**Wells (WEL) NERR Nutrient Metadata**
**January-December 2013**
**Latest Update: June 21, 2024**

## I. Data Set & Research Descriptors

### 1) Principal investigator(s) and contact persons


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### 2) Research objectives

#### a) Monthly grab sampling program:

The monthly grab samples provide data for 5 additional water quality variables to supplement the 15-minute interval data stream from the YSI 6600's. Grabs are collected from a similar depth stratum as the YSI datalogger (within 1 m of the depth of the probes) at each site. These variables (nitrate-nitrite, ammonium, orthophosphate, silicate and chlorophyll a), are important indicators of estuarine trophic status and point and non-point sources of nutrient enrichment. Although limited, these data enable estimation of average trophic status, and may demonstrate seasonal patterns. Our datalogger monitoring design allows for gradient analysis from head of tide to inlet in the Webhannet estuary, allowing comparison of the Little River and Webhannet River estuaries at their inlets, where they exchange water directly with the Atlantic Ocean. Monthly grab data provide the basis for investigation of questions regarding watershed and marine inputs of nutrients in Wells NERR estuaries, and nutrient influence on trophic status as indicated by chlorophyll a.

#### b) Diel sampling program:

At the Webhannet Inlet site, the monthly grab samples are augmented with a 24-hour sampling series (at 2 hr 15 min intervals for a total of 12 samples – 1 sample per 2 hr 15 min interval). These data can provide estimates of temporal variation in nutrients and chlorophyll on the scale of hours, providing a context for interpretation of data collected less frequently. This finer scale information will also inform interpretation SWMP grab sample data. These data can be used to investigate the relationship between nutrients, chlorophyll, and dissolved oxygen, an integrator of water column metabolism.

## 3) Research methods

### a) Monthly grab sampling program:

Monthly grab samples are collected at 2 sites in the Webhannet River Estuary and 2 sites in the Little River Estuary. These sites coincide with the four data sonde sites: Head of Tide (HT), Skinner Mill (SM), and Inlet (IN) in the Webhannet River; and the Mouth (LM) in the Little River. All grab samples are taken within a 24-hour period. Efforts are also made to allow for a previous dry period of 72 hours prior to sampling; however, this was not always possible due to lengthy periods of inclement weather. Replicate (N=2) 1-liter samples are collected at a depth of 0.5 meters below the water surface at the HT, SM, and LM sites. Replicate (N=2) samples at the IN site are taken by pumping the sample up through the ISCO sampler. All samples are collected in 1-liter wide-mouth amber Nalgene bottles that were previously washed with Fisherbrand Versa-Clean and water, acid washed (10% HCl), rinsed (3x) with distilled-deionized water, dried, and rinsed (3x) with ambient water prior to collection of the sample. Samples are immediately placed on ice in a dark cooler and returned to the laboratory for immediate processing.

### b) Diel sampling program:

Diel samples are collected once a month, during the same 24-hour period as our grab sample collection, at the Webhannet River Inlet (IN) datalogger site. An ISCO 6700 automated sampler is deployed on a floating dock at the Wells Harbor pier. As with the grab samples, efforts are made to begin the automated sampling between +/- 3 hours slack-low tide. Efforts are also made to allow for a previous dry period of 72 hours prior to sampling, however this was not always possible due to lengthy periods of inclement weather. Sampling events are staggered each month at the optimal low tide, given constraints of Reserve personnel scheduling. A 1-liter sample is taken every 2-hours and 15 minutes over the complete tidal cycle (just over 24 hrs) for a total of 12 samples. All samples are pumped into ISCO 1-liter polypropylene wedge sample bottles that were previously washed with Fisherbrand Versa-Clean and water, acid washed (10% HCl), rinsed (3x) with distilled-deionized water and dried prior to collection of the sample. The ISCO sampler is filled with ice and/or frozen gel packs prior to deployment, and at the end of the 24-hour period the sample bottles are immediately capped, kept in the dark, and returned to the laboratory for immediate processing.

Once back in the Wells NERR laboratory, samples are shaken and processed for nutrient and chlorophyll-a analysis. All samples are filtered at the Wells NERR. The chl-a analysis is completed on-site at the Wells NERR laboratory with a Turner Designs 10-AU field fluorometer, and the nutrient analysis takes place at the Virginia Institute of Marine Science (VIMS).

The nutrient processing methodology includes filtering 50 ml of a sample through 25 mm, 0.45 μm HV Millipore Durapore® membrane filters using a Becton, Dickinson and Co. (BD) 60 ml polyethylene syringe with Luer-Lok® tip locked to a Millipore Swinnex 25 mm polypropylene filter holder. If a sample is particularly turbid, a 25 mm PALL A/E glass fiber filter is used to filter the sample prior to filtering through the 0.45 μm Millipore filter, although this happens very rarely. The liquid volume of the filtered sample is collected into a Fisherbrand 50 ml polypropylene centrifuge tube (after rinsing collection tube (3x) with sample) and placed in the freezer and mailed overnight delivery to VIMS for analysis.

The Chl-a processing methodology here at the Wells NERR Research Laboratory follows the non-acidification method, "A Procedure For Measuring Extracted Chlorophyll a Free From the Errors Associated With Chlorophyll b and Pheopigments", adapted from the EPA Method 445.0: "In Vitro Determination of Chlorophyll a and Pheophytin a in Marine and Freshwater Algae by Fluorescence." This methodology involves filtering 200-1000 ml of a sample through 47 mm Whatman® GF/F filters using a vacuum pump and filter flask apparatus, and to determine the Chl-a concentration we use a Turner Designs 10-AU Field Fluorometer.

All laboratory glassware, centrifuge tubes, syringes, filter holders, 1-liter graduated cylinders, and forceps were previously washed with Fisherbrand Versa-Clean and water, rinsed (3x) with distilled-deionized water and dried prior to filtration of the sample; and rinsed (3x) between samples with distilled-deionized water to avoid any contamination.

**4) 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 in the Webhannet River Estuary is approximately 5 sq. km and is composed of large intertidal marshes (predominantly *Spartina patens* and *Spartina 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, which enter the estuary. These tributaries flow across sand and gravel deposits near the headwaters and the impermeable sandy muds of the Presumpscot Formation in the lower reaches.

The watershed for the Little River estuary covers an area of 84 sq. km and has a total of 2 tributaries. The backbarrier system in the Little River Estuary is approximately 2.51 sq. km and is composed of large intertidal marshes (predominantly *S. patens* and *S. alterniflora*), intertidal sand and mud flats, and tidal channels. 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 Little River is connected to the ocean by an unstructured, double spit system and is one of the few tidal inlets along the southern Maine coast that is not stabilized by either natural outcrops or artificial jetties. 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. These estuarine systems are 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, which 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 Merriland River and Branch Brook meet south of Route 9 to form the Little River, which drains an area of 10.75 sq. 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 (WELNERR RMA 1996; Holden 1997).

The following information regarding annual weather patterns in the area was supplied by Maine State Climatologist Professor Gregory A. Zielinski extracted from "Monthly Station Normals of Temperature, Precipitation, Heating and Cooling Degree Days 1971-2000", Climatography of the United States No. 81, National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC. and "Daily Normals of Temperature, Precipitation, and Heating and Cooling Degree Days, 1971-2000", Climatography of the United States No. 84: "Average monthly temperatures range from 21.6F in January to 66.7F in July with daily highs averaging just below freezing in January and lows around 11F. Daily highs in July average around 76F and daily lows around 57F. The sea breeze often keeps daily highs lower during the summer than areas inland. Annual average temperature is 44.6F. Annual precipitation is 47.07 inches, including the water equivalent of snowfall, with monthly averages ranging from 3.01 inches in July to 4.77 inches in October. August receives just 3.02 inches on average. Annual snowfall is around 66 inches." According to Zielinski, "cool ocean temperatures keep down the number of afternoon showers and especially thunderstorms resulting in low summer precipitation amounts."

There are two sampling sites in the Webhannet River estuary. These are located at the Head of Tide (HT), and at the Inlet (IN). The tidal range at each of these sites is 2.6-2.9 meters. There are two sampling sites in the Little River estuary, the Little River Mouth (LM) and Skinner Mill (SM). The tidal range of the Little River estuary is 2.6-3.0 meters (Mariano and FitzGerald, 1989).

The Head of Tide (HT) site is located 4 miles south of the Wells Reserve, just downstream of the Webhannet Falls (freshwater) and 10 feet east of Route One (Latitude 43°17'54.25227" N, Longitude 70° 35' 13.82728" W). 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. Depth at MHW for the sample site is approximately 1.5 meters. 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 Skinner Mill (SM) site is located approximately 100 meters downstream from the intersection of the Merriland River (tributary to Merriland/Branch/Little River estuary) and Skinner Mill Road (at 43.34533° -70.552094°). This site is approximately 70 meters downstream from the Watershed Evaluation Team (Educational water quality program at Wells NERR) site L5. The substrate is mud/sand bottom, salinities range from 0 ppt on low or outgoing tides and as high as 27 ppt on high tides. Depth at MHW for the sample site is approximately 1.9 meters. Data prior to 5/30/2006 is from the original SM site located approximately 70 meters upstream from the current site, which is approximately 20-30 meters beyond the head of the estuary where mixing between fresh and marine waters occur. Please see the 2006 Water quality metadata for a better description of the original site.

The Inlet site (IN) is located 1.5 miles south of the Wells Reserve, at the Wells Harbor pier (Latitude 43°19'12.44804" N, Longitude 70°33'13.82728" W). The mouth of the Webhannet estuary forms an extensive wetland/salt marsh area, which 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 maximum depth of the Inlet site is 3 meters. 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.

The Little River Mouth (LM) site is located 1,270.78 meters upstream from the mouth of the estuary, and 813.94 meters direct from the Wells NERR Coastal Ecology Center (Latitude 43°20.413’ N, Longitude 70°32.441’ W). The tidal range of the Little River estuary is 2.6-3.0 meters (Mariano and FitzGerald, 1989). The Little River sites existed in a shallow and relatively pristine system with a sandy to mud bottom and a salinity range of 0 - 32 ppt. Depth at MHW for the sample site is approximately 2.6 meters. There are two major freshwater inputs, the Merriland and Branch Brook Rivers, which converge to form the Little River. The Little River Mouth site is our comparative system site.

Note: Both original Little River Mouth sites were abandoned in prior years due to problems with heavy sediment movement in the inlet of the Little River. We were forced to relocate the site twice. The first location (N 43 deg 20.176 Latitude, W 70 deg 32.497 Longitude) was located in the main channel of the river, just inland of a spit, beside a bank. The second location (N 43 deg 20.083 Latitude, W 70 deg 32.585 Longitude) was located 1/8 mi. southwest of the first site, within an inlet, just inland of a spit. The second site was located in an area of much lower current than the first site and often drains completely during low tides. It was also placed within a pool next to incipient low marsh peat that retains calm water during low tides.

**5) Coded variable definitions**

Reserve code:
wel = Wells NERR

Station codes:
in = Webhannet River Inlet
sm = Skinner Mill (on Merriland River)
ht = Head of Tide at Webhannet River
lm = Little River Mouth

Program code:
nut = nutrient sampling program

These abbreviations are combined to form the sample name as follows:
welinnut = sample taken from Webhannet River Inlet as part of the Wells NERR nutrient sampling program

The monitoring codes are set as "1" to indicate grab samples and "2" to indicate diel samples. Replicates are also given specific codes. Grab samples in which a duplicate sample is collected are indicated by "1" for first sample and a "2" for second sample. Diel samples are always labeled with a "1" since only one sample is taken at each 2 hr 15 min interval.

**6) Data collection period**

Diel Sampling, every 2 hours, 15 minutes as follows:

| Site | Start Date/time | End Date/time |
|---|---|---|
| welinnut | 1/16/2013 10:00 | 1/17/2013 10:45 |
| welinnut | 2/20/2013 10:30 | 2/21/2013 11:15 |
| welinnut | 3/20/2013 10:45 | 3/21/2013 11:30 |
| welinnut | 4/18/2013 9:45 | 4/19/2013 10:30 |
| welinnut | 5/16/2013 9:15 | 5/17/2013 10:00 |
| welinnut | 6/18/2013 9:15 | 6/19/2013 10:00 |
| welinnut | 7/18/2013 11:00 | 7/19/2013 11:45 |
| welinnut | 8/28/2013 9:00 | 8/29/2013 9:45 |
| welinnut | 9/25/2013 9:15 | 9/26/2013 10:00 |
| welinnut | 10/17/2013 9:00 | 10/18/2013 7:30 |
| welinnut | 11/25/2013 11:45 | 11/26/2013 12:30 |
| welinnut | 12/12/2013 11:30 | 12/12/2013 22:45* |

*Last 6 diel samples missing

Grab Sampling (once monthly)

| Site | Date and Time of Grabs |
| --- | --- |
| welinnut | 1/17/2013 10:59 |
| welinnut | 1/17/2013 11:00 |
| welinnut | 2/21/2013 11:39 |
| welinnut | 2/21/2013 11:40 |
| welinnut | 3/21/2013 11:43 |
| welinnut | 3/21/2013 11:44 |
| welinnut | 4/19/2013 11:17 |
| welinnut | 4/19/2013 11:18 |
| welinnut | 5/17/2013 10:09 |
| welinnut | 5/17/2013 10:10 |
| welinnut | 6/19/2013 10:50 |
| welinnut | 6/19/2013 10:51 |
| welinnut | 7/19/2013 12:05 |
| welinnut | 7/19/2013 12:06 |
| welinnut | 8/29/2013 9:48 |
| welinnut | 8/29/2013 9:49 |
| welinnut | 9/26/2013 10:28 |
| welinnut | 9/26/2013 10:29 |
| welinnut | 10/18/2013 10:45 |
| welinnut | 10/18/2013 10:46 |
| welinnut | 11/26/2013 13:10 |
| welinnut | 11/26/2013 13:11 |
| welinnut | 12/13/2013 12:55 |
| welinnut | 12/13/2013 12:56 |

| Site | Date and Time of Grabs |
| --- | --- |
| welhtnut | No samples for Jan, Feb, March, or Dec due to Ice |
| welhtnut | 4/19/2013 10:52 |
| welhtnut | 4/19/2013 10:53 |
| welhtnut | 5/17/2013 9:55 |
| welhtnut | 5/17/2013 9:56 |
| welhtnut | 6/19/2013 10:15 |
| welhtnut | 6/19/2013 10:16 |
| welhtnut | 7/19/2013 11:41 |
| welhtnut | 7/19/2013 11:42 |
| welhtnut | 8/29/2013 9:31 |
| welhtnut | 8/29/2013 9:32 |
| welhtnut | 9/26/2013 10:11 |
| welhtnut | 9/26/2013 10:12 |
| welhtnut | 10/18/2013 10:30 |
| welhtnut | 10/18/2013 10:31 |
| welhtnut | 11/26/2013 12:55 |
| welhtnut | 11/26/2013 12:56 |

| Site | Date and Time of Grabs No samples Jan, Feb, March, or Dec due to Ice |
|---|---|
| wellmnut | 4/19/2013 9:50 |
| wellmnut | 4/19/2013 9:51 |
| wellmnut | 5/17/2013 9:10 |
| wellmnut | 5/17/2013 9:11 |
| wellmnut | 6/19/2013 9:30 |
| wellmnut | 6/19/2013 9:31 |
| wellmnut | 7/19/2013 11:15 |
| wellmnut | 7/19/2013 11:16 |
| wellmnut | 8/29/2013 7:39 |
| wellmnut | 8/29/2013 7:40 |
| wellmnut | 9/26/2013 7:58 |
| wellmnut | 9/26/2013 7:59 |
| wellmnut | 10/18/13 9:00* |
| wellmnut | 10/18/13 9:01* |
| wellmnut | 11/26/13 9:00* |
| wellmnut | 11/26/13 9:01* |

*samples missing

| Site | Date and Time of Grabs No samples Jan, Feb, or March due to ice |
|---|---|
| welsmnut | 4/19/2013 11:48 |
| welsmnut | 4/19/2013 11:49 |
| welsmnut | 5/17/2013 8:55 |
| welsmnut | 5/17/2013 8:56 |
| welsmnut | 6/19/2013 11:15 |
| welsmnut | 6/19/2013 11:16 |
| welsmnut | 7/19/2013 8:30 |
| welsmnut | 7/19/2013 8:31 |
| welsmnut | 8/29/2013 9:12 |
| welsmnut | 8/29/2013 9:13 |
| welsmnut | 9/26/2013 11:05 |
| welsmnut | 9/26/2013 11:06 |
| welsmnut | 10/18/2013 11:05 |
| welsmnut | 10/18/2013 11:06 |
| welsmnut | 11/26/2013 12:28 |
| welsmnut | 11/26/2013 12:29 |
| welsmnut | 12/13/2013 11:15 |
| welsmnut | 12/13/2013 11:16 |

**7) Associated researchers and projects**

Please visit our website http://www.wellsnerr.org/research.htm for further information on the Wells NERR research program. 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 2000-2001 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 the NERRS System-Wide Monitoring Program, 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 Stewardship program has been 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 organize and facilitate meetings, workshops, and communications for about 20 partner conservation groups. A key element of the Stewardship program 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. Successful projects completed by the Stewardship Program include a conservation lands map of Southern Maine coastal towns and a series of Conservation Strategy Reports for seven 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 ten years of data on upland and shore birds with which to assess the status of resident and migratory avian populations, and eight 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 1950's, 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. is working on the following projects: "Ecological processes, energy pathways, and the impact of human activities on Maine marsh-estuarine secondary production: a salt marsh panne model". We used stable isotopic tracers (15N additions and naturally abundant 13C) coupled with secondary production measurements (nekton, invertebrates) to track energy flow on the high marsh surface in southern Maine salt marsh systems. The project is still under way.

"Ecological Functions of Fringing Salt Marshes Susceptible to Oil Spills in Casco Bay, Maine". We examined the ecological function of 9 different fringing marsh systems in Casco Bay that ranged from undisturbed to disturbed. Physical parameters measured included sedimentation rates, total suspended solids, and tidal range. Biological parameters included primary production, macroinvertebrate community composition and secondary production (4cm sediment cores), and resident and transient nekton community composition (fyke net). The project is still under way.

"BENTHIC HABITAT CORRELATES OF JUVENILE FISH DISTRIBUTION IN THE BIGELOW BIGHT AND ADJACENT ESTUARIES: LINKAGES BETWEEN FISH, HABITATS, SUBSTRATE AND HUMAN ACTIVITY". This project was a collaboration between the Wells NERR. and several members of the local fishing community. Through the use of beam trawls, gill nets, fish traps, van veen ponar, and a sediment profile imager (SPI camera), we are attempting to correlate benthic habitat type to juvenile groundfish and invertebrate assemblages in estuarine, nearshore, and offshore habitat. Stations were also established near dredge spoil dump sites as well as sewage outflow to determine the impacts of human activity on the coast to benthic habitat. The project is still under way.

The Wells NERR Research Dept. also completed the work on the following project:

In partnership with the York Rivers Association and the Town of York, the Wells Reserve conducted a survey of the York River watershed. In this survey, volunteers looked for sources of pollution within a 250-foot buffer of the river and its tributaries (erosion, trash and debris and runoff from roads and lawns could have a negative impact on water quality). Most pollutants entering water bodies come from such undefined sources. Therefore, this type of survey is the best way to begin to address the problems of pollution in a water body. The idea of the project was to work with the community and landowners to help them understand the problems that come from these types of pollution and learn activities they might be able to do on their own land that would help prevent this pollution from entering the water. The results of the survey will become part of a Watershed Management Plan to improve and restore the water quality of the York River.

The Wells NERR Research Dept. is involved with the following CICEET Projects-

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.

Project Title: Microbial Source Tracking in Two Southern Maine Watersheds. A two-year project written by Maine Sea Grant associate Kristen Whiting-Grant, and funded by Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), involving Wells NERR, UNH Jackson Estuarine Lab (JEL), USM Muskie School, AmeriCorps and the Maine Conservation Corps. We are pioneering the use in Maine of genetic analysis as a means of determining the source species associated with bacterial contamination in the Webhannet and Little River Estuary. Volunteers collect water samples from streams and the estuaries, staff test for and isolate E. coli. At JEL, a genetic technique (ribotyping) creates a genetic fingerprint of the bacteria which is compared to known sources. The project was completed in 2003, although outreach is ongoing by Kristen Whiting-Grant, Maine Sea Grant and Cooperative Extension, located at Wells NERR.

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

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.

**8) Distribution**

NOAA retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data. The NERRS retains the right to be fully credited for having collected and processed the data. Following academic courtesy standards, the NERR site where the data were collected should be contacted and fully acknowledged in any subsequent publications in which any part of the data are used. The data set enclosed within this package/transmission is only as good as the quality assurance and quality control procedures outlined by the enclosed metadata reporting statement. The user bears all responsibility for its subsequent use/misuse in any further analyses or comparisons. The Federal government does not assume liability to the Recipient or third persons, nor will the Federal government reimburse or indemnify the Recipient for its liability due to any losses resulting in any way from the use of this data.

Requested citation format:
National Estuarine Research Reserve System (NERRS). 2012. System-wide Monitoring Program. Data accessed from the NOAA NERRS Centralized Data Management Office website: www.nerrsdata.org; *accessed* 12 October 2012.

NERR nutrient data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Principal investigators and contact persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information link on the CDMO home page) and online at the CDMO home page www.nerrsdata.org. Data are available in comma separated version format.

**II. Physical Structure Descriptors**

**9) Entry verification**

Excel data files containing measured values (except for Chl-a which is analyzed at Wells NERR) are received from the Virginia Institute of Marine Science (VIMS) and are used to generate only one calculated value which is DIN. Both directly measured and calculated values were entered into this document by Jeremy Miller from files and notes kept by Jeremy Miller and from files delivered by VIMS. The SWMP technicians at Wells NERR were responsible for a visual QA/QC to make sure no entry errors are present. The original Excel files received from VIMS are archived on the Wells NERR server and a Maxtor One Touch external hard drive. Edited files containing additional calculated parameters are archived on the Maxtor One Touch external hard drive.

Nutrient data are entered into a Microsoft Excel worksheet and processed using the NutrientQAQC Excel macro. The NutrientQAQC macro sets up the data worksheet, metadata worksheets, and MDL worksheet; adds chosen parameters and facilitates data entry; allows the user to set the number of significant figures to be reported for each parameter and rounds using banker's rounding rules; allows the user to input MDL values and then automatically flags/codes measured values below MDL and inserts the MDL; calculates parameters chosen by the user and automatically flags/codes for component values below MDL, negative calculated values, and missing data; allows the user to apply QAQC flags and codes to the data; produces summary statistics; graphs selected parameters for review; and exports the resulting data file to the CDMO for tertiary QAQC and assimilation into the CDMO's authoritative online database.

**10) Parameter titles and variable names by category**

Required NOAA/NERRS System-wide Monitoring Program water quality parameters are denoted by an asterisks "*". Nutrient parameters sampled at the Wells NERR in this sample period are the Tier I parameters: ammonium (NH4+), combined nitrate + nitrate (N023), orthophosphate (P04), and chlorophyll a; and the Tier II parameter: Silica (SiO4).

| Data Category | Parameter | Variable Name | Units of Measure |
|---|---|---|---|
| Phosphorus | | | |
| | *Orthophosphate | PO4F | mg/L as P |
| Nitrogen | | | |
| | *Nitrite + Nitrate, Filtered | NO23F | mg/L as N |
| | *Ammonium, Filtered | NH4F | mg/L as N |
| | Dissolved Inorganic Nitrogen | DIN | mg/L as N |
| Plant Pigments | | | |
| | *Chlorophyll a | CHLA_N | μg/L |
| Other lab parameters | | | |
| | Silicate, Filtered | SiO4F | mg/L as SI |

Notes:
Time is coded based on a 2400 hour clock and is referenced to Eastern Standard Time (EST).

Reserves have the option of measuring either NO2 and NO3, or if NO2 can be shown to be a minor constituent of NO23 (which it has been shown to be at the Wells NERR), then NO23 can be substituted for NO3 and NO2.

**11) Measured and calculated laboratory parameters**

a) Parameters measured directly
- Nitrogen species: NO23, NH4
- Phosphorus species: PO4F
- Other: CHLA_N, SIO4F

b) Calculated parameters
- Dissolved Inorganic Nitrogen (DIN) NO23+NH4

**12) Limits of detection**

Method Detection Limits (MDL), the lowest concentration of a parameter that an analytical procedure can reliably detect, have been established by VIMS and at the Lachat Instrument website (http://www.lachatinstruments.com/applications/AppsSearch.asp).

Table 1 lists the current MDL values, which are reviewed and revised periodically.

Method Detection Limits (MDL) for measured water quality parameters. The following MDLs were provided by the laboratory at the time the data indicated were provided.

| Parameter | Start Date | End Date | MDL |
|---|---|---|---|
| CHLA_N | 01/01/2013 | 12/31/2013 | 0.11 |

| | | | |
|---|---|---|---|
| NH4F | 01/01/2013 | 12/31/2013 | 0.0056 |
| NO23F | 01/01/2013 | 12/31/2013 | 0.0047 |
| PO4F | 01/01/2013 | 12/31/2013 | 0.0020 |
| SiO4F | 01/01/2013 | 12/31/2013 | 0.0800 |

*NOTE* regarding Chlorophyll *a* limits of measurement:
The following article describes the method used:
"Method 445.0 *In Vitro* Determination of Chlorophyll *a* and Pheophytin *a* in Marine and Freshwater Algae by Fluorescence" Elizabeth J. Arar and Gary B. Collins, Revision 1.2, September 1997, National Exposure Research Laboratory, Office of Research and Development, USEPA, Cincinnati, OH 45268

The above article states in section 1.2:
"Instrument detection limits of 0.05 µg chl *a*/L and 0.06 µg pheo *a*/L in a solution of 90% acetone were determined by this laboratory. Method detection limits (MDL) using mixed assemblages of algae provide little information because the fluorescence of other pigments interferes in the fluorescence of chlorophyll *a* and pheophytin *a*. A single lab estimated detection limit for chlorophyll *a* was determined to be 0.11 µg/L in 10 ml of final extraction solution. The upper limit of the linear dynamic range for the instrumentation used in this method evaluation was 250 µg chl *a*/L."

## 13) Laboratory Methods

**Section 13, part I**: Analysis conducted at Virginia Institute of Marine Science (VIMS)

### a) Parameter: Orthophosphate

Method References: Virginia Institute of Marine Science Analytical Service Center.
SKALAR Method: O-Phosphate / Total Phosphate Catnr. 503-365.1, issue 042993/MH/93-Demo1.
Murphy, J. and J.P. Riley. 1962. A modified single solution method for the determination of phosphate in natural waters. Analytica Chim. Acta 27: 31-36.
EPA 600/R-97/072 Method 365.5 Determination of Orthophosphate in Estuarine and Coastal Waters by Automated Colorimetric Analysis. IN: Methods for the Determination of Chemical Substances in Marine and Estuarine Environmental Matrices - 2nd Edition. National Exposure Research Laboratory, Office of Research and Development. U.S. EPA, Cincinnati, Ohio 45268.

Method Descriptor: Instrumentation: SKALAR San-Plus continuous flow autoanalyzer. Ammonium molybdate and antimony potassium tartrate react in a sulfuric acid environment to form an antimony-phospho-molybdo complex, which is reduced to a blue colored complex by ascorbic acid. Reaction is heat catalyzed at 40°C and measured colorimetrically at 880 nm. The range is 1-50 ppb.

Preservation Method: 100 ml of a sample is filtered through 0.45 µm Millipore filters using a vacuum-pump and a filtering flask apparatus. If samples are extremely dirty a 47 mm GF/C filter may be used to filter the sample prior to filtering through the 0.45 µm Millipore filter. The liquid volume of the filtered sample is collected into a Nalgene bottle and placed in the freezer until shipment time the following day.

### b) Parameter: Nitrate + Nitrite

Method References: Virginia Institute of Marine Science Analytical Service Center.
SKALAR Method: Nitrate + Nitrite/ Total Dissolved Nitrogen Catnr. 461-353.2 issue 120293/MH/93128060.
U.S. EPA. 1974 Methods for Chemical Analysis of Water and Wastes, pp. 207-212. Wood, E.D., F.A.G. Armstrong and F.A. Richards. 1967. Determination of nitrate in seawater by cadmium-copper reduction to nitrite. J. Mar. Biol. Assoc. U.K. 47: 23. Grasshoff, K., M. Ehrhardt and K. Kremling. 1983. Methods

of Seawater Analysis. Verlag Chemie, Federal Republic of Germany. 419 pp. EPA 600/R-97/072 Method 353.4 Determination of Nitrate and Nitrite in Estuarine and Coastal Waters by Gas Segmented Flow Colorimetric Analysis. IN: Methods for the Determination of Chemical Substances in Marine and Estuarine Environmental Matrices - 2nd Edition. National Exposure Research Laboratory, Office of Research and Development U.S. EPA, Cincinnati, Ohio 45268.

Method Descriptor: Instrumentation: SKALAR San-Plus continuous flow autoanalyzer. Nitrate is reduced to nitrite by a copper/cadmium reductor column. The nitrite ion then reacts with sulfanilimide to form a diazo compound. This compound then couples with n-1-napthylenediamine dihydrochloride to form a reddish/purple azo dye and is read colorimetrical at 540 nm. Nitrate concentration is obtained by subtracting the corresponding nitrite value from the NO3- + NO2- concentration. The color development chemistry is the same as that used in Nitrite. Range is 0 -1.2 mg/L.

Preservation Method: 100 ml of a sample is filtered through 0.45 µm Millipore filters using a vacuum-pump and a filtering flask apparatus. If samples are extremely dirty a 47 mm GF/C filter may be used to filter the sample prior to filtering through the 0.45 µm Millipore filter. The liquid volume of the filtered sample is collected into a Nalgene bottle and placed in the freezer until shipment time the following day.

**c) Parameter: Ammonia**

Method References: Virginia Institute of Marine Science Analytical Service Center. U.S. EPA. 1974. Methods for Chemical Analysis of Water and Wastes, pp. 168-174. Standard Methods for the Examination of Water and Wastewater, 14th edition. p 410. Method 418A and 418B (1975). Annual Book of ASTM Standards, Part 31. "Water", Standard 1426-74, Method A, p 237 (1976).
EPA 600/R-97/072 Method 349.0. Determination of Ammonia in Estuarine and Coastal Waters by Gas Segmented Continuous Flow Colorimetric Analysis. IN: Methods for the Determination of Chemical Substances in Marine and Estuarine Environmental Matrices - 2nd Edition. National Exposure Research Laboratory, Office of Research and Development U.S. EPA, Cincinnati, Ohio 45268.

Method Descriptor: Instrument is SKALAR San-Plus continuous flow autoanalyzer. Alkaline phenol and hypochlorite react with ammonia to form indophenol blue that is proportional to the ammonia concentration. The blue color formed is intensified with sodium nitroprusside. Reaction is heat catalyzed at 37°C and is measured colorimetrically at 660 nm. The range is 0.01-2.0 mg/L.

Preservation Method: 100 ml of a sample is filtered through 0.45 µm Millipore filters using a vacuum-pump and a filtering flask apparatus. If samples are extremely dirty a 47 mm GF/C filter may be used to filter the sample prior to filtering through the 0.45 µm Millipore filter. The liquid volume of the filtered sample is collected into a Nalgene bottle and placed in the freezer until shipment time the following day.

**d) Parameter: Silicate**

Method References:
Virginia Institute of Marine Science Analytical Service Center. Technicon Industrial Systems Method: Silica. 1973. Technicon Auto-analyzer II Industrial Method No. 186-72W, Silicates in Water and Seawater.
U.S. EPA. 1982. Methods for Chemical Analysis of Water and Wastewater, 18th edition. Method 4500-Si F. Automated Method for Molybdate-Reactive Silica. pp. 4-122 through 4-123.
Grasshoff, K., M. Ehrhardt and K. Kremling. 1983. Methods of Seawater Analysis. Verlag Chemie, Federal Republic of Germany. pp. 175-180.

Method Descriptor:
Instrumentation: SKALAR San-Plus continuous flow autoanalyzer.
The determination of soluble silicates is based on the reduction of silicomolybdate in acidic solution to

"molybedenum blue" by ascorbic acid. Oxalic acid is introduced to the sample stream before theaddition of ascorbic acid to eliminate interference from phosphates.

Preservation Method:
100 ml of a sample is filtered through 0.45 µm Millipore filters using a vacuum-pump and a filtering flask apparatus. If samples are extremely dirty a 47 mm GF/C filter may be used to filter the sample prior to filtering through the 0.45 µm Millipore filter. The liquid volume of the filtered sample is collected into a Nalgene bottle and placed in the refrigerator until shipment time the following day. Samples may be kept up to 28 days.

**Section 13, part II:** Analyses conducted by Wells NERR.

**e) Parameter: Chlorophyll a**

Method References:
Wells National Estuarine Research Reserve Coastal Ecology Center Laboratory
Strickland, J.D.H., and Parson, T.R. 1972. A Practical Handbook of Seawater Analysis. Fish. Res. Bd. Canada 167:310.
TD-10-AU-005-CE Field Fluorometer Operating Manual. Version 1.4. April 1999. Turner Designs, 845 West Maude Avenue, Sunnyvale, CA 94086.
EPA - Method 445.0. In Vitro Determination of Chlorophyll a and Pheophytin a in Marine and Freshwater Algae by Fluorescence.
Using the Turner Designs Model 10 Analog, The 10AU Digital, Or the TD-700 Fluorometer with EPA Method 445.0. January 19, 1999. Turner Designs, 845 West Maude Avenue, Sunnyvale, CA 94086.
A Procedure for Measuring Extracted Chlorophyll a Free From The Errors Associated With Chlorophyll b and Pheopigments. Turner Designs, 845 West Maude Avenue, Sunnyvale, CA 94086. This method was developed by Dr. Nicholas A. Welschmeyer of Moss Landing Marine Laboratories, Moss Landing, CA.
A paper by Dr. Welschmeyer, Flourometric Analysis of Chlorophyll a in the presence of Chlorophyll b and Pheopigments, which details his research, appears in Limnology and Oceanography (June 1994).

Method Descripton:
Instrumentation: Turner Designs 10-AU-005-CE Field fluorometer.
The Chl-a processing methodology here at the Wells NERR Research Laboratory follows the non-acidification method, "A Procedure For Measuring Extracted Chlorophyll a Free From The Errors Associated With Chlorophyll b and Pheopigments", adapted from the EPA Method 445.0: "In Vitro Determination of Chlorophyll a and Pheophytin a in Marine and Freshwater Algae by Fluorescence." The method used requires filtering a known quantity of water through a glass fiber filter (47 mm GF/F). The sample is steeped in 90% acetone at least 2 hours and not exceeding 24 hours at 4oC, in the dark. The samples are centrifuged and read on the fluorometer. If the samples cannot be read within that time period, they are stored in the research freezer.

Preservation Method:
This methodology includes filtering 500-1000 ml of a sample through 47 mm Whatman® GF/F filters using a vacuum pump and filter flask apparatus. The Whatman type GF/F filter is folded immediately after sample filtering, enclosed in a waxed paper envelope, placed in a petri dish, wrapped with aluminum foil, placed in a sealed freezer bag, and placed in the freezer until analysis. The final concentration of Chl-a = (F x v)/V; where F = the direct fluorescence reading, v = volume of the extract, and V = volume of sample filtered.

## 14) QA/QC Programs

### a. Precision:

i. **Field variability** – True field replicates are taken at each site during grab sampling. Both replicate grabs are taken one immediately after the other.
ii. **Laboratory variability** – none
iii. **Inter-organizational splits** – same samples were not split or analyzed by two different labs

b) **Accuracy:**
i. **Sample spikes** – information unavailable
ii. **Standard reference material analysis** – see lab protocols
iii. **Cross calibration exercises** – WEL NERR did not participate in cross calibration exercises.

15) **QAQC flag definitions –** This section details the primary and secondary QAQC flag definitions.

QAQC flags provide documentation of the data and are applied to individual data points by insertion into the parameter's associated flag column (header preceded by an F_). QAQC flags are applied to the nutrient data during secondary QAQC to indicate data that are out of sensor range low (-4), rejected due to QAQC checks (-3), missing (-2), optional and were not collected (-1), suspect (1), and that have been corrected (5). All remaining data are flagged as having passed initial QAQC checks (0) when the data are uploaded and assimilated into the CDMO ODIS as provisional plus data. The historical data flag (4) is used to indicate data that were submitted to the CDMO prior to the initiation of secondary QAQC flags and codes (and the use of the automated primary QAQC system for WQ and MET data). This flag is only present in historical data that are exported from the CDMO ODIS.

-4 Outside Low Sensor Range
-3 Data Rejected due to QAQC
-2 Missing Data
-1 Optional SWMP Supported Parameter
0 Data Passed Initial QAQC Checks
1 Suspect Data
4 Historical Data: Pre-Auto QAQC
5 Corrected Data

16) **QAQC code definitions** – This section details the secondary QAQC Code definitions used in combination with the flags above.

QAQC codes are used in conjunction with QAQC flags to provide further documentation of the data and are also applied by insertion into the associated flag column. There are three (3) different code categories, general, sensor, and comment. General errors document general problems with the sample or sample collection, sensor errors document common sensor or parameter specific problems, and comment codes are used to further document conditions or a problem with the data. Only one general or sensor error and one comment code can be applied to a particular data point. However, a record flag column (F_Record) in the nutrient data allows multiple comment codes to be applied to the entire data record.

General errors

| | |
|---|---|
| GCM | Calculated value could not be determined due to missing data |
| GCR | Calculated value could not be determined due to rejected data |
| GDM | Data missing or sample never collected |
| GQD | Data rejected due to QA/QC checks |
| GQS | Data suspect due to QA/QC checks |

Sensor errors

| | |
|---|---|
| SBL | Value below minimum limit of method detection |
| SCB | Calculated value could not be determined due to a below MDL component |
| SCC | Calculation with this component resulted in a negative value |
| SNV | Calculated value is negative |
| SRD | Replicate values differ substantially |
| SUL | Value above upper limit of method detection |

Parameter Comments

| | |
|---|---|
| CAB | Algal bloom |
| CDR | Sample diluted and rerun |
| CHB | Sample held beyond specified holding time |
| CIP | Ice present in sample vicinity |
| CIF | Flotsam present in sample vicinity |
| CLE | Sample collected later/earlier than scheduled |
| CRE | Significant rain event |
| CSM | See metadata |
| CUS | Lab analysis from unpreserved sample |

Record comments

| | |
|---|---|
| CAB | Algal bloom |
| CHB | Sample held beyond specified holding time |
| CIP | Ice present in sample vicinity |
| CIF | Flotsam present in sample vicinity |
| CLE | Sample collected later/earlier than scheduled |
| CRE | Significant rain event |
| CSM | See metadata |
| CUS | Lab analysis from unpreserved sample |

*Cloud cover*

| | |
|---|---|
| CCL | clear (0-10%) |
| CSP | scattered to partly cloudy (10-50%) |
| CPB | partly to broken (50-90%) |
| COC | overcast (>90%) |
| CFY | foggy |
| CHY | hazy |
| CCC | cloud (no percentage) |

*Precipitation*

| | |
|---|---|
| PNP | none |
| PDR | drizzle |
| PLR | light rain |
| PHR | heavy rain |
| PSQ | squally |
| PFQ | frozen precipitation (sleet/snow/freezing rain) |
| PSR | mixed rain and snow |

Tide stage

| | |
|---|---|
| TSE | ebb tide |

| | |
|---|---|
| TSF | flood tide |
| TSH | high tide |
| TSL | low tide |

*Wave height*

| | |
|---|---|
| WH0 | 0 to <0.1 meters |
| WH1 | 0.1 to 0.3 meters |
| WH2 | 0.3 to 0.6 meters |
| WH3 | 0.6 to > 1.0 meters |
| WH4 | 1.0 to 1.3 meters |
| WH5 | 1.3 or greater meters |

*Wind direction*

| | |
|---|---|
| N | from the north |
| NNE | from the north northeast |
| NE | from the northeast |
| ENE | from the east northeast |
| E | from the east |
| ESE | from the east southeast |
| SE | from the southeast |
| SSE | from the south southeast |
| S | from the south |
| SSW | from the south southwest |
| SW | from the southwest |
| WSW | from the west southwest |
| W | from the west |
| WNW | from the west northwest |
| NW | from the northwest |
| NNW | from the north northwest |

*Wind speed*

| | |
|---|---|
| WS0 | 0 to 1 knot |
| WS1 | > 1 to 10 knots |
| WS2 | > 10 to 20 knots |
| WS3 | > 20 to 30 knots |
| WS4 | > 30 to 40 knots |
| WS5 | > 40 knots |

**17) Other Remarks**

Data may be missing due to problems with sample collection or processing. Laboratories in the NERRS System submit data that are censored at a lower detection rate limit, called the Method Detection Limit or MDL. MDLs for specific parameters are listed in the Laboratory Methods and Detection Limits Section (Section II, Part 12) of this document. Concentrations that are less than this limit are censored with the use of a QAQC flag and code, and the reported value is the method detection limit itself rather than a measured value. For example, if the measured concentration of NO23F was 0.0005 mg/l as N (MDL=0.0008), the reported value would be 0.0008 and would be flagged as out of sensor range low (-4) and coded SBL. In addition, if any of the components used to calculate a variable are below the MDL, the calculated variable is removed and flagged/coded -4 SCB. If a calculated value is negative, it is rejected and all measured components are marked suspect. If additional information on MDL's or missing, suspect, or rejected data is needed, contact the Research Coordinator at the Reserve submitting the data.

Note: The way below MDL values are handled in the NERRS SWMP dataset was changed in November of 2011. Previously, below MDL data from 2007-2010 were also flagged/coded, but either reported as the measured value or a blank cell. Any 2007-2011 nutrient/pigment data downloaded from the CDMO prior to November of 2011 will reflect this difference.

**Notes:**
*Three of our four sites (SM, LM, and HT) are discontinued through the winter months due to icing in the rivers.

* as of January 2009 we switched our Diel sampling interval from 2 hours, 4 minutes to 2 hours, 15 minutes to better represent a full tidal cycle in the Gulf of Maine.

* Data marked suspect and flagged SRD were replicates which showed high variability between samples.

**<u>The following weather/Rain events were considered significant:</u>**

Significant Rain Events:

- 5/20-5/25 – Intermittent rain events over this 4 day period.
- 6/7-6/8 – heavy rains
- 6/23, 7/1, 7/23, 8/9, 9/2, 9/12, 9/13, 11/27 all saw significant rain events

**References**

Holden, W.F. 1997. Fresh water suspended sediments and nutrient influx into the Little River and Webhannet River estuaries, Wells, ME. Dissertation, Boston University, Boston, MA. 279 pp.

Mariano, C.G. and FitzGerald, D.M. 1989. Sediment transport patterns and hydraulics at Wells inlet, Maine. Boston University, Boston, MA. 143 pp.

Ward, L.G. 1993. Precipitation, streamflow, and water characteristics of the Webhannet River Estuary, Wells, Maine. Jackson Estuarine Research Lab, University of New Hampshire department of Earth Sciences, Durham, NH. 101 pp.

Wells National Estuarine Research Reserve. 1996. Reserve Management Plan. Reserve Management Authority, Wells, Me. 241 pp.