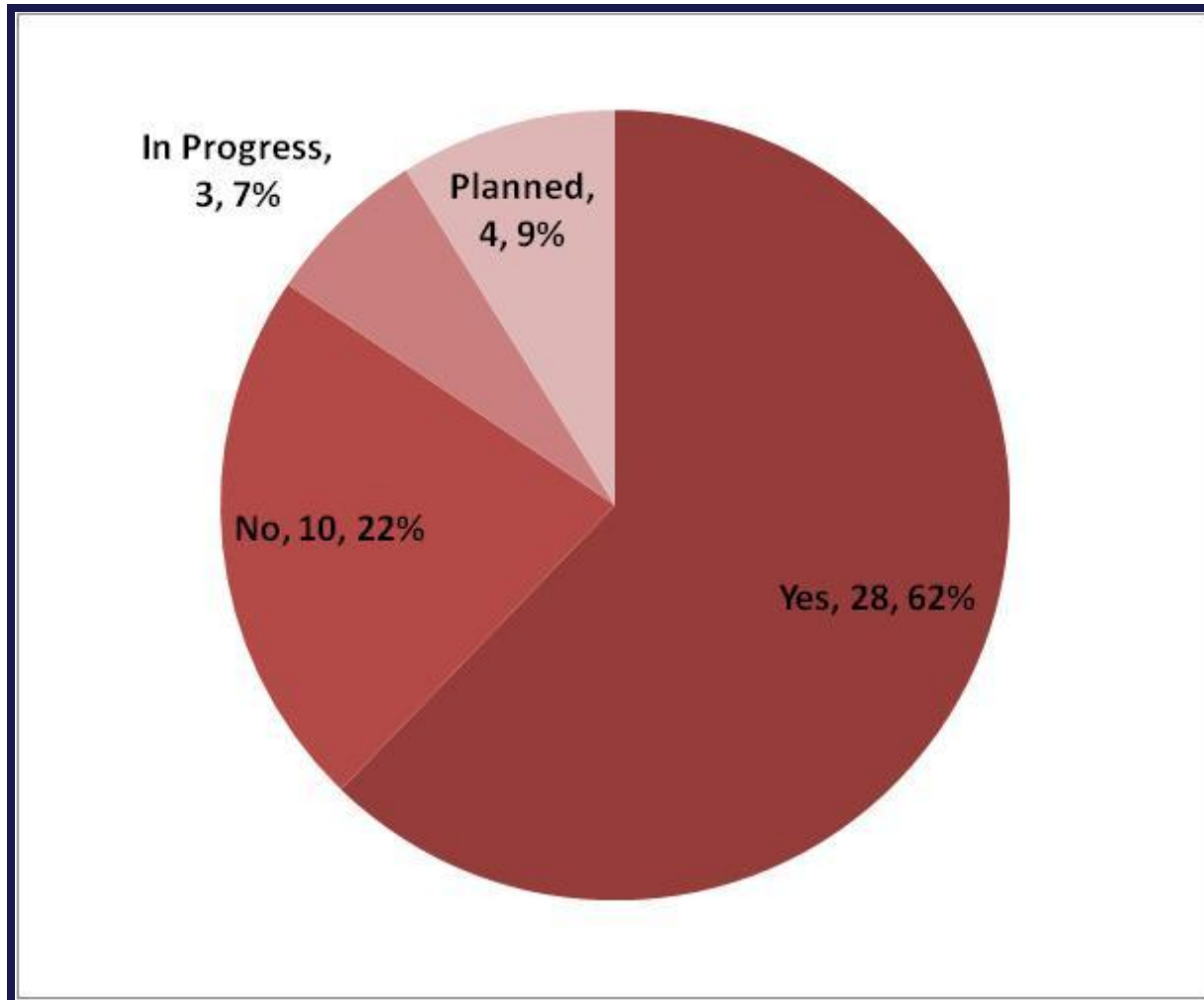
Number of sites deploying terrestrial sensors:



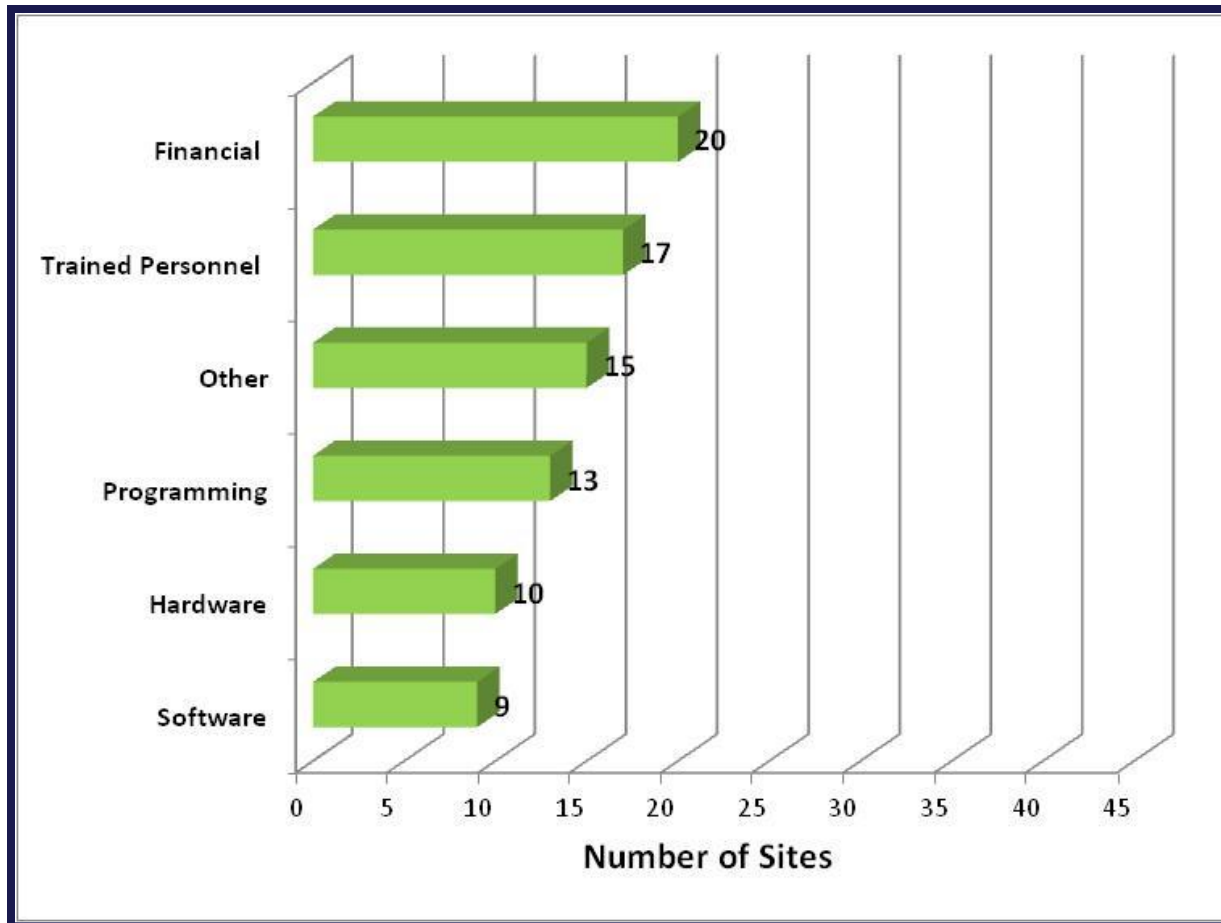
Atmospheric Sensors



Number of sites deploying wireless sensor networks



Barriers to deploying environmental sensors



Results: Workshop

- A Joint NERC Environmental Sensor Network & SensorNIS Workshop was held October 26-28, 2011 at the Hubbard Brook Experimental Forest in West Thornton, NH.
- The workshop was attended by 78 participants from several dozen long term ecosystem research sites.
- The agenda covered the following topics:
 - Sensor Sites in the Northeast
 - LTER Sensor Sites
 - Sensor Science
 - Software and Technology Outlook for Managing Sensor Data
 - Streaming QA/QC
 - Future Directions

Implications and applications in the Northern Forest region

- This project identified a suite of sites and individuals actively engaged in deploying environmental sensors and sensor networks.
- Concrete action items were identified, including the need for advanced training in sensor technology and a report on QA/QC for streaming realtime sensor data.
- A vision for the future was articulated to promote a regional platform for detection of climatic and environmental change for the region.

Future directions

1. Establish an interactive community web portal for information sharing on all aspects of environmental sensors (ES).
2. Develop new streaming, near real-time data sharing tools for NE research sites.
3. Use high resolution ES data to run an ecosystem scale C and N cycling model in real time on daily time steps.
4. Use high resolution ES data to investigate make new discoveries in ecosystem science.
5. Apply emerging visualization and outreach tools to engage stakeholders, including the public.

List of products

- **Publications:**

John L. Campbell, Lindsey E. Rustad, John H. Porter, Jeffrey R. Taylor, Ethan W. Dereszynski, James B. Shanley, Corinna Gries, Donald L. Henshaw, Mary E. Martin, Wade M. Sheldon, Emery R. Boose: 2012. Quantity is nothing without quality: Automated QA/QC for streaming environmental sensor data. BioScience, submitted.

- **Proposals:**

Lindsey E. Rustad, Kathleen Weathers, Jamie Shanley, Mary Martin, Kevin Rose and others. Development of Real-Time Environmental Sensor Technology and Applications for the Northeast: A Proposal from the NERC Northeastern Environmental Sensor Working Group (NESN). Submitted to NSRC 2013.

- **Training**

Software Tools for Sensor Networks Training May 1-4, 2012, Albuquerque, NM
Data Acquisition from Remote Locations June 11-15, 2012, Albuquerque, NM