

Waquoit Bay(WQB) NERR Water Quality Metadata
(September -December 1999)
Latest Update: October 5, 2000

I. Data set and Research Descriptors

1. Principal investigator

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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) from the YSI 6000

data logger to a PC with the YSI 6000 data transfer software (Kermit).

Two of

these (PC6000 and ASCII text formats) are kept on file in the Waquoit Bay National Estuarine Research Reserve archive. The comma delimited format data

file is imported to the EXCEL spreadsheet program (version 5.0) where it is

processed according to standard National Estuarine Research Reserve Central Data

Management Office protocol using the CDMO Excel 5.0 macros. Each file contains

one complete month of data. This standard size has been achieved by concatenating (and truncating if necessary) shorter files of interrupted data

segments. File contents are examined for anomalies (e.g., sensor malfunction,

battery failure, spurious values, etc.) by visualization of data with the Ecowatch Software provided by YSI. Data requiring editing are noted and copies

of the graphs of raw data are saved at WBNERR. Data editing to CDMO protocol is

conducted in EXCEL. Missing data (data logger malfunction or maintenance periods) are represented by periods ".". Outliers (data values not within the

design range of the respective sensors except for turbidity and depth) are

changed to periods. Data values recorded during deployment or retrieval (i.e.,

when the instrument was out of the water or in the laboratory) are also changed

to periods. A record of changes is documented in the Data Anomalies section of the metadata file. The monthly files are sent electronically by FTP to CDMO. Copies of all files are retained at the reserve. The Research Assistant, David Giehtbrock, performs all data management

3. Research Objectives:

The primary issue of concern for the Waquoit Bay ecosystem is the influence of anthropogenic induced alterations by nitrogen enrichment. Waquoit Bay receives nitrogen from several sources, including septic systems from which leachate percolates into groundwater, which eventually enters the bay, atmospheric sources, runoff containing domestic and agricultural fertilizer and animal waste, and runoff from roads. This elevated nitrogen loading to the bay has resulted in eutrophic conditions that have contributed to alterations of habitats in the bay. For example, thick mats of seaweeds now cover the bottom where eelgrass meadows thrived in the 1970's. Unfortunately, there are few definitive records of bay conditions during past decades, which makes it difficult to evaluate the rates of change. To facilitate future evaluation, long-term records from data loggers are being compiled to track several parameters that describe conditions in this eutrophic system. Of particular interest are measurements of dissolved oxygen and turbidity. These long-term records will facilitate evaluation of changes in the ecosystem, which may come about in response to continued development in the watershed. At present, residential areas are still served by private septic systems typically consisting of septic tanks and leach fields and there is ongoing non-industrial commercial development, including construction of golf courses, cranberry bogs, and retail shopping outlets. The long term records will be useful for evaluating the efficacy of remediation efforts intended to reduce the nitrogen loading from these sources to Waquoit Bay.

4. Research methods:

The previous Research Coordinator determined that Metoxit Point would provide a representative sample site of the bay based on data from the WBNERR BayWatcher Volunteers and data loggers (See Metadata 1998 for Waquoit Bay).

This new site represents a change in location for the base line site in 1999.

This site has the coordinates, 41° 34.131' N, 070° 31.294' W. The site was

given the designation of MP. An instrument was operated at this site starting

in September and ran through December 1999. No data were collected at the

Reserve prior to September due to lack of personnel.

Logger sensors were 0.75 m above the bottom to ensure they were above the

dense macro algal mat that covers the bottom of Waquoit Bay. The data logger

records measurements of temperature, specific conductivity, salinity, dissolved

oxygen, turbidity, water level, and pH at 30 minute intervals during deployment

periods of roughly two weeks. The sampling season is generally from March to

December. However, this is dependent on weather conditions and the operational

availability of the boat that serves as tender for the loggers.

Data logger deployment is achieved with a mooring set up that consists of

75 pound anchor to which two lines are attached. One line is for a surface float

that marks the location. The other is shorter and terminates at a smaller float;

line length is such that the float remains submerged throughout tidal changes.

The data logger is attached to this line in a vertical position so that the

sensors (pointing downward) are suspended 75 cm from the bottom. This system was

chosen because local regulations prohibit installation of a more permanent

structure (e.g., a piling) and to minimize opportunities for vandalism.

During colder months, continuous operations are limited to about two weeks

due to limited battery life. In the warmer months, particularly June - September, biofouling of the sensors also limits continuous operation to

about

two weeks even though battery performance during this period would allow longer

deployments.

After a deployment, each logger is brought back to the laboratory for a

post calibration check, data downloading, instrument and sensor cleaning, and

calibration. These procedures are carried out according to the methods described

in the YSI Operating Manual. Salinity sensors were calibrated with reference

seawater that had been previously analyzed with a Guildline salinometer at the Woods Hole Oceanographic Institution. A 2 point calibration was accomplished using pH buffers 7.0 and 10. The turbidity standard solutions were prepared from formazin dilutions to 100 NTU. Temperature sensors were not calibrated. Oxygen sensor membranes were inspected before and after each deployment. Oxygen sensor membranes were replaced after each deployment per recommendation by YSI personnel. Performance was also evaluated during the post-retrieval check in the laboratory test tank prior to post-calibration. After a membrane was replaced, calibration was not done until the membrane had been in place for at least 24 hours. Final calibration was done immediately prior to instrument deployment.

5. Site location and character:

The Waquoit Bay National Estuarine Research Reserve (WBNERR) is located in the northeastern United States on the southern shore 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 200 to 300%.

WBNERR is representative of shallow coastal lagoons that occur from Cape Cod to Sandy Hook, New Jersey. WBNERR is within the Virginian biogeographic province, on the transitional border (Cape Cod) between the Virginian and the more northern Acadian biogeographic province.

Like many embayments located on glacial outwash plains, Waquoit Bay is shallow, 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 forests giving the Bay a salinity range of 0 - 30 ppt. Two narrow, navigable inlets, reinforced with granite jetties, have been constructed through two barrier beaches to connect Waquoit Bay with Vineyard Sound to the south. A third shallow and generally unnavigable inlet opened through the Washburn Island barrier beach during Hurricane Bob in August 1991. It has not been reinforced and its fate remains uncertain. The western shore of uninhabited Washburn

Island, with its low, steep bluffs and forested uplands, forms the western boundary of the reserve. Tidal waters enter and leave the bay proper (and the Reserve) via the Seapit and Eel rivers, which funnel tidal flows along the western shore of Washburn Island, through Eel Pond and out to Vineyard Sound.

Dense housing developments cover the two peninsulas that form the western shore of the two rivers. Although the developments are outside of the Reserve boundaries, nitrogen in discharges from their septic systems (which flows ultimately into the bay via groundwater) and in fertilizer run-off from their lawns has significant effects on the functioning of the Waquoit Bay ecosystem. The impacts of these effects have been a subject of study at the Reserve since its designation in 1988. The subwatersheds are developed to different degrees, some are totally built out with residential housing, some moderately developed, and some are still pristine with no development. This configuration allows robust experimental designs (e.g., substitution of space for time) which augment results from work done within and near to the Reserve.

At the northern end of the bay, coastal bluffs of glacial till rise 30 feet above sea level, marking the highest elevation within the Reserve. The northern basin of the bay is its deepest area, 2.3 m mean low water, albeit much of the remainder of the bay is only slightly shallower, averaging roughly 1.6 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. Although this flow is small, over the centuries it has created a significant delta of coarse sand that overlies much finer sediments found at comparable offshore distances elsewhere. The source of this sand is the sandy beach through which this fresh water discharge must travel.

To the east and south, land in other subwatersheds surrounds several salt and freshwater ponds, including Hamblin and Jehu Ponds, brackish salt ponds that

are connected to the 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 subwatershed, and Jehu Pond and Great River are elements of a

separate subwatershed. Further south lies Sage Lot Pond. It is in the least

developed subwatershed which also contains the 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 subwatershed, lies the highly brackish Flat Pond. It

receives minimal tidal flows of salt water from Sage Lot Pond through a narrow,

excavated channel. Most of the water flowing in to Flat Pond is groundwater and

run off, both of which maybe affected (e.g., nutrients, pesticides, bacteria) by

an adjacent golf course and near-by upper-scale residential development.

The largest source of freshwater to Waquoit Bay is the Quashnet/Moonakis River.

Although named "river", this and the reserve's Childs River might be more appropriately described as "rivulets". A component of yet another subwatershed,

it originates in Johns Pond situated five miles north of the bay and traverses

forests, cranberry bogs, residential areas, and the Quashnet Valley Golf Course

before entering the bay near the southern part of the northern basin.

The river

is called the Quashnet where it flows within the town of Mashpee, and the Moonakis as it enters the brackish estuary at the river's mouth, in the town of

Falmouth. Quashnet will be used hereafter to refer to the entire river.

The Quashnet River is the only component of the Waquoit Bay estuary system

that has sufficient numbers of coliform bacteria to cause it to be closed, at

times, to shell fishing. The source(s) of this bacteria is unknown. The Quashnet

River delivers significantly less nitrogen to Waquoit Bay than does the Childs

River, which lies to the west and also originates in Johns Pond.

The Childs River is the second largest input of freshwater to the bay. A

component of another subwatershed, it runs through densely developed residential areas. The Childs River subwatershed receives the highest nitrogen

loading and is the largest nitrogen contributor of all the subwatersheds in the

Waquoit Bay system.

Another, albeit smaller, source of freshwater is the discharge of Red Brook through brackish marshlands into Hamblin Pond. Additional freshwater enters the bay elsewhere through groundwater seepage, precipitation and the flows of small brooks. A significant groundwater flow enters the eastern end of the mooring basin at the head of the bay. 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.

A data logger is located in Waquoit Bay near the southern tip of a peninsula of land bordering the western mouth of the Quashnet River at 41° 34.131' N, 70° 31.294' W and is identified as "Metoxit Point" or MP. This site is influenced by the freshwater discharge from the Quashnet River watershed runs the gamut of highly developed to pristine forest. This site is also situated within a natural gyre that circulates water in the middle of the bay. Salinity ranges from 27.3 ppt to 31.9 ppt. Tidal Range: Spring Mean (m) 0.57 Neap Mean (m) 0.33. The latitude is 41° 34.131' N and the longitude is 70° 31.294' W. It is the new reference site for the WBNERR data logger water quality monitoring program in 1999. An instrument will be moored at this site for the long term, in order to collect baseline measurement of "ambient" conditions within Waquoit Bay. This information will be considered to represent the general conditions within the bay. The site is well flushed by tides, is 1.8-2.5 m deep, and is in an area that is minimally disturbed by routine activities on the bay (e.g. boat traffic, shell fishing, etc.).

Knowledge of the degree of mixing 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 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

bay whereby currents follow a circular pattern in an anticlockwise direction 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 areas of the bay. The location of the gyre meanders slightly, apparently under the influence of tides and wind. The MP site is more consistently near the outer regions of the gyre, that is, more frequently in the circular current, and those data are less affected by the meandering of the gyre. (Relocating the logger to the central area of the gyre is impractical because that area is frequented by boat traffic and the logger mooring would be a hazard to navigation.)

6. Data collection period

Data collection occurred at site Metoxit Point (MP) from September 20, 1999 15:00:00 to December 20, 1999 10:30:00.

7. Associated researchers and projects

None to report.

8. Variable sequence, range of measurements, units, resolution, and accuracy:

YSI 6000 data logger

Variable Name	Range of Measurements (units)	Resolution	
Accuracy			
Date	1-12, 1-31, 00-99 (Mo,Day,Yr)	1 month, 1 day, 1 year	
NA			
Time	0-24, 0-60, 0-60 (Hr, Min, Sec)	1 hr, 1 min, 1s	
NA			
Temp	-5 to 45 (C)	0.01 C	+/-
0.15C			
SpCOND	0-100 (mS/cm)	0.01mS/cm	+/-0.5% of
reading+			0.001
mS/cm			
Salinity	0-70 Parts per thousand (ppt)	0.01ppt	+/-1.0% of
reading			or 0.1 ppt (whichever is
greater)			
DO	0-200 (% air Saturation)	0.1% @air sat.	+/-2%
@air sat.			
DO	200-500 (% air Saturation)	0.1% @air saturation	+/-6%
@air sat.			
DO	0-20 (mg/l)	0.01mg/l	+/-
0.2mg/l			

DO	20-50 (mg/l)	0.01mg/l	+/-
0.6mg/l			
Depth (shallow)	0-9.1 (m)	0.001m	+/-
0.018m			
pH	2-14 units	0.01units	+/-
0.2units			
Turb	0-1000 NTU	0.1NTU	+/-5% of
reading			
		or 2 NTU (whichever is	
		greater)	

9. Coded variable code definitions

The file names are labeled according to site identifier code, month, year (e.g., mp0999). Identifier codes are; Metoxit Point, Waquoit Bay, mp = a site about 1200 feet north of the cb site (see Metadata Waquoit Bay 1998). Mp was the only site where a data logger was operated during 1999.

10. Data anomalies

October 1999

Metoxit Point

The following were small negative turbidity values, possibly due to a small

calibration error. These data were not deleted.

10/6 15:30, 16:00, 18:30, 19:30, 21:00-23:30
 10/7 0:00-9:00, 16:30-18:00, 23:30
 10/8 0:30, 1:30, 2:30, 3:00, 5:00, 5:30, 22:30, 23:00, 23:30
 10/9 0:00-14:00
 10/10 10:00-11:30, 23:00, 23:30
 10/11 0:00-4:30, 7:00, 18:00, 20:30, 21:00, 22:30
 10/12 2:30-4:00, 5:00, 6:30
 10/13 1:00-8:30, 9:30-10:30
 10/14 21:30:00
 10/16 5:00-5:30, 7:00-8:30, 10:30-13:30, 14:30-15:00, 18:30, 19:00, 20:00, 21:00-23:30
 10/17 0:00-11:30, 12:30, 13:00, 15:00, 16:00-17:00, 19:00-20:00, 22:00-23:00
 10/18 0:00, 1:30, 2:30, 4:30, 6:00-8:00
 10/20 12:30-13:30, 15:00, 15:30 19:00-20:30, 21:30-23:30
 10/21 0:00-1:00, 3:30, 6:30-11:30, 14:00-15:00, 17:30-18:30, 20:30, 22:00-23:30
 10/22 0:30, 1:00, 2:00-17:30, 18:30-22:30, 23:30
 10/23 0:30-11:30
 10/24 20:00

10/25 3:00, 3:30, 4:30-6:30, 8:30-12:00, 13:00-18:30, 19:30, 20:00,
21:00,
23:30

10/26 0:00-23:30

10/27 0:00, 5:00, 6:00, 6:30

10/28 5:00, 6:00, 7:00-11:00, 12:00-16:00

11. Missing data

Data loggers were not operated until September 20.

The following data are missing during the period September 1 through
December
31, 1999:

September 1999:

MP: No data were collected until September 20.

October 1999:

MP: No data were collected between 10/28 16:30 and 10/29 10:00 due
to a
loss of battery power.

November 1999:

MP: No data were collected between 11/19 14:00 and 11/30 23:30.

There was

an apparent power malfunction. It is suspected that the logger took some
kind

of sharp blow during the deployment, causing the circuitry to
malfunction.

December 1999:

MP: No data was collected between 12/01 00:00 and 12/03 14:00.

Please note

comments

for November. Loss of data in November continued until 12/03 14:00.

No data collected from 12/20 11:00 through 12/31 23:30. Period for
collection ended at this time.

12. Other remarks/notes

As suggested by the previous research coordinator, the baseline site
was

moved to 41o 34.131' N 070o 31.294' W. Data were collected at this
site from

September 20, 15:00, through December 20, 10:30.