

Southeast New England Program Watershed Grant
in collaboration with Restore America's Estuaries (RAE)

FINAL REPORT

Upgrade Monitoring in Narragansett Bay through the Narragansett Bay Fixed-Site Monitoring Network (NBFSMN)

Contract Number: (SNEPWG-18-4-RIDEM)



Submitted by
Rhode Island Department of Environmental Management – Office of Water Resources

February 2021

Executive Summary

The Narragansett Bay Fixed-Site Monitoring Network (NBFSMN) is relied upon by managers and researchers to provide the continuous data needed to characterize and track bay water quality conditions and trends including those related to nutrient enrichment. About one-third of Narragansett Bay and its embayments have continued to exhibit the effects of nutrient enrichment referred to as eutrophication. Excess nutrients can produce large algal blooms that deplete oxygen in the water column when the algae die and decay. Low dissolved oxygen, also known as hypoxia, adversely affects many forms of marine life via the sub-lethal negative impacts of reduced growth and reproduction. It is a critical time to monitor bay water quality given that upgrades to wastewater treatment plants in both Rhode Island and Massachusetts have achieved about a fifty percent (50%) reduction in the total loading of nitrogen into Narragansett Bay since the early 2000s. With the significant reduction in pollutant loadings and the influence of climate change, bay water quality conditions are expected to be changing as well. This project entitled “Upgrade to Monitoring in Narragansett Bay through the NBFSMN” was aimed at addressing critical equipment replacement needs and enhancing public access to the data collected via the network. The project addressed a pressing need to upgrade aging equipment utilized in the NBFSMN to ensure continuity of operations.

The Narragansett Bay Fixed-Site Monitoring Network, established in 2005, has operated as a successful multi-agency partnership coordinated by the Rhode Island Department of Environmental Management (RIDEM). Currently, the other partners involved in NBFSMN field operations include: Narragansett Bay Commission (NBC), Narragansett Bay National Estuarine Research Reserve (NBNERR), University of Rhode Island’s Graduate School of Oceanography (URI/GSO) and Massachusetts Department of Environmental Protection (Mass DEP). The NBFSMN has expanded over time to include 14 stations throughout the Bay with greater spatial coverage in the impacted upper bay region. The stations include those operated from buoys as well as from land-based locations, e.g. docks. Nine of the 14 stations are operated by the URI-GSO under an annual agreement with RIDEM which owns the majority of the equipment at these sites. Using consistent instrumentation, all stations record physical water quality data (temperature, salinity, dissolved oxygen, depth, pH, and surface chlorophyll) every 15 minutes at near surface and bottom locations. This level of observation will capture events that occur on short time scales (hours to days) or during times when it is impractical to deploy field crews. The NBFSMN program operates with a Quality Assurance Project Plan (QAPP) approved by the EPA. Extensive effort goes into quality control and review of the large dataset generated annually.

The focus of this project was the purchase of equipment to upgrade select stations within NBFSMN and the related enhancement of public access to the data. Due to outmoded equipment, real-time data transmission from these stations had been lost. During the first year of the project, the RIDEM-Office of Water Resources, working with the University of Rhode Island, purchased and operated the upgraded equipment which was installed at initially three

stations in the NBFSMN: North Prudence (NP), Conimicut Point (CP) and Poppasquash Point (PP). These are considered important upper bay stations that are of high interest with respect to detecting improvements in water quality due to the nutrient pollution reductions. The equipment components replaced included new buoy structures, electronic components, sondes, sensors, cables, and modems for data transfer. Installation of the upgrades, which involved calibration, testing and deployment, was completed in early July 2019. The upgrades restored the capability to transmit data in real-time. Due to cost savings achieved via a manufacturer's trade-in promotion, the RIDEM was able to use a limited amount of remaining grant funds in combination with other RIDEM and NERACOOS funds, to upgrade a fourth station at the Mt. View location in 2020 to enhance its reliability. During the project, the new equipment was operated by URI-GSO under agreement to RIDEM as part annual NBFSMN activities. Guiding operations was a newly revised Quality Assurance Project Plan (QAPP) for the NBFSMN that incorporated the latest technologies used by the network and incorporated the newest partner in the bi-state NBFSMN – the Massachusetts Department of Environmental Protection. As a result of the investment in equipment, four important stations in the NBFSMN were upgraded to reliably operate with reduced maintenance and disruptions.

A second aspect of this project was enhancing access to NBFSMN data. Following the upgrades and beginning in 2019, RIDEM and URI expanded real-time data sharing via its agreement with New England Regional Association of Coastal Ocean Observing Systems (NERACOOS). The upgraded station's data has been made publicly available in near- real time via on their ERDDAP server data portal (<http://www.neracoos.org/erddap/index.html>). The NERACOOS website also provides for automated data visualization tools including graphing. As a result of the project, data from seven NBFSMN stations is now available via NERACOOS. Staff also continued to coordinate Rhode Island Coastal Ecology Assessment Innovation and Modelling's (RIC-AIM's) Rhode Island's Data Discovery Center group at Brown University regarding data sharing arrangements. The historical NBFSMN datasets are now available from its website site along with certain visualization tools. The C-AIM portal also provides users a link to the real-time data available via NERACOOS. The collaborations with NERACOOS and the C-AIM program have expanded access to NBFSMN data for interested users. During 2020, RIDEM and URI-GSO made use of the NERACOOS visualization tools to more quickly assess water quality conditions relative to hypoxia during the investigation of fish kills in Narragansett Bay. Looking ahead, RIDEM and URI-GSO will be continuing to collaborate with NERACOOS, the C-AIM Program and other partners on further enhancements to their data portals.

1. Cover Information

Project Name: Upgrade Monitoring in Narragansett Bay through the Narragansett Bay Fixed-Site Monitoring Network (NBFSMN)

Contract Number: (SNEPWG-18-4-RIDEM)

Grant and Reporting Period: 9/1/2018 – September 30, 2020

Grantee Organization: Rhode Island Department of Environmental Management – Office of Water Resources

Report Contact Person: Susan Kiernan, RIDEM-OWR, 401-222-4700 ex 77600

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Report Type: FINAL

2. Project Report Narrative

Project Overview: The Narragansett Bay Fixed-Site Monitoring Network (NBFSMN) is relied upon by managers and researchers to provide the continuous data needed to characterize and track bay water quality conditions and trends including those related to nutrient enrichment. About one-third of Narragansett Bay and its embayments have continued to exhibit the effects of nutrient enrichment referred to as eutrophication. (See Map/Figure 1- Supporting Materials) Excess nutrients can produce large algal blooms that deplete oxygen in the water column when the algae die and decay. Low dissolved oxygen, also known as hypoxia, adversely affects many forms of marine life via the sub-lethal negative impacts of reduced growth and reproduction. It is an important time to monitor bay water quality given that upgrades to wastewater treatment plants in both Rhode Island and Massachusetts have achieved about a fifty percent (50%) reduction in the total loading of nitrogen into Narragansett Bay since the early 2000s. With the significant reduction in pollutant loadings and the influence of climate change, bay water quality conditions are expected to be changing as well. Given known inter-annual variability in water quality conditions, several years of data will be needed to determine trends. This project addressed a pressing need to upgrade aging equipment utilized in the NBFSMN to ensure continuity of operations.

The Narragansett Bay Fixed-Site Monitoring Network, established in 2005, has operated as a successful multi-agency partnership coordinated by the Rhode Island Department of Environmental Management (RIDEM). Currently, the other partners involved in NBFSMN field operations include: Narragansett Bay Commission (NBC), Narragansett Bay National Estuarine Research Reserve (NBNERR), University of Rhode Island's Graduate School of Oceanography (URI/GSO) and Massachusetts Department of Environmental Protection (MA DEP). The NBFSMN has expanded over time to include 14 stations operating seasonally to year-round throughout the Bay with greater spatial coverage in the impacted upper bay region. The stations include those operated from buoys as well as from land-based locations, e.g. docks. Nine of the 14 stations are operated by the URI-GSO under an annual agreement with RIDEM

which owns the majority of the equipment at these sites. (More information is available at: <http://www.dem.ri.gov/programs/emergencyresponse/bart/stations.php>) The stations utilize consistent instrumentation consistent with the network's QAPP manufactured by Xylem/YSI and/or Nexsens although the specific models and ages of the components vary site to site. Each station includes two sondes (with multi-sensor probes) (near surface and near bottom) which are integral for collecting water quality information. Each station also has components (a datalogger (DCP), power supply with solar panel charging, and modem) which support the transfer of data via cellular communications (See Figure 2 – Supporting Materials) All NBFSMN stations record physical water quality data (temperature, salinity, dissolved oxygen, depth, pH, and surface chlorophyll) every 15 minutes at near surface and bottom locations. This level of observation will capture events that occur on short time scales (hours to days) or during times when it is impractical to deploy field crews. The NBFSMN program operates with a Quality Assurance Project Plan (QAPP) updated through this project and approved by the EPA. Extensive effort goes into quality control and review of the large dataset generated annually.

The focus of this project was the purchase of equipment to upgrade select stations within NBFSMN and enhancement of public access to the data. During the first year of the project, the RIDEM-Office of Water Resources, working the University of Rhode Island, purchased and operated the upgraded equipment which was installed at initially three stations in the NBFSMN: North Prudence (NP), Conimicut Point (CP) and Poppasquash Point (PP). See Figure 1. Equipment at these stations had been used for over a decade and become increasingly unreliable. These are considered important upper-bay to mid-bay stations that are of high interest with respect to detecting improvements in water quality due to the achieved nutrient pollution reductions. The equipment components replaced included new buoy structures, electronic components, sondes, cables, and modems for data transfer. Installation of the upgrades, which involved calibration, testing and deployment, was completed in early July 2019. (Figures 3 & 4 – Supporting materials) Due to cost savings achieved via a manufacturer's trade-in promotion, the RIDEM was able to use a limited amount of remaining grant funds in combination with other RIDEM and NERACOOS funds, to upgrade a fourth station at the Mt. View location in 2020. This location was upgraded to an EXO sonde and an improved DCP to provide more consistent data transfer with NERACOOS. This station was deployed with the fully upgraded equipment as of August 2020. The new equipment procured through this project was operated by URI-GSO under agreement to RIDEM as part annual NBFSMN activities. Guiding operations was a newly revised Quality Assurance Project Plan (QAPP) for the Narragansett Bay Fixed-Site Monitoring Network was completed based on feedback from partners through this SNEP project. The revisions incorporated MA DEP as the newest partner in the bi-state NBFSMN.

A second aspect of this project was enhancing access to NBFSMN data. Following the equipment upgrades and beginning in 2019, RIDEM and URI used the existing data sharing arrangement with New England Regional Association of Coastal Ocean Observing Systems (NERACOOS) to have the upgraded station's data made publicly available in near- real time via on their data portal. NERACOOS funds were used to have the data accessible through the NERACOOS ERDAP server (<http://www.neracoos.org/erddap/index.html>). During 2020,

RIDEM, in collaboration with partners, was able to upgrade an additional station, Mt. View, to the latest sensor technology and data transfer capabilities. In addition, the modem on the Quonset Pt buoy was updated to allow for better data transfer. Staff also continued to coordinate with NERACOOS and Rhode Island Coastal Ecology Assessment Innovation and Modelling's (RIC-AIM's) Rhode Island's Data Discovery Center group at Brown University regarding data sharing arrangements.

During the project, RIDEM and URI-GSO attended a number of SNEP and RAE events including the RAE grant award ceremony in Pawtucket, RI (September 2018), the SNEP partner meeting (10/25/2019) and SNEP monitoring workshop (April 2019) – both held in Fall River, MA. Heather Stoffel of URI-GSO and Heidi Travers of RIDEM participated in the 2018 RAE national summit held in Long Beach, CA (December 8-13, 2018). The project and activities of the NBFMSN was discussed at a meeting of the Rhode Island Environmental Monitoring Collaborative in person in January 2020. The pandemic altered plans for in-person meetings during much of 2020 and resulted in certain activities being carried out remotely by necessity. The RIEMC met remotely in May 2020. RIDEM participated in the 2020 RAE national summit hosted remotely in September 2020.

The status of the Project Tasks is summarized as follows:

Task No.	Task Description	Deliverable	Schedule	Complete/In Progress
Task 1.	Attend Grant Ceremonies	Poster Presentation	September 2018	Completed
Task 2.	Develop and execute data-sharing agreements with NERACOOS	Data sharing agreement between DEM/URI/NERACOOS	On-going	On-going
Task 3.	Update QAPP to reflect planned enhancements to NBFMSN.	QAPP addendum.	June 2020	Completed
Task 4	Procure equipment to upgrade 3 NBFMSN stations		April 2019	Completed
4a.	Prepare bid specifications	Bid Specifications	December 2018	Completed
4b.	Execute procurement	Equipment Acquired	April 2019	Completed
4c.	Preparation and deployment of equipment	Three upgraded stations operational	May 2019; May 2020	Completed
5.	Operationalize real-time transfer with NERACOOS	For 4 stations	August 2020	Completed
5a.	Testing of real-time data transfer	Data in ERDDAP server at NERACOOS	July 2019	Completed
5b.	Real-time transfer operational with NERACOOS for three or more sites	Data accessible via NERACOOS website	August 2019	Completed
5c.	Update RIDEM and URI websites to provide links to real-time data	Active website links	September 2019	Completed
Task 6.	Conduct outreach to inform users about new real-time capability	Communications and related materials	Summer 2020	Completed/ and On-going
Task 7.	Attend SNEP and RAE program meetings required	Meeting participation	December 2018; Sept 2019; Sept 2020	Completed
Task 8.	Progress and final grant reports	Progress and final reports	Quarterly	Completed February 2021

2.A. Results

Equipment Upgrades Completed: The main goal of this project was to upgrade is to purchase needed equipment for 3 stations to sustain data collection and enhance public access to data generated at three critical stations in the mid to upper Bay. In the first phase of the project, under Task 4, new equipment was purchased and deployed in July 2019. One positive aspect of procurement was that the bid process, negotiated discounts and a trade-in promotion from the manufacturer YSI, Inc. during 2019 allowed for enough savings to provide funds for an additional station upgrade. During the 2020 season, additional equipment and supplies for one additional station were purchased and installed. As noted above, as a result of the investment in equipment and supplies, four (4) stations were completely upgraded. These are indicated on Map 1- Supporting Materials and include: North Prudence (NP), Conimicut Point (CP), Poppasquash Point (PP) and Mt. View (MV). A picture of the upgrades at the Conimicut Station is included as Figure 3 – Supporting Materials. The upgrades achieved the project goal of improving the reliability of data collection at important mid-bay stations in the NBFSMN and restoring real-time transfer of data. The equipment will continue to be deployed as part of the NBFSMN into the future.

Through this project, RIDEM completed a revised Quality Assurance Project Plan (QAPP) for the NBFSMN (Task 3). This involved meeting with NBFSMN partners, clarifying aspects of procedures, and incorporating feedback from MA DEP which became a new partner in the network with deployment of two stations in 2017. The updated QAPP underwent partner and EPA reviews. The finalized document dated June 2020 was approved by EPA. It was posted on the DEM website (<http://www.dem.ri.gov/programs/emergencyresponse/bartna/netdata.php>). The process fostered the bi-state collaboration within the NBFSMN and enhanced the working relationships among the core NBFSMN partners.

Data Collection 2019-2020: As noted above, the upgraded stations were operated seasonally during 2019-2020. This occurred despite the emergence of the pandemic during 2020. Regular deployment, operation and retrieval of equipment occurred as planned (See Figure 4 – Supporting Materials). A seasonal intern was retained to support field operations which were carried out by URI-GSO under agreement with RIDEM-OWR. Fortunately, although COVID did impact field operations, it did not result in any major disruption or delays in data collection. Field operations were modified to incorporate precautions including social distancing and required personal protection equipment protocols, e.g. masks. The number of persons authorized to be present on the boats servicing buoy-based stations was curtailed and limited to ensure six-feet of separation. With these precautions, data collection during was 2020 continued. Retrieval of equipment, including buoy-based stations occurred in November 2020. RIDEM and URI-GSO have renewed their cooperative agreement for 2021 and are actively planning for the upcoming NBFSMN monitoring season with continuing COVID precautions.

Two events of note occurred during 2020 related to the upgraded stations. First, in June, the Poppasquash Station was damaged after being struck presumably by a boat. The damage involved loss of the solar panel and damage to the communications equipment (DCP). (Figure 5 – Supporting Materials.) Data collection continued but remote data transfer was disrupted until

repairs could be made. Replacement of damaged components was covered by warranty. Real-time data transmission was restored at the end of September 2020. Secondly, in late summer, the counterweight on the Conimicut Station buoy was damaged causing the weight to become unattached and the station then to flip. This was noticed promptly, and a repair was made within a few days. (See Figures 6 & 7- Supporting Materials.) About 1-2 days' worth of surface data was lost since the surface sonde was out of the water because of the buoy being flipped.

The equipment upgrades proved of immediate benefit during 2020. At RIDEM, tracking bay water conditions to detect declines in dissolved oxygen has been institutionalized as part of preparing and responding to environmental perturbations (events.) While major hypoxic events cannot be prevented, advance warning of a possible event allows both state and municipal personnel to make plans and be prepared to respond quickly and effectively to situations that may occur such as a major fish kill. Conditions are tracked throughout the summer season and into the early fall as warranted. When fish kills or other environmental perturbations do occur, or the public reports something unusual (such as, red patchy water as seen in the fall 2015) in Narragansett Bay, real-time access to network data can be analyzed immediately by managers to help understand the potential cause(s) of a particular incident. During 2020, the RIDEM Division of Marine Fisheries investigated 15 fish kills reports - 11 of which were reported in Narragansett Bay. Hypoxia was implicated as a cause in three of the events with real-time data from the upgraded stations utilized in the investigations by managers to assess fish kills in the Providence River and Greenwich Bay areas.

Enhancing Access to Data: The second goal of this project was to enhance access to the NBFSMN data. The equipment upgrades successfully restored the real-time data transmission capabilities that RIDEM and URI-GSO rely on for several important stations. The improvements led to collaborative efforts that resulted in additional outlets to access NBFSMN data in a more user-friendly manner. Through the project RIDEM-OWR continued its data-sharing arrangement with NERACOOS and re-established the capacity to host near real-time data via its data platform. (Tasks 2 & 5). The process involves transmission of the data via cellular service to a computer managed by URI and routing of the data via an ftp site to display on the NERACOOS website via its ERRDAP server. Data is transmitted to NERACOOS hourly. As needs arise, the frequency of transmission can be adjusted as needed by URI-GSO and RIDEM to support response actions, e.g. major fish kills. As a result of the project, at the end of 2019, seven (7) stations are now sharing data with NERACOOS through their ERRDAP server achieving the original project expectations. A screen shot of the where to access the ERRDAP server among the NERCAOOS data products is in Figure 8- Supporting Materials and the link is: <http://www.neracoos.org/erddap/index.html>. A screen shot of the data search list reflecting the NBFSMN stations that transmit data is in Figure 9- Supporting Materials.

RIDEM and URI-GSO are continuing to work with NERACOOS on the presentation of NBFSMN information, including stations names, on its website. Another portion of the NERACOOS website built to display hourly buoy data is currently not fully functioning but is expected to undergo some updates in the future. The NERACOOS website, including the ERRDAP server, also provides data visualization tools including automated graphing of information. The

NERACOOS webpage displaying the visualization tool is depicted in Figure 10. An example of how the visualization tool was utilized to graph data for assessment of water quality conditions as part of a RIDEM fish kill investigation in Narragansett Bay is included in Figure 11. The NERACOOS tool facilitates the timely production of graphed data which is highly valued in a such situations, e.g. response to environmental perturbations/events.

In addition to NERACOOS, through the project, RIDEM and URI-GSO also worked with Brown University on the development of the Data Discovery Center at <https://ridatadiscovery.org/#/> and depicted in Figure 12- Supporting Materials. This website and data portal are part of a larger EpScor funded initiative referred to as “C-AIM”. (More information at: <https://web.uri.edu/rinsfepscor/>. While the longer-term goal for the C-AIM project was to provide a site with real-time access, their data system and associated public facing website remain a work in progress. The C-AIM site currently provides a link to the NERACOOS EDDRAP server. It also hosts the historical data from NBFSMN which have been published through RI CAIM’s Data Discovery Center to improve the network’s data visualization and accessibility. Through RI C-AIM’s buoy data viewer the user can choose stations, parameters, depths and length of data (daily-multi-annual) Figure 13 is an example of the types of data displays capable through this site. The website for this historical data is <http://pbuoycit.services.brown.edu/buoyportal/larequest.php?request=selectpastdata>. These data visualizations and data download capabilities constitute an improvement because, prior to this grant, the datasets for the RIDEM stations in the NBFSMN were only accessible as annual static data downloads from the RIDEM website <http://www.dem.ri.gov/programs/emergencyresponse/bart/netdata.php>. (Note: NBC and NBNERR provide additional real-time access to data from the stations they operate.)

For the foreseeable future, the RIDEM website will continue to function as a data archive for the entire NBFSMN. Additionally, through its BART webpage, RIDEM provides weekly public outreach for water quality information within Narragansett Bay. Website updates were made to highlight the weekly reports within the large RIDEM website. More recently changes were made to provide links to the real-time data that is now accessible via NERACOOS as a result of this project. The RIEMC website also provides appropriate links to the data portals.

It is acknowledged that the NERACOOS tools are generally more appropriate for the informed user, e.g. researcher, state manager. Looking ahead, further improvements to the visualization of data on the NERACOOS platform and other platforms will be discussed and pursued as resources allow. An extension to the DEM- URI-GSO agreement was executed in October 2020 to continue NBFSMN operations through 2021. In addition, RIDEM anticipates continued collaboration with other partners such as the Narragansett Bay Estuary Program and RI Environmental Monitoring Collaborative with respect to bay water quality indicators and the presentation of information about bay water quality to the general public.

2.C. Compliance

It was determined that RIDEM would revise a full QAPP rather than develop an addendum to the existing QAPP for the three stations that were the original subject to this grant. The major revision of the NBFSMN Quality Assurance Project Plan was completed, signed by the network partners and approved by EPA. (June 2020)

2.D. Project Partners

- RI Department of Environmental Management – Office of Water Resources – Grantee/Grant management, project management, hiring of seasonal staff
- University of Rhode Island – Graduate School of Oceanography (URI-GSO)-site operations for the three upgraded stations, QAPP preparation, data management, and facilitate data transfer with NERACOOS.
- New England Regional Association of Coastal Ocean Observing Systems (NERACOOS)- provide a host website for real-time data of RIDEM and URI-GSO owned stations
- Narragansett Bay Estuarine Research Reserve (NBNERR)-participate in the QAPP process and maintain one station within the NBFSMN
- Narragansett Bay Commission (NBC) participate in the QAPP process and maintain two stations within the NBFSMN
- Massachusetts Department of Environmental Protection (MA DEP)- participate in the QAPP process and maintain two stations within the NBFSMN
- Brown University – collaboration on development of C-AIM data portal

2.E. Volunteer and Community Development

Given the funds for this project were devoted to equipment and supplies, there were limited opportunities to involve volunteers, particularly once the pandemic emerged. However, during 2019, during the summer months, interested students or volunteers occasionally participated in field work activities. COVID-19 curtailed such activities during 2020.

2. F. Outreach and Communications

Outreach for this project was conducted throughout the grant through emails, other communications and participation in meetings. As would be expected there was on-going communication among the project partners which include representative of both the management and research communities Heidi Travers of RIDEM participated in the 2018 RAE national summit held in Long Beach, CA (December 8-13, 2018) including a presentation developed with Heather Stoffel on the project. Through emails and other communications, URI-GSO kept interested researchers, including EPA, Brown University and others, abreast of the upgrades and progress toward the improved data access via several data portals (RIDEM, NERACOOS, and C-AIM). (Figure 14 – Supporting Materials) A newsletter piece was developed for posting and distribution within the larger URI community. (Figure 15 - Supporting Materials) RIDEM and URI-GSO also reported on the NBFSMN, including the project, at various meetings including the Annual NERACOOS meeting in December 2018, SNEP partner meeting

(10/25/2019) and SNEP monitoring workshop (April 2019) – both held in Fall River, MA and meetings of the Rhode Island Environmental Monitoring Committee (RIEMC) in January 2020 as well as remotely in May of 2020. The project partners have also discussed the project with the Narragansett Bay Estuary Program which continues to work on environmental indicators and which has supported further analysis of the NBFSMN data by research Dan Codiga. It is noted that the pandemic altered plans for in-person meetings during much of 2020 and resulted in certain activities being carried out remotely by necessity.

With respect to the general public, RIDEM, in conjunction with URI-GSO, continued to provide interpretations of the real-time data seasonally via the RIDEM BART website (<http://www.dem.ri.gov/programs/emergencyresponse/bart/latest.php>). Overall, these efforts reached a variety of data users from federal, state and academic researchers, state resource manager and other stakeholders, e.g. NGOs, to the general public interested in the health of the Narragansett Bay ecosystem. RIDEM and URI will continue to promote the enhanced access to data during the upcoming 2021 monitoring season.

3. Project Budget

As reflected in the Table below, the RAE Watershed Grant was primarily budgeted to support the purchase of equipment and supplies.

3.A. Summary Budget Table

	Budget Category	Total Budgeted Grant Funds	Total Budgeted Match	Total Budgeted Grant & Match	Actual Grant Funds Expended	Actual Match Funds Expended	Actual Expended Grant & Match	Match Source
a	Personnel		\$82,160*	\$82,160*		\$88,798	\$88,798	State funds
b	Fringe		\$15,081*	\$15,081*		\$16,523	\$16,523	State funds
c	Travel	\$3,000		\$3,000	0	0	0	
d	Equipment	\$285,660		\$285,660	\$288,543.18	0	\$288,543.18	
e	Supplies	\$11,340	\$4,800	\$16,140	\$11,340	\$4,800*	\$16,140	State Funds
f	Contractual						(*)	
g	Other				\$116.82		\$116.82	
h	Total Direct	\$300,000	\$102,041	\$402,041	\$300,000	\$110,121	\$410,121	
i	Indirect	0	0	0	0			
j	Total	\$300,000	\$102,041	\$402,041	\$300,000	\$110,121	\$410,121	

(*) Note: Personnel and fringe expenses are reflected consistent with the budget of the grant agreement. See 3.C. Budget Narrative for additional explanation.

3.B. Detailed Project Budget Table

Cost Item	Cost Basis This quarter	RAE SNEP Grant Total	Budgeted Match Total	Match Source	Total Budgeted Project Cost	Actual Project Costs
Personnel						
Seasonal Summer Intern	960@12.25/hr	0	\$11,760	RIDEM State Funds	\$11,760	\$4,728
NBFSMN QAQC Officer (Heather Stoffel)	184 hrs @\$34	0	\$37,400	RIDEM State funds	\$37,400	\$44,558
Marine Research Assistant (Edwin Requintina)	60 hrs @\$30	0	\$33,000	RIDEM State funds	\$33,000	\$39,513
Total Personnel		\$0	\$82,160		\$82,160	\$88,798
Fringe						
Seasonal Summer Intern	11.6%		\$900	RIDEM State Funds	\$900	\$549
Fringe, NBFSMN QAQC Officer (Heather Stoffel)	19.3%	0	\$7,218	RIDEM State funds	\$7,218	\$8,003
Fringe, Marine Research Assistant (Ed Requintina)	21.1%	0	\$6,963	RIDEM State funds	\$6,963	\$7,971
Total Fringe		\$0	\$15,081		\$15,081	\$16,523
Equipment						
YSI DCP, antenna, sondes for 3 stations	Est. \$276,000	\$285,660			\$285,660	\$288,543.18
Total Equipment		\$285,660			\$285,660	\$288,543.18
Supplies						
Cables, buoy hardware, etc. (Grant funds)	See narrative	\$11,340			\$11,340	\$11,340
YSI Profiler		0	\$3,000	RIDEM property	\$3,000	\$0
Purchase of supplies (state funds)				See notes.		\$4,800
Cellular Provider for modem (static IP)	\$1800 (3 lines - \$50/mth/line)	0	\$1,800	See notes.	\$1,800	\$0
Total Supplies		\$11,340	\$4,800		\$16,140	\$16,140
Travel						
RAE National Summit on Coastal Estuarine Restoration & Mgt		\$3000				
Travel Total					\$3,000	\$0
Other – Audit fees						\$116.82
Total Direct		\$300,000	\$102,041		\$402,041	\$410,121
Indirect 17.5% RIDEM rate					\$0.00	
TOTAL (Total Direct + 17.5% RIDEM)		\$300,000	\$102,041		\$402,041	\$410,121

3.C. Budget Narrative

The large majority of the grant funds were expended for durable equipment (\$288,543.18) and supplies (\$11,340) to complete upgraded configurations of three NBFSMN stations. The NBFSMN is standardized to use water monitoring equipment from YSI, Inc. and purchases included new multi-port sondes (EXO 2) and associated sensors along with related components which replaced the aging equipment in use. New buoy platforms, electronics and equipment to support real-time data transmission including DCP units and solar panels to provide power to the stations were purchased from another vendor (Interactive Oceanographics). Equipment and supply purchases also included gear related to the buoys and their moorings including cables, floats, anchors and fastening hardware among other items. Some of these items were purchased from Trawlworks.

Notes on Deviations from the Original Budget:

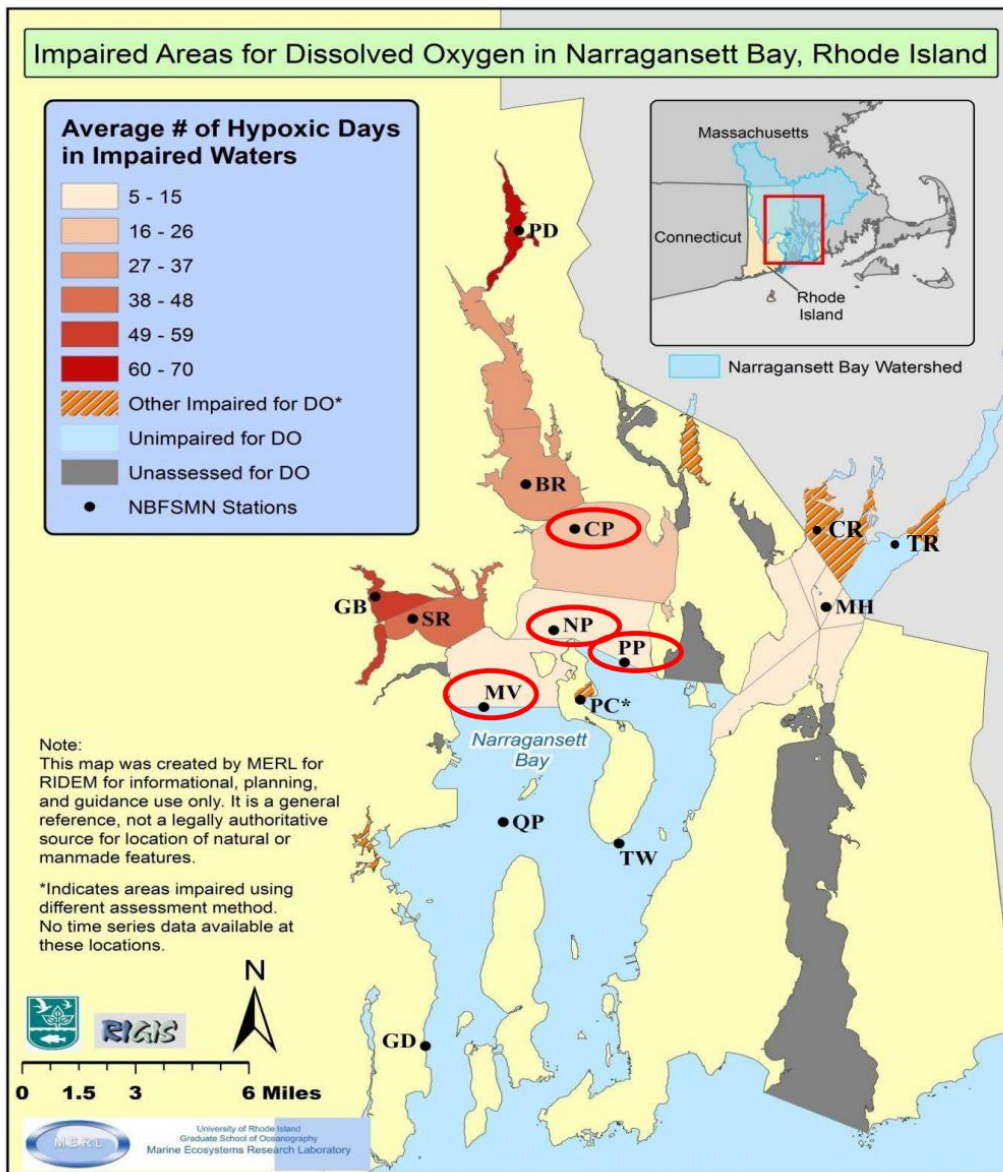
Travel: RIDEM Incurred expenses to support staff travel to the RAE National Summit in December 2018. Due to the state process for invoicing and reimbursing for travel, RIDEM was not able to claim this expense prior to RAE fiscal deadlines. RIDEM covered the expense with other federal funds. To support close out of the grant, the \$3,000 allocation for travel was then re-assigned to equipment, increasing that category to \$288,543 as well as portion treated as an “Other” expense that allows payment of minimal audit fees. During the project, RIDEM identified the need to charge minimal audit fees to the grant as allowable expenses in accordance with broader state grant management policies. This minor change was done in consultation with RAE.

Supplies: During the project RIDEM utilized had available federal funds to support the cellular transmission from the buoy stations. In lieu of this, RIDEM has documented \$4,800 in supplies and operating expenses paid for by the state as part of the URI-GSO agreement as an alternate appropriate source of match.

Personnel and Fringe: The documentation of match was largely budgeted as personnel and fringe. Direct state expenses for salary and fringe were limited to the seasonal intern hired for 2019 (\$5,278). Use of federal funding reduced the amount of time eligible for match associated with employment of the intern who did work fulltime seasonally. The state expenses associated with the intern have been added to the other match documented with the final invoice raising the total state match for the project to \$110,121. The remaining match contribution consists of RIDEM payments to URI-GSO for salary, fringe and operating (supplies) expenses incurred within the duration of the two-year project. These include \$84,071 in salary, \$15,974 in fringe and \$4,800 in supplies. This exceeds the original commitment of \$102,041.

4. Supporting Materials

Figure 1. Map of Impaired Waters and NBFMSN Stations



Map of the NBFMSN stations with areas impaired due to hypoxia. The red circled stations (CP, NP, PP and MV) represent the stations upgraded using SNEP Watershed Grant funding awarded to RIDEM-OWR. CP, NP and PP were upgraded and operational as of July 2019. MV was also upgraded with SNEP and NERACOOS grant funding in August 2020.

Figure 2. NBFSMN Buoy Diagram

The following diagram was used in the presentation at the RAE conference in December 2018 to explain how the upgrades to the stations will be accomplished and the station area.

Buoy Design and Methodology

Diagram of a YSI data buoy fitted for continuous monitoring. Features 2-point mooring, environmental sondes, internal data logger, and wireless telemetry.

Beacon
Solar Power
Wireless Telemetry
Internal battery pack, cellular modem and data logger.

Marker Buoy for pickup line
One Meter
Variable Water Column 5-20 meters (15-60 feet)
Two Point Mooring
Environmental sonde with chlorophyll sensor
150 lb. Weight
Environmental sonde

EXO²

Diagram and sonde photo courtesy of YSI/Xylem Integrated Systems

Methodology: Three seasonal buoys in Upper Narragansett Bay will be equipped with network compatible equipment (YSI Brand). This area is critical for evaluating the recent management decisions to reduced nitrogen loadings to the bay. This project will provide web-based data delivery, custom data acquisition and data visualization systems using network partnered data portals.

Figure 3. NBFSMN Station



Figure 3. (Above) Conimicut Pt Buoy. Stations upgrades included Nexsens communication system with upgraded solar panel tower (including new modem and data transfer electronics) and YSI brand EXO2 sondes. The sondes support a full suite of sensors (temperature, salinity, depth, pH, dissolved oxygen, and chlorophyll). These new sondes have brass guards and a central wiper system to minimize fouling. This is a vast improvement from the old 6-series sondes which were prone to fouling (especially salinity sensor).

Figure 4. (Photo to the right) 2019 Deployment of a NBFSMN Buoy Station



Figure 5. Poppasquash Point Station – Damage 2020

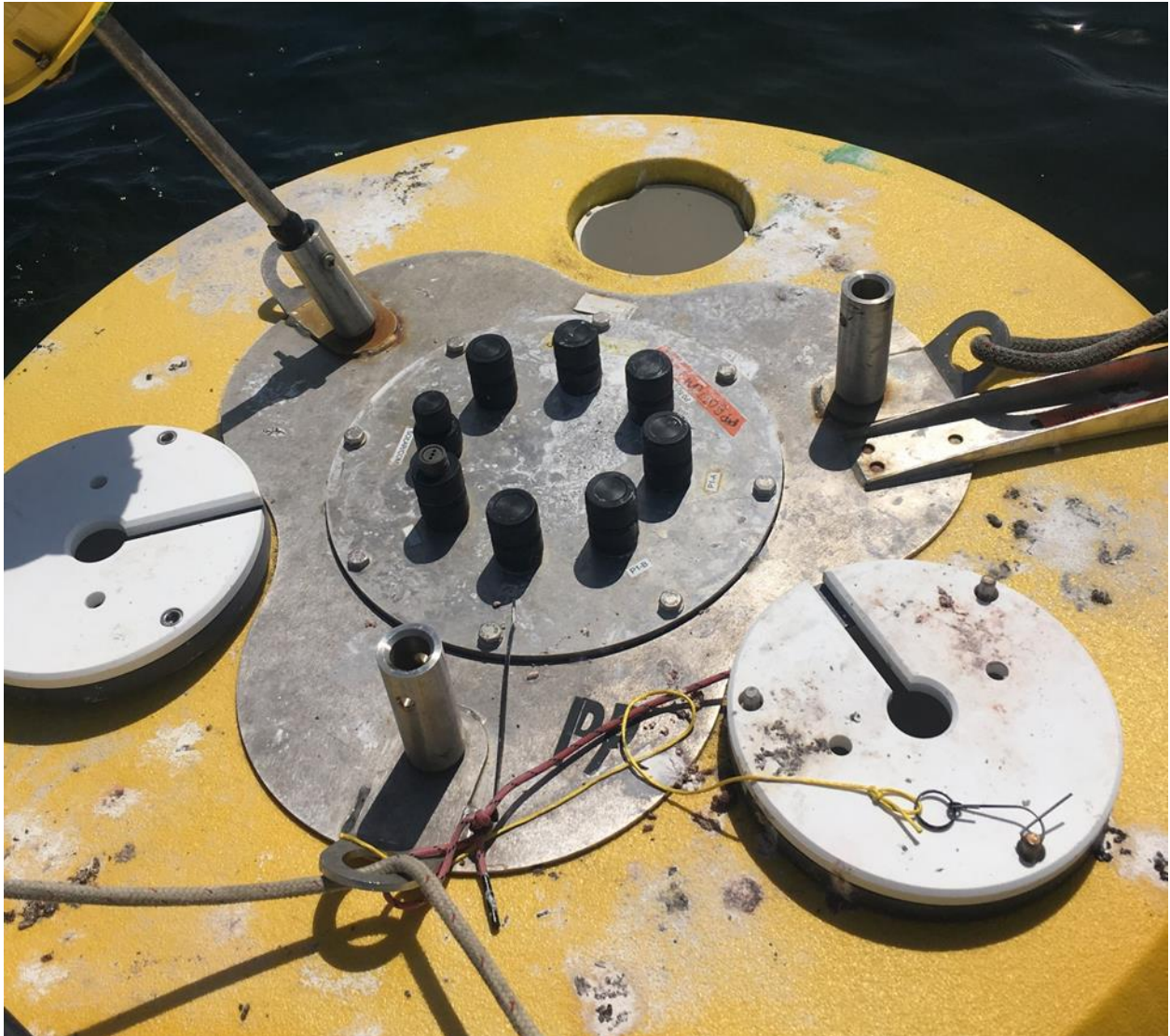


Figure 4. Poppasquash Point Buoy after boat strike during June 2020 which damaged communications equipment. Water quality data was still collected, but real-time data transmission was not accessible from the damage for most of the summer of 2020. These repairs were covered under warranty.

Figure 6. Operational Issue with Conimicut Point Buoy - 2020



Figure 6. During the late summer of 2020, the buoy system counterweight was damaged on the Conimicut Pt Buoy causing the station to flip. Staff were able to get out to the site quickly and no real damage was done to the station. A new counterweight was installed and the station operational again in a few days.



Figure 7. Work being done in 2020 to Conimicut Point buoy to re-install counterweight with added security measures - such as adding a cable around cage counterweight, so if bolts fail, the counterweight will not drop off the buoy.

Figure 8. Screen shot of how to access ERDDAP server on NERACOOS website.

This page is accessed through the “more data” icon on the far right in the bar at the top of the NERACOOS homepage.

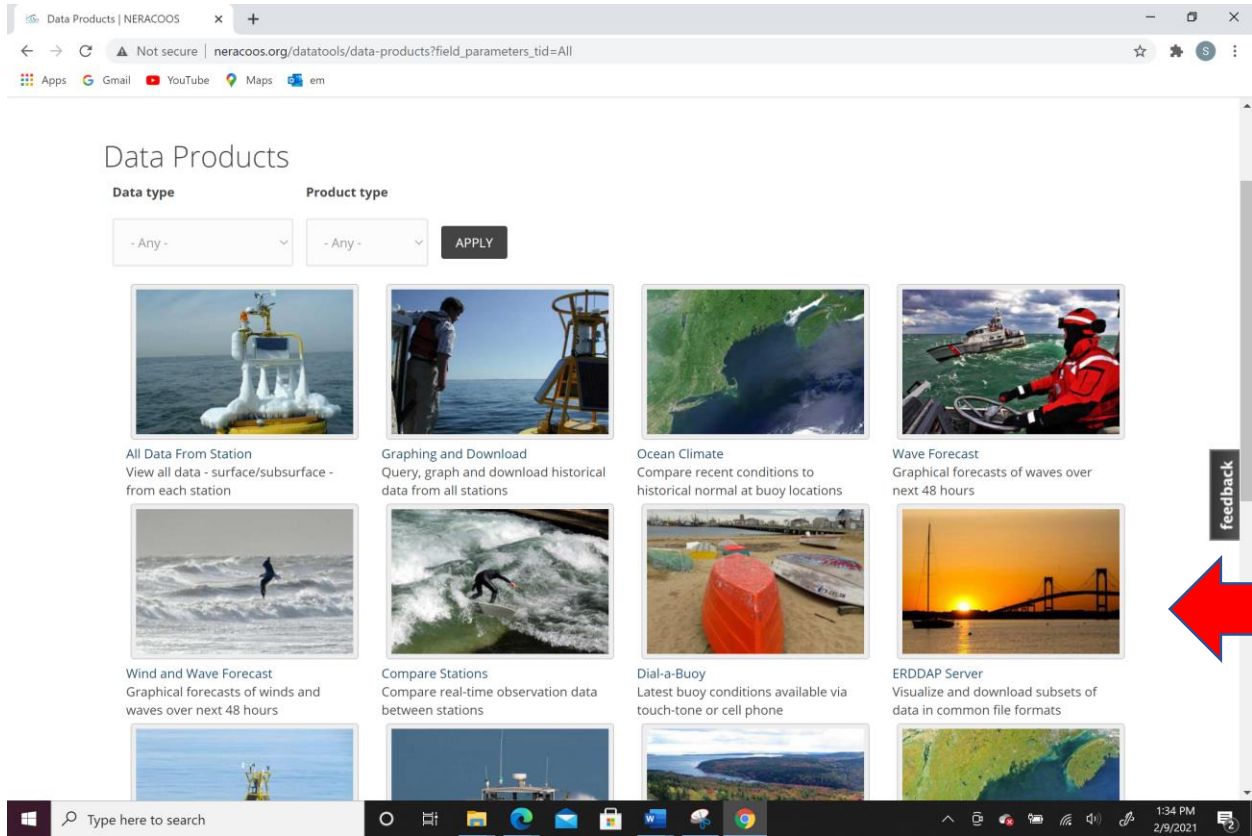


Figure 9. NERACOOS ERDDAP Server Webpage – Search Example

2/4/2021

ERDDAP - Search



ERDDAP
Easier access to realtime and historic NERACOOS buoy observations.

Brought to you by NOAA IOOS NERACOOS

ERDDAP > search

Do a Full Text Search for Datasets:

27 matching datasets, with the most relevant ones listed first.
(Or, refine this search with [Advanced Search](#))

Grid DAP Data	Sub-set	Table DAP Data	Make A Graph	W M S	Source Data Files	Title	Summary	FGDC, ISO, Metadata	Back-ground Info	RS:
		data	graph			URI 168 Mount View, Bottom Sonde		F I M	background	
		data	graph			URI 168 Mount View, Surface Sonde		F I M	background	
		data	graph			URI 169 Quonset Point, Bottom Sonde		F I M	background	
		data	graph			URI 169 Quonset Point, Surface Sonde		F I M	background	
		data	graph			URI Conimicut Point Bottom Sonde		F I M	background	
		data	graph			URI Conimicut Point Surface Sonde		F I M	background	
		data	graph			URI GSO Pier, Surface Exo		F I M	background	
		data	graph			URI GSOPier - SUNA		F I M	background	
		data	graph			URI Greenwich Bay, Bottom Sonde		F I M	background	
	set	data	graph			URI Greenwich Bay, RI Corrected Suna Nitrate Data		F I M	background	
		data	graph			URI Greenwich Bay, SUNA		F I M	background	
		data	graph			URI Greenwich Bay, Surface Sonde		F I M	background	
		data	graph			URI North Prudence Bottom Sonde		F I M	background	
		data	graph			URI North Prudence Surface Sonde		F I M	background	
		data	graph			URI Poppasquash Point Bottom Sonde		F I M	background	
		data	graph			URI Poppasquash Point Surface Sonde		F I M	background	
		data	graph			Scituate Harbor, MA Tide Gauge		F I M	background	
		data	graph			Gloucester, MA Tide Gauge		F I M	background	
		data	graph			Hampton Harbor, MA Tide Gauge		F I M	background	
		data	graph			LOBO 70 Casco Bay 1		F I M	background	
		data	graph			LOBO 72 Bagaduce River		F I M	background	
		data	graph			LOBO 1 Buoy Upper Damariscotta River		F I M	background	
		data	graph			LOBO 2 Buoy Mid Damariscotta River		F I M	background	
		data	graph			LOBO 64 Buoy Wood Island Harbor Saco ME		F I M	background	
		data	graph			LOBO 67 Buoy Ram Island Saco Bay ME		F I M	background	
	set	data	graph			NDBC Standard Meteorological Buoy Data, 1970-present		F I M	background	
	set	data	graph			Buoy Data, Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS)		F I M	background	

The information in the table above is also available in other file formats (.csv, .htmlTable, .itx, .json, .jsonCSV, .jsonKVP, .mat, .nc, .nccsv, .tsv, .xhtml) via a [RESTful web service](#).

ERDDAP, Version 1.82
[Disclaimers](#) | [Privacy Policy](#) | [Contact](#)

Figure 10. NERACOOS Data Visualization Tool Page – Graphing Data

2/4/2021

ERDDAP - URI North Prudence Bottom Sonde - Make A Graph



ERDDAP

Easier access to realtime and historic NERACOOS buoy observations.

Brought to you by NOAA IOOS NERACOOS

ERDDAP > tabledap > Make A Graph

Dataset Title: **URI North Prudence Bottom Sonde**

Institution: Graduate School of Oceanography, Marine Ecosystems Research Laboratory, University of Rhode Island (Dataset ID: URI_NP_BottomSonde)

Range: longitude = -71.35008 to -71.35008°E, latitude = 41.666737 to 41.666737°N, depth = 11.5 to 11.5m, time = 2019-07-16T08:00:00Z to 2020-11-02T20:45:00Z

Information: [Summary](#) | [License](#) | [FGDC](#) | [ISO 19115](#) | [Metadata](#) | [Background](#) | [Data Access Form](#)

Graph Type:

X Axis:

Y Axis:

Color:

Constraints	Optional Constraint #1	Optional Constraint #2
<input type="text" value="time"/>	<input type="text" value=">= 2020-07-01T00:00:00Z"/>	<input type="text" value="<= 2020-09-01T00:00:00Z"/>
<input type="text" value=""/>	<input type="text" value=">="/>	<input "="" type="text" value="<="/>
<input type="text" value=""/>	<input "="" type="text" value=">="/>	<input "="" type="text" value="<="/>
<input type="text" value=""/>	<input "="" type="text" value=">="/>	<input "="" type="text" value="<="/>
<input type="text" value=""/>	<input "="" type="text" value=">="/>	<input "="" type="text" value="<="/>

Server-side Functions

distinct()

Graph Settings

Marker Type: Size:

Color:

Color Bar: Continuity: Scale:

Minimum: Maximum: N Sections:

Y Axis Minimum: Maximum: Ascending:

Redraw the Graph (Please be patient. It may take a while to get the data.)

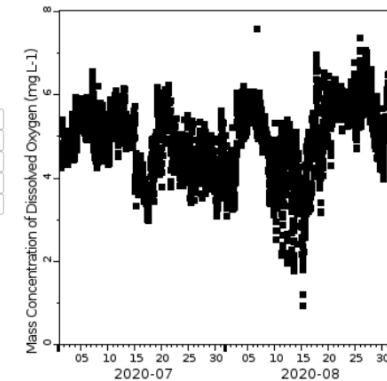
Optional:
 Then set the File Type: (File Type information)
 and [Download the Data or an Image](#)
 or view the URL: http://www.neracoos.org/erddap/tabledap/URI_NP_BottomSonde.htmlTable?
 (Documentation / Bypass this form)

Things You Can Do With Your Graphs

Well, you can do anything you want with your graphs, of course. But some things you might not have considered are:

- Web page authors can [embed a graph of the latest data in a web page](#) using HTML tags.
- Anyone can use ERDDAPs [Slide Sorter](#) to build a personal web page that displays graphs with the latest data (or other images or HTML content), each in its own, draggable slide.

Time range:



■ URI North Prudence Bottom Sonde
 Data courtesy of Graduate School of Oceanography, Marine Ecosystems Research Laboratory, University of Rhode Island

Figure 11. Example Graph of NBFSMN Data

Dissolved oxygen data from the bottom instrument at North Prudence Buoy for the summer of 2020. This data was useful in helping RIDEM F&W determine the cause of a fish kill that occurred in August 2020. The data was accessed in real-time using the NERACOOS ERDAPP server's data portal.

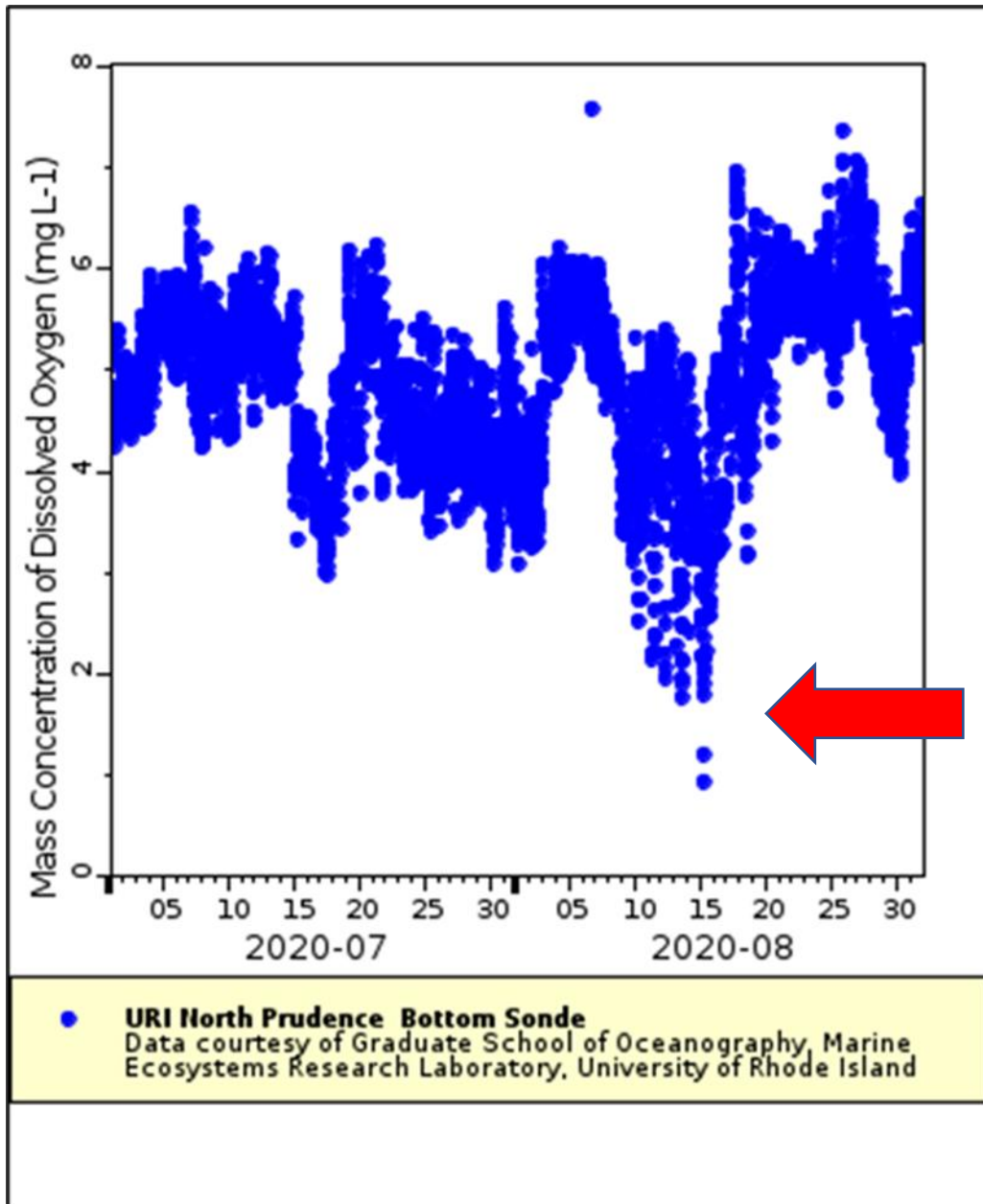


Figure 12. Rhode Island Data Discovery Center Homepage

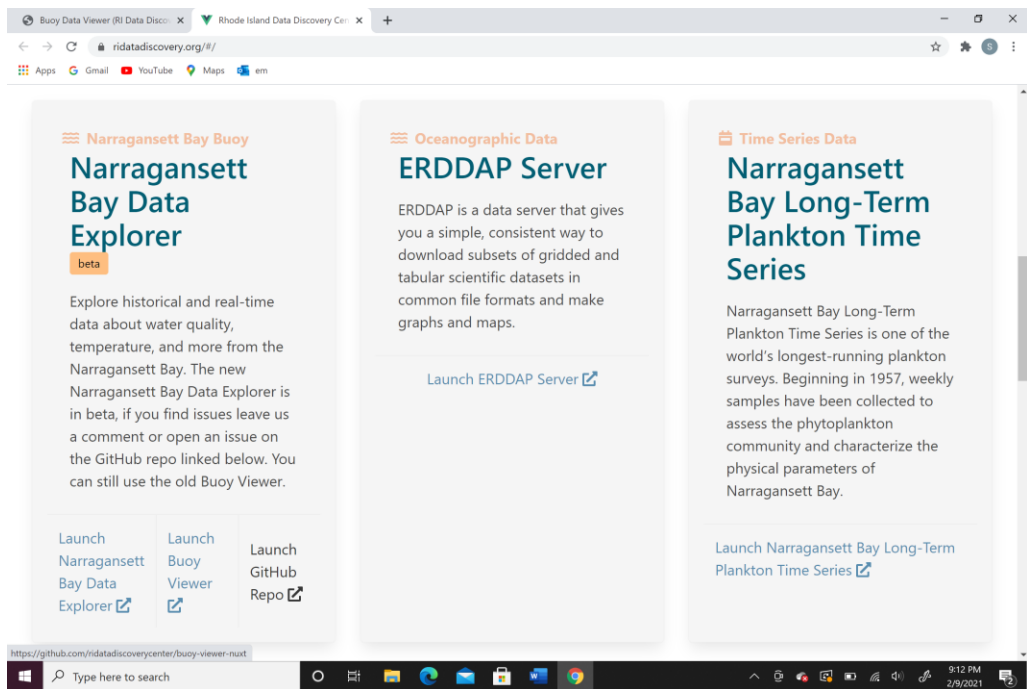
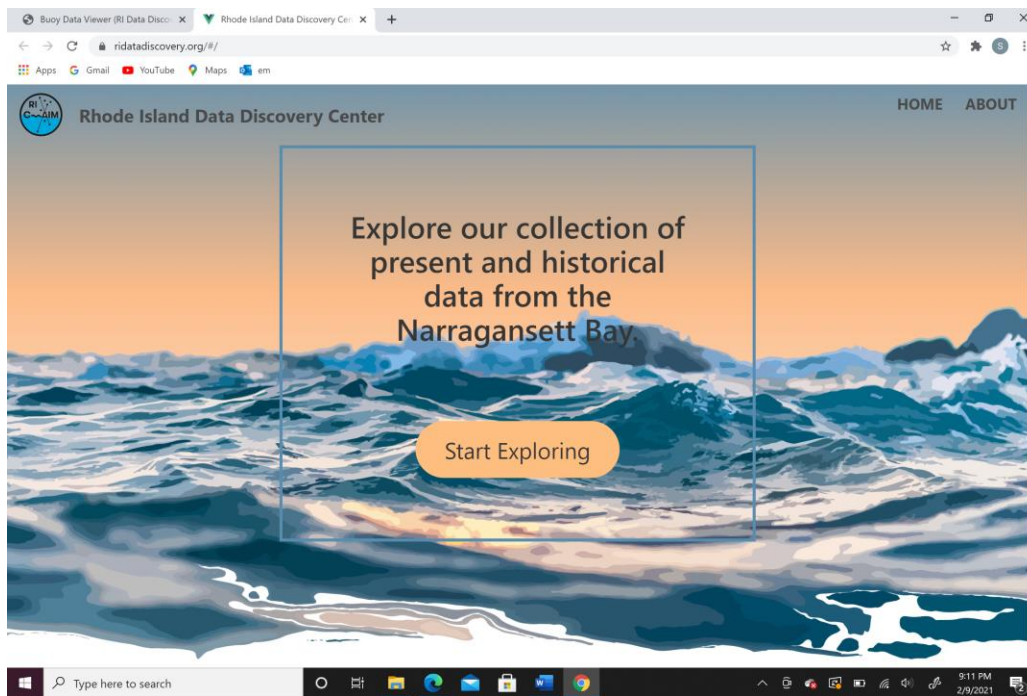


Figure 13. Example of Data Visualization – RI Data Discovery Center

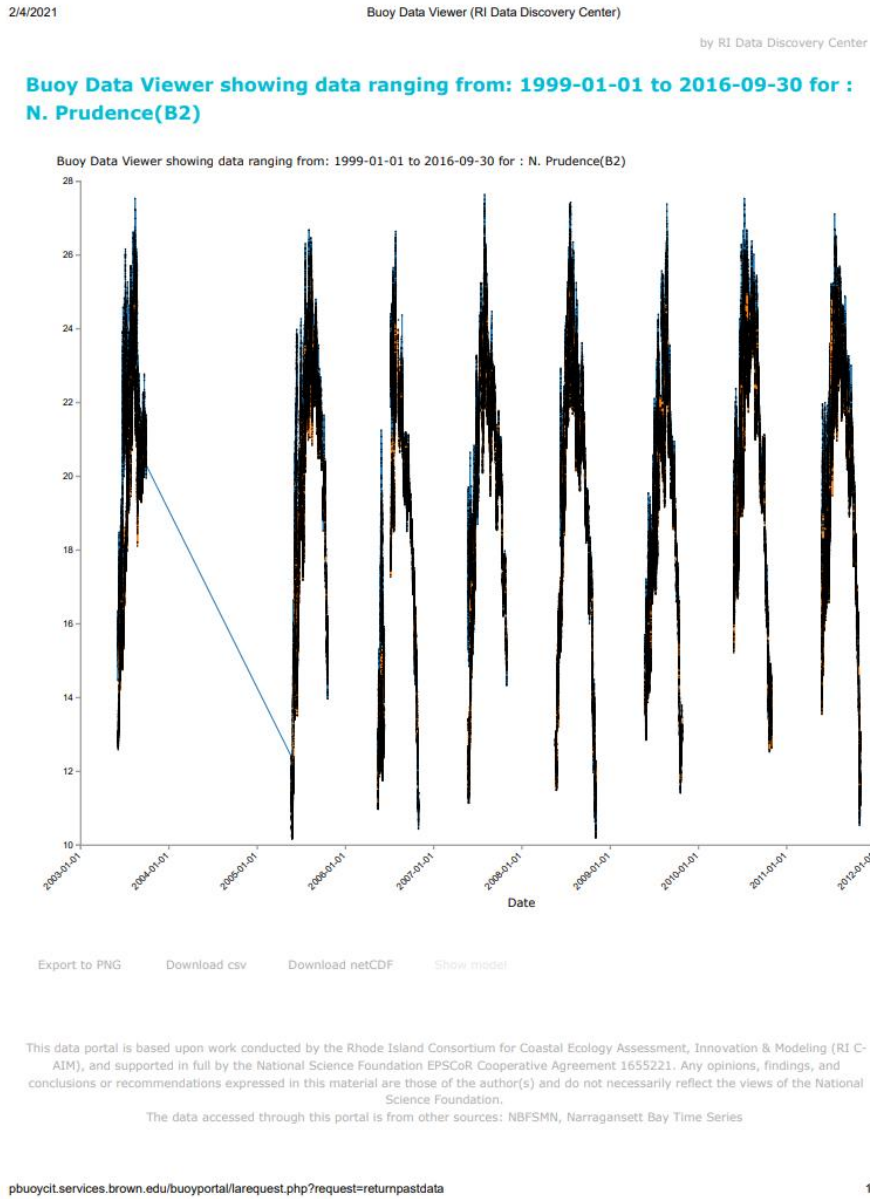


Figure 14. Example of email communication promoting awareness of enhanced access to NBFSMN data

The Rhode Island Department of Environmental Management (RIDEM) and University of Rhode Island Graduate School of Oceanography (URI-GSO) are happy to announce improvements in access real-time data collected via the Narragansett Bay Fixed Site Monitoring Network (NBFSMN). Data for 7 stations operated by URI-GSO under an agreement with RIDEM is now available through the New England Regional Association of Coastal Ocean Observing Systems (NERACOOS) web data portal (<http://www.neracoos.org/erddap/index.html>). Please note this is real-time raw data and has not been reviewed for quality assurance and control. The portal does allow for users to visualize current water quality conditions throughout Narragansett Bay. Users have the capability to download and graphically visualize data based on the user's needs. Users can also make customized visualizations of data based on selected parameters, date ranges, and sites. This real-time data access is designed to improve data distribution and visualization capacity for the user.

As always, all available quality assured data and metadata can be downloaded in annual files from the NBFSMN webpage maintained by the network's lead agency – RIDEM:

<http://www.dem.ri.gov/programs/emergencyresponse/bart/netdata.php> The annual data sets include data from the additional network partners operating monitoring stations – the Narragansett Bay Commission (<http://snapshot.narrabay.com/app>) and Narragansett Bay National Estuarine Research Reserve (<http://cdmo.baruch.sc.edu/pwa/index.html?stationCode=NARTBWQ>). Both these partners also provide additional real-time access to data via their websites.

Improvements to data distribution were made possible by a grant from Restore America's Estuaries (RAE) with funding from the Environmental Protection Agency Southeast New England Program (SNEP) that supported equipment upgrades at several stations in the network. This collaborative effort was also supported by the University of Rhode Island's Graduate School of Oceanography (URI/GSO), RPS group, and URI Coastal Institute.

For further information on access to data, contact Heather Stoffel at stoffel@uri.edu

Figure 15. Newsletter communication

Project Title: Upgrade Monitoring in Narragansett Bay through Narragansett Bay Fixed Site Monitoring Network (NBFSMN)



This project, supported with a 2018 Southeast New England Program grant of \$300,000 awarded to the Rhode Island Department of Environmental Management's Office of Water Resources (RIDEM-OWR), was aimed at addressing critical equipment replacement needs in the Narragansett Bay Fixed-Site Monitoring Network (NBFSMN) and enhancing access to data to expand data access in a timely manner for its various users. RIDEM-OWR improved data access through a data portal agreement with NERACOOS. This agreement allows for near real-time raw data access through <http://www.neracoos.org/erddap/index.html>. The NBFSMN data remain available on RIDEM's website for annual data downloads of all the NBFSMN datasets and metadata, along with weekly water quality reports, at: <http://www.dem.ri.gov/programs/emergencyresponse/bart/stations.php>. The University of Rhode Island's Graduate School of Oceanography is a partner in the NBFSMN and coordinated the project's equipment upgrades under an agreement with RIDEM-OWR.

Read more here...

At RIDEM, tracking bay water conditions to detect declines in dissolved oxygen has been institutionalized as part of response preparedness. While major hypoxic events cannot be prevented, advance warning of a possible event allows both state and municipal personnel to make plans and be prepared to respond quickly and effectively to situations that may occur

such as a major fish kill. When fish kills or other environmental perturbations do occur, or the public reports something unusual (such as, red patchy water as seen in the fall 2015) in Narragansett Bay, real-time access to network data can be analyzed immediately by managers to help understand the potential cause(s) of a particular incident. It aids researchers who are called upon or involved in the response to an event including prioritizing what additional sampling maybe needed. The real-time data is also pertinent to the management response to unplanned releases of untreated wastewater which may occur during severe storm situations or as a result of system breakdowns.

These real-time upgraded systems proved very useful during the summer of 2020. During this year, these stations provided up to date information to help managers assess fish kills in the Providence and Greenwich Bay areas. The real-time system provided current information for managers to report to the public accurate information regarding fish kill events that occurred during summer 2020. In addition, it provided daily updates for researchers to determine where additional monitoring was needed.

Investment in upgrading three stations in the mid to upper bay was critically needed to sustain the network, establish additional real-time data transfer capabilities and improve management’s ability to measure the effectiveness of water pollution control management measures that have significantly reduced nutrient loadings into Narragansett Bay. The SNEP Watershed Grant Program provided the Narragansett Bay with the capabilities to report water quality information to users in a fashion that meets their needs now and, in the years, ahead. The SNEP Watershed Grants are funded by the U.S. Environmental Protection Agency through a collaboration with Restore America’s Estuaries (RAE). For more information on SNEP Watershed Grants, see www.snepgrants.org.



SNEP 2018 Grant Recipient Organization: Rhode Island Department of Environmental Management Office of Water Resources (RIDEM-OWR), 235 Promenade St. Providence, RI 02908

Total Project Cost: \$402,041 Federal Funds: \$300,000 Non-federal Match: \$102,041

Figure 16. Excerpt of Presentation Materials – Annual NERACOOS Meeting – December 2018

Monitoring in Narragansett Bay through Narragansett Bay Fixed Site Monitoring Network (NBFSMN)

NERACOOS Annual Meeting

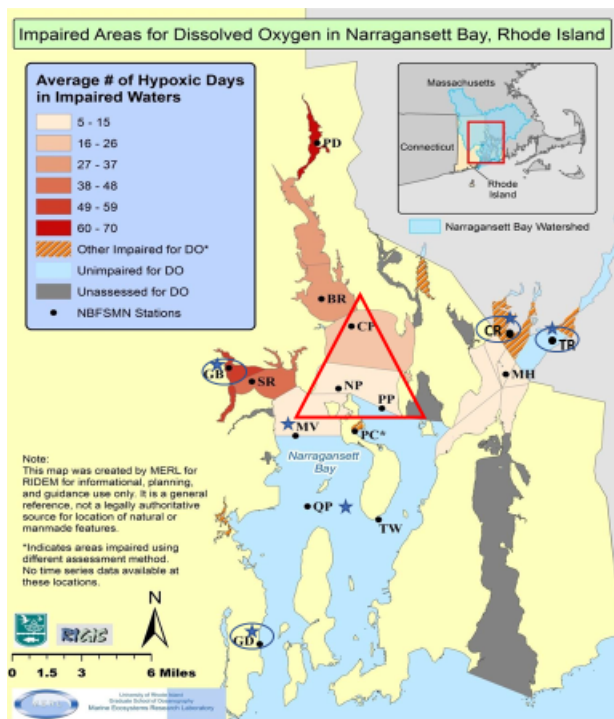
PI: Heather Stoffel and Candace Oviatt
URI/GSO
December 6, 2018

Partners:







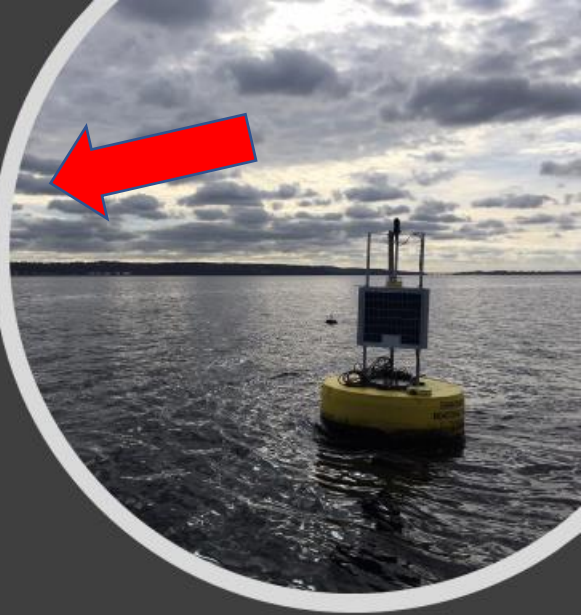
NBFSMN Program Partners Operating Stations in the Network and Providing Data Access: RIDEM-OWR, URI/GSO, Narragansett Bay Commission, NBNERR, MA DEP, NERACOOS.

2018 Operations:
The NBFSMN is a collaborative effort to continuously monitor physical water quality parameters at 14 stations within Narragansett Bay, primarily from May – October, annually.

- ★ Indicate reporting to NERACOOS
- Indicate SUNA nitrate sensors
- **GB also has Cycle Phosphate Sensor
- △ Proposed stations to be upgraded in 2019

Future Plans for NBFSMN Reporting to NERACOOS

- 2019 Field Season-plan to upgrade 3 stations to be reporting to NERACOOS through RIDEM's SNEP grant.
- Nutrient Monitoring- continue monitoring at 4 stations (GB, GD, CR, TR) using NERACOOS and MA DEP funds (2 year agreement).
- Monitoring Protocols- finalize NBFSMN QAPP to include real-time data reporting and SUNA protocols.
- Other-resolve communication issues with phosphate sensor at GB station and SUNA V1 issues at GD.



5. Certification

The undersigned verifies that the descriptions of activities and expenditures in this final report are accurate to the best of my knowledge; and that the activities were conducted in agreement with the grant contract. I also understand that matching fund levels established in the grant contract must be met.

Grantee Signature:

Name: Susan Kiernan

Title: Deputy Administrator, Office of Water Resources

Date: 1-9-2021

Organization: Rhode Island Department of Environmental Management