New Hampshire Volunteer Lake Assessment Program

2014
Seacoast Region
Regional Report

Pawtuckaway Lake, Nottingham

R-WD-16-14

New Hampshire
Volunteer Lake Assessment Program
2014 Seacoast Regional Report

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REGIONAL HIGHLIGHTS

- The Seacoast region consists of those towns in New Hampshire's *Strafford County*, southeastern portions of *Carroll County* and northern portions of *Rockingham County.*

- Regional freshwater recreation, including boating, fishing and swimming, in the Seacoast region generate approximately **$14.5 million dollars in sales, $5 million in household income, and 235 jobs annually** (Nordstrom, 2007).

- **A perceived decline in water quality** as measured by water clarity, aesthetic beauty, or overuse could result in approximately **$6 million dollars in lost revenue, $2 million dollars in lost household income and 100 lost jobs** (Nordstrom, 2007).

- Regional population is expected to grow by approximately **60,000 people in Strafford, Rockingham, and Carroll counties by 2030**. The majority of growth is estimated occur in the towns of Portsmouth, Dover, Hampton, Seabrook, Rochester, Barrington, Somersworth, Farmington, Wakefield, and Milton.

- The Seacoast Region is home to almost **30,000 acres** of lakes, river, wetlands, and estuaries. Over **10,000 acres or 35 percent** of water occurs in the towns predicted to experience the heaviest population growth.

- The regional average summer air temperature was 0.9° F above the historical regional average conditions in 2013 and approximately equal to the historical average in 2014, as reported in Durham, N.H. Regional average surface water temperatures were 0.3° F cooler than the historical regional average, as recorded by VLAP, in 2013 and 1.6° F warmer than average in 2014. Regional average summer precipitation (rainfall) was 1.3 inches above the historical regional average in 2013 and 0.26 inches below average in 2014.

- The Seacoast region consists of **121 lakes** or great ponds. Regional water quality data is collected at **13 lakes participating in VLAP** while the remaining **90 percent of lakes are sparsely monitored** through the NHDES Lake Trophic Survey Program. The University of New Hampshire Lakes Lay Monitoring Program also collects water quality data at 11 lakes however those data are not included in this report.

- Regional lakes are classified into three categories that describe the overall health of the lake as oligotrophic, mesotrophic, or eutrophic by the Lake Trophic Survey Program. Sixteen lakes are oligotrophic, 41 are mesotrophic, 28 are eutrophic, and 36 are un-assessed for trophic classification. Two oligotrophic, nine mesotrophic, and two eutrophic lakes participate in VLAP.

- VLAP lakes are monitored at the deepest point in the lake and at streams entering or exiting the lake. Lakes are monitored monthly during the summer season to establish baseline water quality data and discern long term water quality trends that provide information on overall waterbody health.

- Regional trend analysis performed on historical water quality data found no significant trend for parameters chloride and epilimnetic pH. Acid neutralizing capacity (ANC) significantly increased, which indicates improving conditions. Chlorophyll-*a*, epilimnetic turbidity, conductivity, and total phosphorus significantly increased, and transparency significantly decreased, which indicates declining conditions.

SEACOAST REGION WATER QUALITY INDICATORS

The following describes the water quality indicator measured through VLAP, the regional trend that was detected and the current status of the indicator. Trends were determined with a non-parametric Mann-Kendall trend test of the annual medians for each parameter.

Exotic Species	Chlorophyll -a	Transparency	Phosphorus	Dissolved Oxygen	pH	Conductivity	Chloride	Turbidity

Indicator	Trend	Description
Exotic Species	N/A	Eight waterbodies in the Seacoast region are infested with an exotic species. The Cocheco River, Balch Lake, Belleau Lake, Jones Pond, Northwood Lake, Spaulding Lake, and Sunrise Lake are infested with Variable milfoil, and Mountain Pond is infested with Eurasian milfoil. A new infestation of Variable milfoil was documented in Pawtuckaway Lake in 2015; however, due to early detection and removal by divers, eradication at this site is hoped for. Also in 2015, a new infestation of European naiad was found in Northeast Pond in Milton.
Chlorophyll-a	↑	Significantly increasing (worsening) regional chlorophyll-*a* trend from 1987 - 2014. Regional median chlorophyll-*a* is 4.36 mg/m^3 and representative of mesotrophic conditions or average chlorophyll-*a* levels. Lake specific trend analysis indicates 11 lakes have stable chlorophyll-*a* trends.
Transparency	↓	Significantly decreasing (worsening) regional transparency from 1987 - 2014. The regional median transparency is 3.38 meters and representative of mesotrophic or good conditions. Lake specific trend analysis indicates two lakes with decreasing (worsening) transparency, and nine lakes with stable transparency trends.
Phosphorus (P)	↑	Significantly increasing (worsening) regional epilimnetic phoshporus trend from 1987 – 2014. Regional median epilimnetic phosphorus is 11 ug/L and representative of mesotrophic conditions. Lake specific trend analysis indicates one lake with significantly decreasing (improving) epilimnetic phosphorus, one with significantly increasing (worsening) epilimnetic phosphorus, and nine lakes with stable epilimnetic phosphorus trends.
DO	N/A	Dissolved oxygen levels fluctuate temporally and spatially within a lake system. Ideal levels are between 6.0 and 8.0 mg/L. The average whole water column dissolved oxygen level was 5.74 mg/L, which is in the critical range of supporting aquatic life.
pH	↔	No significant regional epilimnetic pH trend from 1987 - 2014. Regional median epilimnetic pH is 6.55 and within a desirable pH range. Lake specific trend analysis indicates 11 lakes with stable epilimnetic pH trends.
Conductivity	↑	Significantly increasing (worsening) regional epilimnetic conductivity trend from 1987 - 2014. The regional median epilimnetic conductivity is 57.6 uMhos/cm which is within an average range however individual lake conductivity fluctuates from approximately 43 to 232 uMhos/cm due to differences in watershed development. Lake specific trend analysis indicates one lake with significantly decreasing (improving) epilimnetic conductivity, three lakes with significantly increasing (worsening) epilimnetic conductivity, and seven lakes with stable epilimnetic conductivity trends.
NaCl	↔	No significant regional epilimnetic chloride trend from 2002 - 2014. Regional median epilimnetic chloride is 16 mg/L and much less than acute and chronic chloride standards. Lake specific epilimnetic chloride levels range from approximately 6 to 48 mg/L.
Turbidity	↑	Significantly increasing (worsening) regional epilimnetic turbidity trend from 1997 - 2014. Regional median epilimnetic turbidity is 0.9 NTU and is indicative of average water quality however median values increased, particularly since 2002. Turbidity trend analysis is not conducted on individual lakes. Average epilimnetic turbidity values of individual lakes ranged from 0.66 NTU to 1.78 NTU.

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INTRODUCTION AND HISTORY

New Hampshire is home to approximately 1,200 lakes and ponds, and thousands of river miles. Protecting our lakes and rivers is critical to sustaining New Hampshire's drinking water resources, aquatic and natural environments, recreational and tourism industries.

The New Hampshire Department of Environmental Services (NHDES) recognizes the importance of these waterbodies in maintaining a healthy ecosystem for our current and future generations. Protecting high-quality waters and restoring those that are impaired requires coordination and partnership between federal, state and local governments, non-profits, regional commissions, lake associations and watershed residents.

To help citizens assess the health of New Hampshire's lakes and ponds, NHDES established the Volunteer Lake Assessment Program (VLAP) in 1985. The program is a volunteer-driven cooperative effort between the State and local governments, lake associations and lake residents. VLAP trains citizen volunteer monitors to collect water quality data at lakes and their associated tributaries on a monthly basis during the summer. VLAP compiles, interprets and reports the data back to state, federal and local governments, lake associations and lake residents.

VLAP volunteer monitors are invaluable stewards for New Hampshire's lakes. Volunteer monitoring allows NHDES to establish a strong set of baseline chemical and biological data, determine long-term water quality trends and identify emerging water quality issues. NHDES acts on these findings through its funding and regulatory programs. Volunteers use this information to educate lake and watershed residents, businesses and local governments on best management practices to keep New Hampshire's lakes and ponds clean. They have been, and will continue to be, a key element in protecting the integrity of New Hampshire's lakes.

PROGRAM OVERVIEW

VLAP is a cooperative program between NHDES and lake residents and associations. Approximately 500 volunteers monitor water quality at 170 lakes throughout New Hampshire through VLAP. Interest in the program has grown drastically in the past ten years as citizens have become more aware of the connections between land use activities and water quality. Volunteer monitors continually collect high-quality data on their local waterbodies and educate watershed residents.

Volunteer monitors are trained by NHDES to collect lake water quality data, survey the surrounding watershed, and sample the streams and rivers that are tributaries to the lake. Each of the participating lakes must be visited by a NHDES biologist on a biennial basis. This visit is a valuable event in which the volunteer monitors have an opportunity to discuss water quality and watershed concerns and receive recommendations on potential remediation activities. Also, the event allows NHDES biologists to perform a field sampling techniques audit to evaluate volunteer monitor's ability to collect quality data, and to collect information on additional water quality parameters as necessary. Volunteers then sample on their own for the remaining summer months.

To further encourage volunteer monitoring, NHDES, established partnerships with the Lake Sunapee Protective Association (LSPA), Colby Sawyer College (CSC) in New London, NH, and Plymouth State University (PSU) in Plymouth, NH to operate VLAP satellite laboratories. These satellite laboratories serve as a convenient location for volunteers to borrow sampling equipment and deliver water samples for analysis. These strategic locations serve the Dartmouth Lake Sunapee, North Country and White Mountain regions.

The data gathered by the volunteers are reviewed by NHDES quality assurance officers and satellite laboratory managers and imported into NHDES' Environmental Monitoring Database (EMD). During the winter, NHDES biologists review and interpret the water quality data, perform trend analyses, and compile the results into annual reports. The high-quality data gathered through VLAP also helps NHDES to conduct statewide surface water quality assessments. Assessment results are submitted to the Environmental Protection Agency (EPA) by NHDES every two years as a requirement of the Clean Water Act.

Once the volunteer monitors receive the data and the annual report for their lake, NHDES encourages the volunteers to relay that information to their respective associations, organizations, businesses and local governments. Volunteers are also kept informed of the latest in lake management and water quality issues through an annual newsletter, technical and educational materials, regional workshops and information on important legislation. In addition, NHDES biologists give presentations at lake association meetings and participate in youth education events. Educational initiatives, such as those mentioned above, allow volunteers to recognize potential water quality or shoreland violations around the lake and report their findings to NHDES.

MONITORING AND PARAMETER SUMMARY

VLAP encourages the collection of comprehensive data sets on key water quality parameters to determine overall health of the system. Lakes and tributaries are sampled several times each year over a period of years. This establishes baseline water quality data and allows for the discernment of long-term water quality trends. These trends depict lake health and provide invaluable information to NHDES' mission to protect New Hampshire's lakes. The sampling efforts of the volunteer monitors supplement the environmental monitoring efforts of NHDES. Only through the assistance of volunteer monitors can such a high volume of sampling be accomplished throughout the state.

NHDES recognizes the importance of collecting data sets that are representative of varying conditions. VLAP has an EPA-approved Quality Assurance Project Plan (QAPP). The QAPP identifies specific responsibilities of NHDES and volunteers, sampling rationale, training procedures, data management and quality control. NHDES and volunteers adhere to the QAPP regime to ensure high-quality and representative data sets are collected.

Volunteers collect samples once per month in June, July and August, with some lakes monitored more or less frequently. Samples are collected at approximately the same location each month at each of the deep spot thermal layer, major tributaries (those flowing year round) and seasonal tributaries during spring run-off. The samples are analyzed for a variety of chemical and biological parameters including: pH, ANC, conductivity, chloride, turbidity, total phosphorus and *E. coli* (optional). Additional in-lake data are also collected at the deep spot including lake transparency (with and without a viewscope), chlorophyll-a, phytoplankton, and dissolved oxygen and temperature profiles. Volunteer monitors are also trained to identify and collect samples of suspicious aquatic plants and cyanobacteria.

Environmental outcomes are measured by making comparisons to established New Hampshire medians, averages, ranges of lake water quality, and state water quality standards. If analytical results for a particular sampling station frequently exceed state water quality standards, then additional sampling to identify potential pollution sources is necessary. Volunteers often conduct storm event sampling, tributary bracket sampling, and spring run-off sampling to better assess watershed health and provide additional data to guide lake management decisions.

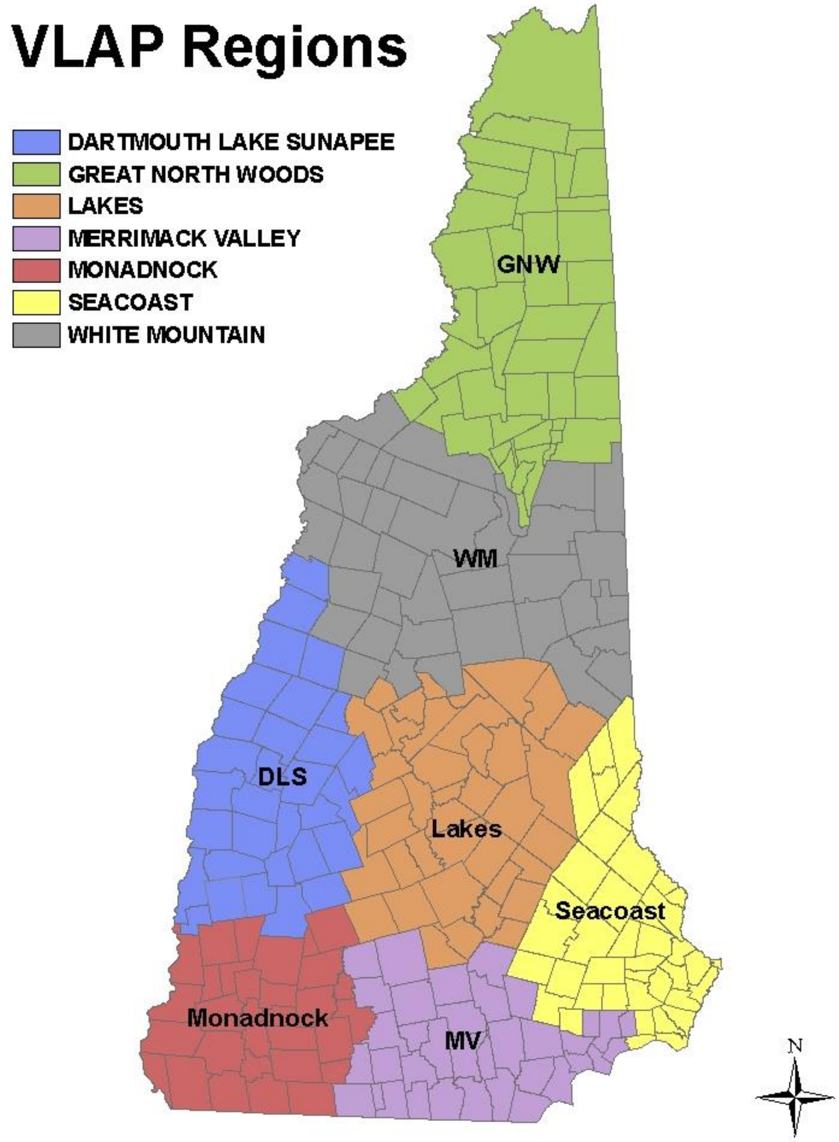
Appendix A includes a summary of each monitoring parameter and Appendix B includes recommended best management practices to remediate pollution sources.

SEACOAST REGIONAL SUMMARY

The Seacoast region consists of those towns in New Hampshire's Strafford County, southeastern portions of Carroll County and northern portions of Rockingham County (Figure 1). Bordering portions of Maine, the Salmon Falls and Piscataqua Rivers, Great Bay and the Atlantic Ocean, the area is home to the University of New Hampshire, Hampton Beach State Park, Strawberry Banke Museum and Prescott Park.

Freshwater resources in the Seacoast region provide valuable drinking water and recreational opportunities and play an important role in the regional economy. Freshwater recreation, including boating, fishing and swimming, in the Seacoast region generate approximately $14.5 million dollars in sales, $5 million in household income, and 235 jobs annually (Nordstrom, 2007). A perceived decline in water quality as measured by water clarity, aesthetic beauty or overuse could result in approximately $6 million dollars in lost revenue, $2 million dollars in lost household income and 100 lost jobs (Nordstrom, 2007).

Figure 1. VLAP Regions

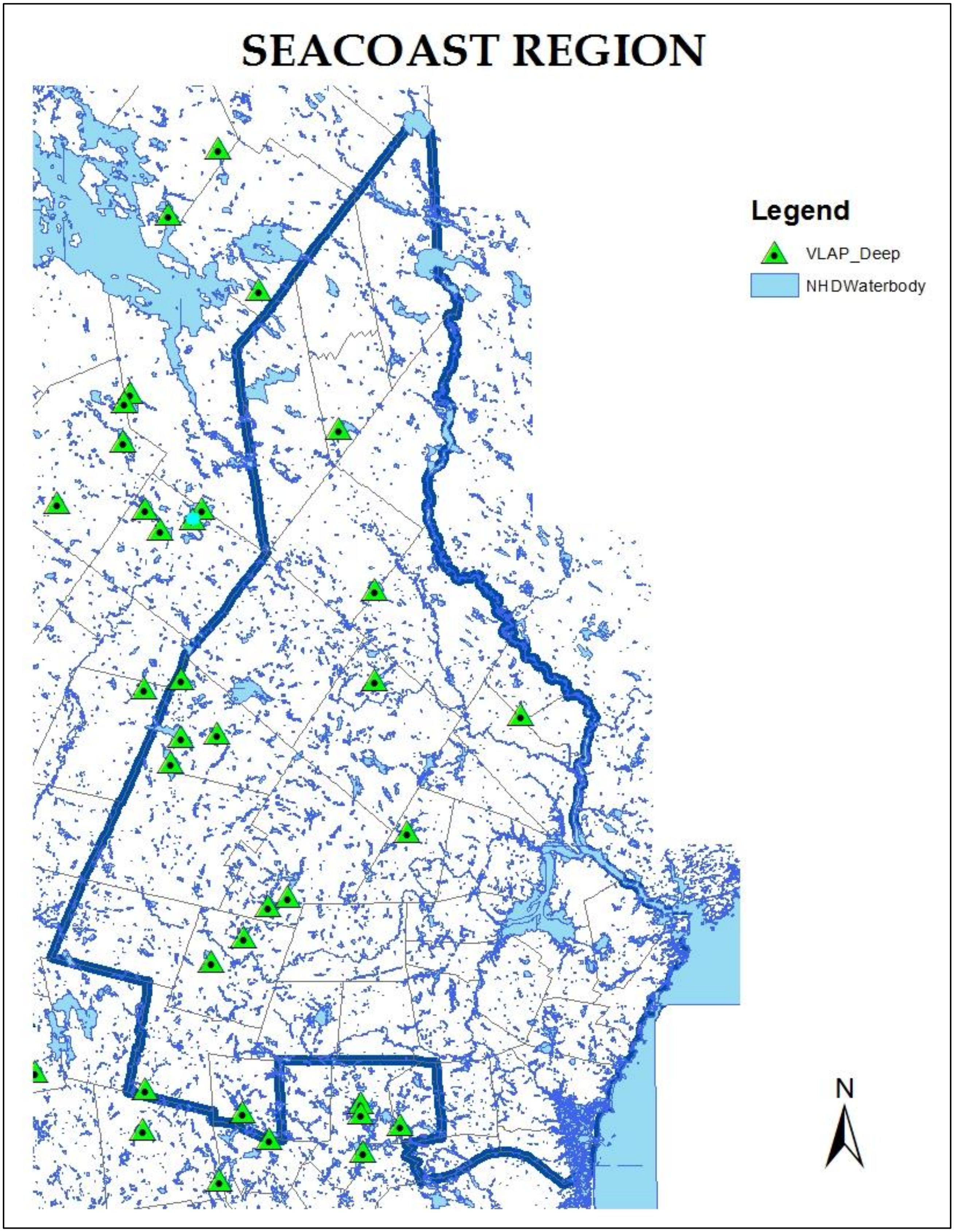


Similarly, a decline in water clarity alone can result in a decrease in New Hampshire lakefront property values. A one meter decrease in water clarity can lead to an average decrease in property values of between 0.9% and 6.0% in New Hampshire (Gibbs, Halstead, Boyle& Huang, 2002). This may negatively impact property tax revenues, especially in a state where there are approximately 64,000 vacation homes concentrated around the Lakes Region (lakes), Seacoast (ocean) and North Country (skiing) (Loder, 2011). According to a 1999 publication of the Society for the Protection of New Hampshire Forests, "The Economic Impact of Open Space in New Hampshire," vacation homes contribute approximately $286 million to state and local tax revenues (note: open space includes lakes). For a town with a large number of lakefront homes (vacation or residential), a decline in water clarity can cause decreased property values and local tax revenue.

The Seacoast region encompasses the Level 8 Hydrologic Unit Code (HUC) Watershed of the Salmon Falls-Piscataqua Rivers. The HUC boundary defines a specific drainage basin of a major river or series of smaller rivers. There are 18 HUC 8 watersheds in New Hampshire. There are seven VLAP regions (Figure 1). The Seacoast region (Figure 2) consists of 13 VLAP lakes as follows. Individual reports for each lake can be found in Appendix E.

Lake Name	**Town**
Ayers Pond	Barrington
Baxter Lake	Farmington
Governor's Lake	Raymond
Harantis Lake (Houston Pond)	Chester
Harvey Lake	Northwood
Jenness Pond	Northwood
Northwood Lake	Northwood
Onway Lake	Raymond
Pawtuckaway Lake	Nottingham
Phillips Pond	Sandown
Pleasant Lake	Deerfield
Sunrise Lake	Middleton
Willand Pond	Dover

Figure 2. Seacoast Region Lakes



LAND USE AND POPULATION GROWTH

According to the 2010 update of the Society for the Protection of New Hampshire Forests' publication "New Hampshire's Changing Landscape 2010," New Hampshire's population is expected to increase by 180,000 through 2030 (Figure 3). Almost 70% of that growth will occur in the Southeastern part of the state, particularly in Merrimack, Hillsborough and Rockingham counties.

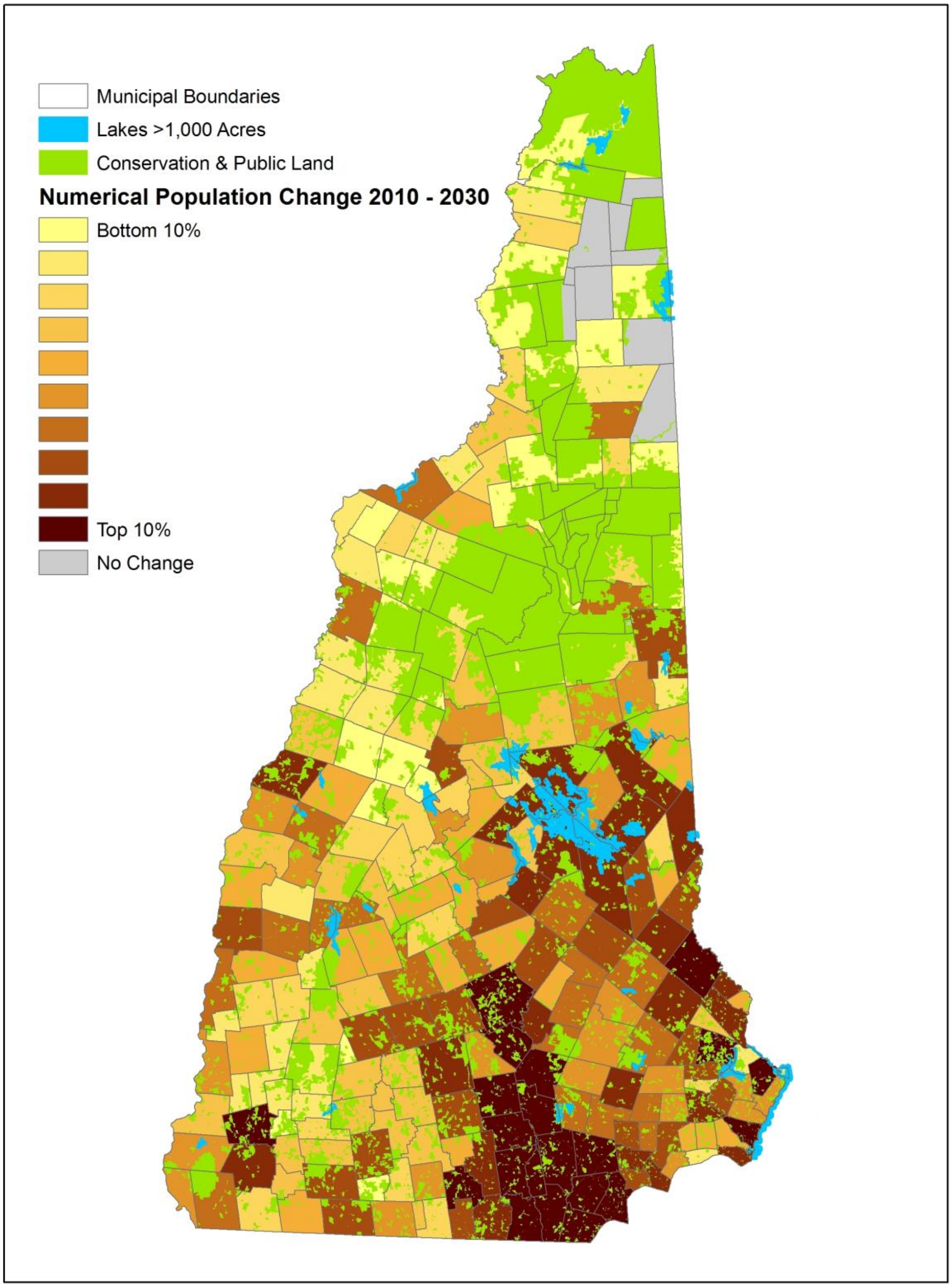
The population is anticipated to grow by approximately 60,000 people in Strafford, Rockingham, and Carroll counties by 2030. The majority of growth is estimated to follow main road corridors and urbanizing areas and is anticipated to be greatest in the towns of Portsmouth, Dover, Hampton, Seabrook, Rochester, Barrington, Somersworth, Farmington, Wakefield and Milton.

The Seacoast region is home to almost 30,000 acres of water (lakes, river, wetlands, and estuaries). Approximately 50% of this water is located in Rockingham County, 10% is located in Carroll County, and 40% is located in Strafford County. Over 10,000 acres of water occurs in the towns predicted to experience the heaviest population growth in these three counties, representing approximately 35% of the total waterbody acreage in the Seacoast region.

Major land categories in the Seacoast region are agriculture, forest, wetland, and developed. Population growth and land use change go hand-in-hand. Growing populations necessitate land clearing to accommodate new homes, housing complexes, roadways and commercial businesses. Developed land corresponds to more impervious surfaces such as roadways, driveways and rooftops. It also corresponds to the loss of tree canopy coverage, unstable sediments, wildlife habitat loss and vegetative buffer loss. Consequences of development can negatively affect our waterbodies through increases in stormwater runoff, water temperatures, erosion, turbidity and nutrients, as well as shifts in aquatic life, aquatic plant, algae and cyanobacteria growth.

Overall, population growth in the Seacoast region could greatly impact a large portion of its waterbodies. Efforts should be made to evaluate current land use activities, infrastructure and regional water quality. This information should facilitate a plan to accommodate projected population growth while conserving and protecting valuable land and water resources.

Figure 3. NH Population Growth per Town 2010-2030



EXOTIC SPECIES

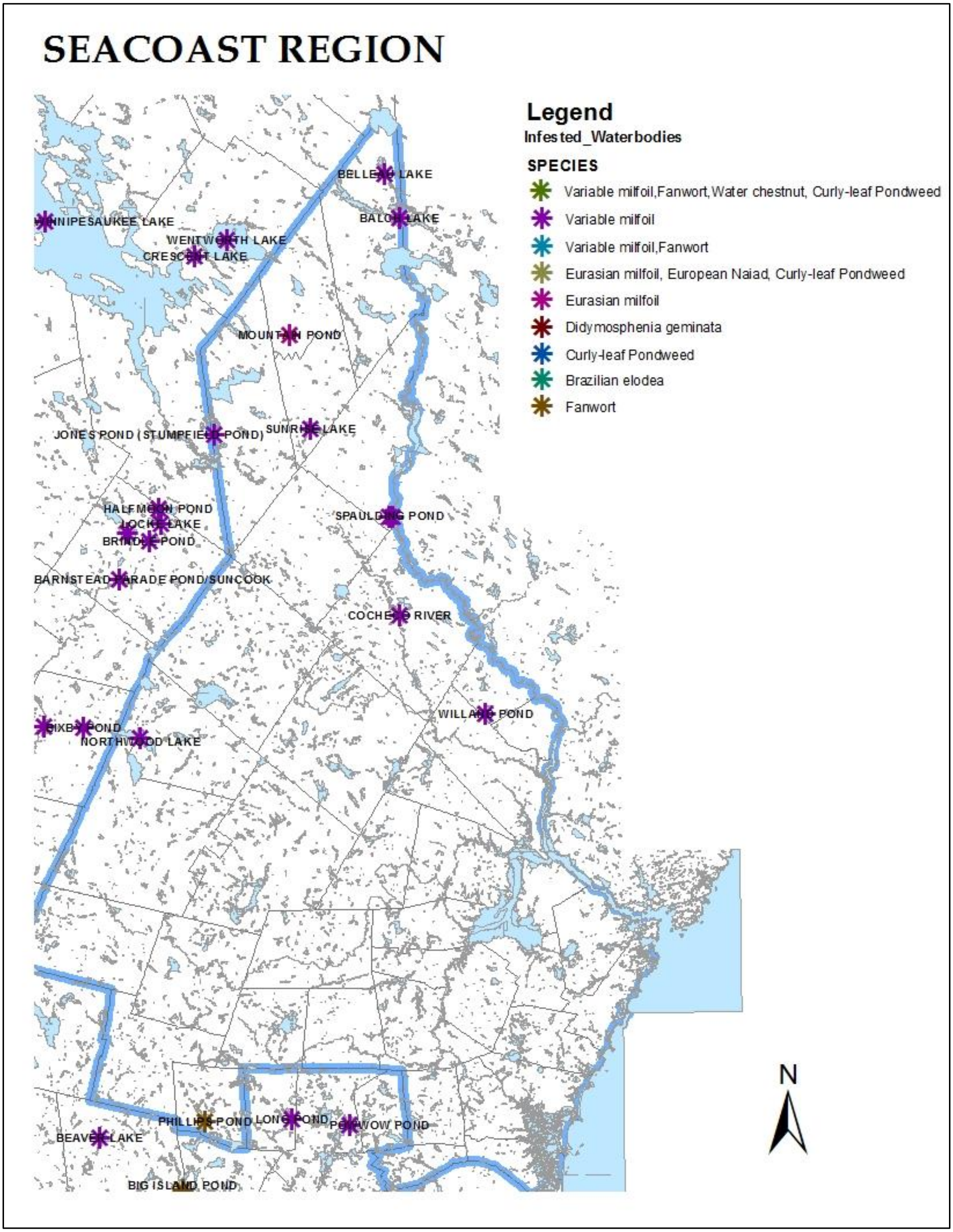
Exotic aquatic nuisance species are those plants and animals not native to New Hampshire's waterbodies, spread quickly through the aquatic environment, negatively affect economic and recreational activities, and can have a detrimental influence on natural habitats, the ecology of the system, and native species. They are a serious threat to the health of New Hampshire's aquatic ecosystems, recreation, and tourism industries.

New Hampshire has 106 exotic plant infestations in 85 waterbodies. Those include Variable milfoil, Eurasian milfoil, Brazilian Elodea, Water chestnut, Curly-leaf Pondweed, Fanwort, European Naiad, and *Didymo* (Rock Snot). Variable milfoil inhabits the majority of infested waterbodies, and *Didymo*, an invasive alga, has now infested 54 river miles in the North Country. Currently, eight waterbodies in the Seacoast region are infested with an exotic species (Figure 4). The Cocheco River, Balch Lake, Belleau Lake, Jones Pond, Northwood Lake, Spaulding Lake, and Sunrise Lake are infested with Variable milfoil, and Mountain Pond is infested with Eurasian milfoil. A new infestation of Variable milfoil was documented in Pawtuckaway Lake in 2015; however it was detected early and removed by divers, with the hopes of eradication at this site. Also in 2015, a new infestation of European naiad was found in Northeast Pond in Milton and management plans are being developed for this site.

The unique nature and invasive tendencies of these exotic species heighten the need to prevent new infestations, manage current infestations and engage watershed residents. Public education is integral in preventing further infestations. One program that educates the public and engages watershed residents is the NHDES Weed Watchers Program. The Weed Watchers program has approximately 750 volunteers dedicated to monitoring lakes and ponds for the presence of exotic aquatic plants. Volunteers are trained to survey their lake or pond once a month from May through September. To survey, volunteers slowly boat, or sometimes snorkel, around the perimeter of the waterbody and its islands looking for suspicious aquatic plant species. If a suspicious plant is found, the volunteers send a specimen to NHDES for identification, either in the form of a live specimen, or as a photograph emailed to the Exotic Species Program Coordinator. Upon positive identification, a biologist visits the site to determine the extent of infestation, initiates a rapid response management technique where possible, and formulates a long-term management plan to control the nuisance infestation.

Another program dedicated to public education and engaging watershed residents regarding exotic plant species is the Lake Host™ program, which was developed in 2002 by the non-profit organization New Hampshire Lake Association (NHLA, a.k.a. NH LAKES) and NHDES. The Lake Host™ Program is funded through NHDES and federal grants and provides courtesy boat inspections at boat ramps to prevent invasive species introduction and spread. Since the program was implemented, the number of participating waterbodies, volunteers and number of "saves" (exotic plants discovered) has consistently increased. The program is invaluable in educating boaters, preventing recreational hazards, avoiding property value and aquatic ecosystem decline, addressing aesthetic issues, and saving costly remediation efforts.

Figure 4. Seacoast Region Exotic Aquatic Plant Infestations



GEOMORPHOLOGY AND CLIMATE

Chemical, physical and biological properties of lakes often reflect how they were formed. Lake formation can occur in a variety of ways. In New Hampshire, most lakes were formed during the last ice age as glaciers retreated approximately 12,000 years ago. Lakes are also formed from rivers (oxbow), and are man- and animal-made (impoundments, dams and beavers). These formations create distinct lake morphology. Included in a lake's morphology are length, width, area, volume and shape. Lake morphology affects the lake's overall ability to adapt to shifts in climate and land use.

Along with the morphological characteristics of lakes, the bedrock and sediment geology is also important in understanding lake properties. Underlying geological properties can affect the pH and ANC of our surface and groundwater. New Hampshire is typically referred to as the "Granite State" because the bedrock geology consists of variations of igneous rock high in granite content that contributes to a lower capacity to buffer acidic inputs such as acid rain. Metamorphic rocks make up the remainder of bedrock geology and consist of slate, schist, quartzite and carbonate rocks which tend to contribute to a more neutral pH and better buffering capacity.

Climate also drives multiple processes in lake systems. Lakes respond to shifting weather conditions such as sunlight, rainfall, air temperature, and wind and wave action in various ways. This variability is reflected in the types and number of biological communities present, and chemical and physical properties of the lake system. It is essential that we understand how these factors influence water quality data collected at individual lake systems. Therefore, volunteers record pertinent weather data, rain and storm event totals, on field data sheets while sampling.

To summarize the Seacoast region climate conditions in 2013, the sampling season experienced slightly warmer air temperatures and above average rainfall based on air and precipitation data recorded in Durham, New Hampshire (Table 1). Air temperatures were warmer than historical averages in June and July, but average in May, August and September resulting in the 2013 average summer air temperature being only 0.9 degrees warmer than the historical average. Surface water temperatures were slightly above average for July, but were below average in June and August, making the 2013 summer average surface water temperature 0.3 degrees below normal. The 2013 monthly rainfall amounts were well above average in May, June and September, and well below average in July and August resulting in the 2013 average summer precipitation being 1.33 inches greater than the historical average.

In contrast, the 2014 sampling season was slightly cooler and drier. Air temperatures were slightly below average or average in May, June, August and September and above average in July resulting in the seasonal average being in line with the historical average. However, surface water temperatures were much warmer than normal and were above average June through August resulting in the 2014 summer average surface water temperature being 1.6 degrees above normal. The 2014 monthly rainfall amounts were below average in May, June and September, and slightly above average in July and August making the 2014 summer average precipitation 0.26 inches below the historical average.

Table 1. Current Year and Historical Average Temperature and Precipitation Data for Seacoast Region

	May	June	July	August	September	Summer
2013 Average Air Temperature (°F)	57.2	67.1	74.1	69.1	62.1	65.9
2014 Average Air Temperature (°F)	57.0	65.8	72.9	67.3	62.1	65.0
Annual Average Air Temperature (°F)	**57.0**	**66.0**	**71.0**	**69.0**	**62.0**	**65.0**
2013 Average Surface Water Temperature (°F)	-------	70.9	79.5	74.3	--------	74.9
2014 Average Surface Water Temperature (°F)	-------	73.2	79.7	77.5	--------	76.8
Annual Average Surface Water Temperature (˚F)		**72.0**	**77.5**	**76.1**		**75.2**
2013 Precipitation (in.)	5.13	7.17	2.87	3.15	7.83	5.23
2014 Precipitation (in.)	3.49	2.14	5.57	5.11	1.89	3.64
Annual Average Precipitation (in.)	**3.99**	**3.92**	**4.23**	**3.54**	**3.80**	**3.90**

MONITORING AND ASSESSMENT

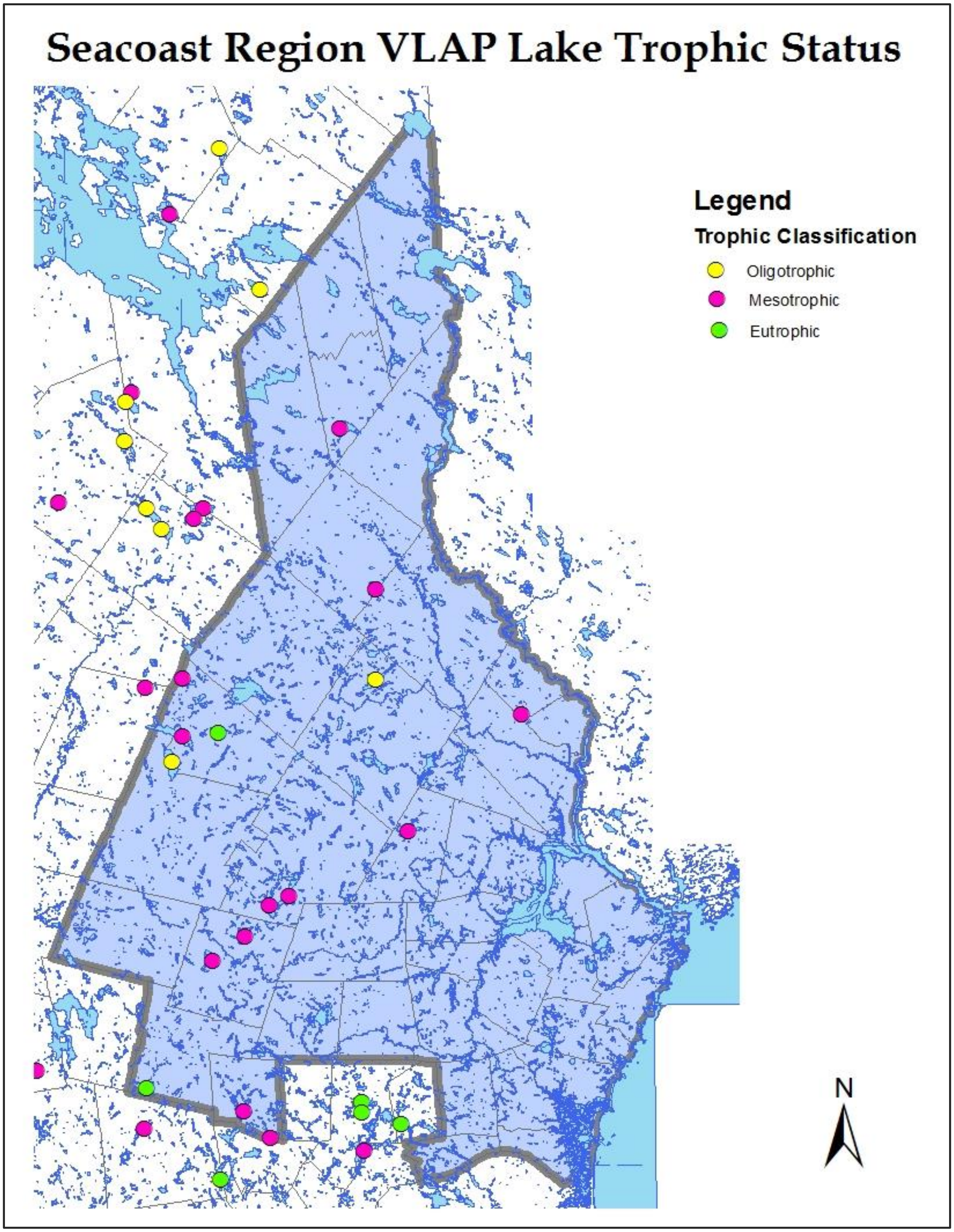
New Hampshire considers a public water to be a great pond or artificial impoundment greater than 10 acres in size, public rivers, streams and tidal waters. The Seacoast region consists of 121 lakes, or great ponds, and 13 of those lakes participate in VLAP. Data on the remaining 90% of lakes are sparse, being only occasionally sampled through the NHDES Lake Trophic Survey Program. However, the University of New Hampshire Lakes Lay Monitoring Program (UNH LLMP) also collects annual water quality data at approximately 11 lakes in the Seacoast region.

The NHDES Lake Trophic Survey Program monitors New Hampshire's lakes on a rotating basis, with the goal of conducting a comprehensive lake survey every 10 to 15 years. The surveys compile chemical, biological and morphological data. The data are used to assign a lake trophic class to each waterbody. The trophic class provides an assessment on how "aged" a lake is and can provide information on how population growth and human activities may be accelerating the aging process, also known as lake eutrophication.

Three trophic classes are used to assess a lake's overall health: oligotrophic, mesotrophic and eutrophic. Oligotrophic lakes have high dissolved oxygen levels (> 5 mg/L), high transparency (> 12 ft. or 3.65 m), low chlorophyll-a concentrations (< 4 mg/L), low phosphorus concentrations (< 10 ug/L), and sparse aquatic plant growth. Eutrophic lakes have low levels of dissolved oxygen (< 2 mg/L), low transparency (< 6 ft. or 1.8 m), high chlorophyll-a concentrations (> 15 mg/L), high phosphorus concentrations (> 20 ug/L), and abundant aquatic plant growth. Mesotrophic lakes have characteristics that fall in between those of oligotrophic and eutrophic lakes for the parameters listed.

The trophic class breakdown of Seacoast region is as follows: Sixteen lakes are oligotrophic, 41 mesotrophic, 28 eutrophic and 36 are un-assessed for trophic classification due to lack of data. Two oligotrophic, nine mesotrophic and two eutrophic lakes participate in VLAP (Figure 5). Approximately 50% of the Seacoast lakes are classified as Oligotrophic and Mesotrophic; however nearly half of those lakes do not participate in VLAP or a similar monitoring program. As human activities in watersheds accelerate lake aging, it is imperative to keep a close eye on the health of those lakes. Efforts should also be made to gather data on the un-assessed waterbodies. Protecting a lake and preventing lake aging is much more cost-effective than restoring a damaged lake.

Figure 5. Seacoast Region VLAP Lake Trophic Status



VLAP Water Quality Data Interpretation

The Seacoast region is home to 15 lakes and ponds that participate in VLAP. Volunteer monitors at each lake collect comprehensive data sets at the deepest spot of the lake and from streams entering or exiting the lake. Deep spot sample collection is representative of overall lake quality conditions and provides information into how the lake responds to localized events such as stormwater and drought. Deep spot data are used to establish long-term water quality trends and to provide insight into the overall health of the waterbody. Stream sample collection is representative of what flows into the lake from the surrounding watershed. Stream data are used to identify potential watershed pollution problems so that remediation actions occur before they negatively impact the overall health of the waterbody.

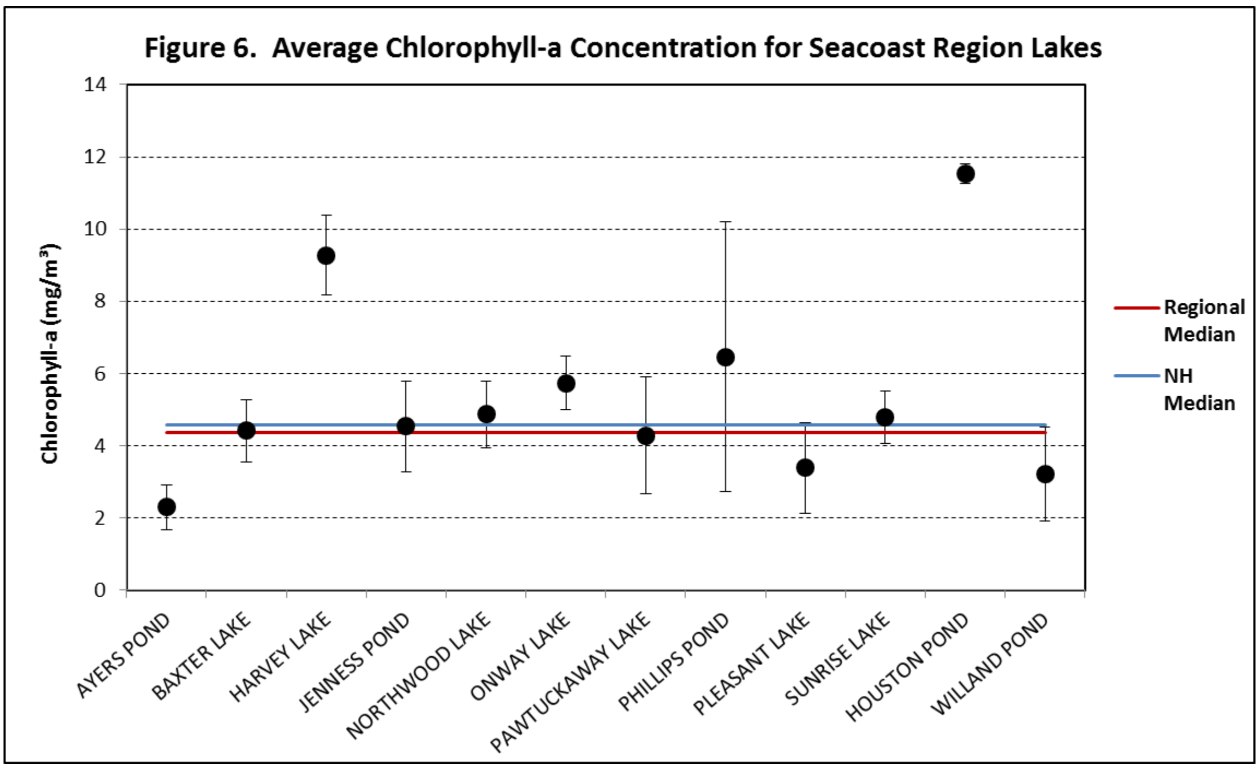
The following section provides a summary of the VLAP monitoring parameters, long-term water quality trends, and an analysis of the current year and historical data for the VLAP lakes and ponds in the Seacoast region compared with regional and state medians. The deep spot data for the epilimnion, or surface water layer, is compared to the New Hampshire median to provide an understanding of how the quality of a lake deep spot compares to other New Hampshire lake deep spots. Similarly, the epilimnion data are compared to the regional median to provide an understanding of how the quality of your lake deep spot compares with other local lakes. Median values were utilized to represent historical state and regional conditions as the value tends to better represent the actual middle number while minimizing the effects of outlier values. Average annual lake and regional values are then compared to the historical medians.

A complete list of monitoring parameters and how to interpret data are included in Appendix A.

Annual and Historical Chlorophyll-*a* Data Analysis

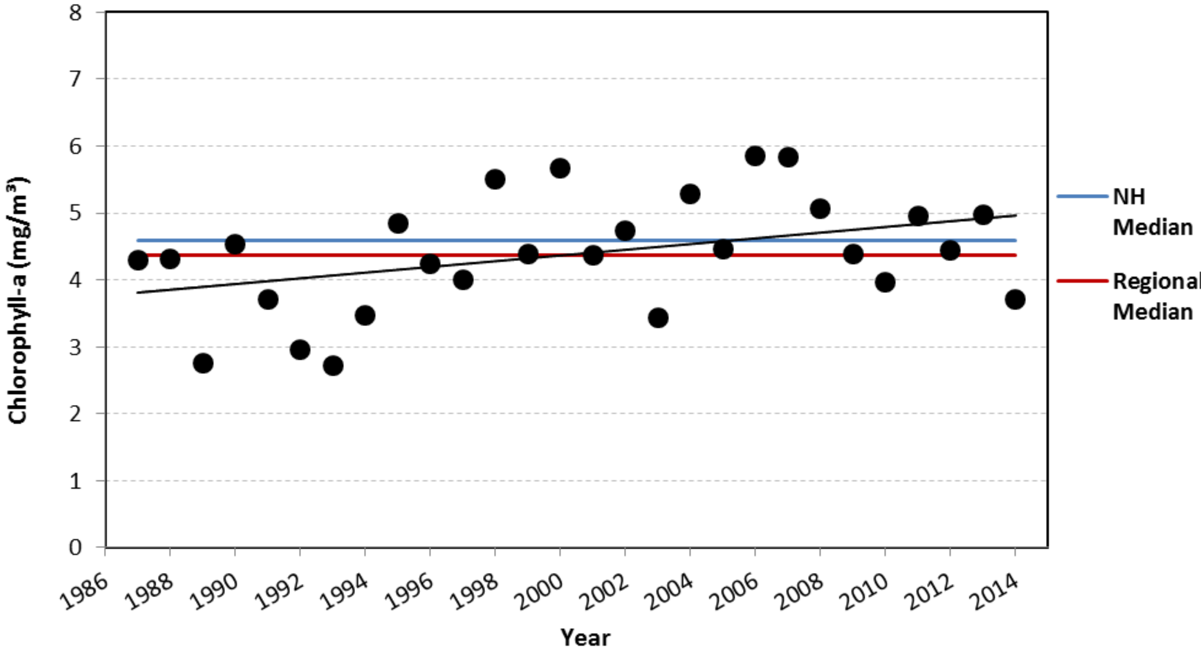
Algae are microscopic plants that are naturally found in the lake ecosystem. Algae, including cyanobacteria, contain chlorophyll-*a*, a pigment used for photosynthesis. The measurement of chlorophyll-*a* in the water gives biologists an estimation of the algal abundance or lake productivity. **The median summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 4.58 mg/m3. The median chlorophyll-a concentration for the Seacoast region is 4.36 mg/m^3.**

The combined 2013 and 2014 average chlorophyll-*a* concentrations for each lake in the Seacoast region are represented in Figure 6 compared with state and regional medians. The average chlorophyll-*a* concentration at six lakes is equal to or less than the state and regional medians and typically representative of good to average water quality. Four lakes have average chlorophyll-*a* concentrations slightly greater than the state median, while two lakes experienced chlorophyll-*a* concentrations much greater than the state median and representative of poor water quality. Typically, chlorophyll-*a* concentrations that exceed 5.0 mg/m^3 are considered higher than desirable. Overall, approximately 70% of the sampled deep spots have chlorophyll-*a* concentrations representative of oligotrophic and mesotrophic classifications.



The median annual chlorophyll-*a* concentrations for the Seacoast region are represented in Figure 7 compared with state and regional medians. Median chlorophyll-*a* concentrations generally fluctuated between 3.0 and 5.0 mg/m^3 from 1987 to 1994. However, since then, median chlorophyll-*a* concentrations have generally remained greater than 4.5 mg/m^3 and the state median.

Figure 7. Seacoast Region Median Annual Chlorophyll-a Concentration



Chlorophyll-*a* Trend Analysis

The regional median chlorophyll-*a* concentration was subject to Mann-Kendall non-parametric statistical analyses to determine if a significant regional trend existed using a 95% confidence limit. A significantly increasing (worsening) chlorophyll-*a* trend was detected for the region and was the only state region with a significant increase in chlorophyll-*a* concentrations (Appendix D: Table D-1).

In addition to the regional trend analysis, Seacoast Region lakes with 10 or more consecutive years of data were subject to linear regression analyses to determine whether water quality trends were significantly increasing, decreasing, or stable over time. Chlorophyll-*a* trends were assessed for approximately 11 deep spots at 10 lakes in the region representing 80% of the Seacoast Region VLAP lakes. Chlorophyll-*a* concentrations have remained stable at all lake deep spots (Appendix D: Table D-7). The stable trends at individual lakes are a positive sign; however, the regional median has significantly increased. Chlorophyll-*a* concentrations are typically related to phosphorus concentrations. Phosphorus is a nutrient that promotes plant and algal growth in New Hampshire lakes. As phosphorus levels increase in lakes, it will normally cause an increase in algal growth.

Annual and Historical Transparency Data Analysis

Volunteer monitors use the Secchi disk, a 20 cm disk with alternating black and white quadrants, to measure how far a person can see into the water. Transparency, a measure of water clarity, can be affected by algae and sediment in the water, as well as the natural color of the water. Transparency may also be measured using a viewscope, a cylindrical tube, designed to decrease surface water properties that may cause difficulty in viewing the Secchi disk. A comparison of transparency readings collected with and without the use of a viewscope shows that the viewscope typically increases the depth to which the Secchi disk can be seen into the lake, particularly on sunny and windy days. **The median summer transparency for New Hampshire's lakes and ponds is 3.20 meters. The median transparency for the Seacoast region is 3.38 meters.**

Figure 8 represents the combined 2013 and 2014 average transparency for Seacoast region lakes compared with regional and state medians. The average transparencies at seven lakes are equal to or less than the state median and are typically representative of poor to average water quality conditions. Five lake transparencies are greater than the regional median and are typically representative of good water quality. Overall lake depth plays an important role when interpreting transparency data. Shallow lakes will typically report lower transparencies than deeper lakes, yet these waterbodies may be quite clear. A better representation would be to look at how transparency changes over time.

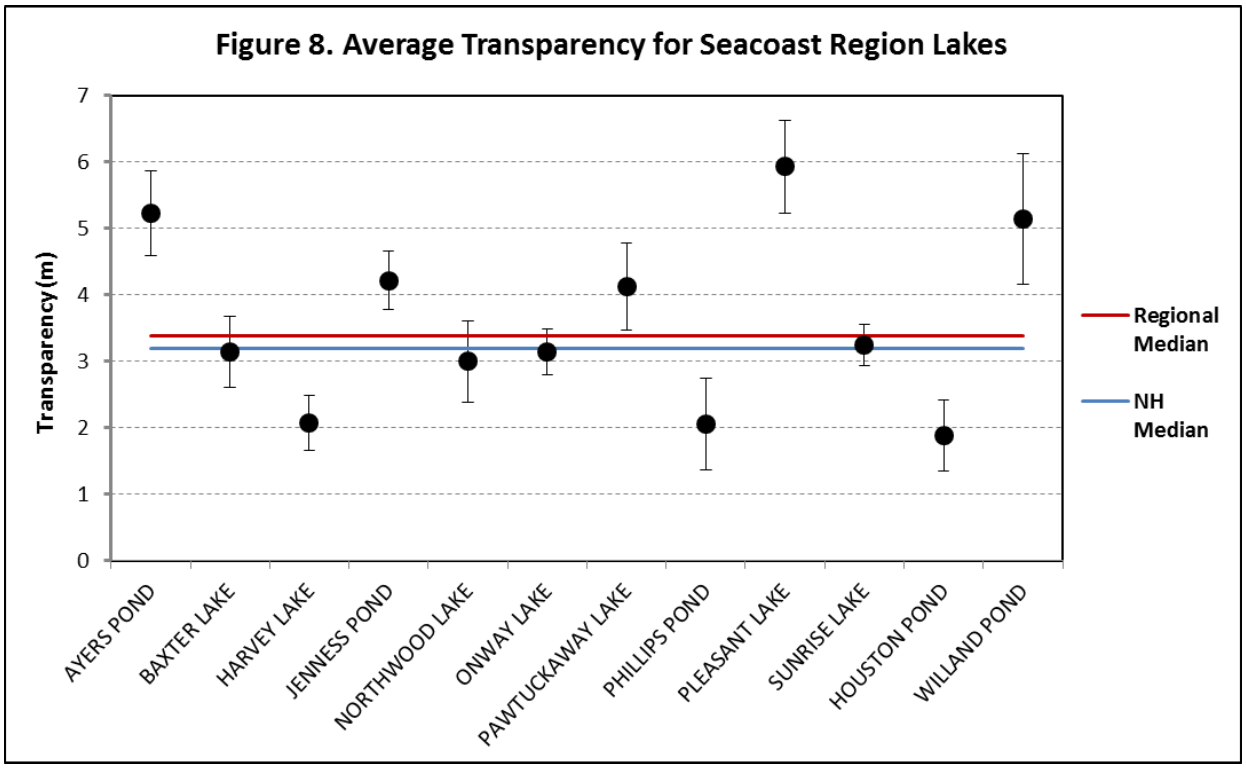
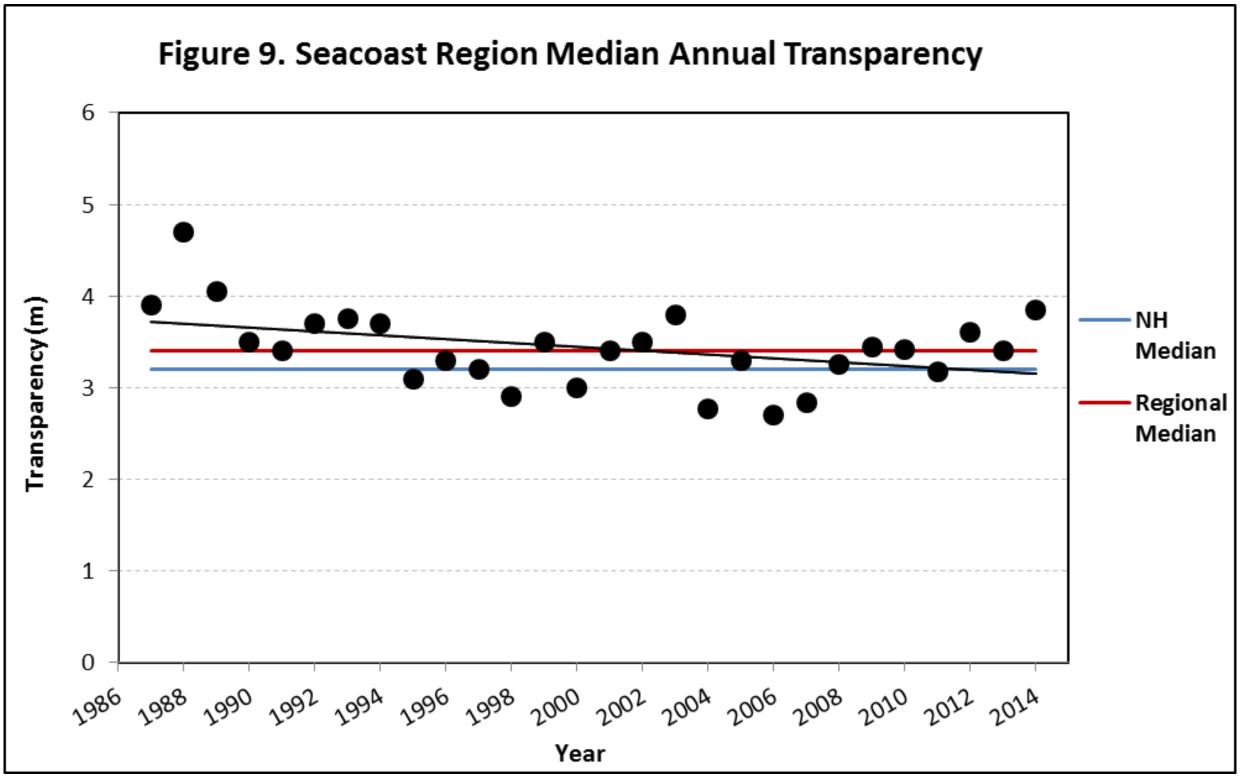


Figure 9 represents the median annual transparency for the Seacoast region compared with state and regional medians. Regional transparency generally remained between 3.0 and 4.0 meters from 1987 to 1994 however regional transparency generally decreased to less than 3.5 meters from 1995 to 2007. Since 2007 transparency has improved slightly with the 2014 median transparency the being best measured since 2003.



Transparency Trend Analyses

The regional median transparency was subject to Mann-Kendall non-parametric statistical analyses to determine if a significant regional trend existed using a 95% confidence limit. A significantly decreasing (worsening) trend was detected for the Seacoast region which is consistent with the majority of state regions (Appendix D: Table D-1), and consistent with the significantly increasing (worsening) chlorophyll-*a* trend.

In addition to the regional trend analysis, Seacoast Region lakes with 10 or more consecutive years of data were subject to linear regression analyses to determine whether water quality trends were significantly increasing, decreasing or stable over time. Transparency trends were assessed for approximately 11 deep spots at 10 lakes in the region representing approximately 80% of the region's VLAP lakes. Trend analysis revealed two lake deep spots with decreasing (worsening) transparency and nine lake deep spots with relatively stable transparency trends (Table 2; Appendix D: Table D-7). The majority of individual lakes have stable transparency trends which are a positive sign; however, the regional transparency trend continues to be significantly declining (Figure 9; Appendix D: Table D-7).

Transparency, or water clarity, is typically affected by the amount of algae, color, and particulate matter within the water column. The regional decline in lake transparency seems to be caused by an increase in algal growth as depicted in the regional chlorophyll-*a* trend. Algae utilize nutrients, mainly phosphorus to grow. Phosphorus sources in lake watersheds may include lawn fertilizers, sandy beaches, septic systems and agriculture. Stormwater runoff can transport nutrients and other debris to lake systems. The increased frequency and intensity of storm events highlights the importance of identifying potential areas of concern in the watershed and utilize best management practices to control stormwater and erosion.

Please refer to Appendix B for reference material on do-it-yourself stormwater best management practices.

Table 2. Significant Transparency Trends in Seacoast Region Lakes

Lake Name	Transparency
	Decreasing Trend
	p
Harvey Lake	< 0.01
Jenness Pond	< 0.01

Annual and Historical Total Phosphorus Data Analysis

Phosphorus is typically the limiting nutrient for vascular plant and algal growth in New Hampshire's lakes and ponds. Excessive phosphorus in a pond can lead to increased plant and algal growth over time. **The median summer epilimnetic (upper layer) total phosphorus concentration of New Hampshire's lakes and ponds is 12 ug/L. The median epilimnetic total phosphorus concentration for the Seacoast region is 11 ug/L.**

Figure 10 represents the combined 2013 and 2014 average epilimnetic total phosphorus concentration for Seacoast region lakes compared with state and regional medians. The regional median is slightly less than the state median, and is considered to be representative of mesotrophic conditions. Seven lakes have average phosphorus concentrations equal to or less than the regional and state medians and representative of oligotrophic/mesotrophic conditions. Four lakes experienced average phosphorus greater than the state median and representative of mesotrophic/eutrophic conditions. Overall, regional epilimnetic phosphorus concentrations are generally representative of oligotrophic and mesotrophic conditions.

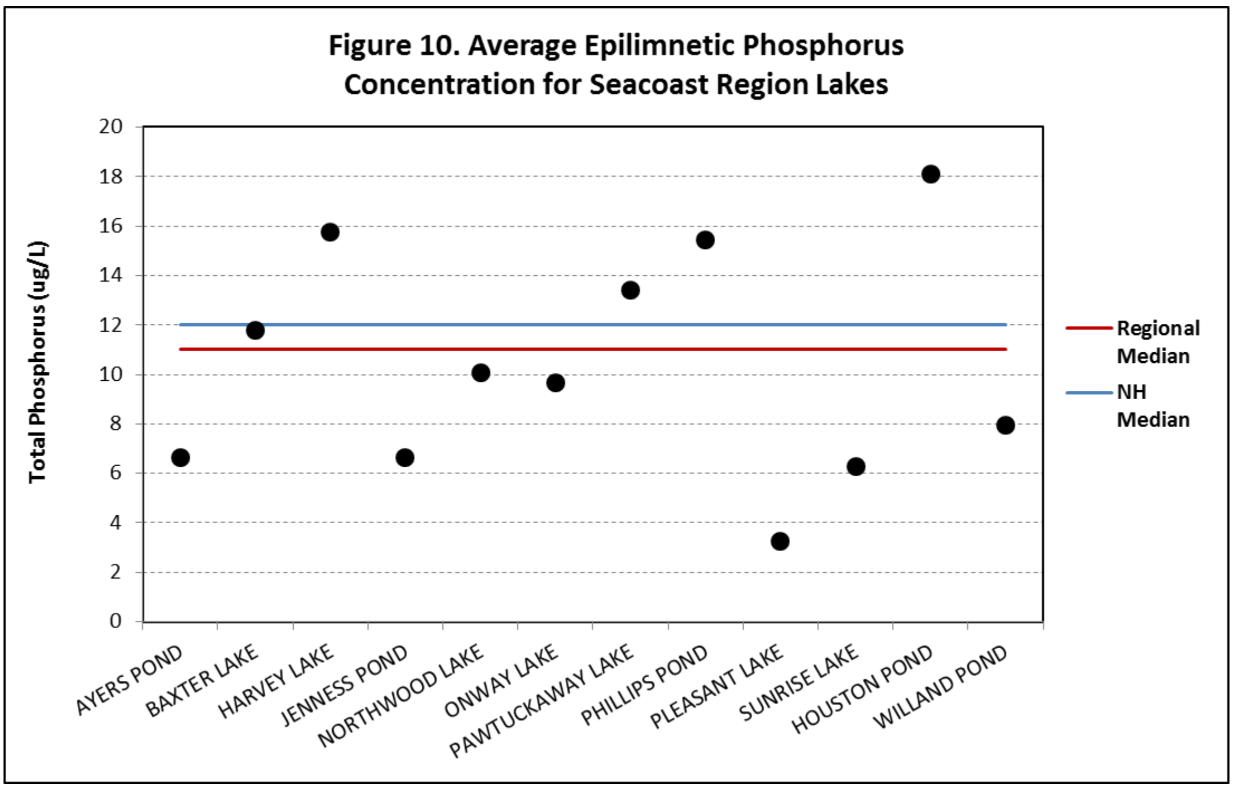
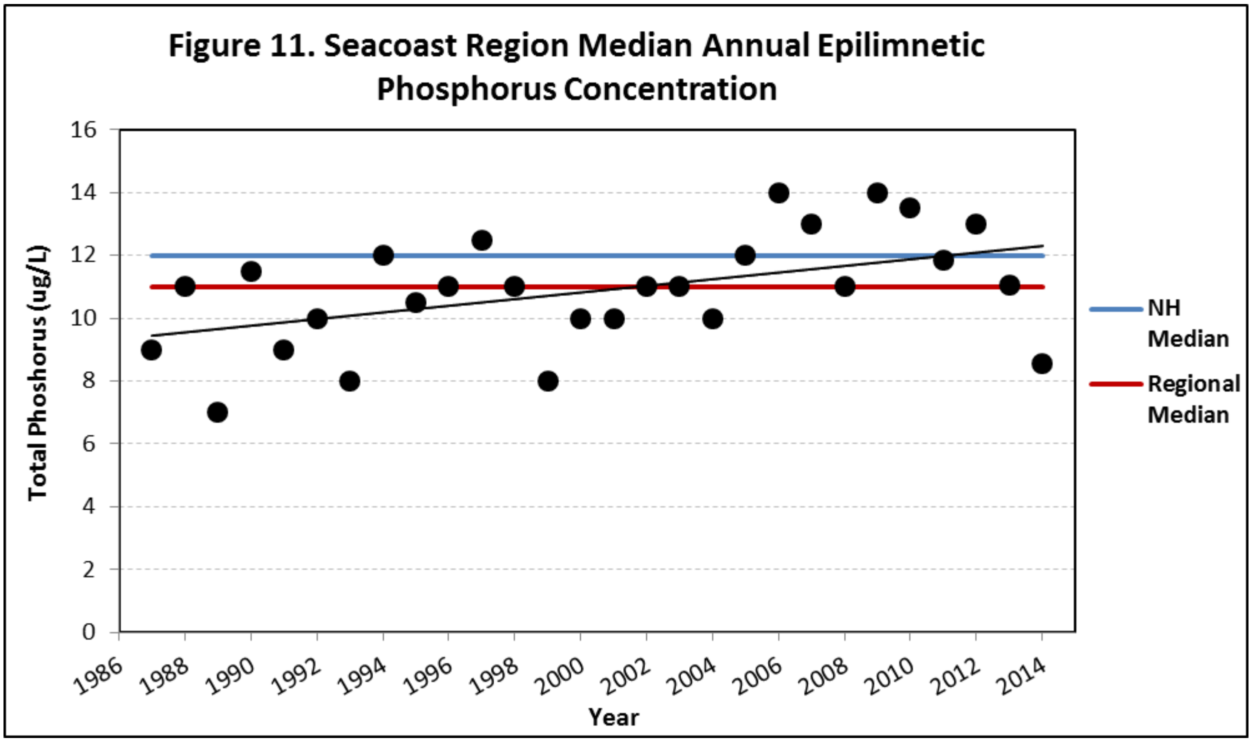


Figure 11 represents the median annual epilimnetic phosphorus concentration for the Seacoast region compared with state and regional medians. The median annual epilimnetic phosphorus concentration generally remained between 8 and 11 ug/L from 1987 to 2004. Since 2004, median epilimnetic phosphorus concentrations have increased and generally remained greater than 12 ug/L.



Epilimnetic Phosphorus Trend Analyses

The regional median epilimnetic phosphorus was subject to Mann-Kendall non-parametric statistical analyses to determine if a significant regional trend existed using a 95% confidence limit. A significantly increasing (worsening) epilimnetic phosphorus trend was detected for the Seacoast region and is the only region of the state to experience a phosphorus increase (Appendix D: Table D-1). The increasing phosphorus trend likely contributes to the worsening regional chlorophyll-*a* and therefore transparency trends.

In addition to the regional trend analysis, Seacoast region lakes with 10 or more consecutive years of data were subject to linear regression analyses to determine whether water quality trends were significantly increasing, decreasing, or stable over time. Epilimnetic phosphorus trends were assessed for approximately 11 deep spots at 10 lakes in the region representing approximately 80% of the region's VLAP lakes. Trend analysis revealed one lake deep spot with significantly decreasing (improving) phosphorus levels and one lake deep spots with significantly increasing (worsening) phosphorus levels, while nine lake deep spots experienced stable trends (Table 3; Appendix D: Table D-7). Although the majority of individual lakes experience stable trends, the regional median epilimnetic phosphorus levels continue to be significantly declining (Figure 11; Appendix D: Table D-1).

Increasing epilimnetic phosphorus trends are often a result of phosphorus-enriched stormwater runoff related to increased watershed development. An increase in watershed development often results in an increase in impervious surfaces and unstable sediments. This contributes to an increase in stormwater runoff and sedimentation to rivers and lakes. Efforts should be made to adopt watershed ordinances to limit stormwater runoff and other phosphorus contributions. Watershed residents should be educated on utilizing and installing best management practices to control stormwater runoff from their own properties.

For more information and resources to control phosphorus loading, refer to Appendix B.

Table 3. Significant Epilimnetic Total Phosphorus Trends in Seacoast Region Lakes

Lake Name	Total Phosphorus (Epilimnion)	
	Increasing Trend	Decreasing Trend
	p	p
Pawtuckaway Lake, North Stn.	< 0.01	
Pleasant Lake		0.02

Dissolved Oxygen Data Analysis

The presence of dissolved oxygen is vital to bottom-dwelling organisms as well as fish and amphibians. If the concentration of dissolved oxygen is low, typically less than 5 mg/L, species intolerant (i.e., sensitive) to this situation, such as trout, will be forced to migrate closer to the surface where there is more dissolved oxygen but the water is generally warmer, and the species may not survive. Temperature and time of day also play a role in the amount of dissolved oxygen in the water column. Water can hold more oxygen at colder temperatures than at warmer temperatures. Therefore, a lake will typically have a higher concentration of dissolved oxygen during the winter, spring and fall than during the summer. Oxygen concentrations are typically lower overnight than during the day. Plants and algae respire (use oxygen) at night and photosynthesize (produce oxygen) during the day. Dissolved oxygen levels may shift depending on the abundance of aquatic plants and algae in the littoral (near shore) and pelagic (deep water) zones.

Dissolved oxygen and temperature profiles are collected at VLAP lakes on an annual or bi-annual basis. The average dissolved oxygen levels for the Seacoast region is 5.74 mg/L, which is in a critical range to support aquatic life.

For additional information regarding dissolved oxygen, please refer to Appendix A.

Annual and Historical Deep Spot pH Data Analysis

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 6.0 typically limits the growth and reproduction of fish. A waterbody is considered impaired for aquatic life when the pH falls below 6.5 or above 8.0. **The median epilimnetic pH value for New Hampshire's lakes is 6.6, which indicates that the state surface waters are slightly acidic. The median epilimnetic pH for the Seacoast region is 6.55.**

Figure 12 represents the combined 2013 and 2014 average epilimnetic pH for individual lakes in the Seacoast Region compared with state and regional medians. Five lakes have epilimnetic pH values less than the regional median and considered lower than desirable for aquatic life. Seven lakes have epilimnetic pH values greater than the state median and within a desirable range to support aquatic life. The lowest, most acidic, epilimnetic pH value was 6.14 measured at Harantis Lake in Chester, whereas; the highest, most basic, epilimnetic pH value was 6.82 measured at Sunrise Lake in Middleton.

Figure 12. Average Epilimnetic pH for Seacoast Region Lakes

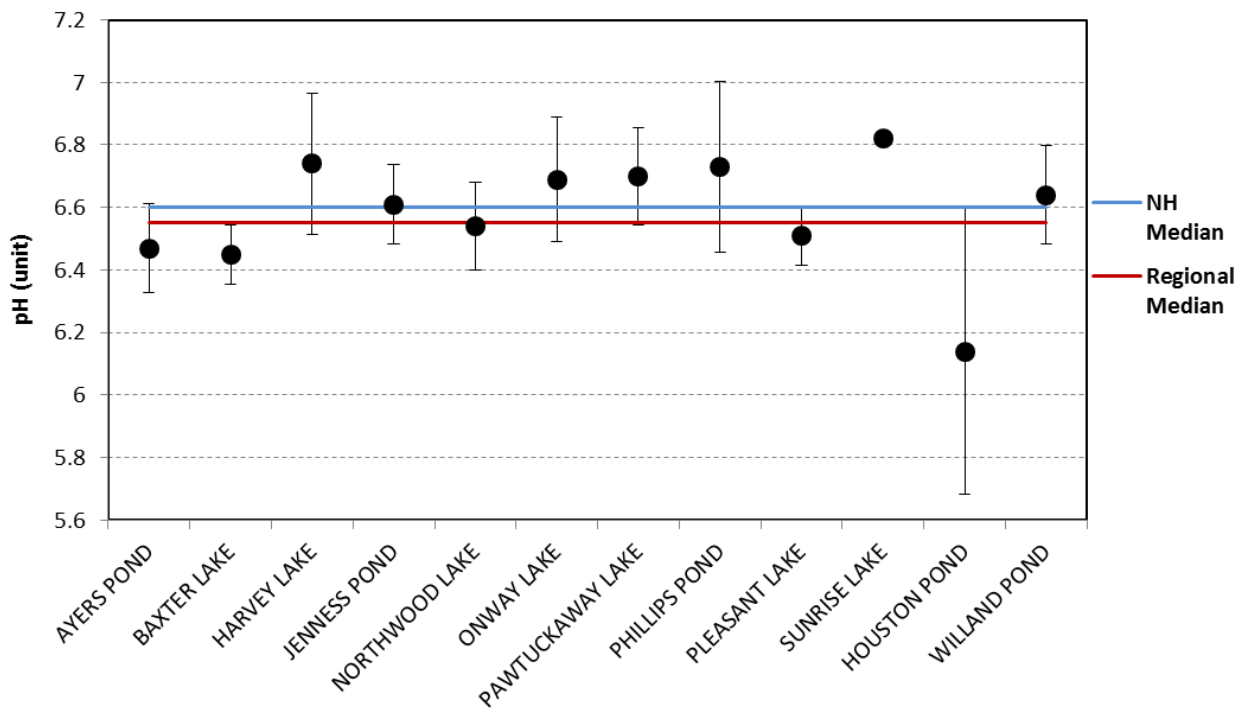
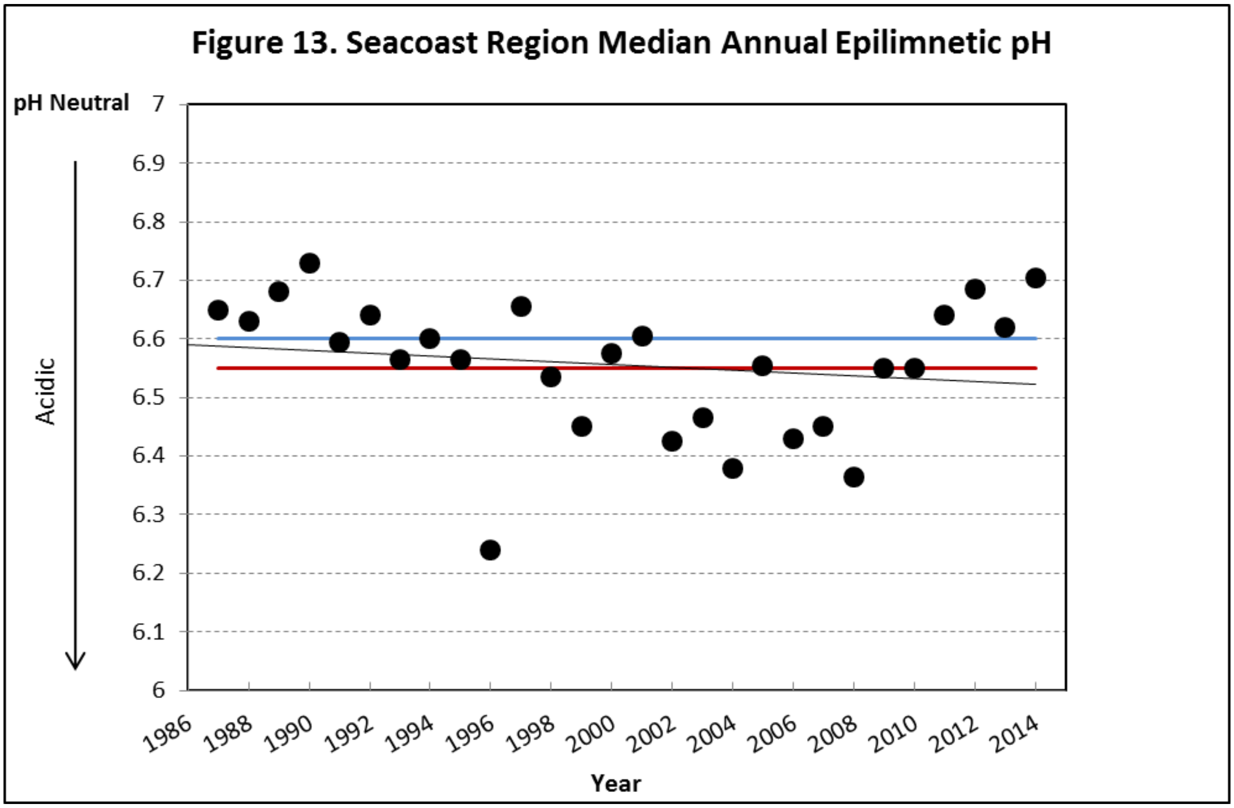


Figure 13 represents the median annual epilimnetic pH value for the Seacoast region compared with state and regional medians. The median epilimnetic pH generally decreased from 6.7 to 6.3, or became more acidic, between 1987 and 2008. Since then, the pH has started to recover and the 2014 median epilimnetic pH value was 6.71 and the highest (best) measured since 1990.



pH Trend Analysis

The regional median epilimnetic pH was subject to Mann-Kendall non-parametric statistical analyses to determine if a significant regional trend existed using a 95% confidence limit. A stable epilimnetic pH trend was detected for the region (Appendix D: Table D-1) and is one of three state regions with a stable trend.

In addition to the regional trend analysis, Seacoast Region lakes with 10 or more consecutive years of data were subject to linear regression analyses to determine whether water quality trends were significantly increasing, decreasing, or stable over time. Epilimnetic pH trends were assessed for approximately 11 deep spots at 10 lakes in the region representing approximates 80% of the region's lakes. Trend analysis revealed stable epilimnetic pH at all lake deep spots in the region (Appendix D: Table D-7).

Variations in pH values between lakes and between different geographical regions may depend on the composition and weathering of underlying bedrock and the lake water chemistry. Another contributing factor to pH is acid deposition received as a result of emissions from power plants and vehicles. This increases levels of atmospheric carbon, nitrogen and sulfur which fall back to the earth in the form of acidic precipitation.

A recent report published by NHDES "Acid Rain Status and Trends New Hampshire Lakes, Ponds and Rainfall" analyzed trends in historical pH, ANC, conductivity, sulfate and nitrate concentrations from three state-wide monitoring programs to determine if the state's lakes and ponds are recovering from the effects of acid rain. The Acid Outlet, Remote Pond and Rooftop Rain programs have been collecting data since the early 1970s and 1980s. Analysis of sulfate, nitrate, and pH concentrations of precipitation indicate that pH levels have significantly increased (become less acidic), and sulfate and nitrate concentrations have significantly decreased (improved) since 1972. Analysis of sulfate, nitrate, pH, and ANC concentrations of lake water indicate that the majority of lakes sampled have experienced a stable trend or increase (improvement) in pH and ANC as well as a 90% reduction in sulfate and nitrate concentration. This supports significant improvements in local and national air quality as regulations have improved acid rain; however our surface waters reflect a slower rate of recovery.

Annual and Historical ANC Data Analysis

ANC measures the buffering capacity of a water body, or its ability to resist changes in pH by neutralizing acidic inputs. These "buffers" are typically bases such as bicarbonate and carbonate. Geology can play an important part in a water body's buffering capacity. Lakes located in areas with predominantly limestone (calcium carbonate), sedimentary rocks and carbonate-rich soils often have a higher ANC, while lakes located in areas with predominantly granite and carbon-poor soils often have a lower ANC. The higher the ANC, the more readily a waterbody can resist a change in pH. **The median ANC value for New Hampshire's lakes and ponds is 4.8 mg/L, and the median ANC value for the Seacoast region is 3.6 mg/L, which indicates that many lakes and ponds in the region are *moderately vulnerability* to acidic inputs.**

Figure 14 represents the combined 2013 and 2014 average epilimnetic ANC for individual lakes in the Seacoast Region compared with state and regional medians. Four lakes have epilimnetic ANC values less than the regional median and are borderline *moderate to extremely vulnerable* to acidic inputs. Seven lakes have epilimnetic ANC values greater than the state and regional medians and less than 10.0 mg/L and representative of *moderately vulnerable* to acidic inputs. One lake has epilimnetic ANC greater than 10 mg/L and considered to have *low vulnerability* to acidic inputs. The lowest epilimnetic ANC value was 2.7 mg/L measured at Jenness Pond in Northwood, while the highest ANC value was 12.8 mg/L measured at Phillips Pond in Sandown.

Figure 14. Average Epilimnetic ANC for Seacoast Region Lakes

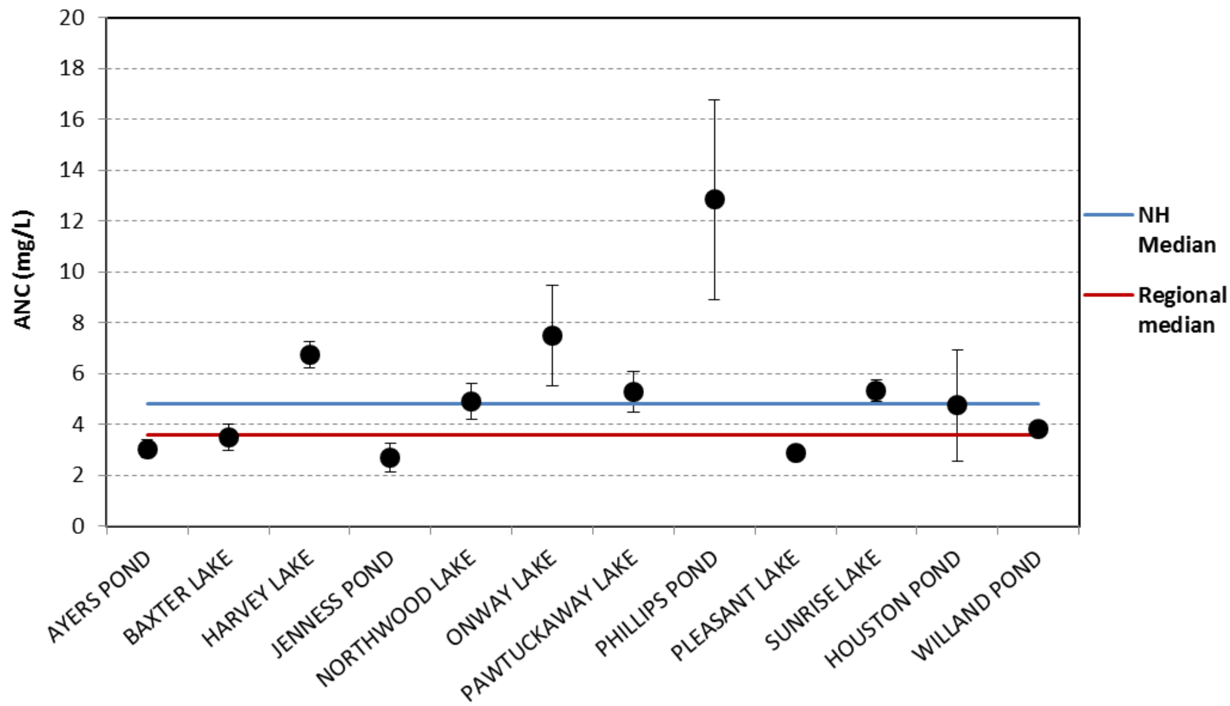
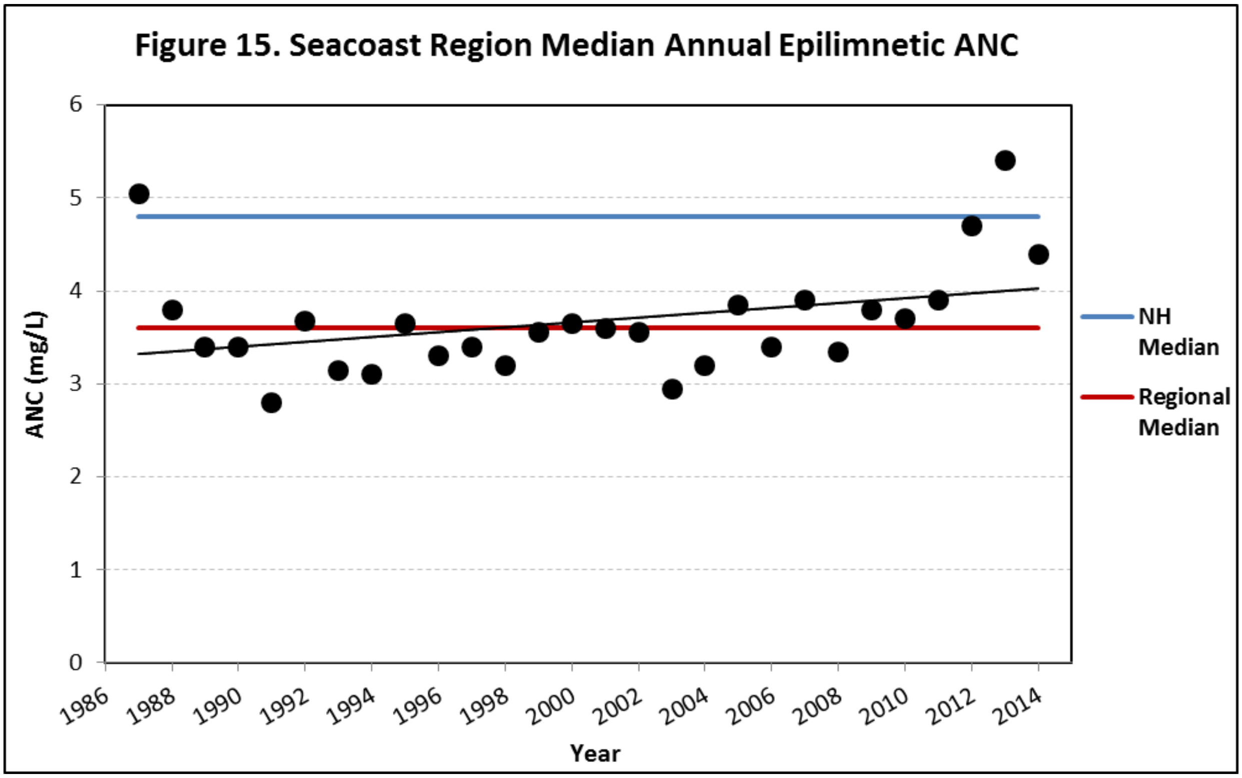


Figure 15 represents the median annual epilimnetic ANC for the Seacoast region compared with state and regional medians. The median epilimnetic ANC generally remained less than 3.50 mg/L from 1987 through 2004, and since then has increased to greater than 3.5 mg/L and greater than 4.0 mg/L since 2012. Epilimnetic ANC values tend fluctuate from year to year and from lake to lake, however it appears regional ANC may be recovering due to the reduction in air pollutants known to contribute to acid precipitation.



Acid Neutralizing Capacity Trend Analysis

The regional median ANC was subject to Mann-Kendall non-parametric statistical analyses to determine if a significant regional trend existed using a 95% confidence limit. A significantly increased (improving) trend was detected for the Seacoast region (Appendix D: Table D-1; Figure 15) indicating that regional buffering capacity is improving. This further supports the NHDES "Acid Rain Status and Trends New Hampshire Lakes, Ponds and Rainfall" report.

Annual and Historical Deep Spot Conductivity Data Analysis

Conductivity is the numerical expression of the ability of water to carry an electric current, which is determined by the number of negatively charged ions from metals, salts, and minerals in the water column. The soft waters of New Hampshire have traditionally low conductivity values, generally less than 50 uMhos/cm. However, specific categories of good and bad levels cannot be constructed for conductivity because variations in watershed geology can result in natural fluctuations. **The median conductivity value for New Hampshire's lakes and ponds is 40.0 uMhos/cm. The median epilimnetic conductivity value for the Seacoast region is 57.6 uMhos/cm.**

Figure 16 represents the combined 2013 and 2014 average epilimnetic conductivity for individual lakes in the Seacoast region compared with state and regional medians. The regional median is slightly greater than the state median however not above a level of concern. Three lakes have epilimnetic conductivity between the state and regional medians and represent average water quality. Five lakes have epilimnetic conductivity greater than the state median but less than 100.0 uMhos/cm and still considered to be within an average range for surface waters. Four lakes have epilimnetic conductivity greater than 100 uMhos/cm and considered higher than NHDESirable and indicative of more urbanized landscapes. The lowest epilimnetic conductivity was 43.4 uMhos/cm measured at Pawtuckaway Lake in Nottingham whereas the highest epilimnetic conductivity was 231.7 uMhos/cm measured at Willand Pond in Dover. A wide range of watershed types and degrees of development exists in the region. Pawtuckaway Lake is located in a rural, less developed watershed, whereas Willand Pond is located in downtown Somersworth/Dover and receives stormwater runoff from shopping centers and main roadways.

Figure 16. Average Epilimnetic Conductivity for Seacoast Region Lakes

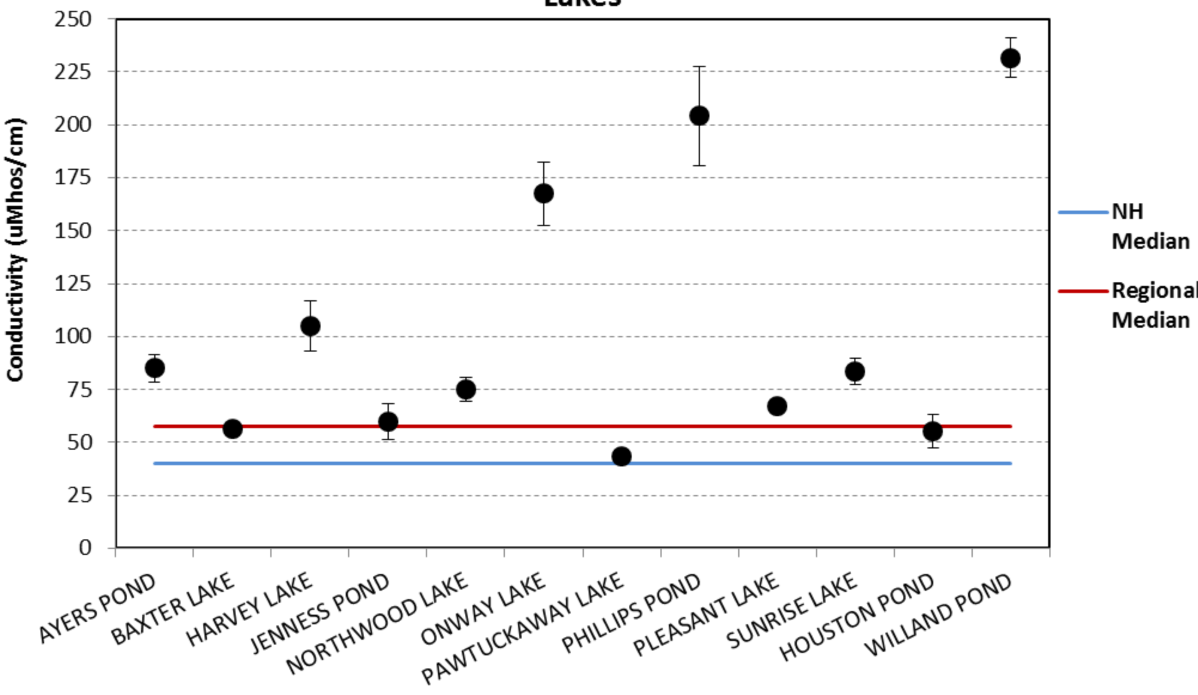
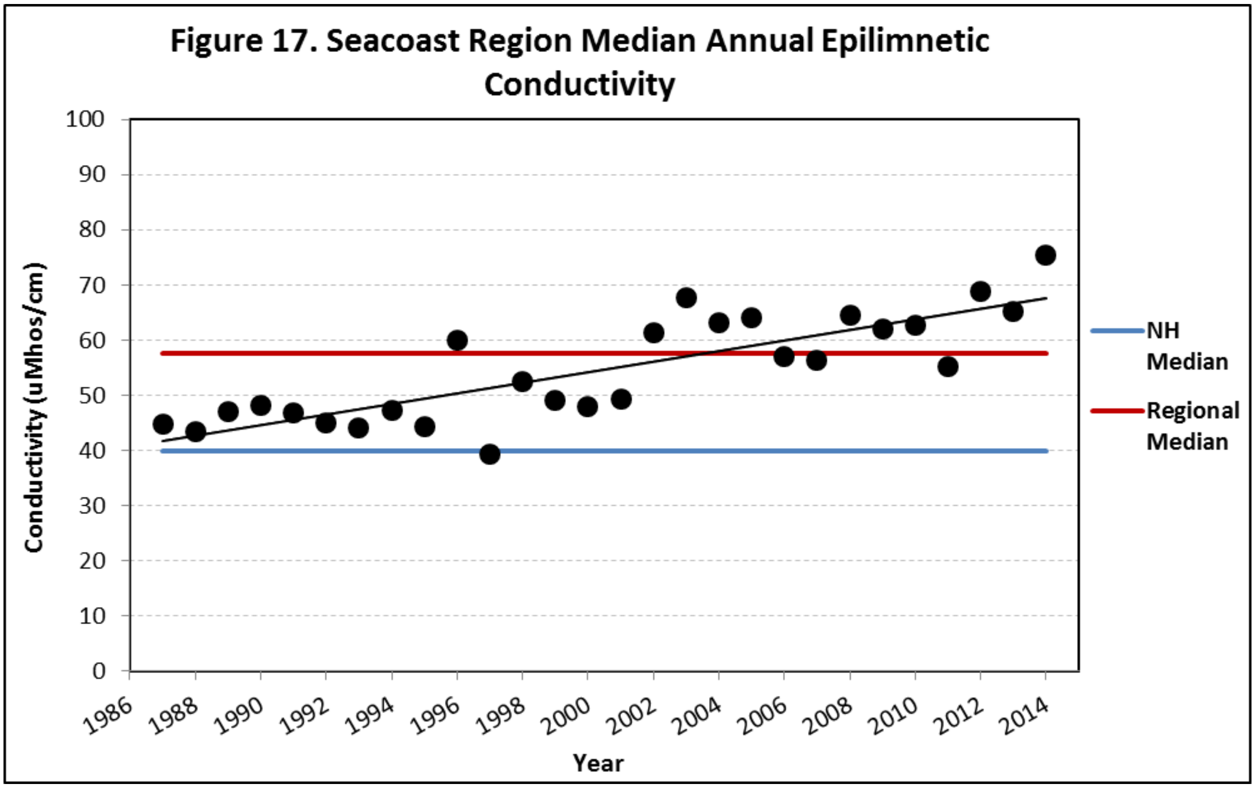


Figure 17 represents the median annual epilimnetic conductivity for the Seacoast region compared with state and regional medians. Regional epilimnetic conductivity remained fairly stable between 40.0 and 50.0 uMhos/cm from 1987 to 2001. Since 2002, median epilimnetic conductivity has generally remained greater than 60.0 uMhos/com and the 2014 median epilimnetic conductivity was 75.5 uMhos/cm and the highest measured since monitoring began. Regional conductivity has increased since 1987, and likely is a result of new lakes joining the program, population growth and development.



Historical Conductivity Trend Analysis

The regional median epilimnetic conductivity was subject to Mann-Kendall non-parametric statistical analyses to determine if a significant regional trend existed using a 95% confidence limit. A significantly increasing (worsening) epilimnetic conductivity trend was detected for the Seacoast region which is consistent the majority of state regions (Figure 14; Appendix D: Table D-1).

In addition to the regional trend analysis, Seacoast region lakes with 10 or more consecutive years of data were subject to linear regression analyses to determine whether water quality trends were significantly increasing, decreasing or stable over time. Epilimnetic conductivity trends were assessed for approximately 11 deep spots at 10 lakes in the region representing approximately 80% of the region's VLAP lakes. Trend analysis indicates one lake deep spot with significantly decreasing (improving) epilimnetic conductivity, three deep spots with significantly increasing (worsening) epilimnetic conductivity, and seven deep spots with relatively stable epilimnetic conductivity (Table 4; Appendix D: Table D-7).

Table 4. Significant Epilimnetic Conductivity Trends in Seacoast Region Lakes

Lake Name	Conductivity (Epilimnion)	
	Increasing Trend	Decreasing Trend
	p	p
Ayers Lake	< 0.01	
Harantis Lake	0.02	
Sunrise Lake	< 0.01	
Jenness Pond		0.014

Generally, conductivity values in New Hampshire lakes exceeding **100 uMhos/cm** indicate cultural, meaning human, disturbances. An elevated conductivity trend typically indicates point sources and/or non-point sources of pollution are occurring within the watershed. These sources include failed or marginally functioning septic systems, agricultural runoff, and road runoff, and groundwater inputs. New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could also contribute to increasing conductivity. In addition, natural sources, such as mineral deposits in bedrock, can influence conductivity.

Annual and Historical Deep Spot Chloride Data Analysis

High conductivity values are often due to elevated chloride levels, which are generally associated with road salt and/or septic inputs. The chloride ion (Cl^-) is found naturally in some surface and ground waters and in high concentrations in seawater. The chloride content in New Hampshire lakes is naturally low in surface waters located in remote areas away from habitation. Research has shown that elevated chloride levels can be toxic to freshwater aquatic life. In order to protect freshwater aquatic life in New Hampshire, the state has adopted acute and chronic chloride criteria of 860 and 230 mg/L respectively. **The median chloride value for New Hampshire's lakes is 4 mg/L. The median epilimnetic chloride value for the Seacoast region is 16 mg/L.**

Figure 18 represents the combined 2013 and 2014 average epilimnetic chloride for individual lakes in the Seacoast region compared with state and regional medians. The regional median is slightly greater than the state median but much less than the state acute and chronic chloride standards. Five lakes have epilimnetic chloride between the state and regional medians and six lakes have epilimnetic chloride equal to or greater than the regional median. In particular, three lakes have epilimnetic chloride greater than 40 mg/L which is indicative of a more urbanized watershed. The chloride measurement is relatively new for VLAP and is an optional analyte for participating lakes. Lakes that serve as water supplies or where conductivity levels may be influenced by chloride are analyzed annually.

Figure 18. Average Epilimnetic Chloride for Seacoast Region Lakes

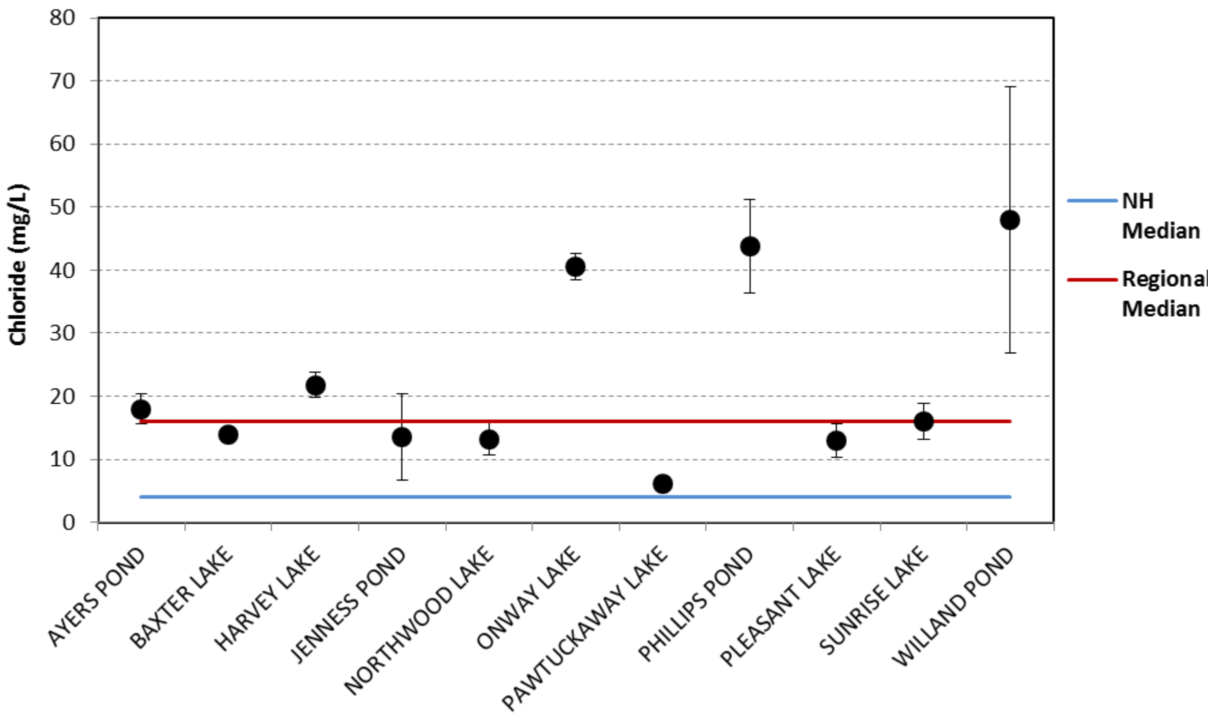
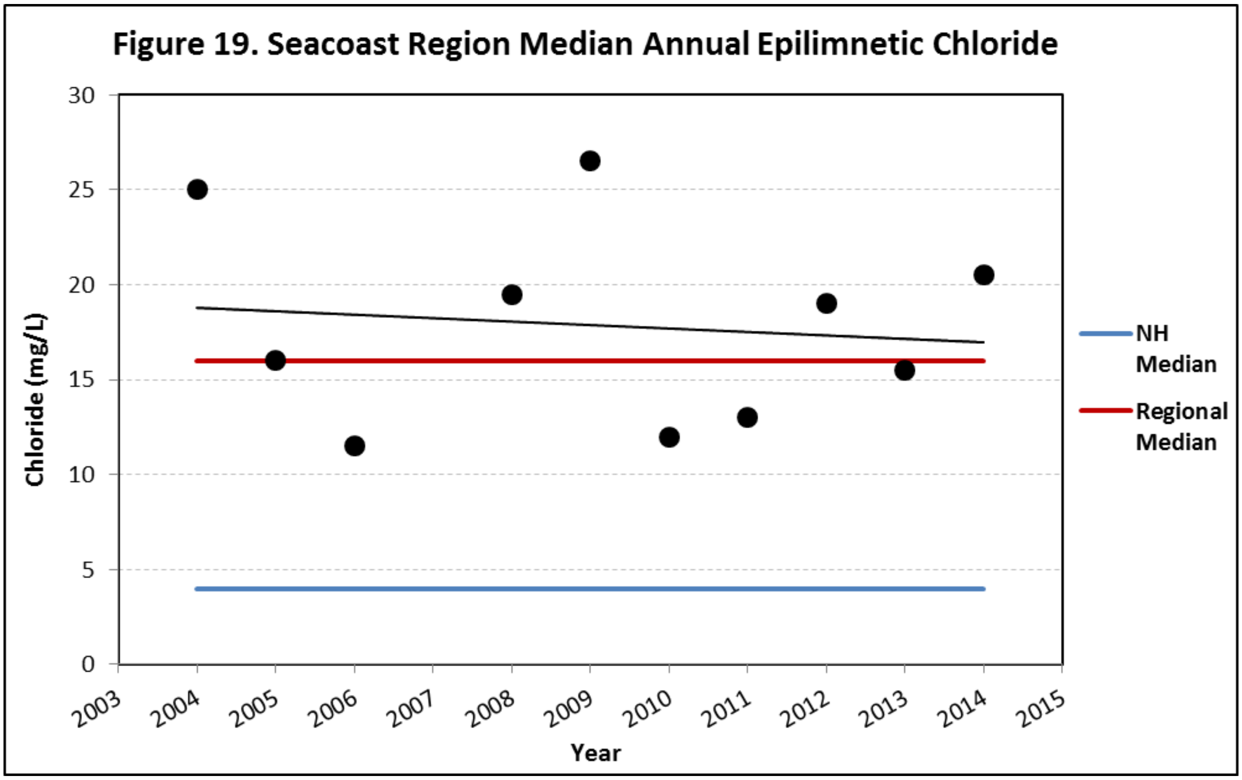


Figure 19 represents the median annual epilimnetic chloride levels for the Seacoast region. Median epilimnetic chloride levels have fluctuated between 10 and 30 mg/L since 2004. This is much less much less than the state acute and chronic chloride standards, however is slightly greater than what we would typically measure in undisturbed New Hampshire surface waters.



Historical Chloride Trend Analysis

The regional median epilimnetic chloride was subject to Mann-Kendall non-parametric statistical analyses to determine if a significant regional trend existed using a 95% confidence limit. No significant trend was detected for the Seacoast region (Appendix D: Table D-1, Figure 19). This trend is consistent with all regions of the state.

Watershed management efforts to control un-natural sources of conductivity and chloride in waterbodies should employ a combination of best management practices in regards to winter salting practices. State and local governments and private homeowners should evaluate the use of road salt and alternatives to reduce the amount of material applied while maintaining public safety.

For additional information on the relationship between conductivity and chloride, please refer to Appendix A. For additional information on best management practices, please refer to Appendix B.

Annual and Historical Deep Spot Turbidity Data Analysis

Turbidity in the water is caused by suspended matter (such as clay, silt and algae) that cause light to be scattered and absorbed, not transmitted in straight lines through water. Water clarity is strongly influenced by turbidity. **The Class B surface water quality standard for turbidity is no greater than 10 NTUs over the lake background level. The median epilimnetic turbidity for the Seacoast region is 0.90 NTU.**

Figure 20 represents the combined 2013 and 201 average epilimnetic turbidity of individual lakes in the Seacoast region compared with state and regional medians. Four lakes have epilimnetic turbidity less than the regional median and within a low range. Four lakes have epilimnetic turbidities greater than the regional median and less than 1.2 NTUs and considered to be within an average range. Four lakes have epilimnetic turbidity greater than 1.2 NTU and are slightly higher than desirable.

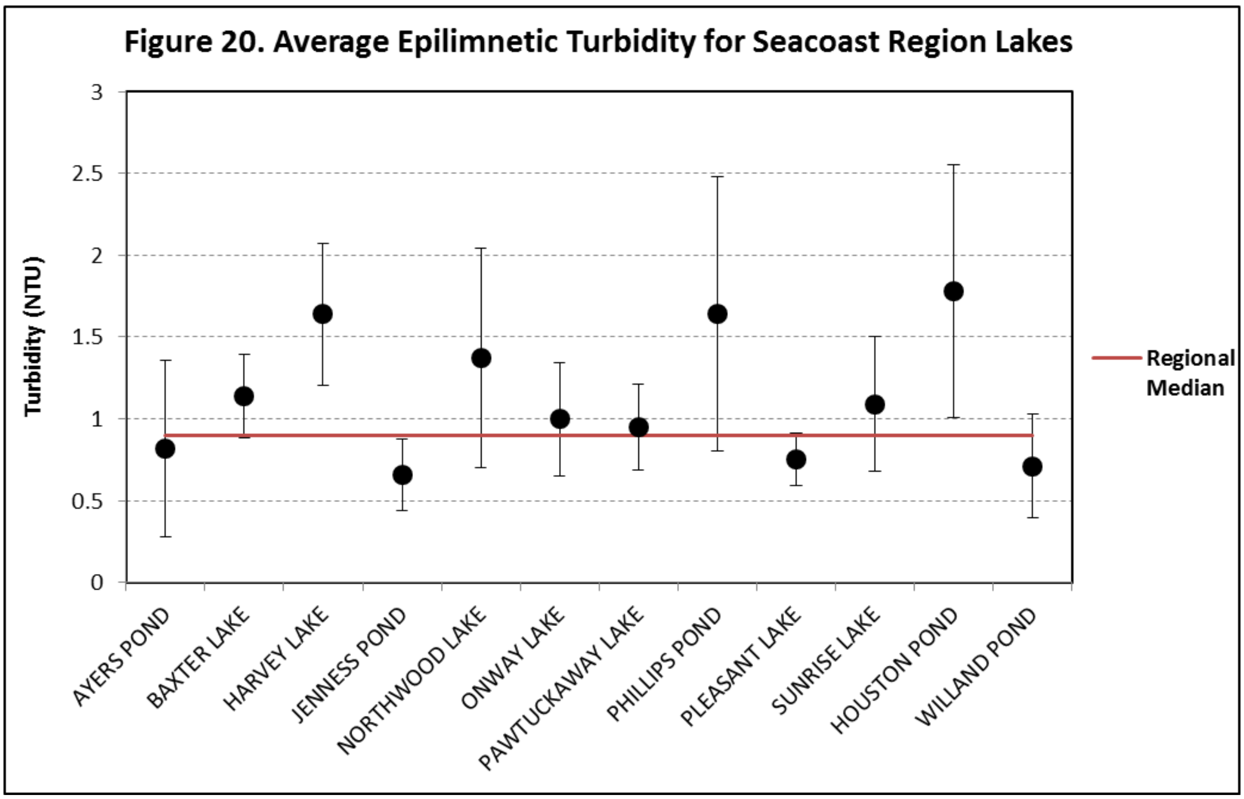
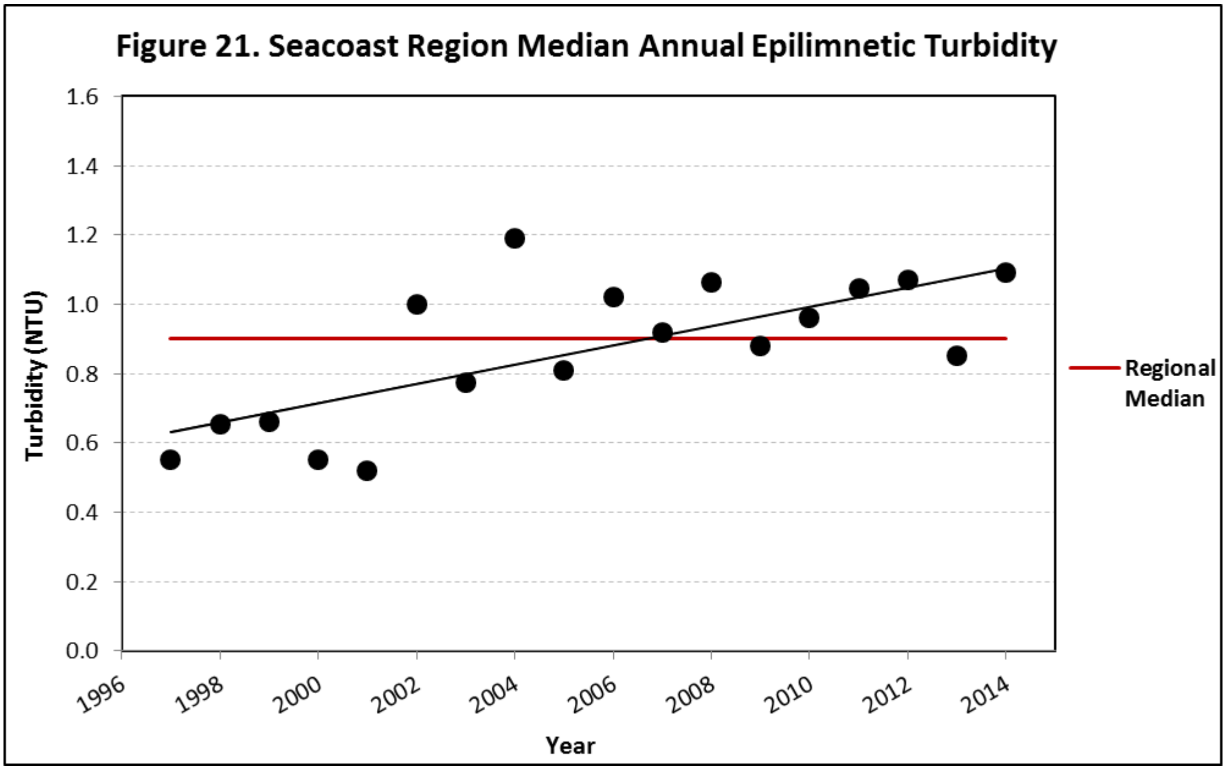


Figure 21 represents the median annual epilimnetic turbidity for the Seacoast region compared with the regional median. Median epilimnetic turbidity was approximately equal to 0.6 NTU from 1997 to 2001 and considered to be low. Since then epilimnetic turbidity has generally remained between 0.8 and 1.2 NTU and within an average range for most New Hampshire lakes. New Hampshire has experienced more significant rainfall events in recent years, and the Seacoast region is one of the fastest growing regions in the state. The large volume rainfall events combined with an increase in development and impervious surfaces may contribute to an increase in stormwater runoff and turbidity in the region's lakes.



Historical Turbidity Trend Analysis

The regional median epilimnetic turbidity was subject to Mann-Kendall non-parametric statistical analyses to determine if a significant regional trend existed using a 95% confidence limit. A significantly increasing (worsening) trend was detected for the Seacoast Region (Appendix D: Table D-1, Figure 21). This trend is consistent with all regions of the state.

Elevated deep spot turbidity levels are typically the result of stormwater runoff, algal or cyanobacteria blooms, and/or disturbance of lake bottom sediments. Stormwater BMPs should be implemented when possible to reduce the amount of suspended sediments and debris transported to surface water. Boating activity in shallow areas should adhere to rules specified by the New Hampshire Marine Patrol in regards to speed and no wake zones. If an algal or cyanobacteria bloom is observed, please contact NHDES immediately.

For additional information on stormwater BMPs, boating, algae and cyanobacteria, please refer to Appendices A and B.

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