

## **Description of the Vermont Lake Assessment Program 2015**

The lake assessment program is funded by [Clean Water Act Section 106 Funds](#). This funding is designed to support the lake assessment program's ambient water quality monitoring and assessment, monitoring strategy enhancement, participation in the National Aquatic Resource Surveys, water quality standards development, surveillance and enforcement, water quality planning, assistance to local agencies and public information efforts. The primary function of the lake assessment program is to monitor the status and trends of Vermont's waters. The Vermont Water Quality Standards describe in detail the expectations Vermonters have about what condition our lakes and ponds should exhibit. The Vermont Water Quality Standards are Vermont standards based on the vision outlined in the Clean Water Act. The Clean Water Act was enacted to meet the vision Americans had of what condition our lakes and ponds should exhibit. The Vermont Water Quality Standards limit the amount of change Vermonters will allow to all waters, with different levels of change allowed depending on the class of the waterbody. The idea being that some lakes and ponds in the state are exceptional and or rare and should be maintained in this state for future generations. For all other waters the standards attempt to find more of a balance between the use of lakes and ponds with the inevitable impacts those uses will have on them against the desire to maintain high quality waters. To accomplish any of these goals, it is necessary to monitor Vermont's lakes and ponds in a manner that both describes status and trends. Once having established the status and trends, the lake assessment program shares these findings so that appropriate management strategies can be employed by partners both within and outside the Agency of Natural Resources.

### **Assessing Status of Vermont Lakes and Ponds**

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#### **National Lake Assessment**

"Statistical surveys are a cost-effective means of assessing all waters as called for under CWA section 305(b)" ([EPA, 2013](#)). Every 5 years, starting in 2007 the national lake assessment (NLA) is conducted during the summer index period. Vermont uses the NLA approach and rounds as an opportunity to conduct its statewide assessment. The results from these surveys are used to assess the extent to which lakes meet designated uses for 305B reporting as well as provide statistically-defensible assessments of water quality at the state scale. In order to accomplish this effort, lake assessment staffing is doubled for the NLA year such that enough lakes can be sampled (n=50) to be statistically valid in assessing the condition of all the lakes in the state. Even with that increased staffing, the sampling effort is very rigorous. Results from the 2007 National Lake Assessment were summarized in the report "Gauging the Health of Vermont Lakes" ([VTDEC, 2013](#)).

#### **Next Generation Lake Assessment**

In years that the National Lake Survey is not being conducted, VTDEC targets high priority lakes for an intensive multiday survey during the summer index period (July – Early September). In non-NLA years, the lake assessment program only has the capacity to sample roughly 5 to 13 lakes a summer with a team of 2 scientists. High priority lakes are selected based on information needed by the Lakes and Ponds Management and Protection Section, the WSMD's Basin Planning Program and other groups within and outside the Agency of Natural Resources.

The summer lake assessment is a comprehensive survey of the condition of a lake. The survey has three main focus areas, the deep open water 'index site', ten randomly distributed shoreland and littoral habitat sites, and the inlets and outlet. The team of two scientists collect a suite of physical, chemical and biological parameters at each of the three focus areas. The parameters measured as part of the survey are listed in Table 1.

Parameter	Location(s) measured
TotalHard, RegAlk, TCa, TMg, TK, TNa, TurbNTU, Secchi, Sediment Diatoms	Index site
Conductivity, Dissolved Oxygen, DO%, pH, Temperature C, TN, TP, TCl, Chlorophyll a	Index site, Tributaries and Outlet
Macroinvertebrates, physical habitat complexity, shallow water habitat, lakeshore habitat, lakeshore disturbance	10 random sites around the lake
Crayfish	3 sites with good crayfish habitat
Aquatic plants, algae and maximum depth of colonization	10 random sites around the lake and tributaries
Area and depth of deltas	Tributaries and sites of significant erosion

Table 1. Parameters measured during the summer index period as part of the Next Generation Lake Assessment protocols

In addition to the sampling protocols enumerated in Table 1, the Lake Assessment Program, in conjunction with the AIS program, is developing macrophyte biocriteria. Macrophyte biocriteria are in the early stages of development, however, if successful this method will be incorporated into the Next Generation Lake Assessment protocols.

### Assessing Trends in Vermont Lakes and Ponds

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#### Spring Phosphorus Program

The Spring Phosphorus Program is the decades old monitoring program that the Lake Assessment Program relies upon for trends. It has been monitoring the trends in phosphorus since 1977. Since 1977, numerous other parameters have been monitored as well (Table 3).

Parameter	Date began monitoring
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TP, Secchi	4/14/1977
TotalHard, RegAlk, TCa, TMg	4/11/1996
Conductivity, Dissolved Oxygen, DO%, pH, Temperature C, TN	4/8/1998
Chlorophyll a, ORP,	4/24/2003
TCl	4/7/2006
TK, TNa, TurbNTU	4/1/2010
Color	Spring 2014
DOC	TBD

Table 3. Parameters measured at the index site as part of the Spring Phosphorus Program during spring turnover and the dates the monitoring began.

Species data collected as part of the lake assessment program is shared with the VTFW Nongame and Natural Heritage Program when rare, threatened, endangered or species of special concern observations are made. Similarly, when aquatic invasive species are observed, the information is shared with VTDEC's Aquatic Invasive Species Scientists.

### Special Studies

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Occasionally, it is necessary for the Lake Assessment Program to conduct additional monitoring. These studies may focus in on a particular stressor or a particular lake or may be necessary to help better interpret the data already being collected. Occasionally, studies are conducted to develop new methodologies to measure standards described in the Vermont Water Quality Standards.

**Littoral Habitat Assessment:** The 2007 National Lakes Assessment found that the most widespread stressor to Vermont's lakes was not phosphorus, acid rain or aquatic invasive species, but lakeshore disturbance ([VTDECa, 2013](#)). From 2005 through 2011, the lake assessment program studied the effects unbuffered lakeshore development was having on Vermont lakes, specifically with respect to the Vermont Water Quality Standards. This study found that the impacts that unbuffered lakeshore development was having on aquatic habitat and biota was in conflict with the Vermont Water Quality Standards ([Merrell, Howe and Warren, 2009](#)). Further study, in collaboration with Maine DEP found

that lakeshore developed following Maine's minimum mandatory shoreland zoning standards complied with Vermont's Water Quality Standards ([Merrell, Deeds, Mitchell and Bouchard, 2013](#)).

**Mercury:** A joint USEPA and USFW study of Northeastern lakes in the early 1990s found that mercury was a more widespread stressor to northeastern lakes than shoreline alteration, eutrophication or acidification (Whittier et al, 2002). Beginning in spring of 1998, the Vermont Department of Environmental Conservation (VTDEC), in cooperation with the New Hampshire Department of Environmental Services, Syracuse University, USEPA, and several other collaborators, launched an effort to measure the level of mercury (Hg) contamination in lakes and lake biota across Vermont and New Hampshire. Over the course of the 1998 through 2000 field seasons, we conducted an intensive field measurement program on 103 lakes and ponds. The goal of this project was to determine which larger, publicly used Vermont and New Hampshire lakes are of the type that 1) have excessive mercury in their sediments, 2) possess the conditions linked to processing mercury into its toxic form, and 3) have high mercury concentrations in plankton, fish, and fish-eating wildlife. The results of this study are being used to refine fish tissue consumption advisories in Vermont and New Hampshire, and to learn more about the process of bioaccumulation of mercury in freshwater biota. The results of this study provide baseline chemical and biological indicators against which future reductions of atmospherically emitted mercury can be measured.

**Climate Change:** Both the status and trend data collected by the Lake Assessment Program will be influenced by climate change. Accurately assessing what that change is and teasing it out from local land use impacts will be important for informing future lake management decisions. In addition, according to EPA's National Water Program's 2012 Strategy, certain designated uses are at risk from climate change impacts. Understanding which designated uses are being impacted and how will help focus implementation of antidegradation requirements. Antidegradation, at a minimum, requires maintenance and protection of existing uses and the level of water quality necessary to protect the existing uses ([http://water.epa.gov/scitech/climatechange/upload/epa\\_2012\\_climate\\_water\\_strategy\\_sectionIV\\_water\\_quality\\_final.pdf](http://water.epa.gov/scitech/climatechange/upload/epa_2012_climate_water_strategy_sectionIV_water_quality_final.pdf)).

**Diagnostic Studies:** Diagnostic studies are typically aimed at identifying the cause of eutrophication in Vermont lakes. Over the years, Vermont has performed numerous such monitoring studies, and the results of many of these studies have led to concrete remediation steps. Lakes on which notable diagnostic studies have been performed include Harvey's Lake (Barnet), Lake Morey (Fairlee), Lake Iroquois (Hinesburg), Lake Champlain, Lake Carmi (Franklin), Lake Parker (Glover), Ticklenaked Pond (Ryegate) and Lake Memphremagog (Newport).

A wide variety of parameters are sampled in conjunction with diagnostic studies, with the actual tests performed specific to the project. Standard eutrophication parameters (phosphorus, Secchi disk transparency, dissolved oxygen) are always measured. Other parameters from both the sediment and the water column are measured as needed.

**Bioassessment:** According to [EPA's Water Standards Academy](#) basic course, "biological monitoring is the best integrator of multiple stressors/pollutants to indicate a problem. Follow-up monitoring and analysis are needed to identify the pollutant(s) causing the impairment. Supplemental indicators are used to determine potential problem areas (e.g., emerging contaminants, pesticides from agricultural production, excess sediments and nutrients from increased development or road construction)." VTDEC uses monitoring of fish and macroinvertebrates for direct assessment of aquatic life use attainment in streams. The lake assessment program began evaluating the status of selected biological species and communities in 1996 with the aim of developing numeric measurements to assess aquatic life use attainment in lakes. This initial effort led to the development of protocols for phytoplankton ([Kamman, 2003](#)) and macroinvertebrates ([Kamman, 2006](#)). In 2009, further development of approaches for using macroinvertebrates ensued as part of the Littoral Habitat Assessment study. A Vermont and NEIWPC led regional lake biomonitoring workgroup continues to pursue the development of biocriteria for lakes.