Maine EPSCoR FY19-24 NSF EPSCoR RII Track-1
Proposal Development Process Phase I – Research Concept Papers

1) Proposed Research Focus:	*Forests to Fish: Developing the Knowledge and Capacity to Enable Maine's Fish and Forest-Dependent Economies to Grow and Thrive*

2) Primary Contact Person:

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D. Brady, C. Isenhour, B. McGreavy, A. Strong, A. Weiskittel, T. Willis, & K. Wilson made major contributions to the revision of this concept paper. For the full list of those who've expressed interest in this project, and the 10+ institutions with which they are affiliated, please see http://tinyurl.com/EPSCoR-2019

4) Intellectual Merit: (the research focus)

A. *Need:* Maine's natural resources are the foundation of our rural communities, contributing vital jobs and shaping local culture. We pride ourselves on the distinctiveness of our communities, the prominence of owner-operated small businesses, and the beauty and productivity of our forest, coastal, and marine ecosystems. Yet, Maine's environment is experiencing significant change, potentially threatening our resource-dependent economies. On land, changing temperatures and precipitation patterns are contributing to shifts in species interactions, seasonal cycles, and ultimately the productivity of forest-dependent products. In the sea, rising ocean temperatures have already impacted the productivity of economically important fisheries, including lobster. Similarly, shifting markets for forest and marine products have deeply affected local economies, resulting in mill closures and catch limits. These economic biophysical changes – together with people's responses to them – are creating both opportunities and challenges. The recent collapse of the forest products industry and the decline in lobster landings in southern New England are but two examples of the magnitude and complexity of managing natural-resource dependent systems.

The future for Maine's forest and fish-dependent economies is not about harvesting harder, it is about developing new multi-sector approaches that add value to Maine's forest and seafood resources through next-generation stewardship and strategic planning. Maine is well positioned to rise to these challenges but scientific understanding of socio-ecological systems – and what enables communities to be resilient to economic and environmental change – is still in its infancy. **To catalyze forest and fish-related economic development and ultimately, to thrive, Maine's traditional and emerging industries and rural communities need knowledge, technical assistance, and skilled human resources.**

B. *Research Goal & Objectives:* We propose a transformative, five-year initiative focused on building a responsive research and development (R&D) capacity, well connected to the needs of Maine's forestry and fishery sectors, and their direct and indirect connections to the aquaculture, technology, and tourism sectors. **The scientific goal is to deepen understanding of the reciprocal connections between people and environmental systems through field research on environmental and economic drivers occurring at different spatial and temporal scales.** Our interdisciplinary, cross-institutional team of natural and social scientists will work with community and industry representatives from the beginning of this project to engage in modeling, scenario development, and ultimately, adaptive management in ways that are relevant and responsive to the needs of Maine's natural resource dependent communities and businesses.

This project will be guided by the following questions:

1. What ecological and social mechanisms in fish and forest dependent communities and the ecosystems on which they depend enable these coupled systems to be resilient to changing environmental and economic conditions?
2. What mechanisms need to be in place to make these communities and ecosystems resilient to changes

in the future?
3. How can these mechanisms be replicated and scaled up to sustain natural-resource dependent communities in Maine and beyond?

Our objectives are to work intensively in three communities[1] that are representative of the range of socioeconomic and environmental contexts facing rural Maine communities. We will nest intensive social-ecological studies in these communities within a geographically more extensive set of efforts to parameterize coupled systems models and develop social-ecological scenarios within the Penobscot River watershed. These nested scales of social-ecological, and biophysical and economic observations will enable us to leverage existing information (e.g., census and ocean observing data), and ensure that all project activities meet the needs of the diverse sectors and citizens across the state.

This project will improve research infrastructure and capacity throughout the state by engaging stakeholders, particularly foresters and fishermen, in building and deploying instruments that contribute to the body of knowledge from which models and scenarios will be constructed. It will build R&D capacity relevant to forest and fisheries-dependent communities by providing a physical model, organizational framework and tool kits for translating knowledge and technology into action in other natural-resource dependent economies beyond the state.

A number of hypotheses related to the dynamics of the coupled social-ecological systems associated with Maine's forest and fisheries sectors will be tested, including:

1. Communities with a greater diversity of employment opportunities and natural resource dependent ecosystem services (e.g., food, forest products, and tourism) are more resilient to environmental and economic shocks than those communities with fewer options.
2. Relatedly, local institutional form and function (e.g., lobster cooperatives, municipal government) impact adaptive capacity, i.e., the ability to respond and adapt to environmental and economic change.
3. Resilience of forested and marine ecosystems to environmental shocks will vary with the productivity, diversity, and geographic connectivity with the larger landscape and seascape.
4. Geographic distribution of communities that exhibit high social resilience and adaptive capacity may not be spatially correlated with those that exhibit high ecological resilience (for context, see Wilson 2006, *Ecology & Society*; Leslie et al. 2015, *PNAS*).
5. Deliberate engagement of researchers and knowledge brokers (e.g., cooperative extension agents) with communities, foresters and fishermen can contribute to increased adaptive capacity and resilience in the face of economic and environmental shocks.
6. Communities with active participants in environmental monitoring and other citizen science will exhibit high social resilience in comparison with communities where citizen scientists are not active.

C. Research Actions: To enable tests of these hypotheses and to aid in coordination and communication within and beyond the project team, research activities will be binned in one of three areas:

1. Documenting the resilience and adaptive capacity of communities and the ecosystems of which they are part through field observations, modeling, and scenario development;
2. Knowledge building, through in situ and remote sensing technologies and observations;
3. Data integration, visualization, and sharing via distributed nodes and a virtual network.

To generate data needed to understand the coupled system dynamics and to share emerging knowledge from the project, we will launch two 'collaboratives' that deliberately connect the research areas (please see the Project Framework at http://tinyurl.com/lzu6mkq) These will be durable post-EPSCoR and leverage funding secured by individual, PI-led projects and ongoing work in the region, e.g., Climate Reanalyzer.

[1] Current candidates are Millinocket, Bucksport, and Stonington, pending conversations with community and industry leaders.

D. Priority: In direct response to NSF's strategic plan, the research undertaken as part of this project will advance the emerging interdisciplinary science of coupled social-ecological systems (a.k.a. sustainability science), as well as develop new knowledge in fundamental science and engineering fields, including biological and environmental sciences, computer science, engineering, geosciences, and the social, behavioral, and economic sciences.

5) Broader Impacts: (related to the research focus)

E. Societal Benefit Impacts*:* This project will directly address all five EPSCoR goals, with specific emphasis on *Broadening participation*. Meaningful engagement with Maine companies and communities will be essential to the project's success. We will achieve it by fostering a project-wide culture of collaboration in which all PIs help steward and grow the relationships with leaders who are best positioned to be involved in our project. Also, we will draw on innovative approaches to Public Participation in Scientific Research (PPSR) such as citizen science and evidenced-based modes of science communication (after NAS, 2016). With the PPSR approach, we will emphasize generating and interpreting observational data, and using these data to inform local to regional scale decision making related to Maine's natural resources.

Previous research has demonstrated that, in terms of the observing systems and cyberinfrastructure, an "if we build it, stakeholders will come" mentality does not work. **When interdisciplinary researchers fail to effectively work together to synthesize their findings or neglect to connect with end users effectively, mountains of unusable data are produced.** By drawing on the rapidly growing field of the Science of Team Science and related approaches, we will study this project's collaborations so as to help build effective observing and data toolkits and enable understanding of the social-ecological impacts from these activities.

F. Economic Development Impacts*:* This project will be closely linked with economic and community development organizations, to ensure that activities and outcomes are in line with Maine's technology sectors and community needs.[2] For example, we anticipate that project advisors and partners will include the Alliance for Maine's Marine Economy, a collaboration of 20+ Maine-based organizations including universities and nonprofit research institutions; commercial fishing and aquaculture interests; community-based organizations; and large and small private sector businesses. By connecting with the Alliance, researchers, students, and industry and community partners will be better able to communicate their interests and pursue collaborative opportunities that benefit the diverse communities, businesses and research institutions of the state and ultimately, contribute in meaningful ways to economic development throughout the state's marine economy.

G. Workforce Development Impacts: While traditional graduate and undergraduate training will be keystone elements, this project also will leverage the capacity of Maine's community colleges and career and technical education schools to develop workforce development programs that directly respond to the needs articulated by industry and community leaders. Special attention will be given to develop programs that embrace the geographic and demographic diversity of Maine rural communities and enhance the internet connectivity of Maine communities and businesses, in the 'last mile.' An emphasis on citizen science and other forms of engagement will provide experience with STEM and build the capacity of non-degree seeking individuals.

H. R&D and Education Infrastructure Impacts*:* These investments will be consistent with the EPSCoR program's five goals. Through careful design and evaluation and thoughtful governance and engagement, this project will catalyze targeted investments in research and education that can be sustained beyond the life of the project and will enhance the competitiveness of Maine's research and industry enterprises. We anticipate that this project will create a virtual Center for Community Resilience, analogous to the Stockholm Resilience Centre, and tailored to the needs of Maine. This distributed Center will include nodes at academic and community development institutions across the state and build on the strengths our many partners. The Center will enable researchers, practitioners, and community members to continue to develop durable solutions that enable adaptation and transformation of natural resource dependent communities in the face of change.

[2] This project will be in alignment with four of Maine's seven targeted technology sectors (forest products & agriculture; marine technology & aquaculture; information technology; and environmental technologies).