Maine EPSCoR FY24-29 NSF EPSCoR RII Track-1
Proposal Development Process
Phase I – Research Concept Papers

1) Proposed Research Focus:		**Building a data network to understand fine-scale impacts of rapid warming on Maine's coastal ecosystems and watersheds**			
2) Primary Contact Person:					
Name:	**Institution:**	**Title:**	**Dept.**	**E-mail:**	**Phone:**
Graham Sherwood	GMRI	Interim Chief Scientific Officer	Research	gsherwood@gmri.org	228-1644
3) Suggested/Potential Key Senior Personnel:					
Name:	**Institution:**	**Title:**	**Dept.**	**E-mail:**	**Phone:**
Janet Duffy-Anderson	GMRI	Chief Scientific Officer (Mar '22)	Research	jduffy-anderson@gmri.org	NA
Lisa Kerr	GMRI	Research Scientist	Research	lkerr@gmri.org	228-1639
Kathy Mills	GMRI	Research Scientist	Research	kmills@gmri.org	228-1657
Kanae Tokunaga	GMRI	Research Scientist	Research	ktokunaga@gmri.org	228-1696
Blaine Grimes	GMRI	Chief Ventures Officer	GMRI Ventures	bgrimes@gmri.org	228-1655
Leigh Peake	GMRI	Chief Education Officer	Education	lpeake@gmri.org	228-1632
Jonathan Labaree	GMRI	Chief Community Officer	Community	Jlabaree@gmri.org	228-1630
David Reidmiller	GMRI	Climate Center Director	Climate Center	dreidmiller@gmri.org	228-1695
Riley Young-Morse	GMRI	Senior Program Manager	Ocean Data Products	rmorse@gmri.org	228-1663

4) Intellectual Merit:

A. ***Need:***

The Gulf of Maine is warming faster than 96.2% of the global ocean. Our ability to monitor the changes associated with this unprecedented regional warming in Maine coastal ecosystems and watersheds is limited by the scale of existing systems (e.g., NERACOOS buoys which monitor offshore ocean conditions) and lack of networked observation data from nearshore and coastal environments. An integrated system of bay- and watershed-scale monitoring infrastructure and initiatives in Maine would allow for a more detailed understanding of current ecosystem conditions and impending changes that would, in turn, allow Maine communities and businesses (e.g., fisheries and aquaculture) to plan for uncertain futures. More local-scale monitoring capacity will also open the door for increased involvement of Maine youth and key communities (e.g., Indigenous communities) in authentic, locally-relevant scientific investigations.

B. ***Research Goal & Objectives:***

The goal of this research is to identify and quantify the directions, magnitude and mechanisms of change across Maine's land- and coastal sea-scapes through an integrated, innovative suite of biophysical monitoring efforts at the scale of Maine interests (e.g., bays, rivers, towns). This system of monitoring capabilities, which will both serve foundational research and engage Maine youth and other communities in STEM pursuits, will allow for deeper understanding of the consequences and outcomes of environmental/socio-ecological shifts associated with climate change. This, in turn, will enable Maine researchers to develop a suite of data and decision support tools (e.g., visualizations, nowcasts, forecasts, projections) to engage, empower, and improve the climate readiness of Maine communities and industry stakeholders (e.g. fisheries, aquaculture, coastal managers).

C. ***Research Actions:***

1) Monitor at relevant scales – Build a technologically advanced observation data network that integrates sensor and monitoring data from both ongoing and new efforts across Maine's watersheds, to advance a state-wide rapid response system to better detect and respond to climate and ecosystem change at the scale of Maine interests (e.g., bays, towns, rivers).

2) *Create data to knowledge pipelines* – Build data management systems to centralize and integrate disparate monitoring data and make it accessible through dashboards, visualizations, decision support tools (nowcasts, forecasts, projections) for a variety of stakeholder groups and the interested public.

3) *Engage Maine youth* – Establish schools as community-based field stations designed, equipped, and trained to execute "muddy boots" ground-truthing and monitoring in lock step with broader network/research goals.

D. ***Priority:***

This proposed research aligns very well with the White House's 2021 R&D Priorities. We envision a network of capabilities that will address the climate science priority to "*advance understanding of the societal and economic impacts of climate change [on human and ecosystem health, wildlife and fisheries]*". Specifically, we will establish a system that will address WH goals to improve observation networks and modeling capabilities for local-scale processes. This work will also address WH goals to "*facilitate public access to climate-related information that will assist federal, state, local and tribal governments in climate planning and resilience*". Of further note, our research addresses the WH Co-STEM (Committee on STEM Education) vision to build strong foundations for STEM literacy, increase DEI in STEM, and prepare the STEM workforce for the future.

For Maine, our proposed research aligns well with education, climate, sustainability, and business development strategies. Particularly, our work will "*Grow Local Talent*" by building interest in STEM careers through exposure to relevant, local STEM and providing professional development for educators. Our work will also "*Promote Innovation*" by advancing the development, operational efficiency, scaling and diversification of the aquaculture industry in Maine and by providing critical baseline measurements and sustainable data collection tools to support ongoing environmental assessments, siting decisions and farm development. This, in turn, will support jobs growth, seafood production, and operational resilience in the face of climate change. With respect to the Maine Climate Action Plan, our work aligns with goals to "*support the ability of Maine's natural resource economies to adapt to climate change impacts*", "*increase technical service provider capacity to deliver data, expert guidance, and support for climate solutions to communities, farmers, loggers, and foresters at the Department of Agriculture, Conservation and Forestry, Maine Forest Service, Department of Inland Fisheries and Wildlife, the Department of Marine Resources, and the University of Maine*", and broadly to **"*enhance monitoring and data collection to guide decisions*",** a key aspect of our proposed work.

5) Broader Impacts:

E. ***In-state collaborations****:*

We envision this concept to align well with the goals and strategies of multiple entities in Maine including the University of Maine, the Roux Institute (particularly for data expertise), the Department of Marine Resources, The Department of Environmental Protection, the Island Institute, Friends of Casco Bay, the Wells National Estuary, and the University of Southern Maine. We are excited to explore this concept with multiple partners already involved in coastal monitoring, for example, through NECSA or the Northeast Coastal Stations Alliance which includes numerous field stations in Maine (see https://seagrant.umaine.edu/2017/03/19/northeastern-coastal-station-alliance-nesca-small-field-stations-unite/ for a list of participating institutions). We will engage partners on the land side including the UMaine Cooperative Extension, Maine Land Trust Network, Maine Inland Fisheries and Wildlife and entities involved in river monitoring (e.g., Maine river herring network). On the education side, we envision conversations with Educate Maine, a leader in computer science at K-12 for the AI/machine learning aspect, the Mitchell Center (social and behavioral science research), local schools and communities, potentially our network of partners on the Learning Ecosystems Northeast project (including 4H, Maine State Library, Wabanaki Youth in Science, Gateway Community Services, and numerous informal learning institutions across the state). Finally, from a ventures and an end-user perspective we imagine engaging with the Roux Institute (GMRI/Roux Residency program for

entrepreneurs to be launched in Ocean Data/Climate in FY2022), the Maine Aquaculture Innovation Center (e.g., for sensor bundling) and aquaculture farms that may be partners for testing platforms for sensor development.

F. ***Regional/national collaborations****:*

This work will align well and enhance regional monitoring and data integration efforts underway by the Northeast Regional Association of Coastal Ocean Observing Systems (NERACOOS). We may also collaborate with researchers at the University of New Hampshire to include observations from the southern end of Maine (e.g., Shoals Marine Laboratory). We envision collaborations with the Climate and Fisheries Initiative at NOAA. GMRI is a founding partner of the Learning Ecosystems Northeast project that includes a network of 12 science centers across the northeast states who are creating learning opportunities for youth (https://www.learningecosystemsnortheast.org/). GMRI is also deeply involved in a NOAA diversity internship program known as IN-FISH, a program that may provide a mechanism to involve undergraduate students from diverse backgrounds in Maine-focused research. Finally, GMRI is part of the NOAA Collaborative Institute for the North Atlantic Region (CINAR) which also includes the University of Maine (full list of partners can be found at www.cinar.org).

G. ***Economic development****:*

This work advances technological development within the state, broadens the computer science and advanced technology knowledge base, builds infrastructure and internal capacity, and will make the state attractive for private sector entities looking for a technologically savvy workforce. More specifically, this project will develop an array of new capabilities in the areas of new monitoring tools, computer science (computing infrastructure for data management and access), AI/machine learning, forecasting/prediction, and data visualization. This work will support new and existing industries (e.g., fisheries, aquaculture, agriculture) to navigate climate challenges by providing baseline data and predictive tools for assessing impacts to ecosystems at a scale relevant to the scale of their operations (e.g., bay/watershed scales).

H. ***Workforce development****:*

To effect change in the STEM workforce, students must be engaged in STEM activities at a young age and move from being *interested* in science, to *believing* they can do science, to *identifying* as scientists. GMRI education programs are designed around this trifecta and it is this level of expertise that we will bring to this work. Specifically, we will leverage GMRI's existing Ecosystem Investigation Network (https://investigate.gmri.org/) to create community science investigations that support youth engagement with the monitoring network. We will also benefit from GMRI's Learning Ecosystems Northeast project which is engaging 100s of formal and informal educators and librarians in creating STEM learning opportunities for youth. This network provides a starting cohort of educators ready to engage youth as ground-truthers and field-based monitors; this is where interest in science and identifying as a scientist can begin. GMRI also runs an NSF-funded Research Experience for Undergraduates (REU) which in the last three years has trained 20 undergraduate students, 75% of whom come from underrepresented communities in marine science (including minorities, 1st generation college students and community college students). We see a marked change in attitudes of these student who identify more as scientists upon program completion. We envision this proposed work providing a range of opportunities to engage K-12, undergraduate and graduate students in monitoring and climate change research. In addition to preparing students, this work will provide opportunities to build high-level research capacity in Maine through the addition of researchers (faculty) with expertise in ecosystem monitoring/modeling, climate science, computer science, engineering, AI and machine learning.

I. ***Infrastructure****:*

We envision a variety of infrastructure improvements in Maine resulting from this work. First, we will establish a high-tech, integrated monitoring system throughout Maine's coastal and inland ecosystems for the purpose of tracking change at a scale relevant to Maine's communities and businesses. This infrastructure will also be valuable in providing research opportunities for students and academics (e.g., climate change research, big data, AI/machine learning). We will also establish soft infrastructure in the form of a network of communities and a connected learning ecosystem (e.g., by involving schools and various communities in monitoring activities and data interpretation).