# NONPOINT SOURCE SUCCESS STORY

## New Hampshire

# Wetland Enhancements and In-Lake Treatments Restore Aquatic Life Uses at Kezar Lake

## Waterbody Improved

In the 1960s Kezar Lake experienced elevated levels of nutrients, which led to algal blooms and a large-scale fish kill. In 1980 local stakeholders, the state of New Hampshire, and the U.S. Environmental Protection Agency (EPA) began addressing the poor quality in Kezar Lake. Although the New Hampshire Department of Environmental Services (NHDES) had long been aware of Kezar Lake's problems, the methodology to assess chlorophyll-*a* (chl-*a*) and total phosphorus (TP) levels for designated use support were not developed until 2009. Based upon the assessment using that methodology, NHDES placed Kezar Lake on the 2010 Clean Water Act (CWA) section 303(d) list of impaired waters for chl-*a* and TP. After years-long and multiphase restoration efforts, including detailed analyses and monitoring, wetland enhancement, and implementation of in-lake treatments, Kezar Lake has improved. It was removed from New Hampshire's 2012 CWA section 303(d) list for its aquatic life use impairment due to satisfactory chl-*a* and TP concentrations.

## Problem

Kezar Lake is a 182-acre lake in Sutton, New Hampshire. The lake's maximum depth is 27 feet, and the mean depth is 9 feet (NHLAK700030303-03-01). The 6,848-acre watershed is mostly forested, but also includes the I-89 highway corridor, residential development and agricultural lands. In 1934 Kezar Lake was chosen as the location for Wadleigh State Park due to the lake's beauty and recreational value.

In 1931 the town of New London constructed a wastewater treatment plant that discharged treated, but high-nutrient, effluent to Lyon Brook, which is upstream of Kezar Lake. Algal blooms (Cyanophyceae) began to plague Kezar Lake in 1963 (Figure 1). Initially the concerns with this condition centered on aesthetics and recreational opportunities. Five years later, following continued blooms and a massive fish kill, lake-shore property values around Kezar Lake dropped significantly (1968 Sutton Town Report). Throughout the 1960s and early 1970s NHDES applied nearly 3 tons of copper sulfate to Kezar Lake and performed mechanical destratification by pumping compressed air to the bottom of the lake in an attempt to reduce the elevated phosphorus concentrations and stop the algae blooms. The success of these efforts was short-lived, however, and eventually proved to be ineffective because of the resistance of the dominant genus of *Aphanizomenon holsaticum* to copper sulfate treatments.

Figure 1. Algal blooms, such as this one in Kezar Lake in 1963, prompted restoration efforts.

In 1978 a CWA section 314 lake classification study determined that Kezar Lake was a high priority for restoration, which led to a 19-year, three-phase lake restoration project. In 1983 NHDES completed a Diagnostic and Feasibility (D&F) study, which evaluated numerous criteria at 12 stations around the lake, and documented elevated nutrient levels and internal phosphorus loading from sediments contaminated by years of wastewater treatment plant effluent. Although the treatment plant was decommissioned in 1981, algae blooms persisted in Kezar Lake. Although already listed as impaired for dissolved oxygen saturation, Kezar Lake appeared on the 2010 CWA section 303(d) list of impaired waters for aquatic life use via the newly established TP and chl-*a* indicators.

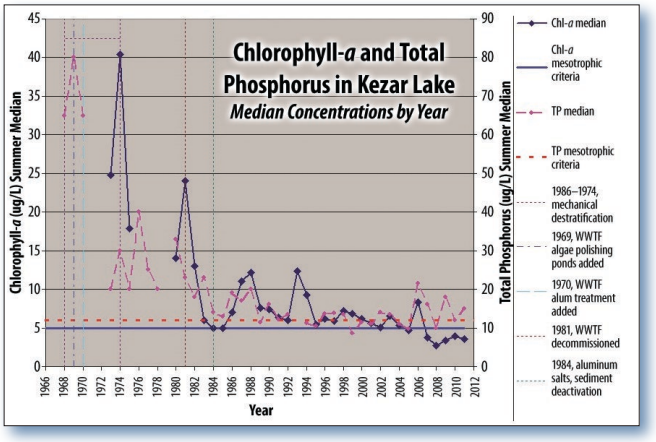


Figure 2. Chlorophyll-*a* and total phosphorus concentrations in Kezar Lake have declined over time.

## Project Highlights

Remediation efforts began during the second phase of the project, which involved implementing strategies identified in the D&F study. Two main approaches were employed to reduce phosphorus concentrations in the lake. First, in 1983, NHDES installed flashboards to elevate the water level in the Chadwick Meadows wetlands, which allowed for increased precipitation of suspended particulates that transport phosphorus. That same year, the Kezar Lake Protective Association joined the New Hampshire Volunteer Lake Assessment Program (VLAP), which is a program offered by NHDES that provides training, annual lake visits by NHDES biologists, equipment, and analyses of lake and tributary samples collected. Second, in 1984, aluminum salts were injected into 100 acres of the lake bottom to bind the available phosphorus. The aluminum forms insoluble precipitates with phosphorus, thereby removing the phosphorus from the water column and depositing it in the sediment in forms unusable by algae. In 1985 the wetland was further enhanced by the planting of wild rice, which was chosen for its high phosphorus attenuation potential.

To measure changes in the lake's condition, NHDES established a water quality monitoring program from 1984 through 1988. Monitoring was conducted, in part, through a CWA section 314 EPA grant for a restoration/protection project. To determine the success of the restoration strategies, NHDES evaluated many parameters, including water chemistry, sediment composition, fish tissue analyses and macroinvertebrate communities.

*Photo courtesy of pamperkinsrealestate.com*

Figure 3. Kezar Lake water quality has improved.

## Results

The thresholds established for a mesotrophic lake are 5 micrograms per liter (µg/L) for chl-*a* and 12 µg/L total phosphorus. Before restoration efforts, chl-*a* values were as high as 50 µg/L, and TP values were as high as 57 µg/L. The median values calculated for the 2012 assessment are 4.5 µg/L chl-*a* and 12 µg/L TP. Annual VLAP monitoring data indicate that chl-*a* is still on an improving trend, and TP is stable and meeting standards (Figure 2). Although dissolved oxygen saturation and pH are still not supporting designated uses, and chloride measures are trending higher (likely due to road salt), the restoration efforts at Kezar Lake have proven to be successful in reducing TP concentrations and the occurrence of algal blooms (Figure 3). Because of these efforts Kezar Lake transitioned from eutrophic to mesotrophic between 1978 and 1984 and aquatic life use is no longer impaired by chl-*a* and TP. As a result, these impairments were removed from NH's 2012 CWA section 303(d) list.

## Partners and Funding

This project involved cooperation of the Kezar Lake Protective Association, the town of Sutton, the New Hampshire Fish and Game Department, Jody Connor and the NHDES Watershed Management Bureau, and EPA. The association of local volunteers, along with town, state, and federal staff worked cooperatively throughout the project period. EPA provided significant support for this project by funding the initial D&F study, providing partial funding for the restoration implementation phase, and through a $121,577 CWA section 314 grant for the post-implementation Phase III analysis. Additionally, in-kind services and assistance of staff, equipment and other resources have been provided by NHDES programs which are supported by CWA section 319 grant funds. The Kezar Lake Protective Association, in cooperation with NHDES, continues to provide additional funding and in-kind services through volunteer monitoring activities.

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