

I. Data Set & Research Descriptors

1. Principal investigator & contact persons:

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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.

Files are exported from EcoWatch in a comma-delimited format (.CSV or .CDF) and uploaded to the CDMO where they undergo automated primary QAQC and become part of the CDMO's online provisional database. Excessive pre- and post-deployment data are removed from the file prior to upload with a minimum of 2 hours of pre-and post-deployment data retained. During primary QAQC, data are flagged if they are missing or out of sensor range. The edited file is then returned to the Reserve to undergo 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 graphs data for review. It allows the reserve to apply QAQC flags and codes to the data, remove remaining pre- and post-deployment data, append files, and export finalized data files to CDMO for tertiary QAQC and assimilation into the CDMO's authoritative online database. 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:

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:

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 2012. 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.

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 depth (m), and pH at 15 minute intervals during deployment periods extending for approximately two to three weeks (three weeks during the winter months, two weeks during summer months due to fouling). 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 12/2008), Child’s River site (from 3/2003 through 12/2008), Menauhant site (from 7/2006 to 12/2008), and our Sage Lot site (from 6/2006 to 12/2008) we have been using a YSI 6025 optic chlorophyll fluorescence sensor and these data are available by contacting the reserve directly (and included in the raw files sent to CDMO).

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. Salinity sensors are calibrated with reference seawater that had been previously analyzed with a Guideline salinometer at the Woods Hole Oceanographic Institution (David Wellwood is currently the technician for this instrument). 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 123.0 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. 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 2012, SWMP water quality data were collected continuously at all our dockside sites and continuously after May at the open water sites (dockside sites, Child’s River and Menauhant, open water sites, Metoxit Point and Sage Lot). Ice conditions and tower maintenance necessitated the removal of the Metoxit Point and Sage Lot sondes from early January until mid May.

Two types of mooring silos house the sondes during their deployment. The Metoxit Point and Sage Lot stations are located offshore and away from shore structures. The Sonde moorings for these stations consist of a vertical PVC pipe tower (2” ID), about 1.5 meters in height extending from a 120 lb cast concrete base resting on the bottom. Attached to this tower is a 0.7 m PVC pipe section (4” ID), referred to as the silo, that holds the Sonde and is adjustable for setting the depth of the sensor package. The Sondes are lowered and inserted into the 4” PVC silo from the surface at low water, when the top

of the tower is only about 0.3 m below the surface. The lower part of the silo section is perforated with numerous 1.5" holes to allow the YSI Sonde's sensors direct exposure to the flow of ambient waters. The Metoxit Point and Sage Lot silos are set so that the sensor package is 0.7 m and 0.5 off the bottom, respectively. This ensures that the sensors are above the macro algal mats in the case of Metoxit Point, and sufficiently into the water column because of the thick eelgrass meadow in Sage Lot. In December 2012 (12/12-13/2012), new silos were installed for Metoxit Point and Sage Lot sites. They were placed at their new sites in November and left to settle for approximately one month. When it was time to retrieve the deployed sondes, the new sondes were placed inside the new silo's at each site and the old sondes were left for an extra day so that we could determine the new depth difference between the new/old silo locations. A description of the new silo's will be submitted in the annual metadata documents once that depth data has been evaluated.

The Menauhant and Child's River stations are dock-side locations and their moorings are a more typical type of silo – a single PVC section (4" ID) mounted vertically on a pier piling. 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 0.4 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.

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 tikvahiae*, 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%) (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 lies 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 culvered channel. 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).

The Metoxit Point station (MP) (41° 34.131' N 70° 31.294' W, 2.2 m deep January December 2012) (41° 34.119 N 70° 31.281' W beginning December 2012) 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). In December of 2012 the MP site was moved on 12/12/-13/2012. The old sonde came out the day after the new sonde was deployed. The new tower set up in the fall, for a one day overlap to determine change in depth between old/new sonde and sites.

The Menauhant station (MH) (41° 33.156' N 70° 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. In the summer 2006, the absolute elevation of the station relative to NGVD29 (National Geodetic Vertical Datum, sometimes referred to as 1929 Sea Level) and NAVD88 was calibrated. Precision is estimated to be 0.025 m. Depth to base of the Sonde (base of the sensor guard) at the Menauhant site is -0.786 m NGVD29. The calibrated mean depth sensor height above the guard base for our YSI 6600 instruments is 0.26 m (SD<0.01m). Therefore depth readings (uncorrected for air pressure) at this station for this year should be interpreted as water surface heights above -0.516 m NGVD29 or -0.779 NAVD88. 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).

In July of 2006, a Sutron Sat-Link2 transmitter was installed at this station and transmits data to the NOAA GOES satellite, NESDIS ID #3B030074 (where 3B030074 is the GOES ID for that particular station.) The transmissions are scheduled hourly and contain four (4) datasets 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 QAQC and assimilation in the CDMO’s “Authoritative” online database. This data can be viewed by going to <http://cdmo.baruch.sc.edu>.

The Child’s River station (CR) (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. In autumn 2003, the absolute elevation of the station relative to NGVD29 (National Geodetic Vertical Datum, sometimes referred to as 1929 Sea Level) was calibrated. Precision is uncertain at this time (but estimated to be within 0.1 m). Depth to base of the Sonde (base of the sensor guard) at the Child’s River site is -0.86 m NGVD29. The calibrated mean depth sensor height above the guard base for our YSI 6600 instruments is 0.26 m (SD<0.01m). Therefore depth readings (uncorrected for air pressure) at this station for this year should be interpreted as water surface heights above -0.58 m NGVD29. 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).

The Sage Lot station (SL) (41° 33.254' N 70° 30.612' W, 1.2 m deep January to December 2012) (41° 33'15.12" N, 70° 30'30.20" W December 12 – 31 2012) 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. Indeed 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. In summer 2006, the absolute elevation of the station to relative to NGVD29 (National Geodetic Vertical Datum, sometimes referred to as 1929 Sea Level) was calibrated. Precision is estimated to be within 0.025 m). Depth to base of the Sonde (base of the sensor guard) at the Sage Lot site is about - 0.420 m NGVD29. The calibrated mean depth sensor height above the guard base for our YSI 6600 instruments is 0.26 m (SD<0.01m). Therefore depth readings (uncorrected for air pressure) at this station for this year should be interpreted as water surface heights above -0.160 m NGVD29. A mean tidal range of 0.40m (SD = 0.14) is calculated based on one month of data (May 2003), with a minimum of 0.11 m and a maximum of 0.67 m. 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). In December of 2012 the SL site was moved from 12/13-14/2012/ The old sonde came out the day after the new sonde was deployed. The new tower set up in the fall, allowing for one day overlap to determine change in depth between old/new sonde and sites.

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 2012, data loggers were deployed at the Metoxit Point (MP), Menauhant Yacht Club (MH), Childs River (CR), and Sage Lot (SL) sites as of on the first day of the year. The deployment dates and times for 2012 are indicated below:

Metoxit Point Site

BEGAN	ENDED
12/19/11, 10:00	01/17/12, 10:45
01/24/12, 11:15	03/29/12, 14:00
03/29/12, 14:15	04/25/12, 09:15
04/25/12, 09:30	05/17/12, 15:45
05/17/12, 16:00	06/21/12, 13:15
06/21/12, 13:45	07/09/12, 07:30

07/09/12, 07:45	08/13/12, 12:15
08/13/12, 12:30	09/15/12, 15:45
09/15/12, 16:30	10/10/12, 15:00
10/10/12, 15:15	11/13/12, 16:00
11/13/12, 16:30	12/12/12, 15:00
12/12/12, 15:15	01/17/13, 15:45

*Old sonde came out day after new sonde deployed. New tower set up in fall, time of one day overlap to determine change in depth between old/new sonde sites.

Menauhant Site

BEGAN	ENDED
12/27/11, 12:45	01/25/12, 11:45
01/25/12, 12:00	02/27/12, 10:15
02/27/12, 10:30	03/29/12, 13:00
03/29/12, 13:15	04/23/12, 23:45
04/24/12, 15:30	05/21/12, 12:15
05/21/12, 13:00	06/21/12, 17:45
06/21/12, 18:00	07/07/12, 10:15
07/07/12, 10:30	08/12/12, 15:15
08/12/12, 15:45	09/06/12, 14:15
09/06/12, 14:45	10/10/12, 10:30
10/10/12, 11:00	11/13/12, 14:30
11/13/12, 15:00	12/14/12, 14:00
12/14/12, 14:15	01/10/13, 15:00

Child's River Site

BEGAN	ENDED
12/27/11, 12:30	01/24/12, 15:00
01/24/12, 15:15	02/27/12, 10:30
02/27/12, 10:45	03/27/12, 16:15
03/29/12, 13:45	04/24/12, 15:00
04/24/12, 15:30	05/21/12, 12:45
05/21/12, 13:00	06/21/12, 17:45
06/21/12, 18:00	07/07/12, 10:30
07/07/12, 11:00	08/03/12, 15:30
08/03/12, 15:45	09/06/12, 14:30
09/06/12, 15:00	10/10/12, 10:45
10/10/12, 11:15	11/13/12, 14:45
11/13/12, 15:15	12/13/12, 14:30
12/13/12, 14:45	01/08/13, 15:15

Sage Lot Site

BEGAN	ENDED
12/19/11, 12:45	01/19/12, 12:45
03/30/12, 12:30	04/25/12, 14:45
04/25/12, 15:00	05/18/12, 14:30
05/18/12, 14:45	06/21/12, 13:45
06/21/12, 14:00	07/09/12, 10:00
07/09/12, 10:15	08/13/12, 15:15
08/13/12, 15:30	09/15/12, 14:30

09/15/12, 15:00	10/10/12, 15:30
10/10/12, 15:45	11/14/12, 13:30
11/14/12, 14:00	12/13/12, 13:00
12/13/12, 13:15	01/17/13, 16:15

*Old sonde came out day after new sonde deployed. New tower set up in fall, time of one day overlap to determine change in depth between old/new sonde sites.

7. Distribution:

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 processed 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.nerrdata.org/>; accessed 12 October 2022.

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. Dissolved inorganic nutrient samples are currently analyzed by Matt Charrette at WHOI. All data is processed and archived at WBNERR and is publicly available through our web site.

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: $\pm 2\%$ of reading for low and medium ranges. Repeatability: $\pm 1\%$. 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 three calibration standards: 0 NTU and 40 NTU and 100 NTU; the standards are run after running five sites each time.

Two bottles of water are now collected at each site, at approximately 0.5m below the surface, by locking the bottles into a hand-held 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 (0.5m) 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)

Parameter: Temperature, Conductivity/ Salinity, Dissolved Oxygen, pH, Depth

See below for probe specifications.

YSI 6600/YSI 6600EDS data logger (nine (9) units)

All data Sondes used at the Waquoit Bay NERR sites in 2012 were non-vented models.

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: Dissolved Oxygen % saturation
Units: percent air saturation (%)
Sensor Type: Rapid Pulse – Clark type, polarographic
Model #: 6562
Range: 0 to 500 % air saturation
Accuracy: 0-200 % air saturation, +/- 2 % of the reading or 2 % air saturation, whichever is greater;
200-500 % air saturation, +/- 6 % of the reading
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: Rapid Pulse – Clark type, polarographic
Model #: 6562
Range: 0 to 50 mg/L
Accuracy: 0 to 20 mg/L, +/- 2 % of the reading or 0.2 mg/L, whichever is greater; 20 to 50 mg/L, +/- 6 % 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 30 ft (9.1 m)
Accuracy: +/- 0.06 ft (0.018 m)
Resolution: 0.001 ft (0.001 m)

Parameter: pH
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

YSI 6600 V2 data logger (one (1) unit)
All parameters are the same as the YSI 6600/YSI 6600EDS data logger except dissolved oxygen.

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

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). The YSI 6600 EDS data sondes increased 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:

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

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 yearly water quality data for the Metoxit Point site)

11. QAQC flag definitions:

QAQC flags provide documentations of the data and are applied to individual data points by insertion into the parameter's associated flag column (header preceded by and F_). During primary automated QAQC (performed by the CDMO), -5, -4, and -2 flags are applied automatically to indicated data that is above or below sensor range and missing. 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	Open - reserved for later flag
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 of Post Dep	DO	Baro.	Depth	Depth	SpCond	pH 7	pH 10	Turbidity	Turbidity	Chl 0	Chl	Rhodamine
			Pres.		Offset				DI		DI	Rhodamine	Std value
		%	mmHg	m	m	mS/cm			NTU	NTU	µg/L	µg/L	µg/L
SL		100.0				50.00	7.00	10.00	0.0	126.0	0.0		
	12/19/11 - 01/19/12	98.8	758.0	-0.030	-0.027	51.32	7.01	9.90	0.9	129.1	3.30	126.1	124.0
	04/24/12	100.6	766.5	0.091	0.088	50.18	6.97	9.93	0.4	121.1	0.2	-	119.8

05/18/12	98.9	756.5	-0.038	-0.048	49.53	7.07	10.00	0.2	128.2	0.4	114.8	116.8
06/21/12	96.6	754.0	-0.075	-0.082	50.00	6.90	9.88	2.4	130.9	0.00	NS	NS
07/09/12	97.9	754.0	-0.078	-0.082	50.35	7.15	9.98	0.1	106.0	0.60	NS	NS
08/13/12	85.2	759.0	-0.011	-0.014	50.52	7.06	9.94	2.9	124.9	1.60	NS	NS
09/15/12	99.7	762.0	0.032	0.027	53.01	7.05	10.17	2.2	137.1	675.5	NS	NS
10/10/12	99.9	762.0	0.040	0.027	50.35	7.02	9.98	0.6	129.6	0.00	121.3	119.8
11/14/12	102.2	770.0	0.145	0.136	48.20	7.48	10.49	0.0	6.2	19.5	685.0	118.8
12/14/12	99.4	749.0	-0.149	-0.150	51.13	7.07	10.05	-4.7	129.4	0.10	NS	NS
01/17/2013	100.5	756.5	-0.054	-0.048	50.63	6.72	10.01	-0.5	129.1	-0.5	123.90	121.9

Childs River

Site	Date Retrieved	DO %	Baro. Pres. mmHg	Depth m	Depth Offset m	SpCond mS/cm	pH 7	pH 10	Turbidity DI NTU	Turbidity NTU	Chl 0 µg/L	Chl Rhodamine µg/L	Rhodamine Std value µg/L
CR		100.0				50.00	7.00	10.00	0.0	126.0	0.0		
	12/27/11 – 01/24/12	97.4	758.0	-0.029	-0.027	51.14	7.00	10.08	0.2	127.7	1.80	123.10	124.0
	02/27/12	100.8	766.0	0.076	0.082	49.10	7.13	10.13	1.1	127.5	0.20	128.20	123.6
	03/29/12	99.8	764.0	0.055	0.054	49.52	7.07	10.06	0.7	126.0	0.10	119.0	119.8
	04/24/12	100.5	766.5	0.085	0.088	49.39	6.89	9.87	0.1	127.7	0.00	-	119.8
	05/21/12	91.7	763.0	0.054	0.041	49.75	6.90	9.77	-2.3	125.0	0.90	113.20	115.8
	06/21/12	97.7	155.0	-0.076	-0.068	11.21	7.10	9.67	510.3	243.8	9.00	NS	NS
	07/07/12	98.4	754.5	-0.059	-0.075	49.64	6.76	9.72	-0.3	130.4	0.00	NS	NS
	08/03/12	100.6	759.0	-0.012	-0.014	49.96	7.05	10.07	-0.9	130.5	0.6	NS	NS
	09/06/12	96.3	757.5	-0.048	-0.034	49.82	6.90	9.93	0.0	139.7	0.60	117.1	115.8
	10/10/12	100.7	770.0	0.149	0.136	48.82	7.09	10.17	2.3	131.1	0.40	115.40	118.8
	11/13/12	98.2	749.0	-0.146	-0.150	49.67	7.04	10.01	0.0	130.9	-0.30	NS	NS
	01/08/13	100.1	768.0	0.113	0.109	49.35	7.08	10.08	-1.5	129.9	0.00	144.0	119.8

Menauhant

Site	Date Retrieved	DO %	Baro. Pres. mmHg	Depth m	Depth Offset m	SpCond mS/cm	pH 7	pH 10	Turbidity DI NTU	Turbidity NTU	Chl 0 µg/L	Chl Rhodamine µg/L	Rhodamine Std value µg/L
MH		100.0				50.00	7.00	10.00	0.0	126.0	0.0		
	12/27/11 – 01/24/12	80.6	763.0	0.059	0.041	50.23	6.98	10.00	0.3	126.8	0.06	121.8	124.0
	02/26/12	67.3	766.0	0.088	0.082	48.77	7.07	10.09	-0.5	127.1	0.00	123.4	123.6
	03/27/12	64.7	764.0	0.059	0.054	50.10	7.03	9.90	0.3	126.6	1.30	118.8	119.8
	04/18/12	54.4	766.5	0.087	0.088	48.70	7.03	9.96	3.6	119.6	0.0	-	119.8
	05/21/12	92.0	763.0	0.033	0.041	49.41	7.13	10.07	-4.6	121.7	1.5	111.0	115.8
	06/21/12	97.0	754.0	-0.087	-0.082	49.21	7.21	10.06	-0.7	126.5	0.00	NS	
	07/07/12	131.1	754.0	-0.078	-0.082	49.68	7.05	10.12	-3.1	128.0	8.00	NS	NS
	08/12/12	53.5	759.0	-0.002	-0.014	46.19	7.09	9.98	-0.6	131.9	1.3	NS	NS
	09/06/12	71.8	757.5	-0.033	-0.034	49.63	7.14	9.87	-3.9	121.4	26.6	121.6	115.8
	10/09/12	72.4	762.0	0.040	0.027	50.22	7.01	10.03	-14.6	115.0	0.80	116.70	119.8
	11/13/12	30.3	770.0	0.148	0.136	49.15	7.07	10.23	-0.6	134.3	0.30	117.6	118.8
	12/12/12	32.1	749.0	-0.153	-0.150	49.62	7.07	10.05	-18.3	286.2	-0.40	NS	NS

	12/12/12	114.8	769.0	0.128	-0.122	49.49	7.27	10.30	0.8	134.6	-0.80	137.50	165.8
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Metoxit Point

Site	Date	DO	Baro.	Depth	Depth	SpCond	pH 7	pH 10	Turbidity	Turbidity	Chl 0	Chl	Rhodamine
	Retrieved		Pres.		Offset				DI			Rhodamine	Std value
		%	mmHg	m	m	mS/cm			NTU	NTU	µg/L	µg/L	µg/L
MP		100.0				50.00	7.00	10.00	0.0	126.0	0.0		
	12/19/11 – 01/17/12	57.5	758.0	-0.032	-0.027	50.91	7.03	10.01	-0.1	128.5	0.40	127.1	124.0
	03/29/12	100.1	764.0	0.068	0.054	49.72	7.04	10.03	0.3	124.5	0.60	119.4	119.8
	04/25/12	100.8	766.5	0.095	0.088	49.77	7.02	9.94	0.9	127.7	0.10	-	119.8
	05/17/12	99.0	757.0	-0.027	-0.041	49.66	7.03	9.94	-2.4	126.5	-0.30	101.8	116.8
	06/21/12	98.5	754.0	-0.079	-0.082	49.88	7.13	10.15	1.0	139.1	0.00	NS	NS
	07/09/12	97.3	754.0	-0.075	-0.082	49.10	6.97	9.96	-1.50	107.8	-0.20	NS	NS
	08/13/12	98.4	759.0	-0.008	-0.014	48.09	7.11	9.91	3.4	131.4	0.50	NS	NS
	09/15/12	100.1	762.0	0.033	0.027	51.60	6.98	9.96	2.7	127.3	-0.10	119.8	119.8
	10/10/12	103.6	770.0	0.155	0.136	49.46	6.97	10.03	-0.7	132.8	0.00	117.0	118.8
	11/13/12	99.3	749.0	-0.163	-0.150	50.43	7.04	10.01	-0.9	125.4	0.2	NS	NS
	12/12/12												

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>.

NOTE 3: SUSPENSION EVENT RELATED TURBIDITY ANOMALIES: This type of anomaly includes turbidity readings that were either outside the normal range, or spikes way 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 are values over 100NTU that are more than 5 times the magnitude of surrounding values, and linked to high winds. These readings were rejected <-3>.

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.

Other Field-worthy notes:

All times reported in Eastern Standard Time (EST)

January 2012

Child's River: Possible influence from deicer/bubbler instrument at dock site. Particularly impacting DO and temperature data from 1/21 7:45 – 1/24 15:00 which are marked suspect. F Record column marked CSM during end of January to highlight potential impacts to data during this time.

Menauhant: 01/06/12, 08:30 – 01/25/12, 11:45 Suspect that macroalgae became lodged in sonde guard/tower and interfered with chlorophyll optics.

Metoxit Point: Sonde out of water from 01/17/12 11:00 – 01/24/12 11:00.

Sage Lot: Sonde not deployed due to ice from 01/19/2012 – 033012, 12:15.

February 2012

Child's River: Possible influence from deicer/bubbler instrument at dock site.

Metoxit Point: Sonde deployed for 2 months under ice conditions, from 01/24/12 11:15 – 03/29/12 14:00

Sage Lot: Sonde not deployed due to ice from 01/19/2012 – 033012, 12:15.

March 2012

Child's River: Present from December and removed sometime before March 16th.

Menauhant: Small 4" fish (Gunner) inside sonde guard. May have affected some turbidity and Chlorophyll data periodically during deployment from 03/24/12 22:15 – 3/29/12 08:30.

Metoxit Point: Sonde deployed for 2 months, from 01/24/12 11:15 – 03/29/12 14:00

Sage Lot: Sonde deployed 03/30/12, 12:30pm

April 2012

Child's River: Cleaned Sonde Tower with brush to minimize macroalgae growth 04/24/12, 15:05

Metoxit Point: Cleaned Sonde Tower with brush to minimize macroalgae growth 04/25/12, 09:35

Menauhant: Cleaned Sonde Tower with brush to minimize macroalgae growth 04/24/12, 15:18, large piece of macroalgae attached to tower.

Sage Lot: Cleaned Sonde Tower with brush to minimize macroalgae growth 04/25/12, 14:48

May 2012

Child's River: nothing to report

Metoxit Point: 05/17/12 calibration (sonde #02A0804-AF V2), cond/temp, pH, and Turbidity probes failed. Replaced with all new probes.

Menauhant: nothing to report

Sage Lot: nothing to report

June 2012

Child's River: 06/21/12: on retrieval of 05/21/12 deployed sonde, tunicates covered plastic wipers- obscuring optics on Turbidity and some on Chlorophyll probes. Conductivity holes plugged with tunicates as well.

Metoxit Point: nothing to report

Menauhant: nothing to report

Sage Lot: nothing to report

July 2012

Child's River: nothing to report

Metoxit Point: nothing to report

Menauhant: nothing to report

Sage Lot: 7/9/2012 deployment salinity seems high for typical summer values. The match up at the sonde rotation does not align well, but the post-calibration is ok.

August 2012

Child's River: nothing to report

Metoxit Point: nothing to report

Menauhant: nothing to report

Sage Lot: nothing to report

September 2012

Child's River: nothing to report

Metoxit Point: 09/15/12: on retrieval of 08/13/12 deployed sonde, hydroid completely covered the entire chlorophyll probe optic end-dark brown color. Affected conductivity/salinity data as well.

Menauhant: nothing to report

Sage Lot: 09/15/12: on retrieval of 08/13/12 deployed sonde, chlorophyll probe failed during post calibration.

October 2012

Hurricane Sandy hit the Cape approximately on 10/28-10/29/2012. Affected depth at all sites on 10/29.

Child's River: 10/10/12: on retrieval of 09/06/12 deployed sonde, pH probe response in post calibration was very slow.

Metoxit Point: nothing to report

Menauhant: nothing to report

Sage Lot: Chlorophyll data during the 10/10/12 deployment are odd. The post for this data read 685 at the post, both for 0 and in Rhodamine. Data marked suspect during this deployment with negative values rejected.

November 2012

A nor'easter hit Cape Cod on 11/8/2012 00:00-11/8/2012 18:00.

Child's River: nothing to report

Metoxit Point: nothing to report

Menauhant: nothing to report

Sage Lot: nothing to report

December 2012

Child's River: nothing to report

Menauhant: Rapid pulse Dissolved oxygen probe failed all deployments between 10/10/2012 11:00 – 012/14/2012 13:30.

Metoxit Point: 12/12-13/2012, Old sonde came out day after new sonde deployed. New tower set up in fall, for one day overlap to determine change in depth between old/new sonde and sites. (41° 34.7' N 70° 31.18' W). Post calibration data lost due to laboratory computer failure.

Metoxit Point: 12/12-31/2012, Due to change in site location and depth data are marked 1 GSM CWD and other parameters marked 0 GSM CWD through end of the deployment to highlight these changes.

Sage Lot: 12/13-14/2012, Old sonde came out day after new sonde deployed. New tower set up in fall, for one day overlap to determine change in depth between old/new sonde and sites. (41° 34.7' N 70° 31.18' W). 121312 14:00 – 123112 23:00 pH bulb must have broken during deployment travel.

Sage Lot: 12/13-31/2012, Due to change in site location and depth data are marked 1 GSM CWD and other parameters marked 0 GSM CWD through end of the deployment to highlight these changes.

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. If additional information on missing data is needed, contact the Research Coordinator at the reserve submitting the 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
YSI 600									
Deploy	12/19/11	09:21	5.07	47.59	30.36	90.0	9.37	7.94	1.498
Retrieve	01/17/12	10:45	2.19	48.24	30.38	68.2	7.62	8.27	1.527
YSI 600									
Deploy	01/24/12	11:16	3.69	46.50	29.39	78.0	8.46	8.29	1.517
Retrieve	03/29/12	14:12	8.62	46.34	29.82	109.2	10.51	8.11	0.855
YSI 600									
Deploy	03/29/12	14:12	8.62	46.34	29.82	109.2	10.51	8.11	0.855
Retrieve	04/25/12	09:22	13.30	44.35	28.63	96.0	8.41	7.06	0.960
YSI 600									
Deploy	04/25/12	09:22	13.30	44.35	28.63	96.0	8.41	7.06	0.960
Retrieve	05/17/12	15:50	18.56	46.22	30.05	199.4	15.60	8.36	1.089
YSI 600									
Deploy	05/17/12	15:50	18.56	46.22	30.05	199.4	15.60	8.36	1.089
Retrieve	06/21/12	13:20	25.41	45.62	29.53	127.3	8.83	8.10	1.139
YSI 600									
Deploy	06/21/12	13:20	25.41	45.62	29.53	127.3	8.83	8.10	1.139

Deploy	10/10/12	10:33	16.68	47.76	31.16	97.9	7.89	8.11	0.821
Retrieve	11/13/12	14:32	11.64	47.67	30.95	107.8	9.64	7.78	0.370
YSI 600									
Deploy	11/13/12	14:32	11.64	47.67	30.95	107.8	9.64	7.78	0.370
Retrieve	12/14/12	13:37	7.02	48.86	31.47	112.9	11.14	8.00	0.876
YSI 600									
Deploy	12/14/12	13:37	7.02	48.86	31.47	112.9	11.14	8.00	0.876
Retrieve	01/10/13	15:05	4.27	47.44	30.15	122.6	13.03	8.00	0.246

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

	Date	Time	Temp	SpCond	Salinity	DO %	DO Conc.	pH	Depth
CR	M/D/Y	hh:mm:ss	C	mS/cm	ppt	%	mg/L		m
YSI 600									
Deploy	12/27/11	12:48	6.26	44.12	28.05	98.2	10.09	8.19	1.504
Retrieve	01/24/12	15:09	3.76	45.51	28.74	88.6	9.63	8.33	1.692
YSI 600									
Deploy	01/24/12	15:09	3.76	45.51	28.74	88.6	9.63	8.33	1.692
Retrieve	03/29/12	13:24	9.45	45.52	29.29	122.5	11.61	8.00	0.690
YSI 600									
Deploy	03/29/12	13:24	9.45	45.52	29.29	122.5	11.61	8.00	0.690
Retrieve	04/24/12	15:07	16.16	39.35	25.13	92.4	7.80	7.70	1.236
YSI 600									
Deploy	04/24/12	15:07	16.16	39.35	25.13	92.4	7.80	7.70	1.236
Retrieve	05/21/12	12:52	20.33	43.36	27.98	69.1	5.30	7.71	0.942
YSI 600									
Deploy	05/21/12	12:52	20.33	43.36	27.98	69.1	5.30	7.71	0.942
Retrieve	06/21/12	17:50	24.24	44.01	28.40	139.5	9.94	8.13	1.094
YSI 600									
Deploy	06/21/12	17:50	24.24	44.01	28.40	139.5	9.94	8.13	1.094
Retrieve	07/07/12	10:39	26.60	40.99	26.19	59.1	4.09	7.54	0.865
YSI 600									
Deploy	07/07/12	10:39	26.60	40.99	26.19	59.1	4.09	7.54	0.865
Retrieve	08/03/12	15:33	25.95	39.96	25.48	59.5	4.18	7.57	1.134
YSI 600									
Deploy	08/03/12	15:33	25.95	39.96	25.48	59.5	4.18	7.57	1.134
Retrieve	09/06/12	14:33	24.30	43.60	28.11	58.8	4.19	7.50	1.301
YSI 600									
Deploy	09/06/12	14:33	24.30	43.60	28.11	58.8	4.19	7.50	1.301
Retrieve	10/10/12	10:47	17.13	45.45	29.49	72.60	5.86	7.92	0.837
YSI 600									
Deploy	10/10/12	10:47	17.13	45.45	29.49	72.60	5.86	7.92	0.837
Retrieve	11/13/12	14:47	11.38	43.62	28.04	103.0	9.43	7.81	0.657
YSI 600									
Deploy	11/13/12	14:47	11.38	43.62	28.04	103.0	9.43	7.81	0.657
Retrieve	12/13/12	14:33	8.57	43.90	28.08	138.4	13.48	7.94	0.716
YSI 600									
Deploy	12/13/12	14:33	8.57	43.90	28.08	138.4	13.48	7.94	0.716
Retrieve	01/08/13	15:19	3.08	45.44	28.59	126.0	13.94	8.17	0.662

Table 4: Sage Lot:

	Date	Time	Temp	SpCond	Salinity	DO %	DO Conc.	pH	Depth
SL	M/D/Y	hh:mm:ss	C	mS/cm	ppt	%	mg/L		m
YSI 600									
Deploy	12/19/11	12:35	2.84	43.60	27.28	100.14	11.24	8.10	0.728
Retrieve	01/19/12	12:56	1.22	44.41	27.58	67.5	7.89	8.18	0.954
YSI 600									
Deploy	03/30/12	12:18	8.85	45.37	25.15	66.0	6.35	8.05	0.512
Retrieve	04/25/12	14:48	16.30	46.11	29.96	126.7	10.36	8.03	0.580
YSI 600									
Deploy	04/25/12	14:48	16.30	46.11	29.96	126.7	10.36	8.03	0.580
Retrieve	05/18/12	14:35	21.46	41.32	26.41	145.7	10.98	8.11	0.428
YSI 600									
Deploy	05/18/12	14:35	21.46	41.32	26.41	145.7	10.98	8.11	0.428
Retrieve	06/21/12	13:47	26.77	46.54	30.17	160.7	10.86	8.21	0.629
YSI 600									
Deploy	06/21/12	13:47	26.77	46.54	30.17	160.7	10.86	8.21	0.629
Retrieve	07/09/12	10:03	25.85	47.31	30.75	82.4	5.63	7.57	0.553
YSI 600									
Deploy	07/09/12	10:03	25.85	47.31	30.75	82.4	5.63	7.57	0.553
Retrieve	08/13/12	15:04	27.24	44.59	28.75	86.1	5.81	7.78	1.015
YSI 600									
Deploy	08/13/12	15:04	27.24	44.59	28.75	86.1	5.81	7.78	1.015
Retrieve	09/15/12	14:40	22.74	46.88	60.50	113.5	8.21	7.86	0.591
YSI 600									
Deploy	09/15/12	14:40	22.74	46.88	60.50	113.5	8.21	7.86	0.591
Retrieve	10/10/12	15:40	16.95	46.83	30.49	112.1	9.02	8.20	1.076
YSI 600									
Deploy	10/10/12	15:40	16.95	46.83	30.49	112.1	9.02	8.20	1.076
Retrieve	11/14/12	13:34	10.33	46.11	29.76	98.6	9.14	7.90	1.369
YSI 600									
Deploy	11/14/12	13:34	10.33	46.11	29.76	98.6	9.14	7.90	1.369
Retrieve	12/13/12	13:15	6.85	46.24	29.47	106.0	10.69	7.96	0.863
YSI 600									
Deploy	12/13/12	13:15	6.85	46.24	29.47	106.0	10.69	7.96	0.863
Retrieve	01/17/13	16:20	5.48	45.69	29.07	126.8	13.19	7.75	0.527