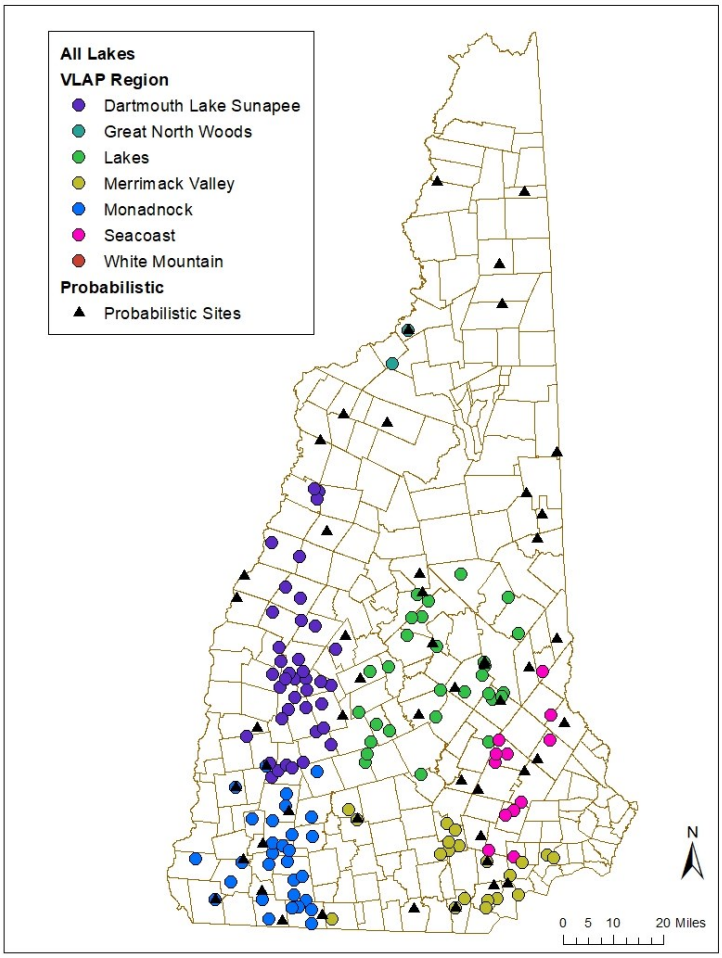
Summary of New Hampshire's Lakes, Ponds and Reservoirs
Designated Use Assessment, Condition Estimates, and Trend Analyses

The Water Monitoring Strategy, published by NHDES in 2016, details the agency's approach for monitoring the condition of the state's inland surface waters. Probabilistic, trend and synoptic monitoring are the three strategies NHDES employs to achieve that goal.

Probabilistic surveys represent a cost-effective way to report on lake condition by sampling a small subset of the population. From 2017 to 2019, NHDES sampled 50 lakes to evaluate statewide conditions. The lakes were randomly selected, which allowed overall condition to be assessed with a known level of confidence. Some of these data also contributed to a national lake assessment by the EPA, and New Hampshire lake data were compared to the Nation and the Northern Appalachian Region (NAP), an ecoregion that contains New Hampshire and other surrounding states.

While probabilistic surveys offer a snapshot of the current condition of the entire lake population, trend monitoring looks at how water quality changes over time by monitoring the same lake over many years. NHDES' lake trend analysis, published in 2020, examined water quality trends in 150 lakes over a 27-year period (1991—2018). A majority of these data were contributed by the Volunteer Lake Assessment Program (VLAP). While neither probabilistic nor trend monitoring provide the entire story of lake condition, the results of each help broaden our understanding of the status of New Hampshire lakes.

Map of lakes used in the 2017—2019 Lake Probability Survey Report or the 2020 Lake Trend Report

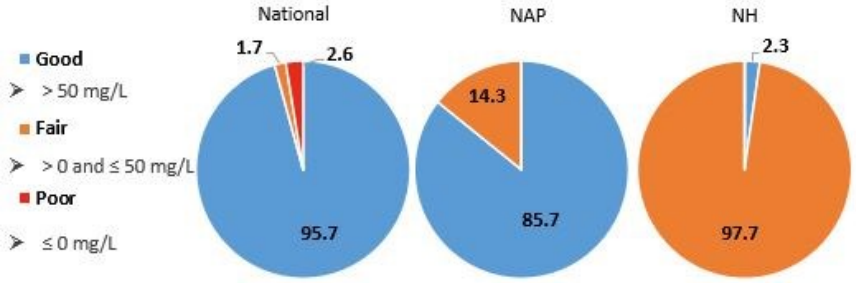


Fifty randomly-selected lakes were surveyed for the Lake Probability Survey from 2017 to 2019. One hundred and fifty VLAP lakes were examined for long-term water quality trends (1991—2018).

Find the full 2017—2019 Lake Probability Survey Report and 2020 Lake Trend Report on our website.

The 2017—2019 Lake Probability Survey Report and 2020 Lake Trend Report are not directly comparable; however, when the same water quality parameter is considered, the results of each report can complement or contrast each other. The text on the following pages present the findings (regular text) and *discussion (italic text)* of these reports.

Acid Neutralizing Capacity (ANC)



A measure of a waterbody's ability to resist acidic inputs, a.k.a. buffering capacity. NHDES expects ANC be ≥ 20 mg/L to support aquatic life. Nationally, EPA thresholds are even higher (> 50 mg/L) to be considered in good condition.

Current condition of ANC found only 19.6% of New Hampshire lakes are at or above the expected threshold, with 80.4% below. Nationally, nearly all of New Hampshire lakes (97.7%) are considered in fair condition (0—50 mg/L). While current condition indicates low support, long-term trends found ANC increased in 59% of lakes from 1991 to 2018, most notably in eutrophic and mesotrophic lakes.

Low support of ANC is attributed to the history of acid precipitation's influence on New Hampshire's lakes. Increasing ANC could partially be due to acid rain recovery as lakes slowly regain positive ions from weathering; however, increasing trends are happening too quickly to be due to recovery alone. Increasing ANC may also be due to road salt pollution. Salt is composed of chloride and sodium, and sodium is a positive ion. An influx of salt, and consequently sodium, may also be increasing ANC.

Bacteria

A measure of the concentration of *E. coli*, a common pathogenic bacterium that is present in the fecal material of warm-blooded animals. This bacterium is an indicator for many potentially harmful bacteria, making it an important indicator for the safety of recreating on lakes. Most New Hampshire lakes are expected to have bacteria levels ≤ 126 cts/100mL to be safe for swimming and ≤ 630 cts/100mL to be safe for boating.

Current condition of New Hampshire's lakes is that 98% are safe for swimming (i.e. primary) contact and 100% are safe for boating (i.e. secondary) contact. Focusing specifically on beaches, trend analyses found that the percentage of beaches issued a fecal bacteria advisory and the number of days the advisory was in place increased from 2003 to 2018.

May 24 to September 15 is considered the critical time period for bacteria exposure since that is when most swimming in New Hampshire waters occurs. Fecal bacteria levels can increase with warmer water temperatures, more recreation, increased waterfowl population, or increased stormwater run-off.

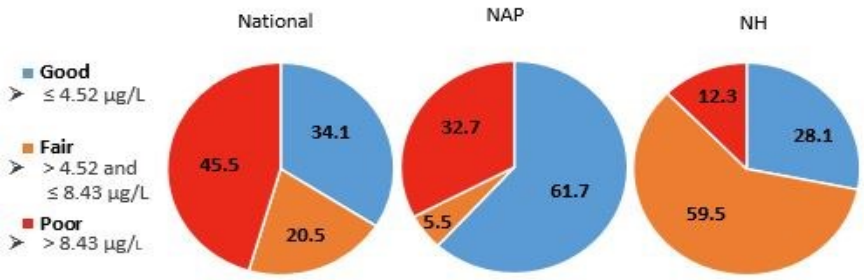
Chloride and Specific Conductance

Chloride is a negative ion, and specific conductance is a measurement of water's ability to conduct electricity. The two are closely linked, as increasing chloride is linked to salt inputs, which will also cause an increase in specific conductance. Freshwaters in New Hampshire tend to have naturally low chloride and specific conductance, making increases in both an indication of human disturbance. Established guidelines indicate that aquatic life is impaired when chloride levels are chronically > 230 mg/L; however, recent research suggests that threshold is likely too high.

Current condition indicates that 100% of New Hampshire lakes support aquatic life based on the established chloride threshold. Although trend analysis did not examine chloride due to a lack of data, specific conductance was found to significantly increase in 41% of lakes from 1991 to 2018, most notably in eutrophic and mesotrophic lakes.

Chloride can be toxic to freshwater organisms and has been found in increasing levels in New Hampshire's groundwater. As more data are collected, future NHDES reports will examine chloride trends in lakes, and it is a parameter NHDES is monitoring closely.

Chlorophyll-*a* (Chl-a)



A photosynthetic pigment found in plants and is used as an measure of the abundance of suspended algae. NHDES expects Chl-a concentration to reflect a lake's natural trophic state to support aquatic life, and to be ≤15 µg/L to be safe for recreation, regardless of trophic status. Lakes that had never been surveyed for their trophic state could not be assessed. National EPA thresholds, while slightly different from NHDES trophic thresholds, considered ≤ 4.52 µg/L to be good condition. The current condition of New Hampshire lakes determined that 28.9% of lakes fully supported aquatic life, while the remainder of lakes were either above their trophic threshold (36%) or unable to be assessed (35.1%). Over ninety percent (94.3%) of New Hampshire lakes were considered safe for recreation. EPA's thresholds indicated 28.1% of New Hampshire lakes are in good condition. Trend analysis found that approximately 10% of lakes had decreasing Chl-a concentration from 1991—2018, with the majority of lakes stable in that time frame.

Chl-a is influenced by nutrients, water color, temperature, and a lake's natural trophic state. Excess Chl-a is often linked to inputs of excess nutrients such as total phosphorus.

Cyanobacteria

Photosynthetic bacteria that are capable of producing toxic blooms. They occur naturally in lakes, but can grow to nuisance levels under certain conditions (e.g. excess nutrients, hot temperatures). In New Hampshire, recreation is considered impaired when cyanobacteria concentration is 70,000 total cells/mL of water. Cyanobacteria can be difficult to monitor, as blooms may last for only a few hours and can change location and depth in the water column.

NHDES did not encounter any cyanobacteria blooms while sampling for the probabilistic survey. Thus, current conditions indicate that 100% of lakes are considered safe for recreation for this indicator. However, over time advisories issued for cyanobacteria have significantly increased from 2003 to 2018, although the total number of days an advisory was in place was stable.

The sampling design of the probabilistic survey was not ideal for tracking ephemeral cyanobacteria blooms since it depended on a single site visit. For the trend analysis, increased awareness of cyanobacteria and sample effort may have led to the increase in the number of advisories issued; however, it is likely that an increasing number of blooms are also be occurring.

Invasive Aquatic Plants

Non-native species are a threat to ecological, aesthetic, recreational and economic values of freshwater resources, so the absence of invasive species is expected to be good for aquatic life. Current condition found 84.7% of New Hampshire lakes had no invasive aquatic species; however, the number of lakes with an invasive species has increased from 2000—2018.

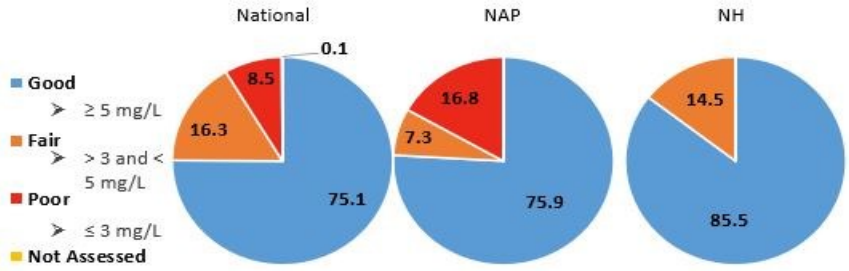
Freshwater invasive aquatic plants have no predators or diseases, which allows them to grow quickly and dominate freshwater systems, making them a threat to aquatic life. Currently, New Hampshire has 91 lakes with 117 infestations.

pH

A measure of the water's acidity, the pH of our lakes is expected to range between 6.5 and 8.0 units to support aquatic life. Current condition found that 16.6% of New Hampshire lakes were within that specified range. Trend analysis found that 13% of lakes had increasing pH from 1991—2018.

Many variables influence pH, such as ANC, DO, carbon dioxide levels, pollutant levels and water temperature. Low pH is often attributed to New Hampshire's history of acid precipitation, and recovery is thought to be occurring slowly as acid inputs have decreased; however, pollutants such as salt can cause pH to increase as well.

Dissolved Oxygen (DO)

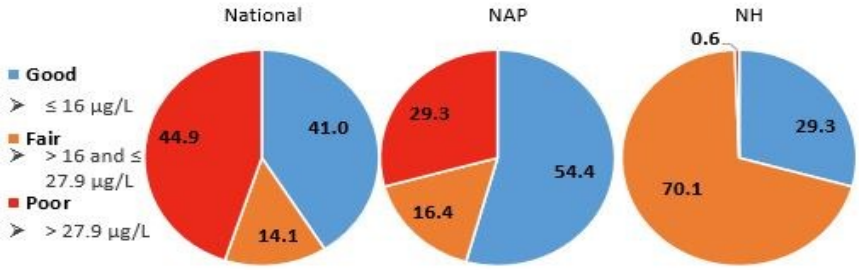


The amount of oxygen in water, measured as concentration (mg/L) or saturation (%) and critical to aquatic life. For most lakes, NHDES assesses DO in the top layer or top 25% of a lake's water column. Similarly, EPA thresholds only look at DO in the top two meters. Acceptable DO levels vary depending on New Hampshire's management goals, but generally DO levels ≥ 6 mg/L (concentration) or ≥ 85% (saturation) are expected in most New Hampshire lakes. At a national level, EPA considers ≥ 5 mg/L to be good condition.

The current condition for DO concentration found that 71.5% of New Hampshire lakes support aquatic life. Support for DO saturation was lower, with only 39.6% of lakes considered to be in good condition. At a national level, New Hampshire lakes compared well to other states, and 85.5% of lakes were categorized in good condition. Trend analysis only considered DO levels at one-meter below lake surface; however, 16% of investigated lakes significantly decreased in DO concentration from 1991—2018, with the greatest change found in mesotrophic lakes.

Differences in DO saturation and concentration likely reflect how the ability of water to hold DO changes throughout the water column. Water can hold more DO with lower temperatures, higher pressures, and lower salinities. As measurements occur deeper in the water column, DO saturation can decline even if DO concentration remains constant, because the deeper water could hold more DO. Dissolved oxygen levels are also influenced by algae and aquatic plant abundance, time of day, decomposition and weather. Declines in DO concentration found by trend analysis may be a response to increasing water temperature, as warmer water holds less dissolved oxygen.

Total Phosphorus (TP)



Phosphorus is typically the limiting nutrient for aquatic plants and algae in New Hampshire lakes. NHDES expects TP to reflect a lake's natural trophic state; however, Chl-a concentration is also considered when impacts to aquatic life are assessed, because Chl-a is expected to respond to changes in TP levels. NHDES expects that TP thresholds are < 8.0 µg/L for oligotrophic lakes, ≤ 12.0 µg/L for mesotrophic lakes, and ≤ 28.0 µg/L for eutrophic lakes. Lakes that had never been surveyed for their trophic state could not be assessed. Alternatively, EPA considers TP levels ≤ 16 µg/L to reflect good lake condition.

Current condition determined 12.9% of New Hampshire lakes fully supported aquatic life, while the remainder of lakes did not meet trophic thresholds (51.9%) or were unable to be assessed (35.1%). For EPA, thresholds indicated 29.3% of New Hampshire lakes are in good condition. Trend analysis found eutrophic lakes have significantly increased TP levels from 1991—2018; however, most lakes were stable.

As the most common limiting nutrient in New Hampshire lakes, changes in total phosphorus concentration can have cascading effects throughout a waterbody. Changes in total phosphorus levels can reflect land use practices in a watershed, and can increase with stormwater run-off, impervious surfaces, fertilizers and vegetation loss. Decreases in TP may reflect better management practices, such as leaving vegetation buffers intact, reducing fertilizer use or regularly pumping septic systems.