NONPOINT SOURCE SUCCESS STORY

Massachusetts

Toxic Algal Blooms Reduced in Lake Attitash

Waterbody Improved Lake Attitash is a popular recreational area and important drinking water source. However, excess phosphorous pollution entering the lake from nonpoint sources (septic systems, excess fertilizer, and pet waste) and point sources (wastewater treatment plants), has led to nuisance plant growth and harmful algal blooms. These blooms pose a risk to drinking water and have led to beach closures. Therefore, Massachusetts Department of Environmental Protection (MassDEP) has included Lake Attitash on the Clean Water Act (CWA) section 303(d) Integrated List of Waters since 1992 for noxious aquatic plants and since 2016 for harmful algal blooms. Since 2002, the City of Amesbury has implemented best management practices (BMPs) to control nonpoint source runoff, led community-based educational efforts, and added in-lake treatments to decrease and sequester phosphorous. As a result, beach closures have decreased and water quality has improved.

Problem

Lake Attitash is a 360-acre "great pond" with 3.9 square miles of contributing watershed area between the city of Amesbury and the town of Merrimac, Massachusetts (Figure 1). The lake is designated as a Class A Outstanding Resource Water because it serves as the back-up water supply source for Amesbury. Excess phosphorous from nonpoint sources, including septic systems, excess fertilizer and pet waste, as well as from point sources (wastewater treatment plants) in the surrounding watershed caused proliferation of noxious aquatic plant species and harmful algal blooms. This prompted MassDEP to add Lake Attitash to its Integrated List of Impaired Waters (303(d) List) for noxious aquatic plants in 1992 and harmful algal blooms in 2016. As the lake is both a regional source of recreation and drinking water, harmful algal blooms have led to public health concerns from the Massachusetts Department of Public Health (MassDPH). Between 2009 and 2012, MassDPH issued over a dozen health advisories to the towns surrounding the lake, which prompted numerous beach closures.

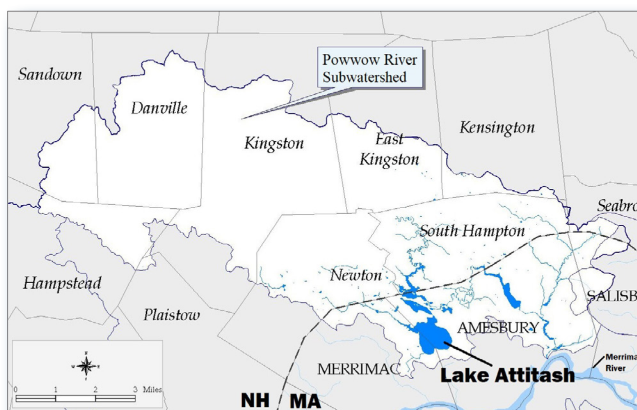

Figure 1. Northeastern Massachusetts' Lake Attitash is in the lower Powwow River subwatershed, which flows into the Merrimac River just west of the Gulf of Maine.

The issues caused by the phosphorous load to the lake from the surrounding watershed is exacerbated by the lake's morphology. The surrounding land use is mainly medium- and high-density residential on a topography dominated by moderate-to-steep hilly terrain. Nonresidential land use in the area includes a boys' camp, the Merrimac's municipal drinking water filtration plant and wellfield, forest, and an agricultural operation. The lake's average depth is just under 12 feet, and it has a maximum depth of 32 feet. The lake has just one inlet (Back River) and one outlet (Birches Dam) that are located close together, which means the lake has limited flushing and turnover and higher phosphorous residence time; this means harmful algal blooms are more likely to occur. Additionally, the lake's bottom of organic muck contained high levels of phosphorous, which can be resuspended in the water column during times of anoxia.

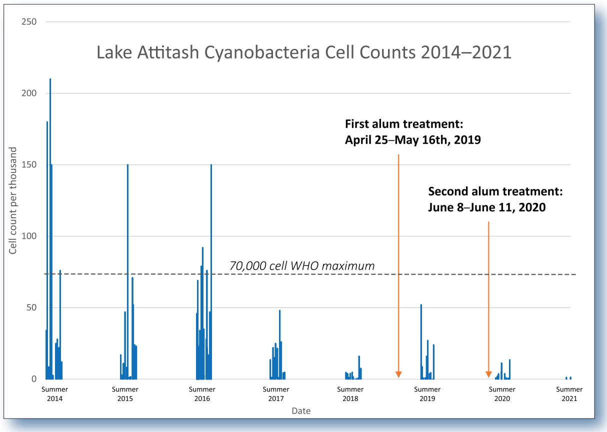

Figure 2. Chart illustrating the drop in cyanobacteria cell counts. Each bar cluster represents a weekly survey interval during a summer survey season.

Story Highlights

Since being listed as impaired in 1992, the U.S. Environmental Protection Agency (EPA), MassDEP, Amesbury, Merrimac, and the Lake Attitash Association had worked to lower phosphorous inputs to Lake Attitash using structural BMPs, municipal ordinances, and public education campaigns. Between 2002 and 2019 the City of Amesbury received three CWA section 319 grants to control nonpoint sources of phosphorous. The first grant focused on implementing structural and nonstructural stormwater BMPs. In 2002–2005, Amesbury designed, permitted and installed a structural BMP consisting of baffle tanks to reduce velocity and trap sediment before stormwater entered the lake. This was paired with sampling as well as a half-day educational seminar for watershed residents.

By the late 2000s, Amesbury, with help from the volunteers at the Lake Attitash Association, had addressed all the specific recommendations in the lake's watershed-based plan (WBP), including installing stormwater BMPs. Despite this, water quality in the lake remained poor, with harmful algal blooms and a season-long beach closure in 2009. A second section 319 grant focused on continuing to reduce runoff to the lake in 2011–2014, this time using low impact development techniques to infiltrate stormwater from urban areas of Merrimac and thus reduce the amount of pollutant-laden runoff entering the lake. The City also removed large amounts of nuisance aquatic weeds—an important internal source of phosphorous—and educated community residents on fertilizer use, pet waste and aquatic weeds.

Although this work had reduced external inputs of phosphorous to the lake, in-lake phosphorous and algal blooms remained a problem. A major source of the remaining phosphorous was determined to be in-lake recycling from the lake sediment, which consisted of 40% of the load. The lake's WBP identified that a 70% reduction in internal recycling would be required to return the lake to "normal" biological activity. To address this, Amesbury received a third section 319 grant to sequester phosphorous in the sediment using aluminum compounds. The City treated lake areas greater than 11.5 feet deep (about 194 acres) with alum at a rate of 40 grams per square meters (g/m2) in 2019 and 60 g/m2 in 2020 (see Figure 1). The alum binds to phosphorous in the water column creating flocs (particles) that float to the bottom, both trapping the phosphorous and creating a layer over the sediment which keeps phosphorous from being recycled into the water column. With less phosphorous being recycled into the water column, harmful algal blooms are less likely to occur.

Results

Years of work to reduce external phosphorous loads to Lake Attitash and the recent in-lake alum treatment have led to a significant decrease in cyanobacterial counts, an indicator of harmful algal blooms. In 2014, before in-lake treatment, the cell counts were over 200,000 cells per millimeter (mL) for cyanobacteria, well above the World Health Organization's (WHO) safe level guidance of 70,000 cells/mL. Cell counts decreased gradually from 2014 to 2017, and once alum was applied the cell counts dropped quickly to well below the WHO guidance level. In 2021, the first water sample of the year had a cell count of 1,170 cell/mL which is roughly 0.5% of the highest reading of 210,000 cells/mL in 2014 (Figure 2). This means residents have a safer lake to recreate in and a safer source of drinking water. If these positive trends continue, Lake Attitash may soon be removed from the 303(d) list of impaired waters for harmful algal blooms.

Partners and Funding

These projects were a collaboration between Amesbury, MassDEP, volunteers from University of New Hampshire, and EPA. The total project cost was $985,665; of that cost, EPA provided $586,245 from three CWA section 319 grants and the City of Amesbury contributed $399,420 in matching funds.

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