



# ECOSYSTEMS + SOCIETY

## Partnerships for Research and Education

A Strategic Plan for:  
Interactions Among Climate, Land Use,  
Ecosystem Services and Society

2013

Jane Nisbet, PI and State Director  
Kevin Gardner, Co-PI and Associate State Director  
Cameron Wake, Co-PI  
William McDowell, Co-PI  
Richard Howarth, Co-PI



*Linking Education, Research, and Economic Development*

An NSF EPSCoR Research Infrastructure Improvement Track-1 Project  
NSF Award # EPS-1101245





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# I. Partnerships for Research and Education

## *A Strategic Plan for: Interactions Among Climate, Land Use, Ecosystem Services, and Society* *An NSF EPSCoR Research Infrastructure Improvement Track-1 Project*

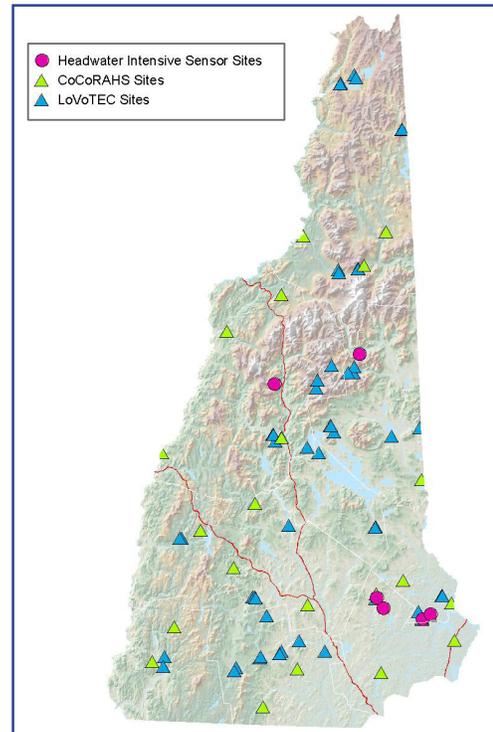
### *Strategic Plan Development Process*

PARTNERSHIPS FOR RESEARCH AND EDUCATION is the New Hampshire EPSCoR strategic plan for implementing the Research Infrastructure Improvement Project *Interactions Among Climate, Land Use, Ecosystem Services and Society*. The program is designed to develop research leadership in this area, to diversify and strengthen the State's scientific and technical human and social capital, and improve both scientific and public understanding of coupled natural/human systems critical to the well-being of society.

The project is a cooperative agreement between the National Science Foundation and the University of New Hampshire, in partnership with institutions of higher education, K-12 education, and informal science educational organizations throughout the State (award EPS-1101245). As part of this cooperative agreement, NH EPSCoR must develop a strategic plan to guide the project. The purpose of this plan is to articulate the mid- and long-term goals and objectives of NH EPSCoR, and to identify the milestones and metrics that demonstrate progress toward those goals.

The strategic plan was developed through a collaborative process that included faculty, staff and administrators from all participating institutions. The strategic planning process began with leaders of the research, education and workforce development, outreach and engagement, and inclusive excellence components of the project developing strategic goals and objectives according to guidance from two external facilitators.<sup>1</sup> A two-day strategic planning meeting was held November 17-18, 2011 at the University of New Hampshire during which researchers, educators, administrators, and Statewide Committee members worked toward a cohesive and comprehensive strategic plan. This document reflects the outcome of the planning process and will be used to guide the project over the coming years. It will be revisited each year and updated as needed to ensure the strategies employed will meet the strategic goals of the project.

<sup>1</sup> The strategic planning process was facilitated by Dr. Julia Melkers, Associate Professor of Public Policy at Georgia Institute of Technology, and Dr. Mark Milutinovich, Program Director, Research Competitiveness Program, American Association for the Advancement of Science.



*NH EPSCoR Sensor Network*

The current update of the Strategic Plan was developed over a series of all-team meetings and a close and critical evaluation of the original plan. Greater detail was added to benchmarks to ensure that benchmarks reflect the most significant aspects of the project and, if met, would be indicative of a successful project. In addition, the original five Project Objectives were consolidated into four objectives that provide better alignment between overarching project goals, objectives and benchmarks.

The Ecosystems and Society project aims to lead the nation in the science and management of healthy ecosystems to support a high quality of life.

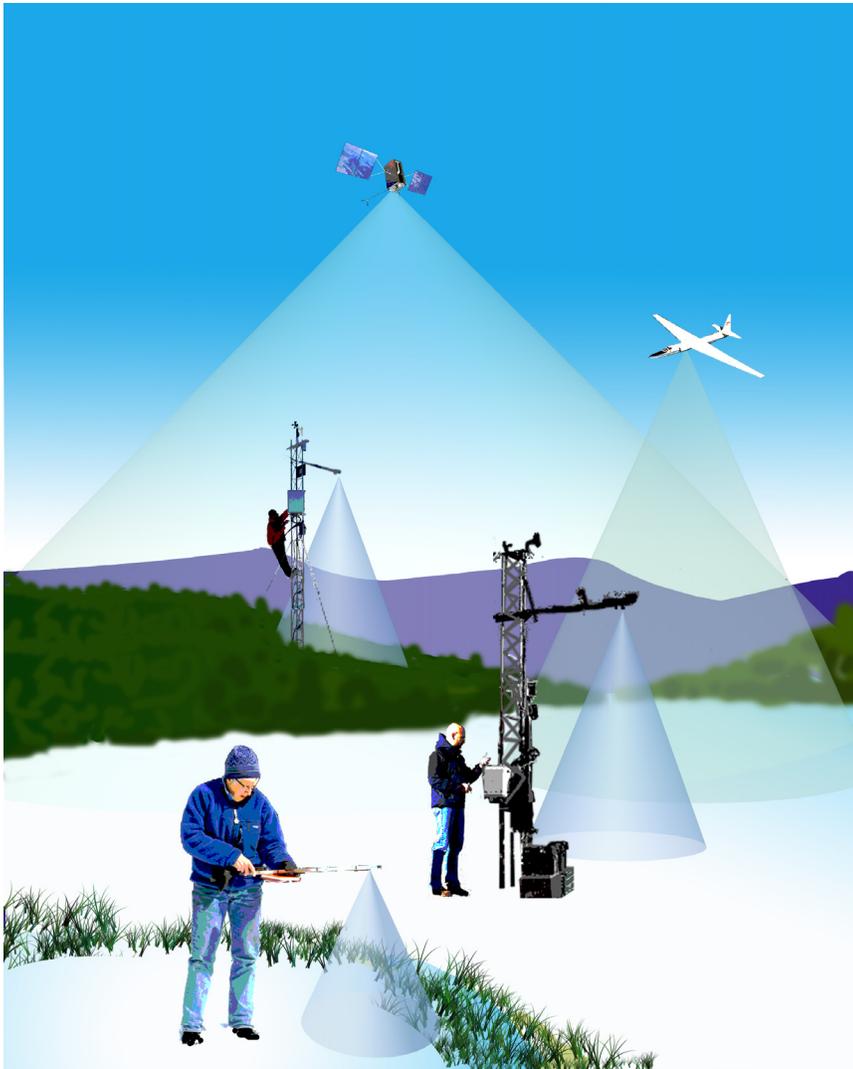
## II. Introduction

New Hampshire's ecosystems provide a wide range of services that are critical to the people who live in the state and the rest of New England. For example, forested landscapes provide clean water, biomass for timber and energy production, carbon storage, climate regulation, nutrient regulation, and opportunities for recreation and aesthetic renewal. These services bring significant benefits to the region's economy and are central to the well-being of its residents. Ensuring that these benefits can be sustained into the future will require improved understanding of basic ecosystem processes and their interactions with changes in climate, land management and the populations they support. Equally critical is to broaden and diversify the capacity to conduct research in the State; to support business, industry and society with a workforce educated in science, engineering and mathematics; and to improve communication between scientists and the public.

The mission of NH EPSCoR is to broaden and strengthen NH's research capacity and competitiveness through research, education and economic development. Since NH became an EPSCoR state in 2004, over \$96 million in federal grants from EPSCoR or EPSCoR-like programs have been awarded to build research capacity in New Hampshire.

The current research infrastructure and improvement award "Ecosystems and Society" aims to lead the nation in the science and management of healthy ecosystems to support a high quality of life. We will (1) broaden NH's research capacity and competitiveness in the science of interactions between society and ecosystems; (2) lead research aimed at understanding the function and management of coupled natural/human systems; (3) recruit and train a diverse STEM workforce and the next generation of researchers; and (4) inform policy makers and citizens on the interactions between land use, ecosystem services and society. This will be facilitated through a robust multi-institutional, interdisciplinary and statewide cyber-enabled network that conducts research, education, outreach and stakeholder engagement.

This plan is based on a model of *engaged scholarship* wherein efforts of research scientists are integrally connected to, and dependent upon, the priorities, objectives and methods for education, outreach, workforce development and diversity initiatives. Engaged scholarship is a mutually beneficial collaboration between researchers and external partners for the purpose of generating and applying relevant knowledge to directly benefit the public. It relies on a true collaboration with stakeholders, where the entire scientific process—from question development through communication of results, is informed by stakeholders.



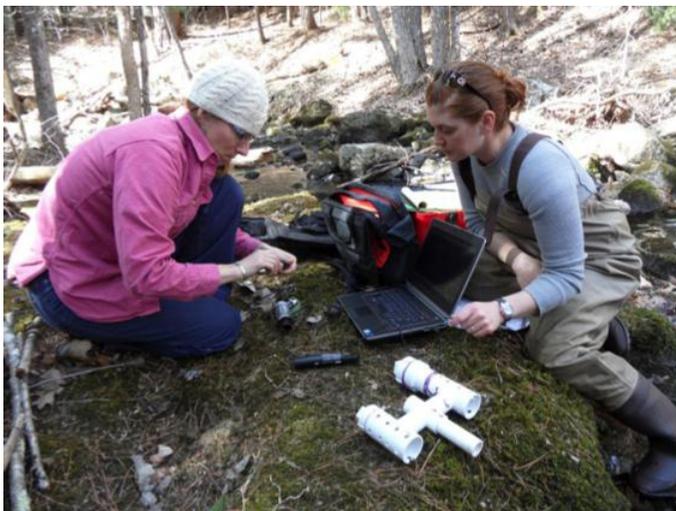
### III. Overarching Goals

There are four overarching goals that encompass this work: (1) To better understand complex interactions among climate, land use, ecosystem function and society, (2) To build capacity for competitive research in interdisciplinary ecosystem-related natural and social sciences, (3) To strengthen and diversify the STEM workforce pipeline in NH, and (4) To inform management and policy decisions regarding ecosystems and their services to, and interactions with, society.

#### *Overarching Goal 1.*

*To better understand complex interactions among climate, land use, ecosystem function and society.*

NH's ecosystems, dominated by the northern forest, provide many services that are the foundation for economic vitality and environmental health of the State. In addition to providing wood, clean water, wildlife habitat and opportunities for recreation and tourism, our ecosystems sequester carbon, regulate regional climate, provide biomass for electricity generation and filter pollutants from air, soil and water. Ecosystem services can be understood generally to include all of the functions of ecosystems that impact human well-being and so are concerned with the human-environment interface. Collectively, these services support many of the State's major industries, sustain the health and well-being of its residents, and serve as an anchor for our cultural identity. In order to support the economic and environmental health of the State, and to capitalize on the strengths of its research institutions, it is critical that we better understand the interactions among climate, land use, ecosystem function and society.



This overarching goal leads to specific Project Objectives, the first of which is to understand how climate variability, climate change and human land use change affect the ability of New Hampshire landscapes to provide essential aquatic and terrestrial ecosystem services to the state and region across multiple scales. This represents a significant and far-reaching goal requiring the integration of multiple objectives related to relationships between land use, development patterns, climate, water quality, water balance, forest dynamics and management policies. In addition, there is close integration with the overall project goal to enable more effective communication among scientists and key stakeholder groups. In order to realize some of the objectives, such as providing policy-relevant statements to stakeholders, it is important that we understand public and stakeholder perceptions and consider ways to improve the success of communicating research findings with policy implications.

Finally, this first overarching goal is dependent on the engagement of citizens across the State (Project Objective 2): without this engagement, collection of key data will be limited and the scientific findings will not achieve their full impact.

## Overarching Goal 2. To build capacity for competitive research in interdisciplinary ecosystem-related natural and social sciences.

A major goal of the NSF EPSCoR program is to increase the capacity for competitive research in its jurisdictions, and the Research Infrastructure Improvement program is a key element of its strategy to achieve this goal. The second overarching goal of the NH EPSCoR project is focused on improving research and educational infrastructure in NH through the broad engagement of researchers, educators, students, businesses, state officials and the public. The integrated observational and modeling network we propose to develop, of which students, teachers and citizens are an integral part, will support and complement several forthcoming national science initiatives and are integral to meeting the research goals of the project. The new collaborations across academic institutions, business, government, and not-for-profit institutions fostered by this project are intended to strengthen networks required to engage in future collaborations to address key societal issues across the region.

This project is a coordinated effort that will build knowledge, infrastructure, social capital (new networks for productive research of critical value to society), and human capital (education and training of individuals) for competitive research. The initiatives for diversity, workforce development and external engagement are integrally connected with each other and with the research methods. The success of the research will be dependent upon success in outreach, education and workforce development: positive interdependence that will ensure the success of all elements of the proposed project.

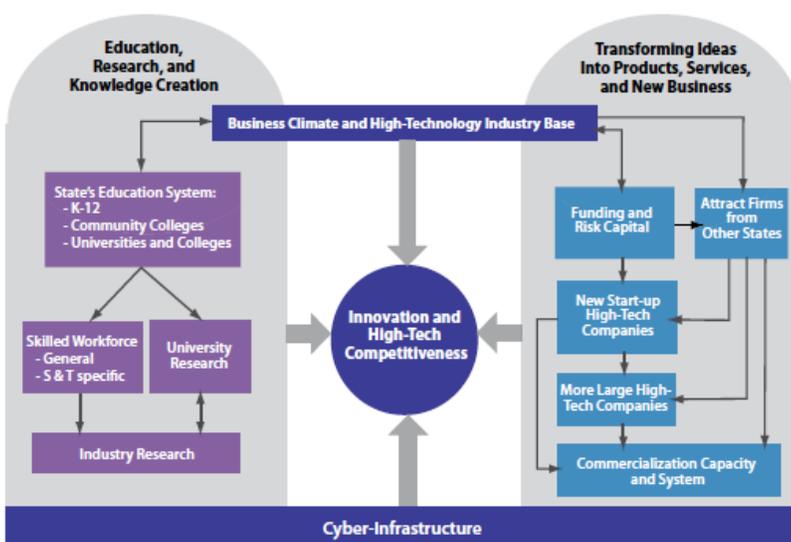
Increasing competitive research capacity in the State is supported by a number of Project Objectives and is embodied in Project Objective 2. Project Objective 3 focuses on building the STEM pipeline which is integral to achieving this overarching goal of the project.

## Overarching Goal 3. To strengthen and diversify the STEM workforce pipeline in NH.

The NH State Science and Technology Plan (NH S&T Plan) identified strengths, barriers, and opportunities for the Research and Development enterprise and its close connection to economic development in the state. As shown in Figure 1, the STEM workforce pipeline contributes significantly to the Innovation System in the State. The NH S&T Plan identified three key recommendations, the second of which is to implement a long-term strategy to ensure that NH develops a highly-skilled S&T workforce.

Historically, New Hampshire has relied heavily on the domestic “importation” of skilled workers (both general and S&T specific). A survey in the year 2000 of state residents revealed that three-quarters of New Hampshire residents with bachelor’s or higher degrees were born in another state. On a regional basis, New Hampshire consistently ranks in the lower half of New England states in S&T workforce. Its underdeveloped S&T workforce will restrict the state’s ability to grow when the nation’s current economic downturn eases and the next technology growth period occurs. New Hampshire will be restricted in its ability to reach higher plateaus of technology employment and economic prosperity. The research, engagement, education and outreach activities described in this proposal align with these key recommendations.

Project Objectives 2 and 3 contribute to this overarching goal, most notably to strengthen and diversify the workforce in the STEM disciplines and expand the capacity for research in New Hampshire. A concerted and geographically targeted effort will be made to engage populations underrepresented in STEM and critical to develop the workforce needed for technologically advanced economy.



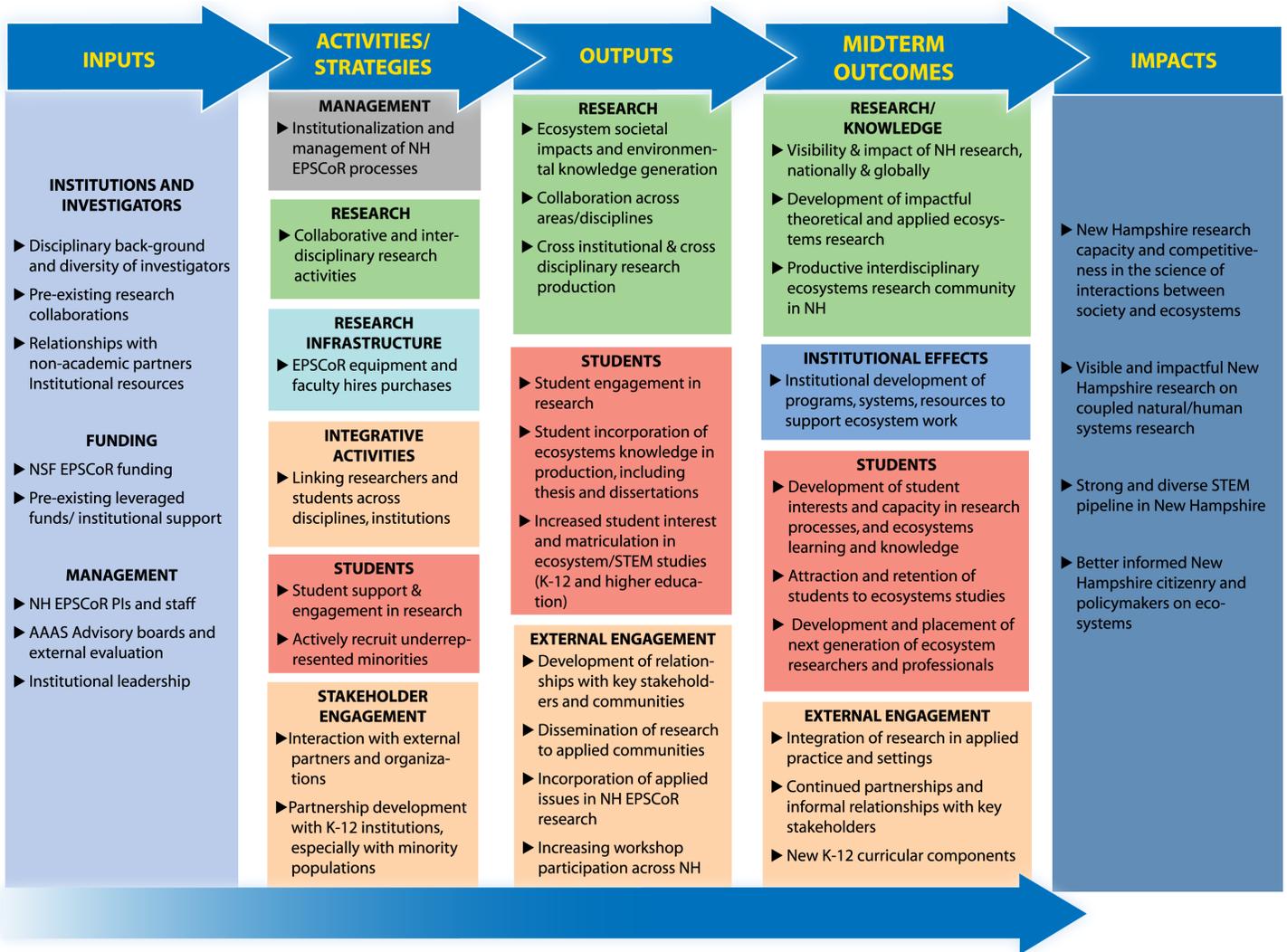
New Hampshire's Innovation System  
(NH S&T Plan, 2011)

#### *Overarching Goal 4.*

*To strengthen management and policy decision capacity in New Hampshire regarding ecosystems and their services to, and interactions with, society.*

This overarching goal is related to integrating efforts of the research scientists and education and outreach professionals from around the state to make the priorities, objectives, and outcomes of this project understandable, accessible, and relevant to NH citizens. Much of this project is modeled on the concept of engaged scholarship, which is a mutually beneficial collaboration between researchers and external partners for the purpose of generating and applying relevant knowledge to directly benefit the public. Partnership with external individuals and organizations will extend through the entire project to reach a broader audience, help refine research questions, assist with data collection and analysis efforts, and provide additional pathways for the dissemination of results. These methods foster engagement of researchers with stakeholders to inform scientific and social learning processes with important feedback loops.





*Logic Model*

The overall logic of the NH EPSCoR project is depicted in the following logic model. This model shows the various activities and strategies, as well as a summary of the interim outputs and outcomes that we expect to develop as we move toward these four overarching goals. The background, activities and strategies for the project objectives and goals, as well as more detailed listing of anticipated outcomes, are provided in Section IV and Section V of this strategic plan.

## IV. Project Objectives, Strategies and Anticipated Outcomes

**Project Objective 1:** To understand how climate variability, climate change and human land use affect the ability of NH landscapes to provide essential aquatic and terrestrial ecosystem services across multiple scales.

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- 1.1 Examine and quantify water quality and water balance impacts of changes in climate, land use, and demographics at a range of spatial scales (hillslope to entire watersheds that intersect the state).
- 1.2 Examine, quantify and value the impacts on terrestrial ecosystem services resulting from changes in climate, land use, and demographics at a range of spatial scales.
- 1.3 Evaluate alternative land use practices and the resulting trade-offs in a variety of aquatic and terrestrial ecosystem services.
- 1.4 Develop and validate linked models that can simulate provision of key ecosystem services by NH landscapes across present-day gradients in climate, human population, socio-economic status and conditions of human land use.
- 1.5 Use the validated models to explore the response of NH's coupled human and natural systems to plausible future scenarios that involve changes in climate, demographics, societal demands, land cover and land management.
- 1.6 Understand how demographic and land use change impacts the current pattern and characteristics of forest cover and carbon storage, and how they may influence future provisioning of ecosystem services by forests.

### **Background:**

New Hampshire's history provides clear evidence that decisions about land management have social and economic impacts across the state. Passage of the Weeks Act and creation of the White Mountain National Forest would not have happened without powerful support from the mill owners (and their employees) in the large cities in the southern part of the state who were concerned about the quality and quantity of water flowing to them from rapidly disappearing northern woodlands. Decisions about future land use management of the regrown forests, agricultural land, waterways, and urban and suburban areas will have significant impacts on New Hampshire's economy and quality of life.

### **Approach/ Strategy:**

Build an innovative, integrated statewide system of terrestrial and aquatic sensors and conduct state-of-the-art aircraft and satellite remote sensing analyses that will inform and test a suite of climate, hydrological and ecosystem models to be applied over the extended statewide domain.

Conduct measurements to examine the effects of forest management and suburban development on vegetation, soils, snow cover and headwater streams in montane, coastal and interior forests. Combine fine-scale longitudinal housing density data with existing forest characteristic, demographic and remote sensing data to examine the relationships among residential development patterns, spatial variations in forest cover, and ecosystem changes in NH.

Use the data collected to parameterize and validate a set of models representing terrestrial and aquatic ecosystems. Apply the models in a coupled framework to examine potential outcomes of a range of future scenarios related to land use, climate, and demographics. Communicate results.

### **Anticipated Outcomes:**

Improved understanding of the functioning of NH ecosystems and a set of more sophisticated models designed to simulate their behavior under a range of conditions.

Direct connections between land use and climatic drivers, soil response (e.g., carbon flux, soil freezing), energy balance, and changes in stream flow and chemistry.

Mechanistic understanding of how regional land use, climate variability and within-stream processing determines water quality and nutrient discharge into coastal zones.

Mechanistic understanding of how ecosystems and land management affect climate forcings via changes in both carbon storage, water budgets and shortwave surface albedo.

Economic valuation of climate regulation, carbon storage and other types of ecosystem services to understand tradeoffs in land management decisions from multiple perspectives.

Improved understanding of forest change and its relation to current and historic demographic and land use change; better understanding of the drivers of local and regional development and its relationship to ecosystem dynamics and services.

Provide an economic valuation of climate regulation, carbon storage and other types of ecosystem services in order to understand trade-offs in land management decisions from multiple perspectives.

**Project Objective 2:** To build capacity for competitive research in interdisciplinary ecosystem-related natural and social sciences.

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- 2.1 Broadly disseminate information about NH EPSCoR research findings, educational activities, and opportunities for engagement to build social and human capital for future competitive research.
- 2.2 Build a statewide network of CoCoRaHS and LoVoTECS volunteers (grade 6 through adult) to collect, analyze, and share data.
- 2.3 Engage students (grades 6-12 and undergraduate) in authentic STEM research
- 2.4 Build social and human capital for future competitive research through the NH science teacher community.
- 2.5 Increase K-12 educator knowledge of research as a teaching paradigm.

**Background:**

A major goal of the NSF EPSCoR program is to increase the capacity for competitive research in its jurisdictions, and the Research Infrastructure Improvement program is a key element of its strategy to achieve this goal. The second overarching goal of the NH EPSCoR project is focused specifically on improving research and educational infrastructure in NH to broaden the engagement of researchers, educators, students, businesses, state officials and the public. The integrated observational and modeling network we propose to develop, of which students, teachers and citizens are an integral part, will support and complement several forthcoming national science initiatives and are integral to meeting the research goals of the project. The new collaborations across academic institutions, business, government, and not-for-profit institutions fostered by this project are intended to strengthen networks required to engage in future research collaborations to address key ecosystem-related natural and social science issues across the region.

**Approach/ Strategy:**

This project is a coordinated effort that will build knowledge, infrastructure, social capital (new networks for productive research of critical value to society), and human capital (education and training of individuals) for competitive research. The initiatives for diversity, workforce development and external engagement are integrally connected with each other and with the research methods. The success of the research will be dependent upon success in outreach, education and workforce development: positive interdependence that will ensure the success of all elements of the proposed project.

**Anticipated Outcomes:**

Increased awareness of NH EPSCoR and its focus on building research opportunities at K-12 and adult levels.

Increased number of volunteer scientists active in data collection and advocacy for environmental issues.

Development of the Data Discovery Center and use of the DDC by volunteer scientists, educators, and external partners.

Increased and more effective use of research as a teaching paradigm at K-14 levels.

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**Project Objective 3:** To strengthen and diversify the STEM workforce pipeline in NH.

- 3.1 Engage students, including those traditionally underrepresented, (grade 6-12; undergraduate) in authentic STEM research.
- 3.2 Develop a strong support network for organizing NH's diverse voices in STEM education and workforce development.
- 3.3 Provide information on NH STEM informal education opportunities to a wide audience
- 3.4 Broaden participation on project teams.
- 3.5 Develop new partnerships to sustain diversity initiatives.
- 3.6 Identify obstacles to STEM careers, promote STEM education and careers.
- 3.7 Increase K-12 educator knowledge of research as a teaching paradigm.
- 3.8 Inspire K-16 students in science, technology, engineering and mathematics

**Background:**

The NH State Science and Technology Plan (NH S&T Plan) identified strengths, barriers, and opportunities for the Research and Development enterprise and its close connection to economic development in the state. The STEM workforce pipeline contributes significantly to the Innovation System in the State. The NH S&T Plan identified three key recommendations, the second of which is to implement a long-term strategy to ensure that NH develops a highly-skilled S&T workforce.

Historically, New Hampshire has relied heavily on the domestic “importation” of skilled workers (both general and S&T specific). A survey in the year 2000 of state residents revealed that three-quarters of New Hampshire residents with bachelor’s or higher degrees were born in another state. On a regional basis, New Hampshire consistently ranks in the lower half of New England states in S&T workforce. Its underdeveloped S&T workforce will restrict the state’s ability to grow and reach higher plateaus of technology employment and economic prosperity.

**Approach/Strategy:**

The NH EPSCoR Outreach and Education Director will lead efforts by a statewide team of STEM education specialists to unite diverse elements within K-12 educational settings. Significant effort will be devoted to outreach to schools with populations of under-represented groups in STEM, including rural, first-generation college families, immigrants, and minorities. Teachers will be offered opportunities for professional development, research experiences, and support in developing collaborations leading to the sharing of resources for STEM education. Our strategy is to directly involve teachers and students in the NH EPSCoR research culture by providing them with opportunities to participate in research data collection and analysis. Utilizing the NH EPSCoR research programs, we will directly engage middle and high school teachers in summer research experiences from which teachers will develop curriculum lesson plans that are aligned with the NH state learning frameworks. Additionally, we will reach students and their parents in 4-H after-school programs in NH’s urban centers (Manchester and Nashua) and distant rural counties.

**Anticipated Outcomes :**

NH EPSCoR will contribute to the transformation in NH STEM education, which includes greater expectation by students and teachers for science-process skills, inquiry-based instruction, and authentic research-learning experiences. Moreover, the contribution by NH EPSCoR will reach diverse and under-represented groups within NH and produce enriched programs, curricula, and research opportunities for student and teacher excellence in STEM

**Project Objective 4:** To strengthen management and policy decision capacity in New Hampshire regarding ecosystems and their services to, and interactions with, society.

- 4.1 Engage a wide range of stakeholders in the development, refinement, and dissemination of plausible scenarios of future land use change.
- 4.2: Assess existing strategies for two way communication between ecosystem researchers and stakeholders, identify barriers, and recommend strategies for improved communication.
- 4.3 Understand how differences in individual characteristics, science knowledge, general beliefs and location influence public perceptions and knowledge of environmental challenges.
- 4.4 Disseminate information about NH EPSCoR research findings to the resource management community.
- 4.5 Translate information about the response of NH's coupled human and natural systems to plausible future scenarios that involve changes in climate, demographics, societal demands, land cover and land management into policy relevant statements and convey these to stakeholders across the region.

**Background:**

This goal is related to integrating efforts of the research scientists and education and outreach professionals from around the state to make the priorities, objectives, and outcomes of this project understandable, accessible, and relevant to the resource management community. Much of this project is modeled on the concept of engaged scholarship, which is a mutually beneficial collaboration between researchers and external partners for the purpose of generating and applying relevant knowledge to benefit the public. Partnership with external individuals and organizations will extend through the entire project to reach a broader audience, help refine research questions, assist with data collection and analysis efforts, and provide additional pathways for the dissemination of results. These methods foster engagement of researchers with stakeholders to inform scientific and social learning processes with important feedback loops.

**Approach:**

In support of this overarching goal, Project Objective 4 is focused on the engagement of scientists and state leaders across the state. This Project Objective relates to working with key stakeholders and with a network of statewide leaders from different sectors with whom project objectives, methods, and findings will be shared and feedback will be brought back to project participants.

**Anticipated outcomes:**

Engaged stakeholders and scientists use project products (data, scenarios, model output) to make more effective land and water management decisions.

Strengthened linkages and communications between ecosystem researchers and stakeholders.

Improved understanding about how different segments of society understand environmental issues and challenges and the associated ramifications for management decisions or policy.



## V: Benchmarks

### Summary of NH EPSCoR Benchmarks: Project Objective 1

Project Objective 1. To understand how climate variability, climate change and human land use affect the ability of NH landscapes to provide essential water resources and ecosystem services across multiple scales.

YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
<ul style="list-style-type: none"> <li>• Deploy initial aquatic and terrestrial sensor networks at hillslope, river basin, and state scale. <b>ESF</b></li> <li>• Assemble essential data for ecosystem and hydrological modeling. <b>MOD</b></li> <li>• Establish preliminary simulation runs for ecosystem and hydrological models. <b>MOD</b></li> <li>• Start winter time snow pack albedo studies with CoCoRaHS. <b>SNO</b></li> <li>• Begin development of WRF coupled with snow module. <b>SNO</b></li> <li>• Assemble supporting data from the U.S. Census Bureau, U.S. Forest Service Forest Inventory and Analysis, and remotely sensed data. <b>LUD</b></li> <li>• Survey research team hardware requirements; acquire, install, and configure hardware. <b>DDC</b></li> <li>• Build Data Discovery Center (<b>DDC</b>) prototype sites for vector and raster data management. <b>DDC</b></li> </ul>	<ul style="list-style-type: none"> <li>• Complete deployment of terrestrial and aquatic sensor network. <b>ESF</b></li> <li>• Create statewide maps of surface water quality under current climate and land use conditions. <b>MOD</b></li> <li>• Begin the integration of the PnET and FRAMES models. <b>MOD</b></li> <li>• Begin winter-time spectral albedo studies (surface-based and airborne). <b>SNO</b></li> <li>• Continue development of WRF snow module and begin assessment of MODIS albedo and WRF skill at simulating snowpack albedo. <b>SNO</b></li> <li>• Evaluate tradeoffs between timber production and forest carbon storage in the White Mountain National Forest (WMNF). <b>IES</b></li> <li>• Develop a framework for valuing the impacts of forest management on surface albedo. <b>IES</b></li> <li>• Develop a case study methodology for the valuation and governance of watershed ecosystem services using multi-criteria techniques. <b>IES</b></li> <li>• Downscaled IPCC FAR climate and EPA ICLUS land use/land cover scenarios provided to modeling teams. <b>SSE</b></li> <li>• Develop a high-resolution (30m) map of forest carbon storage and other characteristics for New Hampshire with a 2010 base year. <b>LUD</b></li> </ul>	<ul style="list-style-type: none"> <li>• Identify variation in water quality along major river networks to quantify controls on delivery of nutrients through river systems. <b>ESF</b></li> <li>• Identify spatial and temporal variation in soil processes. <b>ESF</b></li> <li>• Analyze airborne data and develop spatial data layers of albedo and forest conditions. <b>ESF</b></li> <li>• Couple output from aquatic and terrestrial sensor networks to understand connections between soil processes and water quality in headwater streams and major rivers. <b>ESF, MOD</b></li> <li>• Statewide maps created of surface water quantity relative to water demand under different climate conditions to identify areas at risk for inadequate water supply. <b>MOD</b></li> <li>• Identify hot spots that regulate aquatic and terrestrial ecosystem services; understand the implications of changing land, demographic, and climate conditions. <b>MOD</b></li> <li>• Integration of field measurements into PnET and FRAMES through improved parameterization and validation. <b>MOD</b></li> <li>• Continue development of WRF snow module and begin assessment of MODIS albedo and WRF skill at simulating snowpack albedo. <b>SNO</b></li> <li>• Optimize WRF simulations of present day climate in NH, including improving snow module. <b>SNO</b></li> </ul>	<ul style="list-style-type: none"> <li>• Create statewide maps of surface water quality under future scenarios of climatic or land use conditions, to identify areas at risk for degraded water quality. <b>MOD</b></li> <li>• Identify hot spots of water supply generation, storage, and water resource use to understand the implications for statewide sustainability following future changes in land, demographic, and climate conditions. <b>MOD</b></li> <li>• Apply the PnET and Frames models using spatial data layers of forest conditions and future climate projections. <b>MOD</b></li> <li>• Use WRF to simulate 1850 to present, provide output to terrestrial and aquatic groups. <b>SNO</b></li> <li>• Continue surface-based winter-time spectral albedo studies. <b>SNO</b></li> <li>• Integrate ecosystem services, climate change, and spatial land use processes into an ecological-economic valuation model to analyze short and long-term impacts of private and public land management and develop strategies that meet multiple management objectives.</li> </ul>	<ul style="list-style-type: none"> <li>• Simulate future NH climate with WRF, based on scenarios developed by entire NH EPSCoR team. Provide WRF output to terrestrial and aquatic groups. <b>MOD, SNO</b></li> <li>• Complete the ecosystem model analyses using future scenarios of land use in conjunction with projections of future climate. <b>MOD</b></li> <li>• Continue surface-based winter-time spectral albedo studies. <b>SNO</b></li> <li>• Complete work on the valuation and governance of ecosystem services, integrating this work with the other elements of the project. <b>IES</b></li> <li>• Incorporate the results of our analysis in years 1-4 into grant proposals to support additional interdisciplinary research on coupled human-natural systems with funding to support graduate and post-doctoral students to expand the STEM workforce and capacity for research. <b>LUD</b></li> <li>• Prepare academic and applied publications to disseminate the findings of our research to a broad audience of researchers, policy-makers and the residents of NH. <b>LUD</b></li> </ul>

*continued on next page*

**TEAM LIST:** **COM**—Communication    **DDC**—Data Discovery Center    **E&O**—Education & outreach    **ESF**—Ecosystem sensors and function    **IES**—Integrating ecosystem services, valuation and governance    **LUD**—Land use & demographics    **MGT**—Management  
**MOD**—Modeling    **SNO**—Snow    **SSE**—Scenarios & stakeholder engagement

*Summary of NH EPSCoR Benchmarks: Project Objective 1 — Continued*

YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
	<ul style="list-style-type: none"> <li>• Establish data workflows, design database schema, and initiate research data transfer. <b>DDC</b></li> <li>• Develop and release <b>DDC</b> data ingestion tools. <b>DDC</b></li> <li>• Acquire, standardize, and generalize land cover data for 5 time steps spanning the period 1992-2011; initiate accuracy assessment of 2011 data. <b>DDC</b></li> </ul>	<ul style="list-style-type: none"> <li>• Continue surface-based wintertime spectral albedo studies. <b>SNO</b></li> <li>• Incorporate surface albedo and other ecosystem services in the analysis of forest management options. Extend the analysis to account for climate interactions at an expanded spatial scale. Use multi-criteria analysis to evaluate tradeoffs at the watershed scale. <b>SNO, IES</b></li> <li>• Development of land use, climate, and demographic scenarios. <b>SSE</b></li> <li>• First draft of NH specific land use/land cover scenarios completed. <b>SSE</b></li> <li>• Jointly analyze spatial patterns of demography (from the 2010 Census) and the spatial patterns of forest characteristics to test hypotheses about impacts of population, housing, and other land use on carbon storage and other potential ecosystem services from forests. <b>LUD</b></li> <li>• Survey research teams to establish web site functionality requirements ; develop and release version 1 of <b>DDC</b> user interface(s), incorporating ingestion, query, visualization, and dissemination tools. <b>DDC</b></li> <li>• Complete accuracy assessment of 2011 data; Produce an enhanced land cover time series based on evaluating and modifying the progression of land cover classes through the 20-year time period. <b>DDC</b></li> </ul>	<p>Compare stakeholder values to management strategies for critical watershed-specific ecosystem services. <b>IES</b></p> <ul style="list-style-type: none"> <li>• Revised NH specific land use /and cover scenarios completed . <b>SSE</b></li> <li>• Incorporate historical data and future projections of housing density from USFS sponsored research, contemporary information on forest dynamics derived from the US Forest Service FIA data and our database developed in years 1-3, to examine longitudinal patterns of landscape development and their relationship to current trends in forest cover, carbon storage, and timber harvesting. <b>LUD</b></li> <li>• Release version 2 of <b>DDC</b> user interface(s), with enhanced query/ visualization tools. <b>DDC</b></li> </ul>	<ul style="list-style-type: none"> <li>• Release version 3 of <b>DDC</b> user interface(s), with enhanced query/ visualization tools. <b>DDC</b></li> </ul>

## Summary of NH EPSCoR Benchmarks: Project Objective 2

Project Objective 2: To build capacity for competitive research in interdisciplinary ecosystem-related natural and social sciences.

YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
<ul style="list-style-type: none"> <li>• Training of CoCoRaHS and LoVoTECS volunteers and initial data collection. <b>SNO, ESF, E&amp;O</b></li> <li>• Collection of albedo and snowpack measurements by CoCoRaHS volunteers; data entered into database. Analyze data and provide feedback to CoCoRaHS volunteers. <b>SNO</b></li> <li>• Train graduate and undergraduate students in geospatial and information technologies. <b>DDC</b></li> </ul>	<ul style="list-style-type: none"> <li>• Continue collection, analysis and dissemination of data by CoCoRaHS and LoVoTECS volunteers. Years 2-5. <b>S, SNO, ESF, E&amp;O</b></li> <li>• Train graduate and undergraduate students in geospatial and information technologies. <b>DDC</b></li> <li>• Develop and host 2 summer institutes providing training to 45 teachers in geospatial technologies, incorporating data streams collected by EPSCoR research teams. <b>DDC</b></li> <li>• Provide research opportunities for Grade 6-12 teachers and community college faculty (RET), and research experiences for undergraduates (REU). <b>E&amp;O</b></li> <li>• Science Cafes. Years 2-5 <b>COM</b></li> </ul>	<ul style="list-style-type: none"> <li>• Data collection by CoCoRaHS and LoVoTECS volunteers. <b>SNO, ESF, E&amp;O</b></li> <li>• Information needs of stakeholders and preferred outlets are transmitted to and discussed with researchers. <b>SSE</b></li> <li>• Train graduate and undergraduate students in geospatial and information technologies. <b>DDC</b></li> <li>• Develop and conduct training on use of the Data Discovery Center. <b>DDC</b></li> <li>• Translation of research results to informal science education. Years 3-5. <b>E&amp;O</b></li> <li>• Produce and disseminate briefs for NH citizens <b>C</b></li> <li>• Provide RETs and REUs. <b>E&amp;O</b></li> <li>• Science Cafes. <b>COM</b></li> </ul>	<ul style="list-style-type: none"> <li>• Repeat Granite State Poll; add IData collection by CoCoRaHS and LoVoTECS volunteers. <b>SNO, ESF, E&amp;O</b></li> <li>• Train graduate and undergraduate students in geospatial and information technologies. <b>DDC</b></li> <li>• Update and conduct training on use of the Data Discovery Center. <b>DDC</b></li> <li>• Provide RETs and REUs. <b>E&amp;O</b></li> <li>• Informal science education. <b>E&amp;O</b></li> <li>• Produce and disseminate briefs for NH citizens <b>COM</b></li> <li>• Science Cafes. <b>COM</b></li> </ul>	<ul style="list-style-type: none"> <li>• Data collection by CoCoRaHS and LoVoTECS volunteers. <b>SNO, ESF, E&amp;O</b></li> <li>• Train graduate and undergraduate students in geospatial and information technologies. <b>DDC</b></li> <li>• Update and conduct training on use of the Data Discovery Center. <b>DDC</b></li> <li>• Provide RETs and REUs. <b>E&amp;O</b></li> <li>• Informal science education. <b>E&amp;O</b></li> <li>• Produce and disseminate briefs for NH citizens <b>COM</b></li> <li>• Science Cafes. <b>COM</b></li> </ul>

## Summary of NH EPSCoR Benchmarks: Project Objective 3

Project Objective 3: To strengthen and diversify the STEM workforce pipeline in NH.

YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
<ul style="list-style-type: none"> <li>• Half-day workshops for the semi-annual NH Science Teachers' Association (NHSTA) meetings. At least one NH EPSCoR workshop and one Exhibitor's table per meeting. Years 1-5 <b>E&amp;O</b></li> <li>• Website platform with online searchable database for NH STEM education programs, events, and opportunities for K-16+ audiences developed, launched. <b>E&amp;O</b></li> <li>• NH EPSCoR EOD is standing member of NH STEM leadership team. <b>E&amp;O</b></li> <li>• Inclusive Excellence Advisory Board provides support for recruiting and retaining project staff and new faculty. <b>MGT</b></li> <li>• Provide need-based scholarships to students from URGs to attend STEM camps at UNH, WMCC, KSC. Years 1-5. <b>MGT</b></li> <li>• Support Inclusive Excellence leadership summit. <b>MGT</b></li> <li>• Challenge grants to NH companies to hire NH graduates in STEM disciplines, Years 1-5. <b>MGT</b></li> <li>• Support NH STEM Equity Project: professional development of Grades 6-12 teachers and guidance counselors for gender equity awareness. Years 1-3. <b>MGT, E&amp;O</b></li> </ul>	<ul style="list-style-type: none"> <li>• Provide direct support for at least 12 teachers in at least 6 school districts to help incorporate GIS into their classroom activities. <b>DDC</b></li> <li>• Development of 4-H after-school programs on hydrology using project data and products. Years 2-5. <b>E&amp;O</b></li> <li>• Conduct workshops in hydrology using project data and products for Grade 6-12 teachers, community college faculty, and 4-H Extension educators, Years 2-5. <b>E&amp;O</b></li> <li>• Faculty development workshops in partnership with Campus Compact of NH and SENCER, Years 2-5. <b>MGT, E&amp;O</b></li> <li>• Leadership role in STEM NH, supporting statewide STEM initiatives. <b>E&amp;O</b></li> <li>• Continue NHSTA exhibit and workshop. <b>E&amp;O</b></li> <li>• Update the STEM NH online searchable database (Years 2-5). <b>E&amp;O</b></li> <li>• Continue challenge grants to NH companies. <b>MGT</b></li> <li>• Continue STEM camp scholarships and provide instructors, Years 2-5. <b>MGT, E&amp;O</b></li> <li>• Continue support of NH STEM Equity Pipeline. <b>E&amp;O</b></li> <li>• Hire new faculty with guidance from the Inclusive Excellence Advisory Board. <b>MGT</b></li> <li>• Mini-grants for inclusive excellence initiatives and research proof of concept. Years 2-3. <b>MGT</b></li> <li>• Conduct surveys of recent college graduates. <b>MGT</b></li> </ul>	<ul style="list-style-type: none"> <li>• Deliver training in data analysis skills for external partners. <b>DDC</b></li> <li>• Development of Data Discovery Center for formal and informal educators. <b>DDC</b></li> <li>• Continue workshops in GIS educational software. <b>DDC</b></li> <li>• Implementation of 4-H after school programs in urban centers. <b>E&amp;O</b></li> <li>• Continue NHSTA exhibit and workshop. <b>E&amp;O</b></li> <li>• Update STEM NH database. <b>E&amp;O</b></li> <li>• Update and continue hydrology workshops. <b>E&amp;O</b></li> <li>• Continue hosting and mentoring RETs and REUs. <b>E&amp;O</b></li> <li>• Continue STEM camp scholarships and provide instructors, Years 2-5. <b>MGT, E&amp;O</b></li> <li>• Continue leadership role in STEM NH. <b>E&amp;O</b></li> <li>• Continue faculty development workshops. <b>MGT, E&amp;O</b></li> <li>• Host Student Science Café for graduate students to connect with high school students, Years 3-5. <b>COM</b></li> <li>• Provide professional development workshops and networking opportunities at NH EPSCoR state conferences, Years. 3-5. <b>MGT</b></li> <li>• Transfer scholarships for CCSNH students, Years 3-5. <b>MGT</b></li> <li>• Support Inclusive Excellence leadership summit. <b>MGT</b></li> <li>• Continue mini-grants. <b>MGT</b></li> <li>• Continue challenge grants to NH companies. <b>MGT</b></li> </ul>	<ul style="list-style-type: none"> <li>• Gather feedback from NH K-12 educators on Data Discovery Center tools through surveys, interviews and other methods. <b>DDC</b></li> <li>• Update and continue hydrology workshops. <b>E&amp;O</b></li> <li>• Expansion of 4-H after-school programs to rural counties. <b>E&amp;O</b></li> <li>• Continue NHSTA exhibit and workshop. <b>E&amp;O</b></li> <li>• Update STEM NH database <b>E&amp;O</b></li> <li>• Continue hosting and mentoring RETs and REUs. <b>E&amp;O</b></li> <li>• Continue STEM camp scholarships and provide instructors, Years 2-5. <b>MGT, E&amp;O</b></li> <li>• Continue hosting and mentoring RETs and REUs. <b>E&amp;O</b></li> <li>• Continue leadership role in STEM NH. <b>E&amp;O</b></li> <li>• Continue faculty development workshops. <b>MGT, E&amp;O</b></li> <li>• Continue state conference professional development workshops. <b>MGT</b></li> <li>• Conduct surveys of recent college graduates. <b>MGT</b></li> <li>• Continue challenge grants to NH companies. <b>MGT</b></li> <li>• Continue transfer scholarships. <b>MGT</b></li> </ul>	<ul style="list-style-type: none"> <li>• Update training materials to accommodate revisions to DDC tools and increased project data availability. <b>DDC</b>.</li> <li>• Update and continue hydrology workshops. <b>E&amp;O</b></li> <li>• NHSTA exhibit and workshop. <b>E&amp;O</b></li> <li>• Update STEM NH database. <b>E&amp;O</b></li> <li>• Continue hosting and mentoring RETs and REUs. <b>E&amp;O</b></li> <li>• Continue statewide expansion of 4-H after-school programs. <b>E&amp;O</b></li> <li>• Continue STEM camp scholarships and provide instructors, Years 2-5. <b>MGT, E&amp;O</b></li> <li>• Continue leadership role in STEM NH. <b>E&amp;O</b></li> <li>• Continue faculty development workshops. <b>MGT, E&amp;O</b></li> <li>• Continue state conference professional development workshops. <b>MGT</b></li> <li>• Continue challenge grants to NH companies. <b>MGT</b></li> <li>• Continue transfer scholarships. <b>MGT</b></li> <li>• Support Inclusive Excellence leadership summit. <b>MGT</b></li> </ul>

**TEAM LIST:** COM—Communication    DDC—Data Discovery Center    E&O—Education & outreach    ESF—Ecosystem sensors and function    IES—Integrating ecosystem services, valuation and governance    LUD—Land use & demographics    MOD—Modeling    SNO—Snow    SSE—Scenarios & stakeholder engagement    **MGT**—Management

*Benchmarks for Engaging Groups Underrepresented in STEM*

	TOTAL	URG *	%
<b>Project Employment</b>			
New faculty	6	3	50%
Post-doctoral associates	8	4	50%
Graduate students	18	10	55%
Undergraduate students	20	10	50%
Technical staff	25	10	40%
<b>Workforce Development</b>			
Research Experiences for Undergraduates	24	10	42%
Research Experiences for Teachers	20	8	40%
LoVoTECS/CoCoRaHS for Teachers	36	15	42%
LoVoTECS for 4-H Middle School Students	100	60	60%
Summer Camp Scholarships	125	80	64%
Student Travel Awards	10	6	60%
Transfer Scholarships	12	6	50%
Faculty Development Workshops	200	100	50%
Stay Work Play NH Challenge Grants	15	8	53%
Geospatial Training for Teachers	50	20	40%
K-12 Students Reached by Teacher Training	5000	3000	60%
<b>Total</b>	<b>5669</b>	<b>3350</b>	<b>59%</b>

\* URG in STEM: Female, Black/African American, Hispanic, Other Ethnic, Persons with Disabilities, Veterans, 1st Generation College

*Summary of NH EPSCoR Benchmarks: Project Objective 4*

Project Objective 4: To strengthen management and policy decision capacity in New Hampshire regarding ecosystems and their services to, and interactions with, society.

YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
<ul style="list-style-type: none"> <li>• Develop questions and implement first data collection through Granite State Poll. <b>SSE</b></li> <li>• Establish statewide workgroup on climate, energy, and ecosystem education and outreach network. <b>SSE</b></li> </ul>	<ul style="list-style-type: none"> <li>• Repeat Granite State Poll; add longitudinal analysis component. Years 2-5. <b>SSE</b></li> <li>• Complete land use information gathering from diverse set of NH stakeholders. <b>SSE</b></li> <li>• Baseline survey of EPSCoR project scientists regarding their attitudes and behaviors/strategies for engaging and communicating with NH stakeholders about their research is developed, administered and analyzed. Report on baseline scientist survey presented to EPSCoR. <b>SSE</b></li> <li>• Build list of stakeholders and key audiences in preparation to produce and disseminate briefs for NH citizens: (1) describing importance of ecosystem services and (2) linking services to land use, climate, and demographics. Years 2-5 <b>COM</b></li> </ul>	<ul style="list-style-type: none"> <li>• Granite State Poll <b>SSE</b></li> <li>• Key informant interviews and institutional analyses. <b>SSE</b></li> <li>• Analyze communication strategies used by ecosystem researchers. <b>SSE</b></li> <li>• Identify the degree to which research findings reached intended audiences and their utility. <b>SSE</b></li> <li>• Scenario narrative’s drafted and feedback obtained from diverse set of NH stakeholders <b>SSE</b></li> <li>• Initial survey of a diverse set of NH ecosystem research stakeholders completed regarding their perceptions about and strategies for learning about and using ecosystem research with results compared to baseline scientist survey, and results presented to EPSCoR. <b>SSE</b></li> <li>• Expand awareness of the NH EPSCoR initiatives, research and information resources through communication tools. <b>COM</b></li> </ul>	<ul style="list-style-type: none"> <li>• Granite State Poll <b>SSE</b></li> <li>• Obtain feedback on communication strategies from key stakeholders. <b>SSE</b></li> <li>• Identify the degree to which research findings are used in land use / resource planning and management. <b>SSE</b></li> <li>• Sharing and obtaining stakeholder feedback on the impact of changes to ecosystem services based on model outputs driven by climate and land use scenarios <b>SSE</b></li> <li>• Follow-up survey of EPSCoR project scientists regarding their attitudes and behaviors/strategies for engaging and communicating with NH stakeholders is completed with results compared to baseline survey and to baseline stakeholder survey. Report comparing baseline to follow-up scientist survey results presented to EPSCoR. <b>SSE</b></li> <li>• Development of Data Discovery Center for use by key stakeholders. <b>DDC</b></li> <li>• Gather feedback from NH environmental planners on Data Discovery Center tools through surveys, interviews and other methods. <b>DDC</b></li> </ul>	<ul style="list-style-type: none"> <li>• Granite State Poll <b>SSE</b></li> <li>• Identify problems that interfere with communication between scientists and stakeholders and make recommendations for improvements. <b>SSE</b></li> <li>• Disseminate final results; assess extent to which scenario information is useful to key stakeholders <b>SSE</b></li> <li>• A second survey of NH ecosystem research stakeholders regarding their perceptions of information flow from EPSCoR scientists and their use of the research produced is completed with results presented to EPSCoR. <b>SSE</b></li> </ul>

**TEAM LIST:** **COM**—Communication    **DDC**—Data Discovery Center    **E&O**—Education & outreach    **ESF**—Ecosystem sensors and function    **IES**—Integrating ecosystem services, valuation and governance    **LUD**—Land use & demographics    **MGT**—Management  
**MOD**—Modeling    **SNO**—Snow    **SSE**—Scenarios & stakeholder engagement

## VI: Management Plan

The NH EPSCoR project is guided by a number of groups to ensure the project is fully integrated with the educational, workforce development, research and diversity initiatives across the State. It is governed formally by the Statewide Committee and the project is coordinated, advised, and leveraged by a number of additional committees, councils, and boards that are intended to maximize the impact of the project.

The NH EPSCoR **Science Coordinating Committee** includes the Directors of each of the NASA, DOE, and NSF EPSCoR projects (including cyberinfrastructure) and the NIH INBRE initiatives in the state. This Committee assures that all research, workforce, outreach and evaluation activities are being coordinated and leveraged.

The **Integrating Research Project Committee** consists of five scientists in the areas of climate science, hydrology, forest ecology, ecological economics and social sciences (Wake, McDowell, Ollinger, Howarth, and Grimm) who will individually meet frequently with science team members and will annually review the scientific progress of the grant, provide formative assessments to the project team members, and input to the AAAS Research Competitiveness Service reviewers.

The **NH STEM Advisory Council** is made up of seven members of the NH STEM Coalition and will assist in coordinating workforce, K-12, and outreach activities.

The **Integrating Education, Outreach and Research Committee** will be led by Wake and Hale and will facilitate the integration of research methods and findings with education and outreach initiatives.

The **NH Statewide Inclusive Excellence Committee** will advise the project management team regarding strategies for broadening participation on the research, education, outreach and management teams and act as a resource to the team in developing programs for faculty, post-docs and students.

The **EPSCoR Project Management Team** is composed of PI Nisbet, Co-PI Gardner, Project Manager Gregoire, Outreach Director Hale, and Information Manager Jones and conducts ongoing formative internal review to evaluate whether project activities are conducted as planned and identify any problem areas and new opportunities. They are assisted by a financial coordinator. Grant administration oversight is provided by the UNH Office of Sponsored Research Administration.



The AAAS Research Competitiveness Service will provide assessment and guidance to the work of NH EPSCoR, specifically recommendations on scientific directions, management activities, supporting infrastructure and policies, and evaluation process.

Integration among the individuals and groups involved with the NH EPSCoR project from across the State and throughout the institutions, as well as the integration of the committees and boards overseeing the project, is critical to the success of the overall project. There are a number of mechanisms we will use to provide the structure to ensure this will be accomplished.

At the highest level, we will hold two intensive retreats each year that will bring together all project personnel and will focus on the progress towards meeting all the strategic goals and objectives of the project. The intensive retreats will provide the opportunity to ensure the connection and coordination among project elements, provide updates for all personnel on all facets of the project (including integration of the various efforts), and permit the review of project strategies, metrics, and milestones.

Integration among project elements requires continuous attention and this function will be the focus of two committees: the **Integrating Research Committee** and the **Integrating Education, Outreach and Research Committee**. The goals of the research require integration among many disciplines, and the Integrating Research Committee, staffed by research leads of the involved disciplines, will meet quarterly to discuss the status of the research program and conduct formative assessments of the work to date, with a focus on the integration of science from the different disciplines. Similarly, the project

goals and objectives require integration of research with education and outreach programs. Steven Hale (EOD) and Cameron Wake (Co-PI) will staff the Integrating Education, Outreach and Research Committee, which will operate by organizing and facilitating meetings and workshops among people involved in the different aspects of the project. Both committees will be staffed by Co-PI Gardner and will report out to the Project Management Team and more broadly to the team members.

The **NH STEM Advisory Council** provides an external body that will provide formative assessment of education and outreach programs and will facilitate connections to programs throughout the State. EOD Hale convenes this council twice per year and reports back to the **Project Management Team** (on which he sits) and the **Integrating Education, Outreach and Research Committee**. Similarly, the **NH Inclusive Excellence Committee** is an external body that will provide formative assessment of strategies for broadening participation in STEM. It will be convened twice annually by Co-PI Gardner (who is a member of the Statewide Inclusive Excellence Committee) and will report back to the **Project Management Team**.

The **EPSCoR Project Management Team** will meet every other week and will oversee all aspects of the project. It will hear reports from all of the committees, councils and advisory boards and will call groups to its meeting as needed. It will interface with the **Science Coordinating Committee**, which meets each year to coordinate EPSCoR and IDEA programs, to look for opportunities for leveraging their common purpose. It will meet at least semi-annually with the Academic Leadership Advisory Board to ensure that the partner institutions' needs are met in order to fully participate in the project. The **EPSCoR Project Management Team** will also be the coordinating body for interactions with the **AAAS Research Competitiveness Service** and review from external evaluators.



## Statewide Committee

The NH EPSCoR Statewide Committee is the final decision-making body for the New Hampshire EPSCoR Program and is responsible for the coordination of the jurisdiction's EPSCoR/EPSCoR-like portfolio. The Statewide Committee provides policy guidance, coordinates administrative functions and is the primary advocacy group for the NH EPSCoR Program. The Committee leads the development of the state NH S&T Plan and provides linkages with business and industry, state policy-makers, private and not-for-profit entities, and community members, including members of underrepresented groups

### *NH EPSCoR Committee Members*

**Jenny Houston** — Committee Chair, Vice President of Business Development, Warwick Mills

**Mike Shipulski** — Vice Chair, Director of Advanced Development, Hypertherm, Inc.

**Jeffrey Rose** — Commissioner, NH Resources & Economic Development

**Mary Collins** — State Director, NH Small Business Development Center

**Joanne Donoghue** — Operations Director, Mascoma Corp.

**Katharine Eneguess** — President White Mountains Community College

**Representative Naida Kaen**—NH House of Representatives

**Todd Leach** — Interim Chancellor, University System of New Hampshire

**Michael Melville** — President, IntelliSoft Group

**Samuel Mukasa** — Dean, UNH College of Engineering and Physical Sciences

**John Orcutt** — Associate Dean for Faculty Research, Professor of Law UNH School of Law

**Kevin Shyne** — NH Department of Education, School-to-Work STEM Initiative

**Senator Nancy Stiles** — NH State Senate

**Cory von Wallenstein** — Chief Product Officer, Dyn, Inc.

**Martin Wybourne** — Senior Vice Provost for Research, Dartmouth College

## VII: Evaluation Plan

In order to measure progress toward goals set out in this plan, as well as to provide external non-biased longitudinal data for the continuous improvement of New Hampshire EPSCoR, an external evaluation process and tracking of specific metrics is an important aspect of our overall planning activities. Evaluation and assessment activities are an ongoing formative and summative component of the New Hampshire RII initiative. An external evaluation team will lead this effort, and also advise NH EPSCoR on the on-going tracking of key activity data important for on-going measurement and evaluation.

Over the five years of this grant, the evaluation and assessment will take a broad approach including a) ongoing tracking of performance metrics related to the activities set forth in this plan, and reported in the annual report to NSF; and b) an on-going external evaluation which will include the collection of primary data (survey and interviews) as well as detailed analysis in later years on the publications and related knowledge impacts of New Hampshire EPSCoR work. Both processes are designed with a focus on assessing capacity development within New Hampshire EPSCoR, consistent with the overall NSF EPSCoR goals and objectives. Specific metrics and items addressed in the evaluation (through surveys and other data) are based on the logic model and other details in this report.

**On-Going tracking of Performance Data:** NH EPSCoR contracted the UNH Research Computing and Instrumentation Center to build a multifunctional, secure database to store information, organize data on project participants and provide online reporting functionality for the management team. It includes an electronic event registration system to collect data on outreach and project participants at the time of the event which loads directly into the database. The data is organized by grant and project, which enables the management of multiple grants, sub-awards and contact information for thousands of participants. It will generate reports on demographics, research training compliance, and progress against milestones and metrics such as proposals submitted or awarded, publications,



presentations, honors and awards. Project leads will be able to log in and communicate electronically with the management team. The database provides program continuity independent of changes in staff, and will be a valuable resource for collecting metrics on participants, equipment, and other measurable data annually and at the close of the grant.

**External Evaluation:** The evaluation process is designed to be both formative and summative, and annual reports will include details on how the recommendations from each of these processes have been used in programming and other decisions. With the completion of this first draft of the strategic plan, the external evaluation team will be developing survey instruments and data collection processes to complement and address the items specified in this plan. In Year 1, baseline data will be collected for metrics appropriate in this first year. Subsequent years of the evaluation will continue to collect Year 1 metrics to provide a longitudinal perspective on capacity development and progress toward goals. Subsequent years of the evaluation will also identify key issues or topics for investigation and assessment. As NH EPSCoR develops, appropriate metrics will be added to the evaluation process and reported annually to NH EPSCoR PI's and leadership. The NH EPSCoR annual report will indicate how it is responding to findings and recommendations of this evaluation as a continuous improvement process.

## VIII: Risk Analysis, Mitigation and Succession Plan

There are a number of different types of risk associated with this research project, including the inability of key personnel to fulfill their roles. This section discusses the risks, mitigation approaches to the risk as well as a succession plan for the particular risk of loss of key personnel.

This project represents a team-based approach to scientific research as well as to management. While there is unique expertise among the faculty, researchers, management personnel and staff, the approach taken is such that knowledge, decisions, and approaches are shared among team members and the project is able to recover from the loss of any one person. The team-based approach to research was necessary to accomplish the goals of the work, with the ancillary benefit of a project that is more resilient to changes in personnel. In this section we provide an analysis of risks, mitigation approaches and succession plans broken down by the major themes of the project.

In response to recommendations from the Reverse Site Visit panel regarding the integration of project teams, we have reorganized and renamed the teams to better describe the function of each group. A table of the new teams and faculty or team leaders follows.

### *Ecosystems and Society Teams*

	Institution	Faculty/Team Leaders*
<b>Ecosystem sensors and function</b>	UNH	<b>Bill McDowell</b>
<b>ESF</b>	UNH	<b>Serita Frey</b>
	PSU	Mark Green
	GBCC	David Wilson
	WMCC	Rachel Whittaker
	UNH	Ruth Varner
(also in Modeling team)	UNH	Wil Wollheim
<b>Modeling</b>	UNH	<b>Scott Ollinger</b>
<b>MOD</b>	UNH	<b>Wil Wollheim</b>
	UNH	Richard Lammers
	UNH	Alexander Shiklomanov
	UNH	Mary Martin
	UNH	Mary Stampone
	UNH	Jingfeng Xiao
	St. A	David Guerra
<b>Snow</b>	UNH	<b>Jack Dibb</b>
<b>SNO</b>	UNH	Mary Albert
	UNH	Ian Baker
<b>Integrating ecosystem services, valuation and governance</b>	DC	<b>Richard Howarth</b>
<b>IES</b>	DC	Mark Borsuk
	DC	Ross Jones
	PSU	Shannon Rogers
<b>Scenarios and stakeholder engagement</b>	UNH	<b>Cameron Wake</b>
<b>SSE</b>	UNH	<b>Curt Grim</b>
	UNH	Barbara Wauchope
	UNH	Larry Hamilton
<b>Land use and demographics</b>	UNH	<b>Ken Johnson</b>
<b>LUD</b>	UNH	<b>Mark Ducey</b>
<b>Data Discovery Center</b>	UNH	<b>Fay Rubin</b>
<b>DDC</b>	KSC	Lara Bryant
	UNH	Scott Valcourt
<b>Education and outreach</b>	UNH	<b>Steve Hale</b>
<b>EO</b>	UNH	Karen Graham
	KSC	Sally Jean
	PSU	Doug Earick
<b>Communication</b>	UNH	<b>Evelyn Jones</b>
<b>Management</b>	UNH	<b>Jan Nisbet</b>
	UNH	<b>Kevin Gardner</b>
	UNH	Michelle Gregoire

\*Team leaders in **Bold**

### Ecosystem sensors and function

The major risks identified for this part of the project are:

- Loss of key personnel (McDowell, Frey, Green)
- Loss of expensive sensor packages

This area is one where we have sufficient depth and breadth of team member expertise which, when combined with the team—based approach we are using results in the ability to continue the project despite the loss of a key individual. We have planned for the purchase of additional sensor units to mitigate against loss and are working with vendors to select sufficiently robust sensors with adequate warranties. Loss of Frey would mean that we would need to acquire new project personnel if we could not contract with her should she leave.

### Modeling

The major risks identified for this part of the project are:

- Loss of key personnel (Ollinger, Wollheim, Lammers, Martin, Stampone)
- Lack of integration of new hire into project
- Theft, vandalism or loss of tower-based spectral sensors

The team working on terrestrial sensing and modeling is sufficiently large to mitigate the loss of any of its key personnel. The addition of a new faculty to the group will ameliorate this for the Ollinger-Martin team. Integration of the new hire will be assured by a comprehensive mentoring plan and provision of sufficient project funding and student funding to ensure she/he is significantly engaged in the project.

The CoCoRaHS (Community Collaborative Rain, Hail, and Snow Network) is a robust network with low risk of becoming unavailable. The worst scenario would be that the desired geographic distribution of volunteers would become unachievable. This also is fairly low risk, and the scientific sensitivity to the precise location and distribution is not great: there is sufficient flexibility to this element of the research. Tower-based sensors are in locations where instruments have been housed for years on site at intensive research stations. This risk represents a very low probability event. Should it occur, we would need to replace those sensors for which there would need to be some reallocation of funds.

### Snow

The major risks identified for this part of the project are:

- Loss of key personnel (Dibb, Albert)
- Lack of cooperation and coordination of volunteer groups collecting critical data.

The potential loss of key personnel in this area is a greater risk to the project because it is a smaller group with less overlap of expertise.

Approaches to mitigate risk: If one team member left UNH or Dartmouth, we would first try to subcontract with his/her new institution and keep the project going. If this was not possible, the team of two has been working together for a number of years, and understand the team approach sufficiently that one could train a new researcher with the necessary expertise.

### Integrating ecosystem services, valuation and governance

The major risks identified for this part of the project are:

- Loss of key personnel (Howarth, Borsuk)
- Lack of ability to effectively integrate new hire at Plymouth State into project
- Lack of integration between this and the other project elements upon which this work relies.

The following approaches will be used to mitigate this risk. First, the Dartmouth group has hired post-doctoral fellows who are involved in the work and is effectively forming a cluster of excellence in this area. The new faculty member at Plymouth has been hired and collaborates effectively with the Dartmouth group. She will be mentored by Howarth, further providing strong connections and improving the chances of success.

### Scenarios and stakeholder engagement

The major risks identified for this part of the project are:

- Loss of key personnel (Grimm, Wake, Wauchope, Hamilton)
- Inability to connect with meaningful stakeholders.
- Lack of integration with other project elements.

Loss of key personnel on this team would be ameliorated by bringing on additional personnel with the appropriate expertise, which exist within the institutions involved in the project.



### Land use and demographics

The major risks identified for this part of the project are:

- Loss of key personnel (Johnson, Ducey)

Approaches to mitigate risk: If one team member left UNH, we would first try to subcontract with his new institution and keep the project going. If this was not possible, the team of two has been working together for a number of years, and understand the team approach sufficiently that one could train a new researcher with the necessary expertise. For example, if Johnson were unavailable a new demographer would be sought who could gather and analyze the data necessary according to the approach they have been using in recent years.

### Data Discovery Center

The major risks identified for this part of the project are:

- Loss of key personnel (Rubin)

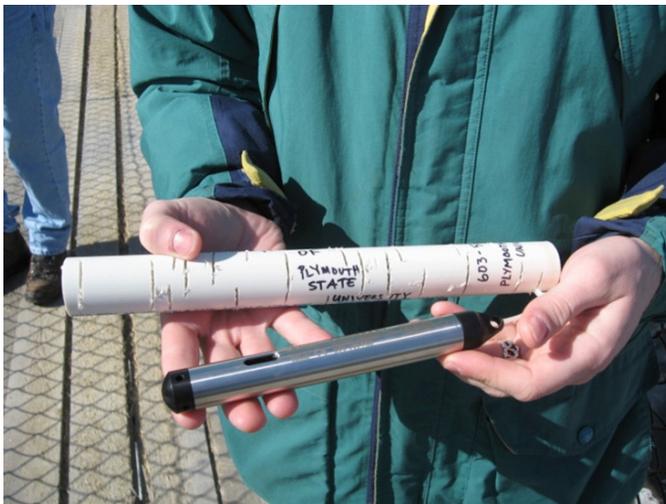
Approaches to mitigate risk: Rubin is a project director within the UNH Earth Systems Research Center, (ESRC) a large research group with multiple personnel involved in the statewide GIS clearinghouse and other data infrastructure that support the EPSCoR Data Discovery Center. If she were to leave the project, ESRC staff would be able to carry on until a replacement could be appointed.

### Education and outreach

The major risks identified for this part of the project are:

- Loss of key personnel (Hale, Jean, Earick, Graham)
- Lack of integration between research and education/outreach
- Inability to attract or engage underserved populations.

Approaches to mitigate risk: The core education and outreach team is comprised of individuals drawn across several NH institutions. The team approach is fully employed within this working group, and their expertise is sufficiently overlapping in the area of teacher preparation, professional development, and the NH education system such that loss of one or a few



individuals would not create substantive disruption. If EOD Hale would leave the project, Leitzel Center Director – Dr. Karen Graham, would fill the EOD role until a replacement was identified. If other team members left, their participation could still be secured at their new post, or an appropriate replacement brought in to the team. The risk of lack of integration between research and education/outreach has been addressed through regular coordination by Co-I Wake and EOD Hale, who meet monthly to coordinate activity schedules and communication. In turn, Wake and Hale will facilitate quarterly communications to ensure integration of the research, education, and outreach efforts. To ensure we are able to attract and engage NH's underserved populations, we have partnered with UNH Cooperative Extension-4H to lead these efforts. Note that there is an internal infrastructure within 4H with supporting educators that can assist to assume their duties in the event of their departure and until their replacements can be made.

### Communication

The major risks identified for this part of the project are:

- Loss of key personnel (Jones)

Approaches to mitigate risk: This is not a single-person team. The communication coordinator works closely with communication personnel at other institutions and in various project teams. She is assisted by personnel who have experience in maintaining the website and data tools for project management who would be able to carry out essential tasks in her absence until a replacement could be appointed.

### Management

The major risks identified for this part of the project are:

- Loss of key personnel (Nisbet, Gardner, Gregoire, Wake, Howarth, McDowell)
- Inability to adequately facilitate integration of project components.

Approaches to mitigate risk: For loss of key personnel, the succession plan included in the original proposal will be followed and is reiterated here. The UNH SVPR will assume responsibility for appointing new Co-PIs. Since the State Director, the PI, and the Senior Vice Provost for Research are the same person, the UNH Provost, John Aber, in consultation with the Management Team and State EPSCoR Committee, will be responsible for appointing a new PI and State Director. The PI will appoint successors to each of the Management Team positions. Successors for team leaders for research and outreach initiatives will be selected by the PI and co-PIs in consultation with the College Deans and Department Chairs at the relevant universities and colleges and the Statewide Research Coordinating Committee.

A number of structures have been created in order to mitigate the risk of lack of integration. There are regular meetings of project personnel charged specifically with evaluating and fostering integration of project components (the Integrating Research and Integrating Education, Outreach and Research Committees described in the management plan).

The management team now oversees diversity initiatives. There has been a change in leadership of the Inclusive Excellence Advisory Board. Wanda Mitchell, UNH Vice Provost for Faculty Development and Inclusive Excellence, who organized the board and initiated the statewide summit series, has been succeeded by Christine Shea, professor of technology and operations management, who is serving in an interim capacity for one year. She will meet with the management team quarterly. Kevin Gardner, associate director of NH EPSCoR and co-PI on this award, continues to serve on the Inclusive Excellence board.



NH EPSCoR  
University of New Hampshire  
35 Colovos Rd. • Gregg Hall • Durham, NH 03824