

1) Proposed Research Focus: Urban Ocean Observatory

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4) Intellectual Merit:

Here we propose to establish a unique Urban Ocean Observatory (UOO) for the city of Portland, Maine. We define the “urban ocean” as any region from a city inner harbor, up into the bay or river as appropriate, and out into the coastal ocean approximately 40 miles. It is where the densest anthropogenic activity occurs and is most likely to have immediate environmental consequences. It is where changes in the ocean environment and undersea threats can have large societal impacts. Within the urban ocean and for Portland and the State of Maine, the research problems are many and of severe consequence. They also center around the need for detailed modeling and imaging of the ocean environment.

The UOO initiative will deploy emerging technologies, including multistatic distributed active sonar, to build a testbed in Portland Harbor for innovation in sensing technologies, data integration, modeling, and the use of “big data” in order to image, understand, and manage the urban ocean. The UOO will focus on integrating information from multiple sensors and sensor systems to drive ocean and acoustic models and provide unprecedented surveillance and understanding of the spatial-temporal complexity of inshore waters affected by humans. Critically needed technology will be created that can be used throughout the Gulf of Maine with application to climate change studies, fisheries management, sustainability, aquaculture, windfarm management, and underwater security. The UOO will also fill the gap in rigorous hydro-acoustics expertise here in Maine that is limiting the advancement of the Maine Blue Economy.

A planning workshop for the newly founded Portland Applied Research Laboratory (PortLab) and UOO was conducted in Portland on December 8, 2021. Video recordings of the workshop in two parts can be downloaded here:

- <https://poweredby.webex.com/poweredby/ldr.php?RCID=e094e3bd3d8f0f55382a9f6969ff001e>
- <https://poweredby.webex.com/poweredby/ldr.php?RCID=6bc5be90adf335f501cc1965113fcdabd>

A. Research Goal & Objectives:

The UOO vision is to create a network of scientists and a system of interconnected observations, sensors, and models to provide an unprecedented view of the urban ocean environment. This will be used to address practical questions related to managing the urban harbors and marine ecosystems in the context of climate change.

The primary goal of the UOO is to develop and fully evaluate underwater surveillance systems in the urban environment, specifically inside Portland Harbor, up through Casco Bay, and out into the shipping lanes and the Gulf of Maine. These surveillance systems will detect and track marine life for the purposes of fisheries management and mitigation of dangers from harmful anthropogenic activities. This includes high-powered sonar and seismic surveys, commercial and military ship strikes, entanglements, pile driving, construction, and explosives work. The research also has application to harbor management and threat detection, such as unmanned underwater vehicles entering our ports and harbors, and as such this project will also be of interest to

Department of Defense and Department of Homeland Security.

To reach the primary goal, the UOO will develop and validate advanced acoustic system simulators, or equivalently coupled ocean-acoustic models plus system performance tools. This requires significant bathymetric and ocean data, to include using the active acoustic system as a tomographic imaging tool to correct the ocean model. Thus, also embedded in this research is very high-resolution and high-accuracy modeling of the ocean environment, with applications to climate change and tidal energy. Another major impediment for the development of active acoustic systems is the potential effects on marine life. The UOO must include extensive and long-term studies on the effects of high-frequency active acoustics on marine life.

A UOO in Portland Harbor would enable extensive regional research and development in underwater acoustics, underwater threat detection and mitigation, and marine mammal protection. Done properly and with sufficient funding, this effort would turn the Portland, Maine harbor and approaches into one of the most technologically advanced in the world.

B. *Research Actions:*

The specific research items that would be implemented would be 1) extensive ocean data collection in Casco Bay; 2) implementation of nested operational ocean models for Portland Inner Harbor, Casco Bay, and the Gulf of Maine; 3) highly advanced monitoring of the marine ecosystem in Casco Bay with very high resolution in the inner harbor and up the Fore River; 4) development of a multi-modal surveillance system that includes distributed multistatic active acoustics that completely images the underwater space in the Portland Inner Harbor; 5) determination of the effects of the active acoustic components on marine life; and 6) the correlation of all of the anthropogenic activities in the Casco Bay region with the effects on the marine ecosystem.

C. *Priority:*

The establishment of PortLab and the UOO will address some of the most serious challenges facing Maine, New England, and our nation.

PortLab and the UOO will address the challenge of Maine's aging workforce. It will attract and grow local talent by offering an inviting place for young bright minds to research and innovate. The lab will contribute to significant growth across Maine's academic institutions.

PortLab will be located on the Portland waterfront and its core mission will be to promote a culture of innovation. The technology developed by PortLab and the UOO initiative addresses threats to Maine's largest industries due to technology and climate change. The underwater surveillance technology will be state of the art, and unlike any underwater acoustic installation in any other port in the world. It will advance underwater security at all scales and all locations. Beyond the acoustic observation of the marine environment, the UOO will provide a highly accessible testbed for emerging technologies like continuous nutrient monitoring and eDNA. Advanced research performed in the UOO will help develop solutions to the most pressing challenges such as the protection of right whales and the preservation of the lobstering industry in the face of climate change. It will also support the development of offshore windfarms in a robust, sustainable, and environmentally friendly manner.

Additionally, the lab will advance the goals of establishing a regional coalition of academic institutions working together in a growing nexus of ocean research excellence.

5) *Broader Impacts:*

D. *In-state collaborations:*

The collaboration potential is high as the R&D encompasses all disciplines within ocean science and engineering. The UOO consortium coming out of the workshop includes several of Maine's most prominent academic institutions. The University of Maine, the University of Southern Maine, the Gulf of Maine Research Institute, the Roux Institute, and the Southern Maine Community College are all part of the current consortium. We expect many of Maine's other academic institutions and governmental, non-profit, and for-profit commercial organizations to leverage the UOO initiative.

E. *Regional/national collaborations:*

The consortium already extends beyond Maine to include the University of New Hampshire, and we also plan to explore potential collaborations with the rest of the robust blue ecosystem in southern New England and up into New Brunswick and Nova Scotia, Canada. Our December planning workshop had representatives from over 40 nonprofit organizations, academic institutions, private sector firms and government agencies, and all of these represent potential collaborators. The attendee list spanned states across New England and beyond, and included representatives from government agencies such as the Office of Naval Research and USCENTCOM, both of which expressed support for the PortLab and UOO initiative.

F. *Economic development:*

PortLab, the lead laboratory for the UOO, will be located in the state's urban center of Portland and staffed by scientists and engineers with broad expertise. It will be central to many academic institutions and can help with STEM education through internships and support of graduate and postdoctoral programs. It can assist all local institutions with applied science, research and development, and commercialization. The economic development potential for Portland and Maine from this initiative is clearly significant. We note that the Maine Director of Economic Development attended the December planning workshop.

G. *Workforce Development:*

The extensive STEM merits were a large part of the discussion at the December planning workshop. PortLab and the UOO will be a place for university students across Maine to explore careers, find internships and apprenticeships, and advance their education with hands-on experience. It will be a place for entrepreneurs to develop and test their technology and advance to commercialization with local partners.

H. *Infrastructure:*

This goes to the core of what the PortLab and UOO initiative is all about. Infrastructure will be created in the way of in-water test facilities, high-performance computing capabilities, an operational ocean model of Portland Harbor, Casco Bay, and the Gulf of Maine, and permanent underwater surveillance systems with broad sustainability applications. We see the presence of a strong and broad applied research laboratory located in the urban center of Portland as key to the growth of the State of Maine's academic research and education capacity.