

The Continued Development of the Northeastern Regional Coastal Ocean Observing System

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Period of Performance: December 1, 2011 – May 31, 2012

1. PROJECT SUMMARY

Long-term goals

The overarching intent of this proposal is to continue operation and further the development of the integrated ocean observing system for the Northeast and to expand the user base through consultation and outreach.

Objectives

At the recommended funding level NERACOOS will achieve the following objectives detailed in the original work plan of the proposal submitted in the fall of 2010. Due to the overlap in the performance periods of the FY2010 and FY2011 IOOS Implementation awards, efforts will be able to be maintained at current capacity without the anticipated decrease in activity with level funding. In addition, enhanced capacity will be achieved in nutrient and water quality monitoring especially in Narragansett Bay and wave measurements on Jeffreys Ledge.

1. Coordinated Regional Management
 - 1.1. NERACOOS office at base capacity.
2. Observing Subsystem
 - 2.1. Planning for future enhancement and National Synthesis of Regional Build Out Plans
 - 2.2. The Gulf of Maine buoy array will be maintained at current capacity (6 buoys – UMaine).
 - 2.3. The Long Island Sound buoy array will be maintained at current capacity (3 buoys – UConn).

- 2.4. The Great Bay Coastal Buoy and Coastal Marine Lab will be maintained at current capacity (UNH).
- 2.5. The Gulf of Maine HFR array will be maintained at current capacity (3 locations – UMaine).
- 2.6. HAB monitoring in the Bay of Fundy and MERIS satellite work will be maintained at current capacity (BIO).
- 2.7. Nutrient work will obtain additional capacity to allow buoy integration at URI and maintain capacity of the AZMP program (URI and BIO).
- 2.8. Enhanced observing capacity will be achieved with continuing the deployment of Jeffreys Ledge CDIP wave buoy (UNH).
- 2.9. Enhanced observing capacity will also be obtained with the real-time telemetry Narragansett Bay Fixed-Site Water Quality Monitoring Network (NBFSMN, URI, SubChem).
- 3. Data Management and Communications Subsystem
 - 3.1. DMAC coordination will be maintained at current capacity (GMRI)
- 4. Modeling and Analysis Subsystem
 - 4.1. The Northeast Coastal Ocean Forecast System will be maintained at current capacity (UMassD).
 - 4.2. The WaveWatch III wave model will be maintained at current capacity (BIO).
- 5. Outreach and Education
 - 5.1. Current capacity at the NERACOOS office will be maintained.

2. PROGRESS AND ACCOMPLISHMENTS

Much of the work has continued to be sustained with funds awarded in previous cooperative agreements with NOAA (NA08NOS4730296 and NA10NOS4730019) where there is a large amount of overlap in goals and objectives. This includes observing subsystem activities not associated with regional build out plans, as well as DMAC and Modeling and Analysis subsystem activities. Subawardees often used funds from multiple subawards to complete tasks during the reporting period making clear differentiation between funding sources for particular accomplishments difficult.

Objective 1 – Coordinated Regional Management

Board Activities – The NERACOOS Board of Directors met twice during the reporting timeframe, on February 8 and May 9. Again, travel distance, time requirements, cost, and carbon footprints were reduced for both meetings with multi-location video teleconferencing (central location of the Seacoast Science Center in New Hampshire and satellite locations in Canada and Connecticut).

Changes to the board of directors membership - At the February meeting John Trowbridge and alternate Larry Madin (WHOI) were replaced by Anthony Kirinich with alternate Aleck Wang, John Conway was replaced by Robert Araujo (Sikorsky Aircraft Corporation) to represent the CT industry, and Justin Huston (Nova Scotia Department of Fisheries and Aquaculture) was elected to represent Canadian Provincial point of view. Jack Ringelberg resigned from the Board on April 26 due to relocation to Florida.

Focused forums during both Board meetings allowed discussion of how NERACOOS could interact with key stakeholder / partner groups with a goal of sharing information to increase understanding and collaboration. In February Capt. Jim McPherson (Chief of Staff, First Coast US Guard District), Art Allen (USCG) and PJ Johnson (Pilot from Portsmouth NH) participated in a Marine Operations

Forum. In May estuarine and nearshore coastal waters were the focus of a forum with directors of the region's National Estuaries Programs (Long Island Sound Study, Narragansett Bay, Buzzards Bay, Massachusetts Bay, Piscataqua Region, and Casco Bay) and National Estuarine Research Reserves (Wells, Great Bay, Waquoit Bay, and Narragansett Bay).

Strategic Planning and Implementation (SPI) Team

Annual Meeting – The major activity of the SPI Team this period was the annual meeting that was held at the Graduate School of Oceanography at URI on April 3. Al Hanson (URI) was selected to be the next Chair of the SPI Team replacing Jim O'Donnell who had chaired the team since 2009. The team heard operational overviews from the funded PIs as well as discussing structure and membership, and talked about reinvigorating working groups during a business session. Merger of the Ocean and Coastal Ecosystem Health (OCEH) and Coastal Hazards Resiliency (CHR) working groups with the similar committees of NROC was agreed to. During lunch, Hal Walker (EPA) presented on “Promoting safe and sustainable waters through integrated management of nutrients in New England”. The Products team gave an update on progress on implementing climatologies in the afternoon followed by a discussion on long-term / historical data management and accessibility. The latter identified the need for developing a regional data management framework. The team also agreed to meeting twice a year with the next meeting at the end of September with a second day focused on the data management framework.

Regional Coordination

The New England – Canadian Maritime Collaboration and Planning Initiative – As mentioned in previous reports, NERACOOS participated in an effort looking at collaboration amongst four regional entities in New England and Canada's Maritime Provinces. The merger of the NERACOOS working groups and NROC committees resulted from recommendations from this initiative. NERACOOS contractor David Keeley has been working with the new Committee Co-Chairs to develop terms of reference for the groups and the new rosters.

Together with the Northeast Regional Ocean Council (NROC), NERACOOS led the *New England-Canadian Maritime Collaboration and Planning Initiative* which brought together 13 regional organizations including the Northeast Coastal and Ocean Data Partnership (NeCODP) and the NOAA North Atlantic Regional Team (NART). A final partner meeting on October 27, 2010 built on the series of four theme-based meetings in May and June (Ocean and Coastal Ecosystem Health, Renewable Ocean Energy, Coastal Hazards, and Ocean Observing). These theme meetings produced project implementation summary sheets for a number of regional priorities and finalized versions with updates from the October 27 meeting are available. The procedures to update these projects and continue collaboration were discussed on a teleconference of partners on May 24, 2012 and an update period of three years was agreed to. Plans are being developed for the next update in 2013.

Ocean Planning

The Northeast Ocean Data Portal Working Group is a collaborative group including NERACOOS, SeaPlan (the renamed Massachusetts Ocean Partnership), The Nature Conservancy, NOAA's Coastal Services Center, Applied Science Associates, the Gulf of Maine Research Institute, and NROC. The CMSP data portal for the northeast that consists of a website (www.northeastoceandata.org) and data viewer was launched in June prior to the national CMSP working at which Ru Morrison presented as part of the National Information Management System session. NROC was awarded funds by NOAA and the Moore Foundation to further develop CMSP in the region and NERACOOS continues to participate in the working group. NERACOOS staff participated in the regional Ocean Planning

meeting sponsored by NROC in Rhode Island on April 12 and 13 and other NROC meetings on January 1 and May 31.

NERACOOS and Northeast Coastal and Ocean Data Partnership (NeCODP)

Merger of the NeCODP with NERACOOS was discussed at the last NeCODP meeting in June 2011 and at NERACOOS board meetings with the general view that this would be beneficial to both parties. However, the NeCODP has not had a chair since before the last meeting and its future is uncertain. NERACOOS staff will be participating in NeCODP Executive Committee calls in the near future to determine appropriate next steps including communicating with membership about the desire to continue.

Other meetings

NERACOOS representatives attended numerous other meetings during the performance period reported on here including those of the Gulf of Maine Council, World Ocean Council, the IOOC DMAC steering team, the Massachusetts Lobstermen's Association, 2012 Ocean Sciences, IOOS Program Office reporting and NFRA board meeting, the ICES Working Group on the Northwest Atlantic Regional Seas, NOAA's North Atlantic Regional Team, ME/NH Port safety forum meetings, MARACOOS Annual Meeting, CBEP Board meetings, More than a Message workshop, COSINE workshop, Project Wet, Families by the Seaside, and NEOSEC meetings.

New Website and Newsletter

The NERACOOS website was redesigned to help highlight NERACOOS activities and partners and make access easier to data and tools. NERACOOS staff worked closely with web development partners, the Ocean Data Products group at the Gulf of Maine Research Institute, to migrate data and tools from the old GoMOOS website which was retired in April 2012. Since then traffic to the NERACOOS website has increased to about fifteen thousand unique visitors a month with a peak of over one thousand three hundred unique visitors in a day. Two issues of the new NERACOOS newsletter have been published and distributed with Constant Contact.

Objective 2 – Observing Subsystem

Objective 2.1 Planning for future enhancement and National Synthesis of Regional Build Out Plans

At a national level, Drs. Holly Price and Leslie Rosenfeld completed their support of the national synthesis of the regional build out plans.

Objective 2.2 The Gulf of Maine buoy array (UMaine) – 6 Buoys were deployed for NERACOOS (B01, E01, I01, M01, N01, and F01). Data from recovered buoys were downloaded and post processed. Data from other UMaine moorings were sent to GMRI for dissemination to NERACOOS. These include A01 (LNG mitigation and Massachusetts Water Resources Authority – MWRA – funded), D02 (Bowdoin College with NASA funding), and E02 (DeepCwind with DOE funding). Surface met sensors and ocean currents have a data return greater than 80% for the period indicating some instrumentation problems. Cruise during the first week of October served Buoy B01, turned around A01 and recovered E02. Buoy M01 broke free on 20 November, 2011 and drifted around Jordan Basin with sensors at all depths reporting indicating that problem was between the end of the wire rope and the top of the float. The buoy was recovered on December 5 by the R/V Delaware on a NOAA/NMFS cruise. Some of the tower instruments were damaged during the recovery (wind sensor, 2 solar panels, tower ring) but the rest of the surface buoy and near-surface instruments (RDI long ranger, Aanderaa current meter and SBE 37SM) were recovered intact. However, the ship was unable

to recover the wire rope and had to cut the wire before recovering the 6 SBE37IMs. During a cruise on R/V Connecticut from February 2-5, 2012 buoys M01, F01, E01, and A01 were serviced. At M01, the acoustic release and float were recovered from the bottom portion of M0118 which was left behind when the tethers failed in Nov 2011. The old mooring failed about 2m from the bottom of the tethers, which appear to have been severed by fishing activity. New buoy M0119 was successfully deployed on 4 Feb 2012. At F01, an external RDI battery and new instrument cable was added to restore the Doppler data at F0122 on 3 Feb 2012. An external battery was also added to E01 to restore its Doppler data on 4 Feb 2012. Buoy A01 was serviced on 5 Feb 2012 which had been damaged in an apparent ship collision (both wind sensors sheared off). Buoy F02 was deployed on 22 February 2012 for the DeepCwind program at 44 23.27'N, 068 49.86'W in a water depth of 20m. This buoy is scheduled to be deployed for approximately 4 months and is measuring surface winds, air temperature, barometric pressure, GPS positions, surface directional waves, and 1-m temperature and salinity. A self-contained surface current meter will not transmit data in real-time but should be available after the buoy is recovered. Data from this buoy is being provided to GMRI/NERACOOS. During March the buoys and instruments were prepared and were turned around with the NOAA Ship Delaware II from 10-17 April 2012. General array servicing (buoy turnarounds at A01, B01, E01, F01, I01), replacement of N0113's Long Ranger Doppler profiler, replacement of M0119's surface current meter, and unsuccessful dragging operations for the SBE37IMs left behind from the recovery of M0118 were completed. Bat detection sensors (stand-alone) supplied by Stantec (Steve Pelletier) have been added to the buoys to be deployed in April at A01, B01, E01 and F01. All UMaine NERACOOS buoys will continue to have fish tag telemetry receivers for NOAA/NMFS (Paul Music, Orono) – the depths will change on this deployment from near surface to near 50m to reduce the near-surface noise. Additional new developments include testing a webcam for possible deployment on buoy F01 next year, working with NMFS in Orono to purchase and integrate new fish tag telemetry receivers capable of real-time data transmission. In addition the UMaine buoy group assisted in the staging and logistics for the deployment of the Wave glider and Fetch instruments by Liquid Robotics and Sonardyne personnel.

Objective 2.3 The Long Island Sound buoy array (UConn) – All 4 axial buoys including Eastern Long Island Sound, Central Long Island Sound, Western Long Island Sound, and Execution Rocks (ELIS, CLIS, WLIS, EXRX, respectively) and two stationary (Ledge Light, Norwalk Aquarium) sites have been operated although the wind direct from the Eastern Sound appeared to be drifting aperiodically. Provisional data is transmitting in real time to LISICOS website and NDBC. The ADCP real-time data stream at Execution Rocks via an acoustic modem is operational but the Western Sound ADCP is internally logging only. Regular servicing has occurred at all sites. Surface YSI water quality probes were serviced at the Eastern Sound and Central Sound buoys on December 1. The Western Sound surface, mid and bottom YSIs were serviced on December 7, as were the surface and mid YSIs and bottom SBE19 at Execution Rocks. However, the bottom SBE19 at Execution Rocks failed after 3 days and was replaced with another SBE19 on December 13. The self-recording bottom mounted ADCP at the Central Sound Station was hauled and replaced on December 12. On February 1, the Central Sound buoy was reported off station by a marine pilot, about 5 miles to the east of its original location. After talking with several marine pilots, it appears to have been there for about a week or two, and was not moving. Anecdotal information suggests that a dredge barge was in the vicinity during this time, and it is suspected that it had been hit and dragged. The RV Connecticut February was scheduled for February 8, two tasks were combined into one trip – Central Sound buoy recovery and repositioning, and the Western Sound recovery. The Central Sound buoy had ended up in 45 feet of water with about 120 feet of chain, but no anchor. The buoy broke anchor either as result of being hit or mechanical failure of the anchor bale. The Western Long Island Sound buoy was redeployed on March 15 and the Execution Rocks was hauled for maintenance to be redeployed on April 3. The

Eastern Sound Station was hauled the following week on March 22, also for repairs and maintenance. The Western Sound buoy was serviced on April 26 and Western and Execution Rocks data buoys on May 30.

Objective 2.4 The Great Bay Coastal Buoy and Coastal Marine Lab (UNH) – The Great Bay Buoy Mooring System Manager was unresponsive in laboratory testing after recovery of the buoy on November 29, 2011 and was returned to Satlantic Inc. for repair. This took longer than expected with the unit not received back until May. The buoy is scheduled for redeployment for its eight season of biogeochemical monitoring in the first half of June. Observations with the automated sensor suite at the Coastal Marine Laboratory continued during the performance period. Some sensors were removed for participation in NOAA and NASA cruises and will be returned to the suite in July.

Objective 2.5 The Gulf of Maine HFR array (UMaine) – All three CODAR stations (Greens Island, Grand Manan, and Cape St Mary) are operational with full range between 190 and 200 km when ionospheric and atmospheric conditions are good. Windy afternoons have the best coverage. GPS has become quite intermittent at Greens Island starting on 25 December, 2011 (the transmitter is shut down when the GPS is not working). A license to operate one of the UMaine HFR sites as a multi-static site was purchased. This should increase the range as well as the accuracy from the standard backscatter geometry. Greens Island is expected to be upgraded as the multi-static site – CODAROS is still evaluating whether Cape St Mary might be also considered. A trip will be made as soon as possible (weather, available boats permitting) to replace the GPS and to install the USB key once confirmation of the multi-static location is received from CODAROS. Another trip to Greens Island in the spring will be needed for rerouting cables and repairing the exterior for the homeowners. Additionally, an equipment enclosure has been procured and will be installed at the site next spring to help regulate temperature, humidity, and dust. At Grand Manan, CODAROS has suggested the installation of a loading coil on the receive antenna to reduce the noise floor. This work cannot be started until after UMaine signs the site agreement with the Canadian Coast Guard. Preparations are underway for site visits for all 3 sites in June. The UMaine systems office is working with the Canadian government agency on some small revisions to the site use agreement.

Objective 2.6 HAB monitoring in the Bay of Fundy and MERIS satellite (BIO) – Weekly *in situ* sampling for *A. fundyense* at five locations in southwest New Brunswick and two additional locations off Grand Manan Island was initiated in early April, 2012. In addition, broad biweekly surveys of the Bay of Fundy were initiated in early June to determine spatial and temporal distributions of *A. fundyense*. Cell concentrations will be determined microscopically. The MERIS satellite-based detection algorithm was tested and refined using additional data from 2011 and 2012 and some promising results were indicated. A manuscript describing the method and results is being prepared for publication. Unfortunately communication with the ENVISAT satellite which houses MERIS was lost in April, and while waiting for the launch and data availability of OLCI on Sentinel-3, the suitability of MODIS Aqua data as a replacement for MERIS will be investigated. This requires considerable additional work to transport the algorithms to MODIS data, adapt it to the waveband specifications of MODIS, which are different from MERIS, and additional tests are required to establish the validity of the algorithm as implemented for MODIS data.

Objective 2.7 Nutrient work with integration (URI) and AZMP program (BIO) – The multi-sensor testing was continued off the URI-GSO Pier with the two nutrient sensor test arrays developed with NOPP Funding. [Sensor Array 1: SubChem APNA multi-nutrient analyzer (NO₃, NO₂, PO₄, NH₃), WET Labs WQM (CTD, O₂,Chl), and SubChem Data to internet communication module. Sensor

Array 2. Wet Labs Cycle-PO4, Satlantic Suna-NO3, SubChem ChemFin-NO3, SeaBird SBE 49 FastCAT CTD, WET Labs ECOPuck (Chl, CDOM, Scattering), Aanderra O2 Optode, and SubChem Data to internet communication module.]. The sensor arrays have undergone maintenance and incremental upgrades including to the ChemFIN Nitrate sensor. The latter is being integrated into one of the buoys of the Narragansett Bay Fixed Site Monitoring Nextwork. Deployment of the sensor arrays is scheduled for early summer. BIO is to continue nutrient sampling on the Fall 2012, AZMP mission. Nutrient sections continue to be used in conjunction with current data to estimate nutrient fluxes into the Gulf of Maine.

Objective 2.8 Deployment of Jeffreys Ledge CDIP wave buoy (UNH) – With partial support from NERACOOS, the Army Corp of Engineers and CDIP, UNH was able to continue nearly full time operation of the Jeffrey's Ledge Datowell waverider buoy (NDBC 44098). Data were reported in realtime every 30 minutes and served on NERA, CDIP and NDBC websites. In late February the buoy failed due to expected battery lifetime and was subsequently recovered, refurbished, and redeployed by March 15, 2012. It has been operating successfully since that time.

Objective 2.9 Real-time telemetry Narragansett Bay Fixed-Site Water Quality Monitoring Network (NBFSMN, URI, SubChem) – Phase I, an initial knowledge discovery and plan development exercise, of the work to integrate the NBFSMN data into the NERACOOS network has been accomplished through meetings between SubChem engineers and NBFSMN personnel and the data integration plan developed. Phase II, initial testing with instruments at the URI GSO pier, is underway and preparations are being made for the final Phase III, connection of as many of the 13 monitoring locations as possible. A workshop to facilitate this is being planned.

Objective 3 – Data Management and Communications Subsystem

Objective 3.1 DMAC coordination (GMRI) – GMRI aided UConn with finalizing the implementation of SOS feed for the Long Island Sound buoy array and ingested the data feed into the NERACOOS database. Work is also underway to integrate URI efforts including the in-situ nutrient measurements and the Narragansett Bay Fixed Site Monitoring Network. Migration of the GoMOOS products to the new NERACOOS Drupal content management website was completed and involved product testing with NERACOOS staff and last minute alterations. In April the GoMOOS website was retired and appropriate web pages with messaging were developed. In May, website and data management activates allowed inclusion of the Liquid Robotics Waveglider and Sonardyne Fetch node deployments onto the NERACOOS website. Cloud server work included migration of the dependent buoy database as well as solving FTP and backup issues. USGS tide stations were also included into the NERACOOS data stream and available through the real-time portal. Routine activities included web and aggregation database maintenance, daily checks, trouble shooting, and bug fixes. GMRI also participated in bi-weekly Regional DMAC Conference calls and SOS reference team bi-weekly calls.

Objective 4 – Modeling and Analysis Subsystem

Objective 4.1 The Northeast Coastal Ocean Forecast System (UMassD) – NECOFS operation has been maintained with system performance monitored on a daily basis. Model skill was also assessed with model-data comparisons for surface elevations at tidal gauges, wind and surface waves at NERACOOS and NOAA NDBC buoys. The FVCOM-GOM3 data assimilation algorithm was modified to improve the computational efficiency. The Scituate inundation model grid was modified by refining the most possible inundation area facilitating sensitivity experiments with comparison to the coarse grid results. NECOFS nesting to the FVCOM global ocean model continues to improve model performance. Work

continues on the reanalysis of Global-FVCOM results from 1978 to 2010 for the study of climate changes on the Gulf of Maine ecosystem, particularly on the physical mechanisms of salinity anomaly trends. B. Beardsley has been working together with S. Couture (NHDES), D. Sowers (PREP), J. Cannon (NWS), and others on developing a new inundation forecast system for the Hampton-Seabrook estuary system, NH. UNH has provided the UMASSD team with high-resolution LIDAR data, and B. Beardsley will supervise creation of the subdomain grid for Hampton-Seabrook and nest it to GOM3-FVCOM.

Objective 4.2 The WaveWatch III wave model (BIO) – The Wavewatch III model was operated at BIO during the performance period although scheduling model runs on the new computer infrastructure still presents some challenges.

Objective 5 – Education and Outreach

NERACOOS and New England Ocean Science Education Collaborative (NEOSEC)

NERACOOS and other NEOSEC partners have continued work on the second year of the NOAA funded *Families by the Seaside* project. Cassie Durette attended a meeting on December 6 and cohosted a science and technology workshop for participants on May 3 with the Encyclopedia of Life. During the reported time period, NERACOOS has been busy planning for the 2012 NEOSEC Ocean Literacy Summit to highlight ocean exploration in November, which NERACOOS is sponsoring. Cassie Durette also attended two NEOSEC Governing Council meetings, presented at the Project WET conference in May, and received funding to develop an exhibit at the Seacoast Science Center in Rye, NH to highlight Right Whale research in Stellwagen Bank National Marine Sanctuary. We have also participated in the monthly NFRA Education and Outreach Committee calls and activities.

NERACOOS Stakeholder Outreach

NERACOOS continues to grow and improve its stakeholder outreach program, which is focused on making stakeholder's aware of NERACOOS products and services, soliciting their feedback on existing products, gathering their needs and priorities for new data and products, and documenting how they are using NERACOOS products and services in their work and recreation. NERACOOS uses a variety of outreach channels to reach its stakeholders including, a quarterly e-newsletter, website features, weekly Facebook updates, participation in stakeholder meetings, conferences, etc., focus groups, and hosting stakeholder forums at our Board of Directors meetings. During the performance period a Communication Strategy was created and NERACOOS staff participated in the "More than a Message" workshop / training organized by the Working Group of the Gulf of Maine Council on the Marine Environment.

One highlight from our outreach efforts is our participation in the annual Maine Fishermen's Forum in March. This is a unique event that brings together many individuals and organizations involved and interested in regional fisheries including fishermen, managers, policy makers, researchers, NGO's and many others. Participants come from throughout New England and Canada. The forum provides a great opportunity for NERACOOS to talk to many of our stakeholders and get feedback on our products and services. NERACOOS staffed a display, hosted a seminar on ocean forecasting, met with several delegation and staff, and conducted a discussion group to better understand how fishermen use ocean observing data. Our ocean forecasting seminar was well attended and included presentations from John Cannon of the National Weather Service, Robert Beardsley of Woods Hole Oceanographic Institution, Kate Burns of the Gulf of Maine Research Institute and James Manning of the Northeast Fisheries Science Center. On the final morning of the forum NERACOOS hosted a discussion group that included fishermen from MA, ME and Nova Scotia.