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2007 Great Bay Water Quality (DataSonde) Monitoring Program

Jonathan Pennock
University of New Hampshire - Main Campus

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A Final Report to

The New Hampshire Estuaries Project

Submitted by

Dr. Jonathan Pennock
University of New Hampshire
Jackson Estuarine Laboratory
85 Adams Point Road
Durham, NH, 03824

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Introduction

In situ water quality assessment has become an important source of data for monitoring, research and management activities in estuaries nationwide. As part of the National Estuarine Research Reserve System, the Great Bay System-Wide Monitoring Program (SWMP) produces *in situ* water quality data for four sites in and around Great Bay. This project extends the SWMP program to include year-round *in situ* data for a station at the University of New Hampshire Coastal Marine Lab pier at the mouth of the Piscataqua River and summmer data for a station in the Salmon Falls (SF) River. This suite of stations provides a comprehensive *in situ* sampling array that monitors the major rivers and open estuary locations within the Great Bay estuarine system.

Project Goals and Objectives

UNH completed this project under contract to the NH Estuaries Project (Project ID #05-M-9). The project goals and objectives per the contract were to:

> (1) support *in situ* water quality monitoring for the April – December sampling season at the Lamprey River (LR), Squamscott River (SQ), Oyster River (OR), Great Bay (GB) and Coastal Marine Lab (CML) sites; and
>
> (2) fund the deployment of *in* situ water quality monitoring at the Salmon Falls (SF) for July, August and September.

The final work product was agreed to be a series of Excel data files containing full data records for each of these sites along with appropriate meta-data for these data.

Methods

The methods for this project followed the procedures prescribed by the National Estuarine Research Reserve Central Data Management Office (CDMO) and detailed in Small et al. (2003).

Briefly, YSI 6600 DataSondes are programmed to obtain measurements of specific conductivity, salinity, dissolved oxygen, percent saturation, pH, temperature, water level, and turbidity every half-hour. The instruments are deployed continuously during ice-free seasons, except for brief periods when they are removed for cleaning, maintenance and recalibration. Pre and post-deployment calibrations are performed using the diagnostics menu of the YSI Ecowatch program and QA/QC procedures developed by NERR Research Coordinators and YSI engineers. VWR conductivity and

pH standards are used for calibration. YSI formazin is used to calibrate turbidity probes. DataSondes are deployed approximately one meter from the bottom and recovered for data download every 2-4 weeks depending upon the time of year.

Beginning in 2007, the CDMO required the use of a new data processing protocol that assimilates and integrates all of the annual data from the four core NOAA NERRS SWMP stations (LR, SQ, OR & GB) and compiles them into a single annual data file. QA/QC macros within the program compare these data against historic data to assist in identifying potential outliers. One difference between this procedure and that mandated in previous years is that all data, even those identified as outliers by the macro or by our additional QA/QC review, are included in these files; their questionable status is identified in comment fields and in the metadata for each file.

For the CML and SF stations, the QA/QC procedures that have been used in recent years were followed and monthly data files are provided. This was required as a result of the fact that the new NOAA NERRS SWMP protocols carried out on the core SWMP stations (see above) cannot be applied to these stations as the multi-year historical data needed for the QA/QC macro is not available and integrated into the CDMO process. For these stations, the historic QA/QC procedures were followed.

Files are first examined and graphed using Ecowatch software. Missing and/or anomalous data are noted. Files are then transferred to a Macintosh computer and opened in Excel software and edited. Missing data due to routine YSI maintenance and probe failure or communication errors noted. Files are verified by means of CDMO Excel macros. The CDMO cdmomac3.xls macro allows the user to automatically format column widths to the correct number decimal places based on the YSI sensor specifications. It also allows the user to QA/QC each data logger generated file for missing data points, and find all data points that fall outside the range of what the datalogger is designed to measure (outliers). The CDMO import.xls macro allows PC users with 30-minute data to automatically create a monthly Excel file from a two-week deployment. In addition, in November 1999 a graphing capability was added to this macro allowing users to produce single parameter and missing point graphs on a monthly basis. All files are graphed in Excel and examined in order that anomalous data points can be identified and removed.

Results and Discussion

Data for the DataSondes deployed as part of the NERRS SWMP program have been submitted and accepted by the NERRS CDMO. So as not to create potentially different data sets (CDMO potentially modifies the data that are submitted to them), the data and all associated meta-data for the GB, LR, SQ and OR sites are available at http://cdmo.baruch.sc.edu/home.html and by following the links to: (a) NERR Data; (b) NERR Data and Associated Metadata; (c) NERR SWMP Water Quality Data; and (d) Great Bay (GRB).

For the CML site, DataSondes were successfully deployed as follows:

Began		Ended	
Date	Time	Date	Time
1/1/07	0000	1/18/07	1500
1/18/07	1600	2/23/07	1600
2/23/07	1630	3/27/07	1500
3/27/07	1530	5/9/07	1630

5/9/07	1700	6/13/07	730
6/13/07	0800	7/12/07	1330
7/12/07	1415	8/20/07	1445
8/20/07	1500	9/18/07	1300
9/18/07	1330	10/31/07	830
10/31/07	0900	12/12/07	1400
12/12/07	1500	12/31/07	2300

For the SF site, DataSondes were successfully deployed as follows:

Deployment dates

Began		Ended	
Date	Time	Date	Time
7/3/07	1400	8/9/07	1000
8/9/07	1030	9/13/07	1230
9/13/07	1330	10/15/07	1230

The CD included with this report contains the following information for the CML and SF DataSonde deployments: (a) raw data files; (b) edited data files (these are the files that should be used and distributed); and (c) meta-data, calibration and deployment files.

Conclusions and Recommendations

The *in situ* water quality monitoring program provides important data on basic water quality parameters in the Great Bay estuary. The CML site at the mouth of the Piscataqua River provides particularly critical information on the marine 'end-member' for the Great Bay system necessary for modeling and other integrative studies. The SF site provides important information on water quality during the critical summer period when dissolved oxygen levels may potentially decrease. When combined with the NERRS SWMP DataSonde program, these instruments provide comprehensive coverage of the Great Bay estuary.

References

Tamara D. Small, Ashly D. Norman, Danna D. Swain, Jesse Friedmann and Dwayne E. Porter. (2003) CDMO NERR SWMP DATA MANAGEMENT MANUAL Version 5.0 (December 2003). NOAA National Estuarine Research Reserve, Centralized Data Management Office, Georgetown, SC.

2007 Water Quality (DataSonde) Monitoring Program Meta-Data (Appendix 1)

Research Methods

Datasondes are programmed to obtain measurements of specific conductivity, salinity, dissolved oxygen, percent saturation, pH, temperature, water level, and turbidity every half-hour. The instruments are deployed continuously during ice-free seasons, except for brief periods when they are removed for cleaning, maintenance and recalibration. Pre and post-deployment calibrations are performed using the diagnostics menu of the YSI Ecowatch program and QA/QC procedures developed by NERR Research Coordinators and YSI engineers. VWR conductivity and pH standards are used for calibration. YSI formazin is used to calibrate turbidity probes. YSI 6600 datasondes are deployed approximately one meter from the bottom and recovered for data download every 2-4 weeks depending upon the time of years. Beginning in 2007, the CDMO required the use of a new data processing protocol that assimilates and integrates all of the annual data from the four core NOAA NERRS SWMP stations (LR, SQ, OR & GB) and compiles them into a single annual data file. QA/QC macros within the program compare these data against historic data to assist in identifying potential outliers. One difference between this procedure and that mandated in previous years is that all data, even those identified as outliers by the macro or by our additional QA/QC review, are included in these files; their questionable status is identified in comment fields and in the metadata for each file.

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Dissolved Oxygen Qualifier: The reliability of the dissolved oxygen (DO) data 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). Many reserves have upgraded to the YSI 6600 EDS data sondes, which increases DO accuracy and longevity by reducing the environmental effects of fouling. The user is therefore advised to consult the metadata and to exercise caution when utilizing the DO data beyond the initial 96-hour time period. However, this 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. The Research Coordinator at the specific NERR site should be contacted concerning the

reliability of the DO data because of the site and seasonal variation in the fouling of the DO sensor.

Missing or Anomalous Data
CML 2007

<u>Anomalous or Suspect Data</u>:

During 2007 the sonde was not in a fixed position so depth data does not reflect actual tides.

Much of the pH and dissolved oxygen for the deployment that begins 1/18 and ends 2/23 appears aberrant and should be considered suspect. The pH data up until approximately 1/30 looks correct.

The following turbidity data were out of range and deleted.

Date	Time	Turbidity+
3/7/07	10:30:00	1205.2
3/7/07	12:00:00	1207
3/7/07	20:00:00	1209.7
3/8/07	21:00:00	1205.2
3/10/07	3:30:00	1211
3/16/07	10:30:00	1226.1
3/17/07	7:00:00	1216.4
3/17/07	10:30:00	1219
3/17/07	15:00:00	1220.4
3/17/07	16:30:00	1217.9
3/17/07	18:00:00	1216.3
3/17/07	21:00:00	1216.5
3/17/07	22:30:00	1222.5
3/17/07	23:30:00	1222.8
3/18/07	2:30:00	1225
3/18/07	8:00:00	1214.8
3/18/07	9:00:00	1216.1
3/18/07	11:30:00	1226.8
3/19/07	9:00:00	1217.8
3/21/07	19:00:00	1209.2
3/26/07	21:00:00	1106.6

The following DO data were aberrant and deleted

3/20/07	18:00:00	81.9	9.13
3/20/07	18:30:00	65.5	7.36

The pH data from the deployment that began 3/27 and ended 5/9 appear aberrant and should be considered suspect. It's possible the probe malfunctioned, or an obstruction became lodged in the end of the probe.

The drop in salinity beginning 4/16 was caused by heavy rains.
The increase in turbidity after 5/24 may have been the result of heavy rainfall that occurred 5/15 – 5/20 and 6/4 – 6/5.

The following turbidity values were out of range and deleted.

Date	Time	Turb
6/30/07	22:30:00	1197.4
7/1/07	07:00:00	1147.9
7/1/07	09:30:00	1062.9
7/1/07	12:30:00	1170.6
7/1/07	13:00:00	1033.3
7/1/07	14:00:00	1114.1
7/1/07	16:30:00	1091.9
7/1/07	18:30:00	1102.6
7/1/07	22:00:00	1081.4
7/1/07	23:00:00	1116.1
7/1/07	23:30:00	1123.9
7/2/07	00:30:00	1101.5
7/2/07	01:00:00	1014.6
7/2/07	08:00:00	1159.7
7/2/07	10:30:00	1085.6
7/2/07	11:30:00	1122.6
7/2/07	15:00:00	1098.8
7/2/07	16:00:00	1084.6
7/2/07	19:00:00	1016.6
7/2/07	20:30:00	1079.1
7/2/07	22:30:00	1044.8
7/4/07	07:00:00	1197.3
7/4/07	10:00:00	1128.8
7/4/07	12:00:00	1097.1
7/4/07	15:30:00	1129.9
7/4/07	17:00:00	1002.1
7/4/07	19:30:00	1010.2
7/4/07	21:00:00	1025.6
7/4/07	23:00:00	1440.5
7/5/07	05:00:00	1002.7
7/5/07	08:30:00	1150.3
7/5/07	10:00:00	1152.5
7/5/07	11:00:00	1143.1
7/5/07	12:00:00	1253.5
7/5/07	13:00:00	1044.5
7/5/07	15:30:00	1214
7/5/07	18:00:00	1201.3
7/5/07	20:00:00	1227.8
7/6/07	04:00:00	1284.4
7/6/07	06:30:00	1309.5
7/6/07	07:30:00	1056.6
7/7/07	04:00:00	2670.2
7/7/07	04:30:00	1218.9

7/8/07	04:30:00	1132.4
7/8/07	06:00:00	1083.5
7/8/07	07:30:00	1099
7/8/07	08:00:00	1078.3
7/8/07	19:00:00	2159
7/9/07	16:00:00	1031.5
7/9/07	17:00:00	1033.3
7/9/07	22:30:00	1079.9
7/10/07	00:30:00	1083.7
7/10/07	03:30:00	1068.8
7/10/07	07:00:00	1186.3
7/10/07	11:00:00	1396.3
7/10/07	21:00:00	2729.2
7/10/07	22:00:00	1000.2
7/11/07	00:00:00	1147.8
7/11/07	23:00:00	2750.5
7/12/07	01:00:00	1109.5
7/12/07	11:30:00	2744.3

The following pH point was aberrant and deleted.

6/15/07	05:00:00	7.53

PH values gradually decline during the deployment that began 7/12, possibly due to fouling of the probe.

On 9/8 the salinity and specific conductivity data are aberrant and should be considered suspect. The erroneous data continue until the end of the deployment on 9/18. The post deployment reading for the probe was acceptable so it is unknown what caused the anomalous data.

During the deployment that began 9/18 and ended 10/31, 62 turbidity points were out of range and deleted. They ranged from 1010.9 to 1889.7

The pattern of salinity and specific conductivity change between 9/19 and 9/98 appear odd or anomalous, although the numbers are within normal salinity ranges for this site.
It is doubtful that an instrument malfunction caused this because the subsequent data for the deployment appear accurate

The following dissolved oxygen data were aberrant and deleted.

11/24/07	15:30:00	25.6	2.54
11/26/07	17:30:00	34.3	3.39
11/27/07	19:00:00	35	3.46
11/27/07	19:30:00	44.6	4.44

There are two anomalous (based upon the trend) pH points on 11/26 and 11/28. The data were retained but should be considered suspect.

Missing or Anomalous

SF Data 2007

During the July deployment, the sonde was moved or dragged by a boat to another, shallower location.
As a result, many of the depth and turbidity readings are negative at low tide.
Also affected by the sonde being exposed at low tides are the temperature, salinity, pH, dissolved oxygen and specific conductivity data.

SF070307
The following turbidity values were out of range and deleted

7/27/07	14:30:00	1341.7

SF080907

9/8/07	08:00:00	1058.6

SF091307

10/7/07	18:00:00	1505.2
10/13/07	1:30:00	2521
10/13/07	17:30:00	2515.9

Sometime during the 8/9 to 9/13 deployment, the glass pH bulb broke. This was a probe with an exposed bulb that was very easily broken. YSI has ceased offering this probe perhaps because of the fragility of the design. pH data from this deployment should be considered suspect since it is not known when the bulb broke.

During the deployment that began 9/13, the temperature/conductivity probe failed. It is not known precisely when it failed so the temperature, salinity and specific conductivity data should be considered suspect.
The probe passed its pre-deployment calibration but failed post-deployment.
The instrument was again dragged to a shallower position around 9/27.

The following rain events occurred during deployment times.
July 16-20 two big rainstorms occurred.
Heavy rain fell on the following dates.
September 11, 15, 27
October 6, 8, 11, 12
For specific rainfall amounts, go to http://www.weather.unh.edu