WELLS (WEL) National Estuarine Research Reserve
January-December 1999 Water Quality Metadata Report
Latest Update: September 27, 2001

I. Data Set & Research Descriptors

1. Principal investigator(s) & contact persons:

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2. Entry verification:

The data are directly downloaded in the YSI-PC6000 format (as a .dat file) and the Comma Delimited format (as a .csv file) from the dataloggers to an IBM laptop. The data are reviewed using the PC6000 software (Eco-Watch). Graphs and basic statistics are then generated with the Eco-Watch program and the information is printed out for each data file. These graphs are used to determine any obvious data outliers and sonde and/or probe malfunction. All downloaded data files from the dataloggers (both raw unedited .dat and .csv files) are then transferred via disk to a Power Mac G3, where all files are reviewed and formatted for CDMO and stored. Here the raw unedited .csv data files are imported into Microsoft Excel 98. After a complete month of data has been recorded, each file is ready to review, which requires several steps. The NERR CDMO QA/QC Excel macros are used for all data. A data file is created (from the merged raw unedited .csv data files) in Excel format with a full month of data. The first step is to make sure that the parameter columns are in the correct order, specified by the NERR CDMO. If any parameters are not collected

due to probe failure or other causes, the cells with this missing data are filled in with periods (.) and documented and explained in the appropriate section of the metadata. Secondly, missing dates and times are inserted in the data file where data were not collected due to maintenance, sonde failure, etc., and the cells with this missing data are filled in with periods (.) and documented and explained in the appropriate section of the metadata. The first NERR CDMO QA/QC Excel macro is then run to determine if there are any missing dates and times; and if so these missing dates and times are inserted. Next, the second NERR CDMO QA/QC Excel macro is used to find and filter all data readings outside the sonde specification measuring range for each parameter. Here the outlier data generated by the second macro are examined and determined as either explained or unexplained anomalies, as specified by NERR CDMO Operations Manual (Version 3.0). All anomalous data (explained and unexplained) are documented and explained in the appropriate sections of the metadata. The explained anomalous data are then removed from the data file and replaced by periods. The unexplained anomalous data are investigated for validity based on weather data, field observations, instrument diagnostics, and Eco-Watch printouts. If these data are rejected from the file then these are removed and replaced by periods. Lastly, the third and final NERR CDMO QA/QC Excel macro is used to reformat all the columns in the data file to the correct number of significant digits. After this last step, once the file has been completely formatted and edited as specified by NERR CDMO, the file is saved as a Tab delimited (.txt) text file and sent by FTP to the CDMO. The metadata form is also submitted with the data file to the CDMO, sent also as a text file (text only with line breaks). Scott Orringer is responsible for this task of entry verification with the analyses of suspect and anomalous data. Michele Dionne supervises, proofs and answers questions with the evaluation of suspect and anomalous data.

The use of the newest (Version 2.0) National Estuarine Research Reserve (NERR)

System-Wide Monitoring Program (SWMP) YSI 6-Series Multi-Parameter Water Quality
Monitor Standard Operating Procedures began in July 1999 when they became available.

3. Research objectives:

The Webhannet River estuary is located in proximity to heavily used beaches in Wells, Maine. It has a shoreline that is highly developed with residential and commercial structures. The estuary receives water from a 14 sq. mi. watershed that is well forested. We are measuring variations in hydrologic variables in the Webhannet River estuary at the Head of Tide and at the Inlet. Data from Head of Tide will integrate surface and ground water inputs (from both point and non-point sources) from the freshwater watershed into the estuary. Data from the Inlet will integrate surface and ground water inputs from the freshwater watershed and the estuarine watershed. Differences in data between the Head of Tide and the Inlet will indicate inputs from the estuarine portion of the watershed (on the ebb tide), and inputs from the Gulf of Maine on the flood tide. The instruments will track runoff events via salinity, and will measure pollutant-carrying sediment particles via turbidity. Our working hypothesis is that the freshwater watershed is the primary source of sediment and therefore potential NPS pollutants in the estuary. These two variables will indicate the potential for non-point source pollutants to enter the estuary, and whether they are of upland, estuarine or Gulf of Maine origin. Other variables measured by the data loggers (DO, temperature, pH, specific conductivity, and water level) will provide important baseline data to track changes in the estuary's physico-chemical parameters over the long term. These variables can be affected by changes in human water use, and by natural or human induced changes in Inlet and river channel morphology, climate, and organic loadings. The Inlet site is heavily impacted at the Wells Harbor dock and is our long-term monitoring site. The Head of Tide site is relatively unimpacted, located just

east of the Route One bridge, and is our ³roving² site.

4. Research Methods

The Wells NERR YSI monitoring program began in April 1995 at one site (Head of Tide site-HT) and May 1995 at a second site (Inlet site-IN) in the Webhannet River estuary. The two data loggers are installed with bottom moorings, as described below. Both data loggers have 1/4 inch black vector mesh placed on the outside (using rubber bands) of the sonde guard to prevent fouling and unwanted animals. All deployment structures (PVC tubes) described below are labeled with the Wells NERR information.

*IMPORTANT CHANGES TO NOTE AT THE INLET SITE (IN) where our telemetry unit is stationed: A new vented level YSI 6600 with its new vented level cable was deployed to collect its first data on 5/4/99 at 12:00. The YSI telemetry unit began collecting its first data on 3/16/98 at 10:30:00.

The Inlet site (IN) deployment methods are different than the other site (HT), due to the installation of a YSI telemetry unit. A 23 foot, 4-inch diameter high-grade PVC tube was installed against a dock piling. Four steel flat bars with bolts were used to attach this 23-foot PVC tube against the dock piling. A 3 by 1.5 inch PVC transducer was glued on the inside bottom of the PVC tube to allow the sonde to sit exactly 1.0 meter (3.28 ft) off the bottom. Several vertical holes, representative of the sonde guard, were cut out the circumference near the bottom of the PVC pipe to allow water flow to the probes. An L-shaped steel bar with two end-holes is placed through two created slits about a half of foot from the top of the PVC tube. A stainless steel wire (1/16) is attached to the sonde bail using two stainless steel clips; and to one end of the L shaped steel bar for sonde deployment and retrieval. A marine lock is attached through the other end of the L-shaped steel bar to hold the bar, wire, and sonde in place and for security. A PVC threaded cap screws into the threaded top of the PVC tube, also for security. A hole was

created in the PVC cap to allow the sonde to hook up with the telemetry unit using the 50-foot cable. The collection of data parameters at the Inlet (IN) site is slightly different then at the roving (HT) site, due to the telemetry unit installation. Two to four week variable sampling periods were chosen due to limitations created by the life of the dissolved oxygen membrane and probe fouling. Battery power is not needed anymore within the sonde itself (although, battery power is needed during calibrations and downloading) at the time of deployment at this site because of the telemetry unit's solar batter power. Measurements of temperature, specific conductivity, salinity, percent saturation, dissolved oxygen, depth, pH, and turbidity are recorded at 30 minute intervals throughout the deployment period. Time, date, and battery voltage are no longer programmed to be recorded by the sonde, since these parameters are already programmed with the Eco-Watch Program (see YSI's Eco-Watch Users Guide).

The other site, Head of Tide (HT), is deployed similarly, except for sonde height off the bottom (see below). This site uses a 5 foot, 4 inch diameter high grade PVC tube. The PVC tube is attached to a 12 foot, heavy steel signpost using a stainless steel bolt at the bottom of the tube, a stainless steel cable wrap at the top, and several thick electrical cable ties in between. The steel signpost was pounded in about 7 feet into the river bottom, such that the bottom of the PVC tube was flat on the river bottom. The PVC tube has one 3 by 1.5 inch PVC transducer glued on the inside bottom of the PVC tube to allow the sonde to sit exactly at a certain height off the bottom (see below). Several vertical holes, representative of the sonde guard, were cut out the circumference near the bottom of the PVC pipe to allow water flow to the probes. An L shaped steel bar with two end-holes is placed through two created slits about a half of foot from the top of the PVC tube. A stainless steel wire (1/16) is attached to the sonde bail using two stainless steel clips; and to one end of the L-shaped steel bar for sonde deployment and retrieval. A

marine lock is attached through the other end of the L-shaped steel bar to hold the bar, wire, and sonde in place and for security. A flotation buoy is tied to the PVC tubes incase the deployment structure ever gets dislodged. The deployment depth for the Head of Tide site (HT) is such that the probe-end of the data logger is secured 0.30 meters (1.0 ft) off the bottom.

Two to four week variable sampling periods were chosen for the data sonde due to limitations created by the life of the dissolved oxygen membrane, probe fouling, and limited battery power. Measurements of temperature, specific conductivity, salinity, percent saturation, dissolved oxygen, depth, pH, and turbidity are recorded at 30 minute intervals throughout the deployment period.

After the deployment period, the data logger is brought back into the Wells Reserve Laboratory for downloading, cleaning, and calibration. These procedures are carried out to the methods described in the YSI Operating Manual. Calibration standards are needed and used for only specific conductivity (10 mS/cm), pH (buffer solutions of pH 4, 7, and 10), and turbidity (100 NTU). Conductivity and pH standards are purchased from Fisher Scientific. Turbidity standards are purchased from Advanced Polymer Systems, Inc. (Redwood City, CA). The dissolved oxygen membranes are replaced and sit 6-24 hours before each deployment. After approximately 6-24 hours of down time for cleaning, maintenance and recalibration, the YSI Datalogger is redeployed for another sampling period. Also, with our extra data sonde, we have been reducing the amount of time of missing data from calibrations and maintenance for this site.

Note: The Wells NERR two Drakes Island sites (see 1996-1997 metadata) are currently being monitored (since 1996), but we are using the data for another project (CICEET-Wells Harbor dredge; see Section 7-Associated Researchers and Projects); and are not collecting the dissolved oxygen, percent saturation, and pH parameters.

The use of the newest (Version 2.0) National Estuarine Research Reserve (NERR) System-Wide Monitoring Program (SWMP) YSI 6-Series Multi-Parameter Water Quality Monitor Standard Operating Procedures began in July 1999 when they became available.

5. Site location and character:

The Wells National Estuarine Research Reserve is located in York County, within the Town of Wells, on the coast of southern Maine and faces the Atlantic Ocean. The Wells NERR is approximately 31 km (20 miles) south of Portland, Maine and 110 km (70 miles) north of Boston, Massachusetts. The Reserve encompasses 1,690 acres along the Gulf of Maine coastline of tidally flushed wetlands, riparian and transitional upland fields and forests within the Little River Estuary and the larger Webhannet River Estuary. Both estuaries arise in the sandy glacial outwash plain about eight miles inland. Both rivers empty into Wells Bay, a sandy basin stretching for approximately ten miles along the Atlantic coast. Bordering each river's Inlet are double spit barrier beaches attached to the mainland. The backbarrier system is approximately 5 sq. km and is composed of large intertidal marshes (predominantly S. patens and S. alterniflora), intertidal sand and mud flats, and tidal channels. The watershed for the Webhannet River estuary covers an area of 35 sq. km and has a total of 6 streams, brooks or creeks that enter the estuary. These tributaries flow across sand and gravel deposits near the headwaters and the impermeable sandy mud of the Presumpscot Formation in the lower reaches. The Webhannet River is connected to the ocean via Wells Inlet, which has a spring tidal prism of 28,200,000 cub. m (Ward 1993). The force and volume of tidal action affect the salinity level of both rivers. In the Wells region, the annual mean wave height is almost 20 inches. The estuarine system is dominated by semi-diurnal tides having a range of 8.5 to 9.8 feet. The volume of freshwater influx into both estuaries is moderate to low (on the order of 0.5 cubic meters/second), especially in the summer, because of the rivers relatively small drainage areas

and the presence of deep glacial deposits. The relatively low flows from these two rivers taken in with the 20 inch per year average runoff of the area surrounding the estuaries combine to form a fresh water flow that is dwarfed by tidal flushing. Twelve-foot tides dwarf the freshwater flow into the Webhannet estuary, which has a drainage area of 14.1 square miles. The Webhannet estuary, fed by both Blacksmith and Depot Brooks, is adjacent to the harbor and greatly developed land. It offers a valuable opportunity for comparison with the relatively pristine Little River estuary. The land use of the Webhannet estuary include a total of 15% for wetland, fresh water, and tidal marsh; a total of 63.7 % for woodland; and a total of 18.6% for developed land (compared to a total of 5.7% development in the Little River estuary) (WNERR RMA 1996; Holden 1997).

There are two sampling sites in the Webhannet River estuary. These are located at the Head of Tide and at the Inlet. The tidal range at each of these sites is 2.6-2.9 meters.

The Head of Tide site is located 4 miles south of the Wells Reserve, just downstream of the Webhannet Falls (freshwater) and 10 feet east of Route One (43 deg 17' 54.25227" Latitude, 70 deg 35' 13.82728" Longitude). Route One is used heavily with traffic all year, especially during the summer tourist months. This site has soft mud, sand, and a rocky substrate, and the low and high tide depth is relatively shallow. The salinity range here is 0-31 ppt, with a mean of 3.6 ppt. These headwaters of the Webhannet are relatively undeveloped. This site is located just 10 feet east of the Route One bridge, and is our roving site.

The Inlet site is located 1.5 miles south of the Wells Reserve, at the Wells Harbor pier (43 deg 19' 12.44804" Latitude, 70 deg 33' 13.82728" Longitude). The mouth of the Webhannet estuary forms an extensive wetland/salt marsh area that is surrounded by development. Wells Harbor, which was most recently dredged in 1971, has moorings for approximately 200 commercial fishing and recreational boats. The mouth of the river flows between two jetties to the

Atlantic Ocean. This channel was dredged in 1974. This site has a predominately sand substrate and is characterized by strong current during incoming and outgoing tides. The salinity range here is 7-35 ppt, with a mean of 31 ppt. The Inlet site is heavily impacted at the Wells Harbor dock and is our long-term monitoring site.

6. Data collection period:

The Webhannet River Head of Tide (HT) site data collection was re-deployed (after being pulled in December 1995, December 1996, December 1997, and December 1998) on March 11, 13:00 and pulled after December 31, 23:30 for the winter months to prevent ice damage. This site gets a large amount of ice coverage from December through late March.

The Webhannet River Inlet (IN) site data collection began May 29, 1995, 13:00. The IN datalogger is ongoing throughout the year and is considered our long-term monitoring site, as this site remains relatively ice-free.

7. Associated researchers and projects:

WELLS NATIONAL ESTUARINE RESEARCH RESERVE RESEARCH AT THE RESERVE 1999-2000:

The Research Program at the Wells NERR conducts and supports research, monitoring, workshops, and research/resource management planning of relevance at local, regional and national levels. The overall aim of our work is to produce science-based information needed to sustain or restore Gulf of Maine coastal habitats and resources, especially those found in salt marsh estuaries and watersheds. During 1999-2000 twenty-three different studies (involving 79 scientists, students, and staff from the Reserve, 26 academic institutions and 19 resource management groups) focused on several related themes: 1) the quality of water resources in salt marsh estuaries and watersheds 2) land conservation strategies to protect coastal watersheds 3) factors controlling salt marsh accretion, erosion and plant community vigor 4) the value of salt marsh as habitat for fish, shellfish and birds, and 5) restoration of salt marsh habitat

degraded through human actions.

Estuarine Water Resource Quality

Water quality is monitored continuously at several stations with automated instruments as part of a NERRS System Wide Monitoring Program (SWMP), as well as bimonthly at 15-20 stations through our WET volunteer monitoring program. The WET program also monitors two important biological parameters: fecal coliform bacterial contamination (an indicator of human health risk) and phytoplankton productivity (an indicator of estuarine health). These data have 1) allowed us to identify several bacterial hot spots that we will be working to eliminate, 2) are used to identify and open areas safe for shellfishing, and 3) have uncovered a relation between tides and low dissolved oxygen (a stressful condition for marine life) that needs further study. Our water quality work has contributed to the designation of several Priority Watersheds in coastal Southern Maine by the Maine Department of Environmental Protection.

Coastal Conservation Strategies

The Coastal Mosaic Project is a new program developed in response to requests for support from the conservation community to increase the quantity, quality and ecological integrity of conserved lands in our region. Research staff organizes and facilitate meetings, workshops, and communications for 18 partner conservation groups. A key element of the Project is the Conservation Resource Center, a Reserve staffed GIS facility with a growing database able to provide maps of property, natural features and other data needed to develop effective conservation goals and strategies. The Project is nearing completion of conservation lands maps for 13 Southern Maine coastal towns, and is undertaking an initiative to develop coastal watershed conservation strategies for 12 coastal watersheds within these towns. The Reserve has a particular interest in educating communities about the ecologic and economic benefits of land conservation, especially along estuarine and riverine shorelines.

Salt Marsh Habitats and Communities

Factors that control the dynamics and vigor of salt marsh plant communities and

marsh peat formation consequently determine the ability of a salt marsh to persist in the face of sea level rise. Through a combination of experimental manipulations and long term monitoring, a number of multi-year studies are currently producing data to answer questions concerning the sustainability of salt marsh habitats in this region. These studies are looking at nutrient-plant relations, plant community responses to physical and hydrologic disturbance, and the relative contribution of short-term natural events (e.g. storms) and human activities (dredging, tidal restriction) on patterns of sediment accretion and erosion. The Reserve's marshes and beaches are already among the best studied sites in the U.S. with regard to long term accretion and erosion (over thousands of years).

HABITAT VALUE FOR FISH, SHELLFISH AND BIRDS

The Reserve combines long-term monitoring with periodic surveys and short-term experiments to identify species and measure trends and changes in populations of fish, crustaceans, clams and birds. We have 10 years of data on upland and shore birds with which to assess the status of resident and migratory avian populations, and 8 years of wading bird data that we use as a gross level indicator of salt marsh health, which appears to be stable. Our periodic larval, juvenile and adult fish surveys have produced the best available data for fish utilization of salt marsh estuaries in the Gulf of Maine. In the coming year we plan to develop a long-term monitoring program for finfish that will be coordinated with other sites within the Gulf of Maine and along the east coast. Since 1994 we have been conducting surveys and field experiments to look at the survival and growth of hatchery seed, juvenile and adult softshell clam with regard to habitat characteristics and predation by the invasive green crab.

Salt Marsh Degradation and Restoration

Salt marsh ecosystems in the Gulf of Maine have sustained themselves in the

face of sea-level rise and other natural disturbances for nearly five thousand years. Since colonial times large areas of salt marsh (up to half of the total area) have been lost through diking, draining and filling. Today, the remaining marshland is fairly well protected from outright destruction, but during the past 100 years, and especially since the 1950¹s, salt marshes have been divided into fragments by roads, causeways, culverts and tide gates. Most of these fragments have severely restricted tidal flow, leading to chronic habitat degradation and greatly reduced access for fish and other marine species. Since 1991, the Wells Reserve has been studying the impact of these restrictions on salt marsh functions and values, and the response of salt marshes to tidal restoration. We have been working to promote an awareness of the damage being done and the benefits of salt marsh restoration throughout the Gulf of Maine.

Research Program Update:
In addition to the Reserve-sponsored projects outlined above, numerous visiting investigators will be involved in on-site research. Topics include: the effects of land use, sea level, and climate on estuarine productivity; the relationship between soil nutrients and plant community patterns; the influence of soil salinity on plant community interactions; the effect of tidal restriction on marsh peat accretion; the comparative ecology of fringe marshes and back barrier marshes; habitat use by upland birds, and the ecology of lyme disease.

€ The Wells NERR Research Dept. was just funded to work on the following project this spring: Community-based plan to manage current and future threats from point and non- point source pollution in the Merriland River and Branch Brook Watersheds of the Little River Estuary. There will be a shoreline survey of the Little River and its Watershed this March. The preliminary goal of this project is a) to produce a community-based watershed management plan for the Branch Brook, Merriland River, Little River combined watersheds, and b)to convey

the elements of the plan to critical audiences through a succinct road show,
culminating in a public event to showcase the plan.

€ The Wells NERR Research Dept. was also funded this year to work on the following project: Measuring the Health of the York River Ecosystem using Fish
as Indicators. The results of this study will provide information on the ecology and fisheries of the York River that is essential for wise stewardship
of this precious but threatened community resource. The goal of this project is
to assist the York Rivers Association and partners in their work as stewards of
the York River and its watershed, through an assessment of the current and
potential fish habitat value of this exemplary coastal ecosystem.

€The Wells NERR Research Dept. is involved with the following two CICEET* Projects:

I. Project Title: Estuarine Responses to Dredging: Analysis of Sedimentary and
Morphological Change in Back Barrier Marsh to Aid Local Management and Develop a
Regional Management Tool
Principal Investigator (s): Michele Dionne, Wells NERR, ME; Duncan Fitzgerald,
Boston University; Joe Kelley, University of Maine; David Burdick and Larry
Ward, University of New Hampshire

Management Issue: Coastal management tool for assessing the impacts of dredging
in estuaries
Project Summary: An adequate supply of sediment is essential for maintaining
salt marshes. Human activities, such as channel dredging and tidal restriction
due to road construction, can alter water flows in estuaries and result in
dramatic changes in salt marsh sediment supply, affecting the speed of salt
marsh erosion. The objective of this project is to determine the impact of
dredging and tidal restriction on salt marshes in the Wells NERR. A digital
coastal management guide will be created on CD ROM, providing coastal managers
with useful conceptual models for predicting the impacts of dredging and other
activities that affect water flow and sediment deposition in salt marshes.

II. Project Title: Application of a Continuous Imaging Flow Cytometer for Monitoring Estuarine Microplankton
Principal Investigators: Mike Sieracki and Chris. Sieracki, Bigelow Laboratory
for Ocean Studies

Management Issue: New technology for detecting harmful algal blooms
Project Summary: Marine plankton is a significant component of highly productive
estuaries, affecting the distribution of oxygen, nutrients, and contaminants.
Estuarine marine plankton is also the primary food for the larvae of many commercially and ecologically important finfish and shellfish. In addition to
their highly productive role, some species of plankton occasionally form nuisance or toxic blooms that affect human health as well as fish and shellfish.
This project is developing an imaging system, calledFlowCam, to continuously
monitor plankton for the presence and abundance of harmful algal species. The
same technology could also be used to monitor the effects of harbor dredging on
plankton.

The Wells NERR Research Dept. is assisting with the maintenance and data collection of the FlowCAM instrument and FlowCAM computer.

*The following information on CICEET taken directly from its website: (http://www.ciceet.unh.edu)

Wells NERR Graduate Research Fellowships (GRF's):
1) Patrick Ewanchuck and Mark Bertness, Ph.D.; Brown University
Project Title: Patch persitence and seedling dynamics in a Southern Maine marsh and the process and pattern in western Atlantic salt marsh plant communities: a biogeographical perspective.
2) Linday Whitlow, University of Michigan
Project Title: Integration of individual behavior and community dynamics to determine mechanisms by which the invasive green crab impacts populations of
the native soft-shell clam.
3) Pamela Morgan, University of New Hampshire
Project Title: Functions and values of salt marshes in northern New England: a comparison of fringing marshes and back barrier marshes.

Other Onsite Research:
Michele Dionne, Wells NERR, Nancy McReel, Chuck Lubelczyk
Project Title: Effect of herbivory by deer on forest regeneration.

June Ficker
Project Title: Monitoring avian productivity and survivorship.

Outside Researchers:

€Theresa Theodose, Ph.D., University of Southern Maine
Project Title: Relationships between soil nutrient availability and species
composition of a high salt marsh in southern Maine.

€David Burdick, Ph.D. and Roelof Boumans, Ph.D.
University of New Hampshire, University of Maryland
Project Title: Sediment dynamics in salt marshes: functional assessment of
accretionary biofilters

€Peter Rand, M.D., Chuck Lubelczyk, Robert Smith, M.D.
Maine Medical Center
Project Title: Ecological determinants of the spread of the tick vector of Lyme
disease and other pathogens.

This summary was taken from summaries written by Michele Dionne, Research Director, and put together and updated from Scott Orringer, Research Associate

Abstracts, Reports and Publications 1997-1999

The following titles describe research, management, education and outreach
activities to which Reserve staff, visiting investigators, interns, or volunteers made contributions. The nature of these contributions include data
collection, management, or analysis; authorship; or workshop/committee participation.

Bayse, N. and M. Smith (1999) Landowner options for creating great communities.
Coastal Mosaic Project, Wells National Estuarine Research Reserve. 4 pages.

Belknap, D. F., and J. T. Kelley (1998) Development of Holocene relative sea-
level curves in Maine: Geological Society of America Abstracts with Programs,
v. 30, p. 4-5.

Boumans, R., D. Burdick, and M. Dionne (1999) Modeling habitat change in salt
marshes following tidal restoration. Manuscript in review.

Bryan, R., M.Dionne, R. Cook, J. Jones and A. Goodspeed (1997) Maine citizens
guide to evaluating, restoring, and managing tidal marshes. Maine Audubon
Society, Falmouth, ME.

Buchsbaum, R., D.M. Burdick, R. Cook, T. Diers, M. Dionne, K. Hughes, R. Milton,
H. A. Neckles, L. Roberts, C.T. Roman, J. Taylor, and D. Thompson (1999)

Standards and criteria for evaluating tidal wetland restoration in the Gulf of
Maine: workshop results. Estuarine Research Federation Abstracts with Programs.

Burdick, D. M., R. M. Boumans, M. Dionne and F. T. Short (1999) Impacts to salt
marshes from tidal restrictions and ecological responses to tidal restoration.
Report submitted to the Estuarine Reserves Division, National Oceanic and Atmospheric Administration. 51 pages plus figures and appendices.

Burdick, D. M., R. M. Boumans, and M. Dionne (1999) Modeling habitat change
following tidal restoration in New England salt marshes. Estuarine Research
Federation Abstracts with Programs.

Burdick, D., M. Dionne, R. Boumans and F. Short (1997) Ecological responses to
tidal restoration in two New England salt marshes. Wetlands Ecology and Management 4:129-144.

Dionne, M. (1999) Fish utilization of salt marsh habitat in the Gulf of Maine.
Gulf of Maine News (Spring): 1-7.

Dionne, M., D. Burdick, R. Cook, R. Buchsbaum, and S. Fuller (1998) Scoping
paper 5: physical alterations to water flow and salt marshes: protecting and
restoring flow and habitat in Gulf of Maine salt marshes and watersheds. Final
draft of a working paper. Commission for Environmental Cooperation and Global
Program of Action Coalition for the Gulf of Maine. 68 pp.+ appendices.

Dionne, M., F. Short, and D. Burdick (1998) Fish utilization of restored, created and reference salt marsh habitat in the Gulf of Maine. American Fisheries Society Symposium 22: Fish habitat: Essential Fish Habitat (EFH) and
Rehabilitation: 384-404.

Dionne, M. (1997) Animal interactions and secondary productivity in northeastern
tidal marshes. Pages 19-24 in R. A. Orson, R. S. Warren, W. A. Niering and P.Van
Patten (eds), Research in New England Marsh-Estuarine cosystems:directions and
priorities into the next millenium. Connecticut Sea Grant Publications, University of Connecticut, Groton.

Dionne, M. (1997) Nutrients and dissolved oxygen in Maine estuaries and embayments. Final data report submitted to New England Interstate Water

Pollution Control Commission. 46 pp including appendices.

Hoffman, C. 1997. Drakes Island Marsh Restoration Project Report. Contracted
out by the Wells NERR.

Holden, W.F. 1997. Fresh water, suspended sediment and nutrient influx to the
Little River and Webhannet River Estuaries, Wells, Maine. Ph.D. dissertation,
Boston University. pp 1-179

Kelley, J. T., S. M. Dickson, D. F. Belknap and W. A. Barnhardt (1998) Nearshore
sand volume as a component of littoral sand budgets in Maine, Norhern New
England, USA: International Coastal Symposium, Coastal Education and Research
Foundation. Journal of Coastal Research SI 26, p. A16-A17.

Kelly, J. R. (1997) Dissolved oxygen in Maine estuaries and embayments: 1996
results and analyses. Report submitted to Wells National Estuarine Research
Reserve. 89 pp including appendices.

Maine State Planning Office (1998) Improving Maine¹s beaches: recommendations of
the Southern Maine Beach stakeholder group. 16 pp.

Miller, G.T., D. F. Belknap, J.T. Kelley, D.M. Fitzgerald (1997) Ground-
penetrating radar of a coastal moraine compared to seismic reflection profiles
of moraines preserved on the inner shelf off Southwestern Maine. Abstracts with
Program -Geological Society of America 29: 67.

Morgan, P. A. and F. T. Short (1999) Functions and values of fringing salt
marshes in northern New England. New England Estuarine Research Society
Abstracts (spring meeting).

Moser, Susanne (1998) Talk globally, walk locally: the cross-scale influence of
global change information on coastal zone management in Maine and Hawaii. ENRP
Discussion Paper E-98-16, Kennedy School of Government, Harvard University. 60
pp. [The Wells NERR was one of many interviewees that contributed to this
study.]

Rand, P. W., E. H. LaCombe, R. P. Smith, Jr., and J. Ficker (1998). Participation of birds ŒAves¹ in the emergence of lyme disease in Southern

Maine. Journal of Medical Entomology 35: 270-276.

Short, F. T. (1997) New England Estuarine Society Spring Meeting held at the
Wells National Estuarine Research Reserve, Wells, Maine. Environmental Conservation 24: 291-292.

Short, F. T., C. A. Short, R. C. Davis, D. M. Burdick, and P. Morgan (1998)
Developing success criteria for multiple estuarine habitats. Abstracts with
Program -Goal Setting and Success Criteria for Habitat Restoration, Charleston,
S.C.

Sinson, D. A., D. F. Belknap, and J. T. Kelley (1998) Shoreface vibracore analysis: Wells embayment, southern Maine: Geological Society of America Abstracts with Programs, v. 30, p. 74.

Smith, M. (1999) Southern Maine Coastal Mosaic habitat conservation project.
Coastal Mosaic Project, Wells National Estuarine Research Reserve. 5 pages plus
maps and appendices.

Theodose, T. A. (1999) Nutrient availability, nutrient limitation, and species
diversity in salt marsh forb communities. New England Estuarine Research Society Abstracts (spring meeting).

Theodose, T. A. and J. B. Roths (1999). Relationships between nutrient availability. stress and diversity on two New England salt marshes. Plant
Ecology. In press.

Theodose, T. A. (1997) Relationships between stress, nutrient availability, and
plant community diversity on two high salt marshes in southern Maine. Ecological Society of America Abstracts.

Theodose, T.A. (1997) Spatial variation in soil nutrient availability, production, and plant species diversity on two high salt marshes in southern
Maine. New England Estuarine Research Society Abstracts (spring meeting).

Wade, Stephen (1999) Effects of tidal restriction on elevation and plant communities in five tidal marshes in Wells and Kennebunk, Maine. Masters Project, Antioch New England Graduate School. 23 pages plus figures and maps.

Ward, L. G. 1993. Precipitation, streamflow, and water characteristics (physical and chemical) of theWebhannet River Estuary, Wells, Maine. Draft

final report by UNH, Jackson Estuarine Laboratory, Durham, NH. NOAA Technical
Memorandum, pp. 1-13.

WNERR RMA 1996. Wells NERR Management Plan. Prepared by the WNERR Management
Authority (RMA) and NOAA, SRD Division. pp. 1-120.

Whitlow, Lindsay (1999) Size-dependent vulnerability of soft-shell clams to
predation by the invasive green crab in Wells, ME. Abstracts Program. 1st
National Conference on Marine Bioinvasions.

Wood, Robert (1998) Town of Wells softshell clam program: options and
recommendations. Wells National Estuarine Research Reserve, Wells, ME.
9 pp.

II. Physical Structure Descriptors:

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

a. YSI 6000 datalogger

| Variable | Range of Measurements | Resolution | Accuracy |
|---|---|---|---|
| Date | 1-12, 1-31, 00-99 (Mo,Day,Yr) | 1 mo, 1 day, 1 yr | NA |
| Time | 0-24, 0-60, 0-60 (Hr,Min,Sec) | 1 hr, 1 min, 1 s | NA |
| Temp | -5 to 45 (c) | 0.01 C | +/- 0.15C |
| Sp COND | 0-100(mS/cm) | 0.01mS/cm | +/-0.5% Of reading + 0.001mS/Cm |
| Salinity | 0-70 Parts per thousand (ppt) | 0.01 ppt | +/- 1% of Reading or 0.1 ppt, (whichever is greater) |
| DO | 0-200 (% air saturation) | 0.1% @air sat | +/-2% @air Saturation |
| DO | 200-500 (% air saturation | 0.1% @ air sat | +/- 6% @ Saturation |
| DO | 0-20 (mg/l) | 0.01 mg/l | +/- 0.2mg/l |
| DO | 20-50 (mg/l) | 0.01 mg/l | +/- 0.6mg/l |
| Depth (shallow) | 0-9.1 (m) | 0.001m | +/- 0.018m |
| PH | 2-14 units | 0.01 units | +/- 0.2units |
| Turb | 0-1000 NTU | 0.1 NTU | +/- 5% of |

Reading or 2 NTU (whichever is greater)

Data columns are separated by tabs. Each file contains a two line column header at the top of the page which identifies measurements and units for each column.

9. Coded variable indicator and variable code definitions:

Site definitions: HT = Head of Tide of Webhannet River

IN = Inlet at Webhannet River Mouth

File definitions: YSI deployment site/month/year (example: IN0799 = Webhannet
Inlet site, data from July 1999).

10. Data anomalies:

January, 1999 Sampling Period
Head of Tide: None to report; sonde not deployed until March.

Inlet:
Depth data for the month of January is suspect possibly due to the presence
of ice in the deployment tube. Depth was about half its normal range. Data
retained.

No data collected from 1/1 0:00 through 1/2 21:30 due to a data gap. Logger
did not record data within this time range, possibly due to an overwrite of
data.
No pH data from 1/2 22:00 to 1/20 10:30 due to a pH probe crash. These data
were suspect and deleted.
The post-cal was unreliable and the probe could not be recalibrated upon return
to the lab.
The following were episodes that sonde was suspected out of the water, due to
shallow positive and negative depths, low specific conductivity and salinity,
cold temperatures, high rollover turbidity, and high dissolved oxygen and
percent saturation data. This could have been due extremely cold winter
temperatures and possible ice in sonde deployment tube. These data were suspect
and deleted.
1/3 4:00-6:30, 17:30-18:00
1/4 5:30-7:00, 17:30-20:30
1/5 6:00-8:00, 18:30-21:00
1/6 19:30-21:00
1/7 20:00-22:30

1/14 17:00 - 18:00
1/16 15:30-17:30
1/17 4:00-4:30, 16:00-18:30
1/18 17:00-18:30
1/19 17:30-19:30
1/20 6:00-7:30
The following are shallow positive depth data (23 values with a range of 0.0 to
0.09 m; mean of 0.045 m). Sonde probes suspected to be underwater as other
parameters check out normal. These data were not deleted.
1/3 19:00
1/4 5:00
1/6 21:30
1/7 8:00-9:30
1/12 13:30-14:00
1/16 3:00-4:30, 15:00, 18:00
1/17 3:30, 5:00
1/18 16:30, 19:00
1/19 5:00, 7:00, 20:00
1/20 5:30
The following are shallow negative depth data (5 values with a range of -0.01 to
-0.04 m; mean of -0.022 m). Sonde probes suspected to be underwater as other
parameters check out normal. These data were not deleted.
1/3 18:30
1/19 5:30-6:30, 17:00
Small negative turbidity values were recorded throughout the following time
span: 1/2 22:30-1/13 9:30 (logging period recorded 39 anomalies), possibly due
to a small calibration error. These data were not deleted.
The following were high positive turbidity spikes, including one roll over
episode (>1000 NTU), that were not consistent with the overall data record.
This suspect data were not deleted, as we are not absolutely sure that these
values were bad.
1/3 7:00 (1019), 7:30 (399), 8:00 (173)
1/4 21:00 (286)
1/5 8:30 (956), 9:00 (439), 21:30 (387), 22:00 (68)
The following are 16 suspect dissolved oxygen and percent saturation values,
due to extremely high outliers not consistent with the overall data record
(range from 14.4/122.5 to 21.2 mg/l and 190.0%, mean of 18.0 mg/l and 159.7%).
These high outliers fell in between the normal, consistent range from 1/4 22:00
through 1/5 5:30. Although these suspect values were not consistent with the

overall data record, they were not deleted as they do not fall out of the probe
range. Other parameters, the dissolved oxygen post-cal, and recalibration were good.

February, 1999 Sampling Period
Head of Tide: None to report; sonde not deployed until March.

Inlet:
The following was a high positive turbidity spike that was not consistent with
the overall data record. This suspect datum was not deleted, as we are not
absolutely sure that this value was bad.
2/28 2:00 (47.0)

March, 1999 Sampling Period
Head of Tide:
Small zero and/or negative turbidity values were collected sporadically throughout the following time span: 3/11 13:00-3/31 9:00 (logging period recorded 257 anomalies), possibly due to a small calibration error. These data
were not deleted.
The following was a high positive turbidity spike that was not consistent with
the overall data record. This suspect datum was not deleted, as we are not
absolutely sure that this value was bad.
3/29 2:30 (165.0)

Inlet:
No data on 3/3 11:30 due to a data gap. Logger did not record data possibly due
to an overwrite of data.
The following were high positive turbidity spikes, including one roll over
episode (>1000 NTU), that were not consistent with the overall data record.
This suspect data were not deleted, as we are not absolutely sure that these
values were bad.
3/9 1:30 (60.1)
3/14 3:30 (50.7)
3/15 1:30 (1454.7) - 2:00 (149)
3/24 6:00 (400.2), 20:30 (129)
3/25 0:30 (98.9), 2:00 (75.9)

April, 1999 Sampling Period
Head of Tide:
Small zero and/or negative turbidity values were collected sporadically throughout the following time span: 4/13 12:30-4/27 5:30 (logging period recorded 158 anomalies), possibly due to a small calibration error. These data

were not deleted.
The following are shallow positive depth data (63 values with a range of 0.04 to
0.09 m; mean of 0.074 m). Sonde probes suspected to be underwater as other
parameters check out normal. These data were not deleted.
4/13 11:00-19:30
4/14 0:00-7:30, 12:00-16:30
4/26 10:00-18:00
No turbidity data from 4/27 8:30 to 4/29 11:30 due to a turbidity probe malfunction.

Inlet:
No data from 4/1 0:00 through 4/30 23:30 due to a telemetry unit battery crash
(continued from the 3/29 deployment) and telemetry unit downtime (as we were
getting prepared for the deployment of the new vented level YSI 6600 - see
Section 4, Research Methods).

May, 1999 Sampling Period
Head of Tide:
The following are shallow positive depth data (51 values with a range of 0.052
to 0.099 m; mean of 0.082 m). Sonde probes suspected to be underwater as other
parameters check out normal. These data were not deleted.
5/12 17:30-18:30
5/13 0:30-4:00
5/19 5:30-6:00, 7:00-7:30
5/23 20:00-23:30
5/24 0:00-4:00, 13:30-22:30
There were two high positive turbidity spikes on 5/13 3:00 (539.7)* and 5/19
14:00 (557.2) that were not consistent with the overall data record. These
suspect data were not deleted, as we are not absolutely sure that these values
are bad.
*The first of these data points is not included in the range of high positive
turbidity spikes described just below, even though it was within this range.
There was a continuous range of high positive turbidity spikes from 5/11 6:00
through 5/15 21:00 (except for 5/13 3:00; which is mentioned above) (222 values
with a range from 4.0-233.9; mean of 63.15) that were not consistent with the
overall data record. These suspect data were not deleted, as we are not
absolutely sure that these values are bad. (Although the first few spikes are

not normally labeled anomalous as they are not considerably high spikes, they
are included in this range because of continuously increasing values).

Inlet:
No data collected on the following dates/times; due to a data gap. Logger did
not record data within this time range, possibly due to an overwrite of data.
5/7 0:00 to 5/12 9:00
5/14 10:00-17:00
5/27 17:00-17:30
The following were high positive turbidity spikes, including one roll over
episode (>1000 NTU), that were not consistent with the overall data record.
This suspect data were not deleted, as we are not absolutely sure that these
values were bad.
5/21 9:30 (179.6)
5/22 22:30 (55.3)
5/24 12:00 (114.9)
5/25 11:00 (297.2), 14:00 (61)
5/26 14:30 (52), 16:00 (54.1), 20:00 (54.6)
5/27 6:00 (142.2), 15:30 (1592)
5/28 13:30 (211.7), 14:00 (185.3)-14:30 (249.3)
5/31 10:00 (54.4)

June, 1999 Sampling Period
Head of Tide:
The following are shallow positive depth data (51 values with a range of 0.052
to 0.099 m; mean of 0.082 m). Sonde probes suspected to be underwater as other
parameters check out normal. These data were not deleted.
6/1 2:00-23:00
6/2 2:30, 6:30, 7:30-14:00
6/3 0:00, 3:00
6/4 1:00, 14:30-15:30
6/4 19:30-23:30
6/5 0:00-1:30, 4:30-23:30
6/6 0:00-2:30, 5:00-15:00, 16:30-17:00
6/7 4:00, 5:00-5:30, 17:00-18:00
6/8 5:00, 6:00
6/9 17:30, 21:00-23:30
6/10 0:00-6:00, 9:30-18:00, 22:30-23:30
6/11 0:00-7:00, 10:30-19:00
6/12 0:00-8:00, 11:30-20:00
6/13 1:00-9:00, 12:30-20:30
6/14 2:00-2:30
6/15 3:00, 14:00
6/16 3:30, 12:00, 15:00
6/17 16:00
6/18 17:00-23:30

6/19 0:00-1:30
6/19 5:30-14:30, 17:30-23:30
6/20 0:00-3:00, 6:00-16:00, 18:00-23:30
6/21 0:00-4:30, 6:30-14:30, 17:00, 19:00-21:30
6/22 5:30-7:00, 20:00
6/23 7:00-8:00, 18:30, 21:00
6/24 8:00, 22:00
6/25 9:00, 20:00, 22:30
6/26 20:30, 23:30
6/27 11:00
6/28 0:00, 22:00
6/29 16:30-22:30

The following are shallow negative depth data (685 values with a range of -0.001 to -0.239 m; mean of -0.081 m). Sonde probes suspected to be underwater as other parameters check out normal. These data were not deleted.

6/2 3:00-6:00, 7:00, 14:30-23:30
6/3 3:30-23:30
6/4 00:00 - 00:30, 04:00 - 14:00, 16:00-19:00
6/6 17:30-23:30
6/7 0:00-3:30, 6:00-16:30, 18:30-23:30
6/8 0:00-4:30, 7:00-17:00, 20:00-23:30
6/9 0:00-5:00, 8:30-17:00
6/14 3:30-10:00, 13:30-21:30
6/15 3:30-11:00, 14:30-22:30
6/16 4:00-11:30, 15:30-23:30
6/17 4:30-12:30, 16:30-23:30
6/18 0:00-0:30, 5:00-13:30
6/21 22:00-23:30
6/22 0:00-5:00, 7:30-17:30, 20:30-23:30
6/23 0:00-6:30, 8:30-18:00, 21:30-23:30
6/24 0:00-7:30, 8:30-19:00, 22:30-23:30
6/25 0:00-8:30, 9:30-19:30, 23:00-23:30
6/26 0:00-20:00
6/27 0:00-10:30, 11:30-21:00
6/28 0:30-21:30
6/29 1:00-9:30, 15:00 - 16:00

There was a continuous range of high positive turbidity spikes from 6/25 15:30 through 6/27 2:30 (71 values with a range from 27.3 to 434.8 NTU; mean of 141.28) that were not consistent with the overall data record. These suspect data were not deleted, as we are not absolutely sure that these values are bad. (Although the first few spikes are not normally labeled anomalous as they are not considerably high spikes, they are included in this range because of continuously increasing values).

There was one suspect dissolved oxygen (15.0 mg/l) and percent saturation (188.2%) spike on 6/28 11:30 that was not consistent with the overall data record. This suspect data spike was not deleted.

Inlet:
No data collected on the following dates/times; due to a data gap. Logger either (1) did not record data within this time range, possibly due to an overwrite of data; or (2) did record the same data values because of an overwrite (these data were deleted).
6/2 14:30-20:00
6/18 14:30 to 6/23 16:30
No turbidity data from 6/1 0:00 through 6/30 11:30 due to a turbidity probe malfunction.
Small negative turbidity values were collected sporadically throughout the following time span: 6/30 18:00-23:30 (logging period recorded 12 anomalies), possibly due to a small calibration error. These data were not deleted.

July, 1999 Sampling Period
Head of Tide:
No dissolved oxygen data or percent saturation data from 7/1 0:00 through 7/4 1:30 due to a suspected DO membrane puncture or tear and probe malfunction (DO charge upon return was below the acceptable range).
Small zero and/or negative turbidity values were collected sporadically throughout the following time span: 7/3 17:30-7/4 0:00 (logging period recorded 6 anomalies), possibly due to a small calibration error. These data were not deleted.
There were two consecutive pH spikes on 7/2 14:30 (8.3) and 15:00 (8.0) that were not consistent with the overall data record. These data were not deleted, as the cause was most likely from a higher than normal tidal range (a regular monthly occurrence) at this Head of Tide site.
No data collected from 7/4 2:00 through 7/31 23:30 due to a major battery crash, where battery voltage dropped quickly from 12.0 to 6.1 volts within approximately a 5 day span. Possible causes of this crash (after conferring with YSI engineers) include static electricity from a car seat prior to deployment or a nearby lightning strike.

Inlet:
No data collected on the following dates/times; due to a data gap. Logger either (1) did not record data within this time range, possibly due to an overwrite of data; or (2) did record the same data values because of an overwrite (these data were deleted).
7/1 11:00 to 7/2 16:30
7/22 15:30-18:30

Small negative turbidity values were recorded throughout the following time span: 7/1 0:00-7/31 1:30 (logging period recorded 569 anomalies), possibly due to a small calibration error. These data were not deleted.
The following dissolved oxygen and percent saturation data on 7/5 23:30 are suspect as they were small, negative values which are outside the listed range of the dissolved oxygen probe. These suspect values were not consistent with the overall data record, and were deleted on the basis of absolute data rejection. Other parameters, the dissolved oxygen post-cal, and recalibration were good.
The following are episodes of low dissolved oxygen (range from 0.1 to 2.7 mg/l, mean of 1.6 mg/l) and percent saturation (range from 0.6 to 35.2%, mean of 19.64%) during several low tide fluctuations that were not consistent with the overall data record (at high tide the readings returned to the consistency of the overall data record). These suspect data were not deleted, as we are not absolutely sure that these values are bad. Other parameters, the dissolved oxygen post-cal, and recalibration were good.
7/5 10:00-11:00, 12:00, 23:00
7/6 0:30
7/8 13:30
7/9 0:00, 3:30-4:00
7/12 6:00
The following were high positive turbidity spikes, some of these a continuous range, including one roll over episode (>1000 NTU), that were not consistent with the overall data record. This suspect data were not deleted, as we are not absolutely sure that these values were bad.
7/8 0:30 (50)
7/9 10:30-12:00 (range 52-114)
7/10 12:30-14:30 (range 192-659), 15:30 (112), 17:30 (244), 18:00 (342)
7/11 2:30-3:30 (range 67-92), 10:30-15:00 (range 51-1722), 17:00-17:30 (range 95-183)
7/12 4:30 (52), 15:00-16:00 (range 109-490)
7/16 21:30 (63), 22:30 (114)
7/17 22:30 (103)
7/25 3:30 (54)

August, 1999 Sampling Period
Head of Tide:

No data collected from 8/1 0:00 through 8/17 11:00 due to a major battery crash
(continuation from 7/4 2:00 crash), where battery voltage dropped quickly from
12.0 to 6.1 volts within approximately a 5 day span. Possible causes of this
crash (after conferring with YSI engineers) include static electricity from a
car seat prior to deployment or a nearby lightning strike.
No dissolved oxygen data or percent saturation data from 8/17 11:30 through 8/24
5:30 due to a suspected DO membrane puncture or tear and probe malfunction (DO
charge upon return was below the acceptable range).
The following are shallow positive depth data (93 values with a range of 0.0 to
0.099 m; mean of 0.023 m). Sonde probes suspected to be underwater as other
parameters check out normal. These data were not deleted:
8/17 15:30, 18:00
8/18 4:30, 6:00, 18:30
8/19 5:30-6:30, 17:00, 19:30-23:30
8/20 0:00-18:00, 20:30-23:30
8/21 0:00-11:30, 21:30
8/22 8:30, 19:30, 22:30
8/23 9:30-10:00, 23:30
The following are shallow negative depth data (685 values with a range of -0.001
to -0.239 m; mean of -0.081 m). Sonde probes suspected to be underwater as
other parameters check out normal. These data were not deleted.
8/17 11:30-15:00, 18:30-23:30
8/18 0:00-4:00, 6:30-16:00, 19:00-23:30
8/19 0:00-5:00
8/19 7:00-16:30
8/21 12:30-18:30, 22:30-23:30
8/22 0:00-8:00, 9:00-19:00, 23:00-23:30
8/23 0:00-8:30, 10:30-20:00
8/24 0:00-5:30
No data collected from 8/24 6:00 through 8/31 23:30 due to a SECOND major
battery crash (see above), where battery voltage dropped quickly from 12.0 to
6.0 volts within approximately a 8 day span. Possible causes of this crash
(after conferring with YSI engineers) include static electricity from a car seat
prior to deployment or a nearby lightning strike.

Inlet:
Small negative turbidity values were recorded throughout the following time
span: 8/3 14:30- 15:30 and 8/28 00:00 - 13:30 (logging period recorded 14
anomalies), possibly due to a small calibration error. These data were not

deleted.
The following are episodes of low dissolved oxygen (range from 1.7 to 3.1 mg/l,
mean of 2.67 mg/l) and percent saturation (range from 19.3 to 37.8%, mean of
32.76%) during several low tide fluctuations that were not consistent with the
overall data record (at high tide the readings returned to the consistency of
the overall data record). These suspect data were not deleted, as we are not
absolutely sure that these values are bad. Other parameters, the dissolved
oxygen post-cal, and recalibration were good.
8/9 2:30
8/10 3:00-4:00
8/11 4:00
8/23 2:30
8/25 3:30
8/26 4:00-4:30
The following were 651 high positive turbidity spikes (>50 NTU), some of these a
continuous range, that were not consistent with the overall data record (range
from 50-977 NTU, mean of 140.65 NTU). This suspect data were not deleted, as we
are not absolutely sure that these values were bad.
8/3 8:30
8/5 6:00, 16:30-17:30
8/6 20:00
8/7 2:00-2:30, 11:00-11:30, 12:30-13:00, 14:00-16:00, 19:00-23:30
8/8 0:00-5:30, 6:30-8:30, 15:00, 16:00, 17:00, 22:00, 23:00-23:30
8/9 0:00-8:00, 9:00-11:00, 12:00, 13:00-18:00, 21:00-23:30
8/10 0:00-9:30, 11:30-20:00, 22:00, 23:00-23:30
8/11 0:00-9:00, 10:00, 11:00, 12:00-23:30
8/12 0:00-11:00, 12:00-23:30
8/13 0:00-23:30
8/14 0:00-11:30, 13:00-21:00, 22:00-22:30, 23:30
8/15 0:00-21:00, 22:00, 23:30
8/16 0:00-1:00, 2:00-4:30, 5:30-11:00, 12:00, 18:30
8/19 13:00-13:30, 15:00-15:30, 16:30, 20:00, 21:00-22:00
8/20 1:00, 2:00, 3:00-5:30, 7:00-9:00, 10:00-12:00, 13:00-17:00, 18:00, 19:00-
20:00, 21:00-23:00
8/21 0:00, 2:00, 3:00, 4:00-5:00, 6:00, 7:00-10:00, 11:00-14:00, 15:00, 16:30-
17:30, 19:00, 20:30-21:00, 22:30-23:30
8/22 0:00, 1:00, 2:00, 4:00-12:00, 13:00-14:00, 15:00, 16:00, 17:00, 18:00,
19:00, 20:00, 21:00-23:00
8/23 0:00-5:30, 6:30, 7:30-10:00, 11:00-12:00, 13:00-23:30
8/24 0:00-3:00, 4:00-5:00, 6:00-23:30
8/25 0:00-23:30
8/26 0:00-9:30

The following were several roll over episodes (>1000 NTU), with a range of high positive turbidity spikes (<1000 NU) that were not consistent with the overall data record. These suspect data were not deleted, as we are not absolutely sure that these values were bad.
8/14 12:30 (1264)
8/15 21:30 (1665), 23:00 (1307)
8/16 1:30 (1287), 5:00 (1609)
No data collected on 8/18 10:00-14:30; due to a data gap. Logger did not record data within this time range, possibly due to an overwrite of data.

September, 1999 Sampling Period
Head of Tide:
No data collected from 9/1 0:00 through 9/30 23:30 due to a SECOND major battery crash (a continuation from the 8/24 6:00 crash), where battery voltage dropped quickly from 12.0 to 6.0 volts within approximately a 8 day span. Possible causes of this crash (after conferring with YSI engineers) include static electricity from a car seat prior to deployment or a nearby lightning strike.

Inlet:
There was one suspect dissolved oxygen (10.7 mg/l) and percent saturation (129.9%) spike on 9/27 12:30 that was not consistent with the overall data record. This suspect data spike was not deleted.

October, 1999 Sampling Period
Head of Tide:
No data collected from 10/1 0:00 through 10/31 23:30 due to a SECOND major battery crash (a continuation from the 8/24 6:00 crash), where battery voltage dropped quickly from 12.0 to 6.0 volts within approximately a 8 day span. Possible causes of this crash (after conferring with YSI engineers) include static electricity from a car seat prior to deployment or a nearby lightning strike.

Inlet:
The following are 9 suspect dissolved oxygen and percent saturation values, due to extremely high outliers not consistent with the overall data record (range from 9.9/112.6 to 31.1 mg/l and 356%, mean of 19.22 mg/l and 221.16%). These high outliers fell in between the normal, consistent range from 10/5 10:30

through 10/6 12:00. Although these suspect values were not consistent with the overall data record, they were not deleted, as they do not fall out of the probe range. Other parameters, the dissolved oxygen post-cal, and recalibration were good.
10/5 10:30, 11:30, 12:30
10/6 8:00, 9:00-9:30, 10:30-11:00, 12:00
The following were 49 high positive turbidity spikes (>50 NTU), some of these a continuous range, including one roll over episode (>1000 NTU), that were not consistent with the overall data record (range from 50-1341 NTU), mean of 242.92 NTU. This suspect data were not deleted, as we are not absolutely sure that these values were bad.
10/3 14:30
10/6 6:30
10/10 12:30
10/19 5:00
10/21 2:30
10/23 0:00, 1:00-1:30, 5:00, 7:00-7:30, 8:30, 11:00, 12:30, 17:00, 18:30, 19:30, 21:00, 22:30, 23:30
10/24 2:00-3:00, 9:00, 10:30, 21:30, 22:30
10/25 0:00, 1:30, 4:00-4:30, 5:30, 7:00, 8:30, 11:00, 12:00-12:30, 15:00, 16:30, 19:30, 22:00, 23:30
10/26 1:00, 2:30, 4:00, 5:30, 8:00-8:30, 11:00

November, 1999 Sampling Period
Head of Tide:
Small zero and/or negative turbidity values were recorded throughout the following time span: 11/5 16:00-11/30 16:00 (logging period recorded 1,096 anomalies), possibly due to a small calibration error. These data were not deleted.
The following are shallow positive depth data (136 values with a range of 0.0 to 0.098 m; mean of 0.038 m). Sonde probes suspected to be underwater as other parameters check out normal. These data were not deleted:
11/9 15:00-23:30
11/10 1:30-10:30, 14:30-21:30
11/14 10:30-14:00, 16:30-23:30
11/15 0:00-18:30
11/16 16:00-16:30, 17:30
11/17 2:00-11:30
The following are shallow negative depth data (58 values with a range of -0.001 to -0.064 m; mean of -0.035 m). Sonde probes suspected to be underwater as

other parameters check out normal. These data were not deleted.
11/15 20:00-23:30
11/16 0:00-15:30; 18:00-23:30
11/17 0:00-0:30
The following were several episodes of higher and lower than normal readings of
dissolved oxygen and percent saturation. These episodes were not deleted, as
post calibration tests were accepted; and may have been a result of low winter
temperatures and the monthly astronomical tides.
11/23 11:00-13:30 (range: 7.82/66.8 to 16.52 mg/l and 143.1%)
11/24 11:30-15:30 (range: 6.42/64.2 to 16.86 mg/l and 150.1%)
11/25 12:30-15:30 (range: 12.26/118.9 to 15.33 mg/l and 135.1%)
11/26 13:30-17:00 (range: 12.39/117.1 to 18.24 mg/l and 160.4%)
There was a continuous gradual increase of high dissolved oxygen and percent
saturation readings from 11/27 1:30 through 11/31 23:30. These high values
began at approximately the low value range of 12.84 mg/l and 112.9% to a
stabilized high value range of 17.03 mg/l and 125.1% (mean of 14.76 mg/l and
118.83%). These readings were not deleted, as post calibration tests were
accepted; and these higher than normal values could have been a result of low
winter temperatures.
No data collected on the following dates/times, due to a data gap:
11/30 23:00 - 23:30

Inlet:
Small negative turbidity values were recorded throughout the following time
span: 11/17 5:30-11/20 9:00 (logging period recorded 16 anomalies), possibly due
to a small calibration error. These data were not deleted.
There was a range of lower than normal dissolved oxygen and percent saturation
from 11/27 13:30 through 11/29 0:00, during astronomical tides with several low
tide fluctuations; that were not consistent with the overall data record (at
high tide the readings returned to the consistency of the overall data record).
These suspect data were not deleted, as we are not absolutely sure that these
values are bad.

December, 1999 Sampling Period
Head of Tide:
There was a continuous stabilized range of high dissolved oxygen and percent

saturation readings from 12/1 0:00 through 12/17 9:30 (a continuation of the
gradual increase of high dissolved oxygen and percent saturation readings from
11/27 1:30 through 11/31 23:30). These high continuous stabilized values had a
range from 14.77/121.7 to 18.38 mg/l and 129.7% (mean of 16.66 mg/l and
125.93%). These readings were not deleted, as post calibration tests were
accepted; and these higher than normal values could have been a result of low
winter temperatures.
Small zero and/or negative turbidity values were recorded throughout the
following time span: 12/2 11:00-12/31 23:00 (logging period recorded 1183
anomalies), possibly due to a small calibration error. These data were not
deleted.
No dissolved oxygen data or percent saturation data from 12/17 10:00 through
12/31 23:30 due to a suspected DO membrane puncture or tear and probe
malfunction.
No data collected on the following dates/times; due to a data gap. Logger did
not record data within this time range, possibly due to the cold temperatures.
12/28 1:30-2:00, 12:30, 23:30
12/29 0:00, 9:30

Inlet:
Small negative turbidity values were recorded throughout the following time
span: 12/18 8:00-12/20 14:00 (logging period recorded 30 anomalies), possibly
due to a small calibration error. These data were not deleted.

11. Missing data:

January, 1999 Sampling Period
Head of Tide: No data in January; sonde not deployed until March.

Inlet:
No data collected from 1/1 0:00 through 1/2 21:30; due to a data gap. Logger
did not record data within this time range, possibly due to an overwrite of
data.
No pH data from 1/2 22:00 to 1/20 10:30 due to a pH probe crash.
The following were episodes that the sonde was suspected to be out of the
water.
These data were suspect and deleted.
1/3 4:00-6:30, 17:30-18:00
1/4 5:30-7:00, 17:30-20:30
1/5 6:00-8:00, 18:30-21:00

1/6 19:30-21:00
1/14 17:00 - 18:00
1/7 20:00-22:30
1/16 15:30-17:30
1/17 4:00-4:30, 16:00-18:30
1/18 17:00-18:30
1/19 17:30-19:30
1/20 6:00-7:30
No data from 1/20 11:00 to 1/31 23:30 due to downtime for calibration, maintenance and downloading.

February, 1999 Sampling Period
Head of Tide: No data in February; sonde not deployed until March.

Inlet:
No data from 2/1 0:00 to 2/12 11:00 due to downtime for calibration, maintenance
and downloading.

March, 1999 Sampling Period
Head of Tide:
No data on 3/1 0:00 to 3/11 12:30; this was the first datalogger deployment
(3/11 at
13:00) at this site for 1999.

Inlet:
No data on 3/3 11:30 due to a data gap. Logger did not record data possibly due
to an overwrite of data.
No data from 3/25 9:00 to 3/31 23:30 due to downtime for calibration, maintenance and downloading; a telemetry unit battery crash (from a 3/29 deployment) and telemetry unit downtime (as we were getting prepared for the
deployment of the new vented level YSI 6600 - see Section 4, Research Methods).

April, 1999 Sampling Period
Head of Tide:
No turbidity data from 4/27 8:30 to 4/29 11:30 due to a turbidity probe malfunction.
No data from 4/29 12:00 to 4/30 16:00 due to downtime for calibration, maintenance and downloading.

Inlet:
No data from 4/1 0:00 through 4/30 23:30 due to a telemetry unit battery crash
(continued from the 3/29 deployment) and telemetry unit downtime (as we were
getting prepared for the deployment of the new vented level YSI 6600 - see
Section 4, Research Methods).

May, 1999 Sampling Period

Head of Tide:
No missing data due to downtime for calibration, maintenance and downloading.

Inlet:
No data from 5/1 0:00 through 5/4 14:30 due to downtime for calibration and
maintenance of the first deployment of vented level YSI 6600 (see Section 4,
Research Methods).
No data collected on the following dates/times; due to a data gap. Logger did
not record data within this time range, possibly due to an overwrite of data.
5/7 0:00 to 5/12 9:00
5/14 10:00-17:00
5/27 17:00-17:30

June, 1999 Sampling Period
Head of Tide:
No data from 6/29 10:00-16:00 due to downtime for calibration, maintenance and
downloading.

Inlet:
No data collected on the following dates/times; due to a data gap. Logger
either (1) did not record data within this time range, possibly due to an overwrite of data; or (2) did record the same data values because of an overwrite (these data were deleted).
6/2 14:30-20:00
6/18 14:30 to 6/23 16:30
No turbidity data from 6/1 0:00 through 6/30 11:30 due to a turbidity probe
malfunction.
No data from 6/30 12:00-17:00 due to downtime for calibration, maintenance and
downloading.

July, 1999 Sampling Period
Head of Tide:
No dissolved oxygen data or percent saturation data from 7/1 0:00 through 7/4
1:30 due to a suspected DO membrane puncture or tear and probe malfunction (DO
charge upon return was below the acceptable range).
No data collected from 7/4 2:00 through 7/31 23:30 due to a major battery crash,
where battery voltage dropped quickly from 12.0 to 6.1 volts within pproximately
a 5 day span.  Possible causes of this crash (after conferring with YSI engineers) include static electricity from a car seat prior to deployment or a

nearby lightning strike.

Inlet:
No data collected on the following dates/times; due to a data gap. Logger
either (1) did not record data within this time range, possibly due to an overwrite of data; or (2) did record the same data values because of an overwrite (these data were deleted).
7/1 11:00 to 7/2 16:30
7/22 15:30-18:30
The following dissolved oxygen and percent saturation data on 7/5 23:30 are
suspect as they were small, negative values which are outside the listed range
of the dissolved oxygen probe. These suspect values were not consistent with
the overall data record, and were deleted on the basis of absolute data rejection. Other parameters, the dissolved oxygen post-cal, and recalibration
were good.

August, 1999 Sampling Period
Head of Tide:
No data collected from 8/1 0:00 through 8/17 11:00 due to a major battery crash
(continuation from 7/4 2:00 crash), where battery voltage dropped quickly from
12.0 to 6.1 volts within approximately a 5-day span. Possible causes of this crash
(after conferring with YSI engineers) include static electricity from a car seat
prior to deployment or a nearby lightning strike.
No dissolved oxygen data or percent saturation data from 8/17 11:30 through 8/24
5:30 due to a suspected DO membrane puncture or tear and probe malfunction
(DO charge upon return was below the acceptable range).
No data collected from 8/24 6:00 through 8/31 23:30 due to a SECOND major battery crash (see above), where battery voltage dropped quickly from 12.0
to 6.0 volts within approximately an 8-day span.
Possible causes of this crash (after conferring with YSI engineers) include
static electricity from a car seat prior to deployment or a nearby lightning strike.

Inlet:
No data collected on 8/18 10:00-14:30; due to a data gap. Logger did not record
data within this time range, possibly due to an overwrite of data.
No data from 8/26 10:00 to 8/27 15:30 due to downtime for calibration, maintenance and downloading.

September, 1999 Sampling Period
Head of Tide:
No data collected from 9/1 0:00 through 9/30 23:30 due to a SECOND major battery crash (a continuation from the 8/24 6:00 crash), where battery voltage dropped quickly from 12.0 to 6.0 volts within approximately a 8 day span. Possible causes of this crash (after conferring with YSI engineers) include static electricity from a car seat prior to deployment or a nearby lightning strike.

Inlet:
No missing data to report.

October, 1999 Sampling Period
Head of Tide:
No data collected from 10/1 0:00 through 10/31 23:30 due to a SECOND major battery crash (a continuation from the 8/24 6:00 crash), where battery voltage dropped quickly from 12.0 to 6.0 volts within approximately a 8 day span. Possible causes of this crash (after conferring with YSI engineers) include static electricity from a car seat prior to deployment or a nearby lightning strike.
Also, no data collected due to data sonde repairs and downtime for calibration and maintenance.

Inlet:
No data from 10/26 12:00-10/31 23:30 due to downtime for calibration, maintenance and downloading.

November, 1999 Sampling Period
Head of Tide:
No data from 11/1 0:00 to 11/5 15:00 due to downtime for calibration, maintenance and downloading.
No data collected on the following dates/times, due to a data gap:
11/30 23:00 - 23:30

Inlet:
No data from 11/1 0:00 to 11/5 14:30 due to downtime for calibration, maintenance and downloading.

December, 1999 Sampling Period
Head of Tide:
No dissolved oxygen data or percent saturation data from 12/17 10:00 through 12/31 23:30 due to a suspected DO membrane puncture or tear and probe malfunction.
No data collected on the following dates/times; due to a data gap.
12/28 1:30-2:00, 12:30, 23:30

12/29 0:00, 9:30

Inlet:
No data from 12/17 10:30 to 16:00 due to downtime for calibration, maintenance and downloading.

12. Other Remarks/Notes:

(IMPORTANT CHANGES TO NOTE AT THE INLET SITE (IN); where our telemetry unit is stationed, a new vented level YSI 6600 with its new vented level cable was deployed to collect its first data on 5/4/99 at 12:00. The YSI telemetry unit began collecting its first data on 3/16/98 at 10:30:00 (see Section 4-Research Methods).

(Note: The Wells NERR two Drakes Island sites (see 1996-1997 metatdata) are currently being monitored (since 1996), but we are using the data for another project (CICEET-Wells Harbor dredge; see Section 7-Associated Researchers and Projects); and are not collecting the dissolved oxygen, percent saturation, and pH parameters.

(The use of the newest (Version 2.0) National Estuarine Research Reserve (NERR) System-Wide Monitoring Program (SWMP) YSI 6-Series Multi-Parameter Water Quality Monitor Standard Operating Procedures began in July 1999 when they became available.

(With our extra data sonde, we have been reducing the amount of time of missing data from calibrations and maintenance for all sites. Some months have no missing data from the use of this extra sonde.

(Any time a reference is made to turbidity data being negative and/or zero, it was recorded as a negative in the raw data file and a zero in the edited data file due to the formatting of Excel. The technician edited none of these data points by hand nor did he/she delete any of them.