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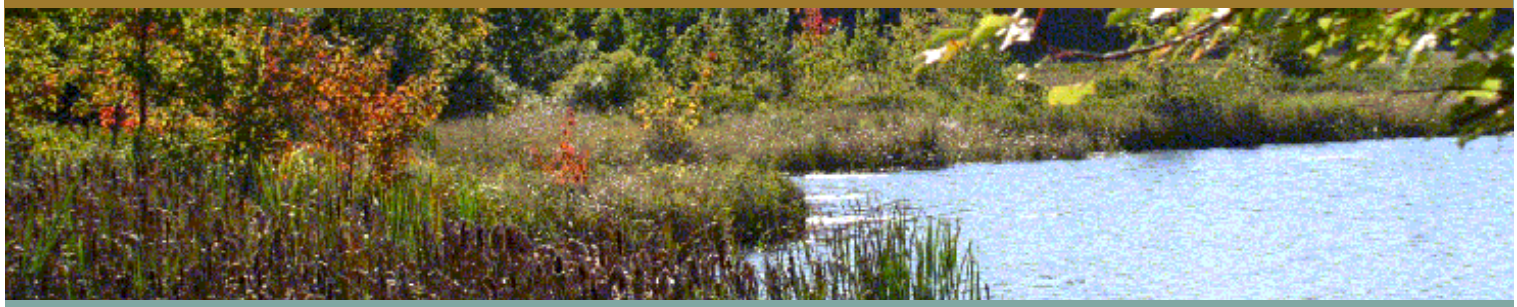

Summary of Freshwater Monitoring Programs in New Hampshire's Coastal Watershed: Recommendations for the NHEP Monitoring Program

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NewHampshire EstuariesProject

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Introduction

The New Hampshire Estuaries Project (NHEP) is part of the US Environmental Protection Agency's National Estuary Program, which is a joint local/state/federal program established under the Clean Water Act with the goal of protecting and enhancing nationally significant estuarine resources. The NHEP uses a Monitoring Plan to track changes in the estuarine environment as a result of the NHEP's efforts. Up to this point, the Monitoring Plan has focused exclusively on conditions in the estuaries. The purpose of this report is to evaluate the feasibility of including water quality data from the freshwater portion of New Hampshire's coastal watershed in the Monitoring Plan.

Project Goals and Objectives

To summarize the existing monitoring programs for water quality in rivers and lakes in New Hampshire's coastal watershed and to make recommendations for ways that the NHEP can coordinate these data to assist with management decisions.

Methods

This study followed a three step process.

Step 1: Gather and summarize information on existing water quality monitoring programs in the coastal watershed. Only ongoing monitoring programs with no planned end date were included. The specific tasks that were used to gather these data were:

- Queried all water quality data on rivers, streams, and lakes in the coastal watershed (HUC8 01060003) collected by DES programs between 1/1/00 and 6/1/04 from the DES Environmental Measurement Database.
- Reviewed the NHEP Summary of Coastal and Estuarine Monitoring Programs in New Hampshire.
- Reviewed the Gulf of Maine Council for the Marine Environment Inventory of Marine Monitoring Programs in the Gulf of Maine.
- Contacted researchers at the University of New Hampshire, State agencies, and Federal agencies.
- Reviewed websites for various programs.

Step 2: Develop NHEP data needs and monitoring questions for river and lakes in the coastal watershed.

Step 3: Summarize available data that satisfy the presumptive NHEP needs and make recommendations.

Results and Discussion

Summary of Existing Freshwater Monitoring Programs in the Coastal Watershed

NHDES Volunteer River Assessment Program

PURPOSE: TO SUPPLEMENT THE NHDES AMBIENT RIVER MONITORING PROGRAM (ARMP) BY TRAINING VOLUNTEERS IN STATE (EPA APPROVED) PROTOCOLS TO ASSESS THE QUALITY OF NEW HAMPSHIRE RIVERS.

STUDY AREA: STATEWIDE WHEREVER THERE IS VOLUNTEER INTEREST.

DESIGN: PROJECT DESIGN IS DEVELOPED COLLABORATIVELY, BASED ON LOCAL INPUT, EXISTING DATA, AND PERCEIVED WATER QUALITY ASSETS AND IMPAIRMENTS. BI-WEEKLY SAMPLING IS TYPICAL. VRAP BASELINE PARAMETERS INCLUDE (EQUIPMENT PROVIDED FOR): TEMPERATURE [C], DISSOLVED OXYGEN [MG/L, % OF SATURATION], PH, SPECIFIC CONDUCTANCE (CONDUCTIVITY) [MICROS/CM], AND TURBIDITY [NTU]. SAMPLING OF ADDITIONAL PARAMETERS (I.E. NUTRIENTS, BACTERIA, METALS) DETERMINED BY THE AVAILABILITY OF FUNDS/IN-KIND DONATIONS OR FOR THE DESIRED ANALYSES.

PRESENCE IN THE COASTAL WATERSHED: THERE ARE FIVE RIVERS IN THE COASTAL WATERSHED ENROLLED IN THE VOLUNTEER RIVER ASSESSMENT PROGRAM: COCHECO RIVER; ISINGLASS RIVER; OYSTER RIVER; LAMPREY RIVER; AND EXETER RIVER. THE BELLAMY RIVER MAY BE JOINING THE PROGRAM IN 2004. A TOTAL OF 82 STATIONS ON THESE RIVERS HAVE BEEN MONITORED BY VRAP BETWEEN JANUARY 1, 2000 AND PRESENT. BETWEEN 1300 AND 1500 MEASUREMENTS OF VRAP BASELINE PARAMETERS WERE MADE DURING THIS PERIOD. IN ADDITION, THE VRAP GROUPS HAVE ANALYZED 516 SAMPLES FOR *E. COLI*. NUTRIENTS HAVE BEEN MEASURED IN LESS THAN 100 SAMPLES AND AT UNEVEN FREQUENCY. THREE VRAP STATIONS ARE CO-LOCATED WITH USGS STREAM GAGE STATIONS:

- 09-OYS ROUTE 155A BRIDGE/USGS GAGING STATION
- 07-LMP PACKERS FALLS ROAD BRIDGE. GAGING STATION IS 200' UPSTREAM FROM BRIDGE.
- 02-ISG ROCHESTER NECK ROAD BRIDGE. THE GAGING STATION IS ABOUT 600' UPSTREAM FROM THE BRIDGE USED FOR MONITORING.

THE VRAP STATIONS IN THE COASTAL WATERSHED ARE SHOWN ON FIGURE 1. ADDITIONAL INFORMATION IS AVAILABLE AT: HTTP://WWW.DES.NH.GOV/WMB/VRAP/.

NHDES Ambient Rivers Monitoring Program

PURPOSE: TO CONDUCT WATER QUALITY SAMPLING OF RIVERS AND STREAMS TO DETERMINE IF WATER QUALITY SUPPORTS USES (I.E. SWIMMING, FISHING) DESIGNATED BY LEGISLATIVE CLASSIFICATION.

STUDY AREA: PRIMARY FOCUS WAS ON THE ANDROSCOGGIN, SACO AND PISCATAQUA RIVER BASINS PLUS 17 TREND MONITORING STATIONS LOCATED THROUGHOUT THE STATE.

DESIGN: MAJORITY OF SAMPLES ARE COLLECTED FROM JUNE THROUGH AUGUST. 17 TREND STATIONS ARE MONITORED THREE TIMES ANNUALLY (JUNE-AUGUST). NON-TREND STATIONS ARE MONITORED ON AN AS NEEDED BASIS. MONTHLY SAMPLES FROM MARCH TO DECEMBER ARE COLLECTED AT NINE TRIBUTARIES TO GREAT BAY AND LITTLE HARBOR AS PART OF THE NH ESTUARIES PROJECT MONITORING PROGRAM. THE TRIBUTARY SAMPLES ARE TAKEN AT THE HEAD OF TIDE IN THE WINNICUT, SQUAMSCOTT, LAMPREY, OYSTER, BELLAMY, COCHECO, SALMON FALLS,

SAGAMORE CREEK, AND BERRYS BROOK. ESTUARINE TRIBUTARY SAMPLES ARE ANALYZED FOR: DO, TEMPERATURE, CONDUCTIVITY, PH, TURBIDITY, TOTAL KJELDAHL NITROGEN, AMMONIA, SUM OF NITRATE AND NITRITE, TOTAL PHOSPHORUS, BOD, E. COLI, CHLOROPHYLL-A, AND TSS. FUNDING FOR TRIBUTARY SAMPLES IS PROVIDED BY USEPA VIA THE NH ESTUARIES PROJECT.

PRESENCE IN THE COASTAL WATERSHED: 106 STATIONS HAVE BEEN MONITORED BY THE ARMP BETWEEN 1/1/00 AND PRESENT WITH A TOTAL OF 6158 PARAMETER MEASUREMENTS. THE MOST COMMON PARAMETERS MEASURED (ACCOUNTING FOR 90% OF THE DATA) ARE: BASELINE PHYSICOCHEMICAL PARAMETERS, *E. COLI*, TURBIDITY, PHOSPHORUS, TKN, NITRATE+NITRITE, NH4, CHLOROPHYLL-A, TSS, AND BOD. NONE OF THE TREND MONITORING STATIONS ARE LOCATED IN THE COASTAL WATERSHED. THEREFORE, NONE OF THE ARMP STATIONS IN THE COASTAL WATERSHED ARE MONITORED AT A SET FREQUENCY. THE ARMP STATIONS IN THE COASTAL WATERSHED ARE SHOWN ON FIGURE 1.

NHDES Beach Monitoring Program

PURPOSE: MONITOR AND SAMPLE FRESHWATER AND MARINE PUBLIC BEACHES ON A ROUTINE BASIS THROUGHOUT THE SWIM SEASON. ISSUE AND POST ADVISORIES FOR BACTERIA AND CYANOBACTERIA.

STUDY AREA: STATEWIDE

DESIGN: FRESHWATER BEACHES ARE SAMPLED ONCE PER MONTH FROM MID-JUNE THROUGH LABOR DAY. TIER I MARINE BEACHES ARE SAMPLED WEEKLY AND TIER II MARINE BEACHES ARE SAMPLED BI-WEEKLY FROM JUNE 1ST THROUGH LABOR DAY. ALL FRESHWATER BEACH SAMPLES ARE ANALYZED FOR *E. COLI*, WHILE ALL MARINE BEACH SAMPLES ARE ANALYZED FOR ENTEROCOCCI.

PRESENCE IN THE COASTAL WATERSHED: THE DES BEACH PROGRAM MONITORS 15 FRESHWATER BEACHES IN THE COASTAL WATERSHED. POSTINGS AT THESE BEACHES DUE TO ELEVATED BACTERIA CONCENTRATIONS ARE USED AS AN INDICATOR IN THE NHEP MONITORING PLAN. THE FRESHWATER BEACHES THAT ARE MONITORED BY NHDES ARE SHOWN ON FIGURE 2. ADDITIONAL INFORMATION IS AVAILABLE AT HTTP://WWW.DES.NH.GOV/BEACHES/.

NHDES Acid Lake Outlet Surveys

PURPOSE: TO DOCUMENT ACID RAIN-RELATED TRENDS IN RELATIVELY LOW ELEVATION ACCESSIBLE PONDS TO COMPLEMENT THE REMOTE POND PROJECT.

STUDY AREA: STATEWIDE

DESIGN: MONITOR ACID RAIN-RELATED PARAMETERS IN 20 CLEAR-WATER HEADWATER PONDS WITH RELATIVELY SMALL WATERSHEDS AND NO POINT OR SIGNIFICANT NON-POINT SOURCES OF POLLUTANTS (I.E., PONDS SENSITIVE TO ACID RAIN IMPACTS). THE POND OUTLETS ARE SAMPLED TWICE EACH YEAR DURING SPRING AND FALL OVERTURN WHEN OUTLET WATER REPRESENTS A WELL-MIXED ENTIRE WATER COLUMN LAKE SAMPLE.

PRESENCE IN THE COASTAL WATERSHED: THERE ARE TWO LOCATIONS MONITORED IN THE COASTAL WATERSHED. BOTH OF THE STATIONS ARE NEAR THE WESTERN EDGE OF THE WATERSHED (BOW LAKE IN STRAFFORD, COOKS POND IN BROOKFIELD). THE ACID OUTLET MONITORING STATIONS IN THE COASTAL WATERSHED ARE SHOWN ON FIGURE 3.

NHDES Volunteer Lake Assessment Program

PURPOSE: THE NEW HAMPSHIRE VOLUNTEER LAKE ASSESSMENT PROGRAM (VLAP) WAS INITIATED IN 1985 IN RESPONSE TO AN EXPRESSED DESIRE OF LAKE ASSOCIATIONS TO BE INVOLVED IN LAKE PROTECTION AND WATERSHED MANAGEMENT. VLAP IS A COOPERATIVE PROGRAM BETWEEN

VOLUNTEER MONITORS AND THE DES WHICH LEADS TO LOCAL AWARENESS OF LAND USE AND HUMAN PRACTICES THAT MAY BE DETRIMENTAL TO LAKE QUALITY AND ALSO EMPOWERS COMMUNITIES IN THEIR DECISION-MAKING REGARDING LAKE MANAGEMENT ISSUES. ROUTINE VOLUNTEER MONITORING RESULTS IN EARLY DETECTION OF WATER QUALITY CHANGES, ALLOWING DES TO TRACE POTENTIAL PROBLEMS TO THEIR SOURCE BEFORE THE LAKE/POND IS SEVERELY IMPACTED. IF A NEGATIVE TREND IS OBSERVED IN A LAKE/POND, THE VOLUNTEER MONITORS COULD BECOME INVOLVED WITH MORE INTENSE WATERSHED STUDY THROUGH THE NHDES CLEAN LAKES PROGRAM. IN ADDITION, MONITORING DATA IS USED IN THE STATE'S REPORT TO THE EPA FOR INCORPORATION INTO THE REPORT TO CONGRESS WHICH ASSESSES THE QUALITY OF THE NATION'S WATERS. THE SAMPLING EFFORTS OF THE VOLUNTEER MONITORS SUPPLEMENT THE ENVIRONMENTAL MONITORING EFFORTS OF DES. THE VOLUNTEER MONITORS HAVE BEEN, AND WILL CONTINUE TO BE, A KEY ELEMENT IN PROTECTING THE INTEGRITY OF NEW HAMPSHIRE'S LAKES AND PONDS. POLLUTION PREVENTION THROUGH ROUTINE VOLUNTEER MONITORING ULTIMATELY SAVES THE COMMUNITY AND THE STATE THE COST OF EXPENSIVE, AFTER-THE-FACT REMEDIATION. MAINTAINING CLEAN WATER AND QUALITY LAKE RESOURCES BENEFITS ALL OF US.

STUDY AREA: THIS IS A STATEWIDE PROGRAM. ANY LAKE ASSOCIATION/MONITORING GROUP THAT WOULD LIKE TO MONITOR THEIR LAKE/POND THROUGH VLAP CONTACTS DES TO JOIN THE PROGRAM. IN 2003, APPROXIMATELY 500 VOLUNTEERS FROM 154 LAKES AND PONDS LOCATED THROUGHOUT THE STATE OF NEW HAMPSHIRE PARTICIPATED IN VLAP.

DESIGN: VLAP IS A COOPERATIVE EFFORT BETWEEN LAKE RESIDENTS AND LAKE ASSOCIATIONS THROUGHOUT THE STATE AND STAFF AT DES. THE ROLE OF DES: TEACH PRINCIPLES OF LAKE ECOLOGY TO VOLUNTEER MONITORS. PROVIDE SAMPLING EQUIPMENT, UPON ADVANCED REQUEST, TO VOLUNTEER MONITORS. TRAIN VOLUNTEER MONITORS IN PROPER SAMPLING TECHNIQUES DURING AN ANNUAL VISIT. ANALYZE SAMPLES. INTERPRET THE DATA AND COMPILE IN PERIODIC UPDATES AND ANNUAL REPORTS. PROVIDE AN ANNUAL NEWSLETTER. PROVIDE TECHNICAL/EDUCATIONAL MATERIALS. PROVIDE NOTIFICATION OF WORKSHOP OPPORTUNITIES AND OTHER DES VOLUNTEER PROGRAMS. INVESTIGATE WATER QUALITY COMPLAINTS. MEET WITH LAKE ASSOCIATIONS, UPON REQUEST, TO ADDRESS CONCERNS. INCORPORATE DATA COLLECTED BY VOLUNTEER MONITORS INTO THE STATE WATER QUALITY REPORT FOR SUBMISSION TO THE EPA AND CONGRESS. THE ROLE OF THE VOLUNTEER MONITOR: NOTIFY DES OR SATELLITE LABORATORY OF SAMPLING DATES IN ADVANCE. SCHEDULE EQUIPMENT AND BOTTLE PICK-UP IN ADVANCE. CONTACT DES TO SCHEDULE ANNUAL LAKE VISIT WITH BIOLOGIST. COLLECT WATER SAMPLES AT LEAST ONCE PER MONTH DURING THE SUMMER (TYPICALLY JUNE - AUGUST) ACCORDING TO ESTABLISHED QUALITY ASSURANCE AND QUALITY CONTROL GUIDELINES. DELIVER COLLECTED WATER SAMPLES TO THE LABORATORY WITHIN 24 HOURS OF SAMPLE COLLECTION. PROVIDE MINIMAL FINANCIAL SUPPORT FOR SAMPLE ANALYSIS. REPORT ON POTENTIAL WATER QUALITY VIOLATIONS TO DES WHEN NECESSARY. PASS ON WATER QUALITY INFORMATION INCLUDING ANNUAL REPORT AND ANNUAL NEWSLETTER TO ASSOCIATIONS, COMMUNITY, AND TOWN OFFICIALS. A DES BIOLOGIST CONDUCTS AN ANNUAL VISIT TO EACH LAKE/POND TO PROVIDE TRAINING, CONDCUT QA/QC ASSESSMENTS, AND TO COLLECT ADDITIONAL SAMPLES. MONITORS ARE ENCOURAGED TO SAMPLE AT LEAST TWO ADDITIONAL TIMES DURING THE SUMMER (JUNE, JULY, AUGUST) ON THEIR OWN, AND MAY BE TRAINED TO CONDUCT STORM AND BRACKET SAMPLING TO IDENTIFY POLLUTION SOURCES. MONITORS ARRANGE TO PICK UP EQUIPMENT FROM THE LIMNOLOGY CENTER IN CONCORD, OR AT ONE OF THE SATELLITE VLAP LABORATORIES.

PRESENCE IN THE COASTAL WATERSHED: THERE ARE 9 VLAP LAKES IN WATERSHED: AYERS POND, BAXTER LAKE, BOW LAKE, GOVERNORS LAKE, LAKE IVANHOE, MILL BROOK POND, ONWAY LAKE, PAWTUCKAWAY LAKE, AND SUNRISE LAKE. THE VRAP MONITORING STATIONS IN THE COASTAL WATERSHED ARE SHOWN ON FIGURE 3. TYPICAL PARAMETERS MEASURED DURING THE SUMMER SEASON AT THESE LAKES ARE:

- CHLOROPHYLL A, UNCORRECTED FOR PHEOPHYTIN
- DEPTH
- DISSOLVED OXYGEN
- DISSOLVED OXYGEN SATURATION

- ESCHERICHIA COLI
- GRAN ACID NEUTRALIZING CAPACITY
- PH
- PHOSPHORUS AS P
- SECCHI DISK TRANSPARENCY
- SPECIFIC CONDUCTANCE
- TEMPERATURE WATER
- TURBIDITY
- WEATHER COMMENTS

ADDITIONAL INFORMATION IS AVAILABLE AT HTTP://WWW.DES.NH.GOV/WMB/VLAP/.

NHDES Lake Trophic Surveys

PURPOSE: TO DETERMINE LAKE TROPHIC CLASS AND MONITOR PHYSICAL, CHEMICAL AND BIOLOGICAL WQ PARAMETERS

STUDY AREA: STATEWIDE

DESIGN: EACH YEAR, 40 DIFFERENT LAKES AND PONDS ARE SURVEYED, ONCE IN THE SUMMER AND ONCE IN THE WINTER. THE SURVEYS ARE COMPREHENSIVE PHYSICAL, CHEMICAL AND BIOLOGICAL SURVEYS, INCLUDING ELECTRONIC DEPTH SOUNDINGS, MACROPHYTE (ROOTED AQUATIC PLANTS) IDENTIFICATIONS AND ABUNDANCE RATINGS, SHORELINE BACTERIA SAMPLING AND, AT THE DEEP SPOT (ADDITIONAL STATIONS IN LARGER LAKES), A TEMPERATURE/DISSOLVED OXYGEN/PERCENT SATURATION PROFILE, SECCHI DISK TRANSPARENCY READING, SAMPLES FOR CHLOROPHYLL, CALCIUM, MAGNESIUM, SODIUM AND POTASSIUM IN THE UPPER WATER LAYER, PHYTOPLANKTON AND ZOOPLANKTON NET HAULS FOR IDENTIFICATION AND COUNTS AND DISCRETE WATER SAMPLES AT TWO (THERMALLY UNSTRATIFIED) OR THREE (THERMALLY STRATIFIED) DEPTHS FOR PH, ANC, APPARENT COLOR, CONDUCTIVITY, TOTAL PHOSPHORUS, TOTAL KJELDAHL NITROGEN, NITRITE+NITRATE NITROGEN, CHLORIDE AND SULFATE. THE SURVEYS ARE DESIGNED TO ASSESS CURRENT BASELINE CONDITIONS AND COMPLIANCE WITH WATER QUALITY CRITERIA, IDENTIFY THE LAKE'S TROPHIC STATUS, DETERMINE ACID RAIN IMPACTS AND THE EXISTENCE OF EXOTIC AQUATIC PLANTS AND PROVIDE INFORMATION FOR GROSS LONG-TERM TREND ANALYSES. LAKES ARE SELECTED FOR SAMPLING BASED ON TIME SINCE LAST SURVEY, REQUESTS FROM CITIZENS, VOLUNTEER MONITORS, OTHER BUREAU PROGRAMS AND OTHER STATE AGENCIES, AND THE USE OF THE LAKE. THE PROGRAM WAS INITIATED IN 1975 AND, AS OF 2003, 790 DIFFERENT LAKES AND PONDS HAVE BEEN SURVEYED AT LEAST ONCE - MANY HAVE BEEN SURVEYED TWO TO FOUR TIMES. NUMEROUS OTHER WATERBODIES WERE VISITED BUT NOT SURVEYED BECAUSE OF ACCESS OR PRIVACY ISSUES OR BECAUSE THE WATERBODY WAS MORE WETLAND OR RIVER THAN LAKE. MOST REASONABLY ACCESSIBLE LAKES IN NEW HAMPSHIRE (AND SEVERAL REMOTE ONES) HAVE BEEN SURVEYED AT LEAST ONCE IN THIS PROGRAM.

PRESENCE IN THE COASTAL WATERSHED: APPROXIMATELY 70 LAKES IN THE COASTAL WATERSHED HAVE BEEN SURVEYED SINCE THE PROGRAM BEGAN IN 1976. LAKES ARE SURVEYED ONCE EVERY 15 TO 20 YEARS ON AVERAGE. THE LAKES THAT HAVE BEEN ASSESSED BY NHDES ARE SHOWN IN FIGURE 3.

NHDES Biomonitoring Program

PURPOSE: THE DEPARTMENT'S BIOMONITORING PROGRAM ASSESSES THE BIOLOGICAL HEALTH AND INTEGRITY OF AQUATIC ECOSYSTEMS THROUGHOUT THE STATE. THE RESULTS OF THESE ASSESSMENTS ARE USED TO ESTABLISH REFERENCE LOCATIONS FOR "LEAST DISTURBED" CONDITIONS IN THE STATE, IDENTIFYING AREAS THAT ARE BIOLOGICALLY IMPAIRED, AND FOR PRIORITIZING THOSE AREAS NEEDING MANAGEMENT, RESTORATION, OR PRESERVATION EFFORTS.

STUDY AREA: STATEWIDE

DESIGN: TO COLLECT BIOLOGICAL DATA FROM ALL 109 HUC12 WATERSHEDS IN THE STATE. STATIONS ARE SAMPLED ONCE AND NOT REVISITED. MONITORING ACTIVITIES THAT TAKE PLACE AT MOST SITES INCLUDE:

- COLLECTION AND IDENTIFICATION OF AQUATIC MACROINVERTEBRATES
- COLLECTION AND IDENTIFICATION OF THE RESIDENT FISH COMMUNITY
- ASSESSMENT OF RIPARIAN HABITAT AND LAND USES
- PHYSICAL AND CHEMICAL MEASUREMENTS FOR ASSESSING WATER QUALITY

PRESENCE IN THE COASTAL WATERSHED: THERE ARE 39 STATIONS IN THE COASTAL WATERSHED (SEE FIGURE 4). MORE INFORMATION IS AVAILABLE AT: HTTP://DES.NH.GOV/WMB/BIOMONITORING/

UNH Lay Lakes Monitoring Program

PURPOSE: TO MONITOR LAKE WATER QUALITY TRENDS

STUDY AREA: STATEWIDE

DESIGN: WATER QUALITY PARAMETERS ARE MONITORED BY LOCAL VOLUNTEERS DURING THE SUMMER SEASON. TYPICAL PARAMETERS ARE PHOSPHORUS, CHLOROPHYLL-A, SECCHI DISK DEPTH, AND ALKALINITY. THE DATA AND TECHNICAL ASSISTANCE ARE MANAGED BY THE UNH CENTER FOR FRESHWATER BIOLOGY (HTTP://WWW.FBG.UNH.EDU/).

PRESENCE IN THE COASTAL WATERSHED: THE UNH LLMP INCLUDES SEVERAL LAKES IN THE COASTAL WATERSHED.

UNH Lamprey River Hydrologic Observatory

PURPOSE: TO STUDY THE BIOGEOCHEMICAL TRANSFORMATIONS IN A SUBURBAN WATERSHED, AND TO ASSIST WITH NATURAL RESOURCE EDUCATION AT UNH.

STUDY AREA: LAMPREY RIVER WATERSHED

DESIGN: NUTRIENTS, PARTICULATES, AND PHYSICOCHEMICAL PARAMETERS ARE MONITORED WEEKLY AT THE USGS STREAM GAGE AT PACKERS FALLS (01073500). WATER SAMPLES ARE COLLECTED DURING STORM EVENTS WHEN POSSIBLE. THE LOCATION OF THIS STATION IS SHOWN ON FIGURE 1.

USGS Cooperative Water Program – NH Streamflow Monitoring

PURPOSE: TO MONITOR THE QUANTITY AND TIMING OF STREAMFLOW IN THE STATE'S RIVERS AND STREAMS.

STUDY AREA: STATEWIDE

DESIGN: STREAMFLOW IS MEASURED NEAR CONTINUOUSLY AT STREAM GAGES PLACED ON CRITICAL RIVERS. ADDITONAL INFORMATION ON THE PROGRAM IS PROVIDED AT: HTTP://WATERDATA.USGS.GOV/NH/NWIS/CURRENT/?TYPE=FLOW

PRESENCE IN THE COASTAL WATERSHED: THERE ARE 9 ACTIVE STREAM GAGES IN THE COASTAL WATERSHED OF NEW HAMPSHIRE. THE NHEP CURRENTLY USES DATA FROM SIX OF THE GAGES TO ESTIMATE FLOW FROM THE TIDAL TRIBUTARIES TO GREAT BAY. THE ACTIVE GAGES IN THE WATERSHED ARE SHOWN ON FIGURE 5.

ACTIVE GAGES IN THE COASTAL WATERSHED

01072100 SALMON FALLS RIVER AT MILTON, NH
01072800 COCHECO RIVER NEAR ROCHESTER, NH.

01072870 ISINGLASS R AT ROCHESTER NECK RD, NR DOVER, NH
01073000 OYSTER RIVER NEAR DURHAM, NH
01073460 NORTH RIVER ABOVE NH 125, NEAR LEE, NH
01073500 LAMPREY RIVER NEAR NEWMARKET, NH
01073587 EXETER RIVER AT HAIGH ROAD, NEAR BRENTWOOD, NH
01073785 WINNICUT RIVER AT GREENLAND, NR PORTSMOUTH, NH
01073848 HAMPTON FALLS RIVER @ MILL LANE, NEAR SEABROOK, NH

Other Monitoring Programs Considered

USGS National Water Quality Assessment Program

NH's coastal watershed is part of the New England Coastal Basins study unit for the National Water Quality Assessment Program. The USGS periodically produces reports on the water quality in this study unit. However, the USGS does not have any surface water quality stations in NH's coastal watershed. Information about the New England Coastal Basins NAWQA Program is available at: http://nh.water.usgs.gov/CurrentProjects/nawqa/nawqaweb.htm.

NHDES Mercury in Fish Sampling Program

Starting 1998, the Department of Environmental Services (DES) added a program to monitor trends in fish tissue mercury using a systematic monitoring program. The goals of the program were to allow for trend detection over time and to generate the data needed to test whether certain lake characteristics (lake color, acidity, and dissolved oxygen) had an effect on the fish-Hg levels. Two fish species in particular were chosen for the program: largemouth bass (LMB) and yellow perch (YLP). The State tests many fish for mercury each year. However, most of these samples are collected on an *ad hoc* basis, which prevents their use in statistical analyses. By conducting a small, standardized sampling program, the Department hoped to be able to document any trends in fish-Hg levels and to understand the why there was variability between lakes. None of the lakes chosen for this program are in the coastal watershed. Therefore, the only data on mercury in freshwater fish comes from fish samples voluntarily collected by anglers. More information is available at: http://des.nh.gov/wmb/VLAP/mercury/volunteer.htm.

UNH Gulf of Maine Watershed Information and Characterization System (GM-WICS)

The GM-WICS program monitored nutrients (nitrogen and phosphorus species) at the terminus of the Great Bay tributaries between 1998 and 2002. Nearly daily measurements were made in 1998-1999. Sampling occurred bimonthly in 2000-2002. The project is no longer collecting data in the coastal watershed. However, the data from 1998-2002 is available at http://www.gm-wics.sr.unh.edu/html/download.html.

NH Coastal Program/USGS Coastal Water Quality Monitoring Network.

The NH Coastal Program and USGS collaboration began in 2000 with a jointly funded sampling program and is currently in the data analysis and reporting phase of the project. The purpose of the network is to assess how various intensities of urbanization influence stream quality and ecology and to provide information to local and county planning officials on the

effects of development on streams in the Seacoast Region of New Hampshire. Sampling sites, therefore, were selected to represent a range of the amount of impervious surfaces within ten small coastal watersheds. Water samples were collected to assess levels of nitrogen, phosphorus, bacteria, pH, and dissolved oxygen from 2001-03. Aquatic insect samples were collected once during each summer. Pesticides, and bed sediment quality samples were also collected, as were stream habitat assessments. Preliminary results indicate that nitrogen, phosphorus, and bacteria levels generally increase, while aquatic insect populations generally become degraded, with higher amounts of impermeable surfaces in the watersheds. Based on these results and the continued growth of development in the region, establishment of a longer-term regional sampling network with 10-15 sites in the watershed has been discussed between the NH Coastal Program and USGS.

Seacoast Groundwater Sustainability Study

Several State and Federal agencies (USGS, NH Coastal Program, NHDES, and NH Geological Survey) are collaborating on a 3-year, large-scale, hydrologic assessment of the Seacoast region of New Hampshire. The goal is to provide towns with information to make good decisions about water resources to guide future growth. The partners are compiling existing data on water quantity, collecting new data, and developing a groundwater flow simulation model. Additional information is available at:
http://nh.water.usgs.gov/CurrentProjects/seacoast/index.htm
http://www.state.nh.us/coastal/Restoration/groundwater.htm

Summary of NHEP Monitoring Questions for Coastal Rivers and Lakes

The NHEP's Management Plan contains some specific references to goals for river and lake water quality. The relevant sections are presented in Table 1. References to freshwaters are highlighted in yellow.

Table 1: Summary of NHEP Management Goals, Objectives, and Monitoring Questions Relevant to Freshwaters in the Coastal Watershed

Management Goal	Management Objective	Monitoring Question
Water Quality Goal #1: Ensure that NH's estuarine waters and tributaries meet standards for pathogenic bacteria including fecal coliform, *E. coli*, and Enterococci	WQ1-3: Increase water bodies in the NH coastal watershed designated 'swimmable' by achieving state water quality standards	Do NH surface freshwaters meet the state *E. coli* standards?
Water Quality Goal #2: Ensure that New Hampshire's estuarine waters, tributaries, sediments, and edible portions of fish, shellfish, other aquatic life, and wildlife will meet standards for priority contaminants such as metals, PCBs, PAHs, and oil and grease.		
Water Quality Goal #3: Ensure that NH's estuarine waters and tributaries will meet standards for organic and inorganic nutrients, especially nitrogen, phosphorus, chlorophyll-a, dissolved oxygen, and biological oxygen demand.	WQ3-1: Maintain inorganic nutrients, nitrogen, phosphorus, and chlorophyll-a in Great Bay, Hampton Harbor, and their tributaries at 1998-2000 baseline levels. WQ3-2: Maintain organic nutrients in Great Bay, Hampton Harbor, and their tributaries at 1994-1996 baseline levels	Do any surface freshwaters exhibit chlorophyll-a levels that do not support swimming standards (partially support: 20-30 ug/l; does not support: >30 ug/l) Have surface tidal or freshwaters shown a significant change in turbidity (total suspended solids or nephalometric turbidity units) over time? Have levels of phytoplankton (chlorophyll-a) in NH waters changed significantly over time?
	WQ3- 3: Maintain dissolved oxygen levels at: >4 mg/L for tidal rivers; >6 mg/L for embayments (Great Bay and Little Bay); >7 mg/L for oceanic areas (Hampton Harbor and Atlantic Coast).	Do any surface tidal or freshwaters show less than 75% saturation of dissolved oxygen? For what period of time?
	WQ3-4: Maintain NPDES permit levels for BOD at wastewater facilities in the NH coastal watershed.	Do any surface tidal or freshwaters show a significant change in biological oxygen demand?

Based on these goals, the NHEP's data needs for the freshwater portion of the coastal watershed can be summarized by three monitoring questions.

1. What percent of the surface waters in the coastal watershed meet standards for swimming (both for *E. coli* and chlorophyll-a) and aquatic life use support (dissolved oxygen)?

2. What are the trends over time for concentrations of chlorophyll-a, turbidity, and biological oxygen demand in freshwaters in the coastal watershed?

3. What are the loads of bacteria, toxic contaminants, and nutrients from the coastal watershed to the estuary?

Available Data to Answer NHEP Monitoring Questions

1. What percent of the surface waters in the coastal watershed meet standards for swimming (both *E. coli* and chlorophyll-a) and aquatic life use support (dissolved oxygen)?

Almost all of the programs listed in the preceding section provide information that can be used to assess attainment of water quality standards. Nevertheless, NHDES found that the majority of the assessment units in the watershed had incomplete information for assessments of swimming and aquatic life use support in the 2004 §305(b) Water Quality Report (see Table 2). Therefore, there is a critical need for additional data – or a change in the approach.

The majority of the assessment units in the watershed are river segments or impoundments. Therefore, river and impoundment monitoring should be the priority. Additional data could be obtained by starting VRAP groups on the Salmon Falls, Bellamy, and Winnicut Rivers. All the VRAP groups in the watershed could be coordinated to ensure that they are collecting sufficient *E. coli,* chlorophyll-a, dissolved oxygen, and biomonitoring data in each assessment unit per the NHDES Consolidated Assessment and Listing Methodology.

The total effort needed to assess all of the units is large. For example, three *E. coli* measurements during 60 day period between May 24 and September 15 are needed in each assessment unit to evaluate primary contact recreation. There were 481 assessment units that were classified as either "Not Assessed" or "Insufficient Information" in 2004. One thousand four hundred and forty three (1443) *E. coli* samples would be needed to classify all of these assessment units for a total cost of approximately $30,000 (not including labor to collect the samples). For aquatic life use support, biomonitoring data would be needed for approximately 300 4th order or smaller stream assessment units. The laboratory cost per biomonitoring sample is approximately $200. Therefore, the total cost of the biomonitoring samples would be $60,000, not including the labor costs to collect the samples.

An alternative to monitoring each assessment unit is to conduct a probabilistic sampling survey to generate inferred assessments for 100% of the river and impoundment units. The probabilistic design would require approximately 50 samples from randomly selected locations in the watershed.

Table 2: Summary of Use Support Determinations in NHDES' 2004 §305(b) Water Quality Report

	Aquatic Life Use Support		Primary Contact Recreation	
	# of AUs	% of AUs	# of AUs	% of AUs
Fully Supporting	1	0.2%	49	8.3%
Insufficient Information	111	17.7%	63	10.7%
Not Assessed	391	62.4%	418	71.2%
Not Supporting	124	19.8%	57	9.7%
TOTAL	627	100%	587	100%

2. What are the trends over time for concentrations of chlorophyll-a, turbidity, and biological oxygen demand in freshwaters in the coastal watershed?

The trends of greatest relevance to the NHEP are trends in concentrations in the tributaries to the estuaries. The NHEP already funds monthly monitoring by the DES ARMP at the head of tide of the Great Bay tributaries, which can be used to detect trends. Trends on the main stem of the Lamprey River are also being monitored by the UNH Lamprey River Hydrologic Observatory. Therefore, additional sampling is not needed to answer this monitoring question. Trend information in lakes is also available from the VLAP and LLMP stations for the summer index period. However, trends in individual lakes will be more representative of local conditions than of conditions in the watershed as a whole. Therefore, tracking trends in individual lakes should not be used as an indicator for the NHEP.

3. What are the loads of bacteria, toxic contaminants, and nutrients from the coastal watershed to the estuary?

The load of bacteria and nutrients to the estuary is already calculated by the NHEP using the DES ARMP stations at the head of tide and the USGS stream gages. The toxic contaminant load is not monitored. Therefore, the only data gap for this question is toxic contaminant monitoring in the tributaries. Given that toxic contaminants in water are not even being monitored in the estuary itself, starting a toxic contaminant monitoring program in the tributaries should be a low priority. The nutrient load estimates might be improved by using the USGS SPARROW model to predict loads based on watershed characteristics. This model has been proven successful for larger watersheds and may be applicable to NH's coastal watershed. In addition, it may be possible to add a water quality component to the water quantity models from the Seacoast Groundwater Sustainability Study.

Conclusions

1. There are insufficient monitoring programs in the coastal watershed to assess all of the lakes and rivers for attainment of water quality standards for swimming and aquatic life. The greatest need is for river and impoundment monitoring.
2. Existing monitoring programs can be used to monitor trends in water quality in rivers and loads of bacteria and nutrients to the Great Bay.
3. Water quality trends in lakes can be tracked using existing data but these trends are unlikely to be relevant to estuarine condition.
4. There are no programs to systematically monitor loads of toxic contaminants into the estuaries.

Recommendations

1. The NHEP should play a greater role in coordinating the VRAP groups in the coastal watershed to increase the number of river and impoundment assessment units that are sampled or to complete a probabilistic sampling survey for the rivers and impoundments. A probabilistic sampling survey would be the most cost-effective solution.
2. The NHEP should promote the creation of VRAP groups on the Salmon Falls, Bellamy, and Winnicut rivers. There is already strong interest by a local group in starting a VRAP group on the Bellamy River.
3. The NHEP should not use water quality trends in lakes as an indicator of estuarine condition.
4. The NHEP should not initiate monitoring programs for toxic contaminant loads to the estuary because this datagap is a low priority.
5. The NHEP should compare the predictions from the USGS SPARROW model to the measured nitrogen loads to the estuary and measured nutrient concentrations in river samples. If the model is unable to accurately predict conditions in some subwatersheds, it may be necessary to initiate sampling in these areas. The NHEP should also look for opportunities to build a water quality component onto the water quantity models from the Seacoast Groundwater Sustainability Study.

References

NHDES Beach Program, HTTP://WWW.DES.NH.GOV/BEACHES/

NHDES Biomonitoring Program, HTTP://DES.NH.GOV/WMB/BIOMONITORING/

NHDES Mercury in Fish Sampling Program,
http://des.nh.gov/wmb/VLAP/mercury/volunteer.htm.

NHDES Volunteer Lake Assessment Program, HTTP://WWW.DES.NH.GOV/WMB/VLAP/

NHDES Volunteer River Assessment Program, HTTP://WWW.DES.NH.GOV/WMB/VRAP/.

Seacoast Groundwater Sustainability Study
http://nh.water.usgs.gov/CurrentProjects/seacoast/index.htm
http://www.state.nh.us/coastal/Restoration/groundwater.htm

UNH Gulf of Maine Watershed Information and Characterization System (GM-WICS),
http://www.gm-wics.sr.unh.edu/html/download.html.

USGS Cooperative Water Program - NH Streamflow Monitoring Program,
http://waterdata.usgs.gov/nh/nwis/current/?type=flow

USGS National Water Quality Assessment Program,
http://nh.water.usgs.gov/CurrentProjects/nawqa/nawqaweb.htm.

Appendix A: Figures

Figure 1:
River Monitoring Stations in NH's Coastal Watershed

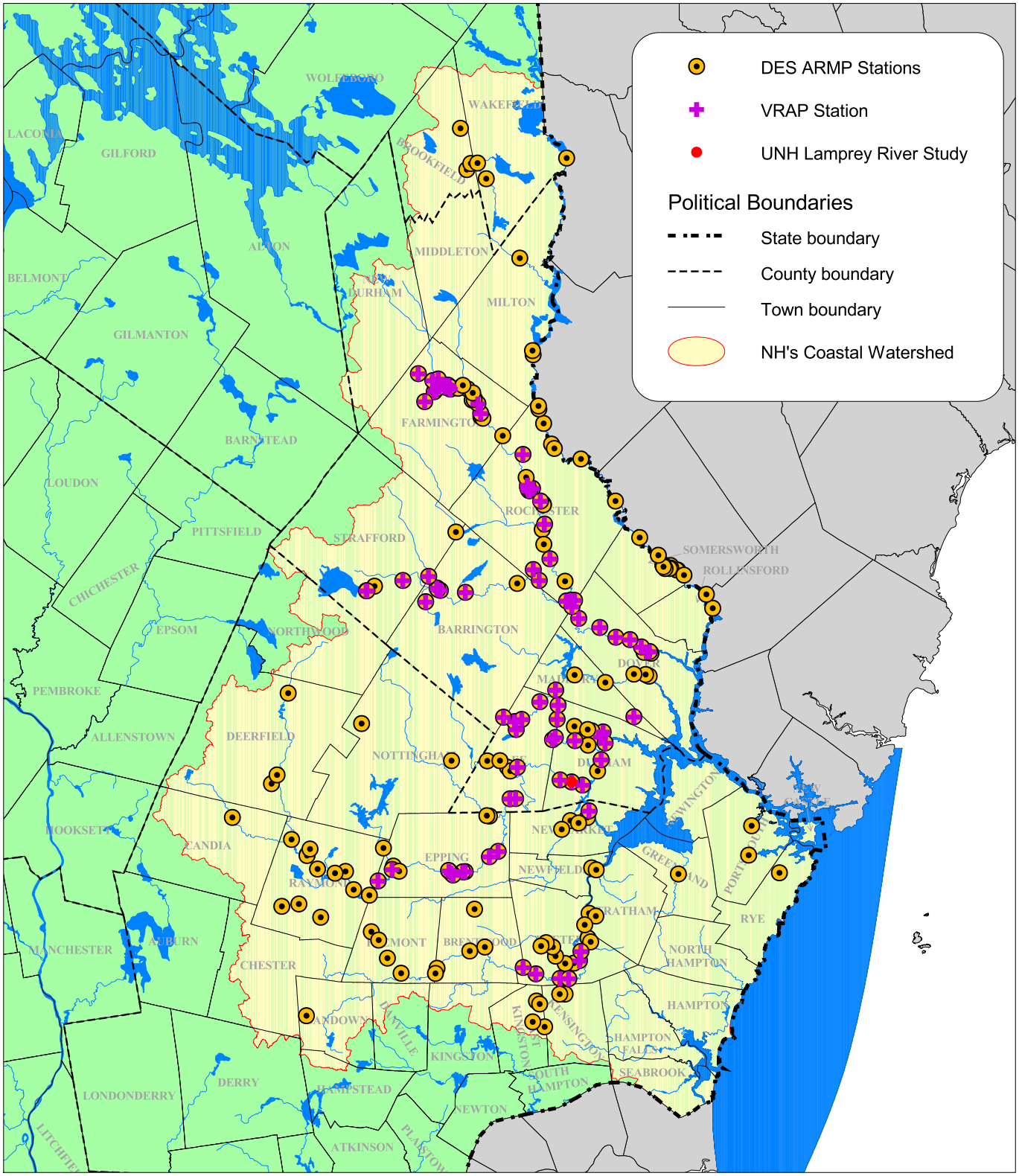


Figure 2:
Freshwater Public Bathing Beaches in NH's Coastal Watershed

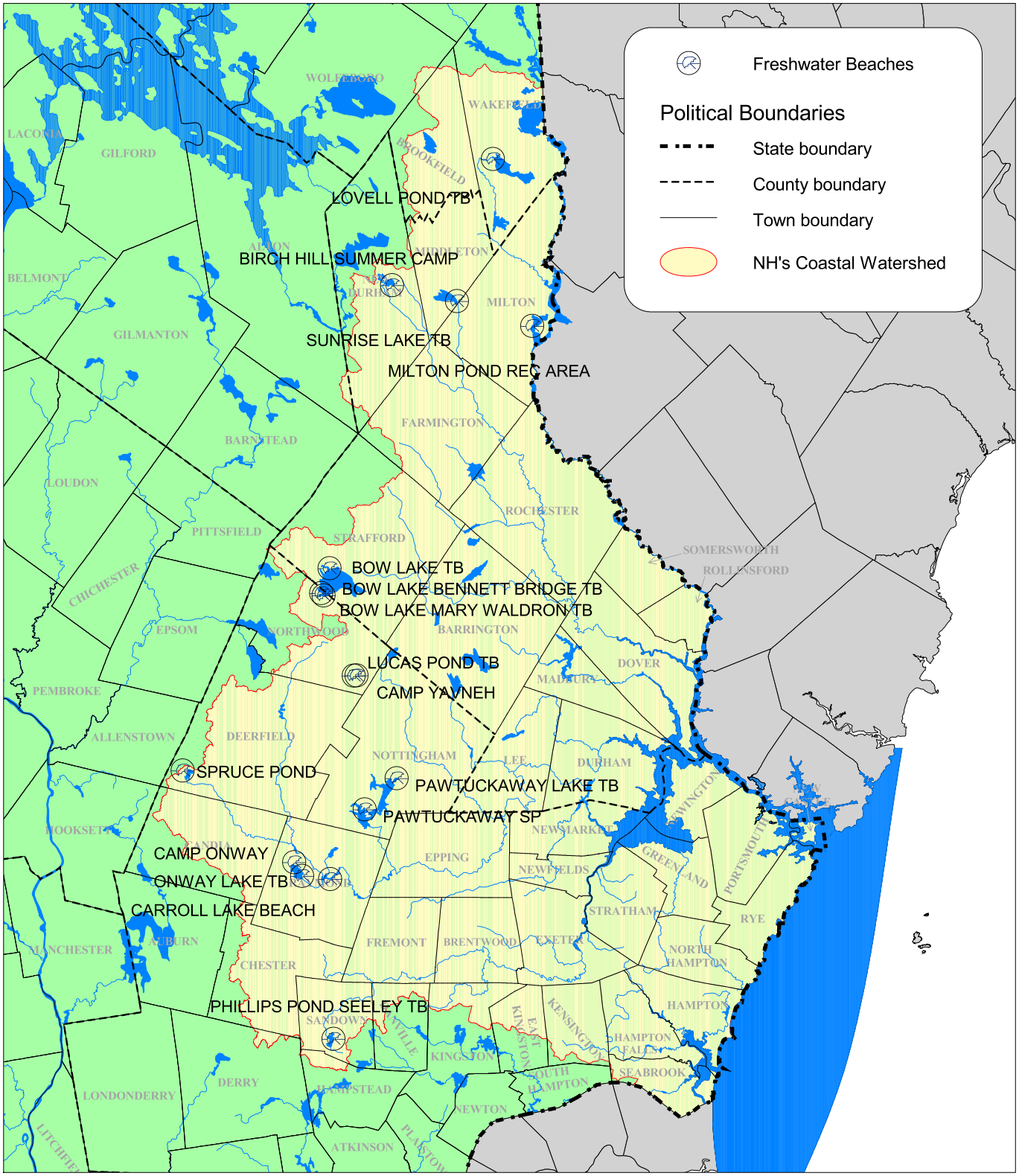


Figure 3:
Lake Monitoring Stations in NH's Coastal Watershed

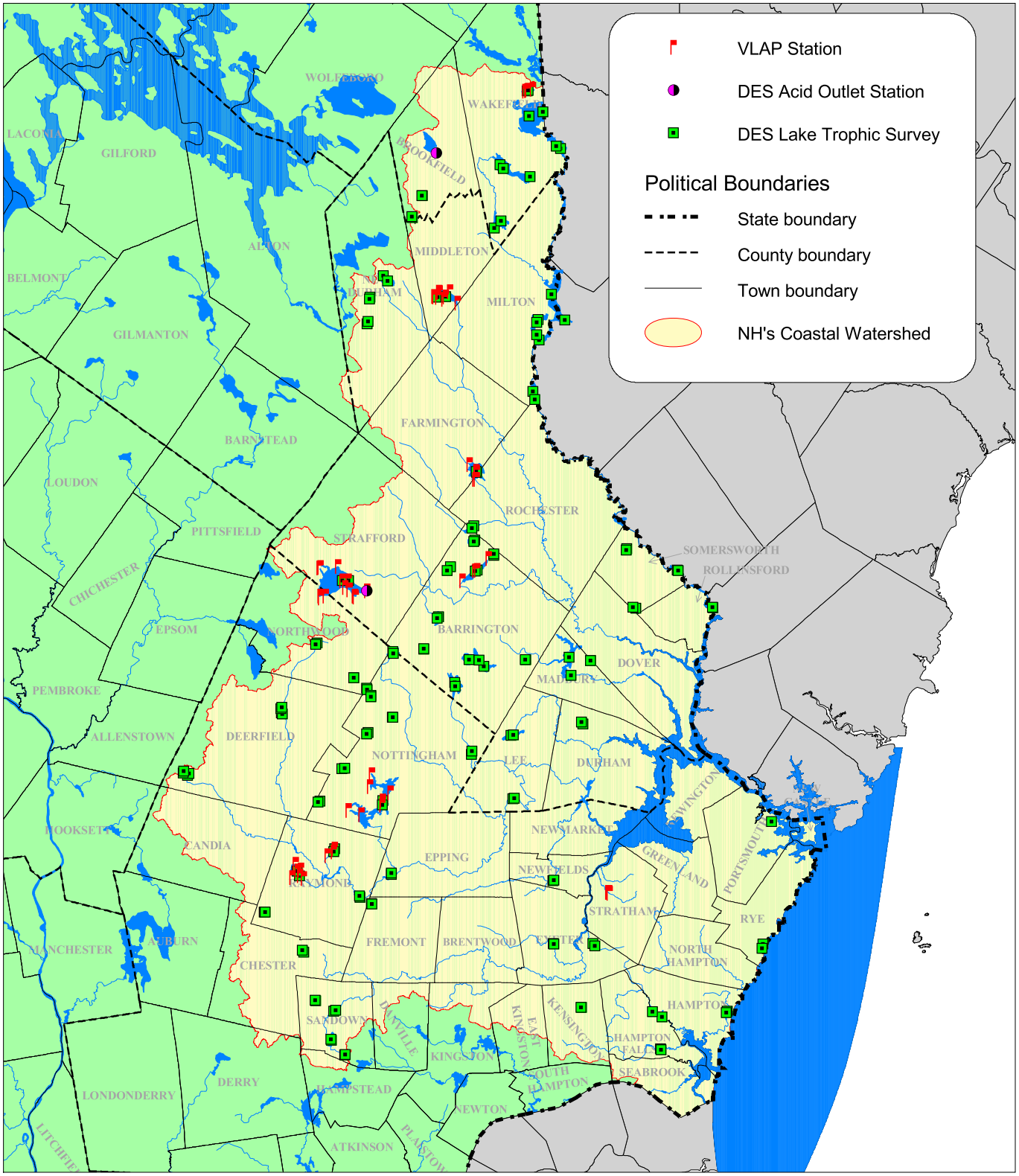
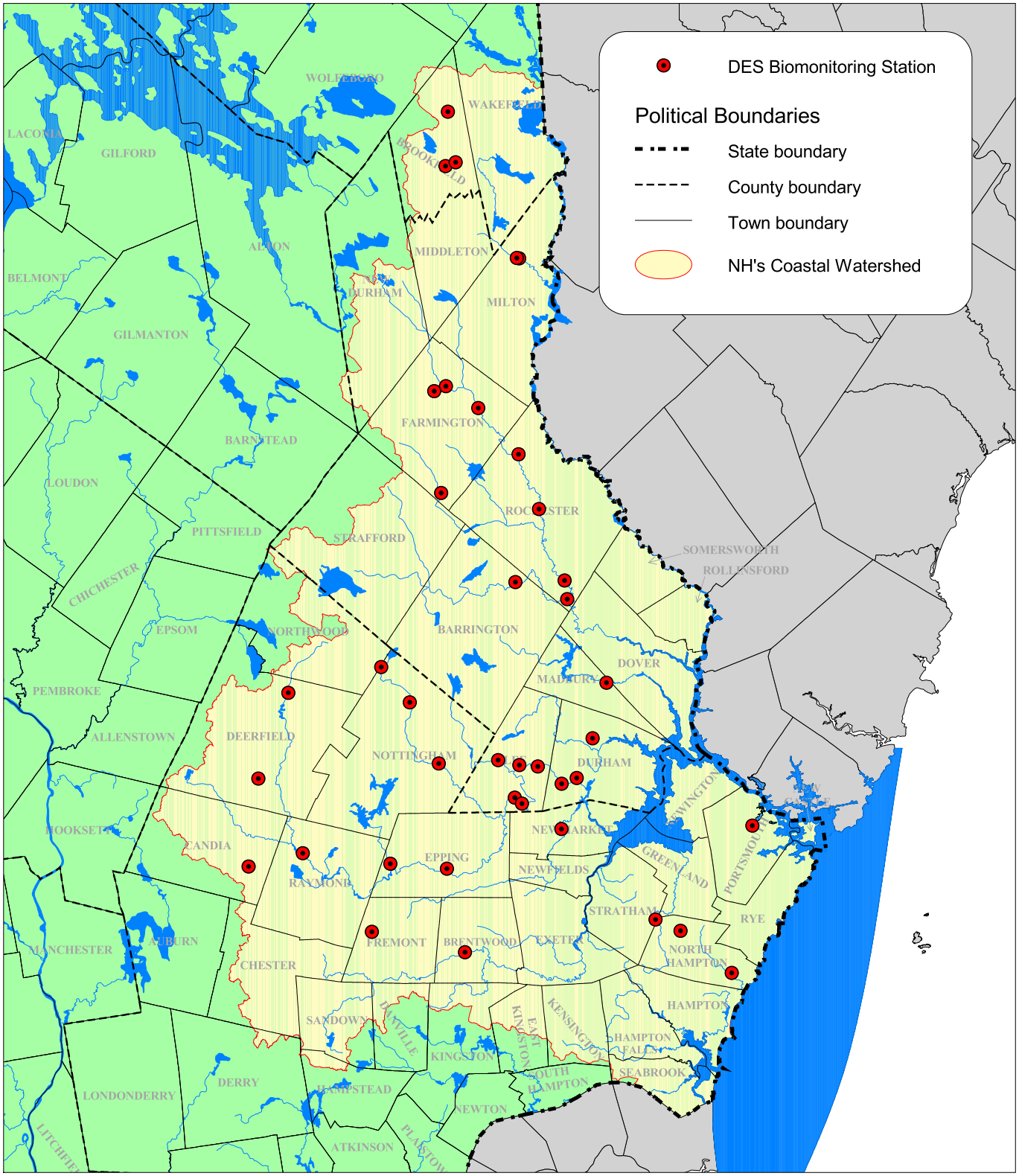


Figure 4:
Biomonitoring Stations in NH's Coastal Watershed



5 0 5 10 15 Miles

Environmental Services

NewHampshire EstuariesProject

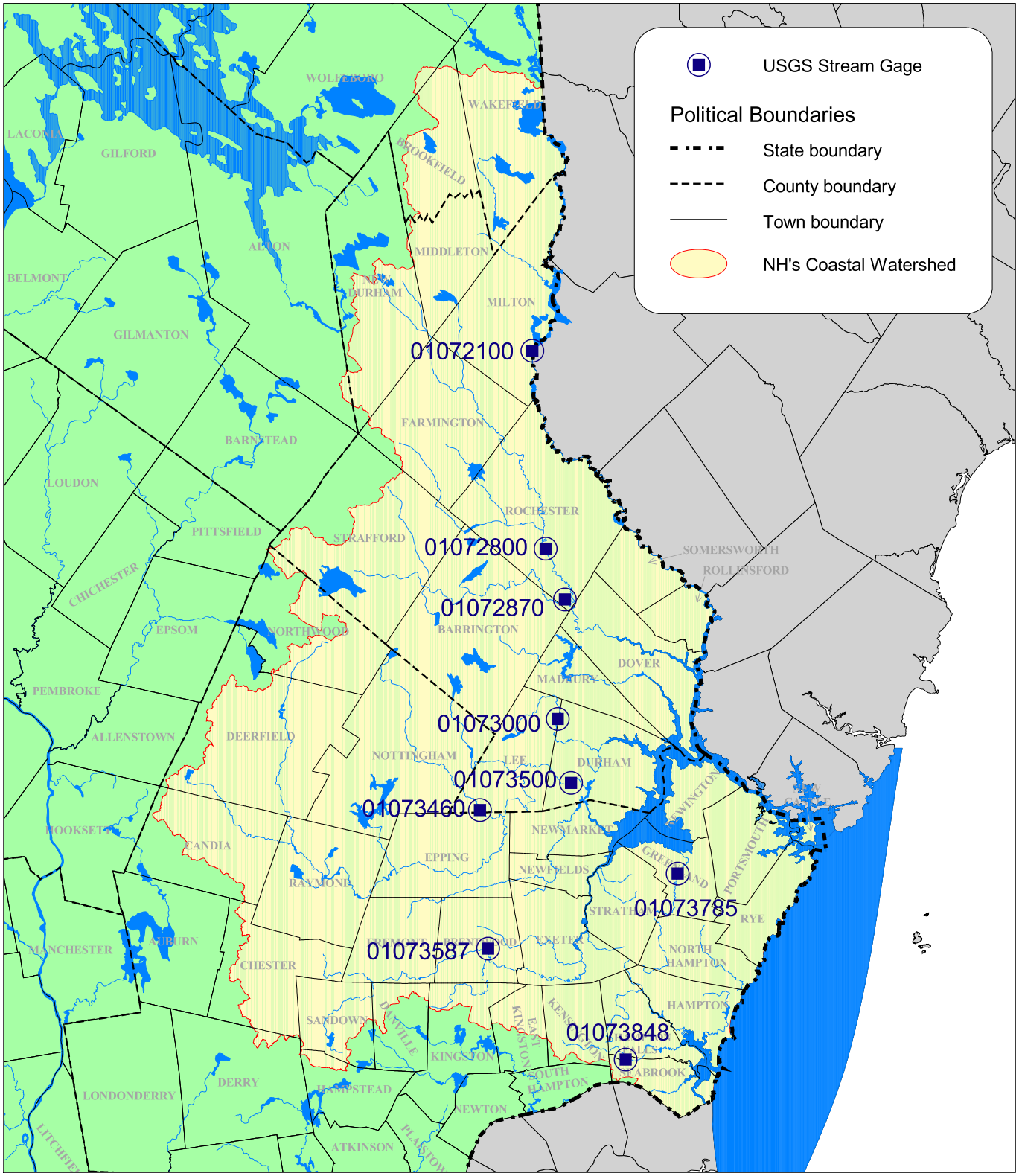



Figure 5:
Stream Gages in NH's Coastal Watershed