Waquoit Bay (WQB) National Estuarine Research Reserve Water Quality Metadata
January 2014 – December 2014
Latest Update: February 24, 2016

I. Data Set & Research Descriptors

1) Principal investigator & contact persons:

Address: Waquoit Bay NERR
PO Box 3092
131 Waquoit Highway
Waquoit, MA 02536
(508) 457-0495
Email: waquoit.bay@state.ma.us

Contact persons:

Dr. Chris Weidman, Research Coordinator
Email: Chris.Weidman@state.ma.us; (508) 457-0495 ext. 105

Jordan Mora, Research Associate
Email: jordan.mora@state.ma.us; (508) 457-0495 ext. 128

2) Entry verification:

The data are uploaded in three file formats (each to separate files identified with the same file name but with unique extensions: .CSV, .DAT, .INI) from the YSI 6600 data loggers to a PC with the YSI 6600 EcoWatch software. Two of these (PC6000 and ASCII text formats) are kept on file in the WBNERR archive. Initially, file contents visually examined for anomalies (e.g., sensor malfunction, battery failure, spurious values, etc.) by a technician after downloading data after deployment and post calibration analysis.

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) 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.

Copies of all files are retained at the Reserve which includes the formatted PC6000 data files (.dat), as well as the raw text files (.csv) and final exported text files (.txt) archived at the CDMO site.

3) Research objectives:

For the NERR System-Wide Monitoring Program (SWMP), the YSI 6600 data loggers are programmed to record water quality parameters every 15 minutes. A total of four SWMP sites were located in the Waquoit Bay estuarine system during 2014. These four are: 1) Metoxit Point (MP), in operation since 1998, is located in the middle of Waquoit Bay's main basin; 2) Menauhant (MH), in operation since March 2001, is located adjacent to Eel Pond Inlet on Vineyard Sound – one of the two tidal inlets into the Waquoit Bay estuary; 3) Child's River (CR), in operation since May 2002, located near the head of the tidal section of Child's River— one of the two main surface fresh water sources to Waquoit Bay; and 4) Sage Lot (SL), in operation since May 2002, located in Sage Lot Pond—a relatively pristine tidal pond surrounded by salt marsh and barrier beach, possessing one of the bay's few remaining eelgrass stands.

The main purpose of the SWMP water quality monitoring program is to aid Waquoit Bay NERR in one of its priority missions - to perform as a natural laboratory and platform for coastal and estuarine research. The long term, continuous detailed monitoring of the estuary's basic hydro-physical parameters is an essential tool and context for any research activities located here. Besides this overarching mission, there are also several specific research interests. One primary issue for the Waquoit Bay ecosystem is the influence of anthropogenic induced alterations by nitrogen enrichment. Waquoit Bay receives nitrogen from several sources, including but not limited to septic systems (their leachate percolates into groundwater which then enters the bay), run off from roads, run off containing domestic and agricultural fertilizer and animal waste, and atmospheric sources. This elevated nitrogen loading to the bay has resulted in enhanced eutrophication that has contributed to the alteration of the bay's habitats. For example, thick mats of seaweeds (macroalgae) now cover the bottom where eelgrass meadows thrived in the 1970's. Unfortunately, there are few definitive records of the bay's water quality conditions during that period, which makes it difficult to evaluate the rates of change. To facilitate future evaluation, long-term records from SWMP can be used to track water column conditions. Of particular interest, in this regard are measurements of dissolved oxygen (DO) and turbidity, as well as dissolved nitrogen and chlorophyll concentration (this data is available by contacting the reserve). Such records will facilitate evaluation of changes which may come about from a continuation of watershed alteration that result from current development patterns (i.e., non-sewered residential areas served by private septic systems typically consisting of septic tanks and leach fields) as well as non-industrial commercial development, such as golf courses, cranberry bogs, and retail shopping outlets. The records will be useful for evaluating the efficacy of remediation efforts intended to reduce the nitrogen loading from these sources to Waquoit Bay.

Another focus of long-term research interest is the detection of climate change and the determination of its effects on the estuarine environment. Characterizing the variability of the various water column parameters, such as their scale, magnitude and frequency, is likely to be an important aspect of the estuarine ecosystem that may be sensitive to climate change. Related to this focus is an interest in the

impact of storms (hurricanes and northeasters) and other extreme meteorological events on the estuary. For example, what temperature and wind field thresholds exist that might bring about or trigger certain conditions within the bay? The observations recorded by the SWMP will allow for these types of studies.

4) Research methods:

YSI 6600 series Sondes are deployed at each permanent water quality monitoring station at the Waquoit Bay Reserve. Since in-situ instrumentation can only record conditions at a specific location, permanent monitoring stations for SWMP are chosen to be in some way representative of the overall estuary. This is difficult in practice since estuaries by their very definition are coastal regions where large physical, chemical and biological variations tend to occur in space and time, so that often no particular location within the system is "typical" of the overall system. Establishing a number of stations can overcome this problem somewhat, and as of 2002 four permanent stations were established in the Waquoit Bay estuaries. Our current SWMP stations are situated to represent, as much as possible, the diversity of the estuary and its inputs/outputs. Additional details concerning the station characteristics are discussed in the next section.

The YSI Sondes measure and record ambient water temperature, specific conductivity (and calculate salinity), dissolved oxygen (mg/L and % saturated), turbidity (NTU), Chlorophyll-a (ug/L) water level (m), and pH at 15 minute intervals during deployment periods extending for approximately three weeks (three weeks during the summer months, four weeks during winter months). Note that the pressure sensors currently in use are non-vented and so variations in atmospheric pressure are recorded as changes in water depth (atmospheric data are available from our SWMP meteorological station (as of January 2002) and other nearby meteorological observatories), so it is possible to make this correction to the depth data (approximately +1 cm of depth is equal to +1 mb of air pressure), for increased accuracy. Also, at our Metoxit Point site (from 12/2000 to present), Child's River site (from 3/2003 to present), Menauhant site (from 7/2006 to present), and our Sage Lot site (from 6/2006 to present) we have been using a YSI 6025 optic chlorophyll fluorescence sensor.

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Sondes are deployed and retrieved every two to three weeks. The "old" Sonde is retrieved and a "new" replacement Sonde is deployed immediately so that ideally no record gap occurs. The 2-3 week deployment duration is constrained by a combination of battery life (shorter life in colder waters) and fouling of the DO sensor (and other sensors to a lesser degree) during the warm summer months. Prior to deployment (usually within 24 hrs), each instrument is checked and its sensors re-calibrated using standard YSI (Operating Manual) protocols. Similarly, after a deployment, each Sonde is brought back to the laboratory for a post-deployment check, data downloading, instrument and sensor cleaning. The conductivity sensors are calibrated with 50.00 mS/cm YSI standard. The pH sensors are calibrated with 7.0 and 10.0 pH standard solutions (2-point calibrations). The turbidity standard used is YSI 6073G turbidity standard for 126.0 NTU, and distilled water (DI) for 0 NTU. Temperature sensors are checked periodically against a calibrated mercury thermometer. The chlorophyll probe is calibrated on a 2-point calibration with distilled water (DI) and a Fluorescent Red Dye (Rhodamine WT) at a 0.5 mg/ L concentration. *See Chlorophyll Qualifier in Sensor Specifications section below regarding chlorophyll fluorescence accuracy.* Oxygen sensor membranes are inspected before and after each deployment. Oxygen sensor membranes are replaced 24 hours prior to each deployment when the sensor seemed to need reconditioning. Final DO calibration was not done until the membrane had been in place for at least

8 hours. As another check on instrument performance, in-situ measurements of air and water temperature, DO, salinity, Specific Conductance, and pH are made using a hand-held YSI 650 at deployment/retrieval times.

In 2014, no SWMP water quality data were collected between January 22nd and April 9th. On April 9th, a sonde was deployed at Menauhant. However, the other three stations were not occupied until late May (Childs River) or early June (Metoxit Point and Sage Lot Pond). Ice conditions and tower maintenance necessitated the removal of the Metoxit Point and Sage Lot sondes from early January until the end of May.

Two types of silos housed the YSI sondes during their deployment. One type for dock side stations (Menauhant and Childs River) and the other for open water stations away from shore structures (Metoxit and Sage Lot). For open water, a two part structure has been designed consisting of a submerged fixed tower and a separate removable silo apparatus that sleeves over the fixed tower. . The removable silo apparatus can be lifted on and off the tower for inspection, cleaning or other maintenance. The sondes are deployed into the removable silos consisting of open-ended vertically mounted 4" PVC pipe (each silo is perforated in its lower portion around the business end of the sonde). The fixed tower structure consists of a vertical reinforced concrete filled 3" PVC pipe about 1.3 meters in height extending upward from a 300 lb cast reinforced concrete base (30" in diameter and 6" thickness) anchored into the bottom by a reinforced concrete filled 4" PVC pipe about 1 m in length. The whole structure is somewhat reminiscent of large "child's toy top". The Metoxit Point and Sage Lot silos are set so that the sonde's sensor package is 0.5 m off the bottom. For dock-side locations and the silo apparatuses are a more typical type – a single PVC section (4" ID) mounted vertically onto a pier piling or bulkhead. The Menauhant site, located at a yacht club dock, is adjacent to a tidal inlet, and the Child's River site, located at commercial marina and boat yard, is adjacent to the upper reaches of a tidal river. The base of these silos is also ventilated with large holes (1.0" diameter) and their sensor packages (bottom of the Sonde) are both mounted about 0.5 m off the bottom. All mooring silos are painted with antifouling paint at the beginning of the spring season, and periodically checked and scrubbed during the summer season.

In July of 2006, A Sutron Sat-Link2 transmitter was installed at the (*insert station name*) station on mm/dd/yy and transmits data to the NOAA GOES satellite, NESDIS ID # NESDIS ID #3B030074 (where 3B030074 is the GOES ID for that particular station.) 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.

5) Site location and character:

General description of Waquoit Bay estuarine system:

The Waquoit Bay National Estuarine Research Reserve (WBNERR) is located in the northeastern United States on the southern coast of Cape Cod, Massachusetts. About 8,000 people maintain permanent residency in Waquoit Bay's drainage area, which covers parts of the towns of Falmouth, Mashpee, and Sandwich. During summer months, the population swells 2-3 times with the greatest housing concentrations immediate to the coastline (water views and frontage). In addition, the upper portions of the watershed include a military base, Otis Air Force Base and the Massachusetts Military Reservation, portions of which have been designated by the EPA as Superfund sites due to past practices of dumping jet fuel and other volatile groundwater contaminants.

WBNERR's estuaries are representative of shallow tidal lagoons that occur from Cape Cod to Sandy Hook, New Jersey. WBNERR is within the northern edge of the Virginian biogeographic province, on the transitional border (Cape Cod) with the Acadian biogeographic province to the north and east. Like many embayment's located on glacial outwash plains, Waquoit Bay is shallow (< 5 m), fronted by prominent barrier beaches (i.e., those of South Cape Beach State Park and Washburn Island), and is backed by salt marshes and upland coastal forests of scrub pine and oak. Two narrow, navigable inlets, reinforced with granite jetties, pass through two barrier beaches to connect Waquoit Bay with Vineyard Sound to the south. A third shallow and generally un-navigable inlet opened through the Washburn Island barrier beach during Hurricane Bob in August 1991, and closed up in February 2002.

Bottom sediments in the bay are organic rich (Corg conc. ~ 3-4%) silts and medium sands. Sediment cores taken in summer of 2002 indicate that the depth of these estuarine sediments is up to 9 m thick in places. Dating work on these sediment cores suggests that the Waquoit Bay basin has been inundated by the sea for about 5000 years, and sedimentation rates over the past 500 years are estimated to be range from 1.6 to 4.9 mm/yr. Thick (up to 0.3 m) macroalgae (seaweed) mats overlie much of the bottom of the bay, and largely consist of species *Cladophora vagabunda*, *Gracilaria tikvahiayae*, and *Enteromorpha*. The dominant marsh vegetation in Waquoit Bay is *Spartina alterniflora* and *Spartina patens*. Dominant upland vegetation includes mixed forests of red oak, white oak, and pitch pine, and other shrubs and plants common to coastal New England. Land-use in the bay's watershed is about 60% natural vegetation, but the remaining land is largely residential housing, with some commercial (retail malls), and minor amounts of agriculture (~3%; e.g., cranberry bogs).

Dense housing developments cover the two peninsulas that form the western shore of the Waquoit Bay estuarine system. Although the developments themselves are outside of the Reserve boundaries, dissolved nitrogen in discharges from their septic systems (via groundwater) and in fertilizer run-off from their lawns has significant effects on the functioning of the Waquoit Bay ecosystem. These impacts have been a primary subject of study at the Reserve since its designation (1988). One outcome of this research has been the delineation of sub-watersheds within the overall drainage area for Waquoit Bay, of which WBNERR is a small part. This knowledge allows for the design of experiments based on the spatial variation of nutrient loading and other land-use related impacts.

At the northern end of the bay, an area comprising a separate sub-watershed, coastal bluffs of glacial till rise 30 feet above sea level. The northern basin of the bay, just below these bluffs, is its deepest area (approximately 3 m MLW), while much of the remainder of the bay is about 1.5 m. Bourne, Bog, and Caleb Ponds are freshwater kettle hole ponds on the northern-most shore of the bay. As components of the same sub-watershed, they have a common albeit minor freshwater outflow into the bay's northern basin via a narrow channel through a brackish marsh. To the east and south, other sub-watersheds

surround several tidal and freshwater ponds, including Hamblin and Jehu Ponds, brackish salt ponds that are connected to the main bay by the tidal waters of Little and Great Rivers, respectively. The shorelines of the ponds are developed with residences that are occupied both seasonally and year round. Hamblin Pond and Little River are components of one sub-watershed, and Jehu Pond and Great River are elements of a separate sub-watershed. Further south lays Sage Lot Pond. It is in the least developed sub-watershed and also contains a barrier beach and salt marsh ecosystem of the reserve's South Cape Beach State Park. To the east of Sage Lot Pond and within the same sub-watershed, lies the highly brackish Flat Pond. It receives minimal tidal flows of salt water from Sage Lot Pond through a narrow, excavated and culvert. In the spring of 2008 two (2) channel culverts were replaced, one with a bridge and the second with a wider, less restrictive culvert to aid in tidal flushing of the pond. The preponderance of the input to Flat Pond is groundwater and run off, both of which are likely affected (e.g., nutrients, pesticides, bacteria) by an adjacent golf course and near-by upper-scale residential development.

The largest source of surface freshwater to Waquoit Bay is the Quashnet / Moonakis River. Although named "river", this and Child's River are more appropriately described as "streams" because of their small channels and discharge ~1.0 CFS. A component of yet another sub-watershed, the Quashnet River originates in Johns Pond situated north of the bay and traverses forests, cranberry bogs, residential areas, and the Quashnet Valley Golf Course before entering the bay near the southern "boundary" of the northern basin. ("Quashnet" applies to that portion of the river within the town of Mashpee, and "Moonakis" refers to the brackish estuary at the river's mouth, lying in the town of Falmouth. Quashnet will be used hereafter to refer to the entire river.) The Quashnet River's tidal portion has sufficient numbers of coliform bacteria to cause it to be closed to shell fishing most of the time. The source(s) of these bacteria (human or avian) is unknown at this time.

The Childs River is the second largest input of surface freshwater to the bay. A component of another sub-watershed, it runs through densely developed residential areas. The Childs River sub-watershed receives the highest nitrogen loading and is the largest nitrogen contributor to the Waquoit Bay system of all the sub-watersheds. In the upper tidal portions of the river the highest nutrient and chlorophyll levels and the lowest dissolved oxygen readings of any region in the bay have been recorded and so this location represents an end-member for looking at anthropogenic inputs and impacts on the system. Another, albeit smaller, source of freshwater to Waquoit Bay is the discharge of Red Brook through brackish marshlands into Hamblin Pond. Additional freshwater enters the bay elsewhere through groundwater seepage (perhaps up to 50% of all freshwater input into the bay), precipitation and the flows of smaller brooks. There is relatively little surface water runoff entering directly into the bay due to the high percolation rates of Cape Cod's coarse, sandy soils.

Knowledge of the homo/heterogeneity of the water masses in Waquoit Bay was originally derived from measurements made by reserve staff and from data obtained by the reserve's volunteer water quality monitoring group, the Waquoit BayWatchers who have collected depth profiles of Waquoit Bay water quality since 1993. Subsequent research by reserve staff (including some numerical modeling by T. Isaji) has revealed that lateral mixing has considerable influence because tidal currents follow a general course through the bay. This results in an overall structure to horizontal patterns of water quality characteristics. The pattern it produces is a gyre in the central portion of the main bay whereby currents follow a generally counter-clockwise flow around a central area that exhibits reduced exchange with the remainder of the bay. The flushing rate within the gyre is diminished when compared with other more

peripheral areas of the bay. The location of the gyre meanders slightly, apparently under the influence of tides and wind. Because of the shallow conditions, restricted tidal inlets, and low amplitude tidal forcing of Vineyard Sound here (tides are semi-diurnal with a range about 0.5 m) water levels in the bay are also strongly influenced by wind forcing. Southerly winds increase tidal heights and advance the phase of the flood and retard the phase of ebb (Northerly winds have the opposite effect).

Metoxit Point (MP)

The Metoxit Point station (41^{o} 34.119 N 70^{o} 31.281' W, 2.2 m deep) initiated in 1998, is located in the main basin of Waquoit Bay and was selected to be within or near the outer regions of the gyre (described above) and more or less represents "typical" water mass conditions and residence times for the bay. The location is at least a half mile from shore, well flushed and mixed by tides, and is in an area that is minimally disturbed by routine activities on the bay (e.g. boat traffic, shell fishing, etc.). Bottom sediments at the site are organic rich mud often overlain by thick algal (*Cladophora*) mats. Because of this site's fairly open exposure to the south (greatest fetch over the bay), it has been observed that when sustained southerly winds are greater than about 20 kts, the Metoxit Point site experiences increased turbidity (sediment suspension events).

A mean tidal range of 0.46m (SD = 0.17) is calculated based on one month of data (May 2003), with a minimum of 0.13 m and a maximum of 0.91 m. A mean monthly salinity range of 4.2 ppt, from a mean monthly min of 27.8 ppt to a mean monthly max of 32.0 ppt, has been calculated for this site based on one year of observations (2002).

Menauhant Yacht Club (MH)

The Menauhant station (41^{o} 33.156' N 70^{o} 32.912' W, 1.2 m deep), initiated in March 2001, is located within the Eel Pond Inlet at the Menauhant Yacht Club dock. Eel Pond Inlet is the westernmost of the two main tidal inlets into the Waquoit Bay system. The site was chosen because it occupies one of the strategic locations for gauging the system's water mass characteristics. Entering waters represent the marine end-member while outflows represent the final product of estuarine water mass modification and export to shelf waters. The site also has easy walk-in access to a secure private pier that extends into the throat of the inlet.

Also, because of the turbulent tidal flow within the inlet, conditions are vertically well mixed, and the site can be maintained year round even through ice-over conditions in the rest of the bay during severely cold winters. Bottom sediments at this site are clean sands and gravels with almost no attached bottom vegetation. Since inception, we have noted that strong south to southeast (onshore) winds tend to produce turbidity events at this site from the wave induced suspension of fine sediments and organic material in the upstream near-shore zone. While we have found that these types of turbidity events are localized to windward near-shore areas in the bay, the transport of these sediments at inlet mouths during such times is perhaps a dominant sedimentation process within the estuarine system. In other words, while the choice of our location may be producing a localized signal in one of our measured parameters that signal may reflect key processes in the system at large.

A mean tidal range of 0.48m (SD = 0.19) is calculated based on one month of data (May 2003), with a minimum of 0.11 m and a maximum of 0.99 m. A mean monthly salinity range of 3.9 ppt, from a mean monthly min of 28.5 ppt to a mean monthly max of 32.4 ppt, has been calculated for this site based on one year of observations (2002).

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Child's River (CR)

The Child's River station (41° 34.793' N 70° 31.854' W, 1.2 m deep), initiated in May 2002, is located on a dock piling at Edwards Boat Yard, a commercial marina near the upper tidal reaches of Child's River— one of the two main surface fresh water sources to Waquoit Bay (see general description of Waquoit Bay watershed above). This location is very strongly stratified, characterized by a salt wedge with fresher river water overlying saline ocean water. Vertical salinity ranges can run from 0-10 ppm at the surface to more than 30 ppm just 1 m below. The Sonde sensors are usually well within the salt wedge portion of the water column, nonetheless this location is also our freshest SWMP site, and is at the opposite end of Child's River from the seaward Menauhant station. Bottom sediments are fine organic rich muds.

This location represents the most terrigenously and anthropogenically-impacted SWMP site. Monthly water quality, collected near this location for the past decade, shows very high chlorophyll concentrations during the warmer months and more recent dissolved nutrient records show very high nutrient-loads. Boat traffic at the marina likely leads to increased turbidity during the boating season as well. As this site is dockside at a private marina, general security is high and access is easy available. The station is also serviceable year-round and usually not subject to seasonal shutdown due to ice over.

A mean tidal range of 0.46 m (SD = 0.17) is calculated based on one month of data (May 2003), with a minimum of 0.11 m and a maximum of 0.95 m. A mean monthly salinity range of 14.7 ppt, from a mean monthly min of 15.8 ppt to a mean monthly max of 30.5 ppt, has been calculated for this site based on one year of observations (2002).

Sage Lot (SL)

The Sage Lot station (41° 34.7' N 70° 31.18' W, 1.2 m deep), initiated in May 2002, is located in a deeper portion of Sage Lot Pond – a small sub-estuary of Waquoit Bay (20 ha) surrounded by salt marsh and barrier beach. Its small watershed is the least developed of all of Waquoit Bay's sub-watersheds and Sage Lot Pond is considered to be its least impacted and most pristine sub-estuary. Bottom sediments are organic rich muds. Sage Lot Pond possesses one of the few remaining eelgrass beds in the Waquoit Bay system.

The Child's River and Sage Lot Pond sites are considered to represent opposite end-members of nutrient-loading and human-induced influence. Researchers often locate their experiments in these two locations to take advantage of this difference. However, Sage Lot Pond is hydrologically connected to an upstream brackish source -- Flat Pond – via a series of tidal creeks, drainage ditches and culverts. Flat Pond borders a country club and golf course and some concern exists for its impact on the water quality of Sage Lot Pond. Currently, Sage Lot Pond is closed to shellfishing in summer months because of high fecal coliform concentrations, though these are thought to be of avian source.

A mean monthly salinity range of 4.9 ppt, from a mean monthly min of 27.2 ppt to a mean monthly max of 32.1 ppt, has been calculated for this site based on one year of observations (2002).

6) Data collection period:

SWMP water quality monitoring in Waquoit Bay was initiated in 1995. Several different pilot sites (i.e., North Basin and Central Basin) were occupied for varying durations before settling on our first permanent long term site at Metoxit Point in summer 1998. The Menauhant site was our second permanent station and began operation in March 2001. Sage Lot and Childs River sites began operation in May 2002. For 2014, the Sage Lot and Metoxit Point station towers were removed over the winter to prevent damage or loss of station from ice. The stations were reinstalled and instrumented in June 2014. At Menauhant, following the hard winter, this station was reoccupied in April 2014. Childs River also began continuous data collection in May 2014. The deployment dates and times for the all four quarters (January - December) of 2014 are indicated below:

Menauhant Site

START	END
12/12/2014, 13:00	01/22/2014, 01:00 *(downloaded from satellite/CDMO)*
04/09/2014, 16:00	05/27/2014, 21:30
(missing data 5/27/14 - 5/30/14 due to battery failure)	
05/30/2014, 16:15	06/23/2014, 08:45
06/23/2014, 09:00	07/15/2014, 09:15
07/15/2014, 09:30	08/08/2014, 08:15
08/08/2014, 08:30	08/22/2014, 12:45
08/22/2014, 13:15	09/16/2014, 13:45
09/16/2014, 13:30	10/08/2014, 09:30
10/08/2014, 09:45	10/29/2014, 12:00
10/29/2014, 12:15	11/03/2014, 11:00
11/03/2014, 11:15	11/23/2014, 11:45
11/23/2014, 12:15	12/18/2014, 10:45
12/18/2014, 11:00	12/19/2014, 10:30 *(30 minute interval data)*
12/19/2014, 11:15	01/07/2015, 14:00

Metoxit Point Site

START	END
06/06/2014, 09:00	06/27/2014, 09:30
06/27/2014, 10:00	07/17/2014, 10:00
07/17/2014, 10:15	08/04/2014, 07:45
08/04/2014, 08:00	08/26/2014, 13:45
08/26/2014, 14:00	09/18/2014, 12:00
09/18/2014, 12:15	10/10/2014, 09:15
10/10/2014, 09:30	10/30/2014, 09:30
10/30/2014, 09:45	11/19/2014, 00:30
(missing data from 11/19/2014 to 11/25/2014 due to unexpected battery failure)	
11/25/2014, 12:15	12/18/2014, 13:45

Child's River Site

START	END

05/30/2014, 16:00	06/23/2014, 08:45
06/23/2014, 09:00	07/15/2014, 09:30
07/15/2014, 09:45	08/08/2014, 08:45
08/08/2014, 09:00	08/28/2014, 08:45
08/28/2014, 09:00	09/16/2014, 13:45
09/16/2014, 14:00	10/08/2014, 09:45
10/08/2014, 10:00	10/30/2014, 11:00
10/30/2014, 11:30	11/23/2014, 12:30
11/23/2014, 12:45	12/18/2014, 11:00

Sage Lot Site

START	END
06/04/2014, 15:30	06/25/2014, 09:30
06/25/2014, 09:45	07/17/2014, 12:00
07/17/2014, 12:15	08/11/2014, 10:15
08/11/2014, 10:30	08/26/2014, 12:30
08/26/2014, 12:45	09/19/2014, 10:30
09/19/2014, 10:45	10/09/2014, 10:45
10/09/2014, 11:00	10/31/2014, 12:45
10/31/2014, 13:15	11/25/2014, 13:00
11/25/2014, 13:15	12/15/2014, 14:45

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 http://cdmo.baruch.sc.edu/. Data are available in comma delimited format.

8) Associated researchers and projects:

The Reserve has carried out a citizen-based water quality monitoring program since 1993 called *BayWatchers*. Water quality measurements are carried out at 9 sites within Waquoit Bay estuary for the purposes of 1) constructing a long time series of water quality information to determine trends, as well as 2) providing a sentinel role to detect unusual changes and events. Monthly (October-May) and Bi-weekly (June-September) measurements are made year-round on a set schedule. Chl-*a* samples are processed and analyzed using a HACH spectrophotometer at WBNERR until August 2015 and a Turner 10-AU fluorometer following August 2015. Dissolved inorganic nutrient samples are currently analyzed bycollaborating laboratory. All data are processed and archived at WBNERR and are publicly available.

A new field procedure was initiated in July 2007 and a ninth site was added at the south basin of Waquoit Bay at the first inlet buoy in the main channel. A change at this time was made from previous wet chemical measurements to utilizing hand-held YSI 85 meters to measure water temperature, salinity, and dissolved oxygen (% and mg/L). Each meter is calibrated each sampling period for dissolved oxygen. Measurements are taken at the surface (0.25m) and the bottom at each site. The bottom depth is recorded. Additionally, due to shallow depths in most sites, water clarity measurements with Secchi discs have been discarded for a more meaningful analysis of turbidity. Turbidities are run on a portable turbidity meter (Orbeco-Helige Model #3322). The direct-reading display gives results in 0.01 NTUs (Nephelometric Turbidity Units), has drift-free reading, has an automatic error-free decimal shift, and a low battery signal. The turbidity meter range and sensitivity are: Low: 0.00 to 19.99 NTU, resolution 0.01 NTU; Medium: 00.0 to 199.9 NTU, resolution 0.1 NTU; High: 000 to 999 NTU, resolution 1 NTU. Accuracy: ±2% of reading for low and medium ranges. Repeatability: ±1%. Design in accordance with USEPA Method 180.1. Sample tubes are optically reproducible 28 mm O.D. X 61 mm glass vials with screw caps. The reserve utilizes two calibration standards:0 NTU and 100 NTU; the standards after every five samples.

Two bottles of water are now collected at each site, at approximately 0.25m below the surface, by locking the bottles into a handheld apparatus. This new sampling procedure has helped in standardizing the depth sampled for all sites in our chemical analysis. The bottles are mounted to a pole and capped with rubber stoppers attached to a rope. When the bottles are lowered to a marked level (0.25m) on the apparatus, the rope is pulled and water enters the bottle. The cap is placed on the bottles and returned back to the lab for turbidity, chlorophyll, and nutrient analysis. Physical characterization of the site and sampling period are recorded each sampling date (time of sampling, weather conditions-sun/clouds/rain/fog, name of team members, etc) and any other observations are recorded.

II. Physical Structure Descriptors

9) Sensor specifications:

YSI 600QS/YSI 650 EDS data logger (**Hand-held YSI for field comparison readings only**)
Parameter: Temperature, Conductivity/ Salinity, Dissolved Oxygen, pH, Depth
See below for probe specifications.

YSI 6600 V2 data logger (six (6) units)
Parameter: Temperature
Units: Celsius (C)
Sensor Type: Thermistor
Model #: 6560
Range: -5 to 45 °C
Accuracy: +/-0.15 °C
Resolution: 0.01 °C

Parameter: Chlorophyll
Units: microgram per Liter (µg/Liter)
Sensor Type: optical, fluorescence, with mechanical cleaning
Model #: 6025
Range: 0 to 400 µg/L Chl; 0-100 Percent Full Scale (%FS) Fluorescence
Accuracy: No specification provided
Resolution: 0.1 µg/L Chl; to 0.1 % FS

Parameter: Conductivity
Units: milli-Siemens per cm (mS/cm)
Sensor Type: 4-electrode cell with auto-ranging
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

Parameter: Non-Vented Level – Shallow (Depth)
Units: feet or meters (ft or 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: 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: +/- 5 % reading or 2 NTU (whichever is greater)
Resolution: 0.1 NTU

Parameter: Dissolved Oxygen % saturation
Units: percent air saturation (%)
Sensor Type: Optical, Luminescence Lifetime
Model#: 6150
Range :0 to 500% air saturation
Accuracy: 0-200% air saturation, +/-1% if the reading or 1% air saturation, Whichever is greater
200-500% air saturation, +/- 15% of reading; Relative to Calibration Gases.
Resolution: 0.1% air saturation

Parameter: Dissolved Oxygen mg/L (Calculated from % air saturation, temperature and salinity)
Units: milligrams per Liter (mg/L)
Sensor Type: Optical, Luminescence Lifetime
Model #: 6150
Range: 0 to 50 mg/L
Accuracy: 0 to 20 mg/L, +/- 1% of the reading or 0.1 mg/Lm whichever is greater
20 to 50 mg/L, +/- 15% of the reading; Relative to Calibration Gases.
Resolution: 0.01 mg/L

Sensor Qualifiers:

Dissolved Oxygen Qualifier (Rapid Pulse / Clark type sensor):

The reliability of dissolved oxygen (DO) data collected with the rapid pulse / Clark type sensor after 96 hours post-deployment for non-EDS (Extended Deployment System) data sondes may be problematic due to fouling which forms on the DO probe membrane during some deployments (Wenner et al. 2001). Some Reserves utilize the YSI 6600 EDS data sondes, which increase DO accuracy and longevity by reducing the environmental effects of fouling. Optical DO probes have further improved data reliability. The user is therefore advised to consult the metadata for sensor type information and to exercise caution when utilizing rapid pulse / Clark type sensor DO data beyond the initial 96-hour time period. Potential drift is not always problematic for some uses of the data, i.e. periodicity analysis. It should also be noted that the amount of fouling is very site specific and that not all data are affected. If there are

concerns about fouling impacts on DO data beyond any information documented in the metadata and/or QAQC flags/codes, please contact the Research Coordinator at the specific NERR site regarding site and seasonal variation in fouling of the DO sensor.

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:

All NERRS sites are required to use the following file naming convention.

File definitions: NERR Reserve/YSI deployment site/data type code/year

Station Codes:

Sampling Station	Sampling Site Code	Station Code
Metoxit Point	MP	wqbmpwq
Menauhant	MH	wqbmhwq
Child's River	CR	wqbcrwq
Sage Lot	SL	wqbslwq

Example: wqbmpwq2008 (designates 2008 water quality data for the Metoxit Point site)

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.

-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:

End of Deployment Post-calibration Readings in Standard Calibration Solutions**:**

Sage Lot

Site	Date Retrieved	DO	Baro. Pres.	Depth	Depth Offset	SpCond	pH 7	pH 10	Turbidity DI	Turbidity	Chl 0 DI	Chl Rhodamine	Rhodamine Std value
		%	mmHg	m	m	mS/cm			NTU	NTU	µg/L	µg/L	µg/L
SL	06/25/2014	97.9	760	0.0070	0.0	49.86	6.87	9.9	1.5	126.7	-0.4	121.4	125.7

	07/17/2014	99.9	759	-0.019	-0.014	50.26	7.03	9.99	2.8	128.6	0.8	121.0	121.3
	08/11/2014	101.9	756.6	-0.027	-0.046	50.0	7.09	9.81	0.1	124.3	-0.5	118.5	121.8
	08/26/2014	100.2	759.0	-0.016	-0.014	49.77	6.99	9.96	1.5	129.6	-1.0	125.7	124.0
	09/19/2014	100.3	769.0	0.123	0.122	48.63	7.05	10.03	2.3	127.1	1.3	112.8	120.4
	10/09/2014	100.0	758.0	-0.010	-0.028	50.47	6.62	9.94	1.8	128.2	0.4	157.2	153.7
	10/31/2014	99.5	759.0	-0.010	-0.014	49.86	7.07	10.16	0.1	129.2	-0.4	155.9	153.9
	11/25/2014	100.5	759.0	-0.012	-0.014	49.40	7.07	10.10	2.1	126.3	0.5	151.2	148.3
	12/15/2014	100.5	752.0	-0.108	-0.109	49.68	7.0	10.0	-1.7	125.9	-0.1	110.0	120.9

Childs River

Site	Date Retrieved	DO	Baro. Pres.	Depth	Depth Offset	SpCond	pH 7	pH 10	Turbidity DI	Turbidity	Chl 0	Chl Rhodamine	Rhodamine Std value
		%	mmHg	m	m	mS/cm			NTU	NTU	µg/L	µg/L	µg/L
CR	06/23/2014	99.0	764	0.059	0.054	49.71	7.08	10.07	-1.6	135.0	-0.1	119.4	124.4
	07/15/2014	98.7	756	-0.064	-0.054	51.95	7.09	10.04	2.4	128.1	15.2	117.8	117.8
	08/08/2014	99.8	760	0.01	0.0	51.68	7.07	10.13	1.9	125.3	0.2	140.9	145.3
	08/28/2014	97.1	755.0	-0.061	-0.068	50.33	6.91	9.96	1.6	127.4	-0.1	121.6	122.7
	09/16/2014	97.6	759.0	-0.013	-0.014	50.36	7.05	10.11	2.8	127.2	0.3	128.7	125.1
	10/08/2014	97.0	755.0	-0.073	-0.068	49.93	7.05	10.04	0.3	125.4	0.8	142.5	144.8
	10/30/2014	99.3	758.0	-0.038	-0.028	49.3	7.0	10.0	1.7	128.0	0.3	116.4	117.4
	11/23/2014	100.4	753.0	-0.091	-0.096	50.33	6.89	9.86	1.6	125.1	-0.1	117.3	120.4
	12/18/2014	99.1	755.5	-0.067	-0.062	49.26	7.09	10.09	2.3	125.8	0.7	111.6	123.2

Metoxit Point

Site	Date Retrieved	DO	Baro. Pres.	Depth	Depth Offset	SpCond	pH 7	pH 10	Turbidity DI	Turbidity	Chl 0	Chl Rhodamine	Rhodamine Std value
		%	mmHg	m	m	mS/cm			NTU	NTU	µg/L	µg/L	µg/L
MP	06/27/2014	100.8	763	0.043	0.041	51.11	7.15	10.13	1.7	124.6	-0.5	118.4	121.7
	07/17/2014	99.4	759	-0.003	-0.014	49.97	7.04	10.03	-0.5	126.8	0.2	127.2	120.9
	08/04/2014	100.9	761	0.019	0.014	49.50	6.98	9.99	1.1	125.0	0.8	139.1	139.2
	08/26/2014	98.6	759	-0.011	-0.014	50.05	7.11	9.96	-1.1	125.6	0.1	120.3	125.7
	09/18/2014	100.3	769	0.116	0.122	48.76	7.03	9.96	1.3	126.1	0.3	114.8	120.4
	10/10/2014	100.4	761.4	0.025	0.019	49.81	7.02	9.99	1.3	127.6	-0.3	152.7	153.4
	10/30/2014	100.0	758.0	-0.029	-0.028	49.10	7.19	10.20	-2.3	125.4	-1.4	116.6	117.4
	11/25/2014	101.1	759.0	-0.050	-0.014	49.26	7.03	10.05	2.3	126.1	0.6	141.1	144.8
	12/18/2014	99.5	755.0	-0.069	-0.068	50.48	7.11	10.13	-2.4	124.2	-0.3	116.0	126.6

Menauhant

Site	Date Retrieved	DO	Baro. Pres.	Depth	Depth Offset	SpCond	pH 7	pH 10	Turb DI	Turb	Chl 0	Chl Rhodamine	Rhodamine Std value
		%	mmHg	m	m	mS/cm			NTU	NTU	µg/L	µg/L	µg/L
MH	06/23/2014	97.9	761	0.030	0.014	31.86	7.19	10.27	-1.9	124.0	4.00	125.3	125.9
	07/15/2014	99.4	755.5	-0.06	-0.061	50.14	6.84	9.87	-3.4	129.2	-0.8	121.4	119.4
	08/08/2014	101.1	760	0.0	0.0	49.84	7.11	10.12	4.7	129.4	0.5	134.3	137.0
	08/22/2014	0.0	762	0.0	0.027	49.07	7.08	10.13	-77.9	-77.3	-27.6	-40.2	120.2
	09/16/2014	101.4	759	0.013	-0.014	51.32	7.08	10.05	2.1	126.8	0.1	123.2	119.4

10/08/2014	99.2	755	-0.072	-0.068	50.03	6.92	9.92	0.7	125.1	-0.2	149.4	152.4
11/07/2014	98.7	748.0	-0.180	-0.163	48.73	7.13	10.11	2.1	122.1	-0.1	110.4	115.4
11/23/2014	100.6	754.0	-0.067	-0.082	50.26	7.17	10.20	1.7	126.5	0.0	127.1	128.4
12/18/2014	99.4	755.0	-0.072	-0.068	50.83	7.04	10.04	1.3	126.6	0.5	113.2	124.7
01/07/2015	99.0	755.0	-0.068	-0.068	51.50	7.08	10.09	0.3	130.0	-0.7	152.2	140.4

14) Other remarks/notes:

NOTE 1: SMALL NEGATIVE TURBIDITY ANOMALIES: Slight negative turbidity values sometimes occur as a result of small calibration offsets. Often these turbidity minimum values are between 0 and -2 NTU. All of these small negative turbidity values (the minimum for a given deployment) should be considered to be within 2 NTU of the true datum for correction purposes. This data has been given a Flag Code of <1> and retained.

NOTE 2: BIOLOGICAL-RELATED TURBIDITY ANOMALIES: This type anomaly includes turbidity readings that are either outside of the normal range or spikes way above background and unrelated to increased sediment suspension or decreased water column clarity. We believe these records are real (and not sensor malfunction), though not reflective of actual water column turbidity. These extreme values are likely due to biological factors (such as small fish, crabs, or other marine organisms). Our criteria for flagging these data are single spikes (above rather constant background) over 50NTU that are more than 10 times surrounding values. These readings were rejected <-3>. Additionally, turbidity readings that are outside the normal range and may be related to a short-term biological impact (e.g., crab or shrimp hovering near or on the optic sensor), but last for greater than one or two readings, are flagged as suspect <1> STS (sensor-error, turbidity spike).

NOTE 3: SUSPENSION EVENT RELATED TURBIDITY ANOMALIES: This type of anomaly includes turbidity readings that were either outside the normal range, or spikes above background that are related to elevated turbidity levels indicative of wind wave-induced suspension (at the Menauhant site typically where vegetation often re-circulates due to wind and tidal currents or gets caught on the sonde guard) or prop wash-related suspension events (at the Childs River site typically). We believe these are real (and not sensor malfunction), though not reflective of actual water column turbidity. These extreme values are likely due to large floating particles (i.e., seaweeds, detritus, etc.) suspended in the water column during storm events usually from strong southerly winds in the Waquoit Bay area. (see end of section 5 for more detail on these events at this site). Our criteria for flagging these data as rejected <-3> are values over 100NTU that are more than 5 times the magnitude of surrounding values, and linked to high winds.

NOTE 4: SMALL NEGATIVE DEPTH ANOMALIES: This type of anomaly occurs due to barometric pressure differences between time of calibration and the reading and ice conditions. In all such cases, barometric pressure differences are checked as well as comparison with other parameters for indications of aerial exposure to verify that all data are valid submerged readings.

NOTE 5: MISSING DATA: 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.

NOTE 6: ELEVATED CHLOROPHYLL FLUORESCENCE ANOMALIES

Due to interference from biofouling or floating detritus, the chlorophyll fluorescence optic sensors will record values which are above the normal environmental range. Values over three times the magnitude of surrounding values are flagged as suspect <1> and given the code [SCS] indicating a chlorophyll spike. Additionally, sustained values > 100µg/L are considered suspect unless the conditions at the site can be verified (e.g., discrete chlorophyll samples processed in the lab). Spikes that exceed 400 µg/L are flagged as rejected <-3> with the code [SCS].

FIELD and "CSM" NOTES:

All times reported in Eastern Standard Time (EST)

January 2014

Menauhant: The sonde deployed on 11/14/2013 had its batteries replaced on 12/10/2013 (pulled at 9:10 and redeployed at 13:17) but the memory was not reset. The memory filled on 12/22/2013 and subsequent data were not stored on the sonde although they were sent via satellite to the CDMO database. The batteries lasted until 01/22/2014 at 1:00 after which point no data were recorded. The January 2014 data were retrieved through the CDMO website and included in the quarterly provisional data.

February – March 2014

No YSI datasondes deployed.

April 2014

Menauhant: Only sonde occupied site. No field/lab notes.

May 2014

Sage Lot: 6/4/14 – installed silo to station (after winter removal) and deployed 6000series V2 sonde.
Childs River: Started 2014 data collection on 5/30/14
Menauhant: Battery (from 04/09/14 deployment) failed on 05/27/14. Replacement sonde was deployed on 5/30/14 and data collection resumed.
Metoxit Point: 6/6/14 – installed upper silo piece to station tower (after winter removal) and deployed V2 sonde.

June 2014

Childs River: No field/lab notes.

Menauhant: The pH is suspiciously low during the 06/23/2014 – 7/15/2014 deployment – may be incorrect/contaminated buffer standard. Data marked as suspect as part of QA/QC checks.
Metoxit Point: Heavy biofouling clogged the conductivity sensor and caused inaccurate readings for last two days of deployment.
Sage Lot: No field/lab notes.

July 2014

Hurricane Arthur hit the East Coast on July 4th, 2014. Data loggers received no obvious damage.

Metoxit Point: The water quality station tower was knocked over on 07/22/2014 at 19:45 (EST; cause unknown). Depth data during this period of the deployment is rejected. All other parameters during this deployment are notated as "collected at wrong depth". The tower was resurrected to normal upright position on 08/01/2014 at 8:30 (EST).
Sage Lot: No field/lab notes.
Menauhant: No field/lab notes.
Childs River: Upward drift in chlorophyll fluorescence is flagged as "Suspect" between 07/18-2014 to the end of the deployment (08/08/2014).

August 2014

During the first week of August, there was a notable "shrimp kill" due to hypoxic conditions in the estuary. All sondes note this low dissolved oxygen event.

Menauhant: 1) All optic probes failed during deployment on 08/16/14. The malfunction was discovered via the telemetry data online on 08/22/14, and the sonde was rotated out with a calibrated replacement sonde. The rotation occurred at 13:01 (08/22/14). The telemetry cable was suspected of a leak from corrosion at the sonde connection. The telemetry cable was disconnected as a result at 15:30. The infield check and cable disconnection that occurred at 15:30 does not appear to have impacted the readings. 2) Calibration for specific conductivity and salinity appear off between 08/08/2014 to 08/22/2014 (baseline is lower than previous deployment).
Sage Lot: No field/lab notes.
Childs River: No field/lab notes.
Metoxit Point: No field/lab notes.

September 2014

Menauhant: 1) The telemetry cable was replaced on 09/18/2014 and connection was restored to the sonde at 14:45 (data does not appear impacted during those readings). 2) Calibration for specific conductivity and salinity appear off between 08/22/2014 to 09/16/2014 (baseline is higher than previous and following deployments).
Sage Lot: No field/lab notes.
Childs River: No field/lab notes.
Metoxit Point: No field/lab notes.

October 2014

Metoxit Point: The pH measurements were out of calibration when retrieved – entire deployment of pH data appears suspect. Turbidity measurements are also out of calibration – too low. DI solution may have been compromised during initial calibration.
Sage Lot: No field/lab notes.
Childs River: No field/lab notes.
Menauhant: No field notes.

November 2014

Metoxit Point: Battery failure on 11/19/14 resulted in several days of lost data.
Childs River: The pH measurements look suspiciously high following deployment on 11/23/2014. Although the pH was calibrated and then recalibrated with standard buffers (7 and 10) according to calibration sheet, the measurements still seem off.
Sage Lot: Starting on 11/25/14, turbidity calibration is off – numbers are too low. All data is suspect. The pH is also suspect after 11/25/14 – slightly lower on average than previous deployment. However, pH is not outside of reasonable range. Lastly, specific conductivity and salinity are marked as suspect during final deployment because range changes drastically upon sonde rotation. No obvious biofouling was noted on the temperature/conductivity probe and post-calibration was normal.
Menauhant: The pH is suspiciously low during the 11/07/14 to 11/23/14 deployment – may be incorrect/contaminated buffer standard. Data marked as suspect as part of QA/QC checks.

December 2014

Metoxit Point: Turbidity looks too low throughout deployment starting on 11/25/14 – all data marked as suspect; out of calibration during post-calibration, too.
Sage Lot: Turbidity calibration is off – numbers are too low. All data is suspect. The pH is also suspect – slightly lower on average than previous deployment. However, pH is not outside of reasonable range. Lastly, specific conductivity and salinity are marked as suspect during final deployment because range changes drastically upon sonde rotation. No obvious biofouling was noted on the temperature/conductivity probe and post-calibration was normal.
Childs River: No field/lab notes.
Menauhant: Storm event starting December 25, 2014 and dredging of Eel River resulted in high turbidity measurements from December 25 through the end of deployment on January 7th, 2015. Additionally, at Menauhant on December 18th through December 19th, the sonde was accidentally programmed at 30 minute intervals. This mistake was corrected by resetting the sonde (in situe) to 15 minute intervals on December 19th at 11:15.

YSI 650 In-Situ Comparison Data

A hand-held YSI 650 was used for field calibration and data were recorded at YSI deployment depths. Sonde deployment and retrieval (or last / first) comparisons for each site in addition to the hand-held measurements are shown below in Tables 1-4. They represent another form of post-check on retrieved

Sonde data as it is assumed that the recently calibrated deployed Sonde is highly accurate on its initial measurement. If the assumption holds true we should expect last / first readings to be quite similar within the usual 15 minute time difference between readings if the retrieved instrument was still reading accurately. Large differences indicate potential problems. However there are some caveats to this comparison approach. If time differences between retrieval and deployment are much greater than 15 minutes, then parameter differences should be also greater, and certainly lose any usefulness beyond a few hours. Also, at certain times some parameters are changing quite rapidly and a 15 minute interval could allow for real and rather large differences. One example is DO during late morning and early afternoon, when DO is often ramping up rapidly -- or salinity can change rapidly in areas where the gradients (both vertical and horizontal) are large (i.e., Child's River).

Table 1: Metoxit Point (MP) Deployment/Retrieval YSI 650 Data

	Date	Time	Temp	SpCond	Salinity	DO %	DO Conc.	pH	Depth
MP	M/D/Y	hh:mm:ss	C	mS/cm	ppt	%	mg/L		m
Deploy	6/6/14	08:57	18.43	46.95	29.86	88.7	6.96	7.50	0.892
Retrieve	6/27/14	09:35	22.52	46.83	30.47	88.1	6.39	7.73	0.949
Deploy	6/27/14	09:33	22.52	46.83	30.47	88.1	6.39	7.73	0.949
Retrieve	7/17/14	10:04	23.77	44.38	28.66	78.7	5.64	7.47	0.594
Deploy	07/17/14	10:04	23.77	44.38	28.66	78.7	5.64	7.47	0.594
Retrieve	08/04/14	07:46	22.4	45.64	29.60	85.4	6.35	7.71	1.158
Deploy	08/04/14	07:46	22.4	45.64	29.60	85.4	6.35	7.71	1.158
Retrieve	08/26/14	13:57	24.7	46.60	30.26	130.0	9.09	7.87	0.689
Deploy	08/26/14	13:57	24.7	46.60	30.26	130.0	9.09	7.87	0.689
Retrieve	09/18/14	12:14	21.25	48.82	31.81	153.3	11.27	6.89	1.254
Deploy	09/18/14	12:14	21.25	48.82	31.81	153.3	11.27	6.89	1.254
Retrieve	10/10/14	09:19	16.48	47.92	31.25	93.9	7.61	7.71	1.217
Deploy	10/10/14	09:19	16.48	47.92	31.25	93.9	7.61	7.71	1.217
Retrieve	10/30/14	09:14	15.27	45.62	29.6	97.2	8.14	7.22	0.661
Deploy	10/30/14	09:14	15.27	45.62	29.6	97.2	8.14	7.22	0.661
Retrieve	11/25/14	12:03	10.09	46.87	30.28	104.7	9.75	7.36	1.053
Deploy	11/25/14	12:03	10.09	46.87	30.28	104.7	9.75	7.36	1.053
Retrieve	12/18/14	13:47	5.97	46.27	29.53	108.4	11.10	8.04	0.628

Table 2: Menauhant (MH) Deployment/Retrieval YSI 650 Data

	Date	Time	Temp	SpCond	Salinity	DO %	DO Conc.	pH	Depth
MH	M/D/Y	hh:mm:ss	C	mS/cm	ppt	%	mg/L		m
Deploy	4/9/14	16:00	7.90	47.77	30.78	87.9	8.54	8.02	0.28
Retrieve	5/30/14	16:09	18.19	47.51	30.99	115.9	9.11	7.89	1.449
Deploy	5/30/14	16:09	18.19	47.51	30.99	115.9	9.11	7.89	1.449
Retrieve	6/23/14	8:53	21.46	47.74	31.16	113.4	8.35	8.07	1.586
Deploy	6/23/14	8:53	21.46	47.74	31.16	113.4	8.35	8.07	1.586
Retrieve	7/15/14	9:16	23.6	48.06	31.35	99.3	7.03	7.65	0.898
Deploy	07/15/14	09:23	23.6	48.06	31.35	99.3	7.03	7.65	0.898
Retrieve	08/08/14	08:28	23.08	47.85	31.2	102.7	7.34	7.54	1.091
Deploy	08/08/14	08:28	23.08	47.85	31.2	102.7	7.34	7.54	1.091
Retrieve	08/22/14	12:54	23.05	47.76	31.15	97.2	6.96	7.71	1.156
Deploy	08/22/14	13:01	23.05	47.76	31.15	97.2	6.96	7.71	1.156
Retrieve	09/16/14	13:36	22.02	48.78	31.89	118.9	8.64	7.82	1.110
Deploy	09/16/14	13:36	22.02	48.78	31.89	118.9	8.64	7.82	1.110
Retrieve	10/08/14	09:42	18.31	49.72	32.61	101.8	7.88	7.45	1.143
Deploy	10/08/14	09:42	18.31	49.72	32.61	101.8	7.88	7.45	1.143
Retrieve	11/07/14	14:37	12.0	47.03	30.50	102.0	9.05	7.42	0.920
Deploy	11/07/14	14:37	12.0	47.03	30.50	102.0	9.05	7.42	0.920
Retrieve	11/23/14	12:01	8.87	49.46	32.07	100.0	9.45	7.24	1.209
Deploy	11/23/14	12:01	8.87	49.46	32.07	100.0	9.45	7.24	1.209
Retrieve	12/18/14	10:54	6.05	48.58	31.17	102.0	10.33	7.33	1.230
Deploy	12/18/14	10:54	6.05	48.58	31.17	102.0	10.33	7.33	1.230
Retrieve	01/07/15	14:08	3.08	48.49	30.70	97.7	10.64	7.19	0.846

Table 3: Child's River Deployment/Retrieval YSI 650 Data

	Date	Time	Temp	SpCond	Salinity	DO %	DO Conc.	pH	Depth
CR	M/D/YY	hh:mm	C	mS/cm	ppt	%	mg/L		m
Deploy	5/30/14	15:47	18.46	44.25	28.63	127.3	10.14	8.04	1.235
Retrieve	6/23/14	08:35	24.07	44.75	28.91	31.6	2.23	7.26	1.529
Deploy	6/23/14	08:35	24.07	44.75	28.91	31.6	2.23	7.26	1.529
Retrieve	7/15/14	09:39	25.09	41.5	26.57	28.1	1.86	7.57	1.021
Deploy	7/15/14	09:39	25.09	41.5	26.57	28.1	1.86	7.57	1.021
Retrieve	08/08/14	08:48	25.39	44.81	28.94	67.6	4.7	7.56	0.792
Deploy	08/08/14	08:48	25.39	44.81	28.94	67.6	4.7	7.56	0.792
Retrieve	08/28/14	08:55	24.69	44.42	28.69	51.0	3.55	7.22	0.765
Deploy	08/28/14	08:55	24.69	44.42	28.69	51.0	3.55	7.22	0.765
Retrieve	09/16/214	13:52	21.95	45.36	29.4	56.0	4.15	7.71	1.085
Deploy	09/16/214	13:52	21.95	45.36	29.4	56.0	4.15	7.71	1.085
Retrieve	10/08/14	10:00	18.31	38.86	24.84	99.3	8.03	7.64	0.784
Deploy	10/08/14	10:00	18.31	38.86	24.84	99.3	8.03	7.64	0.784
Retrieve	10/30/14	11:16	16.18	45.38	29.43	94.5	7.74	7.47	0.962
Deploy	10/30/14	11:16	16.18	45.38	29.43	94.5	7.74	7.47	0.962
Retrieve	11/23/14	12:37	7.0	43.21	27.5	100.9	10.14	7.52	1.081
Deploy	11/23/14	12:37	7.0	43.21	27.5	100.9	10.14	7.52	1.081
Retrieve	12/18/14	11:10	6.83	45.76	29.26	104.9	10.55	7.83	0.763

Table 4: Sage Lot Deployment/Retrieval YSI 650 Data

	Date	Time	Temp	SpCond	Salinity	DO %	DO Conc.	pH	Depth
SL	M/D/Y	hh:mm:ss	C	mS/cm	ppt	%	mg/L		m
Deploy	6/4/14	15:27	19.82	47.38	30.89	109.4	8.32	7.73	0.815
Retrieve	6/25/14	09:24	22.30	46.58	30.29	83.1	6.17	7.54	0.535
Deploy	6/25/14	09:27	22.30	46.58	30.29	83.1	6.17	7.54	0.535
Retrieve	7/17/14	12:15	24.90	45.09	29.14	84.6	5.9	7.25	0.139
Deploy	7/17/14	12:15	24.90	45.09	29.14	84.6	5.9	7.25	0.139
Retrieve	08/11/14	10:27	25.17	46.99	30.54	84.9	5.84	7.30	0.621
Deploy	08/11/14	10:27	25.17	46.99	30.54	84.9	5.84	7.30	0.621
Retrieve	08/26/14	12:37	24.62	48.13	31.40	119.3	8.31	7.62	0.798
Deploy	08/26/14	12:37	24.62	48.13	31.40	119.3	8.31	7.62	0.798
Retrieve	09/19/14	10:39	18.89	48.40	31.65	100.8	7.77	7.52	0.865
Deploy	09/19/14	10:39	18.89	48.40	31.65	100.8	7.77	7.52	0.865
Retrieve	10/09/14	10:46	17.11	48.56	31.75	107.8	8.58	7.62	0.726
Deploy	10/09/14	10:45	17.11	48.56	31.75	107.8	8.58	7.62	0.726
Retrieve	10/31/14	13:00	14.24	46.32	30.08	96.5	8.21	7.26	0.682
Deploy	10/31/14	13:00	14.24	46.32	30.08	96.5	8.21	7.26	0.682
Retrieve	11/25/14	13:15	11.56	47.7	30.98	107.2	9.60	7.66	0.907
Deploy	11/25/14	13:15	11.56	47.7	30.98	107.2	9.60	7.66	0.907
Retrieve	12/15/14	14:55	4.56	39.73	24.84	103.1	11.28	7.48	0.338