

**Narragansett Bay (NAR) National Estuarine Research Reserve**

**Water Quality Metadata**

January to December 2016

Last updated: Friday March 16, 2018

# I. Data Set and Research Descriptors

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## 2. Entry Verification

Deployment data are uploaded from the YSI data logger to a Personal Computer (IBM compatible). Files are exported from EcoWatch in a comma-delimited format (.CDF), EcoWatch Lite in a comma separated file (CSV) or KOR Software in an Excel File (.XLS) and uploaded to the CDMO where they undergo automated primary QAQC; automated depth/level corrections for changes in barometric pressure (cDepth or cLevel parameters); and become part of the CDMO’s online provisional database. All pre- and post-deployment data are removed from the file prior to upload. During primary QAQC, data are flagged if they are missing or out of sensor range. The edited file is then returned to the Reserve for secondary QAQC where it is opened in Microsoft Excel and processed using the CDMO’s NERRQAQC Excel macro. The macro inserts station codes, creates metadata worksheets for flagged data and summary statistics, and graphs the data for review. It allows the user to apply QAQC flags and codes to the data, remove any overlapping deployment data, append files, and export the resulting data file for upload to the CDMO. Upload after secondary QAQC results in ingestion into the database as provisional plus data, recalculation of cDepth or cLevel parameters, and finally tertiary QAQC by the CDMO and assimilation into the CDMO’s authoritative online database. Where deployment overlap occurs between files, the data produced by the newly calibrated sonde is generally accepted as being the most accurate. For more information on QAQC flags and codes, see Sections 11 and 12.

Dr. Daisy Durant (Marine Research Specialist II), was responsible for compiling and error checking the January through December 2016 water quality data covered in this document.

## 3. Research Objectives

YSI 6600-V2 and EXO2 data loggers are being deployed off Prudence Island in Narragansett Bay as part of the Narragansett Bay National Estuarine Research Reserve's (NBNERR) System-Wide Monitoring Program (SWMP). The goal is to develop long-term data sets for representative estuarine systems in order to track changes in water quality over time. Because Prudence Island is located in the geographic center of Narragansett Bay, it is an ideal location for monitoring the status and trends in water quality in the Bay over time. One NBNERR water quality monitoring station has been established at Potter Cove since December 1995, on the Island's northeastern shore. This area is impacted by boat traffic and storm runoff from mainland urban and residential areas. The second NBNERR water quality monitoring station, T-Wharf, was established on September 1996 and is situated on the southeastern shore of the island, facing the open waters of Rhode Island Sound. It is approximately 6 miles south of the Potter Cove site. Boat traffic is sparse at this site and storm runoff is less likely to have a significant impact on water quality. A third monitoring site was added in March of 2002. This monitoring site is located in Nag Creek, a salt marsh tidal creek which flows into the West Passage of Narragansett Bay. The addition of this site completes our representation of dominant habitat types occurring in Narragansett Bay (i.e. marsh, cove, and open water). In July of 2002, the T-Wharf monitoring station was replaced with two new monitoring sites located a short distance from the original T-Wharf location. The new stations are situated on either side of a wharf support piling. One data logger records water quality near the surface (approximately 1.0 m deep) while the second records water quality parameters approximately 1.0 m off the bottom. This allows for the identification of both the frequency and duration of any stratification which may occur in the open waters of Narragansett Bay.

## 4. Research Methods

Calibrating procedures

One data logger (also known as sonde) is deployed at each permanent monitoring station at the Reserve on Prudence Island (see map on Section 5). The instruments are deployed for approximately two to four weeks at a time (depending on the season), at the end of which are retrieved and newly calibrated sondes are deployed instead. During these extended deployment, the sondes collect data on water temperature, specific conductance, dissolved oxygen, pH, depth, turbidity conditions, and chlorophyll fluorescence every 15 minutes. Historically, data from all stations were collected at 30-minute sampling intervals. In 2004, the NB NERR became involved with a statewide fixed site water quality monitoring program at which time data collection at all stations were changed to a 15-minute sampling interval in order to be compliant with this local monitoring effort. Two years later, all Reserves within the Reserve System were required also required to collect at 15-minutes sampling intervals.

For each sampling period, each instrument is calibrated against known standards following the methods recommended in the YSI 6-Series Multi-Parameter Water Quality Monitoring Standard Operating Procedure manual and the EXO User Manual-Advanced Water Quality Monitoring Platform. The specific conductivity probe is calibrated using conductivity calibrator 50,000 µS/cm; a three-point calibration is done for pH using pH buffer 4, 7, and 10; a two point calibration (0, 126 with YSI 6600-V2 sonde or 0, 124 with EXO2 sondes) is done for turbidity using deionized water and YSI 6073G turbidity standard; a one-point calibration is done in air-saturated water for dissolved oxygen (DO); and a one-point calibration (0.0) with deionized water is done for chlorophyll fluoresces (data available only upon request). The sonde is programmed to begin taking measurements approximately 10 hours in advance of planned deployment, allowing the DO membrane to stabilize. The file is checked for DO sensor drift before the DO probe is calibrated. Calibration of the dissolved oxygen sensor is usually done within 2 hours of deployment. The V2 and EXO2 sondes have optical DO probes (DO ROX) and membranes are changed annually or when readings become unstable; this sensor can be calibrated at the same time as the other sensors; however, it is usually done within 2 hours of deployment in air-saturated water. At the end of each sampling period, the data loggers are retrieved and freshly calibrated instruments are deployed. The retrieved data loggers are brought back to the laboratory, post-deployment evaluations of the instrument are carried out the same day of retrieval, and the device is cleaned and serviced by methods outlined in the service manuals mentioned above.

During every deployment, sea-truthing is conducted by measuring water quality parameters with an additional data logger taking real-time measurements at the time of deployment. This information is used to compare with the data collected by the sonde to ensure accuracy of the readings. The data is recorded using a hand-held YSI 556-MPS data logger. Values for temperature, specific conductance (and salinity), dissolved oxygen (% saturation and mg/L), and pH are recorded real-time at either 0.5 or 1.0 meter intervals between the surface and bottom at each deployment site. The calibration procedure for the YSI 556 used in sea-truthing follows the same general procedure as that for the sondes used for extended deployments. The YSI 556 specific conductivity and pH sensors are calibrated the day before a planned deployment; dissolved oxygen is calibrated the day of deployment in air-saturated water. Data and calibrating logs for the YSI 556 data logger are kept at the Reserve and available upon request.

Site Infrastructure

The monitoring station at Potter Cove was originally constructed in 1995, and it consisted of a PVC pipe mounted vertically on a piling located approximately 6 feet west of a floating dock. To facilitate water flow across the sensors, openings were cut into the PVC pipes. The pipes were positioned to ensure that the sensors were less than 1 meter from the bottom. In 2006, the infrastructure at Potter Cove was replaced. It currently consists of a short PVC tube attached to an adjacent dock, with a line attached through the pipe to an anchor on the bottom. The sonde is attached to the anchor via a shackle and hook set-up, and a float is attached to the top of the sonde to keep it approximately 0.75 m off the bottom. With this setup, the sonde is free and clear of any pipe affects since the pipe does not extend to the bottom and serves only as a “decoy pipe” to prevent vandalism.

In 1996, the original T-Wharf station was put into service using a PVC pipe mounted on a piling attached to the wharf. In 2002, the two replacement T-Wharf sites (Surface and Bottom) were also deployed in PVC pipes mounted to a piling. The sonde at the T-Wharf Surface station was maintained just below the surface by means of a buoy attached by rope to the adjacent wharf; the sonde at T-Wharf Bottom was maintained approximately 0.5 m off the bottom. On 10/11/06, the PVC deployment pipes and securing structures were replaced. The design was similar to the previous pipe design (following YSI recommendations) and consisted of holes drilled through the pipe and large slits at the bottom of the pipe to allow for free water movement at the sonde. The T-Wharf Bottom pipe extends approximately 6 m though the water to the bottom of the site, where the sonde is kept approximately 1.0 m off the bottom. The T-Wharf Surface pipe extends approximately 2 m under the surface of the water (at low tide), where the sonde was attached to a float to keep it approximately 0.5 m below the surface of the water. After Tropical Storm Irene in August of 2011, the deploying structure was damaged; the PVC pipe was lost and the piling where it was attached to was damaged beyond repair. A temporary deploying structure was build consisting of a steel cable attached to the wharf with an anchor at the end to keep the cable straight and in place. The Surface and Bottom sondes were attached to the cable for each deployment and lowered into the water with a security line. The Reserve made the arrangements to build a permanent deploying structure; a new piling was installed on February 2012, two 4” diameter PVC pipes were installed in June (following YSI recommendations), and the sondes were deployed in July in these new structures. The Surface sonde was deployed attached to a float to be approximately 1.0 m below the surface at low tide, and the Bottom sonde 1.0 m above the bottom substrate. Due to the narrow PVC pipes, the Surface sonde was getting jammed inside and not floating free; thus, the deployment was changed to a fixed one at approximately 0.5 m at low tide. As standard procedure, the pipes have been cleaned monthly with a chimney brush as needed but mostly during the warm months (April to November) to reduce the impact of biofouling on the data.

The Nag Creek sonde was originally deployed in a metal cage which was tethered to the bank. A permanent deployment structure was installed 12/31/02, consisting of a 4” x 4” pressure-treated post with a hinged 2” x 4” horizontal arm. On 09/08/06, the sonde deployment structure was redesigned and changed. The new structure consists of an L-shape wooden structure that held in place in the sediment by a large metal tripod sunk into the mud. The sonde is extended from the arm into the water via a cleat, eye and line system and hangs approximately 0.30 m off the bottom of the creek. In 2012, the deployment structure was changed for a wooden tripod sunken into the mud which facilitated its removal in the winter when the low temperatures freeze up the creek.

Real-time data transmission

A Sutron Sat-Link2 transmitter was installed at the T-Wharf Bottom monitoring station on 07/27/06 and transmits data to the NOAA GOES satellite, NESDIS ID #3B0335EE. The transmissions are scheduled hourly and contain four (4) data sets reflecting fifteen minute data sampling intervals. Upon receipt by the CDMO, the data undergoes the same automated primary QAQC process detailed in Section 2 above. The “real-time” telemetry data become part of the provisional dataset until undergoing secondary and tertiary QAQC and assimilation in the CDMO’s authoritative online database. Provisional and authoritative data are available at [http://cdmo.baruch.sc.edu](http://cdmo.baruch.sc.edu/).

## 5. Site Location and Character

The NBNERR is located close to the geographic center of Narragansett Bay in Rhode Island. It consists of approximately 1802 hectares (4453 acres: 2544 acres of land plus 1909 acres of surrounding estuarine waters, approximately) of diverse estuarine and terrestrial habitats ranging from deep water to salt marshes to forested uplands. The land holdings include approximately 65% of Prudence Island, most of nearby Patience Island, and all of Hope and Dyer Islands (see map below). The most recent land acquisition was the Eugene Chase Farm property, made official by the end of year 2015.

The Narragansett Bay watershed consists of nine subwatersheds draining an area of approximately 4,836square km [[1]](#footnote-2)(Pilson, 1985) and numerous and substantial freshwater inputs to the Bay. Approximately 39% of the watershed lies in Rhode Island and 61% in Massachusetts. It is referred to as a shallow estuary; however, its water depth varies considerably. Depth averages approximately 9.0 m throughout the Bay, but it’s deeper in the East Passage (approximately 15.2 m) and shallower in the West Passage (approximately 7.5 m). More information and a detailed description of the Narragansett Bay NERR and the Narragansett Bay watershed can be found in [[2]](#footnote-3)Raposa and Schwartz, available at <http://nbnerr.org/research-and-monitoring/publications>.

Specific characteristics of the Narragansett Bay National Estuarine Research Reserve

Location: 41°38’ 30” N, 71°20’30” W

Tidal range: -0.2 to 1.7 meters MLW

Salinity: 15 to 32 ppt

Temperature: -1.0 to 26 C

Province: North temperate, Virginian bioregion

Specific characteristics of the Nag Creek site are:

Location: 41° 37’ 29.458” N, 71° 19’ 27.421” W

Depth: 0.1 to 1.4 meters

Bottom habitat: Organic mud

Pollutants: Negligible

Watershed: Narragansett Bay, West Passage

Specific characteristics of the Potter Cove site are:

Location: 41° 38’ 25.984” N, 71° 20’ 27.165” W

Depth: 0.9 to 3.9 meters

Bottom habitat: Sand, silt, some organic mud

Pollutants: Boaters’ wastes, storm runoff from mainland urban areas

Watershed: Narragansett Bay, North Prudence (4801 km2)

Specific characteristics of the T-Wharf Surface site are:

Location: 41° 34’ 42.099” N, 71° 19’ 16.049” W

Depth: 0.2 to 0.9 meters

Bottom habitat: Sand, silt, some organic mud

Pollutants: Negligible

Watershed: Narragansett Bay, South Prudence

Specific characteristics of the T-Wharf Bottom site are:

Location: 41° 34’ 42.099” N, 71° 19’ 16.049” W

Depth: 4.6 to 6.9 meters

Bottom habitat: Sand, silt, some organic mud

Pollutants: Negligible

Watershed: Narragansett Bay, South Prudence

SWMP Station Timeline

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Station Code** | **SWMP Status** | **Station Name** | **Location** | **Active Dates** | **Reason Decommissioned** | **Notes** |
| narncwq | P | Nag Creek | 41° 37' 29.46 N  71° 19' 27.42 W | 03/01/02 00:00 | NA | NA |
| narpcwq | P | Potter Cove | 41° 38' 25.98 N  71° 20' 27.17 W | 12/01/95 00:00 | NA | NA |
| nartbwq | P | T-Wharf Bottom | 41° 34' 42.10 N  71° 19' 16.05 W | 07/01/02 00:00 | NA | NA |
| nartswq | P | T-Wharf Surface | 41° 34' 42.10 N  71° 19' 16.05 W | 07/01/02 00:00 | NA | NA |
| nartwwq | P | T-Wharf | 41° 34' 45.18 N  71° 19' 17.10 W | 09/01/1996 00:00 - 07/01/2002 00:00 | This location was in line with a summertime pycnocline. | It was decided to move the station further out and established T-Wharf Surface and T-Wharf Bottom to examine patterns of water column stratification. |

Note:

SWMP Status Column: P = primary SWMP station

## 6. Data collection period

Date and time of the first and last readings included in each data file downloaded from the sondes deployed at each of the four water quality stations on Prudence Island are shown below for 2016.

Nag Creek (Data collection ongoing since 2002).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Deploy Date | Deploy Time | Retrieve Date | Retrieve Time | EXO 2 Sonde Serial Number |
| **1** 12/15/2015 | 10:00 | 01/08/16 | 10:30 | 14A101167 |
| **2** 04/20/16 | 10:30 | 05/05/16 | 09:15 | 14A101167 |
| 05/04/16 | 09:30 | 05/25/16 | 09:15 | 14A101166 |
| 05/25/16 | 09:45 | 06/15/16 | 08:45 | 14A101167 |
| 06/15/16 | 09:00 | 07/12/16 | 09:45 | 14A101166 |
| 07/12/16 | 10:00 | 08/02/16 | 09:00 | 14A101167 |
| 08/02/16 | 09:30 | 08/31/16 | 08:00 | 14A101166 |
| 08/31/16 | 08:15 | 09/20/16 | 08:45 | 14A101167 |
| 09/20/16 | 09:00 | 10/18/16 | 09:30 | 14A101166 |
| 10/18/16 | 09:45 | 11/08/16 | 11:00 | 14A101167 |
| 11/08/16 | 11:15 | 12/06/16 | 09:45 | 14A101166 |
| 12/06/16 | 10:00 | 12/09/16 | 11:00 | 14A101167 |
| **3** 12/20/16 | 11:45 | 01/17/17 | 11:30 | 14A101166 |

Notes

**1** This deployment started on 12/15/2015 10:00, but only data from 2016 are included in this metadata document and corresponding 2016 dataset file.

**2** Nag Creek was not deployed during January to mid-April because the creek was frozen.

**3** Even though this deployment extends until 01/17/17 11:30, the data included in this metadata document and corresponding 2016 dataset file, is only until 12/31/16 23:45.

Potter Cove (Data collection ongoing since 1995).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Deploy Date | Deploy Time | Retrieve Date | Retrieve Time | EXO 2 Sonde  Serial Number |
| **1** 12/15/15 | 10:30 | 01/08/16 | 11:00 | 14A101164 |
| 01/08/16 | 11:15 | 02/02/16 | 12:00 | 14A101165 |
| 02/02/16 | 12:15 | 03/01/16 | 12:00 | 14A101164 |
| 03/01/16 | 12:30 | 04/06/16 | 11:45 | 14A101165 |
| 04/06/16 | 12:00 | 05/04/16 | 09:45 | 14A101164 |
| 05/04/16 | 10:15 | 05/25/16 | 10:15 | 14A101165 |
| 05/25/16 | 10:30 | 06/15/16 | 09:15 | 14A101164 |
| 06/15/16 | 09:45 | 07/12/16 | 09:00 | 14A101165 |
| 07/12/16 | 09:15 | 08/02/16 | 08:30 | 14A101164 |
| 08/02/16 | 09:00 | 08/31/16 | 07:15 | 14A101165 |
| 08/31/16 | 07:30 | 09/20/16 | 09:15 | 14A101164 |
| 09/20/16 | 09:30 | 10/18/16 | 08:30 | 14A101165 |
| 10/18/16 | 08:45 | 11/08/16 | 10:15 | 14A101164 |
| 11/08/16 | 10:30 | 12/06/16 | 10:15 | 14A101165 |
| 12/06/16 | 10:30 | 12/20/16 | 11:45 | 14A101164 |
| **2** 12/20/16 | 12:15 | 01/17/17 | 11:45 | 14A101165 |

Notes

**1** This deployment started on 12/15/2015 10:30, but only data from 2016 are included in this metadata document and corresponding 2016 dataset file.

**2** Even though this deployment extends until 01/17/17 11:45, the data included in this metadata document and corresponding 2016 dataset file, is only until 12/31/16 23:45.

T-Wharf Surface (Data collection ongoing since 2002).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Deploy Date | Deploy Time | Retrieve Date | Retrieve Time | Sonde Model Number  and Serial Number |
| **1** 12/17/15 | 11:00 | 01/06/16 | 09:45 | 6600V2 01E0876AB |
| 01/06/16 | 10:15 | 02/02/16 | 10:30 | 6600V2 01E0566AA |
| 02/02/16 | 11:00 | 03/01/16 | 10:45 | 6600V2 01E0876AB |
| 03/01/16 | 11:00 | 04/06/16 | 10:00 | 6600V2 01E0566AA |
| 04/06/16 | 10:15 | 05/05/16 | 07:45 | 6600V2 01E0876AB |
| 05/05/16 | 08:00 | 05/24/16 | 09:15 | 6600V2 01E0566AA |
| 05/24/16 | 09:45 | 06/16/16 | 09:00 | 6600V2 01E0876AB |
| 06/16/16 | 09:30 | 07/13/16 | 07:15 | 6600V2 01E0566AA |
| **2** 07/13/16 | 07:45 | 07/16/16 | 08:45 | 6600V2 01E0876AB |
| 08/10/16 | 10:00 | 08/30/16 | 09:00 | 6600V2 01E0566AA |
| 08/30/16 | 09:15 | 09/13/16 | 07:00 | 6600V2 01E0876AB |
| 09/13/16 | 07:30 | 10/12/16 | 07:15 | 6600V2 01E0566AA |
| 10/12/16 | 07:45 | 11/08/16 | 09:30 | 6600V2 01E0876AB |
| **3** 11/08/16 | 10:00 | 12/07/16 | 09:30 | EXO2 16J102354 |
| **4** 12/07/16 | 10:00 | 12/09/16 | 00:45 | EXO2 16J102353 |
| **5** 12/14/16 | 15:15 | 12/20/16 | 10:30 | EXO2 16J102353 |
| **6** 12/20/16 | 10:45 | 01/17/17 | 10:15 | EXO2 16J102354 |

Notes

**1** This deployment started on 12/17/2015 11:00, but only data from 2016 are included in this metadata document and corresponding 2016 dataset file.

**2**Batteries exploded in the battery chamber shortly after deployment; it was noticed at the lab on 08/10, which was the day the sonde has been scheduled to be retrieved.

**3**The NERRS purchased two new EXO2 sondes, which were deployed at T-Wharf Surface on 11/08, replacing the 6600V2 sondes that we use to deploy at the site.

**4** The batteries on this sonde failed and had stopped the program. We replaced the batteries in the field on 12/14 10:45 and restarted the program again.

**5** The EXO2 sonde created a separate file when the batteries were replaced on 12/14. However this data is part of the 12/07/16 deployment.

**6** Even though this deployment extends until 01/17/17 10:15, the data included in this metadata document and corresponding 2016 dataset file, is only until 12/31/16 23:45.

T-Wharf Bottom (Data collection ongoing since 2002).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Deploy Date | Deploy Time | Retrieve Date | Retrieve Time | 6600V2 Sonde  Serial Number |
| **1** 12/17/15 | 11:15 | 01/06/16 | 10:00 | 06C1207AA |
| 01/06/16 | 10:30 | 02/02/16 | 10:45 | 00F0937AB |
| 02/02/16 | 11:15 | 03/01/16 | 10:45 | 06C1207AA |
| 03/01/16 | 11:45 | 04/06/16 | 10:00 | 00F0937AB |
| 04/06/16 | 10:45 | 05/05/16 | 08:00 | 06C1207AA |
| 05/05/16 | 08:30 | 05/24/16 | 09:30 | 05E1065AE |
| 05/24/16 | 10:15 | 06/16/16 | 09:15 | 06C1207AA |
| 06/16/16 | 09:45 | 07/13/16 | 07:30 | 05E1065AE |
| 07/13/16 | 08:00 | 08/10/16 | 07:15 | 06C1207AA |
| 08/10/16 | 09:30 | 08/30/16 | 09:00 | 05E1065AE |
| 08/30/16 | 09:30 | 09/13/16 | 07:15 | 06C1207AA |
| 09/13/16 | 07:45 | 10/12/16 | 07:30 | 05E1065AE |
| 10/12/16 | 08:00 | 11/08/16 | 09:45 | 06C1207AA |
| 11/08/16 | 10:15 | 12/07/16 | 09:45 | 05E1065AE |
| 12/07/16 | 10:15 | 12/28/16 | 10:45 | 06C1207AA |
| **2** 12/28/16 | 11:15 | 01/17/17 | 10:30 | 05E1065AE |

Notes

**1** This deployment started on 12/17/2015 11:15, but only data from 2016 are included in this metadata document and corresponding 2016 dataset file.

**2** Even though this deployment extends until 01/17/17 10:30, the data included in this metadata document and corresponding 2016 dataset file, is only until 12/31/16 23:45.

## 7. Distribution

According to the Ocean and Coastal Resource Management Data Dissemination Policy for the NERRS System-wide Monitoring Program,

NOAA retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data. The NERRS retains the right to be fully credited for having collected and process the data. Following academic courtesy standards, the NERR site where the data were collected should be contacted and fully acknowledged in any subsequent publications in which any part of the data are used. The data set enclosed within this package/transmission is only as good as the quality assurance and quality control procedures outlined by the enclosed metadata reporting statement. The user bears all responsibility for its subsequent use/misuse in any further analyses or comparisons. The Federal government does not assume liability to the Recipient or third persons, nor will the Federal government reimburse or indemnify the Recipient for its liability due to any losses resulting in any way from the use of this data.

Requested citation format:

NOAA National Estuarine Research Reserve System (NERRS). System-wide Monitoring Program. Data accessed from the NOAA NERRS Centralized Data Management Office website: <http://www.nerrsdata.org/>; *accessed* 12 October 2012.

NERR water quality data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Principal Investigators and Contact Persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information link on the CDMO home page) and online at the CDMO home page [www.nerrsdata.org](http://www.nerrsdata.org). Data are available in comma delimited format.

## 8. Associated researchers and projects

Complementary to the existing long-term water quality monitoring program, the NERRS implemented a new nutrient and chlorophyll monitoring program in 2002. The two sub-components of this program include monthly grab sampling at each of the four water quality stations, and diel sampling once a month at one site. The grab sampling program requires the collection of duplicate water samples every month from each of the four long-term water quality monitoring stations with the purpose of quantify seasonal patterns of nutrient and chlorophyll concentrations in different estuarine habitats (marsh creek, cove, surface open water, bottom open water).

The diel sampling program requires to collect a series of samples from one station over an approximately 24-hour period each month to examine how nutrient and chlorophyll concentrations change over diel and tidal cycles. Previously (from 2002 to 2010) the diel station was located at T-Wharf. However, after analyzing the historic data from the site, no significant trends or patterns were found over time. Therefore, the diel station was moved to Potter Cove in January of 2011 in order to characterize nutrients and chlorophyll from this site. All collected grab and diel samples are analyzed for concentrations of phosphates (PO4), ammonia (NH4), nitrite (NO2), nitrate (NO3), NO2+NO3, dissolved inorganic nitrogen (DIN), silicates (SiO4) and chlorophyll *a*.

Reserve staff setting the ISCO at

Potter Cove.

Grab sampling done by Reserve staff.

Since 2001, meteorological data has been collected as part of the SWMP at the weather station (see image below) located on Prudence Island, approximately 389 m south of Potter Cove (41o 38’ 13.703” N, 71o 20’ 21.790” W, Trimble Geo XT, GeoExplorer 2008 Series; see map on section 5, Site Location and Character). Data on air temperature, relative humidity, barometric pressure, wind speed and direction, photosynthetic active radiation, and precipitation are collected. Meteorological data is continually used to complement the water quality, biological monitoring and scientific research efforts at the Reserve, as well as to assist stewardship, training, and educational activities around the Bay.

All this information is available to any interested party through the CDMO [www.nerrsdata.org](http://www.nerrsdata.org), NBNERR <http://nbnerr.org/>, or directly contacting the Research Coordinator or the Marine Research Specialist II.

Weather station on Prudence Island.

In 2004, the NBNERR became involved in the Bay Window Monitoring Program (BWMP). The BWMP housed several programs under different state and federal agencies to study Narragansett Bay’s fish and fisheries, sediment pollution, currents, and hydrography. Even though Bay Window ended in 2010, some programs where able to keep their monitoring with other funding source. Currently, NBNERR continues to be an essential part of the original network of fixed-sites recording water quality data in the Bay (the Bay Assessment and Response Team -BART, <http://www.dem.ri.gov/bart/latest.htm>) under the Rhode Island Department of Environmental Management (RIDEM). NBNERRs’ unique contribution consists of collecting year-around high frequency water quality data since it is the only fix site within the network deploying sondes during the winter months.

Dr. Candace Oviatt at URI-GSO is using NAR NERR chlorophyll data to track the timing and magnitude of winter/spring blooms in Narragansett Bay.

Mrs. Heather Stoffel et al. at URI-GSO compiles NAR NERR dissolved oxygen data from T-Wharf Surface, T-Wharf Bottom stations together with data from the Bay Assessment and Response Team (BART, <http://www.dem.ri.gov/bart/latest.htm>) to study hypoxia in the Bay. The peer reviewed article is listed below:

Codiga, D. L., H. E. Stoffel, C. F. Deacutis, S. Kiernan, and C. A. Oviatt. 2009. Narragansett Bay Hypoxic Event Characteristics Based on Fixed-Site Monitoring Network Time Series: Intermittency, Geographic Distribution, Spatial Synchronicity, and Interannual Variability. Estuaries and Coasts 32: 621-641. Available at <http://www.gso.uri.edu/merl/merl_pdfs/Codiga_etal_2009.pdf>.

# II. Physical Structure Descriptors

## 9. Sensor specifications

In 2016, NAR NERR deployed 6600V2 and EXO2 data loggers from January through December. EXO2 sondes were deployed exclusively at Nag Creek and Potter Cove during this period. However, at Nag Creek, no sondes were deployed from January 8th to April 20th because the creek was frozen. At T-Wharf Bottom, YSI 6600V2 sondes were deployed during this period. At T-Wharf Surface. YSI 6600 V2 were deployed from January to October after which an upgrade to EXO2 sondes was made and were deployed at this site in November and December. All the sondes deployed at all sites were equipped with optical DO ROX probes.

YSI 6600 V2 data sonde configurations

Parameter: **Temperature**

Units: Celsius - oC

Sensor Type: Thermistor

Model #: 6560

Range: -5 to 50 °C

Accuracy: ± 0.15 °C

Resolution: 0.01 °C

Parameter: **Conductivity**

Units: milli-Siemens per cm (mS/cm)

Sensor Type: 4-electrode cell with autoranging

Model #: 6560

Range: 0 to 100 mS/cm

Accuracy: ± 0.5% of reading + 0.001 mS/cm

Resolution: 0.001 mS/cm to 0.1 mS/cm (range dependent)

Parameter: **Salinity**

Units: Parts per thousand (ppt)

Sensor Type: Calculated from conductivity and temperature

Range: 0 to 70 ppt

Accuracy: ± 1.0% of reading or 0.1 ppt, whichever is greater

Resolution: 0.01 ppt

Sensor Type: **Dissolved Oxygen**

Units: Percent saturation

Model #: 6150 ROX optical probe with mechanical cleaning

Range: 0 to 500% air saturation

Accuracy: 0-200% air saturation: ± 1% of the reading or 1% air saturation, whichever is

greater; 200 500% air saturation: ± 15% of reading

Resolution: 0.1% air saturation

Sensor Type: Dissolved Oxygen

Units: milligrams per Liter (mg/L)

Model #: 6150 ROX

Range: 0 to 50 mg/L

Accuracy: 0 - 20 mg/L: ± 0.1% mg/L or 1% of the reading, whichever is greater; 20 to 50

mg/L: ± 15% of the reading

Resolution: 0.01 mg/L

Parameter: Non-Vented Level – Shallow (Depth)

Units: meters (m)

Sensor Type: Stainless steel strain gauge

Range: 0 to 30 ft. (9.1 m)

Accuracy: ± 0.06 ft. (0.018 m)

Resolution: 0.001 ft. (0.001 m)

Parameter: **pH** (bulb probe)

Units: pH units

Sensor Type: Glass combination electrode

Model #: 6561

Range: 0 to 14 units

Accuracy: ± 0.2 units

Resolution: 0.01 units

Parameter: **Turbidity**

Units: Nephelometric turbidity units (NTU)

Sensor Type: Optical, 90° scatter, with mechanical cleaning

Model #: 6136

Range: 0 to 1000 NTU

Accuracy: ± 2 % reading or 0.3 NTU (whichever is greater)

Resolution: 0.1 NTU

Parameter: **Chlorophyll Fluorescence**

Units: micrograms/Liter

Sensor Type: Optical probe with mechanical cleaning

Model#: 6025

Range: 0 to 400 µg/Liter

Accuracy: Dependent on methodology

Resolution: 0.1 µg /L chl *a*, 0.1% FS

YSI EXO2 data sondes configuration

Parameter: **Temperature**

Units: Celsius (C)

Sensor Type: Thermistor

Model#: 599870-01

Range: -5 to 50 C

Accuracy: -5 to -35: ± 0.01, -35 to -50: ± .005

Resolution: 0.01 C

Parameter: **Conductivity**

Units: milli-Siemens per cm (mS/cm)

Sensor Type: 4-electrode cell with autoranging

Model#: 599870-01

Range: 0 to 200 mS/cm

Accuracy: 0 to 100: ± 0.5% of reading or 0.001 mS/cm; 100 to 200: ± 1% of reading

Resolution: 0.001 mS/cm to 0.1 mS/cm (range dependent)

Parameter: **Salinity**

Units: practical salinity units (psu)/parts per thousand (ppt)

Sensor Type: Calculated from conductivity and temperature

Range: 0 to 70 psu

Accuracy: ± 1.0% of reading pr 0.1 ppt, whichever is greater

Resolution: 0.01 psu

Parameter: **Dissolved Oxygen**

Units: Percent saturation

Sensor Type: Optical probe w/ mechanical cleaning

Model#: 599100-01

Range: 0 to 500% air saturation

Accuracy: 0-200% air saturation: ± 1% of the reading or 1% air saturation, whichever is

greater 200-500% air saturation: ± 5% or reading

Resolution: 0.1% air saturation

Parameter: Dissolved Oxygen(Calculated from % air saturation, temperature, and salinity)

Units: milligrams/Liter (mg/L)

Sensor Type: Optical probe w/ mechanical cleaning

Model#: 599100-01

Range: 0 to 50 mg/L

Accuracy: 0-20 mg/L: ± 0.1 mg/l or 1% of the reading, whichever is greater 20 to 50 mg/L:

± 5% of the reading

Resolution: 0.01 mg/L

Parameter: **Non-vented Level - Shallow (Depth)**

Units: feet or meters (ft. or m)

Sensor Type: Stainless steel strain gauge

Range: 0 to 33 ft. (10 m)

Accuracy: ± 0.013 ft. (0.04 m)

Resolution: 0.001 ft. (0.001 m)

Parameter: **pH**

Units: pH units

Sensor Type: Glass combination electrode

Model#: 599701(guarded) or 599702(wiped)

Range: 0 to 14 units

Accuracy: ± 0.01 units within ± 10° of calibration temperature, ± 0.02 units for entire

temperature range

Resolution: 0.01 units

Parameter: **Turbidity**

Units: formazin nephelometric units (FNU)

Sensor Type: Optical, 90-degree scatter

Model#: 599101-01

Range: 0 to 4000 FNU

Accuracy: 0 to 999 FNU: 0.3 FNU or ± 2% of reading (whichever is greater); 1000 to 4000 FNU

± 5% of reading

Resolution: 0 to 999 FNU: 0.01 FNU, 1000 to 4000 FNU: 0.1 FNU

Parameter: **Chlorophyll Fluorescence**

Units: micrograms/Liter

Sensor Type: Optical probe

Model#: 599102-01

Range: 0 to 400 µg/Liter

Accuracy: Dependent on methodology

Resolution: 0.1 µg/L chl *a*, 0.1% FS

### Depth Qualifier:

The NERR System-Wide Monitoring Program utilizes YSI data sondes that can be equipped with either vented or non-vented depth/level sensors. Readings for both vented and non-vented sensors are automatically compensated for water density change due to variations in temperature and salinity; but for all non-vented depth measurements, changes in atmospheric pressure between calibrations appear as changes in water depth. The error is equal to approximately 1.02 cm for every 1 millibar change in atmospheric pressure, and is eliminated for vented sensors because they are vented to the atmosphere throughout the deployment time interval.

Beginning in 2006, NERR SWMP standard calibration protocol calls for all non-vented depth sensors to read 0 meters at a (local) barometric pressure of 1013.25 mb (760 mm/hg). To achieve this, each site calibrates their depth sensor with a depth offset number, which is calculated using the actual atmospheric pressure at the time of calibration and the equation provided in the SWMP calibration sheet or digital calibration log. This offset procedure standardizes each depth calibration for the entire NERR System.  If accurate atmospheric pressure data are available, non-vented sensor depth measurements at any NERR can be corrected.

In 2010, the CDMO began automatically correcting depth/level data for changes in barometric pressure as measured by the Reserve’s associated meteorological station during data ingestion. These corrected depth/level data are reported as cDepth and cLevel, and are assigned QAQC flags and codes based on QAQC protocols. Please see sections 11 and 12 for QAQC flag and code definitions.

**NOTE: older depth data cannot be corrected without verifying that the depth offset was in place and whether a vented or non-vented depth sensor was in use. No SWMP data prior to 2006 can be corrected using this method.** The following equation is used for corrected depth/level data provided by the CDMO beginning in 2010:

((1013-BP)\*0.0102)+Depth/Level = cDepth/cLevel.

### Salinity Units Qualifier:

In 2013, EXO sondes were approved for SWMP use and began to be utilized by Reserves. While the 6600 series sondes report salinity in parts per thousand (ppt) units, the EXO sondes report practical salinity units (psu). These units are essentially the same and for SWMP purposes are understood to be equivalent, however psu is considered the more appropriate designation. Moving forward the NERR System will assign psu salinity units for all data regardless of sonde type.

### Turbidity Qualifier:

In 2013, EXO sondes were approved for SWMP use and began to be utilized by Reserves. While the 6600 series sondes report turbidity in nephelometric turbidity units (NTU), the EXO sondes use formazin nephelometric units (FNU). These units are essentially the same but indicate a difference in sensor methodology, for SWMP purposes they will be considered equivalent. Moving forward, the NERR System will use FNU/NTU as the designated units for all turbidity data regardless of sonde type. If turbidity units and sensor methodology are of concern, please see the Sensor Specifications portion of the metadata.

### ****Chlorophyll Fluorescence Disclaimer:****

YSI chlorophyll sensors (6025 or 599102-01) are designed to serve as a proxy for chlorophyll concentrations in the field for monitoring applications and complement traditional lab extraction methods; therefore, there are accuracy limitations associated with the data that are detailed in the YSI manual including interference from other fluorescent species, differences in calibration method, and effects of cell structure, particle size, organism type, temperature, and light on sensor measurements.

## 10. Coded variable definitions

|  |  |  |
| --- | --- | --- |
| Water Quality Sampling station | Sampling site code | Station code |
| Nag Creek | NC | narncwq |
| Potter Cove | PC | narpcwq |
| T-Wharf Surface | TS | nartswq |
| T-Wharf Bottom | TB | nartbwq |

## 11. QAQC flag definitions

QAQC flags provide documentation of the data and are applied to individual data points by insertion into the parameter’s associated flag column (header preceded by an F\_). During primary automated QAQC (performed by the CDMO), -5, -4, and -2 flags are applied automatically to indicate data that is missing and above or below sensor range. All remaining data are then flagged 0, passing initial QAQC checks. During secondary and tertiary QAQC 1, -3, and 5 flags may be used to note data as suspect, rejected due to QAQC, or corrected.

|  |  |
| --- | --- |
| Flag | Description |
| -5 | Outside High Sensor Range |
| -4 | Outside Low Sensor Range |
| -3 | Data Rejected due to QAQC |
| -2 | Missing Data |
| -1 | Optional SWMP Supported Parameter |
| 0 | Data Passed Initial QAQC Checks |
| 1 | Suspect Data |
| 2 | Open - reserved for later flag |
| 3 | Calculated data: non-vented depth/level sensor correction for changes in barometric pressure |
| 4 | Historical Data: Pre-Auto QAQC |
| 5 | Corrected Data |

## 12. QAQC code definitions

QAQC codes are used in conjunction with QAQC flags to provide further documentation of the data and are also applied by insertion into the associated flag column. There are three (3) different code categories, general, sensor, and comment. General errors document general problems with the deployment or YSI datasonde, sensor errors are sensor specific, and comment codes are used to further document conditions or a problem with the data. Only one general or sensor error and one comment code can be applied to a particular data point, but some comment codes (marked with an \* below) can be applied to the entire record in the F\_Record column.

General Errors

GIC No instrument deployed due to ice

GIM Instrument malfunction

GIT Instrument recording error; recovered telemetry data

GMC No instrument deployed due to maintenance/calibration

GNF Deployment tube clogged / no flow

GOW Out of water event

GPF Power failure / low battery

GQR Data rejected due to QA/QC checks

GSM See metadata

Corrected Depth/Level Data Codes

GCC Calculated with data that were corrected during QA/QC

GCM Calculated value could not be determined due to missing data

GCR Calculated value could not be determined due to rejected data

GCS Calculated value suspect due to questionable data

GCU Calculated value could not be determined due to unavailable data

Sensor Errors

SBO Blocked optic

SCF Conductivity sensor failure

SCS Chlorophyll spike

SDF Depth port frozen

SDG Suspect due to sensor diagnostics

SDO DO suspect

SDP DO membrane puncture

SIC Incorrect calibration / contaminated standard

SNV Negative value

SOW Sensor out of water

SPC Post calibration out of range

SQR Data rejected due to QAQC checks

SSD Sensor drift

SSM Sensor malfunction

SSR Sensor removed / not deployed

STF Catastrophic temperature sensor failure

STS Turbidity spike

SWM Wiper malfunction / loss

Comments

CAB\* Algal bloom

CAF Acceptable calibration/accuracy error of sensor

CAP Depth sensor in water, affected by atmospheric pressure

CBF Biofouling

CCU Cause unknown

CDA\* DO hypoxia (<3 mg/L)

CDB\* Disturbed bottom

CDF Data appear to fit conditions

CFK\* Fish kill

CIP\* Surface ice present at sample station

CLT\* Low tide

CMC\* In field maintenance/cleaning

CMD\* Mud in probe guard

CND New deployment begins

CRE\* Significant rain event

CSM\* See metadata

CTS Turbidity spike

CVT\* Possible vandalism/tampering

CWD\* Data collected at wrong depth

CWE\* Significant weather event

## 13. Post deployment information

Post-calibration information for instruments deployed at each site. Header abbreviations: Retr=retrived, Cal=calibration, Sp Cond=specific conductivity, Chl Fl=chlorophyll fluorescence.

Nag Creek

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deploy Date | Retr./ Post- Cal Date | EXO Sonde | Sp Cond. | Dissolved Oxygen | | pH | | | Turbidity | | Depth | Chl Fl |
| mS/cm | Percent saturation | | units | | | NTU | | Reading (Offset) | µg L-1 |
| mm/dd/yy | mm/dd/yy | Serial No. | 50.00 | ODO 1 | ODO 2 | 7.00 | 10.00 | 4.00 | 0.00 | 124.0 | (m) | 0.00 |
| 12/15/15 | 01/08/16 | 14A101167 | 50.2 | 100.7 | 100.7 | 6.97 | 10.03 | 3.95 | 0.19 | 122.4 | 0.086 (0.091) | -0.44 |
| 04/20/16 | 05/04/16 | 14A101167 | 49.5 | 99.6 | 99.6 | 7.01 | 10.04 | 3.93 | 0.00 | 124.1 | -0.038 (-0.033) | -0.11 |
| 05/04/16 | 05/25/16 | 14A101166 | 49.8 | 100.9 | 100.9 | 6.98 | 9.98 | 3.84 | -0.06 | 123.6 | 0.021 (0.020) | -0.02 |
| 05/25/16 | 06/15/16 | 14A101167 | 49.9 | 99.6 | 99.6 | 7.09 | 10.10 | 4.07 | 0.35 | 123.9 | -0.033 (-0.037) | -0.02 |
| 06/15/16 | 07/12/16 | 14A101166 | 50.4 | 100.4 | 100.4 | 6.95 | 9.88 | 3.93 | 0.12 | 123.6 | 0.125 (0.044) | -0.08 |
| 07/12/16 | 08/02/16 | 14A101167 | 50.1 | 100.1 | 100.7 | 7.07 | 10.09 | 4.07 | 0.23 | 124.3 | 0.089 (0.064) | 0.15 |
| 08/02/16 | 08/31/16 | 14A101166 | 49.9 | 99.1 | 100.0 | 7.03 | 10.02 | 3.98 | 0.02 | 124.9 | -0.047 (0.001) | -0.02 |
| 08/31/16 | 09/20/16 | 14A101167 | 49.9 | 99.7 | 100.5 | 7.01 | 9.99 | 3.95 | 0.19 | 123.3 | 0.073 (0.061) | -0.04 |
| 09/20/16 | 10/18/16 | 14A101166 | 49.8 | 99.7 | 99.8 | 7.02 | 10.02 | 3.95 | 0.16 | 123.0 | -0.012 (-0.012) | 0.07 |
| 10/18/16 | 11/08/16 | 14A101167 | 49.7 | 100.3 | 100.4 | 6.95 | 9.98 | 3.87 | -0.02 | 125.0 | 0.028 (0.034) | 0.02 |
| 11/08/16 | 12/06/16 | 14A101166 | 49.7 | 100.8 | 100.8 | 6.90 | 9.95 | 3.84 | -0.02 | 124.7 | 0.045 (0.045) | -0.01 |
| 12/06/16 | 12/20/16 | 14A101167 | 49.9 | 101.5 | 101.5 | 7.04 | 10.07 | 3.99 | 0.01 | 123.3 | 0.152 (0.155) | -0.01 |
| 12/20/16 | 01/17/17 | 14A101166 | 51.9 | 100.0 | 100.0 | 7.07 | 10.14 | 4.01 | -0.01 | 123.8 | -0.006 (-0.005) | -0.04 |

Notes

Nag Creek was not deployed during January to mid-April because the creek was frozen.

Potter Cove

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deploy Date | Retr. / Post- Cal Date | EXO Sonde | Sp Cond. | Dissolved Oxygen | | pH | | | Turbidity | | Depth | Chl Fl |
| mS/cm | Percent saturation | | units | | | NTU | | Reading (Offset) | µg L-1 |
| mm/dd/yy | mm/dd/yy | Serial No. | 50.00 | ODO 1 | ODO 2 | 7.00 | 10.00 | 4.00 | 0.00 | 124.0 | (m) | 0.00 |
| 12/15/15 | 01/08/16 | 14A101164 | 50.1 | 100.6 | 100.6 | 7.03 | 10.04 | 3.95 | 0.01 | 122.8 | 0.082 (0.090) | -0.30 |
| 01/08/16 | 02/02/16 | 14A101165 | 50.1 | 101.8 | 101.8 | 6.92 | 9.92 | 3.88 | -0.05 | 128.4 | 0.109 (0.118) | -0.02 |
| 02/02/16 | 03/01/16 | 14A101164 | 50.0 | 101.2 | 101.2 | 7.05 | 10.04 | 3.95 | 0.68 | 124.0 | 0.054 (0.054) | 0.02 |
| 03/01/16 | 04/06/16 | 14A101165 | 50.2 | 101.3 | 101.3 | 6.98 | 9.91 | 3.84 | -0.05 | 123.8 | 0.099 (0.102) | -0.09 |
| 04/06/16 | 05/04/16 | 14A101164 | 49.7 | 99.9 | 99.9 | 7.12 | 10.18 | 4.00 | -0.07 | 123.6 | -0.048 (-0.045) | -0.17 |
| 05/04/16 | 05/25/16 | 14A101165 | 49.3 | 100.6 | 100.6 | 7.06 | 10.11 | 3.99 | -0.03 | 123.0 | 0.012 (0.015) | -0.04 |
| 05/25/16 | 06/15/16 | 14A101164 | 49.5 | 98.7 | 98.8 | 7.07 | 10.05 | 4.00 | 0.19 | 123.9 | -0.035 (-2.507) | -0.02 |
| 06/15/16 | 07/12/16 | 14A101165 | 50.0 | 100.7 | 100.4 | 7.07 | 10.05 | 3.99 | 0.09 | 123.5 | 0.045 (0.049) | -0.35 |
| 07/12/16 | 08/02/16 | 14A101164 | 50.0 | 100.2 | 100.6 | 7.04 | 10.04 | 3.97 | -0.08 | 124.1 | 0.060 (0.067) | -0.07 |
| 08/02/16 | 08/31/16 | 14A101165 | 49.7 | 99.0 | 100.0 | 7.06 | 10.05 | 4.01 | 0.31 | 124.8 | -0.017 (0.012) | -0.09 |
| 08/31/16 | 09/20/16 | 14A101164 | 49.9 | 100.0 | 100.5 | 7.02 | 10.00 | 3.97 | 0.26 | 123.6 | 0.066 (0.057) | -0.08 |
| 09/20/16 | 10/18/16 | 14A101165 | 49.8 | 100.0 | 99.9 | 6.99 | 10.00 | 3.94 | -0.03 | 123.0 | -0.004 (-0.001) | -0.17 |
| 10/18/16 | 11/08/16 | 14A101164 | 50.0 | 100.5 | 100.6 | 6.97 | 9.98 | 3.90 | -0.01 | 125.1 | 0.040 (0.045) | -0.05 |
| 11/08/16 | 12/06/16 | 14A101165 | 50.0 | 100.7 | 100.7 | 6.93 | 9.96 | 3.87 | -0.02 | 125.4 | 0.040 (0.041) | 0.08 |
| 12/06/16 | 12/20/16 | 14A101164 | 50.0 | 101.7 | 101.7 | 6.99 | 10.03 | 3.91 | 0.02 | 123.1 | 0.139 (0.145) | 0.05 |
| 12/20/16 | 01/17/17 | 14A101165 | 49.9 | 100.4 | 100.4 | 7.02 | 10.09 | 3.97 | -0.01 | 124.0 | 0.000 (0.000) | -0.05 |

T-Wharf Surface

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deploy Date | Retr./ Post- Cal Date | 6600V2/ *EXO2* | Sp Cond. | Dissolved Oxygen | | pH | | | Turbidity | | Depth | Chl Fl |
| mS/cm | Percent saturation | | units | | | NTU | | Reading (Offset) | µg L-1 |
| mm/dd/yy | mm/dd/yy | Serial No. | 50.00 | Reading 1 | & 2 | 7.00 | 10.00 | 4.00 | 0.00 | 124.0 | (m) | 0.00 |
| 12/17/15 | 01/06/16 | 01E0876AB | 49.9 | 101.3 | 101.3 | 7.04 | 10.06 | 3.99 | 0.30 | 125.5 | 0.159 (0.189) | 1.1 |
| 01/06/16 | 02/02/16 | 01E0566AA | 50.4 | 101.8 | 101.8 | 7.09 | 10.06 | 4.03 | 0.10 | 126.5 | 0.102 (0.111) | 4.40 |
| 02/02/16 | 03/01/16 | 01E0876AB | 50.3 | 100.9 | 100.9 | 7.05 | 10.05 | 3.96 | -0.80 | 123.5 | 0.043 (0.061) | 0.20 |
| 03/01/16 | 04/06/16 | 01E0566AA | 51.1 | 101.3 | 101.3 | 7.05 | 10.02 | 3.98 | 9.10 | 134.7 | 0.069 (0.094) | -6.10 |
| **1** 04/06/16 | 05/05/16 | 01E0876AB | 50.9 | 100.6 | 100.6 | 7.10 | 10.16 | 4.10 | 2138.50 | 2157.3 | -0.095 (-0.082) | -0.40 |
| 05/05/16 | 05/24/16 | 01E0566AA | 50.0 | 101.8 | 101.8 | 7.05 | 10.08 | 4.00 | -0.60 | 123.9 | -0.024 (-0.019) | -1.00 |
| 05/24/16 | 06/16/16 | 01E0876AB | 50.4 | 100.3 | 100.3 | 7.07 | 10.04 | 4.00 | 0.20 | 127.0 | -0.051 (-0.050) | 0.30 |
| 06/16/16 | 07/13/16 | 01E0566AA | 50.2 | 100.9 | 100.9 | 7.12 | 10.08 | 4.12 | -0.40 | 127.1 | 0.049 (0.049) | 0.30 |
| **2** 07/13/16 | 08/10/16 | 01E0876AB | 50.1 | 100.1 | 100.1 | 7.26 | 10.08 | 4.46 | 1.90 | 99.0 | 0.064 (0.075) | 0.40 |
| 08/10/16 | 08/30/16 | 01E0566AA | 50.3 | 100.7 | 100.7 | 7.07 | 9.98 | 4.27 | 0.20 | 125.1 | 0.071 (0.072) | 0.00 |
| 08/30/16 | 09/13/16 | 01E0876AB | 50.5 | 100.7 | 100.7 | 7.07 | 10.08 | 4.03 | 0.70 | 127.1 | 0.087 (0.092) | 0.50 |
| 09/13/16 | 10/12/16 | 01E0566AA | 49.6 | 101.1 | 101.1 | 7.04 | 10.07 | 4.16 | -0.40 | 123.7 | 0.148 (0.151) | -0.20 |
| 10/12/16 | 11/08/16 | 01E0876AB | 50.5 | 101.0 | 101.0 | 7.03 | 10.00 | 4.01 | 0.20 | 125.8 | 0.044 (0.058) | 0.10 |
| 11/08/16 | 12/07/16 | *16J102354* | 50.0 | 100.0 | 100.0 | 7.01 | 10.05 | 3.93 | -0.28 | 123.9 | 0.011 (0.010) | -0.09 |
| 12/07/16 | 12/20/16 | *16J102353* | 49.9 | 101.2 | 101.2 | 7.00 | 10.05 | 3.92 | -0.15 | 122.5 | 0.141 (0.145) | 0.21 |
| 12/20/16 | 01/17/17 | *16J102354* | 49.8 | 101.0 | 101.0 | 7.06 | 10.10 | 3.97 | -0.08 | 125.0 | 0.072 (0.073) | 0.01 |

Note

**1**Turbidity probe failed during deployment.

**2**Batteries exploded shortly after deployment; it was noticed at the lab on 08/10, which was the day the sonde has been scheduled to be retrieved. New batteries were used for post-cal.

T-Wharf Bottom

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deploy Date | Retr. / Post- Cal Date | 6600V2 | Sp Cond. | Dissolved Oxygen | | pH | | | Turbidity | | Depth | Chl Fl |
| mS/cm | Percent saturation | | units | | | NTU | | Reading (Offset) | µg L-1 |
| mm/dd/yy | mm/dd/yy | Serial No. | 50.00 | Reading 1 | & 2 | 7.00 | 10.00 | 4.00 | 0.00 | 124.00 | (m) | 0.00 |
| 12/17/15 | 01/06/16 | 06C1207AA | 50.74 | 101.1 | 101.2 | 6.99 | 10.06 | 3.96 | -1.90 | 126.5 | 0.180 (0.177) | 0.00 |
| 01/06/16 | 02/02/16 | 00F0937AB | 49.77 | 101.6 | 101.6 | 7.09 | 10.05 | 4.00 | -1.00 | 128.3 | 0.109 (0.110) | 0.20 |
| 02/02/16 | 03/01/16 | 06C1207AA | 50.05 | 101.5 | 101.5 | 7.07 | 10.09 | 4.00 | -0.90 | 125.2 | 0.047 (0.054) | 0.00 |
| **1** 03/01/16 | 04/07/16 | 00F0937AB | 50.27 | 99.6 | 99.6 | 7.05 | 10.01 | 4.01 | 0.00 | 126.8 | -0.089 (-0.057) | -0.40 |
| 04/06/16 | 05/05/16 | 06C1207AA | 50.18 | 100.8 | 100.8 | 7.12 | 10.19 | 4.04 | -1.10 | 129.2 | -0.088 (-0.086) | 0.10 |
| 05/05/16 | 05/24/16 | 05E1065AE | 50.39 | 101.7 | 101.7 | 7.07 | 10.13 | 3.99 | -0.30 | 123.4 | -0.028 (-0.023) | 0.30 |
| 05/24/16 | 06/16/16 | 06C1207AA | 50.50 | 100.1 | 100.1 | 7.10 | 10.06 | 4.04 | 0.30 | 128.2 | -0.059 (-0.056) | 0.30 |
| 06/16/16 | 07/13/16 | 05E1065AE | 50.15 | 101.1 | 101.1 | 7.11 | 10.05 | 4.33 | -1.20 | 128.0 | 0.044 (0.049) | 0.30 |
| 07/13/16 | 08/10/16 | 06C1207AA | 52.38 | 100.6 | 100.6 | 7.08 | 10.08 | 4.07 | 0.00 | 130.7 | 0.083 (0.087) | 0.70 |
| 08/10/16 | 08/30/16 | 05E1065AE | 50.40 | 100.9 | 100.9 | 7.09 | 9.97 | 4.23 | 1.00 | 126.1 | 0.057 (0.056) | -0.60 |
| 08/30/16 | 09/13/16 | 06C1207AA | 49.57 | 101.0 | 101.0 | 7.00 | 10.01 | 3.92 | 0.30 | 125.5 | 0.098 (0.098) | 0.10 |
| 09/13/16 | 10/12/16 | 05E1065AE | 49.85 | 101.1 | 101.0 | 7.06 | 10.06 | 4.08 | -0.30 | 126.0 | 0.138 (0.143) | 0.20 |
| 10/12/16 | 11/08/16 | 06C1207AA | 49.60 | 100.4 | 100.4 | 7.02 | 9.97 | 3.95 | -0.10 | 127.1 | 0.056 (0.053) | -0.10 |
| 11/08/16 | 12/07/16 | 05E1065AE | 51.00 | 100.7 | 100.7 | 6.99 | 10.02 | 3.95 | -0.80 | 127.5 | -0.002 (0.000) | -0.10 |
| 12/07/16 | 12/28/16 | 06C1207AA | 50.60 | 100.1 | 100.1 | 7.04 | 10.09 | 3.97 | 0.50 | 125.5 | 0.023 (0.024) | 0.00 |
| 12/28/16 | 01/17/17 | 05E1065AE | 50.30 | 101.0 | 101.0 | 7.10 | 10.13 | 4.05 | 0.10 | 125.4 | 0.075 (0.077) | -0.20 |

Note

**1**Post-cal was done one day after retrieval. The sonde was kept in an aerated bucket with water and collecting data until post-cal was done.

## 14. Other Remarks / Notes

Data are missing due to equipment or associated specific probes not being deployed, equipment failure, time of maintenance or calibration of equipment, or repair/replacement of a sampling station platform. Any NANs in the dataset stand for “not a number” and are the result of low power, disconnected wires, or out of range readings. If additional information on missing data is needed, contact the Research Coordinator at the reserve submitting the data.

Chlorophyll and fluorescence data were collected along with the data presented in this document, but because chlorophyll and fluorescence are not part of the NERR SWMP Water Quality Program, the data are not reported within this dataset. Chlorophyll fluorescence data are available upon request by contacting the Reserve.

Slight depth anomalies frequently occur at the Nag Creek deployment location. Depth at this site may have been influenced to some extent by changes in atmospheric pressure because the sonde was situated in very shallow waters. On occasion, the combination of low atmospheric pressure and shallow water resulted in negative depth values. Weather station data appear to support this theory. It is also suspected that due to its shallow location and location in a salt marsh, freshwater runoff from the island may affect specific conductivity/salinity readings several days after a rain event has occurred. Specific conductivity, salinity, and dissolved oxygen can also vary greatly in Nag Creek over tidal and diel cycles. Nag creek is a very shallow site and is highly affected by tides and rain events. On some occasions, dissolved oxygen (DO) is recorded as negative values at the Nag Creek deployment location. Dissolved oxygen frequently ranges between supersaturation and complete anoxic conditions (DO = 0 % saturation) at this site during the summer months. Ice is also common in Nag Creek. There have been occasions where ice has affected all sonde parameters and are marked in the data as “see metadata”.

It is likely that some of the variability in specific conductivity at Nag Creek is due to freshwater entering the marsh from the red maple swamp abutting it to the east (across the road). The amount of fresh groundwater inflow has not been quantified, but evidence for it comes in the form of 1) the presence of brackish vegetation species along the upland borders of the marsh in areas abutting the swamp, and 2) new data from a salinity mapping project conducted by Dr. Rick McKinney (EPA Atlantic Ecology Division) that quantifies lower salinities along those same borders. The variability is surely exacerbated due to the shallow nature of the creek in which the sonde is located. After rain events, salinities are likely to be relatively high at high tide due to the influx of Bay water, and then correspondingly low at low tide when the surface freshwater predominates.

The following are description of different events that happened during deployment and explanations to the CSM (Comment-See Metadata) code for the four water quality station data files from January to December of 2016.

**Nag Creek**

Throughout the year there are small turbidity spikes marked 0 GSM CTS and 1 STS CSM. Due to the sonde being deployed in a horizontal position, there is at times drift algae that gets caught up on the station and affects the turbidity data.

Deployment 06/15 – 07/12: Data collected at the beginning of the deployment (06/15 09:00 – 06/20 02:30) were flagged and coded as -3 SSM CSM. These data were rejected because we believe a bubble became trapped in the C/T sensor at the moment of deployment making all Specific Conductivity (and salinity) readings appear very low, once the bubble was dislodged, the readings became more specific to the site; these data were flag and coded as 0 CSM.

Deployment 08/12 – 08/22, 10/09 - 10/18: Turbidity data collected during this period were flagged and coded 1 GSM CBF and 0 GSM CBF. We believe there was drift algae caught up on the station and on the sonde which might have caused turbidity data to be slightly higher for an unusual long period of time, mostly at low tide; for this we used 1 GSM CBF. This problem seems to resolve itself, for which times we flagged the data 0 GSM CBF.

Deployment period 08/23 10:45 - 08/31. Turbidity was flagged and coded as 0 SWM CSM. Once the sonde was at the lab after retrieval, we notice the wiper brush fell off. The exact time this happened is unknown. However, we visited the site on 18/23 10:30 and the wiper was still on. It was decided to flag and code the data after our visit as 0 SWM CSM to indicate this fact. The data was not considered suspect since the turbidity data readings were not high.

Deployment 09/12 15:00 – 18:15: Dissolved oxygen percent saturation (DO%) collected during this period was slightly higher than the rest of the deployment and were flagged and coded as 1 GSM CBF. We believe it is due to the accumulation of drift algae near the sonde, at the bottom of the deploying structure, which produces oxygen through photosynthesis and the oxygen is released in the water.

Deployment 10/18 – 11/08: Turbidity data collected during this period were flagged and coded as 1 GSM CBF and 0 GSM CBF. At the end of the deployment we found 1 small fish and 6 grass shrimps in the deploying guard. It seems this biofouling affected the turbidity readings at the beginning of the deployment so we used 1 GSM CBF, but not so much at the end where the turbidity readings were low and we decided to use 0 GSM CBF.

Deployment 11/08 – 12/06: Data collected during this deployment were flagged and coded as 1 GSM CBF and 0 GSM CBF. At the end of the deployment we found 3 small fish and 61 grass shrimp in the deploying guard. It seems this biofouling affected the turbidity readings at the beginning of the deployment so we used 1 GSM CBF, but not so much at the end where the turbidity readings were low and we decided to use 0 GSM CBF.

Deployment 12/30 – 12/31: The creek had ice but was not completely frozen.

Deployment period 12/24 11:30 – 12/31 23:45. Turbidity data collected during this period were flagged and coded as 1 GSM CBF and 0 GSM CBF. At the end of the deployment we found 3 small fish and 61 grass shrimp in the deploying cup. It seems this biofouling affected the turbidity readings at the beginning of the deployment so we used 1 GSM CBF, but not so much at the end where the turbidity readings were low and we decided to use 0 GSM CBF.

**Potter Cove**

Deployment periods 02/25 14:45 – 03/01 11:45, 03/11 19:00 – 03/14 14:30, 08/19 16:30 – 08/20 00:15, 08/29 15:30 – 08/31 07:15. The data collected during these periods were flagged and coded 1 GSM CWD and 0 GSM CDW. Depth data collected was slightly off because it seems the line securing the sonde got tangled with the floating dock and was lifted during high tides. The problem resolved itself. The other water quality parameters were not affected (flagged as 0).

Deployment periods 01/19 05:30 – 22:45, 04/03 05:00 – 20:45: Depth data recorded looks slightly shallower than the rest of the deployment due to very high winds form the N-NW affecting the tides by making them slightly lower than usual. The wind information was obtained from our weather station about 160m south of Potter Cove.

Deployment 06/15 – 07/12: Turbidity data collected at the end of this deployment (07/11 - 07/12) were flagged and coded as 1 GSM CBF and 0 GSM CBF. Once at the lab with the sonde, we found a small gravid female crab inside the guard, bryozoans and recruit slipper snails, polychaetes worm, skeleton shrimps and some algae on the sonde and probes.

Deployment 08/02 – 08/31: Turbidity data collected during this deployment was flagged and coded 1 GSM CBF and 0 GSM CBF. It seems this biofouling affected the turbidity readings at the beginning of the deployment so we used 1 GSM CBF, but not so much at the end where the turbidity readings were low and we decided to use 0 GSM CBF. Once at the lab we found calcareous polychaetes tubes, bryozoans, and some algae on probes and sonde. However, the wiping brush on the sonde kept all the sensors clean.

Deployment 08/31 – 09/20: Turbidity data collected during this deployment was flagged and coded 1 GSM CBF and 0 GSM CBF. It seems this biofouling affected the turbidity readings at the beginning of the deployment so we used 1 GSM CBF, but not so much at the end where the turbidity readings were low and we decided to use 0 GSM CBF. Once at the lab we found calcareous polychaetes tubes and bryozoans on probes and sonde. However, the wiping brush on the sonde kept all the sensors clean.

**T-Wharf Surface**

Record Column CSM 11/08 – 12/31. Deployments on November and December. The equipment at T-Wharf Surface was upgraded from 6600V2 to EXO2 starting with the deployment on November 08 10:00.

Deployment periods 01/19 05:30 – 22:45, 04/03 05:00 – 20:45, 12/16 00:30 – 04:30: Depth data recorded looks slightly shallower than the rest of the deployment due to very high winds form the N-NW affecting the tides by making them slightly lower than usual. The wind information was obtained from our weather station near Potter Cove.

Deployment 03/01 – 04/06: Turbidity data collected at the end of this deployment (04/02 – 04-06) were flagged and coded as -3 GSM CBF. Once at the lab with the sonde, we found barnacle recruits on the sonde and probes which might have caused the high turbidity readings at the end of the deployment.

Deployment 06/16 – 07/13: Turbidity data collected at the end of this deployment (07/02 – 07-13) were flagged and coded as -3 GSM CBF and 0 GSM CBF. Once at the lab with the sonde, we found bryozoans and light sediment plus algae on all probes and sondes, in addition to mussels attached to the probe guard, which we believe might have caused intermittent high turbidity readings which were rejected during this period. Low turbidity readings, which historically are more characteristic of this site, were flagged as 0 GSM CBF.

Deployment 08/10 – 08/30: Specific conductivity and salinity data collected during this deployment were flagged and coded as 1 GSM CBF. Once at the lab with the sonde, we found a polychaete had nested in the specific conductivity sensor building a calcareous tube. The variations observed from 08/15 to 08/24 might have been due the activity of the worm. From 08/24 to the end of the deployment, it seems there was less activity and less variation in the readings but we flagged and coded the same since the calcareous tube remained in the sensor even when the polychaete might have not.

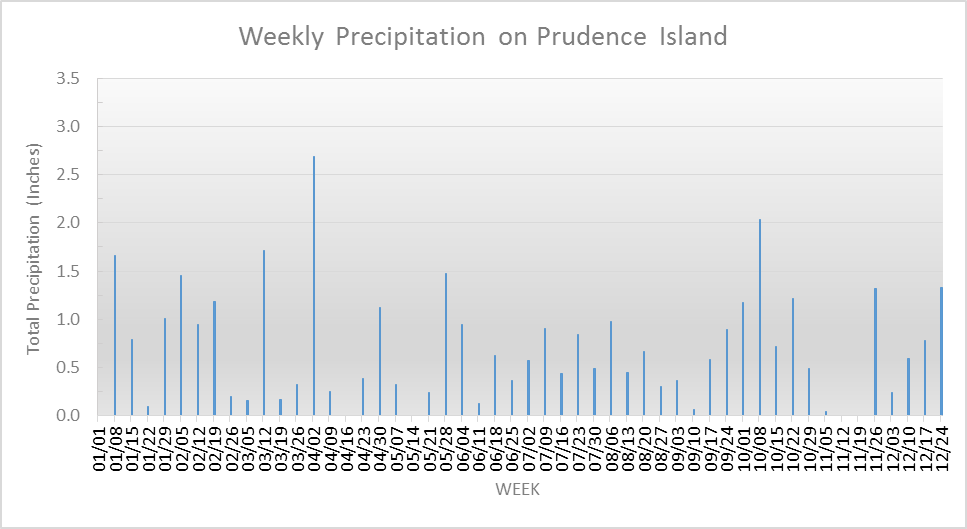
**T-Wharf Bottom**

Record Column CSM 08/10 07:30 – 09:15. Installed a new field cable for the telemetry station.

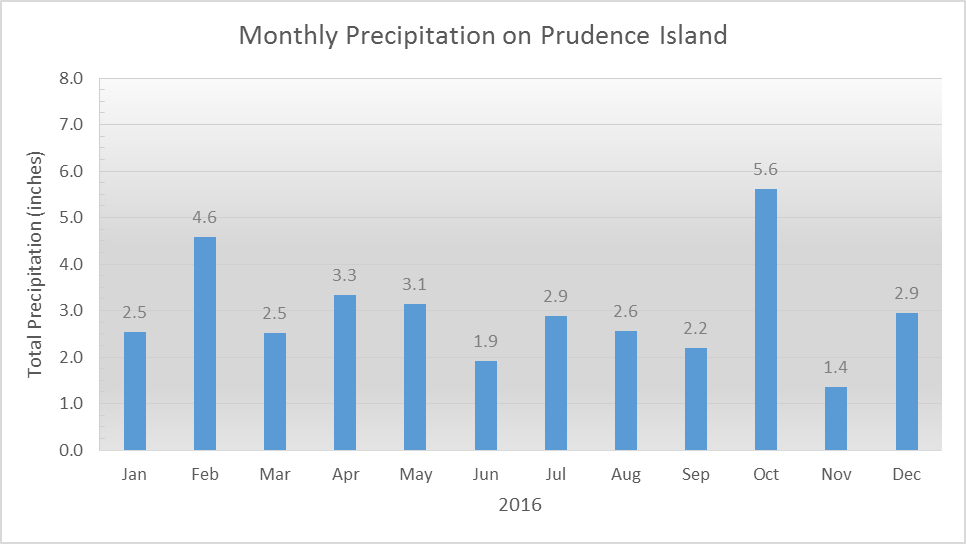
**T-Wharf Surface and Bottom**

Deployment period 08/25 07:45 - 08:30. This data was flagged and coded -3 GOW CSM. The deploying PVC pipe structure was being cleaned of biofouling on the outside by divers. We had the T-Wharf Surface and Bottom sondes out of the water (protected from the air) during this time period. The data was rejected because it was collected out of the water.

Total Precipitation on Prudence Island by week for 2016. Information obtained from NBNERR weather station.



Total Precipitation on Prudence Island by month for 2016. Information obtained from NBNERR weather station.



1. Pilson, M.E.Q. 1985. On the residence time of water in Narragansett Bay. Estuaries 8:2–14. [↑](#footnote-ref-2)
2. Narragansett Bay National Estuarine Research Reserve. 2007. An Ecological Profile of the Narragansett Bay National Estuarine Research Reserve. K.B. Raposa and M.L. Schwartz (eds.), Rhode Island Sea Grant, Narragansett, R.I. 176pp. [↑](#footnote-ref-3)