Regional Build-Out Plan 2023-2028

Introduction

Since 2009, the Northeast Regional Association of Coastal Ocean Observing Systems (NERACOOS) has implemented the U.S. Integrated Ocean Observing System (IOOS) from Long Island Sound to the Scotian Shelf (Fig. 1). The regional observing system managed by NERACOOS is built on a network of fixed moorings, many of which pre-dated the establishment of NERACOOS and therefore provide invaluable data on long-term climatological trends. NERACOOS has worked to sustain and expand this foundational buoy network, and to add complementary observing tools that work with the data generated by buoys and the models they feed to meet a wide variety of user needs. The existing set of assets managed by NERACOOS and the user needs they help to address are summarized below (see "Existing Assets" section) and in complementary NERACOOS documents.

Figure 1. Primary domain of interest to NERACOOS.

The observing system cannot remain static, however, as the ocean environment of the Northeastern U.S. is changing more rapidly than almost any other part of the global ocean. Climate change has caused substantial warming of ocean waters in the Northeast throughout the water column, reflecting the effects of not only atmospheric heating of surface waters but also shifting influences of the Gulf Stream and Labrador Current at depth. Along with temperature, changes are also being measured in salinity, pH, nutrient profiles, and more. Together, these environmental shifts are affecting the marine ecology of the region, with implications for longstanding fishing, coastal aquaculture, recreation, and ecotourism industries. Climate change and its effects on existing industries are in turn spurring new industries, especially offshore wind (OSW) energy in the near-term and potentially offshore aquaculture in the longer term.

Within this context of uncertainty and change, NERACOOS and our partners are continually asking how the regional observing system needs to evolve and expand, and working to move in new directions. This Build-Out Plan summarizes several of the key areas for growth of our system. Needs and opportunities are continually in flux, however, and therefore this plan by necessity must be living and responsive. Indeed, the starting point for system build-out are the currently unfunded projects described in *NERACOOS: A responsive ocean observing system for the changing Northeast region*, which is our 2021-2026 five-year proposal to U.S. IOOS. These remain relevant and worthwhile projects, yet a number of new priorities and opportunities have rapidly emerged in the two years since submission of the proposal. Therefore, herein we expand on the unfunded work in our 2021-2026 five year proposal with exciting new directions.

Importantly, all of the work that NERACOOS will execute in the coming years is guided by our *2022-2025 Strategic Plan*, plus updates to follow. The Plan outlines five core strategic goals, all of which will be executed with an eye to two cross-cutting priorities –

promoting Diversity, Equity, Inclusion, and Accessibility (DEIA), and keeping pace with effects of climate change – and built on a foundation of organizational development (Fig. 2).

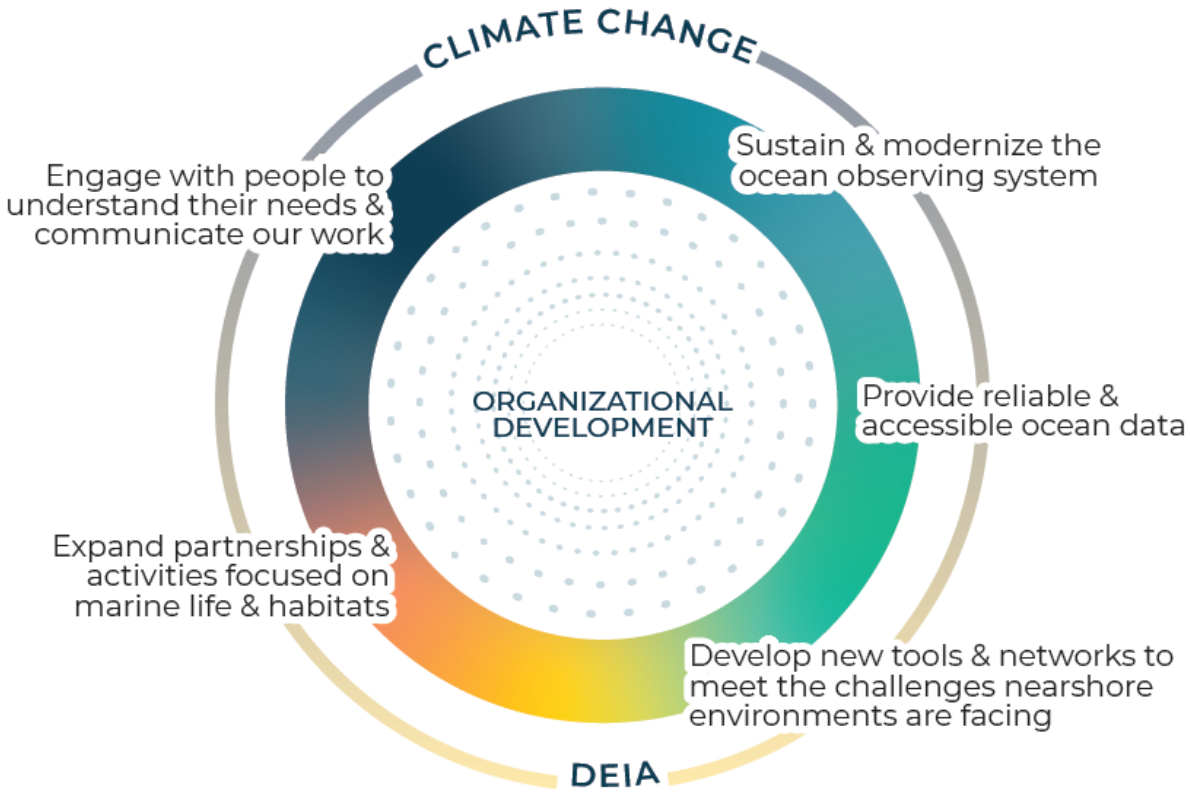


Figure 2. Conceptual relationships among major components of the NERACOOS *2022-2025 Strategic Plan*.

Existing Assets

This existing network of observing assets maintain by NERACOOS and our partners is essential context for this Build-Out Plan. Greater detail on the existing system can be found in complementary documents (geographic coordinates, variables measured and sensor types, etc.), but in summary the systems consists of:

- Eleven metocean/ecosystem buoys.
- Three wave buoys.
- One CO_2 buoy.
- One glider survey.
- Four high-frequency radar stations.
- Four water level monitoring stations.
- Three coastal water quality stations.
- One current profiler.
- Regional satellite imagery.
- Three oceanographic models.
- Data management architecture and a suite of data products.

The geographic distribution of these assets and operating partners are illustrated in Figure 3.

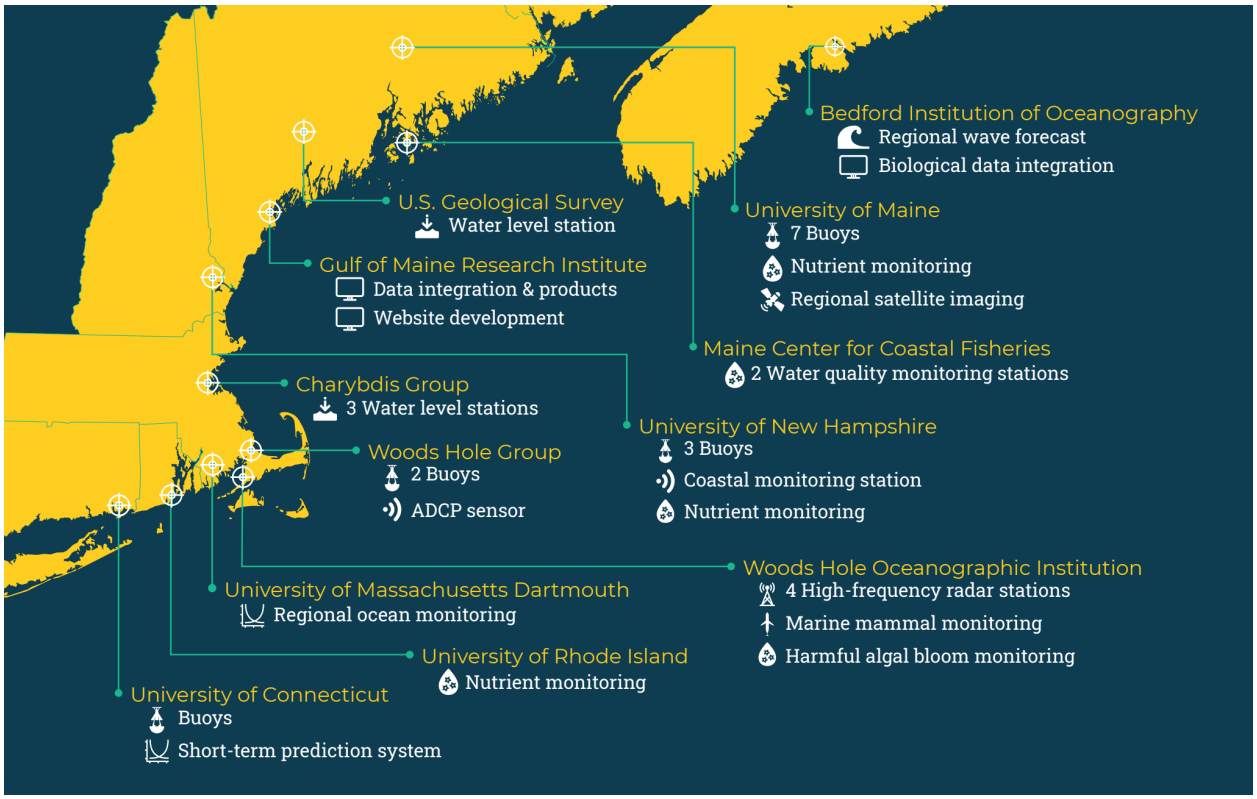


Figure 3. Summary of NERACOOS implementation partners and system assets.

Notably, other partners, including coastal states, the National Data Buoy Center, Coastal Data Information Program, and more, operate complementary observing assets in the region. NERACOOS provides data from the assets we manage to these partners, ingests data from their assets into our models and products, and plans system expansion with an eye to their activities and needs.

Priorities for Expansion

As noted above, needs and opportunities for expansion of the Northeast regional observing system are rapidly emerging in the face of ongoing and uncertain climactic, oceanographic, ecological, political, and economic changes. Table 1 provides a summary of projects at various stages of planning, but not yet to implementation, as this Build-Out Plan is developed, followed by additional descriptions of each. Projects descriptions are grouped as those included but as yet unfunded in our 2021-2026 five-year proposal to IOOS, those expected to be funded through forthcoming support from the Bipartisan Infrastructure Law (BIL), and those needed for the forthcoming development of the Massachusetts-Rhode Island Wind Energy Area (MA-RI WEA) as the most significant alteration of the ocean environment in the region in the coming years.

Table 1. Planned build-out of the Northeast ocean observing system over 2023-2028.

Locations	Partners	Notes
Buoys		
Scotian Shelf	U. Maine	New station in existing Gulf of Maine buoy network
Stellwagen Bank National Marine Sanctuary (SBNMS)	SBNMS, ONMS, NDBC, CPO, MBON	Considering merge with NDBC 44018, moved slightly north to area of overlap with Dedicated Habitat Research Area
Massachusetts-Rhode Island Wind Energy Area	Regional Wildlife Science Collaborative, Responsible Offshore Science Alliance, Ørsted	Network design in process
Gliders		
Gulf of Maine, Long Island Sound, Rhode Island Sound	Woods Hole Oceanographic Institution (WHOI), U. Maine, U. Conn., U. Rhode Island	Guided by Regional Glider Plan, to be developed
High-frequency radar		
Northern Gulf of Maine	Potential collaboration with Canadian partners	Recapitalization & possibly relocation needed for inoperable stations
Southern & Central Gulf of Maine	Maine Dept. of Marine Resources, U. Maine, WHOI	To be built over 2023-2025 to monitor impacts of Offshore Wind Research Array; O&M merged with existing Mass. Bay/Cape Cod Bay network
Long Island Sound	MARACOOS, U. Conn.	Expansion of existing network supported by MARACOOS
Water level sensors		
Region-wide, TBD	Northeast Regional Ocean Council, Gulf of Maine Research Institute, NH Dept. of Environmental Services	As locally supported deployments are emerging, NERACOOS is focusing on DMAC + targeted deployments, esp. for underserved communities
Ships of opportunity		
Region-wide, TBD	Gulf of Maine Lobster Foundation, Northeast Fisheries Science Center (NEFSC)	Sensors affixed to fishing gears through eMOLT program
Ocean & coastal acidification monitoring		
National Estuarine Research Reserve (NERR) sites	Wells NERR, Great Bay NERR, Waquoit Bay NERR, Narragansett Bay NERR, CT NERR	Complement to NERR System-Wide Monitoring Program (SWMP)
Cape Cod Bay, Nantucket Sound	Center for Coastal Studies, Mass. Dept. of Env. Protection, Barnstable County	Capitalizing on local initiatives and capacity in areas with his OCA concern due to importance of shellfish
Rocky intertidal region-wide, TBD	Northeastern U., MBON Pole-to-Pole initiative	Temperature microsensors to determine habitat suitability for shell-forming species vulnerable to OCA
Marine life monitoring		
Plankton monitoring at Coastal Maine (CMTS) & Wilkinson Basin (WBTS) times series stations	MBON, U. Maine, U. New Hampshire, Bigelow Lab., WHOI	Particular focus on keystone species *Calanus finmarchicus*; stations resumed in 2019 but not yet funded beyond 2023
eDNA sampling at CMTS, WBTS & NERR sites	MBON, U. Maine, U. New Hampshire, NERR sites	eDNA sampling with CMTS & WBTS plankton monitoring began in 2019 but not yet funded beyond 2023; pilot coastal program with NERR sites planned
Passive acoustic monitoring region-wide, TBD	U. New Hampshire, SBNMS, NEFSC	Coordinated with existing and forthcoming efforts to develop baseline soundscape and detect endangered marine mammals

Unfunded assets in 2021-2026 IOOS five-year proposal

Buoys

We have identified a priority location for a new metocean/ecosystem buoy at the edge of the Scotian Shelf. Water of Arctic origin enters the Gulf of Maine through the Northeast Channel, where an existing NERACOOS buoy is located[1], and over the Scotian Shelf. At present, we are only monitoring one of these points of inflow, therefore missing significant inputs into the Gulf that affect temperature profiles, salinity, nutrient dynamics, current patterns, and more.

Gliders

The winter glider survey currently supported by NERACOOS traverses coastal and nearshore waters of the Gulf of Maine during the winter months. A priority objective of this survey is acoustic detection of endangered marine mammals to minimize conflicts with human users. This survey also fills gap in environmental monitoring in between coastal observing buoys. We aim to expand glider deployments to other seasons in nearshore waters and especially further offshore, where buoy coverage is less, at all times of year in the Gulf of Maine as well as Long Island Sound and Rhode Island Sound.

The exact number, locations, and timing of new glider surveys will be determined through development of a regional glider plan, which was identified as a high priority during the 2019 NERACOOS Operators' Meeting and is a currently unfunded objective in our five-year proposal. Other glider deployments take place across the region through other funding sources, with more coming online in response to OSW development. Additional NERACOOS glider deployments will consider these other deployments, and possibly develop cost-sharing arrangements where objectives overlap.

High-frequency radar (HFR)

In addition to the four HFR stations covering Massachusetts Bay and Cape Cod Bay, in the past NERACOOS has supported three stations located in Maine and Nova Scotia that cover waters of the Northern Gulf of Maine. However, performance of these stations has suffered from ageing infrastructure and site access limitations, both exacerbated by the coronavirus pandemic. We determined that continued investment in these stations would only be warranted with sufficient funding to recapitalize and possibly relocate them, as well as a stronger use case for the investment. We have recently initiated discussions with prospective Canadian partners, brokered by CIOOS Atlantic, about prospects for cooperative funding and operation of the Northern Gulf of Maine stations.

An assessment of HFR operations and uses in the Northern Gulf of Maine is planned to guide future investments. However, that assessment has been postponed as we pursue new needs and opportunities for HFR installations along the Southern and Central coast of Maine that have arisen in response to the State's intention to build a Floating Offshore Wind Research Array (see "Bipartisan Infrastructure Law projects" below).

[1] Note that NERACOOS and our operating partners at the University of Maine made the difficult decision to suspend operations of Buoy N in the Northeast Channel for 2021, and possibly beyond, due to funding limitations. Our priority will be to resume operation of this station before adding new stations.

In addition to the Gulf of Maine, our 2021-2026 five-year proposal calls for installation of two new HFR stations in Long Island Sound in cooperation with MARACOOS. These installations await sufficient funding.

Coastal stations

Our 2021-2026 five-year proposal includes deployment of a number of targeted coastal observing assets. These aim to meet priority local needs and to connect within a larger regional network. These assets include:

- Up to 10 new tide gauges installed at priority locations to be determined. Note that our strategy for water level monitoring at the coast has evolved considerably since submission of the five-year proposal in ways that do not negate these proposed deployments, but rather direct them in more strategic ways (see "Water level monitoring" section below).
- Installation of pCO_2 sensors at the National Estuarine Research Reserve (NERR) sites in the Northeast to improve monitoring of ocean and coastal acidification (OCA). Note that our 2021-2026 five-year proposal identifies four NERR sites, but a fifth has now been added in Connecticut and our plan is to include this site as well.
- Addition of carbonate sensors to existing water quality programs in Cape Cod Bay and Nantucket Sound run by local partners to further expand OCA monitoring.
- Installation of temperature microsensors in rocky intertidal habitat to determine habitat suitability for shell-forming organisms, as a complement to OCA monitoring

Passive acoustic recorders

Monitoring of underwater sound is a rapidly rising priority in the Northeast in order to detect and avoid adverse interactions with endangered marine mammals, and mitigate acoustic impacts of OSW development. Our 2021-2026 five-year proposal includes new passive acoustic monitoring (PAM) at fixed stations and development of soundscape baselines with which to assess changes and impacts. Funding limitations have precluded initiating these activities, while PAM activity by partner institutions has increased. NERACOOS is therefore coordinating with regional partners on their efforts and gaps in order to define and evolve our role in PAM.

Ships of opportunity

The diverse array of vessels transiting the ocean waters of the Northeast that benefit from the regional observing system managed by NERACOOS can serve as platforms for additional sensor deployments. Commercial fishing vessels in particular are both numerous and spend considerable time on the water, presenting considerable opportunities for additional ocean observing. Accordingly, the Environmental Monitoring on Lobster Traps and Large Trawlers (eMOLT) program run by the Gulf of Maine Lobster Foundation (GoMLF) and Northeast Fisheries Science Center (NEFSC) has been installing sensors on an ever-growing number of vessels in the region. Data generated by eMOLT provide valuable inputs to models and data products managed by NERACOOS, and our 2021-2026 five-year proposal therefore calls for support of eMOLT's *in situ* observing activities as well. Funding limitations have precluded this support to date, although NERACOOS has partnered with GoMLF and NEFSC on a

recently awarded proposal to Sea Grant to expand eMOLT coverage on lobster vessels in Downeast Maine.

Bipartisan Infrastructure Law projects

The Bipartisan Infrastructure Law (BIL) includes support for a number of programs and objectives related to ocean observing. NERACOOS is expecting funding for observing activities directly from U.S. IOOS and as a co-PI on a proposal led by the Northeast Regional Ocean Council (NROC), which is the Regional Ocean Partnership (ROP) in the Northeast. This funding has yet to be finalized, and therefore the projects have yet to be initiated, but we see this as high probability support and the work as important components of our regional build-out in the coming years.

The majority of work proposed for BIL funding from IOOS is to upgrade existing assets in operation by NERACOOS. This includes replacement of existing sensors plus selected additional sensors to be added to buoys. These activities will improve the quality and consistency of data from the existing observing system. Notable new projects are also included in our proposal for BIL funding, however, and these are described below alongside BIL projects proposed for NROC funding. A summary of work proposed for BIL funding from IOOS is provided in Table 2.

<u>HFR for Maine Floating Offshore Wind Research Array</u>

As noted above in the descriptions of unfunded projects in the 2021-2026 five-year proposal to IOOS, an opportunity arose after submission of the proposal to work with the State of Maine on a new HFR network covering the area surrounding the planned Floating Offshore Wind Research Array. Together with the existing NERACOOS HFR network, coverage provided by these three new stations will enable surface current measurements for most of the Western Gulf of Maine, from Cape Cod Bay to Penobscot Bay (Fig. 4).

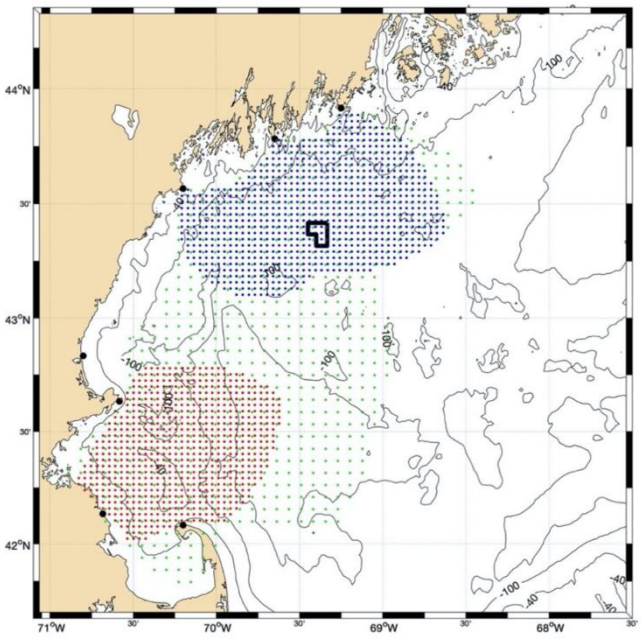


Figure 4. Planned coverage of new HFR stations around the Maine Offshore Wind Research Array (blue) relative to coverage by existing HFR stations (red and green).

These measurements will not only support search-and-rescue efforts for mariners working on the array or in its vicinity, but also help determine whether the array affects localized current patterns and help track the movement of nutrients, larvae, and other particles in the area. NERACOOS has proposed two years of BIL funding to IOOS, with the possibility of continued support thereafter from BIL, IOOS core funding, or other sources, to match the sustained capitalization and operational funding planned by the State.

Table 2. Summary of observing projects proposed to U.S. IOOS for BIL funding. Projects marked with * are new additions to the regional observing system.

Projects	**Year 1**	**Year 2**
Offshore Buoy Network		
Execution Rocks, Long Island Sound	Assemble new float, hull, tower, power supply, and tether	Install sensors and deploy full unit
Buoy A (Mass. Bay)	Purchase and install new wind sensor on one unit	Purchase and install PAR sensors, and new wind sensor on second unit
Buoy B (Western Maine Shelf)	Purchase and install new T/S/P/DO sensor to test new technology before deploying at other stations; purchase and install new wind sensors on one unit	Purchase and install new wind sensors on one unit; purchase and install new PAR sensor
Buoy E (Central Maine Shelf)	Purchase and install new wind sensors on one unit	Purchase and install new PAR and T/S/P/DO sensors, and wind sensors on second unit
Buoy F (Penobscot Bay)	Purchase and install new wind sensors on one unit	Purchase and install new PAR sensors, and wind sensors on second unit
Buoy I (Eastern Maine Shelf)	Purchase and install new PAR sensor to test new technology before deploying at other stations; purchase and install new wind and wave sensors on one unit	Purchase and install new wave and T/S/P/DO sensors, and wind and wave sensors on second unit
Buoy M (Jordan Basin)	Purchase and install ADCP, wind, and wave sensors on one unit	Purchase and install PAR and T/S/P/DO sensors, and wind and wave sensors on second unit
Buoy N (Northeast Channel)	Purchase and install new wind sensor on one unit	Purchase and install new wind sensor on second unit
Stellwagen Bank Buoy*	Engineering design for multi-partner ecosystem mooring within SBNMS and assess asset feasibility	Develop plans for construction, deployment, operations & maintenance, and cost-sharing
Coastal Water Quality		
Great Bay, NH	Purchase and install pH sensor, as well as hardware upgrades and replacements.	Purchase and install new SUNA nitrate sensor on Great Bay buoy
Piscataqua River mouth, NH	Purchase and install pH sensor, as well as hardware upgrades and replacements.	
Narragansett Bay, RI	Purchase new sensors for GSO dock monitoring stations, and begin installation	Purchase additional parts needed, complete installation, test, and resume operations
Coastal Water Levels		
Gloucester, MA	Replace existing unit	
Scituate, MA	Replace existing unit	
Chatham, MA		Repair existing NOAA-NOS unit
High-Frequency Radar		
Maine Offshore Wind Research Array*	Purchase one station; initiate site assessment and outreach	Purchase second station; finalize site approvals; install stations; create linkages to HFR DAC
DMAC		
Substantial and critical system upgrades	Build out new cloud-based infrastructure; migrate most vulnerable data and products	Additional enhancements to the data system; redevelopment and expansion of key data products

Stellwagen Bank ecosystem mooring

The January 2021 *National Marine Sanctuary Climate Change Workshop* prompted NERACOOS and Stellwagen Bank National Marine Sanctuary (SBNMS) to begin more regular and focused discussion about how the regional observing system can better support the Sanctuary, and vice versa. These discussions quickly centered on the idea that SBNMS can serve as a sentinel site for climate change in the Northeast, helping to better understand changes for the region as a whole, and in doing so being better equipped to meet its own management needs. Among a number of activities identified that can contribute to this goal, NERACOOS and SBNMS agreed to begin working toward design, construction, and deployment of a state-of-the-art ecosystem mooring in the Sanctuary to provide a comprehensive picture of environmental conditions.

Due to both the novelty and ambitiousness of this collaboration, a larger group of partners soon entered the discussions. These included the National Day Buoy Center (NDBC), Office of National Marine Sanctuaries (ONMS), Climate Program Office (CPO), and Marine Biodiversity Observation Network (MBON). And NDBC buoy is located nearby SBNMS (#44018), but has experienced the frequent service disruptions due to insufficient funding and maintenance. Therefore, the partners have been discussing creating the new ecosystem mooring as an upgraded replacement of this station, moved slightly to the north to be located more centrally within SBNMS where is overlaps with a Dedicated Habitat Research Area designated by the New England Fishery Management Council (Fig. 5).

This station will work with NERACOOS Buoy A01 and NDBC Buoy 44013 (itself a candidate for upgrade to a full ecosystem mooring if the pilot with NDBC 44018 is successful) to detect land-based influences on SBNMS, as well as plankton and oceanographic measurements supported by MBON at the Coastal Maine Time Series (CMTS) and Wilkinson Basin Time Series (WBTS) stations.

To begin moving this project from planning to execution, NERACOOS has requested BIL funding from IOOS to conduct a detailed engineering design study for the new mooring, and we are actively seeking funding to build one or more units based on the design.

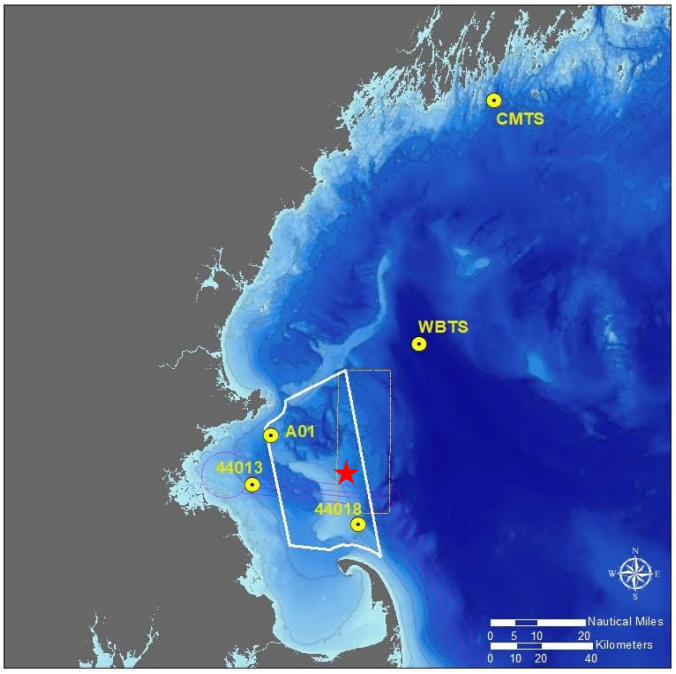


Figure 5. Proposed relocation of NDBC 44018 as an ecosystem mooring within the area of overlap between SBNMS and the NEFMC DHRA (red star) relative to related stations.

Water level monitoring

As noted above in the summary of unfunded projects in our 2021-2026 five-year proposal, NERACOOS proposed installation of up to 10 new low-cost water level monitoring stations across the region. Since submission the proposal, however, a number of locally-driven sensor deployments have been initiated by municipalities, research institutions, and other partners. These initiatives will require systems with which to store and view the data, however. Rather than having each create duplicative architecture, we are capitalizing on the ocean observing economy of scale that NERACOOS represents and focus on creating both the data management structures and a data product that can ingest and visualize data from a wide variety of sensor types. Funding through NROC is expected to support this work.

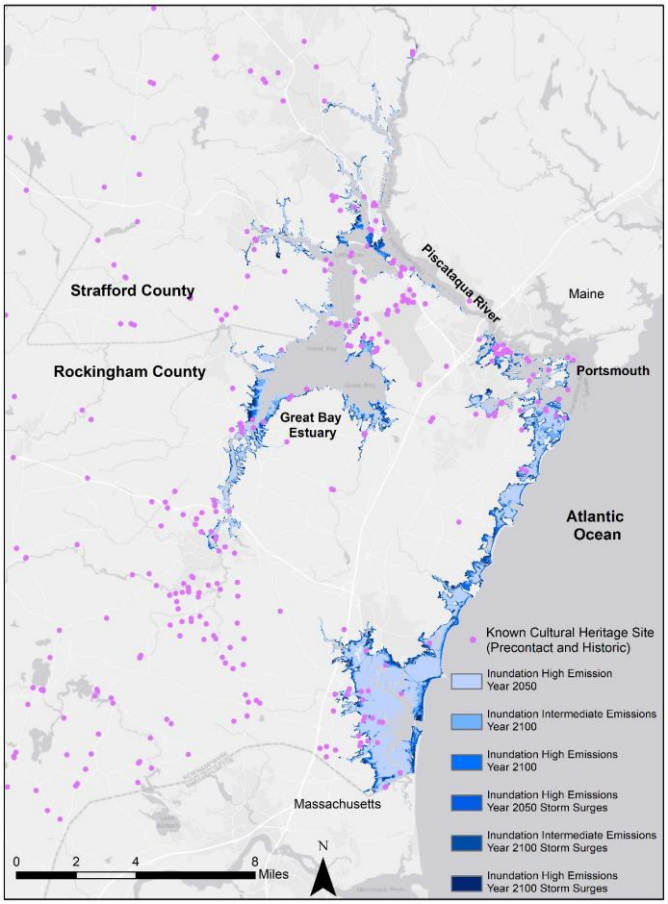


Figure 6. Indigenous and post-colonial cultural heritage sites vulnerable to sea-level rise in the Seacoast of New Hampshire (Howey 2020).

This does not mean that we will not continue to install new stations, however, to complement the existing set of four NERACOOS-supported stations, NOAA stations, USGS stations, and others. Funding for new deployments using funding through NROC has been proposed, possibly supplemented by increases in our IOOS core funding. These deployments will prioritize underserved and marginalized communities in the region. For example, a recent study identified a large number of both Indigenous and post-colonial cultural heritage sites in the Seacoast of New Hampshire that are vulnerable to sea-level rise[2] (Fig. 6). We have begun discussions with Abenaki leaders in New Hampshire, the University of New Hampshire, and the Department of Environmental Services about priority sites for monitoring in light of this analysis. Following this pilot, we then plan to engage with other regional Tribes to identify and work to protect cultural heritage sites in the coastal zone that are at risk.

In addition to Indigenous communities, low income and predominantly non-white communities in the urban centers of Southern New England are disproportionately vulnerable to sea-level rise. A recent study found that urban areas of Massachusetts

[2] Howey MCL (2020) Harnessing remote sensing derived sea level rise models to assess cultural heritage vulnerability: a case study from the Northwest Atlantic Ocean. *Sustainability.* doi:10.3390/su12229429

and Connecticut account for six of the 20 cities nationwide in which affordable housing is most vulnerable[3] (Fig. 7).

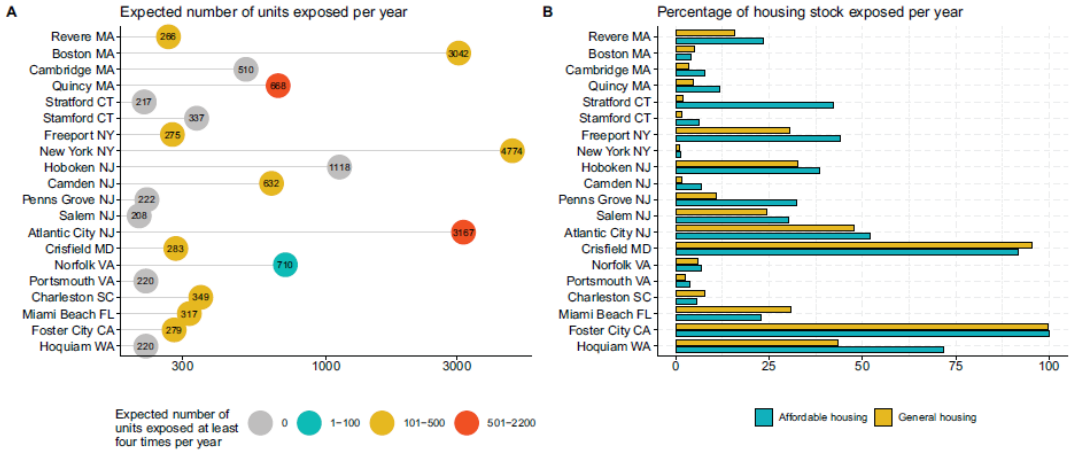


Figure 7. The top 20 cities in the United States in which affordable housing is most vulnerable to sea-level rise, including four in Massachusetts and two in Connecticut (Buchanan et al. 2020).

These urban centers and other vulnerable underserved communities will be priorities for new water level sensor deployments through funding from BIL, IOOS, and other sources.

Ocean & coastal acidification

A rising concern nationwide among aquaculturists, wild shellfish harvesters, natural resource managers, and other is the threat increasing acidification of coastal and ocean waters. This concern gave rise to the Northeast Coastal Acidification Network (NECAN), which is coordinated by NERACOOS. NECAN has prioritized development and implementation of a Regional OCA Monitoring Plan over 2022-2024 to improve tracking of and response to this environmental threat. A recent study that compiled all of the ongoing OCA monitoring efforts in the region found that, although there is widespread coverage of both surface and subsurface measurements, most monitoring is punctuated (every 1-4 years) and sustained monitoring stations are few[4] (Fig. 8). The Plan will aim to address this deficiency.

NROC, a key partner within NECAN, has proposed funding to support both development and implementation of the Plan. Implementation support includes three components: First, we will capitalize on the SOOP monitoring by eMOLT to test and deploy new low-cost pH sensors on fishing gear. Second, we will deploy low-cost temperature microsensors in rocky intertidal habitats to assess habitat suitability for shell-forming organisms. Third, we will create a Challenge Fund to leverage additional funding for projects that support early implementation of the Plan.

[3] Buchanan MK *et al.* (2020) Sea level rise and coastal flooding threaten affordable housing. *Environmental Research Letters.* doi:10.1088/1748-9326/abb266

[4] Siedlecki et al. (2021) Projecting ocean acidification impact for the Gulf of Maine to 2050: new tools and expectations. *Elementa*. doi:10.1525/elementa.2020.00062

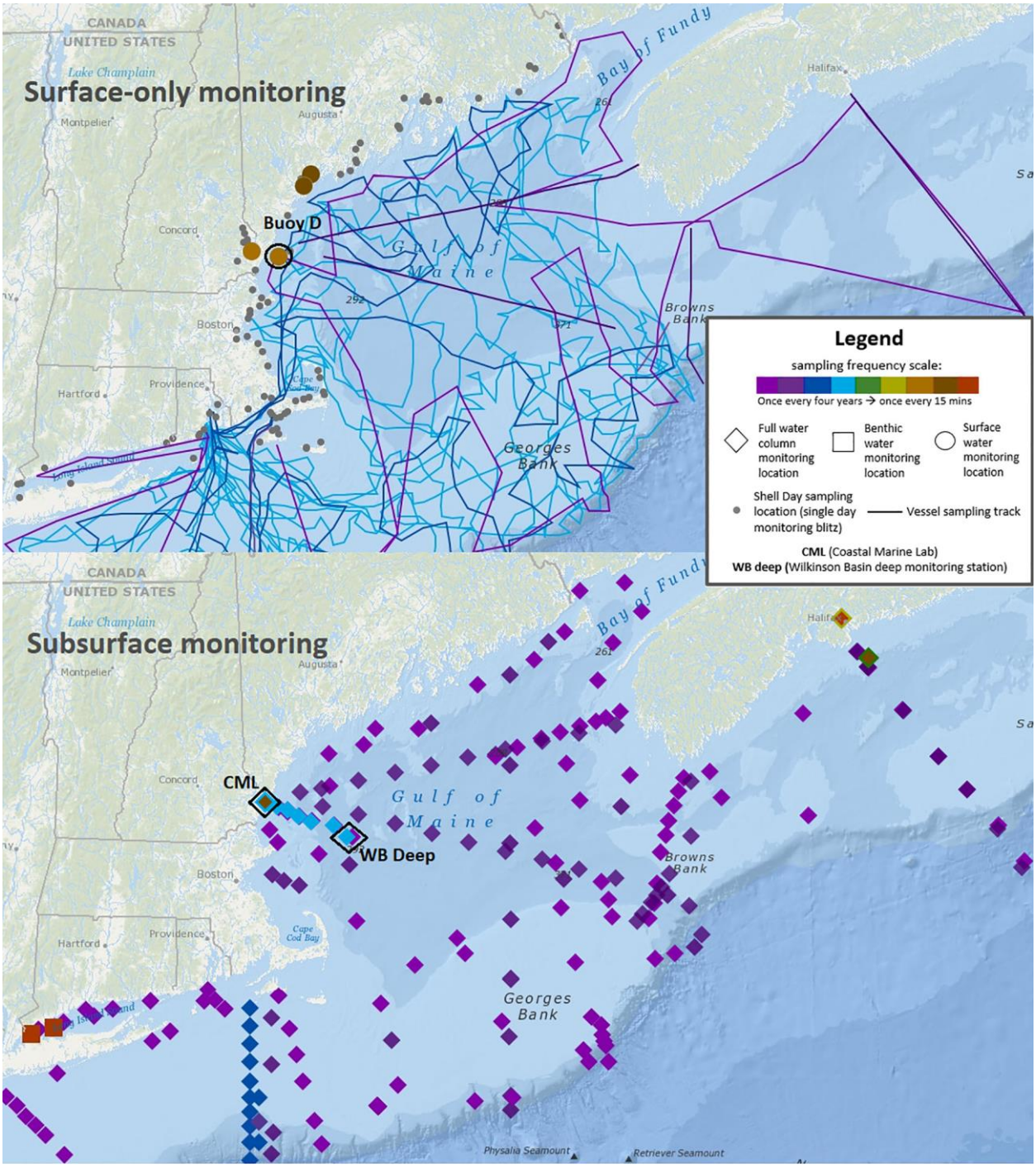


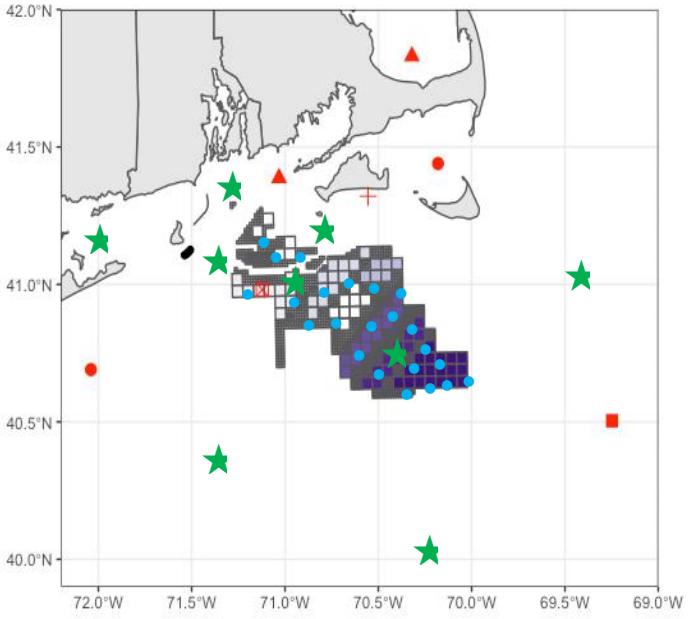
Figure 8. Synthesis of locations and temporal frequency of both surface and subsurface OCA monitoring efforts in the Northeastern U.S. (Siedlecki et al. 2021).

Observing for development of the MA-RI WEA

One of the most significant changes on the horizon for the Northeast ocean, and for many other areas in the U.S. to follow, is OSW development. There is widespread consensus that OSW presents an important opportunity for both economic growth and climate mitigation, consistent with President Biden's Executive Order on Tackling the Climate Crisis and subsequent goal of producing 30GW from OSW by 2030. There is also widespread consensus that OSW development will impact navigation, operations, oceanography, and ecology on the Southern New England Shelf. However, there are considerable debates about both the nature and magnitude of these impacts, and the appropriate mitigation strategies.

Resolving these debates is hindered by insufficient data by which to characterize baseline conditions and assess impacts. As a result, a number of actors – including state and federal agencies, research institutions, energy companies, fishermen, and others – are undertaking new data collection activities. Although laudable, the benefits of many of these activities will be limited by the fact that they are not coordinated, sustained, or at scale.

Accordingly, NERACOOS has been working with the energy industry, especially Ørsted, the Responsible Offshore Science Alliance (ROSA), and the Regional Wildlife Science Collaborative (RWSC) to design and eventually deploy a purpose-built observing buoy array in and around the MA-RI WEA (Fig. 9). This array aims to support policy and operational decisions related to five key issues: Navigation Safety, Environmental Pollution, Tracking Climate Signals, Fisheries Management, and Wildlife Conservation. This design is evolving through ongoing engagement with a wide variety of stakeholders, and we are beginning to explore funding opportunities through the energy industry, coastal states, BIL, Inflation Reduction Act, and other sources to support refinement of the design and implementation.



	●	▲	■	+	☒
Air Pressure	✓			✓	
Air Temperature	✓	✓	✓	✓	
Humidity				✓	
Surface winds	✓		✓	✓	
Above-surface winds			✓	✓	
Visibility					
SST	✓	✓		✓	✓
Waves	✓	✓	✓	✓	✓
Currents		✓			
Conductivity				✓	
Subsurface temp.				✓	
Dissolved oxygen					
Chlorophyll					
pH/PCO2					
CDOM					
Nitrate					
Telemetry receivers					
Passive acoustics					
Active acoustics					
PAR					
Genomics					
Imaging (Plankton)					
HABS/toxins					

Figure 9. Sustained observing assets in and around the MA-RI WEA (red), with measurements by each. A working design for an expanded network tailored to the expected impacts of OSW includes a high-density array of stations within the WEA measuring sea state conditions (blue), and a widespread array of ecosystem moorings at key navigational, oceanographic, and ecological locations (green).