GREAT BAY COAST WATCH
A CITIZEN WATER MONITORING PROGRAM

Original
MANUAL
JULY 1990

Revised/Updated February 2002

by
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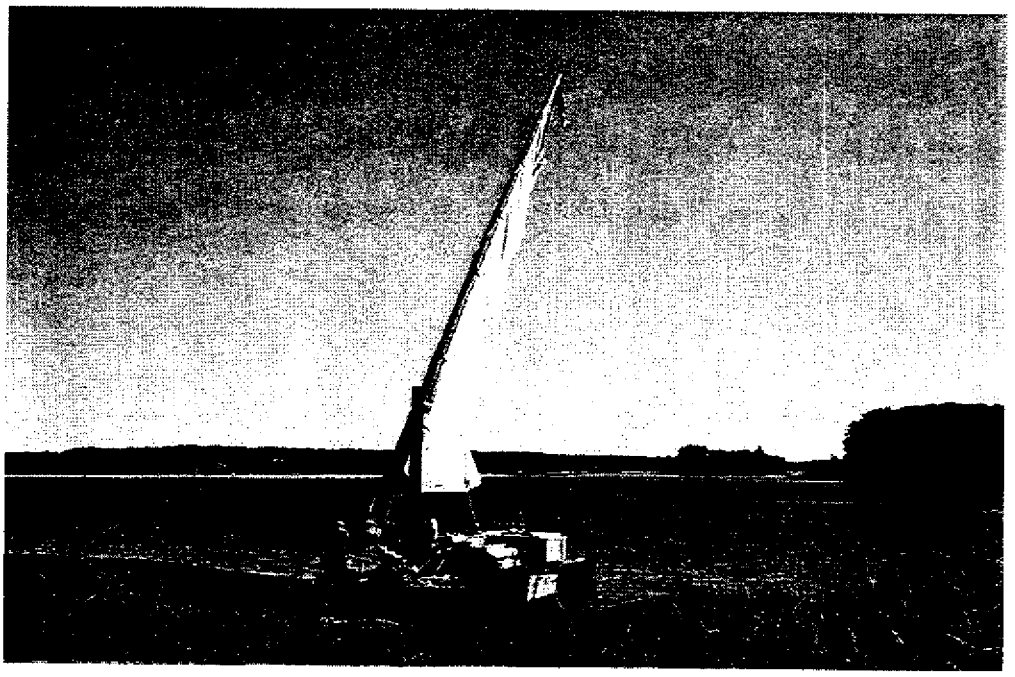

The volunteer monitors in the Great Bay Coast Watch must be recognized and gratefully acknowledged, for it is through their efforts that we all better understand and appreciate the Great Bay and Hampton-Seabrook estuaries.

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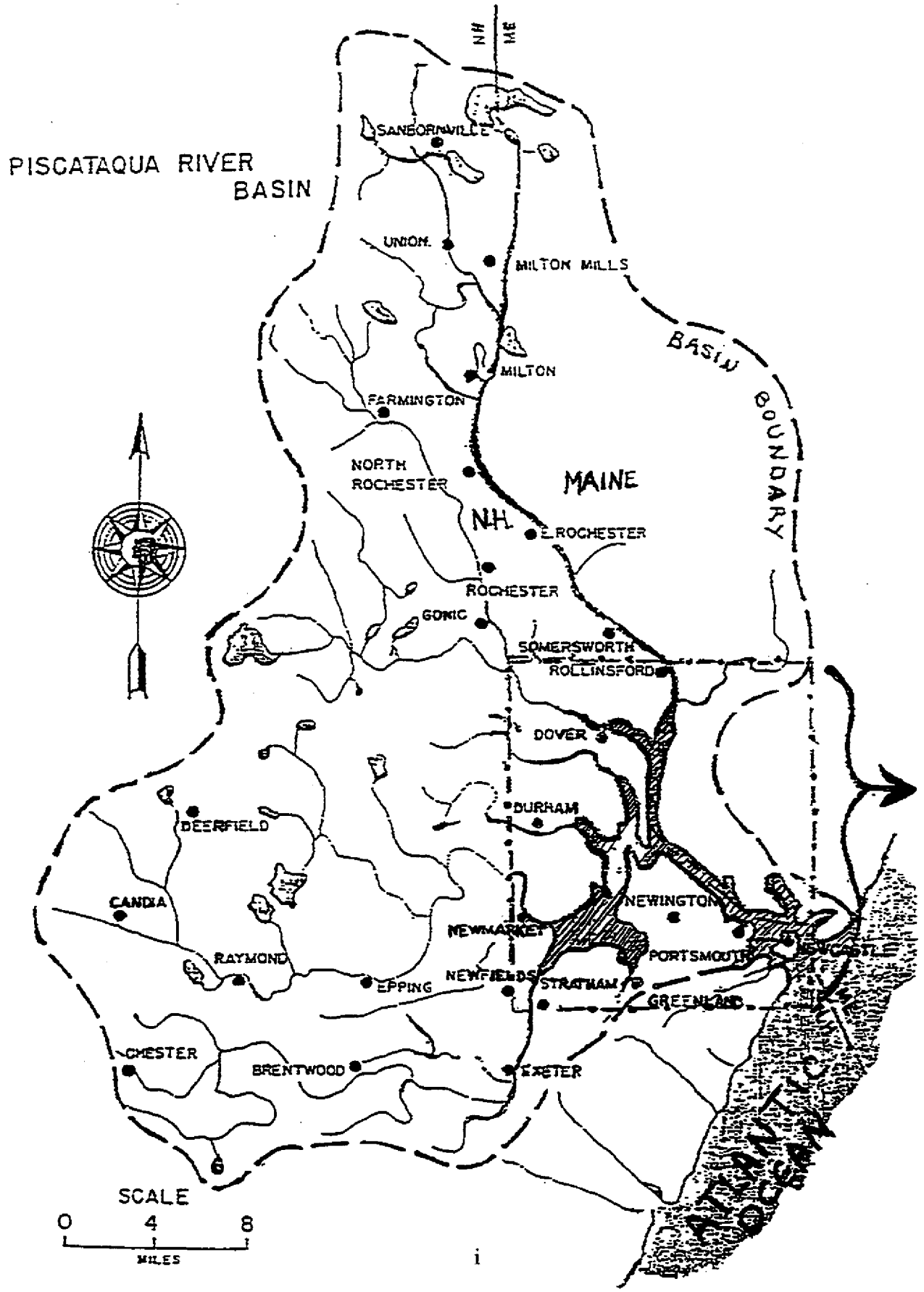


GREAT BAY ESTUARINE SYSTEM AND SITE LOCATIONS

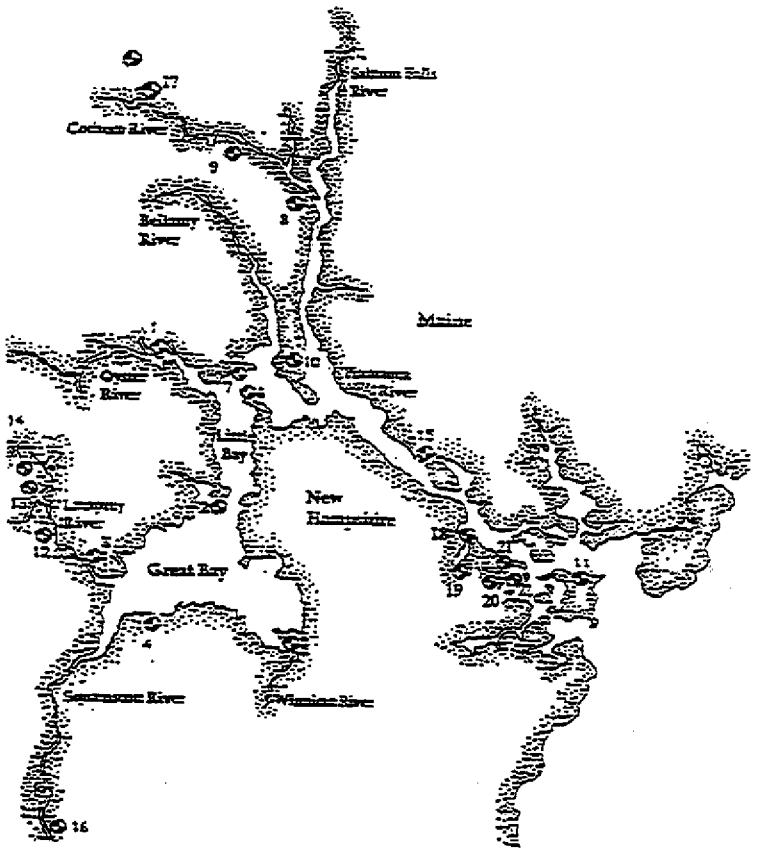
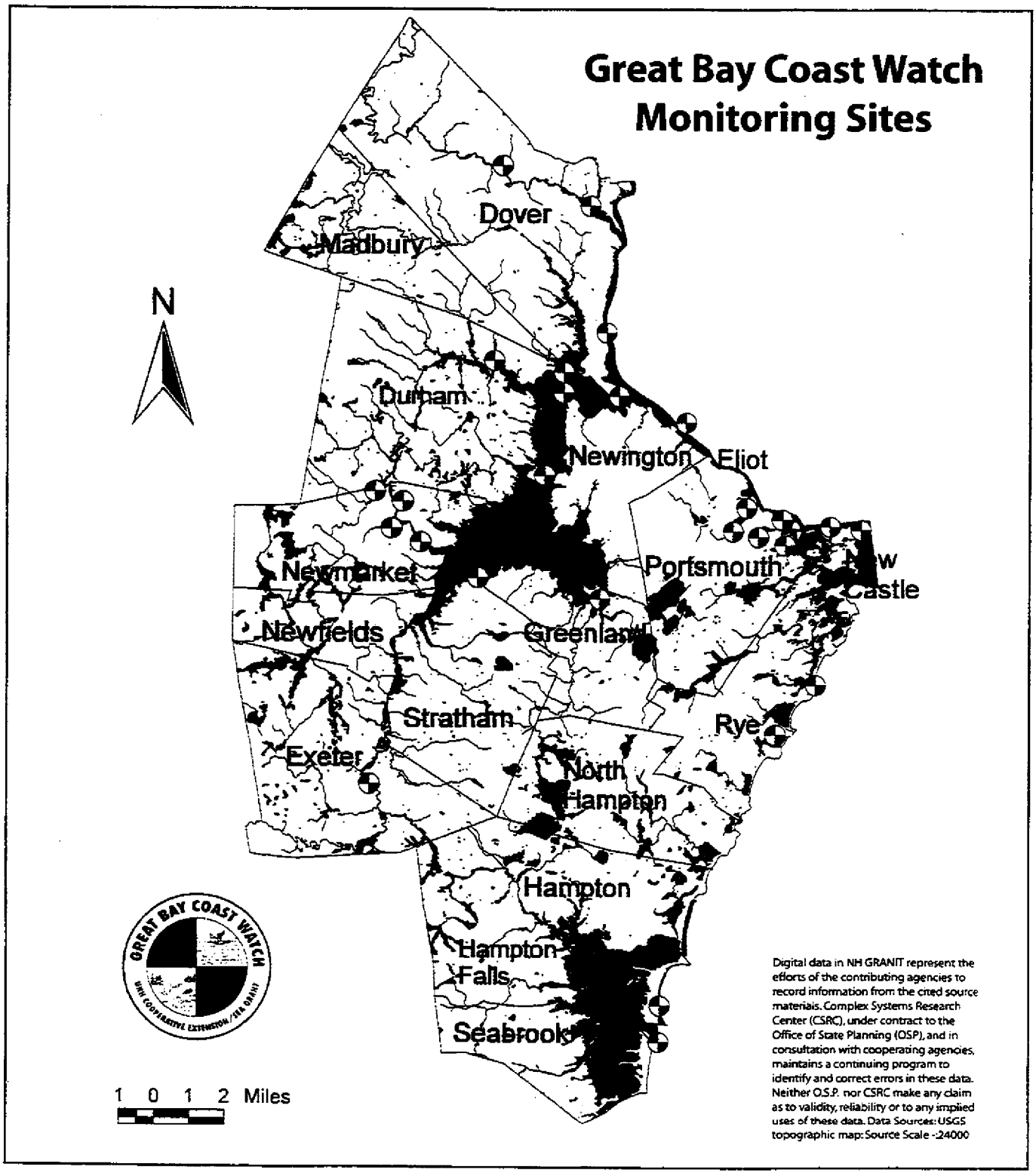


Table of Great Bay Coast Watch Sites: Locations, Towns and Year Started

Site Name	Site #	Location	Town	Year Started	Comments
Peninsula	1	Oyster River	Durham	1990	
JEL	2	Great Bay	Durham	1990	
Lamprey River	3	Lamprey River	Newmarket	1990	
Depot Road	4	Great Bay	Greenland/ Stratham	1990	High tide only as of 1993
PCC	5	Winnicut River	Greenland/ Stratham	1990	
Fox Point	6	Little Bay	Newington	1990	
Cedar Point	7	Little Bay	Durham	1990	
Rakoskes'	8	Piscataqua River	Dover	1990	Inactive as of 1992
Neal's	9	Cocheco River	Dover	1990	
Clark's	10	Piscataqua River	Dover	1991	
CML	11	Piscataqua River	New Castle	1991	
STP	12	Lamprey River	Newmarket	1992	
Marina Falls Land	13	Lamprey River	Newmarket	1992	
Fowler's	14	Lamprey River	Newmarket	1992	
Patten Yacht Yard	15	Piscataqua River	Eliot, Me	1993	
Exeter Docks	16	Squamscott River	Exeter	1994	
Dover Foot-Bridge	17	Cochecho River	Dover	1996	
Maplewood Ave.	18	North Mill Pond	Portsmouth	1997	
Bartlett St.	19	North Mill Pond	Portsmouth	1997	
Junkins Ave.	20	South Mill Pond	Portsmouth	1997	
Pleasant St.	21	South Mill Pond	Portsmouth	1997	
Little Harbour	22	Little Harbour	Portsmouth	1998	

THE GREAT BAY COAST WATCH MISSION STATEMENT

The Great Bay Coast Watch is citizen volunteers, working within the UNH Cooperative Extension/Sea Grant Program, protecting the long-term health and natural resources of New Hampshire's coastal waters and estuarine systems through monitoring and education projects.



UNIVERSITY OF NEW HAMPSHIRE COOPERATIVE EXTENSION

FACT SHEET

Great Bay Coast Watch works to protect the long-term health and natural resources of New Hampshire's coastal waters

Protecting the long-term health and natural resources of New Hampshire's coastal waters and estuarine systems is the focus for a group of dedicated volunteers.

Since 1990, these volunteers have been playing an increasingly important role through monitoring and education projects. Working within the UNH Cooperative Extension/Sea Grant Program and originally called the Great Bay Watch, these volunteers monitor parameters at a number of sites and contribute their data to a database at the University's Jackson Estuarine Laboratory. Over time, the organization evolved into the Great Bay Coast Watch.

Today, over 100 volunteers monitor a wide range of parameters, including fecal coliform levels and the presence of harmful algal bloom at over 30 sites in the estuary and along the New Hampshire coast. In addition to building the important database, the monitors' findings help local communities and state agencies make decisions in matters concerning the health of both the region's citizens and its environment.

Through its activities, the GBCW seeks to achieve three goals:

- to monitor the chemical, physical, and biological systems of the New Hampshire coast and the Great Bay Estuary.
- to educate residents of New Hampshire's coastal and estuarine communities about the health status and protection of these natural resources.
- to develop a management structure that engages volunteers in all aspects of the Great Bay Coast Watch and continuously improves the quality of the monitoring and education projects.

GBCW is always looking for area residents interested in joining its monitoring teams. New volunteers are trained at workshops led by staff, technical advisors, and Watch members. They then participate in one or more aspects of the monitoring program:

- monitoring water quality
- taking shoreline surveys
- doing community outreach
- checking for harmful algal blooms

If you would like to volunteer and want more information before making a commitment, please contact Ann Reid, Great Bay Coast Watch coordinator, at 603-749-1565.

In the beginning, federal grant funds helped to establish and expand GBCW. The availability of these funds has decreased and the Watch is working to develop a broad base of support by building partnerships with state and local agencies and organizations that appreciate the importance of the organization's efforts. It addition, the Watch is seeking to raise $10,000 from local businesses and individuals who care about the health of the Great Bay Estuary and the New Hampshire coast.

Visit Our Web Site at http://www.gbcw.unh.edu

INTRODUCTION

For years, some of us have known the Great Bay Estuary as a place of great beauty and abundant resources. Researchers from the University of New Hampshire and elsewhere utilize it as a "living laboratory." It is an exciting outdoor classroom for University of New Hampshire oceanography and biology classes, and most recently, it is an essential part of the Math and Marine Science (M & M) program for high school students. It is being discovered by many who want a "taste of the coast" without braving the crowds at the beach. Sportsmen wait eagerly for the annual fall bird migrations. Now, people are building homes at a rapid rate along the estuary's rivers and bays, increasing pressures on the already strained sewage treatment facilities in the communities around the estuary. This year 50-55% of Great Bay's clam and oyster beds are off-limits due to pollution. In fact, Great Bay Estuary still has the third highest percentage of area closed to shellfishing in New England, a rather dubious distinction.

Still, the estuary is one of the region's most pristine, and the Great Bay proper recently achieved status as a National Estuarine Research Reserve. The reserve includes 4,471 acres of tidal waters and mudflats and approximately 48 miles of shoreline. The water area includes all of Great Bay, the small channel from the Winnicut River and large ones from the Squamscott and Lamprey Rivers which meet in the center of the Bay to form a channel known as Furber Straits, which connects to Little Bay at Adams Point. Also within the boundary are 800 acres of upland that includes a wide range of environments including salt marshes, tidal creeks, islands, woodlands and open fields.[1]

The U.S. Department of Agriculture has designated portions of the Great Bay Estuary watershed (563,200 acres) as a priority watershed area in the Nonpoint Source Management Plan (in accordance with section 319 of the Clean Water Act). The selected project area encompasses a little less than half the watershed in the Lamprey, Exeter and Oyster River/Great Bay hydrologic units.[2]

The Great Bay Coast Watch (GBCW), a pilot citizen water monitoring program sponsored by Sea Grant Extension through a grant from the National Oceanic Atmospheric Administration (NOAA), has been formed. The dual purposes of the GBCW are to extend and augment monitoring efforts already underway in the estuary by the University of New Hampshire's Jackson Estuarine Laboratory staff, and to involve interested people in an action-oriented educational program. The data that the group collects is being made available to researchers, town and regional planners, state and local government agencies, and other interested parties.

WHY MONITOR?

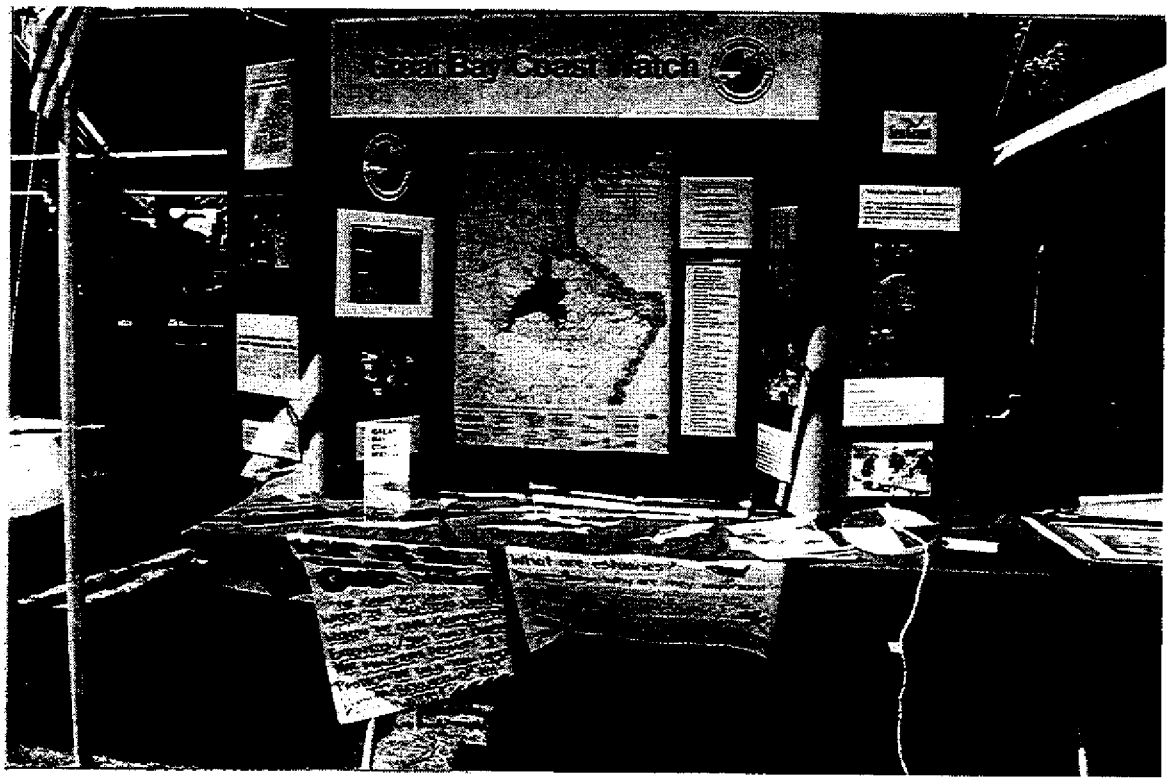
Ecological monitoring can be defined as repetitive measurements or observations recorded over time for determining a condition or tracking change. A number of scientific studies point to the necessity of doing long-term ecological monitoring before drawing conclusions as to the cause and effect of observed changes. Changes are often gradual and subtle. The question is whether they represent trends. For example, is the apparent sea level rise due to warming of earth's atmosphere or just a natural fluctuation? In general, these studies have shown that:

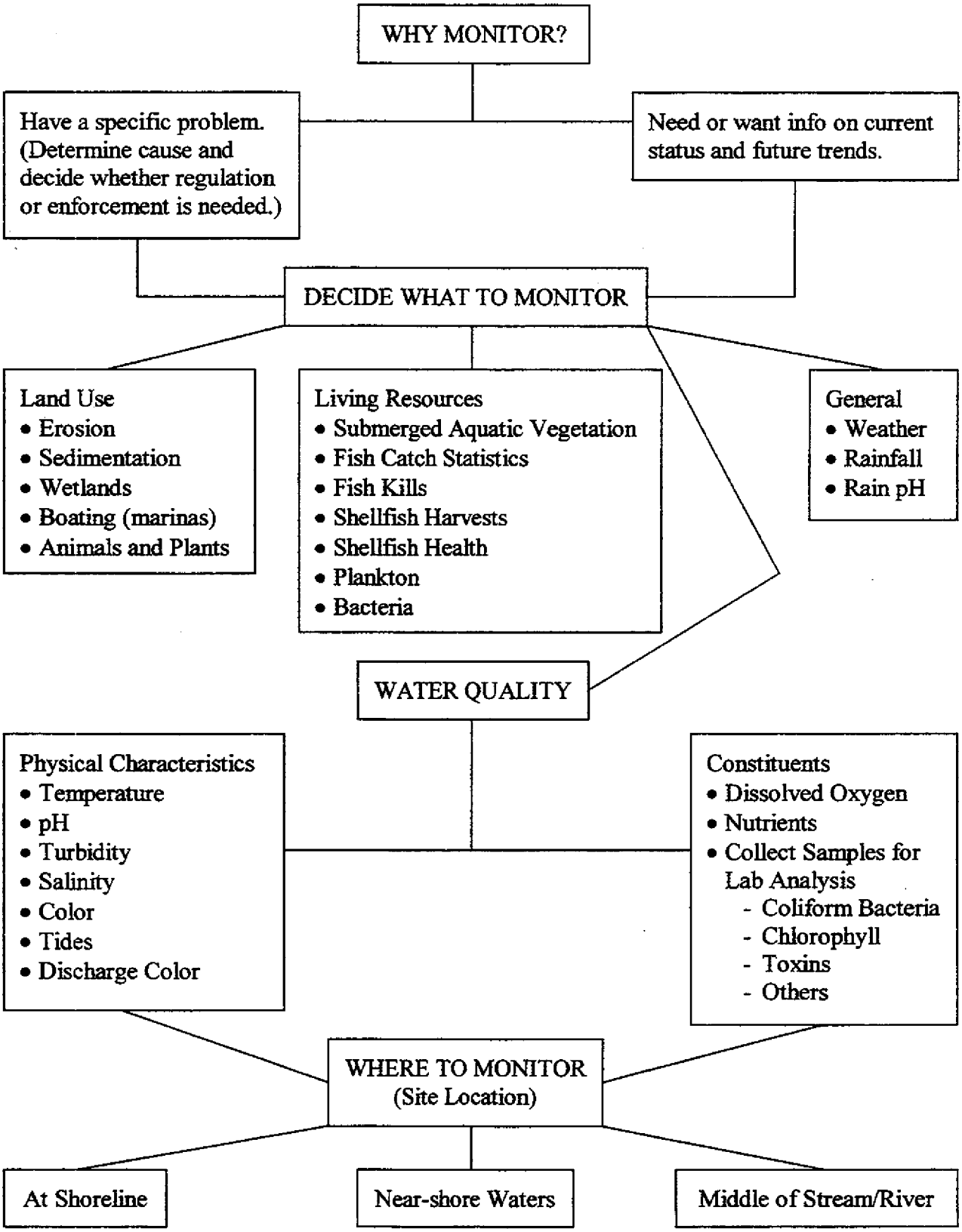
1. complex ecological systems require long-term observation and study for understanding;

2. a sequence of only two to three years of data can be very misleading about the direction of environmental quality;

3. environments have a "memory" or response time which varies greatly. It takes a certain amount of time to detect a change – perhaps a decade for lakes and a century for soil.

While those involved in citizen monitoring efforts are usually not trained scientists, they can, with relatively little training and simple equipment, collect information that will contribute to an ecological study of the site they are investigating. When the data collected at the Great Bay Coast Watch sites are put together, they will become part of the ecological picture of the Great Bay Estuary.




WHY MONITOR?
Have a specific problem. (Determine cause and decide whether regulation or enforcement is needed.)
Need or want info on current status and future trends.
DECIDE WHAT TO MONITOR
Land Use
• Erosion
• Sedimentation
• Wetlands
• Boating (marinas)
• Animals and Plants
Living Resources
• Submerged Aquatic Vegetation
• Fish Catch Statistics
• Fish Kills
• Shellfish Harvests
• Shellfish Health
• Plankton
• Bacteria
General
• Weather
• Rainfall
• Rain pH
WATER QUALITY
Physical Characteristics
• Temperature
• pH
• Turbidity
• Salinity
• Color
• Tides
• Discharge Color
Constituents
• Dissolved Oxygen
• Nutrients
• Collect Samples for Lab Analysis
- Coliform Bacteria
- Chlorophyll
- Toxins
- Others
WHERE TO MONITOR (Site Location)
At Shoreline
Near-shore Waters
Middle of Stream/River

SAFETY FIRST

General Precautions:

Read all instructions to familiarize yourself with the test procedure before you begin. Note any precautions in the instructions.

FOR YOUR SAFETY AND GOOD DATA RECORDING, WORK WITH AT LEAST ONE PARTNER.

Keep all equipment and reagent chemicals out of the reach of small children and animals.

NOTE THAT SOME OF THE REAGENTS ARE CAUSTIC.

In case of an accident or suspected poisoning, immediately call 1-800-562-8236, the Poison Control Center - New Hampshire. If a reagent should get into your eye or on your skin, irrigate the area immediately with fresh water. We have the details on the reagents we are using. See Appendix VI, Material Safety Data Sheets. Call Ann (749-3880) or Sharon (659-5441) at home or at office (749-1565).

PROTECT YOURSELF AND YOUR EQUIPMENT: Use proper analytical technique.

1. Avoid contact between reagent chemicals and skin, eyes, nose, mouth.

2. Wear safety goggles or glasses when handling the reagents.

3. Use stoppers, not your fingers, to cover the bottles during shaking or mixing.

4. Rinse and wipe up any reagent chemical spills, liquid or powder as they occur.

5. Thoroughly rinse jars and bottles before and after each use. Dry your hands and the outside of the bottles.

6. Avoid prolonged exposure of equipment and reagents to direct sunlight. Keep reagents in a dark location, protected from extremes in temperatures.

WASH EVERYTHING THAT WAS IN CONTACT WITH CHEMICALS OR SALT WATER AFTER EVERY TEST. DRY EVERYTHING THOROUGHLY, INCLUDING THE INSIDE OF THE BUCKET.

EQUIPMENT LIST **Site #**_____ **Site Name**_____ **Tool Box #**_____

TEMPERATURE

_____ Air thermometer with string
_____ Armored (water) thermometer #_____

SALINITY

_____ Hydrometer with case and stopper #_____(inside paper on hydrometer stem)
_____ Hydrometer jar (plastic 500ml cylinder)

pH

_____ pH meter #_____
_____ Small brown bottles with caps: _____ (count)
_____ Small bottle for extra buffer

DISSOLVED OXYGEN

_____ Graduated burette (2)
_____ Glass rods (2)
_____ BOD bottle (glass) and stopper (2)
_____ 100ml graduated cylinder
_____ Plastic beaker
_____ 1 box manganese sulfate pillows Count_____
_____ 1 box iodide-azide pillows Count_____
_____ 1 box sulfamic acid pillows Count_____
_____ 1 bottle starch solution
_____ 1 bottle of sodium thiosulfate
_____ 1 scissors
_____ 2 glass marbles

FECAL COLIFORM

_____ Collecting tongs
_____ Whirlpak bags (sterilized) _____ (count)
_____ Permanent marker
_____ Ice pack
_____ Cooler container for samples

SAFETY ITEMS

_____ Container with sticker/emergency numbers
_____ Band-Aids and antiseptic
_____ Plastic container for tap water (for eyewash, pH test and clean-up)
_____ Protective glasses

WATER TRANSPARENCY

_____ Secchi disk with measure line attached

MISCELLANEOUS

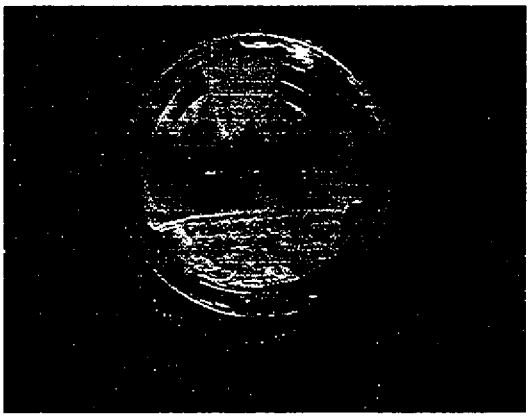
_____ Clipboard with #2 pencil attached
_____ Waste container (1 gallon plastic detergent container)
_____ Clean cloth for drying equipment
_____ GBCW manual and data sheets
_____ Water sample collection container with rope, tubing, clamp and spigot attached

NAME (Please print) _____ **DATE** _____

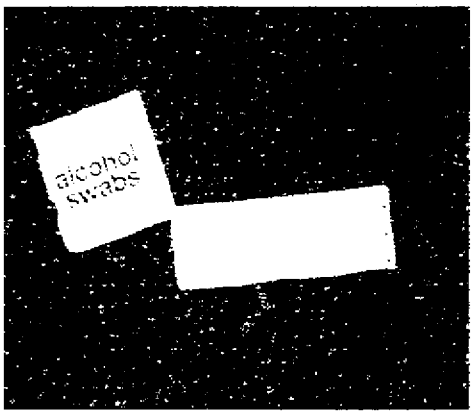
SIGNATURE _____

revised 2/20/2002

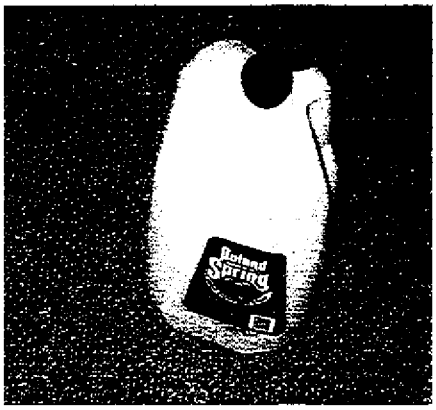
SAFETY EQUIPMENT



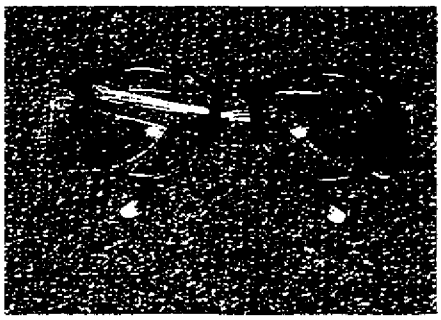
CONTAINER (with sticker and emergency numbers)



BAND-AIDS & ANTISEPTIC

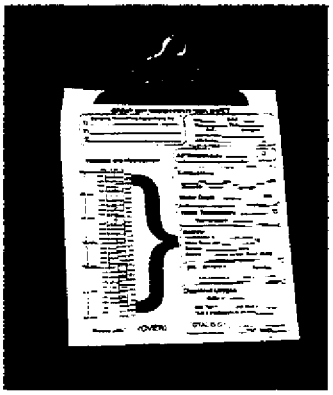


PLASTIC WATER CONTAINER (for eyewash, pH test and clean-up)

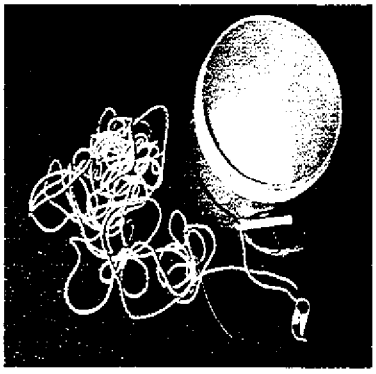


PROTECTIVE GLASSES

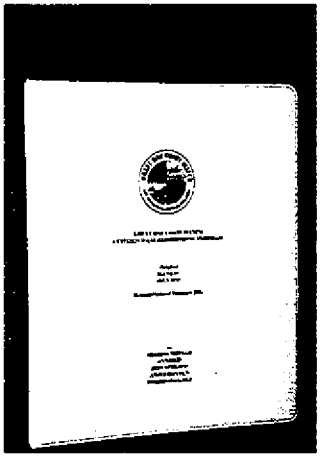
MISCELLANEOUS EQUIPMENT



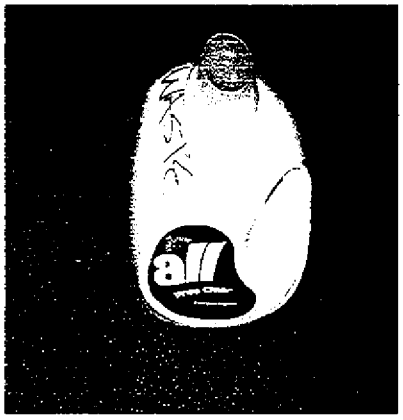
CLIPBOARD (with No. 2 pencil attached)



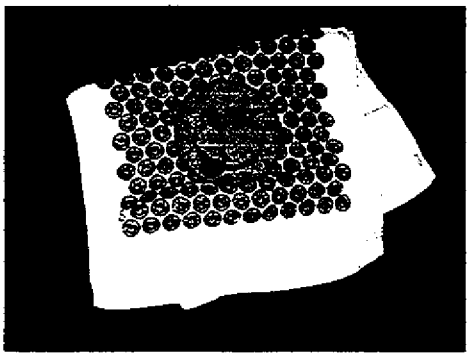
SAMPLING BUCKET



GBCW MANUAL



WASTE CONTAINER



CLEAN CLOTH (for drying equipment)

SAMPLING PROCEDURE SUMMARY

Procedure at the water's edge:

1. Bring instruction manual.
2. Fill out data sheet heading completely.
3. Put air thermometer in place. (We suggest hanging it in a nearby bush out of the sun.) Record temperature after 3-5 minutes.
4. Do Secchi disk readings. Record.
5. Take water depth measurement. Record.
6. Take water sample with bucket.
7. Immediately immerse armored thermometer to measure water temperature. Read after 3-5 minutes – no later. Record.
8. While you are waiting for the temperature reading, draw off water for dissolved oxygen test into your BOD bottle. Do steps 1-4 of the D.O. procedure
9. Take sample of water in sterile bag for coliform test and place in cooler.

Procedure in laboratory: (These may be done at water's edge or site lab.)

10. Determine pH. (Remember to first discard tap water, sample water, and old buffer.)
11. Fill hydrometer jar and immerse both the armored thermometer and the hydrometer in the jar. Read the thermometer after 3-5 minutes. Record. Then read the hydrometer. Record.
12. Determine salinity, using the tables in your book.
13. Complete the dissolved oxygen protocol steps 5-12 (titration).
14. **WASH EVERYTHING THAT WAS IN CONTACT WITH CHEMICALS OR SALT WATER AFTER EVERY TEST.** Dry everything thoroughly, including the inside of the bucket. This will help maintain the life of the equipment.
15. Complete data sheet: Weather, Water, Activity, and, **VERY IMPORTANT**, Observation Narrative. Write in time spent and **have data sheet signed by a member of the site team who has successfully completed a QAQC session. This signature is VERY IMPORTANT as it validates the sampling data.**
16. Complete entries for the Cumulative Data Sheet (page 10) and Time & Mileage Sheet (page 11).
17. Bring water sample for coliform testing (before 6 p.m.) to Kingman Farm, phone #749-1565.

GREAT BAY COAST WATCH FIELD DATA SHEET

Sampling Team (full names please)

1. _____
2. _____
3. _____

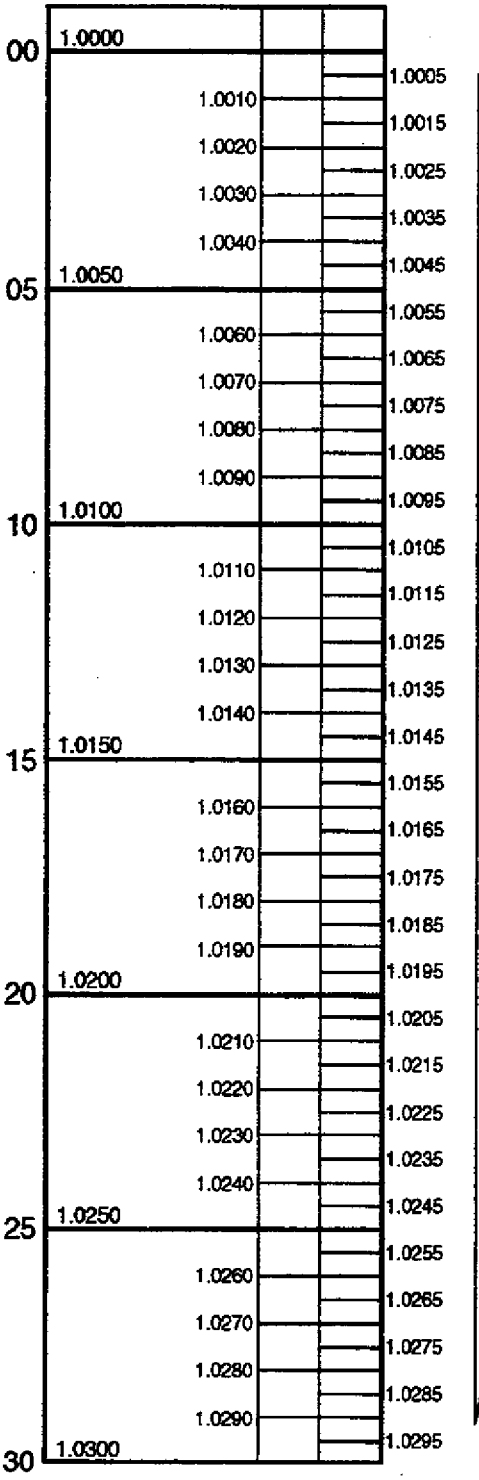
Day_____ Date _____

Tide _____ Time _____

(H or L) (Military)

Site Number _____

Site Name _____



Air Temperature _____ °C

Water Transparency:

_____cm _____cm _____cm

disappear appear average

Water Depth _____cm

Water Temperature _____ °C

Thermometer # _____

Salinity:

Hydrometer # _____

Water Temp (jar) _____ °C

Density _____ g/cc

Salinity _____ ppt (from chart)

pH:

Meter # _____ Reading _____

Dissolved Oxygen:

Bottle # _____

Test 1 _____ ml Test 2 _____ ml

Test 3 (only if diff > 0.3 ml) _____ ml

Total D.O. Reading _____ mg/L

(over)

revised 2/19/2001

GREAT BAY COAST WATCH FIELD DATA SHEET

Please describe the conditions at your site today:

Water: Calm _____ Ripple _____ Waves _____ Whitecaps ____

Weather: Clear___ Partly Cloudy ___ Overcast ___ Fog/Haze__
Showers ___ Downpour ___ Snow ___ Other _____

Activities: Fishing ___ Oystering ___ Boating ___ Hunting ___
Other _____

Fecal Coliform:
Person taking sample _____
Person transporting sample _____

Birds: Type _____ # ___
Type _____ # ___
Type _____ # ___

Horseshoe Crabs:
Total # seen: _____
 # young (< 2 in.):_____
 # amplexus:_____
 # laying eggs:_____

Rainfall in last 24 hrs: _____ in.

Please write an observation narrative:

_____

_____

_____

_____

Time Estimates:

	Sampler 1	Sampler 2	Sampler 3
Field Work:			
Lab Work:			
Travel:			
Total			

FOR OFFICE USE ONLY		
	Date	Initials
Reviewed		
Entered		
Accepted		

Signature _____ Date _____
(QA/QC Qualified)

GREAT BAY COAST WATCH CUMULATIVE DATA SHEET FOR 2002

Site Name:_____ **Site Number:**_____

Sample Date	Tide	4/29	5/28	6/25	7/25	8/26	9/23	10/22	11/6
Air Temperature (°C)	Low								
	High								
Water Temperature (°C)	Low								
	High								
Water Transparency (cm)	Low								
	High								
Water Depth (cm)	Low								
	High								
pH	Low								
	High								
Salinity (ppt)	Low								
	High								
Dissolved Oxygen (mg/l)	Low								
	High								
Percent Saturation	Low								
	High								
Samplers Names	Low								
	High								
Fecal Coliform	Low								
	High								
Water	Low								
	High								
Weather	Low								
	High								
Activities	Low								
	High								

Additional Observation Narrative by Date	
4/29/02	
5/28/02	
6/25/02	
7/25/02	
8/26/02	
9/23/02	
10/22/02	
11/6/02	

(revised 2/20/02)

TIME AND MILEAGE SHEET FOR 2002

NAME:_____

PHONE:_____ E-MAIL _____

DATE	TASK	MILEAGE	HOURS
Example: 4/6/02	Annual Meeting	10	3

Signature:_____

revised 2/20/02

TEMPERATURE

Discussion

Although temperature is one of the easiest measurements to perform, it is one of the most important parameters to be considered. It dramatically affects the rates of chemical and biochemical reactions within the water. Many biological, physical, and chemical principles are temperature dependent. Among the most common of these are the solubility of compounds in sea water, distribution and abundance of organisms living in the estuary, rates of chemical reactions, density, inversions and mixing, and current movements. Because the Great Bay and its tributaries are so shallow, their capacity to store heat over time is relatively small. As a result, water temperature fluctuates considerably.

The temperatures of surface and subsurface water usually differ. With increase in depth, the water generally becomes colder. This results in thermal stratification of deeper water and can lead to density differences. Vertical temperature profiles are fairly predictable. During the spring and summer months, the surface waters are warmer than the deeper waters, due to the warmth of the sun. In the fall, the warming radiation of the sun begins to diminish. As the surface water cools, it increases in density, becoming heavier. Once the surface water becomes colder and denser than the waters toward the bottom, it begins to sink and vertical mixing occurs. Wind and tide may speed up the process. This mixing action can bring nutrients up from the bottom into higher water where more plants and organisms may use it to their advantage. During the winter, the water temperature becomes relatively constant from surface to bottom until March, when the process of surface warming begins again.

Temperature is to reported on the field data sheet in degrees Celsius. You can make conversions either way using the following formulas:

Fahrenheit to Centigrade:

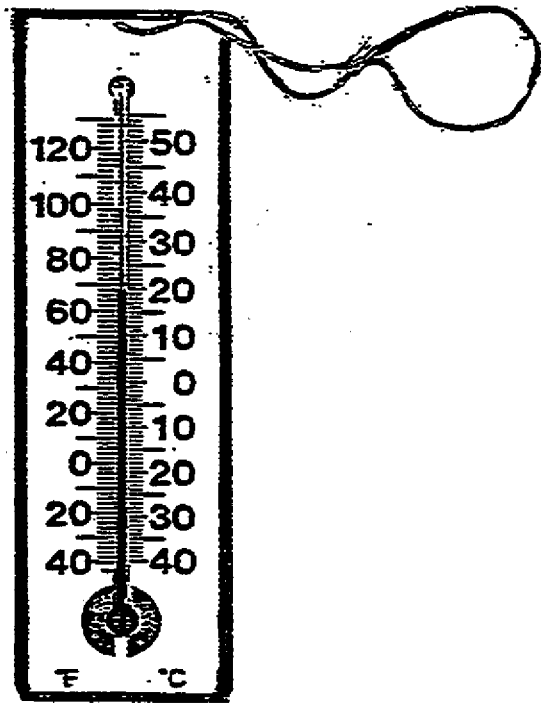
Subtract 32 degrees from Fahrenheit temperature; divide by 9; multiply by 5.

Centigrade to Fahrenheit:

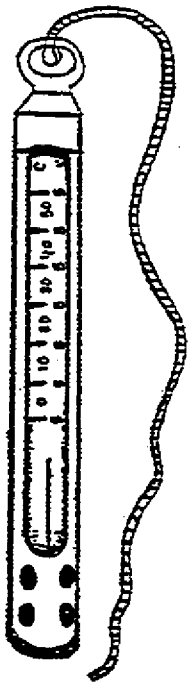
Divide Centigrade temperature by 5; multiply by 9; add 32.

Required Equipment:

- Armored thermometer (for water)
- Air thermometer



AIR THERMOMETER



WATER THERMOMETER
(ARMORED)

Temperature Procedure:

1. Check thermometers for continuous fluid - no breaks.

2. Hang the air thermometer in a nearby bush, out of the sun.

3. Rinse sampling bucket twice by filling it halfway and disposing of contents in an area **away from the sampling spot**. Let water flow through the tube and then clamp tube shut.

4. Take water sample with bucket at a depth of one to two feet, hang armored thermometer in bucket, and record reading after 3-5 minutes.

5. Record air temperature making sure to use Celsius scale. Convert from Fahrenheit if necessary.

WATER TRANSPARENCY (SECCHI DISK)

Discussion

Transparency of water is a quick and easy measurement that integrates many important features of an aquatic system. Algae, microscopic animals, eroded soil, and resuspended bottom sediment contained in the water column interfere with light penetration and lessen the transparency of the water. In late spring and early fall, transparency is usually less because of plankton and algal blooms, and in the early spring, the water may become more turbid with silt being carried into the estuary with spring run-off. Since the sunlight is the basic energy source for all life, the degree of water transparency of the water has an important effect.

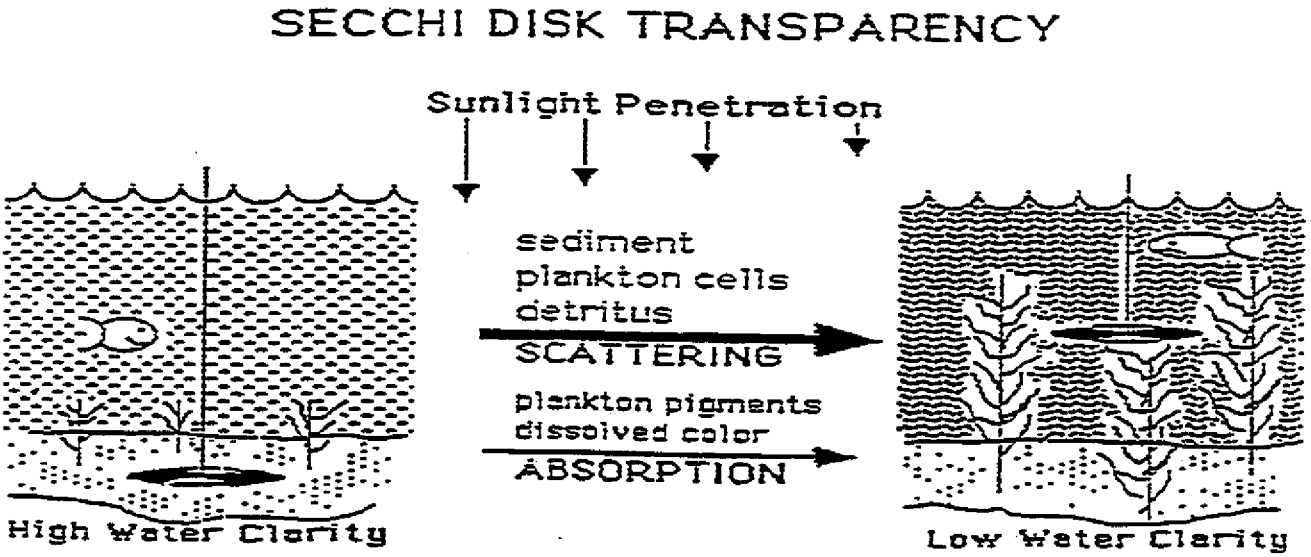
Transparency affects fish and other aquatic life by:

1. limiting photosynthetic processes and increasing respiration, oxygen use and the amount of carbon dioxide produced.

2. clogging of fish gills by suspended particles.

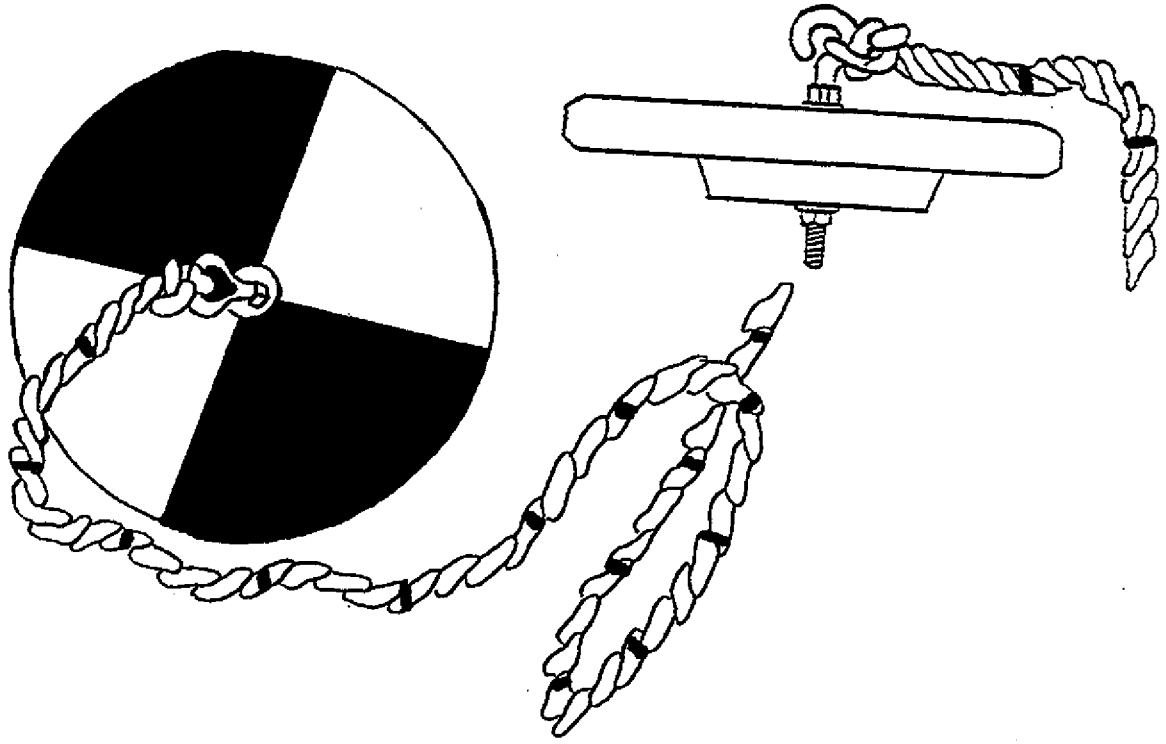
3. obscuring vision of fish and shellfish as they hunt food.

Water color indicates transparency, to a degree, and it is useful to record its color.



Required Equipment:

- Secchi disk, with line marked every five centimeters.



Water Transparency Procedure:

Note: Take these readings at the same spot each time. Do tests during daylight hours.

A. Water Transparency –

1. Lower the Secchi disk into the water (in the shade of your body as you stand with your back to the sun, if possible) until it just goes out of sight. Note and record "disappear" depth to the closest five centimeters. Then raise Secchi disk until it just reappears. Note and record "reappear" depth to the closest five centimeters. Also record the average of the two depths. [If the disk is resting on the bottom and is still visible, record the depth of the water for the average value.]

B. Water Depth –

1. Lower the Secchi disk into the water (in the shade of you body as you stand with your back to the sun) until you feel or see the Secchi disk hit bottom. (At this point the rope will go slack.) Record the water depth to the closest 5 centimeters.

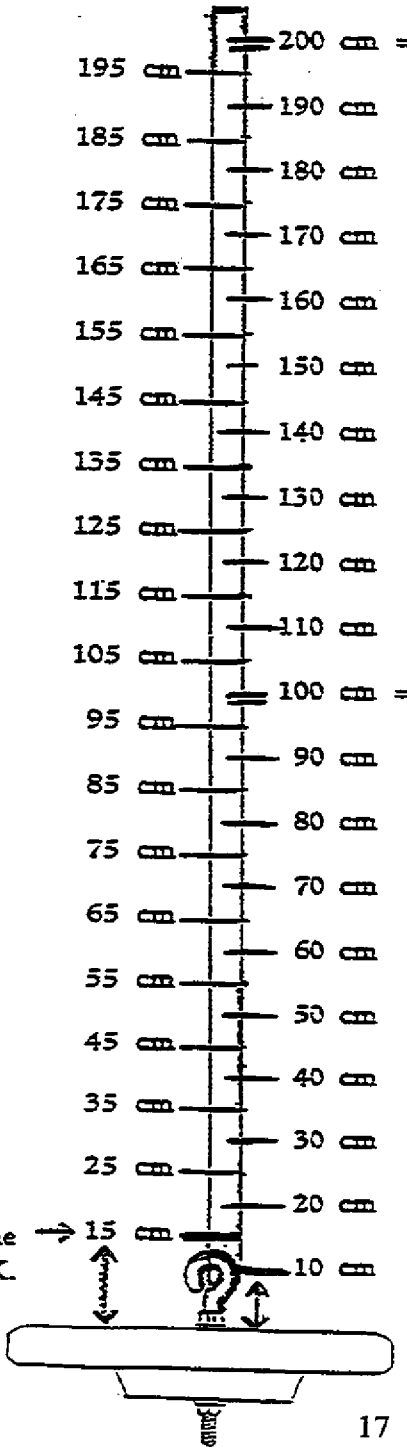
HOW TO READ THE SECCHI DISK

IMPORTANT:

Please start counting from the "surface" of the secchi disk. From the "surface" up to the BLUE line is 10 cm.

Each RED line represents 5 cm each.

When you have counted 10 BLUE lines you have reached the 1 METER line (this is represented by 2 BLACK lines).



200 cm = 2 meters (shows 2 BLACK lines)

100 cm = 1 meter (shows 2 BLACK lines)

= This is the first RED line from the surface of DISK.

= The first BLUE line you see from the surface of DISK.

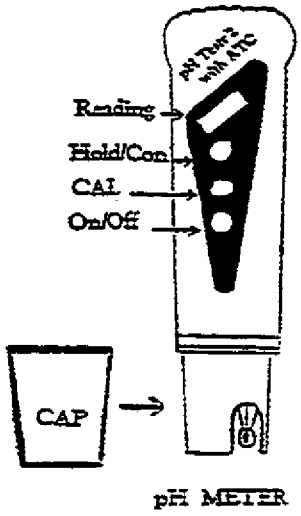
pH

Discussion

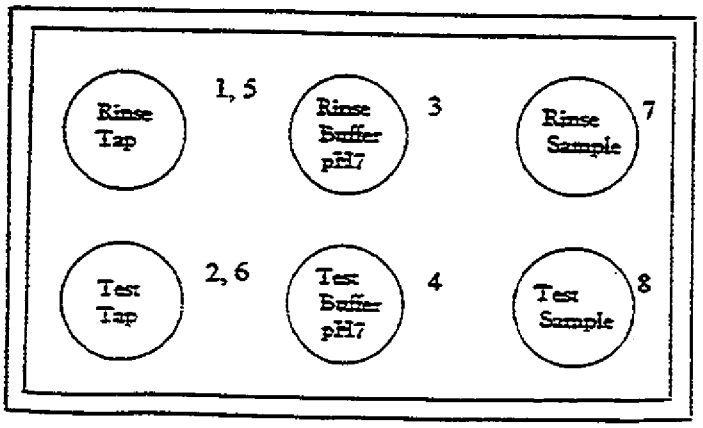
pH is the measure of alkalinity/acidity. The pH scale runs from zero to fourteen, acidic to basic, with 7.0 being neutral. The scale is logarithmic, which means that for each increase of one on the pH scale, pH increases by a factor of ten. At a pH of 4.0 there are ten times as many hydrogen ions as there are at a pH of 5.0, and so on. The pH of ocean water is slightly basic, usually at 8.0 to 8.4. In estuaries, the pH varies more, usually from 7.0 to 8.6, but can vary even more widely at times of extreme influx of fresh water or a high degree of biologic activity. Water dissolves the mineral substances it contacts, picks up aerosols and dust from the air, receives wastes, and supports photosynthetic organisms, all of which affect pH. Water has a buffering capacity, which helps it resist pH change, but some change does occur. Generally, aquatic life can exist between pH of 9.0 and 5.0.

Required Equipment:

- pH pocket meter
- pH 7.0 buffer solution
- Tap water
- Six bottles and tray.



pH METER



BUFFER pH7

pH Procedure :

NOTE: BE SURE TO IMMERSE THE PROBE IN TAP WATER TO THE BLACK LINE FOR AN HOUR BEFORE SAMPLING. BE SURE TO SEE IF pH METER IS FUNCTIONING.

A. Sample Collection –

1. Obtain a sample of estuarine water from your sampling bucket and pour into bottles marked "rinse sample" and "test sample."

B. Calibration and Measurement of pH –

Note: (pH is temperature dependent. Calibration liquid must be near your sample temperature or vise-versa.) If your meter does not calibrate, check the batteries. Change them if necessary and attempt calibration again. If it still does not calibrate correctly, the solution could be weak, or something else could be wrong. Do not take the reading -- bring the meter to the office. (749-1565)

1. Fill two small brown bottles labeled "rinse tap" and "test tap" and fill with tap water.

2. Check two small bottles of pH 7 buffer – bottle marked "rinse buffer" should contain the older, used buffer and bottle marked "test buffer" should contain the fresher, newer buffer.

3. **Remove protector cap from pH probe.**

Caution! In the following steps, Only immerse pH meter to black line and keep meter in dry area of the kit.

4. Turn on meter (Press on/off button).

5. Rinse probe in bottles marked "rinse tap" and "test tap" by stirring gently. No need to take pH readings.

6. Rinse probe in small bottle of buffer solution marked "rinse pH 7", then immerse in "test pH 7." Press the "cal" button to enter calibration mode (you will see CA in window). Stir gently and wait for the displayed value to stabilize. Press "hold/con" (you will see CO in window) to complete calibration.

7. Rinse the probe in tap water, first the "rinse tap" then the "test tap". Do not record any numbers.

8. Rinse probe in small bottle of "rinse sample," then immerse in "test sample". Stir once and allow reading to stabilize. (ATC will correct for temperature changes.)

9. Read pH in the display window.

10. Press on/off button to shut off pH meter.

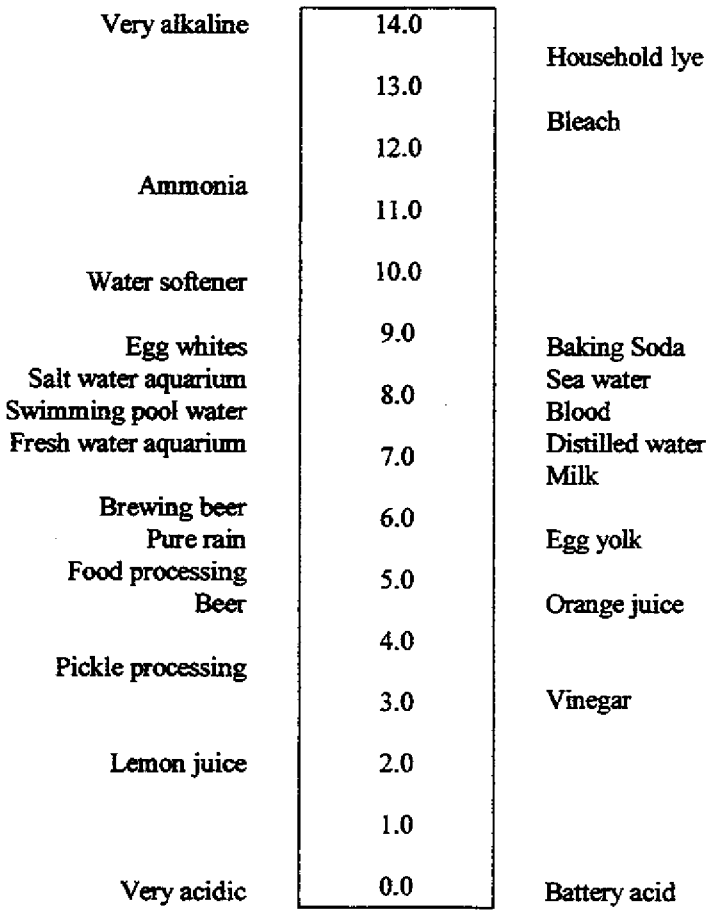
C. Cleanup –

Caution: During cleanup be sure that you do not immerse the electrode on the pH meter above the black line.

1. Rinse probe again in two tap bottles, shake off excess water, replace cap. Rinse sample bottles and tap water bottles in fresh water and dry. Old buffer can be disposed of by pouring down any drain or into waste container. Store meter in toolbox near bottles and in a dry section.

2. Note: At the end of the sampling day, throw out the rinse buffer, wash, dry the "rinse buffer" bottle, and wash the cap. Pour the used test buffer into the "rinse buffer" bottle. Wash "test buffer" bottle and fill with new test buffer solution from extra buffer solution bottle before next sampling day.

pH Scale Showing the pH of Some Common Substances



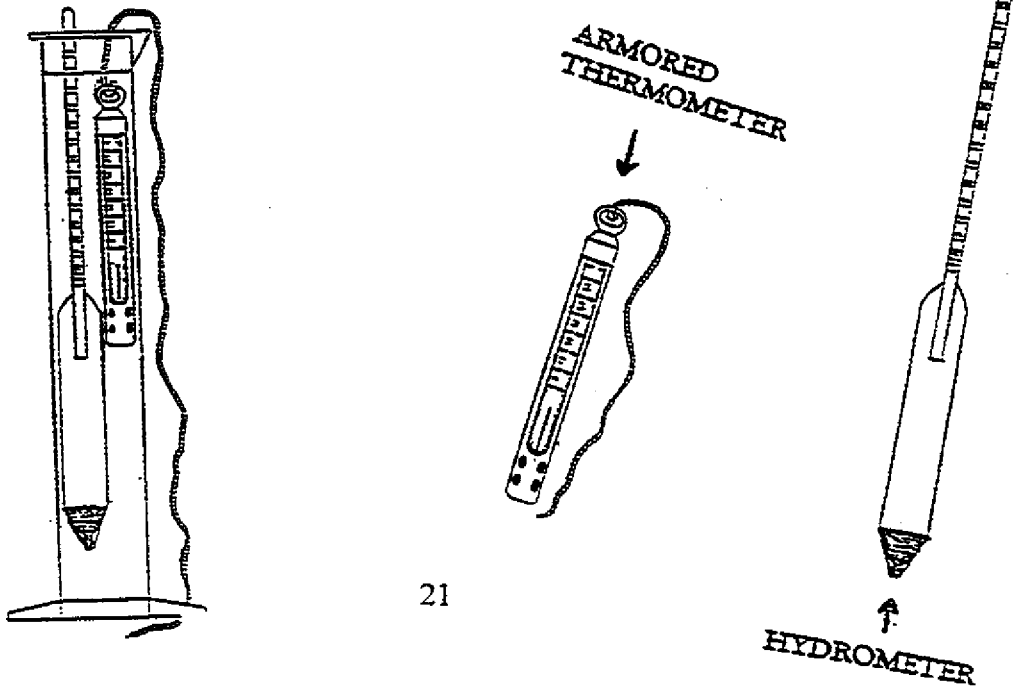
SALINITY

Discussion

Salinity is total amount of dissolved solids in the water and is made up of all known elements. The salinity of the open ocean is approximately 35 parts per thousand (ppt) but in the Gulf of Maine, salinity is slightly lower at about 32 or 33 ppt due to river influx and run-off. In the Great Bay Estuary, seven rivers bring fresh water into embayment, and during the spring run-off, levels of salinity have been recorded as low as 0 ppt. Salinity may also range as high as 30 ppt Tolerance of wide-ranging and sometimes rapidly changing salinity determines, more than any other single factor, which species of plants and animals can survive in an estuary. Although salinity levels are higher at the mouth of the Piscataqua River, and generally become progressively lower as we move into the Great Bay proper, winds and tides cause Little Bay and Great Bay to be well-mixed. Mixing also occurs top to bottom, blending the warmer, fresher water that tends to float on top with the cooler, more dense salt water brought in by the tides.

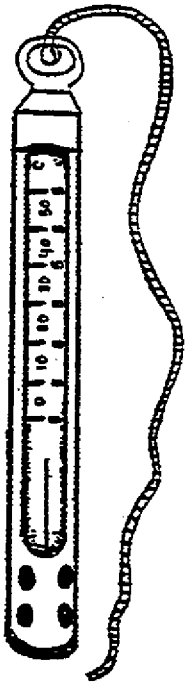
Temperature in the Great Bay estuary has a marked pattern of seasonal variation from a winter low of -1.9 degrees Celsius to 28-30 degrees C° in the summer. Great Bay itself is quite shallow, averaging about 8 feet, which allows for rapid warming and cooling as the seasons change. From 1973 to 1982, time series analyses of hydrographic trends in the estuary by UNH Professor Ted Loder and others showed that water temperature decreased 0.17 degrees C. per year while salinity rose (at Dover Point) 0.34 ppt per year. These trends to colder, saltier water may indicate either local river-flow changes or regional trends affecting the Gulf of Maine.[4]

There are several ways of determining salinity, most of them requiring the use of expensive equipment. However, we will use a hydrometer, an instrument which measures the density of a fluid by making use of Archimedes' Principle. This principle states that "a floating body will displace a volume of water, the mass of which is equal to its own mass." The mass of a hydrometer is fixed so that it floats in pure, distilled water at 1.00 grams per cubic centimeter. Salinity is also related to temperature of the water, which we will measure. Then we will use conversion tables to relate the density and temperature measurements, and extrapolate our salinity reading in parts per thousand.

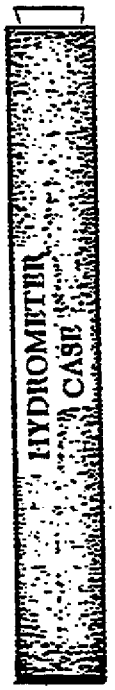


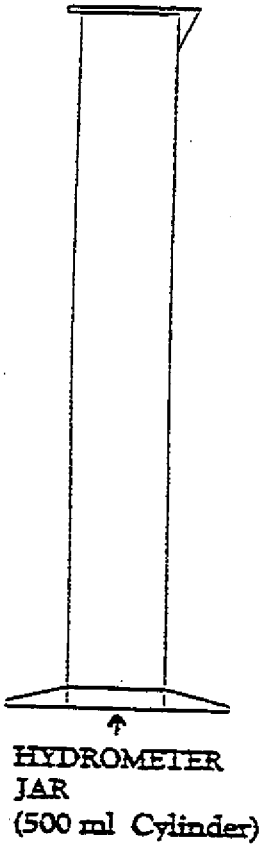
Required Equipment:

- Armored thermometer
- Hydrometer
- Hydrometer jar (500 ml cylinder)



WATER THERMOMETER
(ARMORED)





HYDROMETER
JAR
(500 ml Cylinder)

Salinity Procedure:

1. Using water from the bucket, fill the 500 ml cylinder 3/4 full.

2. Hang the armored thermometer in the jar.

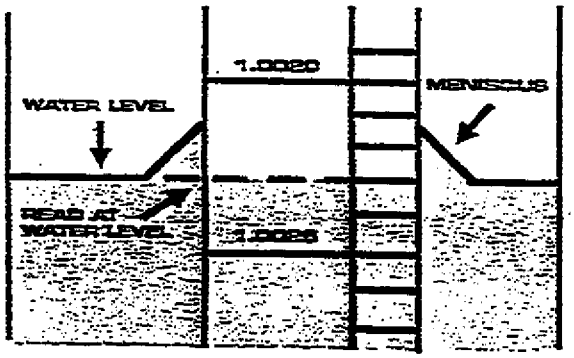
3. **Immediately** insert the hydrometer **carefully** with a twisting motion. (This removes any air bubbles.) Don't just drop the hygrometer into the jar because it might hit the bottom of the jar too hard and break.

4. Level the cylinder so hydrometer is vertical and not touching the sides. (Try to keep it out of the wind.)

5. After 3-5 minutes, read the thermometer to the nearest 0.5 degrees C. and record.

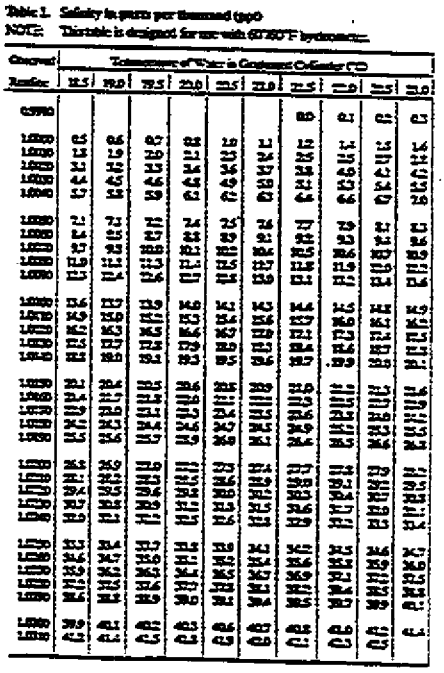
6. Remove the thermometer.

7. Read the density using the scale on the hydrometer, taking care to read at the bottom of the curve formed where the water rises slightly as it touches the sides of the hydrometer. (A magnifying glass may be helpful.) This curve is called the meniscus. On your data sheet, show where the meniscus is by marking the "READING THE HYDROMETER" diagram. Record your density reading on your data sheet.



8. To determine the salinity, use Table 1, the five-page salinity table (see pp.25-29). Salinity is in parts per thousand (ppt). Locate the density in the left hand column and the recorded temperature across the top of the appropriate page. Then, read down to the appropriate salinity and record the result.

   NOTE: If you find the density or temperature reading to be a value ending in five (5), you will need to interpolate the result on the table. This is done by taking the average of the points above and below the value. For example, if the density reading from the hygrometer is 1.0135, you would take the values for 1.0140 and 1.0130 and average them to get the salinity value.



9. Record the number of your hydrometer on the data sheet. It is found near the neck on white paper inside the stem.

Table 1. Salinity in parts per thousand (ppt)

NOTE: This table is designed for use with 60°/60°F hydrometer.

Observed	Temperature of Water in Graduated Cylinder (°C)									
Reading	-1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0
1.0000										
1.0010	0.6	0.6	0.5	0.5	0.2	0.2	0.2	0.2	0.2	0.2
1.0020	1.9	1.9	1.8	1.6	1.6	1.6	1.5	1.5	1.6	1.6
1.0030	3.2	3.1	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.9
1.0040	4.4	4.2	4.2	4.1	4.1	4.1	4.1	4.1	4.1	4.2
1.0050	5.7	5.5	5.4	5.4	5.4	5.3	5.3	5.4	5.4	5.4
1.0060	6.8	6.8	6.7	6.6	6.6	6.6	6.6	6.6	6.7	6.7
1.0070	8.1	8.0	7.9	7.9	7.9	7.9	7.9	7.9	7.9	8.0
1.0080	9.3	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.3
1.0090	10.5	10.5	10.4	10.4	10.4	10.4	10.4	10.5	10.5	10.6
1.0100	11.8	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.8	11.8
1.0110	13.0	13.0	12.8	12.8	12.8	12.8	13.0	13.0	13.1	13.1
1.0120	14.3	14.1	14.1	14.1	14.1	14.1	14.1	14.3	14.3	14.4
1.0130	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.6	15.7
1.0140	16.7	16.6	16.6	16.6	16.6	16.6	16.7	16.7	16.9	17.0
1.0150	17.9	17.9	17.9	17.9	17.9	17.9	17.9	18.0	18.0	18.2
1.0160	19.2	19.1	19.1	19.1	19.1	19.2	19.2	19.3	19.3	19.5
1.0170	20.4	20.4	20.4	20.4	20.4	20.4	20.5	20.5	20.6	20.8
1.0180	21.7	21.7	21.6	21.6	21.7	21.7	21.7	21.8	22.0	22.1
1.0190	22.9	22.9	22.9	22.9	22.9	23.0	23.0	23.1	23.3	23.4
1.0200	24.2	24.2	24.0	24.2	24.2	24.2	24.3	24.3	24.4	24.6
1.0210	25.3	25.3	25.3	25.3	25.5	25.5	25.6	25.6	25.7	25.9
1.0220	26.6	26.6	26.6	26.6	26.6	26.8	26.8	26.9	27.0	27.2
1.0230	27.8	27.8	27.8	27.8	27.9	27.9	28.1	28.2	28.3	28.5
1.0240	29.1	29.1	29.1	29.1	29.1	29.2	29.4	29.5	29.5	29.8
1.0250	30.3	30.3	30.3	30.4	30.4	30.6	30.6	30.7	30.8	30.9
1.0260	31.6	31.6	31.6	31.6	31.7	31.7	31.9	32.0	32.1	32.2
1.0270	32.8	32.8	32.9	32.9	32.9	33.0	33.2	33.3	33.4	33.5
1.0280	34.1	34.1	34.1	34.1	34.2	34.3	34.5	34.5	34.7	34.8
1.0290	35.2	35.2	35.4	35.4	35.5	35.5	35.6	35.8	35.9	36.2
1.0300	36.5	36.5	36.5	36.7	36.7	36.8	36.9	37.1	37.2	37.3
1.0310	37.7	37.7	37.8	37.8	38.0	38.1	38.2	38.4	38.5	38.6

Table 1. Salinity in parts per thousand (ppt)

NOTE: This table is designed for use with 60°/60°F hydrometer.

Observed	Temperature of Water in Graduated Cylinder (°C)									
Reading	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0
1.0000								0.0	0.2	0.3
1.0010	0.5	0.5	0.6	0.6	0.7	0.8	1.0	1.2	1.5	1.6
1.0020	1.6	1.8	1.9	2.0	2.1	2.3	2.4	2.5	2.8	2.9
1.0030	2.9	3.1	3.2	3.3	3.4	3.6	3.7	3.8	4.1	4.2
1.0040	4.2	4.4	4.5	4.6	4.8	4.9	5.0	5.1	5.4	5.5
1.0050	5.5	5.5	5.7	5.8	5.9	6.2	6.3	6.6	6.7	7.0
1.0060	6.8	6.8	7.0	7.1	7.2	7.5	7.6	7.9	8.0	8.3
1.0070	8.1	8.1	8.3	8.4	8.5	8.8	8.9	9.2	9.3	9.6
1.0080	9.3	9.4	9.6	9.7	9.8	10.0	10.2	10.5	10.6	10.9
1.0090	10.6	10.7	10.9	11.0	11.1	11.3	11.5	11.8	11.9	12.2
1.0100	11.9	12.0	12.2	12.3	12.4	12.6	12.8	13.1	13.2	13.5
1.0110	13.2	13.4	13.5	13.6	13.7	13.9	14.1	14.4	14.5	14.8
1.0120	14.5	14.7	14.8	14.9	15.0	15.2	15.4	15.7	15.8	16.1
1.0130	15.8	15.8	16.0	16.2	16.3	16.5	16.7	17.0	17.1	17.4
1.0140	17.0	17.1	17.3	17.5	17.7	17.8	18.0	18.3	18.6	18.7
1.0150	18.3	18.4	18.6	18.8	19.0	19.1	19.3	19.6	19.9	20.0
1.0160	19.6	19.7	19.9	20.1	20.3	20.4	20.6	20.9	21.2	21.3
1.0170	20.9	21.0	21.2	21.3	21.6	21.7	22.0	22.2	22.5	22.7
1.0180	22.2	22.3	22.5	22.6	22.9	23.0	23.3	23.5	23.8	24.0
1.0190	23.5	23.6	23.8	23.9	24.2	24.3	24.6	24.8	25.1	25.3
1.0200	24.7	24.8	25.1	25.2	25.5	25.6	25.9	26.1	26.4	26.6
1.0210	26.0	26.1	26.4	26.5	26.8	26.9	27.2	27.4	27.7	27.9
1.0220	27.3	27.4	27.7	27.8	28.1	28.2	28.5	28.7	29.0	29.2
1.0230	28.6	28.7	28.9	29.1	29.4	29.5	29.8	30.0	30.3	30.6
1.0240	29.9	30.0	30.2	30.4	30.6	30.8	31.1	31.3	31.6	31.9
1.0250	31.1	31.3	31.5	31.7	31.9	32.1	32.4	32.6	32.9	33.2
1.0260	32.4	32.6	32.8	33.0	33.2	33.4	33.7	33.9	34.2	34.5
1.0270	33.7	33.9	34.1	34.3	34.5	34.7	35.0	35.2	35.5	35.8
1.0280	35.0	35.1	35.4	35.6	35.8	36.0	36.3	36.5	36.8	37.1
1.0290	36.3	36.4	36.7	36.8	37.1	37.3	37.6	37.8	38.1	38.4
1.0300	37.6	37.7	38.0	38.1	38.4	38.6	38.9	39.1	39.4	39.7
1.0310	38.9	39.0	39.3	39.4	39.7	39.9	40.2	40.5	40.7	41.0

Table 1. Salinity in parts per thousand (ppt)

NOTE: This table is designed for use with 60°/60°F hydrometer.

Observed	Temperature of Water in Graduated Cylinder (°C)									
Reading	18.5	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.5	23.0
0.9990							0.0	0.1	0.2	0.3
1.0000	0.5	0.6	0.7	0.8	1.0	1.1	1.2	1.4	1.5	1.6
1.0010	1.8	1.9	2.0	2.1	2.3	2.4	2.5	2.5	2.7	2.8
1.0020	3.1	3.2	3.3	3.4	3.6	3.7	3.8	4.0	4.1	4.2
1.0030	4.4	4.5	4.6	4.8	4.9	5.0	5.1	5.3	5.4	5.5
1.0040	5.7	5.8	5.9	6.1	6.2	6.3	6.4	6.6	6.7	7.0
1.0050	7.1	7.1	7.2	7.4	7.5	7.6	7.7	7.9	8.1	8.3
1.0060	8.4	8.5	8.7	8.8	8.9	9.1	9.2	9.3	9.4	9.6
1.0070	9.7	9.8	10.0	10.1	10.2	10.4	10.5	10.6	10.7	10.9
1.0080	11.0	11.1	11.3	11.4	11.5	11.7	11.8	11.9	12.0	12.2
1.0090	12.3	12.4	12.6	12.7	12.8	13.0	13.1	13.2	13.4	13.6
1.0100	13.6	13.7	13.9	14.0	14.1	14.3	14.4	14.5	14.8	14.9
1.0110	14.9	15.0	15.2	15.3	15.4	15.6	15.7	16.0	16.1	16.2
1.0120	16.2	16.3	16.5	16.6	16.7	17.0	17.1	17.3	17.4	17.5
1.0130	17.5	17.7	17.8	17.9	18.0	18.3	18.4	18.6	18.7	18.8
1.0140	18.8	19.0	19.1	19.3	19.5	19.6	19.7	19.9	20.0	20.1
1.0150	20.1	20.4	20.5	20.6	20.8	20.9	21.0	21.2	21.3	21.6
1.0160	21.4	21.7	21.8	22.0	22.1	22.2	22.3	22.5	22.7	22.9
1.0170	22.9	23.0	23.1	23.3	23.4	23.5	23.6	23.8	24.0	24.2
1.0180	24.2	24.3	24.4	24.6	24.7	24.8	24.9	25.2	25.3	25.5
1.0190	25.5	25.6	25.7	25.9	26.0	26.1	26.4	26.5	26.6	26.8
1.0200	26.8	26.9	27.0	27.2	27.3	27.4	27.7	27.8	27.9	28.2
1.0210	28.1	28.2	28.3	28.5	28.6	28.9	29.0	29.1	29.2	29.5
1.0220	29.4	29.5	29.6	29.8	30.0	30.2	30.3	30.4	30.7	30.8
1.0230	30.7	30.8	30.9	31.2	31.3	31.5	31.6	31.7	32.0	32.1
1.0240	32.0	32.1	32.2	32.5	32.6	32.8	32.9	33.2	33.3	33.4
1.0250	33.3	33.4	33.7	33.8	33.9	34.1	34.2	34.5	34.6	34.7
1.0260	34.6	34.7	35.0	35.1	35.2	35.4	35.6	35.8	35.9	36.0
1.0270	35.9	36.2	36.3	36.4	36.5	36.7	36.9	37.1	37.2	37.5
1.0280	37.2	37.5	37.6	37.7	37.8	38.1	38.2	38.4	38.5	38.8
1.0290	38.6	38.8	38.9	39.0	39.1	39.4	39.5	39.7	39.9	40.1
1.0300	39.9	40.1	40.2	40.3	40.6	40.7	40.8	41.0	41.2	41.4
1.0310	41.2	41.4	41.5	41.8	41.9	42.0	42.1	42.3	42.5	

Table 1. Salinity in parts per thousand (ppt)

NOTE: This table is designed for use with 60°/60°F hydrometer.

Observed	Temperature of Water in Graduated Cylinder (°C)									
Reading	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0
0.9980							0.1	0.2	0.3	0.6
0.9990	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.5	1.8	1.9
1.0000	1.8	1.9	2.0	2.1	2.4	2.5	2.7	2.9	3.1	3.2
1.0010	2.9	3.1	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.5
1.0020	4.4	4.6	4.8	4.9	5.0	5.1	5.4	5.5	5.7	5.9
1.0030	5.8	5.9	6.1	6.2	6.3	6.6	6.7	6.8	7.1	7.2
1.0040	7.1	7.2	7.4	7.5	7.7	7.9	8.0	8.3	8.4	8.5
1.0050	8.4	8.5	8.7	8.9	9.1	9.2	9.3	9.6	9.7	10.0
1.0060	9.7	9.8	10.1	10.2	10.4	10.5	10.7	10.9	11.0	11.3
1.0070	11.0	11.3	11.4	11.5	11.7	11.9	12.0	12.2	12.4	12.6
1.0080	12.4	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.7	13.9
1.0090	13.7	13.9	14.0	14.1	14.4	14.5	14.7	14.9	15.0	15.3
1.0100	15.0	15.2	15.3	15.6	15.7	15.8	16.1	16.2	16.5	16.6
1.0110	16.3	16.5	16.7	16.9	17.0	17.3	17.4	17.5	17.8	17.9
1.0120	17.7	17.9	18.0	18.2	18.3	18.6	18.7	19.0	19.1	19.3
1.0130	19.1	19.2	19.3	19.5	19.7	19.9	20.0	20.3	20.4	20.6
1.0140	20.4	20.5	20.6	20.9	21.0	21.2	21.4	21.6	21.8	22.0
1.0150	21.7	21.8	22.0	22.2	22.3	22.5	22.7	22.9	23.1	23.3
1.0160	23.0	23.3	23.4	23.5	23.6	23.9	24.0	24.3	24.4	24.7
1.0170	24.3	24.6	24.7	24.8	25.1	25.2	25.3	25.6	25.7	26.0
1.0180	25.6	25.9	26.0	26.1	26.4	26.5	26.8	26.9	27.2	27.3
1.0190	27.0	27.2	27.3	27.6	27.7	27.8	28.1	28.2	28.5	28.6
1.0200	28.3	28.5	28.6	28.9	29.0	29.2	29.4	29.6	29.8	30.0
1.0210	29.6	29.8	30.0	30.2	30.3	30.6	30.7	30.9	31.1	31.3
1.0220	30.9	31.2	31.3	31.5	31.7	31.9	32.0	32.2	32.5	32.6
1.0230	32.2	32.5	32.6	32.8	33.0	33.2	33.4	33.5	33.8	33.9
1.0240	33.7	33.8	33.9	34.2	34.3	34.5	34.7	35.0	35.1	35.4
1.0250	35.0	35.1	35.2	35.5	35.6	35.9	36.0	36.3	36.4	36.7
1.0260	36.3	36.4	36.7	36.8	36.9	37.2	37.3	37.6	37.7	38.0
1.0270	37.6	37.8	38.0	38.1	38.4	38.5	38.8	38.9	39.1	39.3
1.0280	38.9	39.1	39.3	39.4	39.7	39.8	40.1	40.2	40.5	40.7
1.0290	40.2	40.5	40.6	40.8	41.0	41.2	41.4	41.6	41.8	
1.0300	41.6	41.8	41.9							
1.0310										

Table 1. Salinity in parts per thousand (ppt)

NOTE: This table is designed for use with 60°/60°F hydrometer.

Observed	Temperature of Water in Graduated Cylinder (°C)									
Reading	28.5	29.0	29.5	30.0	30.5	31.0	31.5	32.0	32.5	33.0
0.9980	0.7	0.8	1.1	1.2	1.5	1.6	1.9	2.0	2.3	2.4
0.9990	2.0	2.3	2.4	2.5	2.8	2.9	3.2	3.4	3.6	3.8
1.0000	3.4	3.6	3.7	4.0	4.1	4.4	4.5	4.8	4.9	5.1
1.0010	4.8	4.9	5.1	5.1	5.4	5.5	5.8	5.9	6.2	6.4
1.0020	6.1	6.3	6.4	6.6	6.8	7.0	7.2	7.5	7.6	7.9
1.0030	7.4	7.6	7.7	8.0	8.1	8.4	8.5	8.8	9.1	9.2
1.0040	8.8	8.9	9.2	9.3	9.6	9.7	10.0	10.1	10.4	10.5
1.0050	10.1	10.2	10.5	10.6	10.9	11.0	11.3	11.5	11.7	11.9
1.0060	11.4	11.7	11.8	12.0	12.2	12.4	12.6	12.8	13.1	13.2
1.0070	12.8	13.0	13.1	13.4	13.6	13.7	14.0	14.1	14.4	14.7
1.0080	14.1	14.3	14.5	14.7	14.9	15.2	15.3	15.6	15.7	16.0
1.0090	15.4	15.7	15.8	16.1	16.2	16.5	16.6	16.9	17.1	17.3
1.0100	16.7	17.0	17.1	17.4	17.5	17.8	18.0	18.2	18.4	18.7
1.0110	18.2	18.3	18.6	18.7	19.0	19.1	19.3	19.6	19.7	20.0
1.0120	19.5	19.6	19.9	20.1	20.3	20.5	20.6	20.9	21.2	21.3
1.0130	20.8	21.0	21.2	21.4	21.6	21.8	22.1	22.2	22.5	22.7
1.0140	22.2	22.3	22.6	22.7	23.0	23.1	23.4	23.6	23.8	24.0
1.0150	23.5	23.6	23.9	24.0	24.3	24.6	24.7	24.9	25.2	25.3
1.0160	24.8	25.1	25.2	25.5	25.6	25.9	26.1	26.3	26.5	26.8
1.0170	26.1	26.4	26.5	26.8	27.0	27.2	27.4	27.7	27.8	28.1
1.0180	27.6	27.7	27.9	28.1	28.3	28.5	28.7	29.0	29.2	29.4
1.0190	28.9	29.0	29.2	29.5	29.6	29.9	30.0	30.3	30.6	30.8
1.0200	30.2	30.4	30.6	30.8	30.9	31.2	31.5	31.6	31.9	32.1
1.0210	31.5	31.7	32.0	32.1	32.4	32.5	32.8	33.0	33.3	33.4
1.0220	32.9	33.0	33.3	33.4	33.7	33.9	34.1	34.3	34.6	34.8
1.0230	34.2	34.5	34.6	34.8	35.0	35.2	35.5	35.6	35.9	36.2
1.0240	35.5	35.8	35.9	36.2	36.4	36.5	36.8	37.1	37.2	37.5
1.0250	36.8	37.1	37.2	37.5	37.7	37.8	38.1	38.4	38.6	38.8
1.0260	38.2	38.4	38.6	38.8	39.0	39.3	39.4	39.7	39.9	40.2
1.0270	39.5	39.8	39.9	40.2	40.3	40.6	40.8	41.0	41.2	41.5
1.0280	40.8	41.1	41.2	41.5						

DISSOLVED OXYGEN

Discussion

Dissolved oxygen (DO) is one of the most important indicators of the quality of water for aquatic life. It is essential for all plants and animals inhabiting the Bay. When oxygen levels in the water fall below about 3-5 parts per million (ppm), fish and many other aquatic organisms cannot survive. Oxygen is a particularly sensitive constituent because chemicals present in the water, biological processes, and temperature exert a major influence on its availability during the year.

A DO test (using kit or meter) measures how much oxygen is dissolved in the water, but it does not tell your how much dissolved oxygen the water is capable of holding at the temperature at which it was tested. When water holds all the DO it can hold at a given temperature, it is said to be 100 percent saturated with oxygen. The warmer the water is, the less DO it can hold, and the colder the water, the more DO it can hold. Table 2 shows this relationship at various temperatures.

Oxygen is transferred from the atmosphere into the surface waters by the aerating action of the wind. It is also added at or near the surface as a byproduct of plant photosynthesis. As a result, floating and rooted aquatic plants increase DO levels. Since the existence of plants also depends on the availability of light, the oxygen-producing processes occur only near the surface or in shallow waters. Oxygen levels may be reduced because the water is too warm (e.g., near a power plant) or because there are too many bacteria or aquatic organisms in the area. When algae growth is excessive, as in a "bloom," the upper levels of algae can shade the light to lower levels, causing fish kills, death of other organisms, and bad smells. Also, at night all photosynthesis stops and the algae respire (i.e., breathe). This uses up available oxygen supplies and the algae can suffocate, die, and decay.

While the overall oxygen content in the water is important in assessing the health of a water body, it is also useful to look at DO in terms of "percent saturation." Percent saturation is the ratio of oxygen concentration that is in the water compared to the oxygen concentration that could be in the water, at a given temperature and salinity. One might expect that the highest obtainable percent saturation value to be 100 percent; however, "supersaturation" (i.e., values greater than 100 percent) can occur under certain conditions. Very high concentrations of oxygen are possible in areas with a great deal of aquatic vegetation (i.e., oxygen production through photosynthesis), or in areas with strong wind and wave action (i.e., addition of oxygen through "entrainment" of atmospheric oxygen into the water).

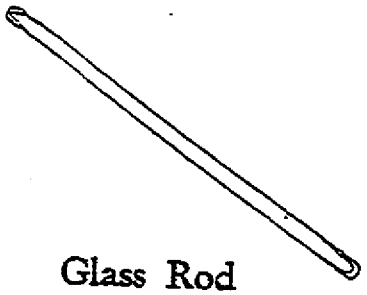
Table 2: Solubility of Dissolved Oxygen in Fresh Water (at 100% Saturation)

Temperature (^{0}C)	Solubility Mg/L (ppm)*	Temperature (^{0}C)	Solubility Mg/L (ppm)*
0	14.6	16	10.0
1	14.2	17	9.8
2	13.8	18	9.6
3	13.5	19	9.4
4	13.1	20	9.2
5	12.8	21	9.0
6	12.5	22	8.9
7	12.2	23	8.7
8	11.9	24	8.6
9	11.6	25	8.4
10	11.3	26	8.2
11	11.1	27	8.1
12	10.9	28	7.9
13	10.6	29	7.8
14	10.4	30	7.7
15	10.2		

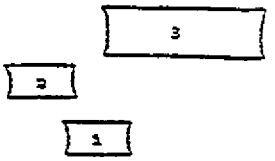
*100% saturation

As shown above in Table 2, the amount of dissolved oxygen in the water varies greatly. It depends not only upon temperature, but on conditions such as photosynthesis, wind, light, algae blooms, etc. Very low readings (under 4 ppm) should be rechecked. Very high readings above those in Table 2 at a given temperature may indicate supersaturated levels of dissolved oxygen. These should be rechecked too. If confirmed by a second reading, such supersaturated levels may be indicated by high wind or very sunny conditions, combined with large amounts of live plant material,

DISSOLVED OXYGEN EQUIPMENT

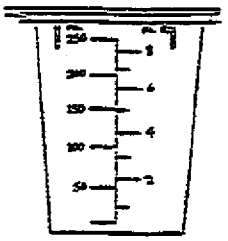


Glass Rod

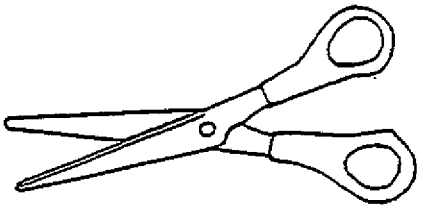


Chemical Pillows

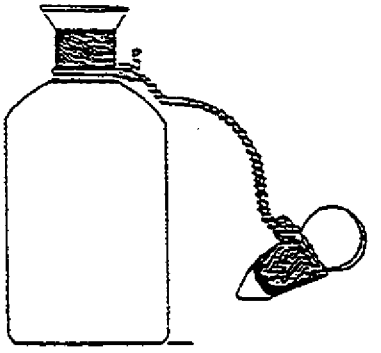
Dropper Bottle



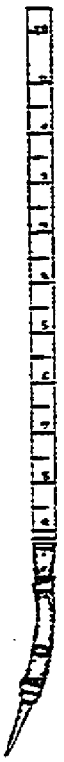
Plastic Beaker



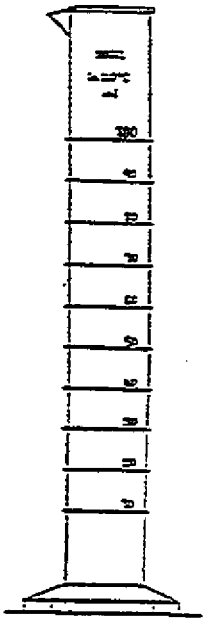
Pillow Cutter



BOD Bottle



Graduated Buret



100 ml Graduated Cylinder

Required Equipment:

- 2 graduated burettes
- 2 glass rods
- 2 glass marbles
- 2 BOD bottles (glass) and stoppers
- 1 100 ml graduated cylinder
- 1 box manganese sulfate pillows
- 1 box iodide-azide pillows
- 1 pair scissors or clippers
- 1 bottle starch solution
- 1 bag of sulfamic acid pillows
- 1 bottle sodium thiosulfate
- 1 plastic beaker

Dissolved Oxygen Procedure:

1. Release clamp, empty the tubing of bubbles, and insert flow tube from sample bucket into bottle, all the way to the bottom of bottle. Keep track of the amount of time it takes to fill the bottle to the point of overflow (counting as it fills will be fine), and allow enough time for the bottle to have filled three times. Remove the flow tube from the BOD slowly before stopping the flow of water. (This ensures the BOD is full to the brim.) Replace glass stopper if carrying sample away from water's edge to do the procedure.

2. Examine sample to make sure no bubbles are trapped inside. Once a satisfactory sample has been collected, proceed to steps 3, 4, and 5.

   NOTE: Be careful not to introduce air into the sample while adding the reagents in steps 3 and 4 below. Simply drop the reagents into the test sample, cap carefully, and mix gently.

3. Cut open the manganese sulfate powder **(pillow #1)** and add to sample.

4. Cut open the alkaline iodide-azide powder **(pillow #2)** and add to sample.

5. Carefully add a small marble to the bottle before replacing the stopper. Replace stopper, twist 1/4 turn to get a good seal, and place finger on top to hold it on bottle. Invert bottle gently several times to mix reagents with water. A precipitate will form. Place sample aside and allow precipitate to settle to bottom half of bottle. Gently invert bottle to mix and allow to settle again.

   NOTE: Addition of the marble in step 5 has two benefits: First, "topping off" the level of the liquid in the bottle eliminates the air bubble that sometimes forms between the liquid and the stopper. Second, the marble helps to mix in the powered reagents when the bottle is shaken. The marble should be clean and should be added gently to prevent the possibility of introducing air into the bottle.

After finishing step 5, go on to your other tests while the sampling is settling. Now that step 5 is complete, contact between the water sample and the atmosphere will not affect the test result. Once the sample has been "fixed" in this manner, it is not necessary to perform the actual test procedure immediately. Thus, several samples can be collected and "fixed" in the field, and then carried back to a testing station or laboratory where the titration procedure is to be performed. (Make certain samples are kept cool if titrating later.)

COMPLETE STEPS 6-13 BELOW WITHIN 1 HOUR

6. Cut open the sulfamic acid (**pillow # 3**) and add to sample. Replace stopper and invert gently several times to mix until precipitate and chemical beads have dissolved. A clear yellow to brown-orange color will develop, depending on the oxygen content of the sample.

7. Pour 100 ml of the sample carefully into a clean graduated cylinder. Tilt the cylinder and pour the sample carefully down the inside wall to avoid mixing bubbles into the sample. Then pour the sample from the cylinder into the test beaker, again, carefully pouring down the inside of the beaker.

8. Fill burette to above the zero mark with sodium thiosulfate titrant, and clear bubbles out of burette. (Make sure liquid fills burette from tip to the zero mark.) Refill to zero mark.

9. Add sodium thiosulfate titrant to sample slowly, stirring as titrant is added. Stop titrating when yellow-brown solution in beaker begins to lighten to a light hay color. (White paper under beaker is used to watch color change.)

10. Add 8 drops of starch solution to beaker. Sample will turn a dark blue color.

11. Now continue the titration process with the sodium thiosulfate remaining in the burette until sample beaker becomes clear. Do not add any more titrant than is necessary to produce the color change. Be sure to stir sample after each drop is added.

12. Using the scale on the side of the burette, count the total number of ml used in the titration. Enter this number in the space provided on your data sheet.

13. Rinse out the beaker, refill burette to zero mark, and repeat steps 7 through 12 on a second sample.

14. Record results of the second titration in the space provided on data sheets.

15. Add the results of both titrations (ml = mg/L) and enter the value on the data sheet.

NOTE: These duplicate titrations are run to guard against errors in analyses. If the DO result in the second titration is 0.3 ml (0.6 mg/L) different than the first titration, you should do a third titration. Record all three results. (Note: If 100ml of the sample do not remain for the third titration, use 50 ml and double the result.)

Once the DO testing has been completed, make sure BOD bottles are rinsed out thoroughly.

Also make sure glass marbles are cleaned and stored so they do not get lost.

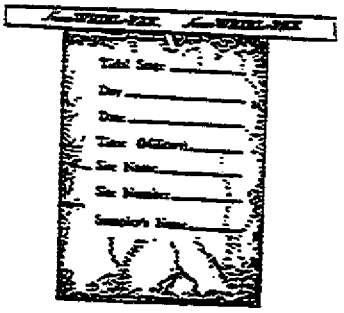
FECAL COLIFORM

Discussion

Fecal coliform bacteria are used as an indicator of human sewage pollution. While fecal coliforms are found in the feces of all warm-blooded animals, their presence is taken to mean that other, more dangerous bacteria are present. Their presence in high numbers can indicate pollution from improperly treated sewage effluent, waste discharges from boats, improperly functioning or failed septic systems, untreated urban storm water, runoff from agricultural operations, feces from wildlife, or other sources. New Hampshire water quality standards for tidal waters use another kind of bacteria (i.e., enterococci) to determine if waters are safe for swimming. State standards for tidal shellfish waters, however, do specify acceptable levels of fecal coliforms. While direct application of shellfish water standards to GBCW data would not be appropriate, these standards can be used to give a general sense of contamination in the estuary. Fecal coliform tests are performed using the membrane filtration (plate count) method.

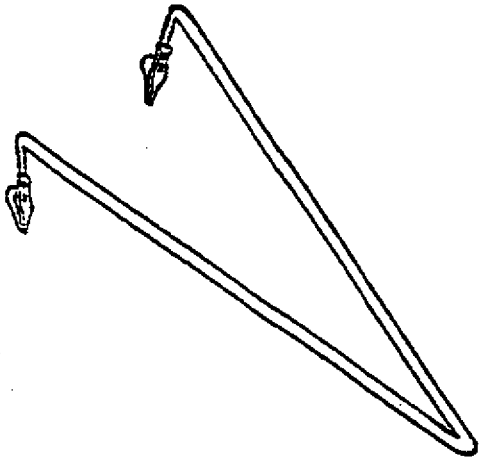
Equipment:

BLACK PERMANENT MARKER

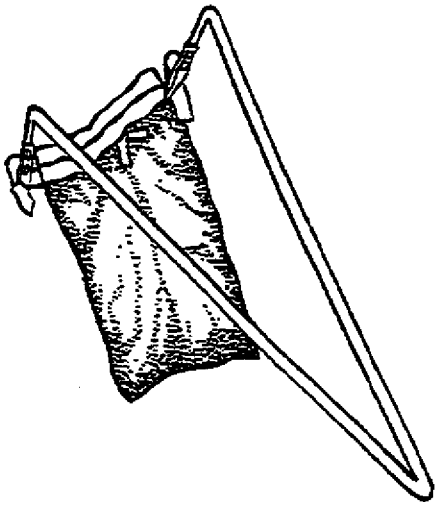


STERILE COLLECTING BAG

(Whirl-Pak)



COLLECTING TONGS



Additional equipment (not pictured) : Cooler and Cold pack

Required Equipment:

- Petri dishes, sterile
- Sampling bags
- Marking pen
- Coliform record sheet
- Cool packs/ cooler
- Sampling tongs
- Spray disinfectant
- Water bath incubator
- Distilled water
- Filtration flask
- Base with stopper
- Aluminum foil
- Labeling tape
- Alcohol
- Phosphate buffer
- Absorbent filter pads
- Membrane filters
- Ampules of growth medium
- Sterile pipettes (10ml and 1 ml)
- Automatic pipetter
- Oil lamp/candle
- Tissues
- UV sterilizer
- Filter funnel
- Filter forceps
- Autoclave tape
- Vacuum pump

Fecal Coliform Procedure:

A. Preparation (in the lab):

1. Label sampling bags and the bottom of the Petri dishes (the smaller inner diameter plate) with a permanent marking pen. Identify the sample site, date and tide on lab tape.

2. Record the label information on the coliform record sheet.

3. Freeze two cool packs.

4. Check the incubator temperature

5. Make sure that all of filtration equipment and a sufficient supply of Petri dishes are sterilized in an autoclave or other stream sterilizer device. The UV bulb should be cleaned with ethanol at least every month. First, place the support stand in the bottom of the sterilizer and make sure that there is two inches of water. Wrap all the items to be sterilized in aluminum foil, stick a piece of autoclave tape on it, and place into the bucket. Place the bucket in the sterilizer with the exhaust channel on the right hand side. Make sure there is a thin layer of petroleum jelly along the beveled edge of the lid. This will ensure a tight seal on the sterilizer. The petroleum jelly should be applied every three to four times the sterilizer is used. Place the lid on the sterilizer by feeding the steam exhaust tube into the exhaust channel of the bucket. Twist the lid so that the engraved marks on the lid and the sterilizer meet. Tighten the lock nuts, two at a time (opposite from each other), to make a tight seal. Put the exhaust valve in open or vertical position. Turn the power switch on.

   Once stream begins to escape from the exhaust valve (after about 20 minutes), it is necessary to wait five minutes to allow the "cold zones" to be flushed out of the sterilizer. Close the exhaust valve by putting it in the horizontal position. When the pressure gauge reads 17 PSI,

it is sterilizing. It must sterilize for at least 35 minutes at this point to completely sterilize the items. After the time is up, just turn the sterilizer off and let the pressure release by carefully lifting the exhaust valve. Use hotpad to release valve.

B. Collecting the sample (at the sample site):

1. Make sure the bag is labeled properly with a medium tip permanent marker: Sample Site Number, Site Name, Date, Day, Time of Sample, Tidal Stage, and Sampler's Name.

2. Attach the alligator clips of the tongs to the metal tabs of the sterile sampling bag. Curl tab over and pinch clips to secure bag to the tongs. Note: The use of gloves here is optional. Finally, tug bottom of bag to make certain the bag is securely held.

3. Remove top of bag perforation strip. Be sure the bag is secure on the clips. **IMPORTANT: Do not touch the bag opening with fingers, or gloves as this will contaminate the sample. Also DO NOT touch the mouth or inside of the bag!**

4. Plunge the bag into the water to a depth of about 12 inches. Use your other hand to support the bottom of the bag, to ease the weight off the tabs.

5. Open the bag now by releasing the handles apart, and fill the bag. Close the bag when returning to the surface.

6. Immediately remove the filled bag from the water and pinch the bottom of the bag to ensure an air space over the surface of the water. (You want the bag to be about 2/3 full.)

7. Now spin the bag over itself several times, so that water will not leak out. Finally, remove the clips and twist the metal tabs together in the shape a bracelet. This helps prevent the sharp ends from puncturing other samples.

8. Refrigerate the samples in a cooler with a cold pack. Bring samples to Kingman Farm before 6:00 p.m. on the day of sampling. If you need the sample picked up, please call Ann at Kingman Farm (749-1565), or at home (749-3880).

9. Ideally, samples should be processed within one hour. If this is not possible the samples may be refrigerated below 10 degrees C and stored for up to six hours.

10. To review this procedure you may borrow the Processing Fecal Coliform video.

C. Processing the sample (in the lab):

1. Check the incubator temperature. It should be 44.5 (± 0.2) degrees C.

2. Disinfect the working surface with Lysol spray disinfectant or alcohol. Wash your hands.

3. UV-sterilize all filtration equipment for at least ten minutes. The filtration apparatus should be placed in the UV-sterilizer with the inside of the funnel facing towards the bulb. Place the filter funnel base into the flask.

4. To begin processing the sample, remove the cover of the Petri dish and pack up side down on the lab surface. **It is important to make sure that you do not touch the inside of the Petri dish at any time**. Place a sterile absorbent pad aseptically into the bottom of the Petri dish, by using the sterile pad dispenser. Twist the cap off the plastic ampule. Then squeeze the nutrient medium onto the absorbent pad. NOTE: It is not necessary to get every drop of the medium.

5. Sterilize a pair of forceps by dipping them open into a container of alcohol and then flaming them. Using a pair of sterile forceps, place a membrane filter on the steel support of the filtration assembly. Keep the filter flat, grid side up, and discard the blue protective paper. Place the funnel over the filter. Rinse a little buffer solution into the funnel and allow it to drip into the glass base. Check for leaks. If there is a leak, remove the funnel and reattach. For the first run (as a blank), simply filter a bottle of buffer solution to test the setup for possible contamination.

6. Shake the bag containing the sample 20-30 times to thoroughly mix. Open the sample bag and pipette the desired dilution amount into a fresh bottle of buffer solution. Slowly pour the diluted sample into the filter funnel.

7. Filter the sample using a vacuum pump or hand pump. When the water is completely filtered, rinse the inside of the funnel with a new bottle of phosphate buffer solution. This ensures that all of the coliform washes onto the filter.

8. Use alcohol to sterilize forceps before lifting membrane from filter. After lifting the funnel, remove the membrane filter from the support with sterile forceps. Place the filter to the absorbent pad in the Petri dish grid side up. NOTE: The filter should be placed on the pad using a "rolling action", touching one end first and proceeding to the other side. Be careful to avoid trapping air bubbles under the membrane. Remember to replace the Petri dish cover. After replacing the cover to the Petri dish, tap the bottom of the dish to get the nutrient medium to go into the membrane.

9. Between site samples, UV-sterilize the funnel, filter, and forceps for three minutes.

10. To process the next sample, rinse the bottom of the funnel with sterile phosphate buffer. Clean the steel support and funnel with alcohol. Wipe excess water from the steel support with a tissue. Wash your hands between each sample.

11. Filter a sample of buffer at the end of a series of samples as a negative control. Other controls might be duplicating a sample or performing split samples with another filtering location. Run a blank filtration of buffer in the middle of the testing. This will allow for the data before the middle test to be valid in case the end control came up positive. Also, to ensure

quality, a second filtration must be performed for 10% of the samples (evenly distributed) in order to ensure that results can be replicated.

12. Enclose the Petri dishes in a tightly closed and labeled Whirlpak bag. You may place up to four dishes in a bag (stacked two on top of each other, two deep).

13. Once a series of samples has been filtered and the Petri dishes bagged, slide the bags into the Petri dish rack. Make sure that the Petri dishes are placed upside down. This is so that the condensation that forms does not ruin the sample. Submerse the rack in a water incubator set exactly at 44.5 degrees C and let the samples incubate for 24 hours.

14. After 24 hours (+/- two hours), remove the dishes and count the number of colonies with a blue, metallic sheen which have grown on the filter paper. Use a dissecting microscope set at 10X if available. This count gives an approximation of the number of fecal coliform bacteria in 100 mL of water.

15. For each sample, record the number of colonies per 100 ml sample on the data sheet. To do this use this formula:

$$\frac{(\text{\# of colonies}) \times (100\text{ml})}{\text{\# of ml used in sample}} = \text{colonies/100ml}$$

16. When you are finished counting the colonies, sterilize the Petri dishes for 35 minutes. Dispose of filters or refrigerate for later viewing.

17. After sterilizing the Petri dishes, dispose of the pad and filter properly, wash in plain hot water.

D. Troubleshooting the process (some helpful hints):

1. If there is a ring around the filter, you probably did not have the filtration assembly closed properly.

2. If colonies do not look rounded, the water was not completely filtered.

3. There might be some other colonies present on the filter besides the blue colonies with the metallic sheen. (These other colonies are most likely to be yellow.) That's OK – they are bacteria other than fecal coliform bacteria. However, do not include them in your count on the data sheet.

4. The accepted range for colonies to be counted on a membrane filter is 20-80 colonies. If you have more than 200 colonies, use a smaller dilution or write TNTC (i.e., Too Numerous To Count) on the data sheet.

Table 3: Suggested Sample Volumes for Membrane Filter Fecal Coliform Test (taken from "Standard Methods")

Water Source	Volume To Be Filtered (ml)						
	100	50	10	1	0.1	0.01	0.001
Lakes, reservoirs	X	X					
Wells, spring	X	X					
Water supply intake		X	X	X			
Natural bathing waters		X	X	X			
Sewage treatment plant			X	X	X		
Farms, ponds, rivers				X	X	X	
Storm water runoff				X	X	X	
Raw municipal sewage					X	X	X
Feedlot runoff					X	X	X

Great Bay Watch Fecal Coliform Data

Sample processed by: _____ Date: _____ ← Incubator Temperature: _____
Examined by: _____ Date: _____ ← Incubator Temperature: _____
_____

Site #	Site Name:	Sampler Name:	Time of Sample:	Tidal Stage:	Dilution:	Fecal Coli. Count:	/100ml Count:	Other Colonies:	Incubate Times: IN:	OUT:	Comments:

5/24/93

GREAT BAY COAST WATCH TIP SHEET

WATER TEMP:

- Make sure thermometer is in water for at least three minutes. Read it while it is still in the water.
- Read the thermometer while it is straight up and down.

DISSOLVED OXYGEN:

- Make sure the tube is touching bottom of the BOD bottle when decanting water from the bucket?
- Did you count the seconds it takes to fill the bottle and then let it overflow twice more?
- Did you remove the tube slowly while still flowing?
- Is the bottle full after removing the tube?
- Add pillow #1, followed by pillow #2 - then stopper the bottle. Was the bottle agitated properly?
- Are there air bubbles trapped inside? (Start over if there are.)

pH:

- Is calibration correct?
- Are the bottles in order?
- Have you remembered to bring a container of fresh water?
- Are the buffer bottles filled?
- Did you remove black cap from the meter to measure the pH?
- Did you throw out the rinse buffer after sampling is completed, and then clean and dry bottles?
- After testing is done, did you follow directions for refilling the "test buffer" bottle?

SALINITY:

- Did you fill below the lip on the hydrometer jar?
- Did you put thermometer and hydrometer into the cylinder at the same time?
- Did you wait three minutes to read the thermometer?
- Did you remove the thermometer before trying to read the hydrometer?
- Did you read from the bottom of the meniscus in reading the hydrometer?
- Did you use chart on the field data sheet to mark the water line?
- Did you use the temp chart and salinity conversion charts correctly?

BACK TO D.O. TEST:

- Did you add the third pillow and make sure grains are dissolved?
- Did you pour down the side of the cylinder rather than dumping water in?
- Did you fill burette to zero?
- Did you clear the bubbles?
- Did you add titrant carefully and stir?
- Did you add eight drops of starch?
- Is the color completely clear?
- Did you do the test twice?

DID YOU CLEAN AND DRY THE EQUIPMENT?

DID YOU PUT ALL EQUIPMENT AWAY PROPERLY!

REFERENCES

1. New Hampshire Office of State Planning, Linda Maxson, Jackson Estuarine Laboratory. 1989. ***Great Bay National Estuarine Research Reserve Management Plan***. Page 7.

2. Ibid.

3. Anne Arundel County, Office of State Planning and Zoning, Annapolis, Maryland. ***1986 Citizen Monitoring Water Quality Monitoring Manual***. Pages 3, 4, intro.

4. Ibid. NHOSP.

5. Maine/New Hampshire Sea Grant Marine Advisory Program and University of Maine; Orono, Maine. Nov. 1992. ***Clean Water: A Guide to Water Quality Monitoring***. Pages 47, 48, 49.

6. New Hampshire Estuaries Project, 152 Court Street, Portsmouth, NH 03801. 2000. ***New Hampshire Estuaries Project Management Plan.*** Appendix 2, "State of the Estuaries."

APPENDICES

Great Bay Coast Watch 1990-1999

A Ten Year Report on the Volunteer Water Quality Monitoring of the Great Bay Estuarine System

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GREAT BAY COAST WATCH

UNH COOPERATIVE EXTENSION/SEA GRANT

13th Sampling Season for Great Bay Coast Watch

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Dates to Remember 2002:

February			
11	M	1-4:30PM	Gathering GBCW Secchi/Valentine's
March			
6	W	7:00-8:30 PM	GBCW Annual Meeting @ NH Fish and Game **Speaker: Rob Roseen** **Topic:** Groundwater Discharge and Nutrient Loading to the Great Bay Estuary
12	T	5:00-7:00 PM	Phytoplankton Training
20	W	5:00-7:00 PM	Training New volunteers
27	W	5:00-7:00 PM	Training New volunteers
April			
3	W	5:00-7:00 PM	GBCW Monthly Meeting
17 & 18		12:00 – 5:00 PM	Quality Control Quality Assurance *Sign up for a 1.5 hr. session*
29	M	All Day	Sampling (1st sampling of 13th season)
May			
8	W	5:00-7:00 PM	GBCW Monthly Meeting
28	T	All Day	Sampling

June

5	W	5:00-7:00 PM	GBCW Monthly Meeting
25	T	All Day	Sampling

July

17 or 18th		5:00-8:00PM	BBQ— and joint meeting of Great Bay Stewards— Great Bay Coast Watch and the Great Bay Wildlife Refuge
22-26	Week		National Marine Educators Association (NMEA) 2002 Conference in Connecticut
25	Th	All Day	Sampling

August

7 or 8		12:00 - 5:00 PM	"QAQC" Quality Assurance Quality Control *Sign up for a 1.5 hr. session*
26	M		Sampling

September

4	W	5:00-7:00 PM	GBCW Monthly Meeting
21	S	Low Tide	Coastal Cleanup
23	M	All Day	Sampling

October

2	W	5:00-7:00 PM	GBCW Monthly Meeting
18	F	All Day	30th Anniversary Clean Water Act Special water quality Sampling projects
22	T	All Day	Sampling

November

6	W	All Day	Sampling
13 or 14		6:00 – 9:00 PM	Chili and Chowdah

December

5 & 6	Th & F		Kit Clean-Up and Inventory
12	Th	10:00 – 3:00 PM	Docent Holiday Lunch

Tidal and Sampling Times for 2002 Season

		Adjustment	29-Apr	28-May	25-Jun	25-Jul	26-Aug	23-Sep	22-Oct	06-Nov
	LOW		7:28	7:11	6:08	6:38	8:02	6:53	6:19	5:22
	HIGH		13:44	13:28	12:23	12:52	14:12	13:02	12:27	11:35
Site 1	LOW	1:50	**9:18**	**9:01**	**7:58**	**8:28**	**9:52**	**8:43**	**8:09**	**7:12**
Peninsula - Oyster River	HIGH	1:45	**15:29**	**15:13**	**14:08**	**14:37**	**15:57**	**14:47**	**14:12**	**13:20**
Site 2	LOW	2:00	**9:28**	**9:11**	**8:08**	**8:38**	**10:02**	**8:53**	**8:19**	**7:22**
Jackson Laboratory	HIGH	2:00	**15:44**	**15:28**	**14:23**	**14:52**	**16:12**	**15:02**	**14:27**	**13:35**
Site 3	LOW	3:00	**10:28**	**10:11**	**9:08**	**9:38**	**11:02**	**9:53**	**9:19**	**8:22**
Lamprey River	HIGH	2:40	**16:24**	**16:08**	**15:03**	**15:32**	**16:52**	**15:42**	**15:07**	**14:15**
Site 4	LOW	2:45	**10:13**	**9:56**	**8:53**	**9:23**	**10:47**	**9:38**	**9:04**	**8:07**
Depot Road (Sandy Pt)	HIGH	2:45	**16:29**	**16:13**	**15:08**	**15:37**	**16:57**	**15:47**	**15:12**	**14:20**
Site 5	LOW	2:40	**10:08**	**9:51**	**8:48**	**9:18**	**10:42**	**9:33**	**8:59**	**8:02**
Portsmouth Country Club	HIGH	2:20	**16:04**	**15:48**	**14:43**	**15:12**	**16:32**	**15:22**	**14:47**	**13:55**
Site 6	LOW	2:00	**9:28**	**9:11**	**8:08**	**8:38**	**10:02**	**8:53**	**8:19**	**7:22**
Fox Point	HIGH	2:00	**15:44**	**15:28**	**14:23**	**14:52**	**16:12**	**15:02**	**14:27**	**13:35**
Site 7	LOW	1:50	**9:18**	**9:01**	**7:58**	**8:28**	**9:52**	**8:43**	**8:09**	**7:12**
Cedar Point	HIGH	1:55	**15:39**	**15:23**	**14:18**	**14:47**	**16:07**	**14:57**	**14:22**	**13:30**
Site 9	LOW	1:20	**8:48**	**8:31**	**7:28**	**7:58**	**9:22**	**8:13**	**7:39**	**6:42**
Cocheco River	HIGH	1:20	**15:04**	**14:48**	**13:43**	**14:12**	**15:32**	**14:22**	**13:47**	**12:55**
Site 10	LOW	1:20	**8:48**	**8:31**	**7:28**	**7:58**	**9:22**	**8:13**	**7:39**	**6:42**
Piscataqua River	HIGH	1:20	**15:04**	**14:48**	**13:43**	**14:12**	**15:32**	**14:22**	**13:47**	**12:55**
Site 11	LOW	0:16	**7:44**	**7:27**	**6:24**	**6:54**	**8:18**	**7:09**	**6:35**	**5:38**
Coastal Marine Lab	HIGH	0:16	**14:00**	**13:44**	**12:39**	**13:08**	**14:28**	**13:18**	**12:43**	**11:51**

Revised 02/08/2002

		Adjustment	29-Apr	28-May	25-Jun	25-Jul	26-Aug	23-Sep	22-Oct	06-Nov
	LOW		7:28	7:11	6:08	6:38	8:02	6:53	6:19	5:22
	HIGH		13:44	13:28	12:23	12:52	14:12	13:02	12:27	11:35
Site 12 Newmarket STP	LOW	3:00	**10:28**	**10:11**	**9:08**	**9:38**	**11:02**	**9:53**	**9:19**	**8:22**
	HIGH	3:00	**16:44**	**16:28**	**15:23**	**15:52**	**17:12**	**16:02**	**15:27**	**14:35**
Site 13 Marina Falls Landing	LOW	3:00	**10:28**	**10:11**	**9:08**	**9:38**	**11:02**	**9:53**	**9:19**	**8:22**
	HIGH	3:00	**16:44**	**16:28**	**15:23**	**15:52**	**17:12**	**16:02**	**15:27**	**14:35**
Site 14 Fowler's Dock	LOW	3:00	**10:28**	**10:11**	**9:08**	**9:38**	**11:02**	**9:53**	**9:19**	**8:22**
	HIGH	3:00	**16:44**	**16:28**	**15:23**	**15:52**	**17:12**	**16:02**	**15:27**	**14:35**
Site 15 Patten Yacht Yard, Inc.	LOW	1:00	**8:28**	**8:11**	**7:08**	**7:38**	**9:02**	**7:53**	**7:19**	**6:22**
	HIGH	1:00	**14:44**	**14:28**	**13:23**	**13:52**	**15:12**	**14:02**	**13:27**	**12:35**
Site 16 Exeter Docks	LOW	2:50	**10:18**	**10:01**	**8:58**	**9:28**	**10:52**	**9:43**	**9:09**	**8:12**
	HIGH	3:10	**16:54**	**16:38**	**15:33**	**16:02**	**17:22**	**16:12**	**15:37**	**14:45**
Site 17 Dover Foot Bridge	LOW	2:50	**10:18**	**10:01**	**8:58**	**9:28**	**10:52**	**9:43**	**9:09**	**8:12**
	HIGH	3:10	**16:54**	**16:38**	**15:33**	**16:02**	**17:22**	**16:12**	**15:37**	**14:45**
Site 18 Maplewood Ave	LOW	1:16	**8:44**	**8:27**	**7:24**	**7:54**	**9:18**	**8:09**	**7:35**	**6:38**
	HIGH	1:16	**15:00**	**14:44**	**13:39**	**14:08**	**15:28**	**14:18**	**13:43**	**12:51**
Site 19 Bartlett St.	LOW	1:16	**8:44**	**8:27**	**7:24**	**7:54**	**9:18**	**8:09**	**7:35**	**6:38**
	HIGH	1:16	**15:00**	**14:44**	**13:39**	**14:08**	**15:28**	**14:18**	**13:43**	**12:51**
Site 20 Junkins Ave.	LOW	1:16	**8:44**	**8:27**	**7:24**	**7:54**	**9:18**	**8:09**	**7:35**	**6:38**
	HIGH	1:16	**15:00**	**14:44**	**13:39**	**14:08**	**15:28**	**14:18**	**13:43**	**12:51**
Site 21 Pleasant St.	LOW	1:16	**8:44**	**8:27**	**7:24**	**7:54**	**9:18**	**8:09**	**7:35**	**6:38**
	HIGH	1:16	**15:00**	**14:44**	**13:39**	**14:08**	**15:28**	**14:18**	**13:43**	**12:51**
Site 22 Little Harbor School	HIGH	1:16	**15:00**	**14:44**	**13:39**	**14:08**	**15:28**	**14:18**	**13:43**	**12:51**

Revised 02/08/2002

March 2002

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
			FEBRUARY S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28	APRIL S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	1 High Tide: 12:04 am, 12:25 pm Low Tide: 6:10 am, 6:39 pm Sunrise: 6:18 am, Sunset: 5:38 pm	2 High Tide: 12:53 am, 1:18 pm Low Tide: 7:03 am, 7:28 pm Sunrise: 6:17 am, Sunset: 5:39 pm
3 High Tide: 1:43 am, 2:12 pm Low Tide: 7:57 am, 8:19 pm Sunrise: 6:15 am, Sunset: 5:34 pm	4 High Tide: 2:36 am, 3:10 pm Low Tide: 8:55 am, 9:14 pm Sunrise: 6:13 am, Sunset: 5:32 pm	5 High Tide: 3:32 am, 4:13 pm Low Tide: 9:56 am, 10:13 pm Sunrise: 6:11 am, Sunset: 5:34 pm	6 **Monthly Meeting 7-8:30 PM** High Tide: 4:33 am, 5:21 pm Low Tide: 11:03 am, 11:18 pm Sunrise: 6:09 am, Sunset: 5:35 pm	7 High Tide: 5:38 am, 6:30 pm Low Tide: 12:11 pm Sunrise: 6:08 am, Sunset: 5:37 pm	8 High Tide: 6:46 am, 7:36 pm Low Tide: 12:26 am, 1:18 pm Sunrise: 6:06 am, Sunset: 5:38 pm	9 High Tide: 7:49 am, 8:33 pm Low Tide: 1:31 am, 2:17 pm Sunrise: 6:04 am, Sunset: 5:39 pm
10 High Tide: 8:44 am, 9:22 pm Low Tide: 2:28 am, 3:08 pm Sunrise: 6:02 am, Sunset: 5:40 pm	11 High Tide: 9:32 am, 10:03 pm Low Tide: 3:18 am, 3:53 pm Sunrise: 6:00 am, Sunset: 5:41 pm	12 Phytoplankton Training 5:00-7:00 PM High Tide: 10:14 am, 10:42 pm Low Tide: 4:02 am, 4:31 pm Sunrise: 5:59 am, Sunset: 5:43 pm	13 High Tide: 10:52 am, 11:15 pm Low Tide: 4:40 am, 5:06 pm Sunrise: 5:57 am, Sunset: 5:44 pm	14 High Tide: 11:27 am, 11:46 pm Low Tide: 5:16 am, 5:37 pm Sunrise: 5:55 am, Sunset: 5:45 pm	15 High Tide, 12:00 pm Low Tide: 5:50 am, 6:08 pm Sunrise: 5:53 am, Sunset: 5:46 pm	16 High Tide: 12:17 am, 12:34 pm Low Tide: 6:23 am, 6:38 pm Sunrise: 5:51 am, Sunset: 5:47 pm
17 St Patrick's Day High Tide: 12:48 am, 1:03 pm Low Tide: 6:58 am, 7:10 pm Sunrise: 5:50 am, Sunset: 5:49 pm	18 High Tide: 1:21 am, 1:46 pm Low Tide: 7:34 am, 7:45 pm Sunrise: 5:48 am, Sunset: 5:50 pm	19 **Meeting for Conservation Commission 3:00—5:00 PM** High Tide: 1:57 am, 2:27 pm Low Tide: 8:15 am, 8:25 pm Sunrise: 5:46 am, Sunset: 5:51 pm	20 Vernal Equinox Training New volunteers 5:00-7:00 PM High Tide: 2:36 am, 3:13 pm Low Tide: 9:00 am, 9:11 pm Sunrise: 5:44 am, Sunset: 5:52 pm	21 High Tide: 3:25 am, 4:07 pm Low Tide: 9:52 am, 10:03 pm Sunrise: 5:42 am, Sunset: 5:53 pm	22 High Tide: 4:20 am, 5:08 pm Low Tide: 10:51 am, 11:04 pm Sunrise: 5:41 am, Sunset: 5:55 pm	23 Innovative Outreach Tactics for Volunteer Organizations: All Day High Tide: 5:22 am, 6:14 pm Low Tide: 11:56 am Sunrise: 5:39 am, Sunset: 5:56 pm
24 Palm Sunday High Tide: 6:28 am, 7:19 pm Low Tide: 12:10 am, 1:01 pm Sunrise: 5:37 am, Sunset: 5:57 pm Easter 31 High Tide: 12:28 am, 1:01 pm Low Tide: 6:45 am, 7:04 pm Sunrise: 5:24 am, Sunset: 6:06 pm	25 High Tide: 7:34 am, 8:18 pm Low Tide: 1:17 pm, 2:02 pm Sunrise: 5:35 am, Sunset: 5:59 pm	26 High Tide: 8:35 am, 9:13 pm Low Tide: 2:19 am, 2:58 pm Sunrise: 5:33 am, Sunset: 6:00 pm	27 Training New volunteers 5:00-7:00 PM High Tide: 9:31 am, 10:03 pm Low Tide: 3:16 am, 3:49 pm Sunrise: 5:32 am, Sunset: 6:02 pm	28 First Day of Passover High Tide: 10:25 am, 10:52 pm Low Tide: 4:10 am, 4:38 pm Sunrise: 5:30 am, Sunset: 6:03 pm	29 Good Friday High Tide: 11:17 am, 11:40 pm Low Tide: 5:02 am, 5:27 pm Sunrise: 5:28 am, Sunset: 6:04 pm	30 High Tide: 12:08 pm Low Tide: 5:54 am, 6:15 pm Sunrise: 5:26 am, Sunset: 6:05 pm

April 2002

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
MARCH S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	1 High Tide: 1:18 am, 1:54 pm Low Tide: 7:38 am, 7:55 pm Sunrise: 5:23 am, Sunset: 6:08 pm	2 High Tide: 2:09 am, 2:51 pm Low Tide: 8:34 am, 8:49 pm Sunrise: 5:21 am, Sunset: 6:09 pm	3 **Monthly Mtg. 5-7 PM** High Tide: 3:04 am, 3:52 pm Low Tide: 9:33 am, 9:48 pm Sunrise: 5:19 am, Sunset: 6:10 pm	4 High Tide: 4:04 am, 4:57 pm Low Tide: 10:37 am, 10:53 pm Sunrise: 5:17 am, Sunset: 6:11 pm	5 High Tide: 5:09 am, 6:04 pm Low Tide: 11:43 am Sunrise: 5:15 am, Sunset: 6:12 pm	6 High Tide: 6:17 am, 7:07 pm Low Tide: 12:00 am, 12:48 pm Sunrise: 5:14 am, Sunset: 6:14 pm
7 Daylight Saving Time Begins 2:00 am High Tide: 8:20 am, 9:03 pm Low Tide: 1:05 am, 2:46 pm Sunrise: 6:12 am, Sunset: 7:15 pm	8 High Tide: 9:16 am, 9:51 pm Low Tide: 3:03 am, 3:36 pm Sunrise: 6:10 am, Sunset: 7:16 pm	9 **Meeting for Conservation Commission 3:00—5:00 PM** High Tide: 10:04 am, 10:32 pm Low Tide: 3:52 am, 4:20 pm Sunrise: 6:08 am, Sunset: 7:17 pm	10 High Tide: 10:47 am, 11:08 pm Low Tides 4:36 am, 4:58 pm Sunrise: 6:06 am, Sunset: 7:18 pm	11 High Tide: 11:25 am, 11:41 pm Low Tide: 5:14 am, 5:31 pm Sunrise: 6:05 am, Sunset: 7:20 pm	12 High Tide: 12:01 pm Low Tide: 5:50 am, 6:03 pm Sunrise: 6:03 am, Sunset: 7:21 pm	13 High Tide: 12:12 am, 12:35 pm Low Tide: 6:24 am, 6:53 pm Sunrise: 6:01 am, Sunset: 7:22 pm
14 High Tide: 12:43 am, 1:09 pm Low Tide: 6:57 am, 7:05 pm Sunrise: 6:00 am, Sunset: 7:23 pm	15 Patriots' Day High Tide: 1:14 am, 1:44 pm Low Tide: 7:32 am, 7:30 pm Sunrise: 5:58 am, Sunset: 7:24 pm	16 High Tide: 1:40 am, 2:22 pm Low Tide: 8:09 am, 8:16 pm Sunrise: 5:57 am, Sunset: 7:26 pm	17 Quality Control Quality Assurance 12:00 – 5:00 PM High Tide: 2:26 am, 3:04 pm Low Tide: 8:50 am, 8:58 pm Sunrise: 5:55 am, Sunset: 7:27 pm	18 High Tide: 3:09 am, 3:52 pm Low Tide: 9:36 am, 9:46 pm Sunrise: 5:53 am, Sunset: 7:28 pm	19 High Tide: 3:58 am, 4:46 pm Low Tide: 10:28 am, 10:41 pm Sunrise: 5:51 am, Sunset: 7:29 pm	20 High Tide: 4:55 am, 5:47 pm Low Tide: 11:27 am, 11:43 pm Sunrise: 5:49 am, Sunset: 7:30 pm
21 High Tide: 5:59 am, 6:51 pm Low Tide: 12:31 pm Sunrise: 5:48 am, Sunset: 7:32 pm	22 High Tide: 7:06 am, 7:55 pm Low Tide: 12:51 am, 1:35 pm Sunrise: 5:46 am, Sunset: 7:33 pm	23 High Tide: 8:12 am, 8:54 pm Low Tide: 1:58 am, 2:35 pm Sunrise: 5:45 am, Sunset: 7:34 pm	24 High Tide: 9:15 am, 9:48 pm Low Tide: 3:01 am, 3:31 pm Sunrise: 5:43 am, Sunset: 7:35 pm	25 High Tide: 10:13 am, 10:39 pm Low Tide: 3:59 am, 4:24 pm Sunrise: 5:42 am, Sunset: 7:36 pm	26 High Tide: 11:08 am, 11:28 pm Low Tide: 4:54 am, 5:14 pm Sunrise: 5:41 am, Sunset: 7:38 pm	27 High Tide: 11:00 pm Low Tide: 5:46 am, 6:02 pm Sunrise: 5:39 am, Sunset: 7:39 pm
28 High Tide: 12:16 am, 12:52 pm Low Tide: 6:37 am, 6:51 pm Sunrise: 5:37 am, Sunset: 7:40 pm	29 **Sampling** High Tide: 1:04 am, 1:44 pm Low Tide: 7:28 am, 7:40 pm Sunrise: 5:36 am, Sunset: 7:41 pm	30 **NH Coastal Program /NH Estuaries Project 10:00 AM— 4:00 PM** High Tide: 1:53 am, 2:37 pm Low Tide: 8:20 am, 8:31 pm Sunrise: 5:34 am, Sunset: 7:42 pm	MAY S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31			

May 2002

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		APRIL S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	1 High Tide: 2:44 am, 3:31 pm Low Tide: 9:13 am, 9:24 pm Sunrise: 5:33 am, Sunset: 7:44 pm	2 High Tide: 3:38 am, 4:29 pm Low Tide: 10:09 am, 10:22 pm Sunrise: 5:31 am, Sunset: 7:45 pm	3 High Tide: 4:35 am, 5:29 pm Low Tide: 11:07 am, 11:33 pm Sunrise: 5:30 am, Sunset: 7:46 pm	4 High Tide: 5:36 am, 6:30 pm Low Tide: 12:08 pm Sunrise: 5:28 am, Sunset: 7:47 pm
5 High Tide: 6:39 am, 7:28 pm Low Tide: 12:28 am, 1:08 pm Sunrise: 5:27 am, Sunset: 7:48 pm	6 High Tide: 7:40 am, 8:21 pm Low Tide: 1:30 am, 2:03 pm Sunrise: 5:26 am, Sunset: 7:50 pm	7 **Meeting for Conservation Commission 3:00—5:00 PM** High Tide: 8:36 am, 9:09 pm Low Tides 2:27 am, 2:53 pm Sunrise: 5:24 am, Sunset: 7:51 pm	8 **Monthly Meeting 5-7 PM** High Tide: 9:27 am, 9:51 pm Low Tide: 3:17 am, 3:36 pm Sunrise: 5:23 am, Sunset: 7:52 pm	9 High Tide: 10:12 am, 10:28 pm Low Tide: 4:02 am, 4:16 pm Sunrise: 5:22 am, Sunset: 7:53 pm	10 High Tide: 10:53 am, 11:03 pm Low Tide: 4:43 am, 4:51 pm Sunrise: 5:21 am, Sunset: 7:54 pm	11 High Tide: 11:31 am, 11:36 pm Low Tide: 5:20 am, 5:25 pm Sunrise: 5:20 am, Sunset: 7:56 pm
12 Mother's Day High Tide: 12:08 pm Low Tide: 5:56 am, 5:59 pm Sunrise: 5:18 am, Sunset: 7:57 pm	13 High Tide: 12:10 am, 12:45 pm Low Tide: 6:12 am, 6:34 pm Sunrise: 5:17 am, Sunset: 7:58 pm	14 High Tide: 12:44 am, 1:23 pm Low Tide: 7:03 am, 7:11 pm Sunrise: 5:16 am, Sunset: 7:59 pm	15 High Tide: 1:22 am, 2:03 pm Low Tide: 7:48 am, 7:52 pm Sunrise: 5:15 am, Sunset: 8:00 pm	16 High Tide: 2:03 am, 2:48 pm Low Tide: 8:32 am, 8:38 pm Sunrise: 5:14 am, Sunset: 8:01 pm	17 High Tide: 2:50 am, 3:37 pm Low Tide: 9:19 am, 9:29 pm Sunrise: 5:13 am, Sunset: 8:02 pm	18 High Tide: 3:42 am, 4:32 pm Low Tide: 10:12 am, 10:26 pm Sunrise: 5:12 am, Sunset: 8:03 pm
19 High Tide: 4:39 am, 5:30 pm Low Tide: 11:09 am, 11:29 pm Sunrise: 5:11 am, Sunset: 8:04 pm	20 Victoria Day (Canada) High Tide: 5:42 am, 6:31 pm Low Tide: 12:09 pm Sunrise: 5:10 am, Sunset: 8:05 pm	21 High Tide: 6:48 am, 7:32 pm Low Tide: 12:35 am, 1:10 pm Sunrise: 5:09 am, Sunset: 8:06 pm	22 High Tide: 7:54 am, 8:30 pm Low Tide: 1:41 am, 2:09 pm Sunrise: 5:08 am, Sunset: 8:07 pm	23 High Tide: 8:57 am, 9:25 pm Low Tide: 2:44 am, 3:06 pm Sunrise: 5:07 am, Sunset: 8:08 pm	24 High Tide: 9:56 am, 10:17 pm Low Tide: 3:43 am, 4:00 pm Sunrise: 5:06 am, Sunset: 8:09 pm	25 High Tide: 10:52 am, 11:07 pm Low Tide: 4:39 am, 4:51 pm Sunrise: 5:05 am, Sunset: 8:10 pm
26 High Tide: 11:45 am, 11:55 pm Low Tide: 5:31 am, 5:41 pm Sunrise: 5:05 am, Sunset: 8:11 pm	27 Memorial Day (observed) High Tide: 12:37 pm Low Tide: 6:22 am, 6:30 pm Sunrise: 5:04 am, Sunset: 8:12 pm	28 **Sampling** High Tide: 12:44 am, 1:28 pm Low Tide: 7:11 am, 7:19 pm Sunrise: 5:03 am, Sunset: 8:13 pm	29 High Tide: 1:32 am, 2:18 pm Low Tide: 8:01 am, 8:09 pm Sunrise: 5:03 am, Sunset: 8:14 pm	30 Memorial Day (traditional) High Tide: 2:21 am, 3:09 pm Low Tide: 8:51 am, 9:00 pm Sunrise: 5:02 am, Sunset: 8:15 pm	31 High Tide: 3:12 am, 4:01 pm Low Tide: 9:42 am, 9:53 pm Sunrise: 5:02 am, Sunset: 8:16 pm	JUNE S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

June 2002

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
				MAY S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	JULY S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	1 High Tide: 4:04 am, 4:54 pm Low Tide: 10:34 am, 10:49 pm Sunrise: 5:01 am, Sunset: 8:36 pm
2 High Tide: 4:59 am, 5:48 pm Low Tide: 11:27 am, 11:47 pm Sunrise: 5:00 am, Sunset: 8:37 pm	3 High Tide: 5:55 am, 6:40 pm Low Tide: 12:10 pm Sunrise: 5:00 am, Sunset: 8:38 pm	4 High Tide: 6:52 am, 7:31 pm Low Tide: 12:45 am, 1:11 pm Sunrise: 4:59 am, Sunset: 8:39 pm	5 **Monthly Meeting** **5-7 PM** High Tide: 7:48 am, 8:18 pm Low Tide: 1:42 am, 1:59 pm Sunrise: 4:59 am, Sunset: 8:39 pm	6 High Tide: 8:41 am, 9:02 pm Low Tide: 2:34 am, 2:45 pm Sunrise: 4:58 am, Sunset: 8:40 pm	7 High Tide: 9:30 am, 9:43 pm Low Tide: 3:22 am, 3:27 pm Sunrise: 4:58 am, Sunset: 8:41 pm	8 High Tide: 10:15 am, 10:22 pm Low Tide: 4:08 am, 4:08 pm Sunrise: 4:58 am, Sunset: 8:41 pm
9 High Tide: 10:58 am, 11:00 pm Low Tide: 4:47 am, 4:47 pm Sunrise: 4:58 am, Sunset: 8:42 pm	10 High Tide: 11:39 am, 11:39 pm Low Tide: 5:27 am, 5:26 pm Sunrise: 4:58 am, Sunset: 8:43 pm	11 High Tide: 12:20 pm Low Tide: 6:06 am, 6:06 pm Sunrise: 4:58 am, Sunset: 8:43 pm	12 High Tide: 12:19 am, 1:02 pm Low Tide: 6:47 am, 6:48 pm Sunrise: 4:58 am, Sunset: 8:43 pm	13 High Tide: 1:01 am, 1:46 pm Low Tide: 7:30 am, 7:34 pm Sunrise: 4:58 am, Sunset: 8:44 pm	14 Flag Day High Tide: 1:47 am, 2:33 pm Low Tide: 8:16 am, 8:23 pm Sunrise: 4:58 am, Sunset: 8:44 pm	15 High Tide: 2:36 am, 3:23 pm Low Tide: 9:05 am, 9:17 pm Sunrise: 4:58 am, Sunset: 8:45 pm
16 Father's Day High Tide: 3:29 am, 4:17 pm Low Tide: 9:57 am, 10:14 pm Sunrise: 4:58 am, Sunset: 8:45 pm	17 High Tide: 4:27 am, 5:13 pm Low Tide: 10:51 am, 11:16 pm Sunrise: 4:58 am, Sunset: 8:45 pm	18 High Tide: 5:28 am, 6:11 pm Low Tide: 11:48 am Sunrise: 4:58 am, Sunset: 8:46 pm	19 High Tide: 6:32 am, 7:10 pm Low Tide: 12:31 am, 12:47 pm Sunrise: 4:58 am, Sunset: 8:46 pm	20 High Tide: 7:37 am, 8:08 pm Low Tide: 1:26 am, 1:46 pm Sunrise: 4:58 am, Sunset: 8:47 pm	21 Summer Solstice High Tide: 8:41 am, 9:04 pm Low Tide: 2:30 am, 2:43 pm Sunrise: 4:58 am, Sunset: 8:47 pm	22 High Tide: 9:42 am, 9:58 pm Low Tide: 3:30 am, 3:39 pm Sunrise: 4:58 am, Sunset: 8:47 pm
23 High Tide: 10:39 am, 10:49 pm Low Tide: 4:26 am, 4:32 pm Sunrise: 4:58 am, Sunset: 8:47 pm 30 High Tide: 3:32 am, 4:14 pm Low Tide: 9:57 am, 10:11 pm Sunrise: 5:01 am, Sunset: 8:28 pm	24 High Tide: 11:32 am, 11:39 pm Low Tide: 5:18 am, 5:23 pm Sunrise: 4:58 am, Sunset: 8:27 pm	25 **Sampling** High Tide: 12:23 pm Low Tide: 6:08 am, 6:12 pm Sunrise: 4:59 am, Sunset: 8:28 pm	26 High Tide: 12:22 am, 1:17 pm Low Tide: 6:56 am, 7:00 pm Sunrise: 4:59 am, Sunset: 8:28 pm	27 High Tide: 1:13 am, 1:58 pm Low Tide: 7:42 am, 7:47 pm Sunrise: 4:59 am, Sunset: 8:28 pm	28 High Tide: 1:59 am, 2:43 pm Low Tide: 8:27 am, 8:34 pm Sunrise: 5:00 am, Sunset: 8:28 pm	29 High Tide: 2:45 am, 3:29 pm Low Tide: 9:12 am, 9:22 pm Sunrise: 5:00 am, Sunset: 8:28 pm

July 2002

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JUNE S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	1 Canada Day (Canada) High Tide: 4:20 am, 5:01 pm Low Tide: 10:42 am, 11:03 pm Sunrise: 5:01 am, Sunset: 8:27 pm	2 High Tide: 5:16 am, 5:47 pm Low Tide: 11:27 am, 11:56 pm Sunrise: 5:02 am, Sunset: 8:27 pm	3 High Tide: 6:02 am, 6:35 pm Low Tide: 12:14 pm Sunrise: 5:02 am, Sunset: 8:27 pm	4 Independence Day High Tide: 6:56 am, 7:23 pm Low Tide: 12:50 am, 1:02 pm Sunrise: 5:03 am, Sunset: 8:27 pm	5 High Tide: 7:51 am, 8:10 pm Low Tide: 1:45 am, 1:50 pm Sunrise: 5:04 am, Sunset: 8:27 pm	6 High Tide: 8:45 am, 8:57 pm Low Tide: 2:37 am, 2:38 pm Sunrise: 5:04 am, Sunset: 8:26 pm
7 High Tide: 9:36 am, 9:42 pm Low Tide: 3:26 am, 3:25 pm Sunrise: 5:05 am, Sunset: 8:26 pm	8 High Tide: 10:23 am, 10:26 pm Low Tide: 4:12 am, 4:10 pm Sunrise: 5:06 am, Sunset: 8:25 pm	9 High Tide: 11:09 am, 11:11 pm Low Tide: 4:57 am, 4:56 pm Sunrise: 5:07 am, Sunset: 8:25 pm	10 High Tide: 11:54 am, 11:56 pm Low Tide: 5:41 am, 5:41 pm Sunrise: 5:08 am, Sunset: 8:25 pm	11 High Tide: 12:39 pm Low Tide: 6:25 am, 6:26 pm Sunrise: 5:08 am, Sunset: 8:24 pm	12 High Tide: 12:43 am, 1:26 pm Low Tide: 7:11 am, 7:17 pm Sunrise: 5:09 am, Sunset: 8:23 pm	13 High Tide: 1:32 am, 2:14 pm Low Tide: 7:58 am, 8:09 pm Sunrise: 5:10 am, Sunset: 8:23 pm
14 High Tide: 2:23 am, 3:04 pm Low Tide: 8:47 am, 9:03 pm Sunrise: 5:11 am, Sunset: 8:22 pm	15 High Tide: 3:16 am, 3:57 pm Low Tide: 9:38 am, 10:01 pm Sunrise: 5:12 am, Sunset: 8:22 pm	16 High Tide: 4:13 am, 4:52 pm Low Tide: 10:31 am, 11:02 pm Sunrise: 5:12 am, Sunset: 8:21 pm	17 BBQ— Great Bay Stewards— Great Bay Coast Watch and the Great Bay Wildlife Refuge High Tide: 5:14 am, 5:49 pm Low Tide: 11:27 am Sunrise: 5:13 am, Sunset: 8:20 pm	18 High Tide: 6:17 am, 6:48 pm Low Tide: 12:06 am, 12:25 pm Sunrise: 5:14 am, Sunset: 8:19 pm	19 High Tide: 7:23 am, 7:48 pm Low Tide: 1:12 am, 1:26 pm Sunrise: 5:15 am, Sunset: 8:18 pm	20 High Tide: 8:29 am, 8:47 pm Low Tide: 2:16 am, 2:26 pm Sunrise: 5:16 am, Sunset: 8:18 pm
21 High Tide: 9:31 am, 9:44 pm Low Tide: 3:18 am, 3:24 pm Sunrise: 5:17 am, Sunset: 8:17 pm	22 National Marine Educators High Tide: 10:28 am, 10:37 pm Low Tide: 4:14 am, 4:19 pm Sunrise: 5:18 am, Sunset: 8:16 pm	23 High Tide: 11:20 am, 11:26 pm Low Tide: 5:06 am, 5:10 pm Sunrise: 5:19 am, Sunset: 8:15 pm	24 Association (NMEA) 2002 High Tide: 12:08 pm Low Tide: 5:54 am, 5:57 pm Sunrise: 5:20 am, Sunset: 8:14 pm	25 Sampling High Tide: 12:12 am, 12:57 pm Low Tide: 6:38 am, 6:42 pm Sunrise: 5:21 am, Sunset: 8:13 pm	26 Conference in Connecticut High Tide: 12:55 am, 1:33 pm Low Tide: 7:20 am, 7:25 pm Sunrise: 5:22 am, Sunset: 8:12 pm	27 High Tide: 1:37 am, 2:13 pm Low Tide: 8:00 am, 8:07 pm Sunrise: 5:23 am, Sunset: 8:11 pm
28 High Tide: 2:18 am, 2:52 pm Low Tide: 8:38 am, 8:49 pm Sunrise: 5:24 am, Sunset: 8:10 pm	29 High Tide: 2:59 am, 3:31 pm Low Tide: 9:17 am, 9:32 pm Sunrise: 5:25 am, Sunset: 8:09 pm	30 High Tide: 3:42 am, 4:12 pm Low Tide: 9:56 am, 10:18 pm Sunrise: 5:27 am, Sunset: 8:08 pm	31 High Tide: 4:27 am, 4:54 pm Low Tide: 10:36 am, 11:07 pm Sunrise: 5:28 am, Sunset: 8:06 pm	AUGUST S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31		

August 2002

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		JULY S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	SEPTEMBER S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	1  High Tide: 5:15 am, 5:40 pm Low Tide: 11:20 am, 11:59 pm Sunrise: 5:29 am, Sunset: 8:05 pm	2 High Tide: 6:07 am, 6:28 pm Low Tide: 12:08 pm Sunrise: 5:30 am, Sunset: 8:03 pm	3 High Tide: 7:03 am, 7:20 pm Low Tide: 12:54 am, 12:59 pm Sunrise: 5:31 am, Sunset: 8:02 pm
4 High Tide: 8:00 am, 8:12 pm Low Tide: 1:50 am, 1:52 pm Sunrise: 5:32 am, Sunset: 8:01 pm	5 High Tide: 8:56 am, 9:05 pm Low Tide: 2:45 am, 2:46 pm Sunrise: 5:33 am, Sunset: 7:59 pm	6 High Tide: 9:49 am, 9:56 pm Low Tide: 3:37 am, 3:39 pm Sunrise: 5:34 am, Sunset: 7:58 pm	7 "QAQC" Quality Assurance Quality Control High Tide: 10:39 am, 10:46 pm Low Tide: 4:27 am, 4:29 pm Sunrise: 5:35 am, Sunset: 7:57 pm	8  High Tide: 11:27 am, 11:33 pm Low Tide: 5:14 am, 5:19 pm Sunrise: 5:36 am, Sunset: 7:56 pm	9 High Tide: 12:13 pm Low Tide: 6:01 am, 6:09 pm Sunrise: 5:38 am, Sunset: 7:55 pm	10 High Tide: 12:25 am, 1:02 pm Low Tide: 6:48 am, 7:00 pm Sunrise: 5:39 am, Sunset: 7:53 pm
11 High Tide: 1:15 am, 1:51 pm Low Tide: 7:36 am, 7:53 pm Sunrise: 5:40 am, Sunset: 7:51 pm	12 High Tide: 2:07 am, 2:41 pm Low Tide: 8:25 am, 8:47 pm Sunrise: 5:41 am, Sunset: 7:50 pm	13 High Tide: 3:01 am, 3:33 pm Low Tide: 9:15 am, 9:44 pm Sunrise: 5:42 am, Sunset: 7:48 pm	14 High Tide: 3:58 am, 4:28 pm Low Tide: 10:09 am, 10:45 pm Sunrise: 5:43 am, Sunset: 7:47 pm	15  High Tide: 4:59 am, 5:26 pm Low Tide: 11:05 am, 11:50 pm Sunrise: 5:44 am, Sunset: 7:45 pm	16 High Tide: 6:04 am, 6:28 pm Low Tide: 12:05 pm Sunrise: 5:45 am, Sunset: 7:43 pm	17 High Tide: 7:11 am, 7:31 pm Low Tide: 12:56 am, 1:09 pm Sunrise: 5:46 am, Sunset: 7:42 pm
18 High Tide: 8:16 am, 8:34 pm Low Tide: 2:03 am, 2:13 pm Sunrise: 5:47 am, Sunset: 7:40 pm	19 High Tide: 9:20 am, 9:33 pm Low Tide: 3:05 am, 3:13 pm Sunrise: 5:49 am, Sunset: 7:39 pm	20 High Tide: 10:16 am, 10:26 pm Low Tide: 4:01 am, 4:08 pm Sunrise: 5:50 am, Sunset: 7:37 pm	21 High Tide: 11:05 am, 11:13 pm Low Tide: 4:51 am, 4:57 pm Sunrise: 5:51 am, Sunset: 7:35 pm	22  High Tide: 11:48 am, 11:56 pm Low Tide: 5:36 am, 5:41 pm Sunrise: 5:52 am, Sunset: 7:34 pm	23 High Tide: 12:27 pm Low Tide: 6:16 am, 6:22 pm Sunrise: 5:53 am, Sunset: 7:32 pm	24 High Tide: 12:35 am, 1:04 pm Low Tide: 6:53 am, 7:01 pm Sunrise: 5:55 am, Sunset: 7:31 pm
25 High Tide: 1:12 am, 1:38 pm Low Tide: 7:28 am, 7:38 pm Sunrise: 5:56 am, Sunset: 7:29 pm	26 Sampling High Tide: 1:49 am, 2:12 pm Low Tide: 8:02 am, 8:16 pm Sunrise: 5:57 am, Sunset: 7:27 pm	27 High Tide: 2:27 am, 2:48 pm Low Tide: 8:36 am, 8:55 pm Sunrise: 5:58 am, Sunset: 7:26 pm	28 High Tide: 3:06 am, 3:25 pm Low Tide: 9:12 am, 9:37 pm Sunrise: 5:59 am, Sunset: 7:24 pm	29 High Tide: 3:48 am, 4:05 pm Low Tide: 9:50 am, 10:22 pm Sunrise: 6:00 am, Sunset: 7:23 pm	30  High Tide: 4:33 am, 4:50 pm Low Tide: 10:33 am, 11:12 pm Sunrise: 6:01 am, Sunset: 7:21 pm	31 High Tide: 5:24 am, 5:40 pm Low Tide: 11:22 am Sunrise: 6:02 am, Sunset: 7:19 pm

September 2002

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1 High Tide: 6:21 am, 6:36 pm Low Tide: 12:08 am, 12:16 pm Sunrise: 6:03 am, Sunset: 7:17 pm	**2** Labor Day High Tide: 7:21 am, 7:34 pm Low Tide: 1:07 am, 1:15 pm Sunrise: 6:04 am, Sunset: 7:15 pm	**3** High Tide: 8:21 am, 8:33 pm Low Tide: 2:07 am, 2:14 pm Sunrise: 6:06 am, Sunset: 7:14 pm	**4** **Monthly Meeting** **5-7 PM** High Tide: 9:18 am, 9:29 pm Low Tide: 3:04 am, 3:12 pm Sunrise: 6:07 am, Sunset: 7:12 pm	**5** High Tide: 10:10 am, 10:23 pm Low Tide: 3:57 am, 4:07 pm Sunrise: 6:08 am, Sunset: 7:10 pm	**6** High Tide: 11:00 am, 11:15 pm Low Tide: 4:47 am, 4:59 pm Sunrise: 6:09 am, Sunset: 7:08 pm	**7** Rosh Hashanah High Tide: 11:48 am Low Tide: 5:35 am, 5:51 pm Sunrise: 6:10 am, Sunset: 7:06 pm
8 High Tide: 12:06 am, 12:36 pm Low Tide: 6:23 am, 6:42 pm Sunrise: 6:12 am, Sunset: 7:05 pm	**9** High Tide: 12:57 am, 1:24 pm Low Tide: 7:11 am, 7:35 pm Sunrise: 6:13 am, Sunset: 7:03 pm	**10** High Tide: 1:50 am, 2:15 pm Low Tide: 8:00 am, 8:29 pm Sunrise: 6:14 am, Sunset: 7:01 pm	**11** High Tide: 2:44 am, 3:07 pm Low Tide: 8:51 am, 9:26 pm Sunrise: 6:15 am, Sunset: 6:59 pm	**12** High Tide: 3:42 am, 4:03 pm Low Tide: 9:43 am, 10:27 pm Sunrise: 6:16 am, Sunset: 6:57 pm	**13** High Tide: 4:43 am, 5:03 pm Low Tide: 10:43 am, 11:31 pm Sunrise: 6:18 am, Sunset: 6:56 pm	**14** High Tide: 5:49 am, 6:07 pm Low Tide: 11:47 am Sunrise: 6:19 am, Sunset: 6:54 pm
15 High Tide: 6:58 am, 7:14 pm Low Tide: 12:39 am, 12:54 pm Sunrise: 6:20 am, Sunset: 6:52 pm	**16** Yom Kippur High Tide: 8:04 am, 8:19 pm Low Tide: 1:46 am, 2:00 pm Sunrise: 6:21 am, Sunset: 6:50 pm	**17** High Tide: 9:04 am, 9:18 pm Low Tide: 2:48 am, 3:00 pm Sunrise: 6:22 am, Sunset: 6:48 pm	**18** High Tide: 9:57 am, 10:09 pm Low Tide: 3:42 am, 3:54 pm Sunrise: 6:23 am, Sunset: 6:46 pm	**19** High Tide: 10:47 am, 10:54 pm Low Tide: 4:30 am, 4:40 pm Sunrise: 6:24 am, Sunset: 6:44 pm	**20** High Tide: 11:32 am, 11:35 pm Low Tide: 5:11 am, 5:22 pm Sunrise: 6:25 am, Sunset: 6:42 pm	**21** Low Tide Coastal Cleanup High Tide: 11:58 am Low Tide: 5:48 am, 6:00 pm Sunrise: 6:26 am, Sunset: 6:40 pm
22 Autumnal Equinox High Tide: 12:11 am, 12:31 pm Low Tide: 6:22 am, 6:35 pm Sunrise: 6:27 am, Sunset: 6:38 pm	**23** **Sampling** High Tide: 12:46 am, 1:02 pm Low Tide: 6:53 am, 7:10 pm Sunrise: 6:29 am, Sunset: 6:37 pm	**24** High Tide: 1:21 am, 1:34 pm Low Tide: 7:25 am, 7:45 pm Sunrise: 6:30 am, Sunset: 6:35 pm	**25** High Tide: 1:57 am, 2:07 pm Low Tide: 7:57 am, 8:22 pm Sunrise: 6:31 am, Sunset: 6:33 pm	**26** High Tide: 2:34 am, 2:43 pm Low Tide: 8:32 am, 9:01 pm Sunrise: 6:32 am, Sunset: 6:31 pm	**27** High Tide: 3:14 am, 3:23 pm Low Tide: 9:11 am, 9:45 pm Sunrise: 6:33 am, Sunset: 6:29 pm	**28** High Tide: 3:59 am, 4:09 pm Low Tide: 9:55 am, 10:35 pm Sunrise: 6:35 am, Sunset: 6:26 pm
29 High Tide: 4:50 am, 5:01 pm Low Tide: 10:45 am, 11:31 pm Sunrise: 6:36 am, Sunset: 6:26 pm	**30** High Tide: 5:48 am, 6:00 pm Low Tide: 11:43 am Sunrise: 6:37 am, Sunset: 6:24 pm	**AUGUST** S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	**OCTOBER** S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31			

October 2002

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
	SEPTEMBER S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	1 High Tide: 6:50 am, 7:03 pm Low Tide: 12:32 am, 12:45 pm Sunrise: 6:38 am, Sunset: 6:22 pm	2 **Monthly Meeting 5-7 PM** High Tide: 7:51 am, 8:05 pm Low Tide: 1:34 am, 1:49 pm Sunrise: 6:39 am, Sunset: 6:20 pm	3 High Tide: 8:49 am, 9:05 pm Low Tide: 2:33 am, 2:49 pm Sunrise: 6:41 am, Sunset: 6:19 pm	4 High Tide: 9:43 am, 10:01 pm Low Tide: 3:28 am, 3:46 pm Sunrise: 6:42 am, Sunset: 6:17 pm	5 High Tide: 10:33 am, 10:55 pm Low Tide: 4:19 am, 4:40 pm Sunrise: 6:43 am, Sunset: 6:15 pm
6 High Tide: 11:22 am, 11:47 pm Low Tide: 5:08 am, 5:32 pm Sunrise: 6:44 am, Sunset: 6:13 pm	7 High Tide: 12:10 pm Low Tide: 5:57 am, 6:24 pm Sunrise: 6:45 am, Sunset: 6:11 pm	8 High Tide: 12:39 am, 12:58 pm Low Tide: 6:45 am, 7:16 pm Sunrise: 6:47 am, Sunset: 6:10 pm	9 High Tide: 1:32 am, 1:49 pm Low Tide: 7:35 am, 8:10 pm Sunrise: 6:48 am, Sunset: 6:08 pm	10 High Tide: 2:26 am, 2:41 pm Low Tide: 8:26 am, 9:06 pm Sunrise: 6:49 am, Sunset: 6:06 pm	11 High Tide: 3:24 am, 3:38 pm Low Tide: 9:22 am, 10:06 pm Sunrise: 6:50 am, Sunset: 6:04 pm	12 Columbus Day (traditional) High Tide: 4:25 am, 4:39 pm Low Tide: 10:21 am, 11:10 pm Sunrise: 6:51 am, Sunset: 6:02 pm
13 High Tide: 5:31 am, 5:44 pm Low Tide: 11:26 am Sunrise: 6:53 am, Sunset: 6:01 pm	14 Columbus Day (observed) Thanksgiving Day (Canada) High Tide: 6:38 am, 6:52 pm Low Tide: 12:17 am, 12:35 pm Sunrise: 6:54 am, Sunset: 5:59 pm	15 High Tide: 7:42 am, 7:57 pm Low Tide: 1:22 am, 1:40 pm Sunrise: 6:55 am, Sunset: 5:57 pm	16 High Tide: 8:39 am, 8:54 pm Low Tide: 2:22 am, 2:40 pm Sunrise: 6:56 am, Sunset: 5:56 pm	17 High Tide: 9:29 am, 9:45 pm Low Tide: 3:14 am, 3:32 pm Sunrise: 6:57 am, Sunset: 5:54 pm	18 30th Anniversary Clean Water Act Special water quality High Tide: 10:12 am, 10:29 pm Low Tide: 4:00 am, 4:17 pm Sunrise: 6:59 am, Sunset: 5:53 pm	19 High Tide: 10:50 am, 11:09 pm Low Tide: 4:39 am, 4:58 pm Sunrise: 7:00 am, Sunset: 5:51 pm
20 High Tide: 11:25 am, 11:45 pm Low Tide: 5:15 am, 5:35 pm Sunrise: 7:01 am, Sunset: 5:49 pm	21 High Tide: 11:56 am Low Tide: 5:47 am, 6:10 pm Sunrise: 7:02 am, Sunset: 5:48 pm	22 **Sampling** High Tide: 12:20 am, 12:37 pm Low Tide: 6:19 am, 6:43 pm Sunrise: 7:03 am, Sunset: 5:46 pm	23 High Tide: 12:55 am, 12:59 pm Low Tide: 6:50 am, 7:17 pm Sunrise: 7:05 am, Sunset: 5:45 pm	24 High Tide: 1:30 am, 1:32 pm Low Tide: 7:23 am, 7:54 pm Sunrise: 7:06 am, Sunset: 5:43 pm	25 High Tide: 2:07 am, 2:09 pm Low Tide: 7:59 am, 8:33 pm Sunrise: 7:07 am, Sunset: 5:41 pm	26 High Tide: 2:48 am, 2:50 pm Low Tide: 8:39 am, 9:17 pm Sunrise: 7:09 am, Sunset: 5:40 pm
27 Daylight Saving Time Ends 2:00 am High Tide: 2:33 am, 2:38 pm Low Tide: 8:25 am, 9:07 pm Sunrise: 6:10 am, Sunset: 4:38 pm	28 High Tide: 3:24 am, 3:32 pm Low Tide: 9:10 am, 10:02 pm Sunrise: 6:12 am, Sunset: 4:37 pm	29 High Tide: 4:22 am, 4:32 pm Low Tide: 10:17 am, 11:03 pm Sunrise: 6:13 am, Sunset: 4:35 pm	30 High Tide: 5:23 am, 5:37 pm Low Tide: 11:22 am Sunrise: 6:14 am, Sunset: 4:34 pm	31 Halloween High Tide: 6:24 am, 6:41 pm Low Tide: 12:04 am, 12:27 pm Sunrise: 6:15 am, Sunset: 4:32 pm	NOVEMBER S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	

November 2002

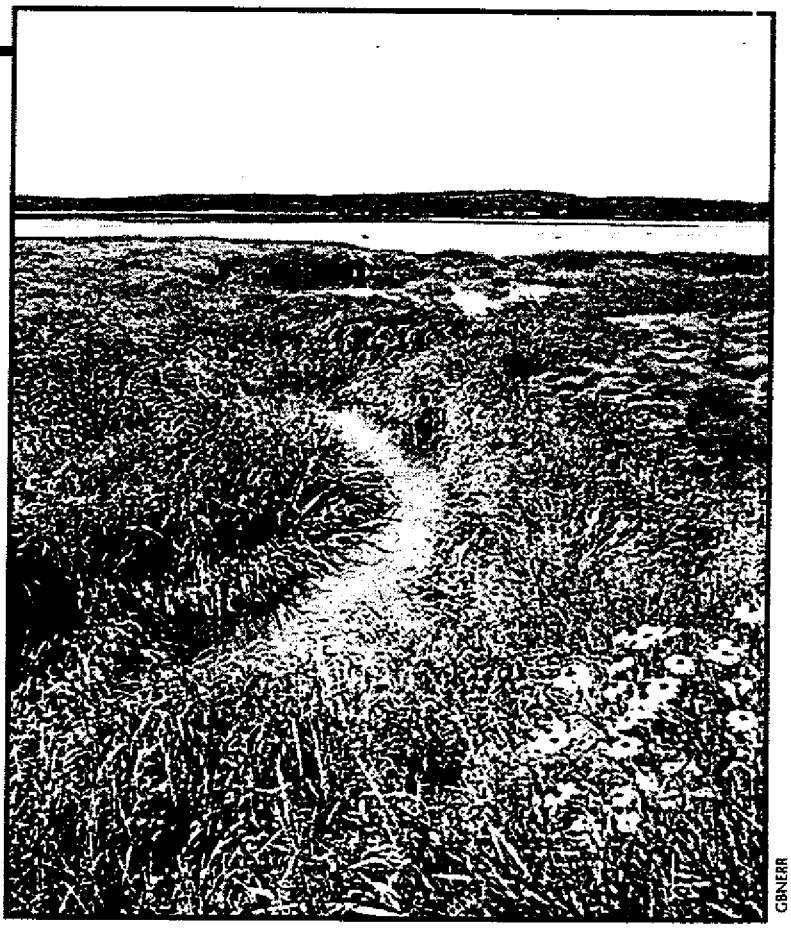
SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
			OCTOBER S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	DECEMBER S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	1 High Tide: 7:22 am, 7:43 pm Low Tide: 1:04 am, 1:29 pm Sunrise: 6:16 am, Sunset: 4:31 pm	2 High Tide: 8:16 am, 8:41 pm Low Tide: 2:00 am, 2:28 pm Sunrise: 6:18 am, Sunset: 4:30 pm
3 High Tide: 9:08 am, 9:37 pm Low Tide: 2:52 am, 3:23 pm Sunrise: 6:19 am, Sunset: 4:28 pm	4 High Tide: 9:57 am, 10:30 pm Low Tide: 3:43 am, 4:16 pm Sunrise: 6:20 am, Sunset: 4:27 pm	5 Election Day High Tide: 10:46 am, 11:22 pm Low Tide: 4:32 am, 5:08 pm Sunrise: 6:22 am, Sunset: 4:26 pm	6 **Sampling** High Tide: 11:35 am Low Tide: 5:22 am, 5:59 pm Sunrise: 6:23 am, Sunset: 4:25 pm	7 High Tide: 12:15 am, 12:26 pm Low Tide: 6:12 am, 6:51 pm Sunrise: 6:25 am, Sunset: 4:24 pm	8 High Tide: 1:09 am, 1:18 pm Low Tide: 7:04 am, 7:47 pm Sunrise: 6:26 am, Sunset: 4:22 pm	9 High Tide: 2:05 am, 2:13 pm Low Tide: 7:59 am, 8:44 pm Sunrise: 6:27 am, Sunset: 4:21 pm
10 High Tide: 3:04 am, 3:13 pm Low Tide: 8:58 am, 9:44 pm Sunrise: 6:29 am, Sunset: 4:20 pm	11 Veterans Day High Tide: 4:05 am, 4:16 pm Low Tide: 10:01 am, 10:46 pm Sunrise: 6:30 am, Sunset: 4:19 pm	12 High Tide: 5:08 am, 5:20 pm Low Tide: 11:06 am, 11:47 pm Sunrise: 6:32 am, Sunset: 4:18 pm	13 6:00 – 9:00 PM Chili and Chowdah High Tide: 6:08 am, 6:23 pm Low Tide: 12:10 pm Sunrise: 6:33 am, Sunset: 4:17 pm	14 High Tide: 7:03 am, 7:20 pm Low Tide: 12:45 am, 1:09 pm Sunrise: 6:34 am, Sunset: 4:16 pm	15 High Tide: 7:53 am, 8:12 pm Low Tide: 1:36 am, 2:02 pm Sunrise: 6:35 am, Sunset: 4:15 pm	16 High Tide: 8:35 am, 8:58 pm Low Tide: 2:21 am, 2:48 pm Sunrise: 6:36 am, Sunset: 4:14 pm
17 High Tide: 9:14 am, 9:39 pm Low Tide: 3:02 am, 3:30 pm Sunrise: 6:38 am, Sunset: 4:13 pm	18 High Tide: 9:49 am, 10:18 pm Low Tide: 3:38 am, 4:08 pm Sunrise: 6:39 am, Sunset: 4:12 pm	19 High Tide: 10:23 am, 10:55 pm Low Tide: 4:12 am, 4:43 pm Sunrise: 6:40 am, Sunset: 4:11 pm	20 Ann's Birthday High Tide: 10:56 am, 11:30 pm Low Tide: 4:46 am, 5:18 pm Sunrise: 6:42 am, Sunset: 4:10 pm	21 **Kit Clean-up?** High Tide: 11:29 am Low Tide: 5:19 am, 5:53 pm Sunrise: 6:43 am, Sunset: 4:09 pm	22 High Tide: 12:07 am, 12:05 pm Low Tide: 5:55 am, 6:31 pm Sunrise: 6:45 am, Sunset: 4:09 pm	23 High Tide: 12:45 am, 12:44 pm Low Tide: 6:33 am, 7:11 pm Sunrise: 6:46 am, Sunset: 4:08 pm
24 High Tide: 1:26 am, 1:27 pm Low Tide: 7:16 am, 7:55 pm Sunrise: 6:47 am, Sunset: 4:07 pm	25 High Tide: 2:12 am, 2:16 pm Low Tide: 8:04 am, 8:45 pm Sunrise: 6:48 am, Sunset: 4:07 pm	26 High Tide: 3:03 am, 3:10 pm Low Tide: 8:57 am, 9:39 pm Sunrise: 6:49 am, Sunset: 4:06 pm	27 High Tide: 3:59 am, 4:10 pm Low Tide: 9:57 am, 10:37 pm Sunrise: 6:51 am, Sunset: 4:06 pm	28 Thanksgiving High Tide: 4:58 am, 5:14 pm Low Tide: 11:01 am, 11:37 pm Sunrise: 6:52 am, Sunset: 4:05 pm	29 High Tide: 5:58 am, 6:20 pm Low Tide: 12:07 pm Sunrise: 6:53 am, Sunset: 4:05 pm	30 First Day of Hanukkah High Tide: 6:56 am, 7:24 pm Low Tide: 12:36 am, 1:11 pm Sunrise: 6:54 am, Sunset: 4:04 pm

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1 High Tide: 7:52 am, 8:24 pm Low Tide: 1:34 am, 2:12 pm Sunrise: 6:55 am, Sunset: 4:04 pm	**2** High Tide: 8:46 am, 9:21 pm Low Tide: 2:28 am, 3:08 pm Sunrise: 6:56 am, Sunset: 4:04 pm	**3** High Tide: 9:37 am, 10:16 pm Low Tide: 3:21 am, 4:02 pm Sunrise: 6:57 am, Sunset: 4:03 pm	**4** High Tide: 10:27 am, 11:08 pm Low Tide: 4:12 am, 4:54 pm Sunrise: 6:58 am, Sunset: 4:03 pm	**5** Kit Clean-Up and Inventory High Tide: 11:17 am Low Tide: 5:03 am, 5:44 pm Sunrise: 6:59 am, Sunset: 4:03 pm	**6** High Tide: 12:00 am, 12:07 pm Low Tide: 5:53 am, 6:35 pm Sunrise: 7:00 am, Sunset: 4:03 pm	**7** High Tide: 12:52 am, 12:57 pm Low Tide: 6:44 am, 7:26 pm Sunrise: 7:02 am, Sunset: 4:03 pm
8 High Tide: 1:44 am, 1:50 pm Low Tide: 7:36 am, 8:19 pm Sunrise: 7:02 am, Sunset: 4:03 pm	**9** High Tide: 2:37 am, 2:44 pm Low Tide: 8:31 am, 9:12 pm Sunrise: 7:03 am, Sunset: 4:03 pm	**10** High Tide: 3:32 am, 3:40 pm Low Tide: 9:28 am, 10:07 pm Sunrise: 7:04 am, Sunset: 4:03 pm	**11** High Tide: 4:27 am, 4:39 pm Low Tide: 10:28 am, 11:02 pm Sunrise: 7:05 am, Sunset: 4:03 pm	**12** High Tide: 5:22 am, 5:38 pm Low Tide: 11:29 am, 11:56 pm Sunrise: 7:06 am, Sunset: 4:03 pm	**13** High Tide: 6:15 am, 6:36 pm Low Tide: 12:28 pm Sunrise: 7:06 am, Sunset: 4:03 pm	**14** High Tide: 7:05 am, 7:30 pm Low Tide: 12:47 am, 1:22 pm Sunrise: 7:07 am, Sunset: 4:03 pm
15 High Tide: 7:51 am, 8:21 pm Low Tide: 1:35 am, 2:12 pm Sunrise: 7:08 am, Sunset: 4:03 pm	**16** High Tide: 8:33 am, 9:07 pm Low Tide: 2:19 am, 2:57 pm Sunrise: 7:09 am, Sunset: 4:03 pm	**17** High Tide: 9:13 am, 9:49 pm Low Tide: 2:59 am, 3:38 pm Sunrise: 7:10 am, Sunset: 4:04 pm	**18** High Tide: 9:51 am, 10:28 pm Low Tide: 3:38 am, 4:17 pm Sunrise: 7:10 am, Sunset: 4:04 pm	**19** High Tide: 10:27 am, 11:07 pm Low Tide: 4:15 am, 4:54 pm Sunrise: 7:11 am, Sunset: 4:04 pm	**20** High Tide: 11:05 am, 11:45 pm Low Tide: 4:53 am, 5:31 pm Sunrise: 7:11 am, Sunset: 4:05 pm	**21** Winter Solstice High Tide: 11:44 am Low Tide: 5:32 am, 6:10 pm Sunrise: 7:12 am, Sunset: 4:05 pm
22 High Tide: 12:25 am, 12:25 pm Low Tide: 6:13 am, 6:52 pm Sunrise: 7:13 am, Sunset: 4:06 pm	**23** High Tide: 1:07 am, 1:10 pm Low Tide: 6:56 am, 7:37 pm Sunrise: 7:13 am, Sunset: 4:06 pm	**24** High Tide: 1:53 am, 1:59 pm Low Tide: 7:47 am, 8:25 pm Sunrise: 7:13 am, Sunset: 4:07 pm	**25** Christmas High Tide: 2:43 am, 2:53 pm Low Tide: 8:41 am, 9:17 pm Sunrise: 7:14 am, Sunset: 4:07 pm	**26** High Tide: 3:36 am, 3:51 pm Low Tide: 9:39 am, 10:12 pm Sunrise: 7:14 am, Sunset: 4:08 pm	**27** High Tide: 4:33 am, 4:55 pm Low Tide: 10:43 am, 11:10 pm Sunrise: 7:15 am, Sunset: 4:09 pm	**28** High Tide: 5:32 am, 6:01 pm Low Tide: 11:49 am Sunrise: 7:15 am, Sunset: 4:09 pm
29 High Tide: 6:32 am, 7:08 pm Low Tide: 12:11 am, 12:55 pm Sunrise: 7:15 am, Sunset: 4:10 pm	**30** High Tide: 7:31 am, 8:11 pm Low Tide: 1:11 am, 1:58 pm Sunrise: 7:15 am, Sunset: 4:11 pm	**31** High Tide: 8:28 am, 9:10 pm Low Tide: 2:09 am, 2:56 pm Sunrise: 7:15 am, Sunset: 4:12 pm	NOVEMBER S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	JANUARY S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31		

APPENDIX IV State of the Estuaries

STATE OF THE ESTUARIES 2

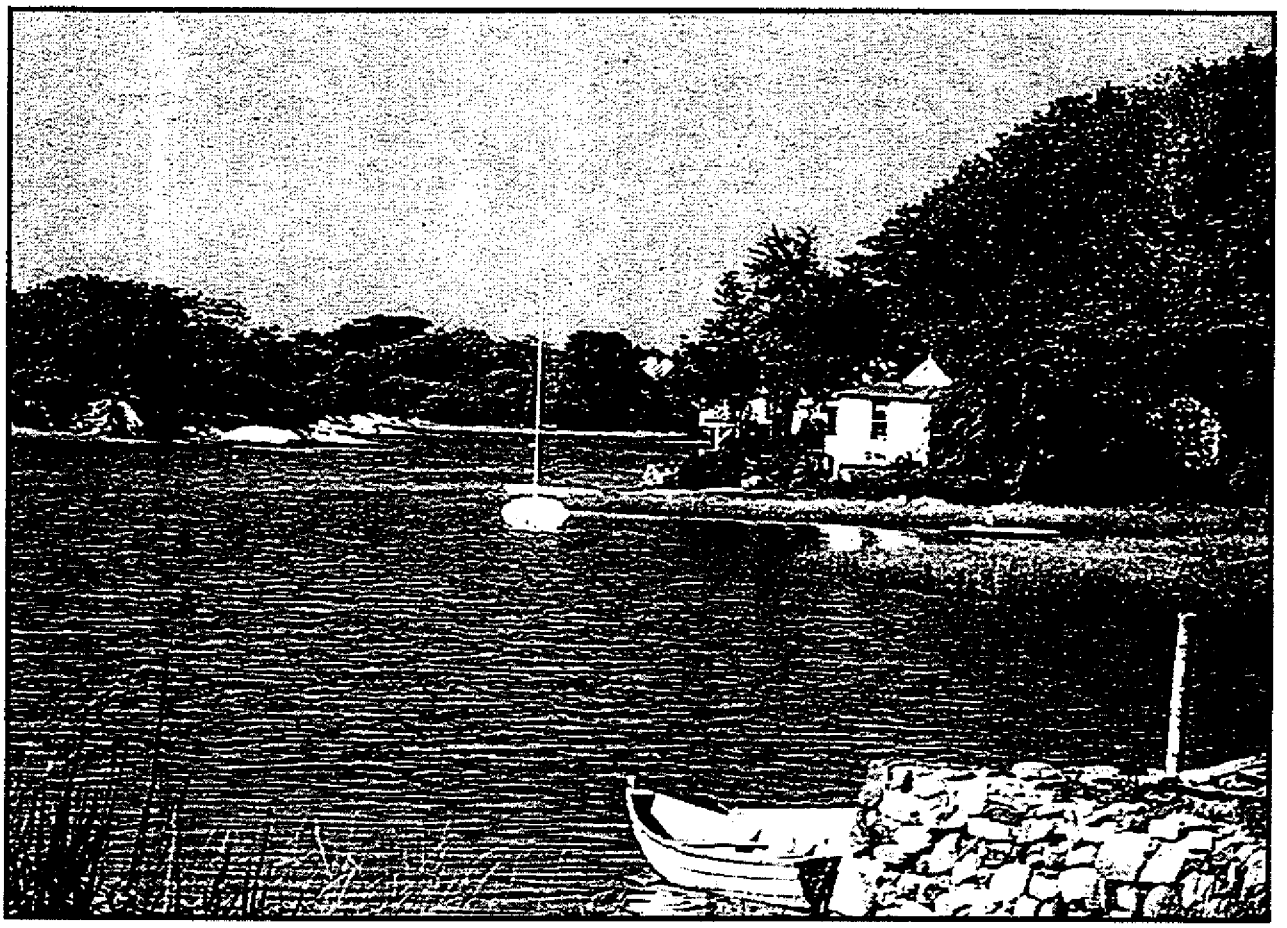
Estuaries are a vital component of the natural, aesthetic, and economic character of coastal New Hampshire. The cultural and natural history of the region has long been shaped by the abundant resources of New Hampshire's estuaries. Archaeological evidence shows that long before European colonization, people were drawn to New Hampshire's estuaries for the bountiful fish, shellfish, and game; to grow crops on the rich soils along the rivers; and to navigate the waterways.



Crommet Creek, Great Bay

The first European settlements in New Hampshire were located at the waters' edge to take advantage of the extraordinary fisheries of the rich estuaries and the nearby Gulf of Maine. Cod, lobster, alewives, sturgeon, menhaden, clams, and oysters sustained the first Europeans and formed the foundation of the early colonial economy. Coastal New Hampshire's link to the estuaries was further strengthened when the forests of the Great Bay watershed were harvested to supply the growing needs of colonial shipbuilding as new boatyards sprang up along the tidewaters. Soon after, enterprising industrialists looked to the tidal rivers and creeks of coastal New Hampshire for waterpower to drive mills and factories. Industry prospered with the combination of abundant waterpower, plentiful natural resources, and access to worldwide markets afforded by tidewater locations.

Today New Hampshire's estuaries still contribute to the economic, aesthetic, and environmental character of our state. However, the very attractions of the coastal location and resources pose a threat due to the affects of population growth and development on the environmental condition of the estuaries that supports the region's prosperity and appeal.



GBNERR

Little Harbor

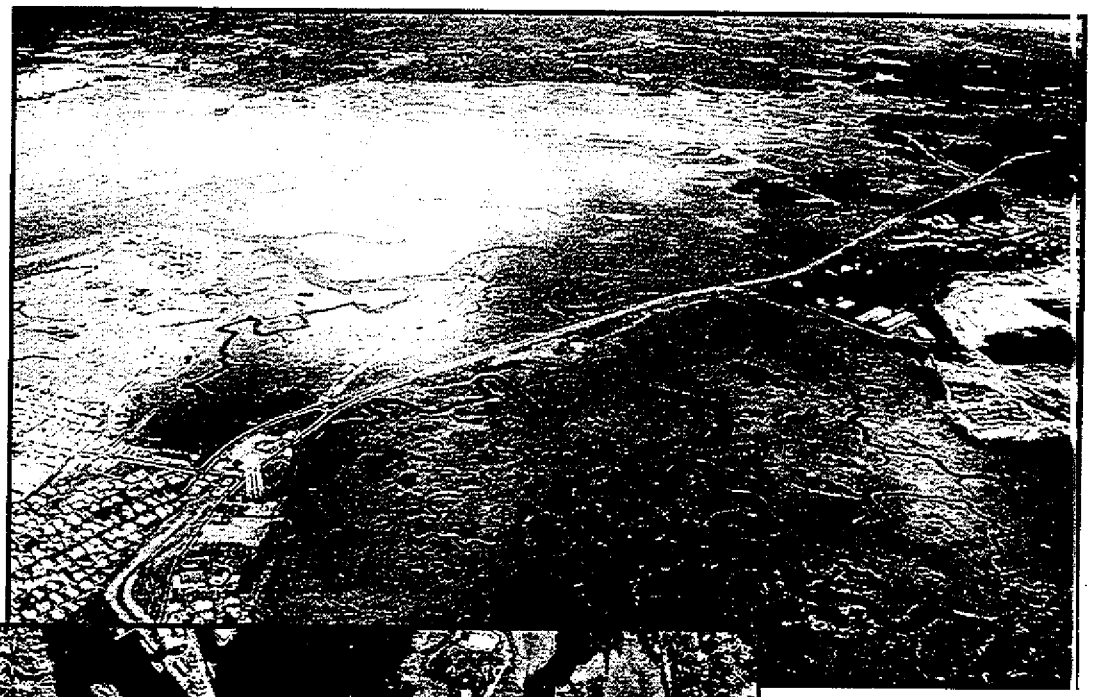
New Hampshire's estuaries face threats that imperil Seacoast traditions of fishing, shellfishing, and other water-dependent activities. Polluted stormwater runoff, overburdened septic systems, and wastewater treatment facility and industrial discharges, all threaten the environmental quality of our estuaries. These threats represent dangers to regional water quality, as well as to the host of living things that depend on New Hampshire's estuaries for their well-being, and make the estuaries so resource-rich.

The activities of area residents and visitors have profound impacts on the estuarine system. Boats put oil and other pollutants in the water, disturb plant and animal life, and erode banks. Shoreline development removes protective plant cover, disturbs soils, increases runoff, and disrupts wildlife habitat and corridors and scenic views. Population growth and development throughout the region add to stormwater problems and burden wastewater treatment systems.

New Hampshire's estuaries provide a coveted coastal atmosphere and setting for life along the coast, as they have throughout history. Located within an hour of Boston, Manchester, and Portland, this unique and beautiful land- and seascape attracts residents, businesses, and tourists, making the New Hampshire Seacoast one of the fastest-growing areas in New England – and compounding the pressures of development on the estuaries. We must use these resources responsibly, to safeguard this legacy for future generations.

WHAT IS AN ESTUARY?

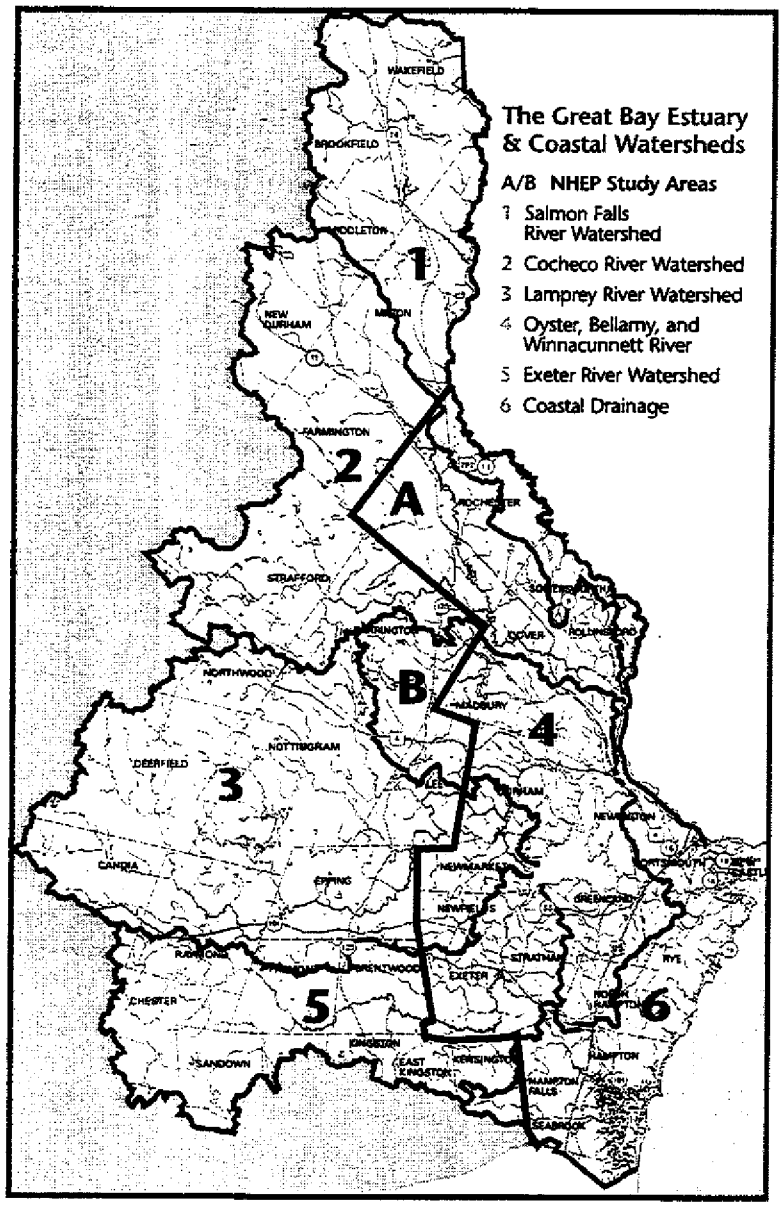
An estuary is a semi-enclosed embayment where freshwaters from rivers and streams mix with saltwater from the ocean. Estuaries are extraordinarily productive and diverse environments because of a unique set of conditions that create unusually nutrient-rich, protected waters. Many biologists consider estuaries among the most productive environments on earth.



Above: the Hampton Seabrook Estuar

Left: South an North Mill Ponds Portsmouth

JFE/UNH



Tidal Tributaries: Salmon Falls/Piscataqua River, Cocheco River, Bellamy River, Oyster River, Lamprey River, Squamscott River, Winnicut River.

NEW HAMPSHIRE'S ESTUARIES

With its Old Man of the Mountains icon, New Hampshire is more often associated with the White Mountains than with marine or estuarine habitat. However, New Hampshire has over 230 miles of sensitive tidal shoreline in addition to 18 miles of open-ocean coastline on the Gulf of Maine.

New Hampshire's estuaries are a varied collection of bays, tidal rivers, and salt marsh systems. The Great Bay and Hampton-Seabrook estuaries are the largest distinct estuaries in New Hampshire. Great Bay, Little Bay, the Squamscott River, and the tidal portions of the Lamprey, Oyster, Bellamy, Cocheco, and Salmon Falls Rivers, the Piscataqua River, Little Harbor, Rye Harbor, Hampton-Seabrook Harbor, and many smaller tidal tributaries are all part of New Hampshire's diverse estuarine systems.

Project Area

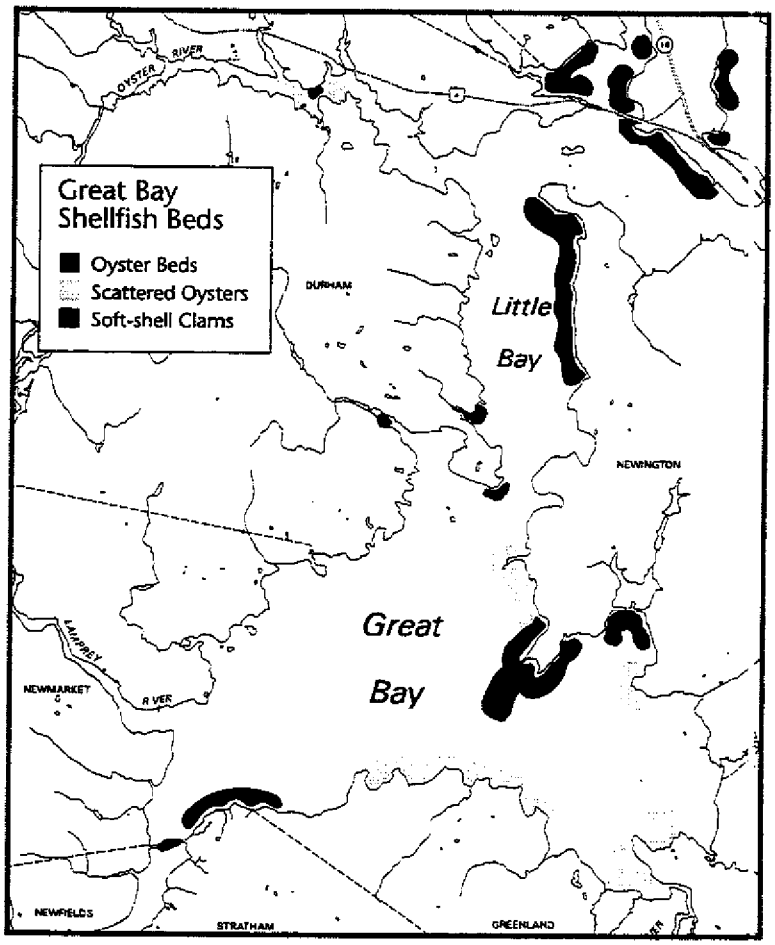
These watershed areas encompass the New Hampshire Estuaries Project study area which includes 43 municipalities, and are the focus of the actions included in the *Management Plan.* (See map of the New Hampshire estuaries watersheds on the inside cover of this *Plan.*)

The entire NHEP area of 43 towns is divided into Zone A and Zone B. The 19 communities of Zone A include all municipalities with tidal shoreline, plus Rochester and Somersworth. Many NHEP Action Plans focus on Zone A cities and towns since they have both the greatest impact and the greatest stake in the environmental health of the estuaries.

Great Bay

The Great Bay Estuary covers 17 square miles with nearly 150 miles of tidal shoreline. Great Bay is unusual because of its inland location, more than five miles up the Piscataqua River from the ocean. Due to its inland location, Great Bay's tidal exchange with the ocean is slow, requiring up to 18 days or 36 tide cycles for water entering the head of the estuary to move to the ocean. With much of Great Bay's shorelines still largely undeveloped, it has

been called "the unknown treasure of the New Hampshire Seacoast."



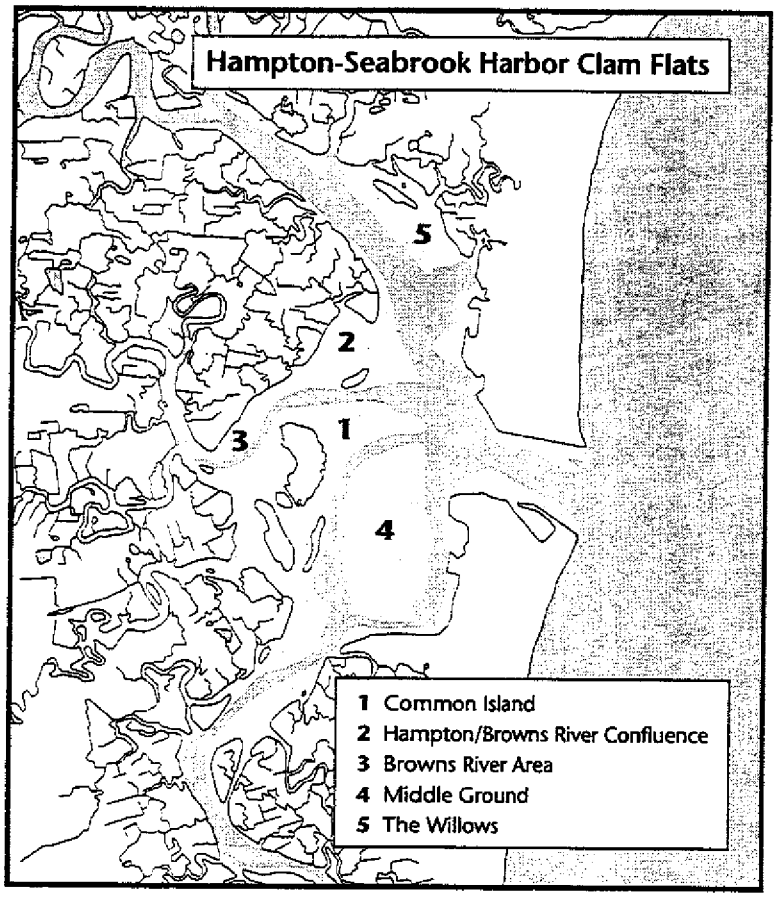
Recreational shellfishers harvest oysters and clams; fishing enthusiasts pursue striped bass, bluefish, herring, or smelt; lobstering is a commercial and recreational activity, and eels are trapped for bait and for export. Birders from all over the country and the world come to view migratory birds against this picturesque backdrop. Great Bay is the state's principal waterfowl overwintering site, and a focus area for the North American Waterfowl Management Plan. The Great Bay National Wildlife Refuge was established on just over 1,000 acres of the former Pease Air Force Base.

Great Bay's relatively undisturbed natural setting attracts scientists, researchers, and teachers interested in estuarine and marine processes, or salt marsh, mudflat, eelgrass, and other habitats. The University of New Hampshire, a land-grant, sea-grant, and space-grant university, is located in Durham within the Oyster River watershed of the Great Bay estuarine system. The University of New Hampshire and New Hampshire's Seacoast have become a nationally and internationally recognized center for research, teaching, and development of practical applications of marine and estuarine science and technology.

Recognized as an estuarine system of national significance, Great Bay is the site of the Great Bay National Estuarine Research Reserve and the University of New Hampshire's Jackson Estuarine Laboratory. The National Oceanic and Atmospheric Administration recently joined with the University of New Hampshire to establish the Cooperative Institute for Coastal and Estuarine Environmental Technology at UNH. The new Joint Hydrographic Center and the Center for Coastal and Ocean Mapping at UNH have drawn the top researchers in this emerging field.

Hampton-Seabrook Harbor

Hampton-Seabrook Harbor encompasses 475 acres of water at high tide. Characterized by extensive salt marshes and separated from the ocean by a series of barrier beaches, this estuary represents a more typical estuarine system. This estuary's 5,000 acres of contiguous salt marsh make it by far the largest salt marsh in the state. Hampton-Seabrook Harbor provides the backdrop for Hampton Beach, one of the busiest tourist attractions and vacation spots in the state. It is also the site of the North Atlantic Energy Service Corporation's Seabrook Station, a nuclear-powered electric generation facility.



Although surrounded by the busy seacoast communities of Seabrook, Hampton, Hampton Falls, and North Hampton, the Hampton-Seabrook Estuary hosts the best clamming in the state. Several thousand New Hampshire residents purchase shellfish licenses each year, most to dig the softshell or steamer clams of the Hampton-Seabrook Estuary.

Estuarine Watersheds

New Hampshire's estuaries are linked to the surrounding upland areas by the freshwater that drains through the Great Bay and coastal watersheds. On its course to the ocean, water collects a variety of materials of both natural and human origin, with profound impacts on the estuaries.

The 43 cities and towns in the 980 square-mile Great Bay and coastal watersheds are linked by water. From rainwater to groundwater, puddles to tidal rivers, across municipal and political boundaries, water moves unerringly through these watersheds along its course to the ocean. Each watershed resident is responsible for safeguarding our mutual interest in the water and natural character of the area, and for leaving a positive environmental legacy of improving the environmental condition of New Hampshire's estuaries.

New Hampshire has benefitted from its close association with the estuaries, but the estuaries themselves have paid a dear price for this association. Rivers that once supported substantial runs of anadromous fish (species that live in saltwater but spawn in freshwater), such as Atlantic salmon, American shad, and alewives and other river herring, now host minimal returns or none at all. Over-harvest and poor estuarine water quality have contributed to declines of seasonal fish populations that depend on estuaries as spawning and nursery grounds.

For many years, our estuaries were used as convenient dumping grounds for sewage and industrial wastes. The industrial history of the Great Bay and coastal watersheds are chronicled in the toxic materials trapped in sediments throughout the estuaries. Dams that once ran mills and factories now restrict freshwater flow and collect sediments. Much of New Hampshire's valuable salt marsh habitat has been lost or degraded to some degree by filling and constriction of tidal flows for roads and development, and by historic ditching and draining for harvesting salt marsh hay and to control mosquitoes. Today we are responsible for dealing with both historic and present-day sources of estuarine contamination.

A REPORT CARD ON NEW HAMPSHIRE'S ESTUARIES

The good news is that our estuaries remain among New Hampshire's crown jewels. The estuaries are a natural and cultural resource treasure. After a long history of sewage and industrial pollution, water quality has improved significantly over the last two decades. The estuaries contain valuable and productive habitats that support diverse species, some rare or endangered.

The bad news is that work remains to be done. Cleaning up the water of the estuaries is critical to the health of resources such as shellfish, and for people to use and enjoy estuarine resources.

The priority water quality problems include:

- Bacterial contamination from runoff from impervious areas, waste water treatment facilities (WWTFs) overloading and malfunctions, illegal direct discharges and cross-connections, and faulty septic systems;
- Nutrient contamination from WWTFs and non-point sources such as tributaries, surface runoff, septic systems, etc.;
- Toxic contaminants from historic industrial sites, oil spills, industrial and municipal wastewater, and stormwater runoff;
- Sediments from upland watersheds or rivers from runoff.

The priority living resource problems include:

- Oyster population declines
- Clam density declines
- Loss or fragmentation of wildlife habitat
- Degraded salt marshes

The management approaches for addressing these problems include:

- Stormwater management
- Elimination or reduction of pollution from WWTFs, cross-connections, and illegal discharges
- Outreach to local and regional planners
- Shellfish resource and sanitation management
- Land conservation
- Shoreland protection
- Limiting sprawl development

Habitat Protection

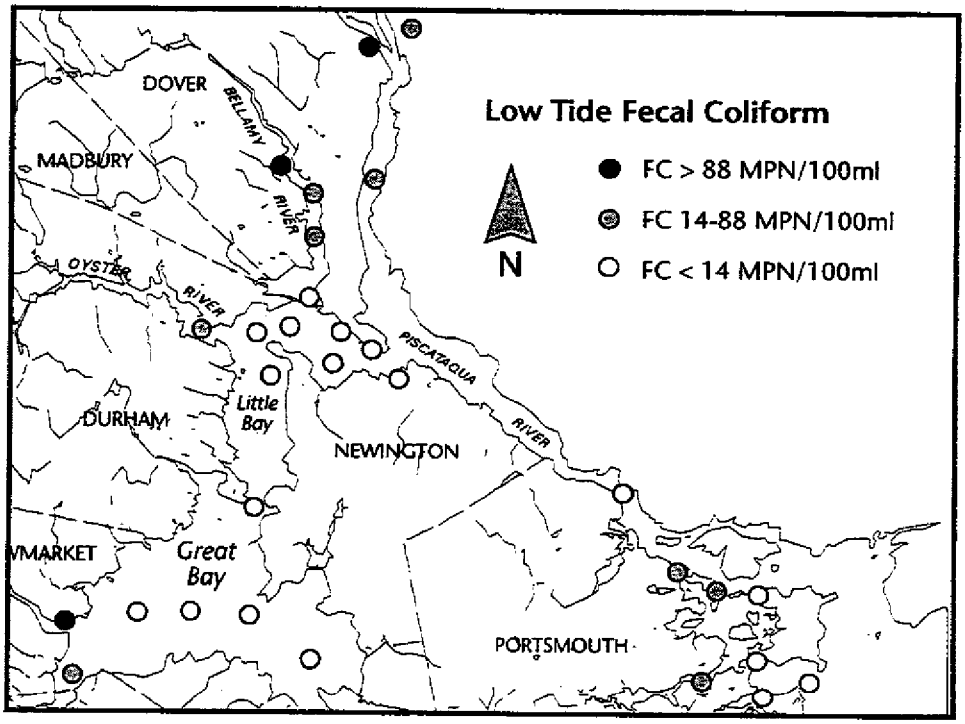
Improving water quality, and improving and restoring habitats and resource management will help address most of these problems. Growth and development present the greatest environmental challenges to the estuaries. In addition to solving existing problems, planning and preventive actions in the estuarine watersheds are needed to protect the estuaries from the increasing pressures of growth and development.

Water Quality

Water quality, an important indicator of environmental health, has a profound influence on the condition of nearly all estuarine habitats, plants, and animals. Water transports and redistributes harmful bacteria, excess nutrients, and toxic materials. Stormwater runoff contributes to degraded water quality and threatens many natural resources throughout the coastal watersheds.

Stormwater contaminates New Hampshire's estuarine waters with pathogenic bacteria and viruses, nutrients, sediment, trace metals and other toxins from roadways, parking lots, roofs, and residential and agricultural areas. Runoff from impervious surfaces carries bacteria and sediments, and is a significant source of trace metal and toxic organic contaminants. Storm runoff from disturbed areas carries sediments and associated nutrients. Runoff resulting from rainfall and snowmelt events in urban and urbanizing areas is the most common source of bacterial contamination in New Hampshire estuaries. This is due to a combination of inflow and infiltration to sewer pipes, overloaded wastewater treatment plants and combined sewer overflows (CSOs), and non-point source runoff. Bacterial contamination is the chief cause of shellfish bed closures.

Non-point source pollution (NPS) is water pollution that comes from diffuse sources and is carried to surface water by rainfall, snowmelt, or groundwater movement. NH DES estimates that over 90% of impairments to lakes, ponds,



Average levels, 1988-98. Levels greater than 14MPN/100ml lead to shellfish harvesting closures.

rivers, and streams statewide are due to non-point sources. Water quality monitoring studies show that non-point sources are a significant problem in New Hampshire coastal waters and tributaries, especially for bacterial contamination. Stormwater runoff can collect, transport, and deposit fecal bacteria, excess nutrients, oils and greases, toxic contaminants from pesticide and herbicide applications, toxic metals, and sediments eroded from shorelines and construction sites. Stormwater runoff, which can include storm sewer cross-connections, is considered the number one water quality problem facing the Seacoast region, and is a factor in keeping some shellfish beds closed.

Point source pollution, typified by both permitted and illegal direct discharges, is a continuing challenge to the environmental character of the coastal watersheds. Wastewater treatment facilities, industrial discharges, and power plants are the most common point sources. While these discharges are closely monitored and regulated through state and federal permitting processes, the demands of regional economic and residential growth challenge wastewater treatment plant capacities, spur demand for electric power, and accelerate the production of industrial waste products. Point source pollution, often characterized by continual low level contaminant loading, tends to increase proportionally with regional growth.

New Hampshire's estuaries are also subject to contamination from the air. **Atmospheric deposition** from both outside and within the state's borders is now recognized as an important source of pollutants to surface waters across the state. Lead, mercury, and nitrogen compounds are deposited directly into surface waters or onto upland watershed areas and delivered to the estuaries in stormwater runoff.

COASTAL AIR QUALITY

An ozone monitoring station at Rye Harbor no longer records levels of ozone that exceed the standards set by the US EPA. Earlier in the 1990s, ozone levels regularly violated EPA's one-hour ozone standard, indicating that the New Hampshire Seacoast, including Great Bay Estuary, had high tropospheric ozone levels. All of Rockingham County was within the ozone non-attainment region, therefore the estuary was in ozone non-attainment. New Hampshire no longer has any areas in violation of this standard.

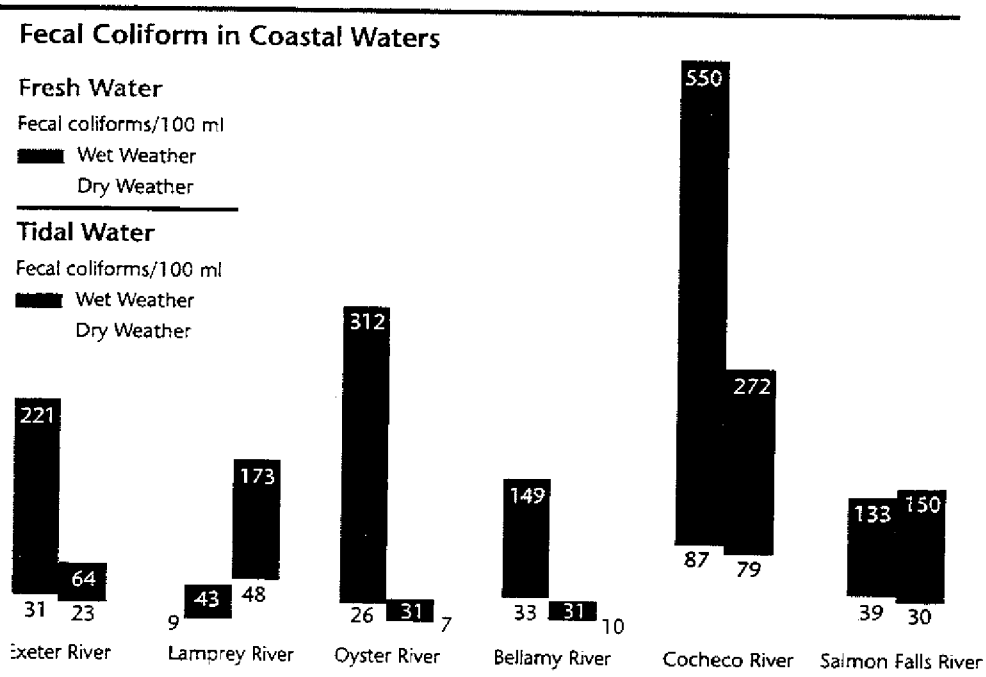
However, EPA recently created a more stringent ozone standard, based on an eight-hour average. Once EPA designates areas of attainment and non-attainment New Hampshire may have some areas that do not meet the eight-hour ozone standard. Air pollution presents health hazards to people and to wildlife, and pollutes surface water as atmospheric deposition. Still, citizens attending NHEP public meetings ranked air quality low in priority, probably because most Seacoast air pollution is beyond the reach of local control.

New Hampshire and other East Coast states affected by ozone pollution carried by air currents from other regions have joined together to form the Ozone Transport Assessment Group (OTAG) to study the problem and seek appropriate actions. Nitrogen oxides (NOx) and volatile organic compounds (VOCs) react together in sunlight to produce low level, or tropospheric, ozone. OTAG studies indicate that NOx is the limiting factor in the photoreaction of NOx and VOC. Of all the NOx generated in New Hampshire, 63% is from mobile sources (motor vehicles) while 24% is from point sources and 13% is from area sources. OTAG data also indicate that the majority of New Hampshire's ozone results from NOx emissions that occur to the south and west, or "upwind." The NH DES has petitioned EPA to mitigate the upwind emissions of NOx by requiring upwind sources to reduce their Nox emissions, in an attempt to reduce New Hampshire's ambient tropospheric ozone concentrations.

The Ozone Transport Assessment Group (OTAG) has completed their policy recommendations and submitted them to EPA for their action. Based on OTAG's data, EPA has proposed new NOx emissions figures that are directed at sources upwind of New Hampshire.

NH DES has also convened a Global Climate Change Workgroup representing a wide range of interests from virtually every sector throughout the state. Their charge is to suggest measures to NH DES to reduce emissions of greenhouse gases cost effectively and without detriment to the economy. There are currently no regulations at the state or federal level aimed specifically at controlling greenhouse gases.

Geometric mean fecal coliforms (colonies/100 ml) in water collected during dry weather and storm events for three consecutive years in tributaries to the Great Bay Estuary: 1993-96.



Bacteria

Fecal coliform bacteria in water is a warning of sewage contamination and may indicate the presence of disease-causing organisms. Found throughout New Hampshire's estuaries, fecal bacteria come from a variety of sources: faulty septic systems, overboard-marine toilet discharges, wastewater treatment facility overflows, and sanitary sewer-stormwater system cross connections. Cross connections occur when sanitary sewers leak – or are illegally connected – into stormwater systems, causing discharge of sewage-contaminated stormwater directly into surface waters. Waterfowl, pet, and livestock waste can also contribute to bacterial contamination. Because of the public health risks associated with these bacteria, fecal coliform levels are routinely monitored throughout coastal New Hampshire in both wet and dry weather. Shellfish beds are closed to harvesting when fecal coliform levels in water exceed 14 per 100 ml.

Although coliform counts in tidal rivers have been reduced dramatically since 1960, water quality sampling throughout the Great Bay Estuary tracks a pattern of elevated counts coming from urban runoff and wastewater treatment plants. Despite significant improvements in recent decades, wastewater treatment facilities (WWTF) in the Seacoast do not meet their required treatment standards 100% of the time. Factors affecting WWTF performance include equipment problems, operational changes, operator errors, storm events, and changes in waste stream. The most severe incidences of bacterial contamination from WWTFs follow rain events that cause systems to overflow.

Bacterial concentrations in New Hampshire estuaries are highest during or immediately after rainfall, indicating that much of the bacterial pollution comes from contaminated stormwater runoff. Storm-associated bacterial pollution has been found in all the primary rivers in the Great Bay watershed, with the highest levels found in the Cocheco River.

High background concentrations of bacteria in the Cocheco River under dry-weather conditions suggest ongoing sewage pollution. Cross-connections that add untreated waste to stormwater systems through cracked pipes and illegal connections are the most likely sources of dry-weather bacterial pollution. Stormwater systems then deliver contaminated water directly to the Cocheco River and streams flowing into Great Bay.

Nutrients

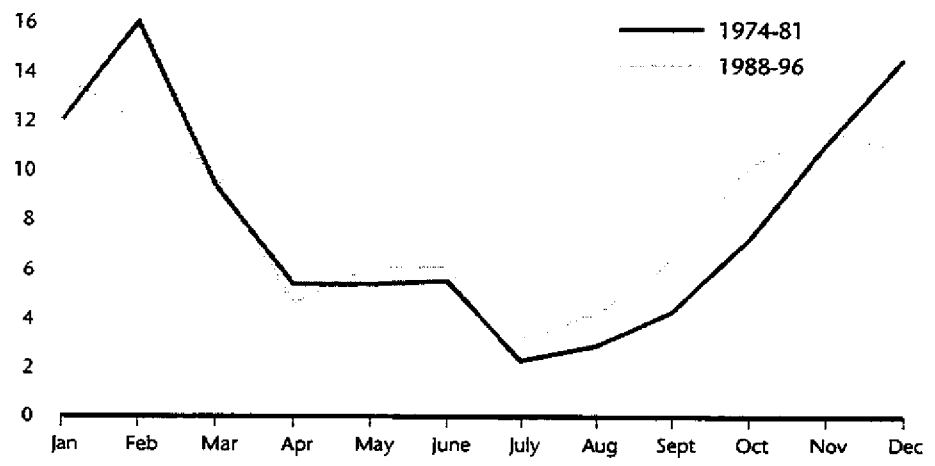
Estuarine systems are especially sensitive to excess nitrogen. Nitrogen is a naturally occurring nutrient essential for plants and algae. But too much nitrogen can promote unrestrained growth of nuisance algae. As these algae blooms die and decompose, they rob the water of oxygen, harming or killing estuarine and marine life.

Nutrient loading is the continual addition of nutrients from natural and human sources. The nutrient load to Great Bay from its tributary rivers comes from both point and non-point sources, and from atmospheric deposition. Nutrient loading occurs in all New Hampshire estuaries and their tributaries. Evidence suggests that nutrient concentrations within the main area of Great Bay have not changed significantly over the past twenty years. No widespread eutrophication effects have been observed. However, local isolated incidents of reduced oxygen levels and intense phytoplankton blooms have been observed in some freshwater tributaries of the Great Bay Estuary. Documented effects of phytoplankton blooms in other areas are rare. Thus, eutrophication and related impacts do not appear to be an imminent widespread problem.

No data is available on nutrient loading in Hampton-Seabrook, Rye, and Little harbors. But given the 80% tidal exchange twice a day, excess nutrients are not believed to be a problem.

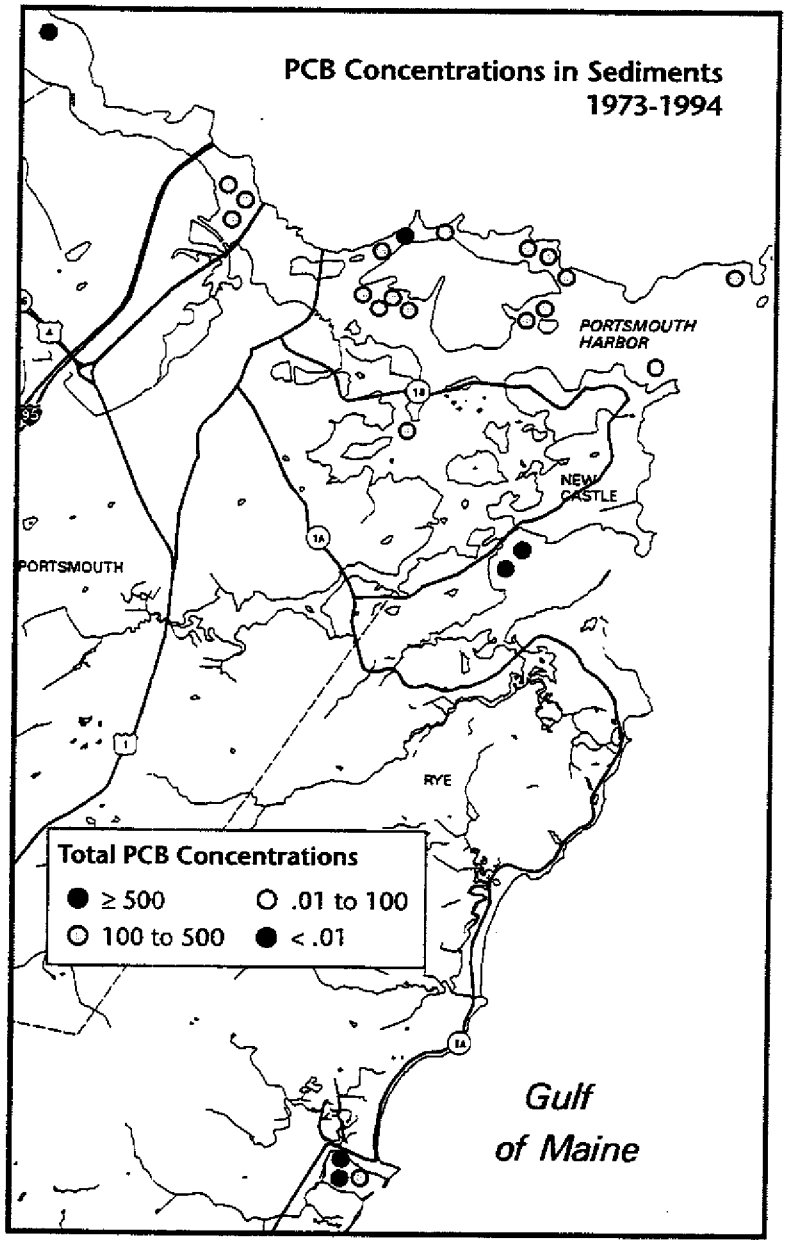
However, sources of nutrient contaminants such as wastewater treatment facility effluent, lawn fertilizer residue, septic systems, and runoff from impervious surfaces, will increase with human population growth and development pressures. For this reason, it is important to continue to monitor nutrient levels in New Hampshire's estuaries as a safeguard against gross nutrient contamination.

Dissolved Inorganic Nitrogen



Monthly mean dissolved inorganic nitrogen at Adams Point in Great Bay for the years 1973-81 and 1988-96.

Nutrient concentrations within the main area of Great Bay have not changed significantly over the past 20 years.



Spatial distribution of PCB concentrations showing hot spots in Hampton Harbor and near the Portsmouth Naval Shipyard.

Toxic Materials

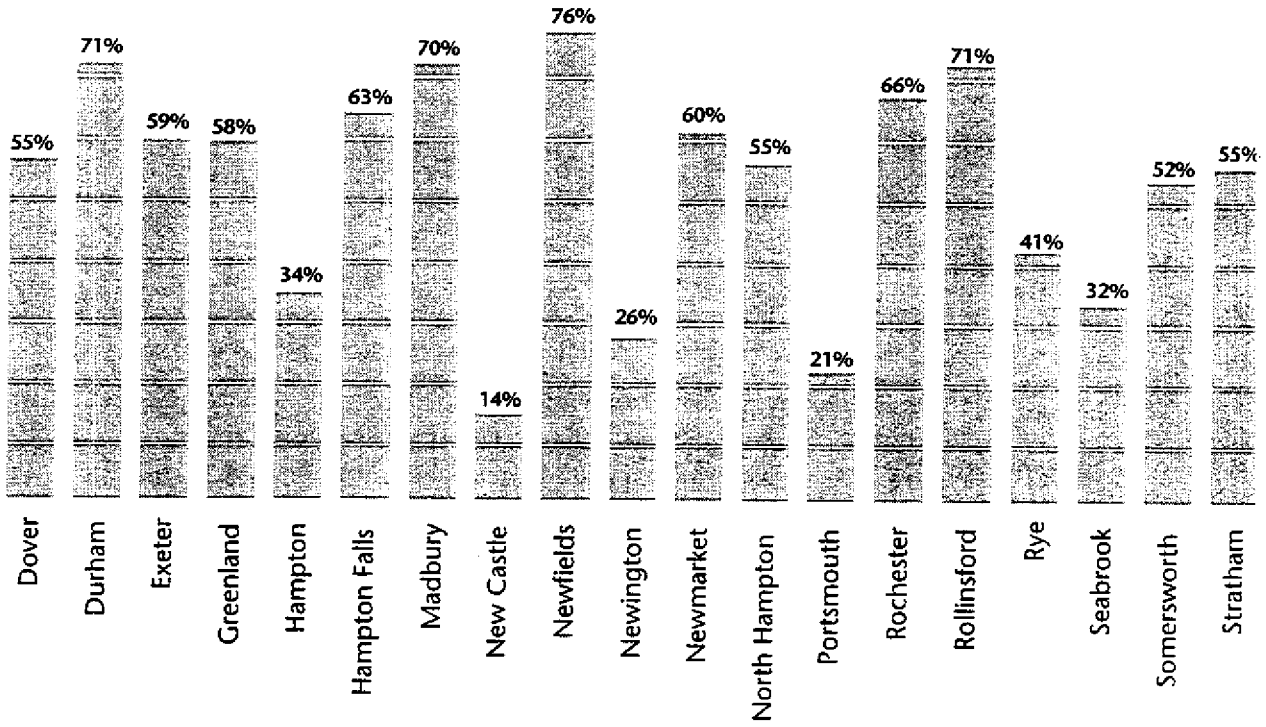
Heavy metal and toxic organic compounds are found throughout New Hampshire's estuaries. The Portsmouth Naval Shipyard, the former Pease Air Force Base, and a few other locations exhibit particularly elevated concentrations of some toxic contaminants. The most common toxic contaminants are chromium, lead, mercury, copper, zinc, and PCBs. A warning has been issued against consuming lobster tomalley due to PCB levels. DDT and other organic pollutants are present at elevated levels at some sites, but not at concentrations of concern to humans and other living things in most cases. Concentrations may warrant limited, localized concern, but remediation is complicated, with issues of stirring up and redistributing contaminants, disposing of dredgespoil, etc.

From colonial times mills, tanneries, and factories were built on the banks of our coastal rivers for their waterpower, shipping access, and easy waste disposal. A legacy of toxic contamination remains stored in the fine-grained sediments dispersed throughout the estuaries. Currently small doses of toxins enter the estuaries from permitted and monitored discharges, pesticides, atmospheric deposition, and occasional oil spills. Other suspected sources include municipal discharges, stormwater runoff, and groundwater contaminated with leachate from hazardous waste disposal sites.

Land Use and Regional Growth

Many of the threats to the environmental character of our estuaries are the direct result of human activities, including development of land for residential, commercial, industrial, and other uses. Continued population growth and development in the coastal region will add more impervious surfaces – paved areas, buildings, etc. – and add to the potential for increased stormwater-related, non-point source pollution. Negative impacts on both water quality and living resources can be managed through careful planning of development. New Hampshire communities – especially those with urbanized areas near surface waters – need technologies that effectively treat runoff.

Potentially Developable Land in the 19 Coastal New Hampshire Municipalities, 1998



The greatest threats to water quality, habitat, and quality of life from land use and development are:

See p. 5-2 for a map of potentially developable land described above.

Impervious surfaces created in the built environment add to the volume and velocity of stormwater, sending more pollutants and sediments through drains and tributaries or directly into the estuaries.

Shoreland development can destroy the natural buffering of vegetated and wooded soils against erosion and runoff, destroys wildlife habitat and travel corridors, and alters scenic vistas from both shore and water.

Sprawl development fragments wildlife habitat and corridors and reduces open space.

In the 19 New Hampshire towns with tidal shoreline (NHEP Zone A), approximately 30% of the land is currently developed. Studies indicate an additional remaining 15% is undevelopable due to permanent conservation and wetlands restrictions. Up to 55% of the total land area within these towns could potentially be developed, i.e., land with no legal restrictions or physical constraints that would prevent development. Future development will magnify runoff-associated problems and create new natural resource management issues by increasing impervious surfaces and destroying or degrading riparian and wetland habitats.

Shorelands are under particularly intense residential development pressure because many people desire to live by water in a coastal area. Shoreland development can impair a riparian area's ability to protect water quality and

provide habitat to several important wildlife species. Recent analyses indicate 35% of New Hampshire's tidal shoreland – defined as a strip of land extending 300 feet from the water's edge – is already developed. Just 16% of tidal shoreland is permanently protected, with an additional 21% likely to remain undeveloped because of natural resource constraints. But approximately 28% of the state's tidal shorelands remain open and developable. Both shoreland preservation and conscientious development of shorelands require careful planning and attention.

Natural Resources

The rich diversity of habitats found in New Hampshire's estuaries support a great variety of plants, animals, and fish, including rare and endangered species. Botanists have identified 67 rare plant species within the Great Bay and coastal watersheds, a dozen associated with estuarine environments.

These estuarine habitats include salt marshes, eelgrass beds, algal beds, rocky intertidal areas, barrier beaches, dunes, mud and sandflats, clam and oyster beds, and subtidal bottom habitats with substrate ranging from mud to cobble and boulders. The NH Coastal Program and the UNH Complex Systems Research Center are developing geographic information system (GIS) data to map the location and extent of these various habitat areas.

Protecting and buffering the variety of habitats found throughout the Great Bay and coastal watersheds safeguards the area's unique natural character, and supports the survival of the species that use and depend on these habitats. Preserving and protecting these important habitats demands careful planning as development pressures grow and human uses within the watershed increase.

Land Use Regulations for 19 Estuarine Communities in Coastal New Hampshire

Regulation	Number of Towns with Regulations	% Towns with Regulations
Master Plan	19	100%
Erosion Control	18	95%
Stormwater Control	17	89%
Wetland Protection	17	89%
Septic Control	15	79%
Gravel Extraction	14	74%
Open Space	13	68%
Floodplain Ordinances	13	68%
Aquifer Protection	12	63%
Shoreland Protection	12	63%
Chemicals/Toxics	8	42%
Growth Management	8	42%
Water Resource Management Protection Plan	5	26%
Marinas	4	21%
Impact Studies	3	16%
Biosolids	2	11%
Review Committees	2	11%

THE NHEP BASE PROGRAM ANALYSIS AND TECHNICAL CHARACTERIZATION

See Chapter 9 for more detailed recommendations from the Base Programs Analysis.

The National Estuaries Program requires a *Base Program Analysis* (BPA) of existing local and state regulatory and management programs for protecting estuarine resources. Gathering this background information was an essential step for the NHEP in designing a realistic and workable *Management Plan.* The NHEP Base Program Analysis, *Regulation and Management of New Hampshire's Estuaries,* evaluated the effectiveness of the existing framework, and provided valuable insight for identifying priority issues and management road-blocks.

The Water Quality; Land Use, Development, and Habitat Protection; Shellfish Resources; and Habitat Restoration chapters of the NHEP *Management Plan* and the Action Plans each have a technical or scientific component taken from *A Technical Characterization of Estuarine and Coastal New Hampshire,* and a regulatory and management section derived from the BPA. The *Technical Characterization* is a detailed review and analysis of current scientific research and knowledge of New Hampshire's estuaries, and is the source for most of the scientific and technical information contained in this *Management Plan.* Both the *Base Program Analysis* and the *Technical Characterization* are available from the NHEP.

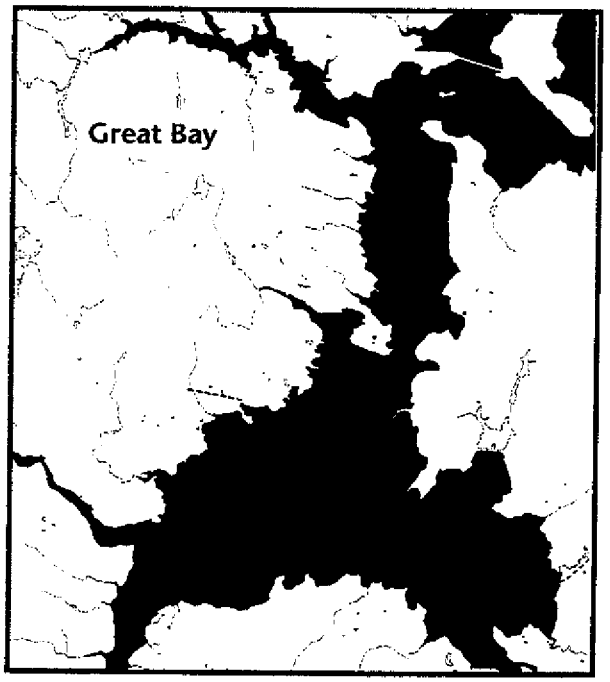
The *BPA* found a reasonably strong regulatory framework for natural resource protection of the estuaries. Programs for shoreland and wetland protection are sound, as are the point source permit program and septic regulations. While regulations for living resource conservation are adequate, follow through is limited in some cases.

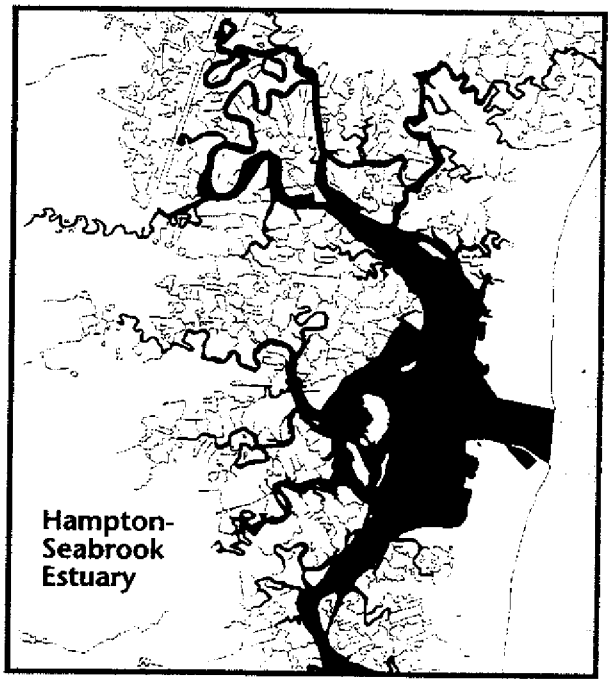
Most other regulatory programs rely on voluntary efforts and Best Management Practices (BMPs) to protect water quality. The effectiveness of this approach depends on BMPs keeping up with constant progress in treatment technologies and scientific understanding. Non-point source and stormwater control BMPs are currently being reviewed and updated.

The BPA identified several additional regulatory and management shortcomings. State stormwater and erosion control regulations apply only when areas of 100,000 square feet or more are disturbed (50,000 square feet in protected shoreland). Shoreland regulations are complicated. Wetlands mitigation practices lack clarity. Protection for vernal pools and wetland drainages is limited. NH Department of Transportation policy on site disturbances and stormwater runoff is unclear. A limited number of communities have used local regulations to address some of the state-level gaps, such as shoreland protection and stormwater and erosion controls.

Regulatory enforcement and site-specific monitoring are also important estuarine management issues. For example, current septic system maintenance and performance requirements are often unenforceable due to the large numbers of systems in each community. Enforcement of local regulations and adequate on-site monitoring can be an administrative burden for volunteer, part-time municipal officials.

1998 Shellfish Water Classifications





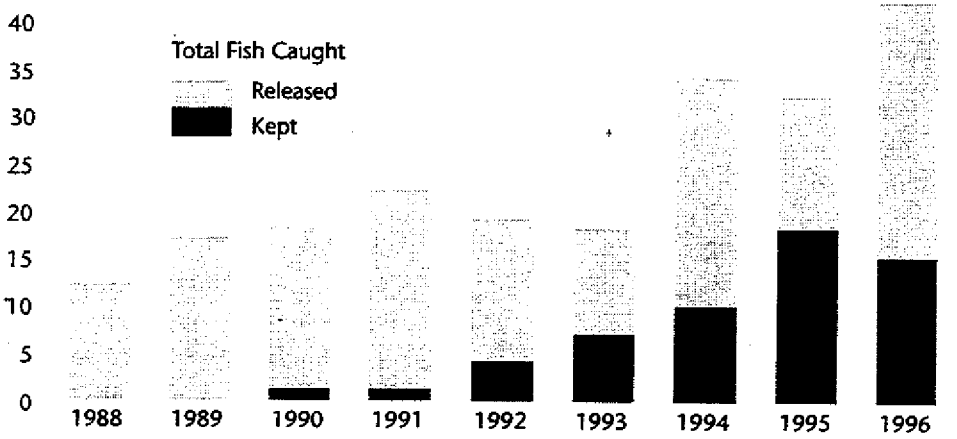
Shellfish Resources

Shellfish in New Hampshire are limited to recreational harvest only, because the state does not have a US Food & Drug Administration approved program for commercial harvesting. Shellfish harvest is a popular recreational pursuit in New Hampshire. However, oyster resources in the Great Bay Estuary have declined in recent years. From 1991 to 1996 oyster density reductions in three beds of recreational importance ranged from 42% to 69%. Other oyster beds have lost significant bed acreage, especially in the Oyster and Bellamy rivers. Oyster harvests reflect these declines: a 1991 study estimated a total harvest of 5,000 bushels of oysters by 1,000 license holders, but by 1997 the estimated harvest had declined to 2,700 bushels by 661 harvesters. Predation, limited availability of suitable larvae-attachment substrate, disease, harvest pressure, and a variety of management issues are likely factors in these declines.

Softshell clam resources in the Hampton-Seabrook Estuary are well documented. Adult populations on three particular flats of the estuary peaked in abundance in the early-to-mid 1980s, then declined sharply through the late 1980s. This decline was most likely due to intense recreational and illegal harvest pressure.

After the flats were closed to harvesting in the late 1980s, adult clam densities began to recover. Conditional reopening of the flats to harvest in 1994 appears not to have significantly affected the resource. From 1990 to 1995 adult clam densities quadrupled on the Middle Ground flat, while Common Island densities remained essentially unchanged. Clam densities in the Hampton River decreased by 50%. One suspected cause of this decrease is a lethal form of leukemia in clams. Little information is available on the softshell clam resources of the Great Bay Estuary and the Little Harbor-Back Channel area.

Tagged Striped Bass Catches



Striped bass caught in New Hampshire with U.S. Fish and Wildlife Service tags: 1988-96.

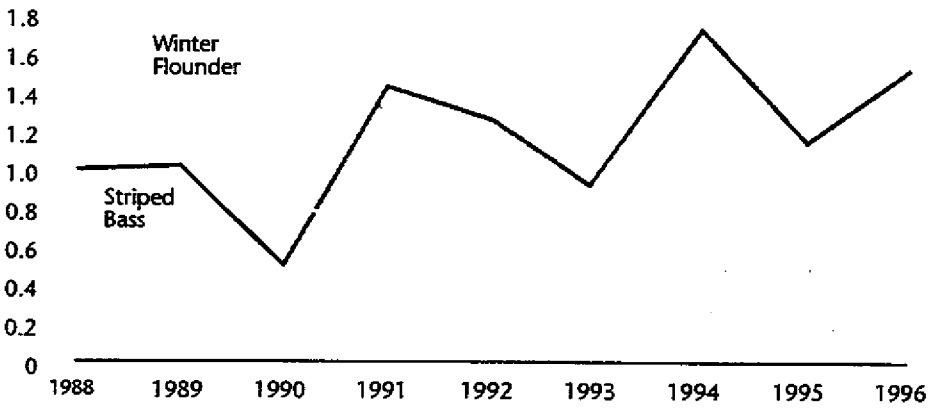
Finfish

A region-wide moratorium and subsequent harvest restrictions on striped bass in the 1980s and 1990s have resulted in dramatic gains in the seasonal occurrence of stripers in New Hampshire waters. Catches of both legal and undersized striped bass tagged by the U.S. Fish and Wildlife Service have increased steadily since 1988. Biologists and anglers generally confirm that fish of all sizes have increased in abundance.

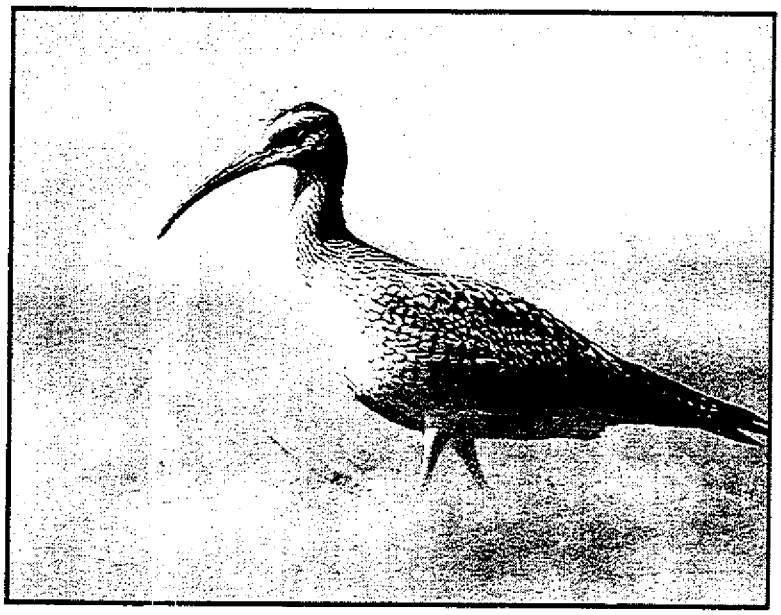
Recreational anglers have not enjoyed this same abundance with winter flounder. Catch per unit effort declined steadily from 1988 to 1993, rose briefly in 1994 and 1995, and then decreased again in 1996. Although juvenile fish appear abundant in the estuaries, adult populations have declined due to commercial harvest pressure in the Gulf of Maine. Commercial landings of winter flounder show a similar, steady decline.

Rainbow smelt catches have varied greatly at several locations in the Great Bay Estuary – peaking in the late 1980s, declining sharply in the early 1990s, and increasing in the mid 1990s. From 1975 to 1996 spring returns of river herring (alewife and blueback) declined in the Exeter, Lamprey, and Taylor rivers, but increased in the Oyster and Cocheco rivers.

Finfish Catches



Catch per trip of striped bass and winter flounder. Based on survey information.



Whimbrel

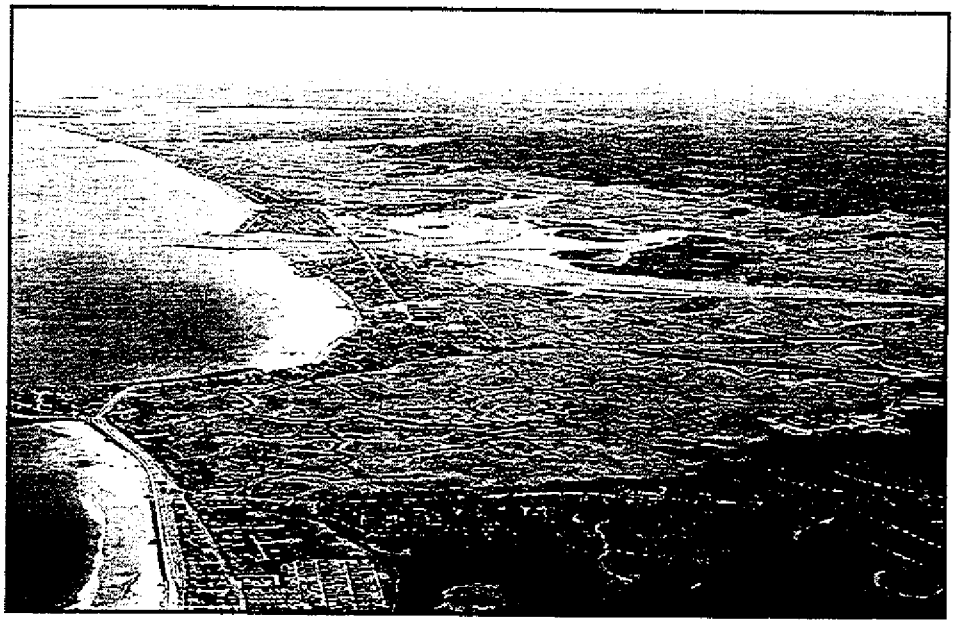
Waterfowl and Shorebirds

The Seacoast is the principal wintering location for waterfowl in New Hampshire, with 75% of the state's overwintering waterfowl found on Great Bay. State, federal, and locally controlled reserves and sanctuaries in the Great Bay area provide over 6,300 acres of wetlands salt marsh and upland habitat. As a result, Great Bay is an important destination for birders interested in a variety of waterfowl and shorebirds. Great Bay is also a focus area for the North American Waterfowl Management Plan. The Great Bay National Estuarine Research Reserve lists over 170 species by season and abundance on its checklist of the birds of Great Bay. A recent mid-winter survey recorded mallards, black ducks, greater and lesser scaup, goldeneye, bufflehead, red-breasted mergansers, and Canada geese as the predominant waterfowl.

Salt Marsh

The 5,000-acre salt marsh of the Hampton-Seabrook Estuary is the largest contiguous salt marsh in the state. Tidal marshes of the Great Bay Estuary total 2,230 acres, with the most extensive salt marshes found along the lower Piscataqua River, the Squamscott River, and Great Bay itself. The fringing marshes of the Great Bay Estuary wind along tidal shorelines between the low tide line and adjacent upland areas, wherever the soils, elevations, and tidal action are favorable.

The Hampton-Seabrook Estuary



GBNERR

MORRISON

Nearly all salt marshes in New Hampshire were subjected to ditching and draining at one time or another into the first half of this century, in attempts to control mosquitoes or increase harvest of salt marsh hay. Present salt marsh acreage in the state is half of what it once was, with most of the lost acreage filled for residential and industrial development and road or rail construction. Total salt marsh acreage has remained the same over the past decade. However, past development of salt marshes and road and railroad crossings have restricted water circulation and tidal flow within the remaining marshes. These changes in the natural tidal flow have degraded salt marsh function, with impacts including growth of invasive species such as purple loosestrife and *Phragmites australis* or common reed.

Recently a number of salt marshes in New Hampshire have been successfully restored by re-establishing tidal flow and freshwater exchange. Most of these projects have re-established tidal flow and exchange to marshes where tides were restricted by undersized or damaged culverts, water control structures, and/or berms of debris or dredge spoil. Recovery of marsh functions and habitat has been rapid and successful. By 1999 the collaborative efforts of many different agencies and landowners had restored or enhanced over 430 acres of salt marsh in New Hampshire.

Eelgrass

Eelgrass beds or meadows form subtidal and intertidal seagrass habitats which cover the greatest area of all habitat types in the Great Bay Estuary. Eelgrass habitats are important as breeding and nursery grounds for finfish, shellfish, and other invertebrates, and as feeding grounds for many fish, invertebrates, and birds. Eelgrass stabilizes bottom sediments, and may also filter nutrients, suspended sediments, and contaminants from estuarine waters.

Eelgrass

Eelgrass wasting disease (caused by the myxomycete *laburinthula sp.)* was first recognized in Great Bay in the 1940s. In the late 1980s wasting disease caused dramatic eelgrass declines in the Great Bay Estuary, arousing great concern into the early 1990s. However, historical eelgrass beds have made an impressive recovery of acreage and densities, and new beds have been observed in areas previously devoid of eelgrass. While overall the resource is improving, recovery of lost eelgrass areas has been significantly slower in Little Bay.

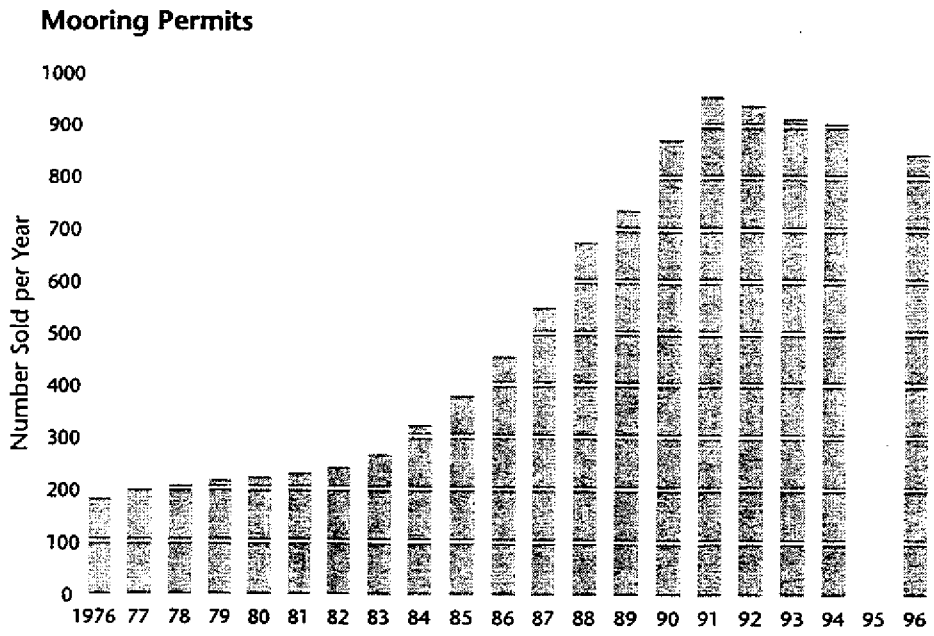
Eelgrass restoration efforts have been conducted at several sites in the Great Bay Estuary, including Little Bay where beds killed by the wasting disease have not recovered in over 10 years. Eelgrass restoration projects have also been undertaken in Rye Harbor and the Piscataqua River adjacent to the State Port Facility expansion.

Recreational and Commercial Uses

Recreational Tourism and Boating

Tourism and recreation are important to the Seacoast economy. Tourism is the region's second-largest industry, with over 15% of jobs tourism-related. Important recreational activities include boating, fishing and shellfishing, sailing, day cruises, and tours. Boating has grown in popularity since the 1980s, with over 8,500 boats registered for tidal waters in 1992. Annual mooring permit sales grew dramatically in the 1980s and into early 1990s, but have leveled off since the NH Port Authority implemented a harbor management plan. Canoeing, rowing, kayaking, and windsurfing are also popular activities in the estuaries.

Annual mooring permit sales by the New Hampshire Port Authority: 1976-1996



Commercial Fishing

The American lobster is the most important commercially harvested species in New Hampshire, yielding about $16 million annually. Lobsters migrate into the estuaries during late spring, with some moving well into Great Bay during the summer. Despite fishing pressure in estuarine and ocean areas from 300 lobster fishers, landings remained relatively stable during the 1990s, averaging almost 1.6 million pounds annually from 1992 to 1997. In 1996 a summer oil spill and an October salinity drop caused by a particularly heavy rainfall event (greater than 12 inches of rain in two days in some areas) had negative impacts on lobsters, particularly those in traps at the time of the events. Mortality estimates are not available, but slightly lower 1997 lobster catches may be partly due to these events.

Landings of cod and winter flounder, also important to New Hampshire's commercial fishing fleet, consistently declined from 1992 to 1997. Spiny dogfish, shrimp, sea urchin, and other species have gained importance to the state's fishing industry. Recent catch records suggest that these species may also be succumbing to increased fishing pressure.

Recreational Fishing

Recreational fishermen pursue a variety of species, including striped bass, bluefish, salmon, mackerel, tomcod, flounder, shad, and smelt. In addition to boat access, numerous shore and bridge locations are used for fishing. Several charter boat companies in the Great Bay and Hampton-Seabrook estuaries take fishermen to inshore and offshore locations. Almost 150 recreational lobstermen set traps throughout the Great Bay and Hampton-Seabrook estuaries. A 1990 NH Fish & Game study estimated 88,000 saltwater anglers spent over $52 million dollars on fishing-related expenses.

NHEP

Striped bass fisherman

Recreational Shellfishing

Recreational shellfishing is an important part of the history and tradition of coastal New Hampshire, with its almost 250 miles of tidal shoreline. Softshell (steamer) clams and oysters are the principal quarries of recreational harvesters, but other shellfish species are also sought. Oysters are primarily harvested from the Great Bay Estuary, while softshell clams are primarily dug from the Hampton-Seabrook Estuary. In 1994 almost 3,000 clamming licenses were sold to New Hampshire residents, while oyster harvesters numbered nearly 1,000. A UNH study in 1992 estimated that recreational clamming in the Hampton-Seabrook Estuary contributed nearly $3 million to the state and local economy.

However, over half the shellfish-growing waters in New Hampshire's estuaries remain closed to harvesting. Shellfish beds are closed due to bacterial contamination, and due to insufficient monitoring to declare areas open and shellfish safe for human consumption. The impacts of wastewater treatment plant overflows, stormwater/sewer cross connections, and stormwater runoff require closure of beds after even small amounts of rain. This demonstrates the links between human activity in the watershed, water quality, and shellfish sanitation.

The NHEP is using shellfish in a number of ways to achieve its water quality goals. First, shellfish are used to directly measure water quality improvements. As estuarine water quality improves, more shellfish beds reopen. Second, shellfish are recognized as a tangible, understandable, and reliable indicator of overall environmental health. Thriving populations of shellfish typically indicate that other estuarine species are also healthy, and help to improve water quality by filtering estuarine water. Finally, the NHEP seeks to reopen as many of the state's closed beds as possible for citizens who enjoy harvesting this public resource.

APPENDIX V Material Safety Data Sheets

MATERIAL SAFETY DATA SHEETS

CAT. NO. 1072

MATERIAL SAFETY DATA SHEET

PO#: UNKSER02
HACH ORDER#: 164682

MSDS DATE: 5/18/95
CHANGE NO.: 16874

For Assistance, Contact:
Regulatory Affairs Dept.
PO Box 907 Ames, IA 50010
(800) 227-4224

HACH COMPANY
PO BOX 907
AMES, IA 50010

Emergency Telephone #
Rocky Mountain Poison Ctr.
(303) 623-5716

I. PRODUCT IDENTIFICATION

PRODUCT NAME: Manganous Sulfate
CAS NO.: 7785-87-7 CHEMICAL NAME: Manganese Sulfate
FORMULA: MnSO4 CHEMICAL FAMILY: Inorganic Salts
MSDS NUMBER: MN029

II. INGREDIENTS

Manganous Sulfate
PCT: 100 CAS NO.: 7785-87-7 SARA: LISTED
TLV: 5 mg/m3 as Mn PEL: C: 5 mg/m3 as Mn
HAZARD: Systemic poison by inhalation.

III. PHYSICAL DATA

STATE: Solid APPEARANCE: Pink powder ODOR: Not determined
SOLUBILITY IN: WATER: Soluble ACID: Not determined
OTHER: Not determined BOILING POINT: NA MELTING PT.: >600°C
SPEC GRAVITY: ND pH: of 5% sols. = 3.7 VAPOR PRESSURE: Not applicable
VAPOR DENSITY (air=1): NA EVAPORATION RATE: NA
METAL CORROSIVITY - ALUMINUM: 0.002 in/yr STEEL: ND STABILITY: Stable
STORAGE PRECAUTIONS: Store in a cool, dry place.

IV. FIRE, EXPLOSION HAZARD AND REACTIVITY DATA

FLASH PT.: Not applicable METHOD: NA
FLAMMABILITY LIMITS - LOWER: NA UPPER: NA
SUSCEPTIBILITY TO SPONTANEOUS HEATING: None
SHOCK SENSITIVITY: None AUTOIGNITION PT.: ND
EXTINGUISHING MEDIA: Use media appropriate to the surrounding fire conditions.
FIRE/EXPLOSION HAZARDS: None reported
HAZARDOUS DECOMP. PRODUCTS: May emit toxic fumes of sulfur oxides and manganese oxides in fire
OXIDIZER: No NFPA Codes: Health: 2 Flammability: 0 Reactivity: 1
CONDITIONS TO AVOID: Extreme temperatures; contact with oxidizers or powdered metals

V. HEALTH HAZARD DATA

THIS PRODUCT MAY BE: Irritating to eyes, skin and respiratory tract.
ACUTE TOXICITY: Moderately toxic
ROUTES OF EXPOSURE: Inhalation
TARGET ORGANS: Lungs
CHRONIC TOXICITY: Cumulative poison
ROUTES OF EXPOSURE: Inhalation
TARGET ORGANS: central nervous system, blood
CANCER INFORMATION: Experimental mutagen and experimental teratogen
ROUTES OF EXPOSURE: Not determined
TARGET ORGANS: Not determined
OVEREXPOSURE: Chronic inhalation may cause psychiatric disorders characterized by irritability, difficulty walking, speech disturbances and compulsive behavior. May also cause mask-like facial expression, cirrhosis of the liver, and Parkinson's-like symptoms.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Persons with pre-existing respiratory, liver, or central nervous system conditions may be more susceptible to the effects of manganese poisoning.

VI. PRECAUTIONARY MEASURES

Avoid contact with eyes and skin.
Do not breathe dust.
Wash thoroughly after handling.
PROTECTIVE EQUIPMENT: Adequate ventilation, lab grade goggles, disposable latex gloves

VII. FIRST AID

EYE AND SKIN CONTACT: Immediately flush eyes with water for 15 minutes. Call physician. Flush skin with plenty of water.
INGESTION: Give large quantities of water or milk. Induce vomiting by sticking finger down throat. Never give anything by mouth to an unconscious person. Call physician.
INHALATION: Remove to fresh air. Give artificial respiration if necessary. Call physician.

VIII. SPILL AND DISPOSAL PROCEDURES

IN CASE OF SPILL OR RELEASE: Sweep up powder. Avoid breathing material. Dissolve in water. Flush down the drain with excess water.
DISPOSE OF IN ACCORDANCE WITH ALL FEDERAL, STATE, AND LOCAL REGULATIONS.

IX. TRANSPORTATION DATA

D.O.T. PROPER SHIPPING NAME: Not Currently Regulated
HAZARD CLASS: NA ID: NA GROUP: NA

I.C.A.O. PROPER SHIPPING NAME: Not Currently Regulated
HAZARD CLASS: NA ID: NA GROUP: NA

I.M.O. PROPER SHIPPING NAME: Not Currently Regulated
HAZARD CLASS: NA ID: NA GROUP: NA

X. REFERENCES

1) TLV's: Threshold Limit Values and Biological Exposure Indices for 1988-1989. American Conference of Governmental Industrial Hygienists, 1988.
2) Air Contaminants, Federal Register, Vol. 54, No. 12, Thursday, January 19, 1989. pp. 2332-2983.
3) Sax, N. Irving. Dangerous Properties of Industrial Materials. 6th Ed. New York: Van Nostrand Reinhold Co. 1984.
4) Gosselin, R.E. et al. Clinical Toxicology of Commercial Products. 5th Ed. Baltimore: The William and Wilkins Co., 1984.
5) Vendor information.
6) Technical judgment
7) Casarett and Doull's Toxicology. 3rd Ed. New York: Macmillan Publishing Co., Inc. 1986.
8) NIOSH Registry of Toxic Effects of Chemical Substances. 1985-86. Cincinnati: U. S. Department of Health and Human Services, April, 1987.
9) List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labelling of Dangerous Substances, Amended November, 1986.

SARA: This product contains a chemical or chemicals subject to the reporting requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

CAT. NO. 1072

MATERIAL SAFETY DATA SHEET

PO#: DAVSGR82
HACH ORDER#: 166482

ISSUE DATE: 4/11/95
CHANGE NO.: 15858

For Assistance, Contact:
Regulatory Affairs Dept.
PO Box 907 Ames, IA 50010
(800) 227-4224

HACH COMPANY
PO BOX 907
AMES, IA 50010

Emergency Telephone #
Rocky Mountain Poison Ctr.
(303) 623-5716

I. PRODUCT IDENTIFICATION

PRODUCT NAME: Alkaline Iodide-Azide Reagent
CAS NO.: NA CHEMICAL NAME: Not applicable
FORMULA: Not applicable CHEMICAL FAMILY: Not applicable
MSDS NUMBER: 000028

II. INGREDIENTS

Lithium Hydroxide, Monohydrate
PCT: <45 CAS NO.: 1310-66-3 SARA: NOT LISTED
TLV: Not established PEL: Not established
HAZARD: Very toxic; corrosive

Potassium Iodide
PCT: <40 CAS NO.: 7681-11-0 SARA: NOT LISTED
TLV: Not established PEL: Not established
HAZARD: May cause irritation

Sodium Azide
PCT: <5 CAS NO.: 26628-22-8 SARA: LISTED
TLV: C: 0.11 ppm PEL: C: 0.3 ppm(CEILING)
HAZARD: Extremely toxic; May cause irritation; Explosion hazard

III. PHYSICAL DATA

STATE: solid APPEARANCE: White crystals ODOR: None
SOLUBILITY IN: WATER: Soluble ACID: Not determined
OTHER: Not determined BOILING POINT: NA MELTING PT.: 110°C(230°F)
SPEC GRAVITY: 1.94 pH: of 5% soln. = 12.6
VAPOR PRESSURE: Not applicable VAPOR DENSITY (air=1): NA
EVAPORATION RATE: NA METAL CORROSIVITY - ALUMINUM: 0.268 in/yr
STEEL: NO STABILITY: Stable
STORAGE PRECAUTIONS: Store in a cool, dry place.

IV. FIRE, EXPLOSION HAZARD AND REACTIVITY DATA

FLASH PT.: Not applicable METHOD: NA
FLAMMABILITY LIMITS - LOWER: NA UPPER: NA
SUSCEPTIBILITY TO SPONTANEOUS HEATING: None
SHOCK SENSITIVITY: Not determined AUTOIGNITION PT.: NO
EXTINGUISHING MEDIA: dry chemical. DO NOT USE WATER
FIRE/EXPLOSION HAZARDS: Contact with metals may give off flammable hydrogen gas.
HAZARDOUS DECOMP. PRODUCTS: Toxic fumes of potassium oxides, NOx, sodium oxides, and iodine & iodine compounds.
OXIDIZER: No NFPA Codes: Health: 3 Flammability: 1 Reactivity: 1
CONDITIONS TO AVOID: Exposure to heat or flames; excess moisture; contact with acids or oxidizers.

V. HEALTH HAZARD DATA

THIS PRODUCT MAY BE: corrosive to eyes, skin and respiratory tract.
ACUTE TOXICITY: Oral rat LD50 = 350 mg/kg = Very toxic
ROUTES OF EXPOSURE: ingestion, inhalation, skin absorption
TARGET ORGANS: central nervous system, liver, kidneys, spleen, lungs, bone marrow
CHRONIC TOXICITY: Not determined
ROUTES OF EXPOSURE: ingestion, inhalation, skin absorption
TARGET ORGANS: central nervous system, liver, kidneys
CANCER INFORMATION: An ingredient of this mixture is an experimental mutagen.
ROUTES OF EXPOSURE: ingestion
TARGET ORGANS: Not determined
OVEREXPOSURE: Causes severe burns, hypotension. May cause respiratory stimulation then depression, anoxia, central nervous system depression, coma, death. Chronic iodide overdose may cause skin rash, runny nose, headaches, fever and irritation of mucous membranes.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Pre-existing: eye, skin, kidney, liver, or respiratory conditions; may cause a larger drop in blood pressure in hypotensive persons than in normotensive persons

VI. PRECAUTIONARY MEASURES

Avoid contact with eyes, skin and clothing
Do not breathe dust.
Wash thoroughly after handling.
PROTECTIVE EQUIPMENT: fume hood, lab grade goggles, rubber gloves, lab coat

VII. FIRST AID

EYE AND SKIN CONTACT: Immediately flush eyes and skin with water for 15 minutes. Remove contaminated clothing. Call physician.
INGESTION: Do NOT induce vomiting. Give 1 - 2 glasses of water. Call a Physician immediately. Never give anything by mouth to an unconscious person.
INHALATION: Remove to fresh air. Give artificial respiration if necessary. Call physician.

VIII. SPILL AND DISPOSAL PROCEDURES

IN CASE OF SPILL OR RELEASE: Scoop material into a beaker and dissolve w/ water. Neutralize to a pH between 6 and 9 with an acid such as hydrochloric acid. Flush neutralized waste to the drain with excess water.
DISPOSE OF IN ACCORDANCE WITH ALL FEDERAL, STATE, AND LOCAL REGULATIONS.

IX. TRANSPORTATION DATA

D.O.T. PROPER SHIPPING NAME: Lithium Hydroxide, Solid Mixture
HAZARD CLASS: 8 ID: UN2680 GROUP: II

I.C.A.O. PROPER SHIPPING NAME: Lithium Hydroxide Monohydrate Mixture
HAZARD CLASS: 8 ID: UN2680 GROUP: II

I.M.O. PROPER SHIPPING NAME: Lithium Hydroxide Monohydrate Mixture
HAZARD CLASS: 8 ID: UN2680 GROUP: II

X. REFERENCES

1) TLV's: Threshold Limit Values and Biological Exposure Indices for 1988-1989. American Conference of Governmental Industrial Hygienists.
2) Air Contaminants, Federal Register, Vol. 54, No. 12, Thursday, J 19, 1989. pp. 2332-2983.
3) In-house information
4) Technical judgment
5) Oxitrim testing.
6) Patty, Frank A. Industrial Hygiene and Toxicology, 3rd Revised Editi Volume 2. New York: A Wiley-Interscience Publication, 1981.
7) Sax, N. Irving. Dangerous Properties of Industrial Materials. 6th Ed. New York: Van Nostrand Reinhold Co. 1984.
8) NIOSH Registry of Toxic Effects of Chemical Substances, 1985-86. Cincinnati: U. S. Department of Health and Human Services, April, 19

SARA: This product contains a chemical or chemicals subject to the reporting requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

CAT. NO. 1073

MATERIAL SAFETY DATA SHEET

PO#: BAKER02
HACH ORDER#: 166482

MSDS DATE: 1/01/95
CHANGE NO.: 12065

For Assistance, Contact:
Regulatory Affairs Dept.
PO Box 907 Ames, IA 50010
(800) 227-4224

HACH COMPANY
PO BOX 907
AMES, IA 50010

Emergency Telephone #
Rocky Mountain Poison Ctr.
(303) 623-5716

I. PRODUCT IDENTIFICATION

PRODUCT NAME: Sulfamic Acid Powder Pillows
CAS NO.: 5329-14-6 CHEMICAL NAME: Sulfamic acid
FORMULA: $HOSO_2NH_2$ CHEMICAL FAMILY: Inorganic Acids
MSDS NUMBER: M00087

II. INGREDIENTS

Sulfamic Acid
PCT: <100 CAS NO.: 5329-14-6 SARA: NOT LISTED
TLV: Not established PEL: Not established
HAZARD: Causes eye burns; causes skin irritation, moderately toxic

Other component
PCT: <1 CAS NO.: NA SARA: NOT LISTED
TLV: Not applicable PEL: Not applicable
HAZARD: Not applicable

Any component of this mixture not specifically listed (eg. "other components") is not considered to present a carcinogen hazard.

III. PHYSICAL DATA

STATE: solid APPEARANCE: White crystalline powder ODOR: None
SOLUBILITY IN: WATER: 1:2 @ 68 C ACID: Soluble
OTHER: Slightly soluble alc., methanol BOILING POINT: NA
MELTING PT.: 205°C decomp SPEC GRAVITY: 2.15 pH: of 1% soln = 1.18
VAPOR PRESSURE: Not applicable VAPOR DENSITY (air=1): NA
EVAPORATION RATE: NA METAL CORROSIVITY - ALUMINUM: 0.212 in/yr
STEEL: 0.814 in/yr STABILITY: Stable
STORAGE PRECAUTIONS: Store tightly closed in a dry place.

IV. FIRE, EXPLOSION HAZARD AND REACTIVITY DATA

FLASH PT.: Not applicable METHOD: NA
FLAMMABILITY LIMITS - LOWER: NA UPPER: NA
SUSCEPTIBILITY TO SPONTANEOUS HEATING: None
SHOCK SENSITIVITY: None AUTOIGNITION PT.: ND
EXTINGUISHING MEDIA: water or dry chemical
FIRE/EXPLOSION HAZARDS: Reacts violently with chlorine, fuming nitric acid, metal nitrates, metal nitrites
HAZARDOUS DECOMP. PRODUCTS: May emit toxic fumes of sulfur oxides, nitrogen and ammonia oxides in fire
OXIDIZER: No NFPA Codes: Health: 2 Flammability: 1 Reactivity: 1
CONDITIONS TO AVOID: Contact with chlorine or fuming nitric acid, metal nitrates, metal nitrites, oxidizers, bases; extreme heat or flame; excess moisture

V. HEALTH HAZARD DATA

THIS PRODUCT MAY BE: corrosive to eyes, irritating to skin and respiratory tract.
ACUTE TOXICITY: Oral rat LD_{50} = 3160 mg/Kg = Moderately toxic
ROUTES OF EXPOSURE: ingestion, inhalation
TARGET ORGANS: Not determined
CHRONIC TOXICITY: Not determined
ROUTES OF EXPOSURE: Not determined
TARGET ORGANS: Not determined
CANCER INFORMATION: Not applicable
ROUTES OF EXPOSURE: Not applicable
TARGET ORGANS: Not applicable
OVEREXPOSURE: Causes eye burns. May cause irritation at the skin, respiratory tract, mouth, oesophagus, and gastrointestinal tract.
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Pre-existing eye, skin and respiratory conditions

VI. PRECAUTIONARY MEASURES

Avoid contact with eyes, skin and clothing
Do not breathe dust.
Wash thoroughly after handling.
Keep away from heat, sparks and open flame.
PROTECTIVE EQUIPMENT: adequate ventilation, lab grade goggles, rubber gloves, lab coat

VII. FIRST AID

EYE AND SKIN CONTACT: Immediately flush eyes and skin with water for 15 minutes. Remove contaminated clothing. Call physician.
INGESTION: Do NOT induce vomiting. Give 1 - 2 glasses of water. Call a physician immediately. Never give anything by mouth to an unconscious person.
INHALATION: Remove to fresh air.

VIII. SPILL AND DISPOSAL PROCEDURES

IN CASE OF SPILL OR RELEASE: Cover contaminated surfaces with soda ash or sodium bicarbonate. Mix and add water if necessary. Use litmus paper to make sure pH of slurry is neutral or add neutralizer until mixture stops bubbling. Scoop up the slurry and wash the neutral waste down the drain with excess water. Wash the site with soda ash solution.
DISPOSE OF IN ACCORDANCE WITH ALL FEDERAL, STATE, AND LOCAL REGULATIONS.

IX. TRANSPORTATION DATA

D.O.T. PROPER SHIPPING NAME: Sulphamic Acid
HAZARD CLASS: 8 ID: UN2967 GROUP: III

I.C.A.O. PROPER SHIPPING NAME: Sulphamic Acid
HAZARD CLASS: 8 ID: UN2967 GROUP: III

I.M.O. PROPER SHIPPING NAME: Sulphamic Acid
HAZARD CLASS: 8 ID: UN2967 GROUP: III

X. REFERENCES

1) TLV's Threshold Limit Values and Biological Exposure Indices for 1988-1989. American Conference of Governmental Industrial Hygienists. 1988.
2) Air Contaminants. Federal Register, Vol. 54, No. 12, Thursday, January 19, 1989. pp. 2332-2983.
3) In-house information
4) Sax, N. Irving. Dangerous Properties of Industrial Materials. 6th Ed. New York: Van Nostrand Reinhold Co. 1984.
5) Technical judgment
6) Outside testing.
7) Gosselin, R.E. et al. Clinical Toxicology of Commercial Products. 5th Ed. Baltimore: The William and Wilkins Co., 1984.
8) List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labelling of Dangerous Substances, Amended November, 1986.

CAT. NO. 24093

MATERIAL SAFETY DATA SHEET

PO#: HACSDS2
HACH ORDER#: 166412

MSDS DATE: 4/25/95
CHANGE NO.: 15948

For Assistance, Contact:
Regulatory Affairs Dept.
PO Box 907 Ames, IA 50010
(800) 227-4224

HACH COMPANY
PO BOX 907
AMES, IA 50010

Emergency Telephone #
Rocky Mountain Poison Ctr.
(303) 629-5716

I. PRODUCT IDENTIFICATION

PRODUCT NAME: Sodium Thiosulfate Standard Solution, Stabilized, 0.0250 N
CAS NO.: NA CHEMICAL NAME: Not applicable
FORMULA: Not applicable CHEMICAL FAMILY: Not applicable
MSDS NUMBER: MS0371

II. INGREDIENTS

Propylene Glycol
PCT: 20 TO 50 CAS NO.: 57-55-6 SARA: NOT LISTED
TLV: Not established PEL: Not established
HAZARD: Causes mild irritation

Sodium Sulfate
PCT: 1 TO 5 CAS NO.: 7757-82-6 SARA: NOT LISTED
TLV: Not established PEL: Not established
HAZARD: May cause irritation

Sodium Thiosulfate
PCT: <1 CAS NO.: 7772-98-7 SARA: NOT LISTED
TLV: Not established PEL: Not established
HAZARD: May cause irritation

Other components, each
PCT: <1 CAS NO.: NA SARA: NOT LISTED
TLV: Not applicable PEL: Not applicable
HAZARD: Not applicable

Demineralized Water
PCT: to 100 CAS NO.: 7732-18-5 SARA: NOT LISTED
TLV: Not applicable PEL: Not applicable
HAZARD: None

Any component of this mixture not specifically listed (eg. "other components") is not considered to present a carcinogen hazard.

III. PHYSICAL DATA

STATE: Liquid APPEARANCE: Clear, colorless ODOR: Sweet
SOLUBILITY IN: WATER: Soluble ACID: Soluble OTHER: Not determined
BOILING POINT: 99°C MELTING PT.: freeze: -7°C SPEC GRAVITY: 1.05
pH: 9.9 VAPOR PRESSURE: Not determined VAPOR DENSITY (air=1): ND
EVAPORATION RATE: 0.9 METAL CORROSIVITY - ALUMINUM: 0.004 in/yr
STEEL: 0.006 in/yr STABILITY: Stable
STORAGE PRECAUTIONS: Store in a cool, dry place away from oxidizers.

IV. FIRE, EXPLOSION HAZARD AND REACTIVITY DATA

FLASH PT.: >212°F METHOD: open cup
FLAMMABILITY LIMITS - LOWER: ND UPPER: ND
SUSCEPTIBILITY TO SPONTANEOUS HEATING: None
SHOCK SENSITIVITY: None AUTOIGNITION PT.: ND
EXTINGUISHING MEDIA: water, dry chemical, alcohol foam or carbon dioxide
FIRE/EXPLOSION HAZARDS: None
HAZARDOUS DECOMP. PRODUCTS: May emit toxic fumes of carbon oxides and sodium oxides in fire
OXIDIZER: No NFPA Codes: Health: 1 Flammability: 0 Reactivity: 0
CONDITIONS TO AVOID: Excessive heat; contact with oxidizers

V. HEALTH HAZARD DATA

THIS PRODUCT MAY BE: Irritating to eyes, skin and respiratory tract.
ACUTE TOXICITY: Not determined
ROUTES OF EXPOSURE: Not determined
TARGET ORGANS: Not determined
CHRONIC TOXICITY: Not determined
ROUTES OF EXPOSURE: Not determined
TARGET ORGANS: Not determined
CANCER INFORMATION: Not applicable
ROUTES OF EXPOSURE: Not applicable
TARGET ORGANS: Not applicable
OVEREXPOSURE: May cause eye, skin, and respiratory tract irritation
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: None reported

VI. PRECAUTIONARY MEASURES

Avoid contact with eyes, skin and clothing
Do not breathe mist or vapor.
Wash thoroughly after handling.
PROTECTIVE EQUIPMENT: Adequate ventilation, lab grade goggles, disposable latex gloves

VII. FIRST AID

EYE AND SKIN CONTACT: Immediately flush eyes with water for 15 minutes. Get physician. Wash skin with soap and plenty of water.
INGESTION: Give large quantities of water. Call physician immediately.
INHALATION: Remove to fresh air.

VIII. SPILL AND DISPOSAL PROCEDURES

IN CASE OF SPILL OR RELEASE: Dilute with water. Pour down the drain with excess water.
DISPOSE OF IN ACCORDANCE WITH ALL FEDERAL, STATE, AND LOCAL REGULATIONS.

IX. TRANSPORTATION DATA

D.O.T. PROPER SHIPPING NAME: Not Currently Regulated
HAZARD CLASS: NA ID: NA GROUP: NA

I.C.A.O. PROPER SHIPPING NAME: Not Currently Regulated
HAZARD CLASS: NA ID: NA GROUP: NA

I.M.D. PROPER SHIPPING NAME: Not Currently Regulated
HAZARD CLASS: NA ID: NA GROUP: NA

X. REFERENCES

1) TLV's Threshold Limit Values and Biological Exposure Indices for 1988-1989. American Conference of Governmental Industrial Hygienists, 1988.
2) Air Contaminants, Federal Register, Vol. 54, No. 12, Thursday, Jan 19, 1989. pp. 2332-2983.
3) In-house information
4) Technical judgment
5) Fire Protection Guide to Hazardous Materials. 10th Ed., Quincy, MA; National Fire Protection Association, 1991.
6) Sax, N. Irving. Dangerous Properties of Industrial Materials. 6th Ed. New York: Van Nostrand Reinhold Co. 1984.
7) Gosselin, R.E. et al. Clinical Toxicology of Commercial Products. 5th Ed. Baltimore: The Williams and Wilkins Co., 1984.
8) NIOSH Registry of Toxic Effects of Chemical Substances, 1985-86. Cincinnati: U. S. Department of Health and Human Services, April, 19