Mirror Lake 2020 Water Quality Update

Mirror Lake is an iconic Adirondack waterbody adjacent to the Village of Lake Placid.

In the summer months, residents and visitors alike paddle Mirror Lake's clear waters or swim at the public beach. The lake is home to the swim portion of the IRONMAN triathlon held each year in Lake Placid. In the winter months, there is a flurry of activity including ice skating, hockey tournaments, tobogganing, and dog sled rides. We know that a healthy Mirror Lake is an essential social and economic resource for the village and the wider region. A recent study in the Lake Champlain region provides evidence that water clarity alone has a significant impact on tourism spending (Voigt et al., 2015). These findings suggest that the clear waters of Mirror Lake have a positive influence on Lake Placid tourism and spending.

Situated in western Essex County and bordered by the Town of North Elba and Village of Lake Placid, Mirror Lake (Figure 1) has a surface area of 50 ha (124 acres) and watershed area of 301 ha (741 acres). Of the total watershed area, 27% is developed; that number increases to 34% developed if we only consider land area. Much of this developed land area in the Mirror Lake watershed is covered by impervious surfaces. Indeed, Mirror Lake has over twice the percentage of developed land compared to any other lake studied in the Adirondack Lake Assessment Program (ALAP; Laxson et al. 2016). This makes Mirror Lake one of the most developed lakes in the Adirondack Park. The headwaters of the watershed, draining from the ridge between Mt. Whitney and Cobble Hill, create Echo Lake which sits 1.5 km east of Mirror Lake. A small brook trout stream travels from Echo Lake, across Mirror Lake Drive through a small underground pipe into the north bay of Mirror Lake. This upstream portion of the watershed is mostly forested. Downstream, in the areas surrounding Mirror Lake, much of the land is developed. The lake drains to the south, through another underground pipe, into the Chubb River which flows into the West Branch Ausable River.

CONTENTS

Abstract 1
Introduction 1
Overview of Findings 2
Methods 2
Results 3
Temperature & D.O. Profile ... 3
Conclusions 4
Acknowledgements 4
Citations 4

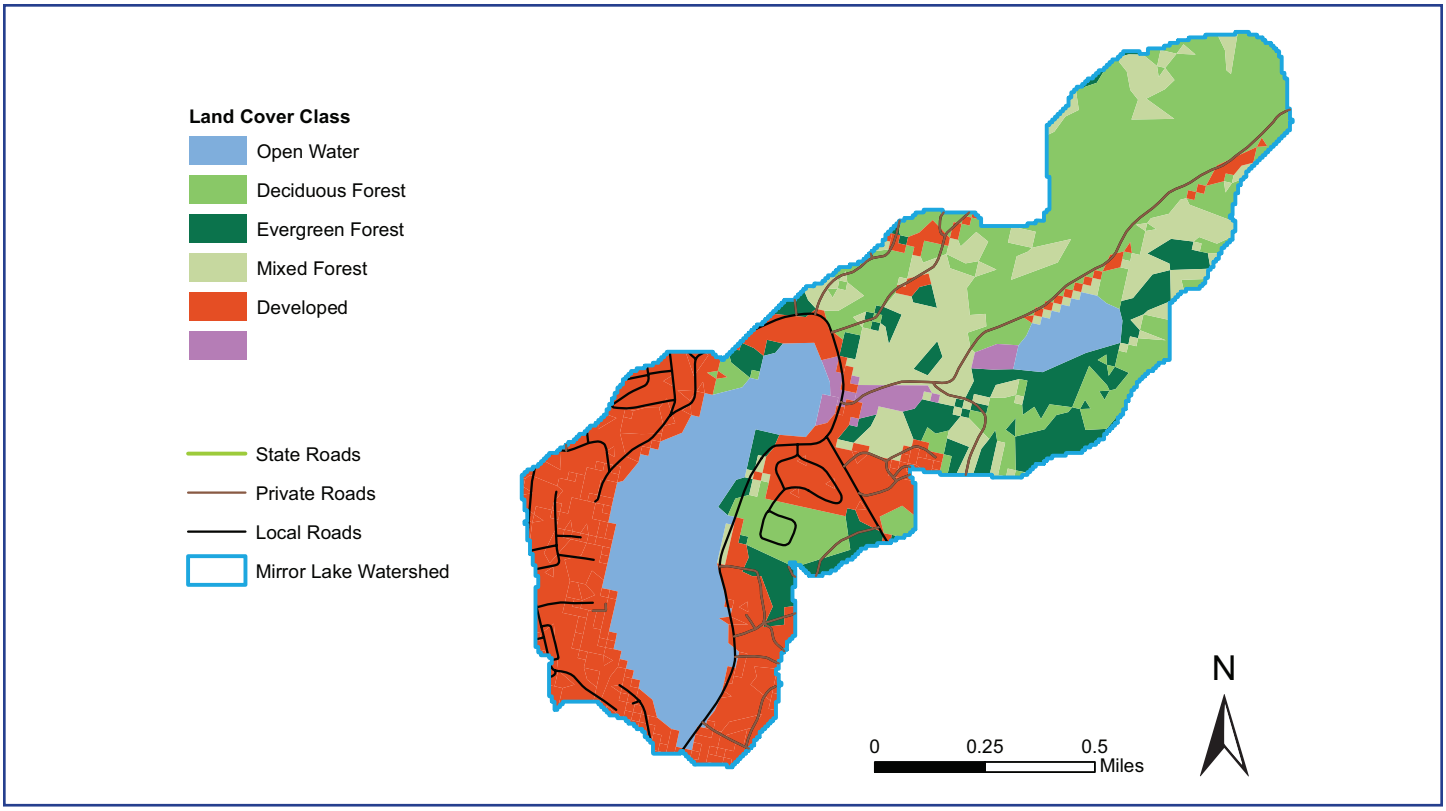

Figure 1. Distribution of land cover and road types within the Mirror Lake watershed. With 27% developed land in the watershed comes a high proportion of impervious surfaces. Stormwater runoff from roads, driveways, parking lots, rooftops, and other impervious surfaces collects and moves quickly, eroding soils and picking up sediment, debris, and pollutants as it makes its way to Mirror Lake.

OVERVIEW OF FINDINGS

Although chloride concentrations in Mirror Lake were lower in 2020 than in the past three years, the water quality of Mirror Lake remains impaired by winter salt use applications. The lake completed turnover in spring and fall of 2020 after a mild 2019-2020 winter season. In late autumn, unusually warm temperatures triggered a harmful algal bloom. The Ausable River Association and its partner the Paul Smith's College Adirondack Watershed Institute continue to monitor and sample Mirror Lake year-round to protect this fragile system from anthropogenic influences.

METHODS

Field data were collected bi-weekly during the open-water season from a canoe anchored over the deepest location of the lake. In winter months, when the lake was covered with ice of sufficient thickness for access by foot, field data were collected directly from a hole drilled in the ice. During each sample visit, a surface water sample, hypolimnetic sample, and profiles of temperature, dissolved oxygen, specific conductance, and pH were collected. The surface water samples were collected from a depth of 0 to 2 meters with an integrated tube sampler. The tube sampler, which allows for collection of an integrated sample of the top 2 meters of the water column, was then emptied into a field rinsed 1L sample bottle. A portion was poured off into an acid-washed and field-rinsed sample bottle for laboratory analysis and 250ml was filtered through a 0.45µm cellulose membrane filter. The filter was folded in half twice, wrapped in foil, and stored on ice for chlorophyll-a analysis. Hypolimnetic samples were collected using a 1.5L Kemmerer bottle from approximately 1 meter above the bottom. This sample was immediately transferred to an acid-washed and field-rinsed sample bottle and stored on ice. All water samples and the chlorophyll-a sample were transported on ice until they could be frozen before being transported to the Adirondack Watershed Institute. Samples were analyzed for pH, conductivity, alkalinity, total phosphorus, nitrate, ammonium, total nitrogen, chlorophyll-a, chloride, sodium, and calcium at the Adirondack Watershed Institute Environmental Research Lab. Transparency was measured during the ice-free period using a 20cm black and white Secchi disk from the shady side of the boat. Profiles of temperature, dissolved oxygen, specific conductance, and pH were collected at 1m intervals from the surface to 17m using a YSI Professional Plus handheld sonde from January to July and a YSI EXO2 sonde from August to December.

RESULTS

Mirror Lake experienced hypoxic conditions (low oxygen levels, a dissolved oxygen reading of <2 milligrams per Liter, or mg/L) in the hypolimnion, or lower lake waters, during each summer from 2015-2020 (Figure 2). Low dissolved oxygen reduces habitat for lake trout and other aquatic organisms essential to lake health and integral to the economic value of the lake. Mirror Lake is oligotrophic, meaning low nutrient content, and had relatively low phosphorus concentrations throughout 2020.

In early November 2020, an algal bloom was detected in Mirror Lake. The dominant algae found was *Dolichospermum lemmermannii*, a species of cyanobacteria that can produce cyanotoxins. Cyanotoxins are capable of producing a number of adverse health effects, and in severe cases death, in both humans and wildlife. The algal bloom in Mirror Lake was likely caused by a combination of unseasonably warm temperatures, still water, sunlight, and the abundance of available nutrients. This algal bloom also coincided with algal blooms that occurred in Lake George and across New York State.

Temperature and Dissolved Oxygen Profile

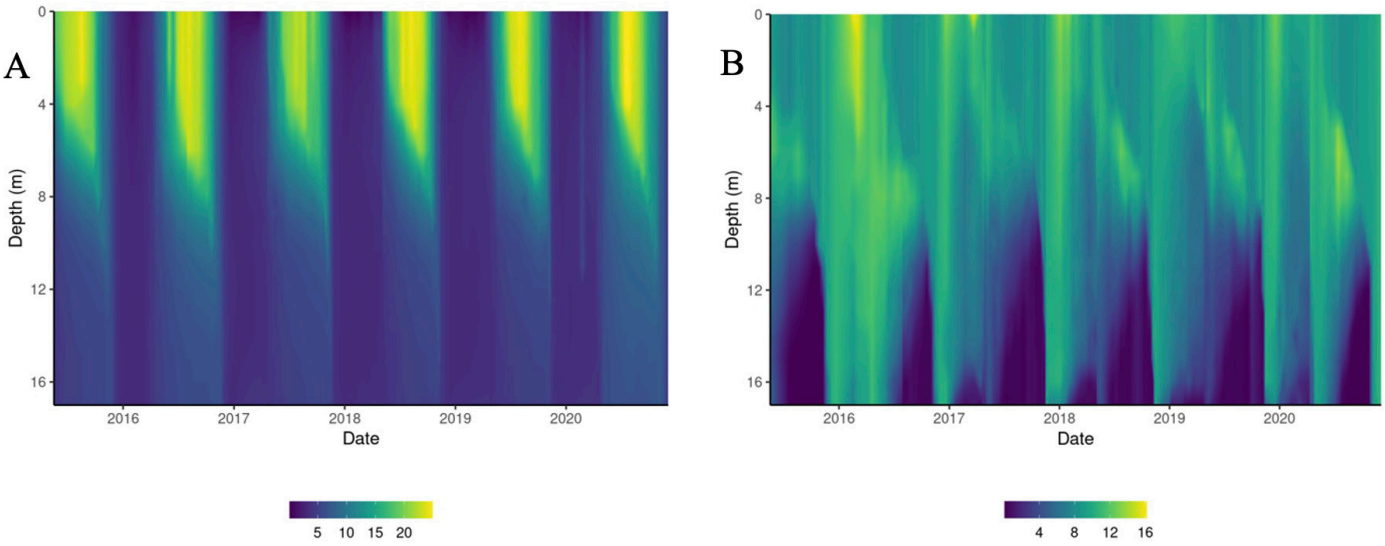

Figure 2. Temperature (°C) (A) and dissolved oxygen (mg/L) (B) from vertical profiles collected at 1m intervals at the deepest part of the lake from 5/18/2015 – 12/31/2020. Lighter color denotes higher temperatures or dissolved oxygen.

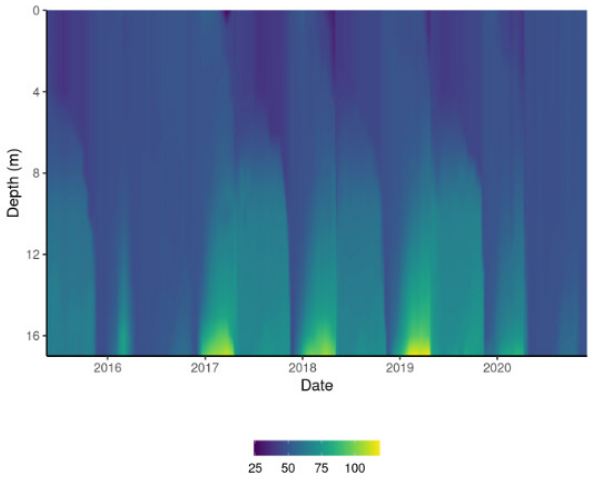

Figure 3. Chloride (mg/L) from vertical profiles collected at 1-m intervals at the deepest part of the lake from 5/18/2015 to 12/31/2020. Lighter color denotes higher concentrations of chloride.

Lake Trout seek out optimal areas where temperatures are cool (<15 °C) and are well oxygenated (>6 mg/L dissolved oxygen, Plumb and Blanchfield, 2009). When these conditions are not met, fish are forced into a narrow range of lake depths. For much of the summer and into the fall of 2020, these conditions were not achieved, and lake trout were likely forced into depths between 8 and 12 meters (Figure 2).

Minimally impacted Adirondack lakes have average chloride concentrations of 0.2 mg/L (Kelting et al. 2012). Road runoff is a major source of chloride in regions where rock salt is used as a road and sidewalk deicer in winter. New York has one of the highest road salt application rates per lane mile in the United States (Kelting & Laxson 2010). Within the Village of Lake Placid, road salt is applied to roads, parking lots, and sidewalks around Mirror Lake. With 27% developed land in the watershed a high proportion of surfaces are impervious, increasing potential application area and facilitating movement of pollutants into nearby waterbodies.

Lower levels of chloride were seen in the hypolimnion in 2020 compared to years prior (Figure 3). This may be attributed to the combination of a mild winter in 2020 and the Salt Use Reduction Initiative that has been working to reduce road salt applications and movement into Mirror Lake. The average hypolimnion chloride concentration for 2020 was 56 mg/L, while in years prior the average hypolimnion chloride concentration was 72 mg/L, 71 mg/L, and 74 mg/L (in 2019, 2018, and 2017 respectively). The highest chloride concentrations recorded in the hypolimnion layer in Mirror Lake were 85 mg/L in 2020. In years prior, chloride concentrations were recorded as high as 125 mg/L (Figure 3). The highest concentrations of chloride were observed from January to April 2020. After April, more uniform conditions were seen, with the mixing of the water column (Figure 3).

CONCLUSIONS

Although Mirror Lake's chloride levels were lower in 2020 than in years prior, road salt continues to be a major concern. It inhibits natural turnover and reduces lake trout habitat (Wiltse et al. 2019). Higher chloride levels also create the optimal conditions for internal phosphorus loading with prolonged hypolimnion anoxia levels. This can lead to algal blooms in the lake, further depleting oxygen resources in the lake. Even when concentrations of phosphorus are low, the interruption of lake mixing due to road salt loading puts the lake at greater risk for harmful algal blooms.

In November of 2020, a harmful algae bloom was detected on Mirror Lake due to unseasonably warm air temperatures and calm waters. Although this algal bloom was not directly caused by high sodium and chloride concentrations, it is a reminder of the harm that can potentially be caused by high usage of road salt in the watershed. In 2021, water quality monitoring continues, and AsRA will continue working with the Village of Lake Placid, the Town of North Elba, our science partners, business owners, and residents in our efforts to reduce the use of road salt applications.

ACKNOWLEDGEMENTS

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