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Land Management Research Program and National Water Quality Program

# Appendix 2. A Structured Decision Analysis for Prevention, Management, and Mitigation of Cyanobacterial Harmful Algal Blooms at Moreau Lake State Park, New York—Results From a Structured Decision Making Workshop, February 10–14, 2020, Troy, New York

Scientific Investigations Report 2022–5053, Appendix 2

U.S. Department of the Interior
U.S. Geological Survey

**Cover.** Left: Moreau Lake swimming beach in Moreau Lake State Park, New York, August 2021. Right: An algal bloom in Moreau Lake, Moreau Lake State Park, September 2018. Photographs by the New York State Office of Parks, Recreation and Historic Preservation.

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Land Management Research Program and National Water Quality Program

Prepared in cooperation with the New York State Office of Parks, Recreation and Historic Preservation and the New York State Department of Environmental Conservation

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**U.S. Department of the Interior**
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## Abstract

In 2018, Moreau Lake, a relatively pristine oligotrophic kettle lake in a forested watershed in Saratoga County, New York, experienced a cyanobacterial harmful algal bloom (CyanoHAB) dominated by the cyanobacteria *Gloeotrichia*, which resulted in two closures of the regulated beach at the lake. A second CyanoHAB, in 2019, also resulted in a brief beach closure. The cause of these blooms is not understood at this time. The beach closures and concern about the health risks associated with the blooms resulted in a high volume of calls from the public and required concerted communication efforts from the New York State Office of Parks, Recreation and Historic Preservation. In February 2020, a structured decision-making workshop was convened to explore short- and long-term strategies for responding to CyanoHABs at Moreau Lake State Park. The most important fundamental objectives for such a strategy focus on protecting health and safety of humans and their pets; maintaining recreational opportunities such as swimming, fishing, and camping; protecting natural resources in the park; maintaining benefits to the local economy; minimizing costs of prevention, treatment, and mitigation; and building public trust through effective communication. Four alternative strategies were developed, ranging from a low-cost, low-effort management-focused strategy consisting of beach closures during blooms and modest watershed improvement to a high-cost, high-effort prevention-focused strategy designed to improve and maintain the health of the watershed and reduce or eradicate CyanoHABs in the lake. Evaluation of the four strategies against the fundamental objectives was impeded by critical uncertainty about the cause of the blooms, such that different strategies would be favored depending on the cause. This insight led to the following proposed course of action: maintain current management of the lake, closing the beach to swimming if and when there are CyanoHABs; initiate a research program in partnership with the U.S. Geological Survey to better understand the cause of the CyanoHABs; explore the potential to use novel non-invasive methods to prevent CyanoHABs from developing within the beach area; and be prepared to adopt other actions, depending on the results of the early research.

## Background

### Park Setting

Moreau Lake is a 128-acre groundwater-fed, oligotrophic kettle lake within Moreau Lake State Park, in Saratoga County, New York. Nearly 70 percent of the topographic watershed in which Moreau Lake sits is forested (a mixture of deciduous and coniferous forest types, fig. 2.1). The New York State Office of Parks, Recreation and Historic Preservation (OPRHP) owns the entire shoreline of the lake and most of the

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watershed (fig. 2.2). Moreau Lake State Park attracts approximately 275,000 visitors per year, with day-use swimming and overnight camping constituting the most popular activities. A regulated beach is open during the summer months and supports a Learn to Swim program. The campground has 145 tent sites, 3 year-round cabins, 6 seasonal cabins, and 2 bathhouses. The lake and campground serve as a gateway to a network of hiking trails in the Palmertown Range.

## Water Quality and History of Cyanobacterial Harmful Algal Blooms

Moreau Lake is classified as a class A(T) lake (New York State Department of State, 2021b [6 CRR–NY 941.6]), which means the lake should be suitable for use as a water supply, use as a public bathing beach, and fish survival (New York State Department of State, 2021a [6 CRR–NY 701.6]). From 1994 to 2002, Moreau Lake was monitored as part of the New York State Department of Environmental Conservation (NYSDEC) Citizens Statewide Lake Assessment Program (CSLAP). In a CSLAP report, transparency levels (mean 7.4-meter Secchi disk clarity), phosphorus concentration (mean 0.006 milligrams per liter), chlorophyll *a* levels (1.6 micrograms per liter), and pH (mean 7.65) all indicated a low-productivity, oligotrophic lake (CSLAP, 2003). Based on the monitoring findings, the lake is well suited for recreation such as swimming. In August 2018, following a 3-year period of unusually low lake levels, a cyanobacterial harmful algal bloom (CyanoHAB) was observed, which was dominated by cyanobacteria in the genus *Gloeotrichia*. The presence of the CyanoHABs led OPRHP beach operators to close the swimming beach twice, for a total of 6 lost recreation days. In 2019, CyanoHABs led to a 3-day beach closure. Prior to 2018, there was no documented history of CyanoHABs in the lake, although anecdotal reports suggest that undocumented CyanoHABS cannot be ruled out.

The occurrence of CyanoHABs at Moreau Lake and the associated beach closures resulted in public concern regarding health risks to people and pets. Public concern was raised on social media and initiated a high volume of calls to the park and regional office. The OPRHP regional and central office staff initiated a concerted communication effort to provide information to the public on CyanoHABs, associated risks, and the actions being taken to understand and respond to the CyanoHABs in Moreau Lake.

## Decision Makers, Partners, and Stakeholders

As the owner of the entire lakeshore and most of the watershed of Moreau Lake (fig. 2.2), the OPRHP is the primary decision maker. In the southwestern part of the watershed, there are several private homes on septic systems (fig. 2.2). The NYSDEC is responsible for evaluating whether permits are needed for any treatments to the lake. The New York State Department of Health provides guidance for management of bathing beaches. Stakeholders include day-use visitors to the park (primarily local residents), camping visitors to the park, and local businesses that experience an economic benefit from park visitation.

## Trigger and Urgency

The need for a structured analysis of management strategies was triggered by the CyanoHABs of 2018 and 2019. The public concern about the beach closures has required a considerable investment of time by the regional communications staff. The OPRHP was interested in investigating strategies in the winter of 2019–20 in preparation for the summer of 2020 but also wanted to begin planning to search for long-term solutions. This report documents the analysis conducted during a workshop held February 10–14, 2020, in Troy, New York, that used the principles of structured decision making (Gregory and others, 2012) to organize the discussion.

This report contains an initial analysis of options; it is not a final and complete analysis, nor is it a proposed or final implementation plan. This document includes a variety of lake management options that were discussed as part of the structured decision-making process. Not all the strategies identified are feasible, endorsed by the NYSDEC, or have a regulatory pathway. Further analysis, as well as consultation with NYSDEC permit administrators, is warranted before management actions are implemented.

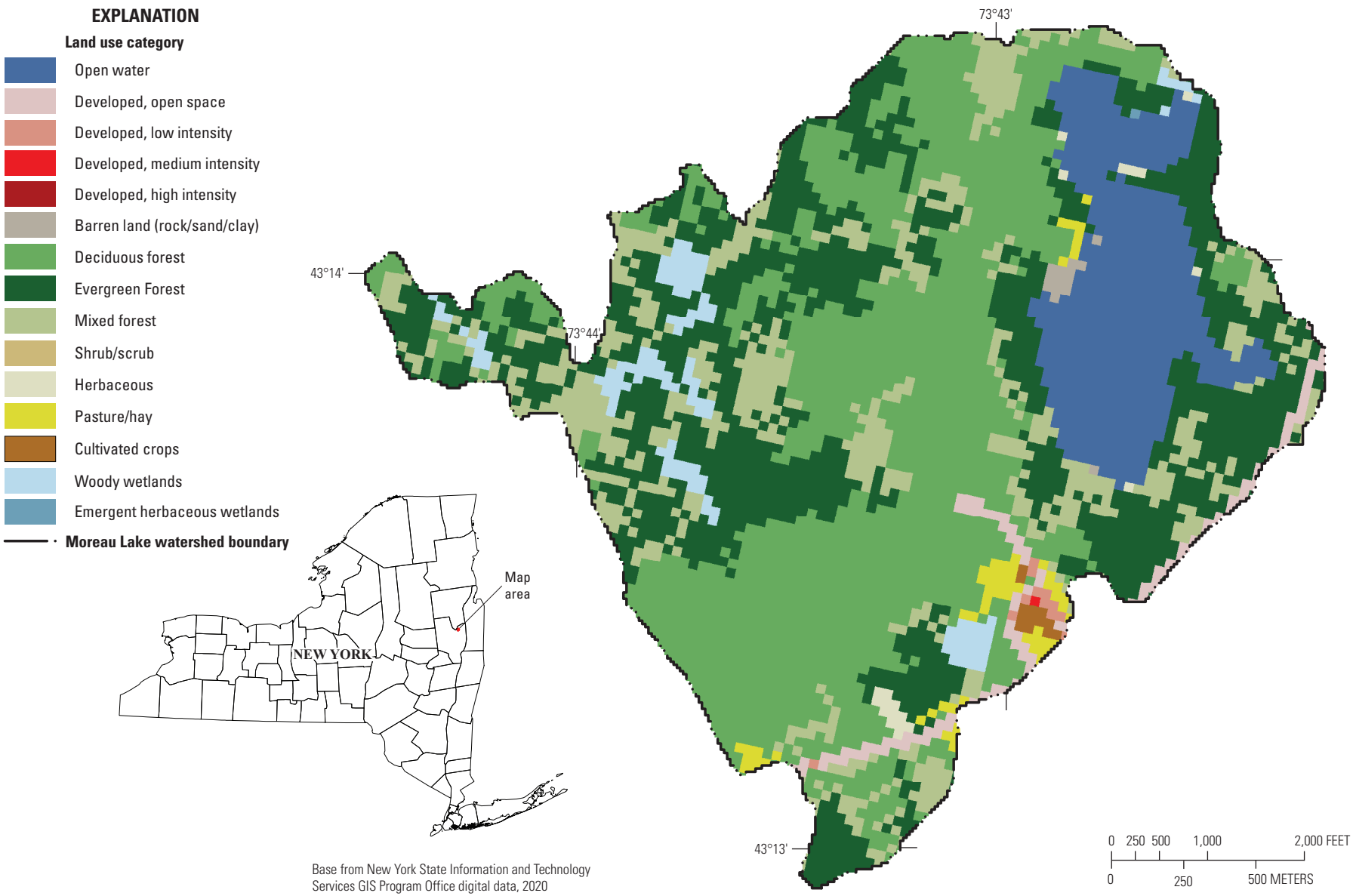


**Figure 2.1.** Land cover in the Moreau Lake watershed. Land cover from the National Land Cover Database (U.S. Geological Survey, 2016).

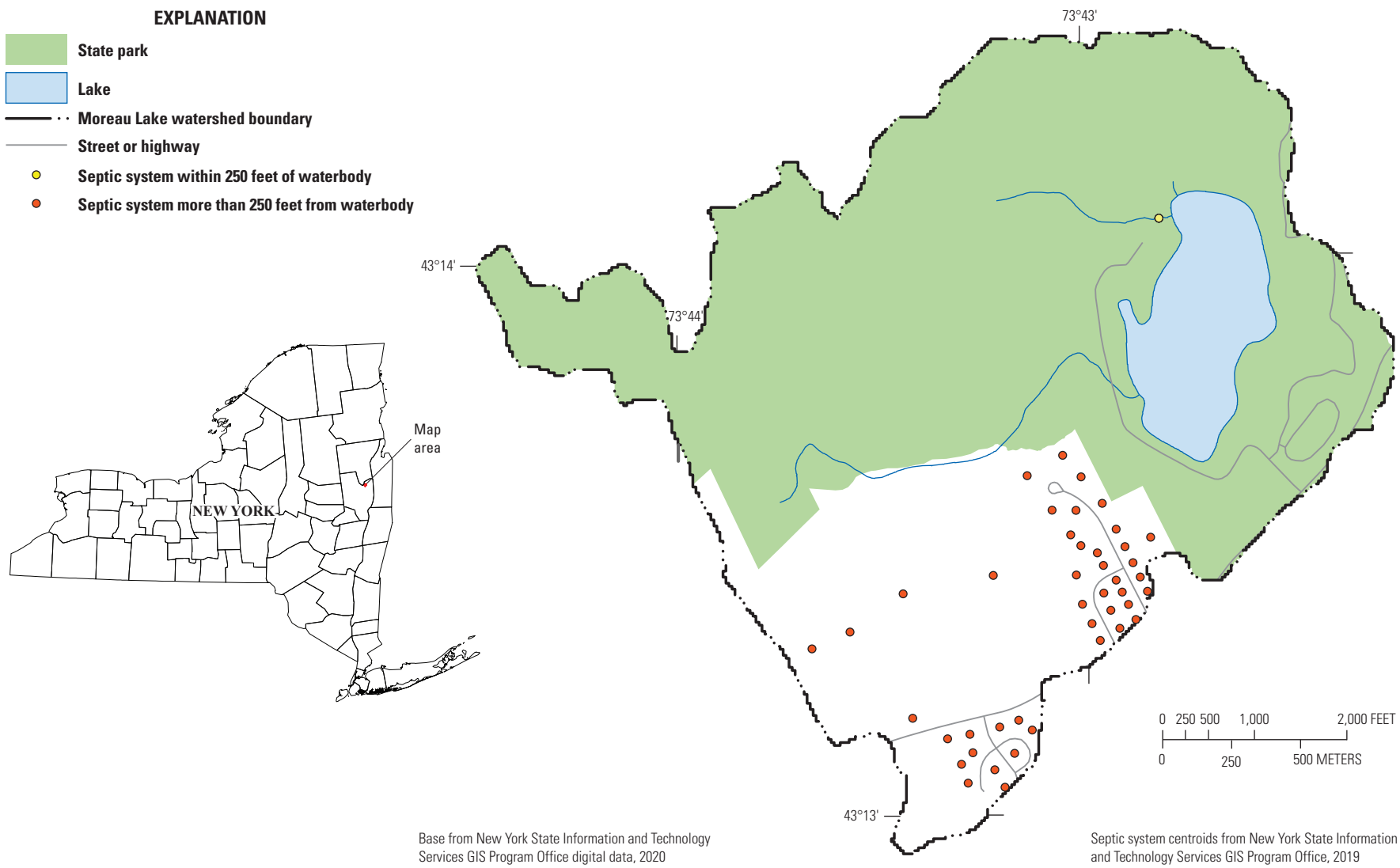


**Figure 2.2.** Landownership and septic systems in the Moreau Lake watershed.

# Objectives

The outcomes sought by the OPRHP arise from several features of the park: the use of the lake by day visitors and campers, the lake's location in a pristine watershed and the high quality of the water, and a close relationship between the park and the local community. The fundamental objectives can be organized into a hierarchy that reflects categories of outcomes (see sidebar). Moreau Lake State Park receives around 275,000 visitors per year, nearly all of whom interact with the lake, whether through day-use swimming, day-use dog walking, camping (and swimming), or boating. One of the highest priority objectives of the park is to minimize adverse health effects to humans and pets associated with CyanoHABs or the treatment of CyanoHABs (objective 1 in sidebar).

In addition to concerns for public health, other objectives important to the park include the desire to provide the recreational and interpretive opportunities for which Moreau Lake is well known. Maximizing the opportunity for swimming (objective 2 in sidebar) is important, not only because the lake is a draw for visitors but also because of specific swimming programs such as the Learn to Swim program and triathlon training. The lake provides an opportunity for year-round recreational fishing (objective 3)—*Oncorhynchus mykiss* (rainbow trout) are stocked in the lake, and *Perca flavescens* (yellow perch), *Esox niger* (chain pickerel), *Lepomis gibbosus* (pumpkinseed), and *Micropterus salmoides* and *M. dolomieu* (bass) are also sought. Maximizing camping opportunities (objective 4) is important, and this objective is tied closely to the opportunity for swimming. When the beach is closed to swimming, people often cancel their camping reservations, although the park has tried to mitigate this loss of opportunity by providing free passes for swimming at the Saratoga Spa State Park, a 20-minute drive away.

Conservation of the natural and cultural resources of the park is important (objective 5). *Gavia immer* (common loons), *Haliaeetus leucocephalus* (bald eagles), and *Pandion haliaetus* (osprey), species associated with northern wilderness, can be found on the lake, and numerous rare plants, including *Pycnanthemum verticillatum* (whorled mountain mint), an imperiled State-listed plant, have been found along the shoreline. Back Pond, the northern lobe of the lake, is a designated wetland. The entire park is an archaeological site, with evidence of use by Native Americans and early European settlers. Conservation of these features could be affected by some of the possible treatments for CyanoHABs, which is a consideration in the long-term management of the lake.

The lake and the park provide ecosystem services and economic benefits to the surrounding community. Economic benefits (objective 6) are associated with attendance at the park: a concessionaire sells food and rents boats near the beach, and local businesses (for example, restaurants and camping stores) generate revenue from visitors. Ecosystem services are also provided from the lake itself; as a class A(T) waterbody, the lake can be used for primary and secondary contact recreation, for fishing, and as a source of water for drinking (New York State Department of Environmental Conservation, 2021). The lake is not currently used, however, as a source of drinking water. Maintaining the quality of water in the lake is an important concern for the park (objective 7).

Three other objectives are important for evaluating management options for CyanoHABs in Moreau Lake. The park would like to minimize the costs of management and treatment (objective 8). The park would like to continue to build trust with the public, particularly through effective communication about the status of CyanoHABs in the lake and what it is doing about them (objective 9). Finally, the park recognizes that there may be other parks with similar problems with CyanoHABs and that learning at Moreau Lake might be valuably applied elsewhere (objective 10).

## Fundamental Objectives Hierarchy for Management of Cyanobacterial Harmful Algal Blooms in Moreau Lake State Park

A. *Protect safety and health of humans and their pets*
   1. Minimize health effects to humans and pets
B. *Provide safe and enjoyable recreational and interpretive opportunities*
   2. Maximize swimming opportunity
   3. Maximize fishing opportunity (stocked with rainbow trout)
   4. Maximize camping opportunity
C. *Protect and restore natural, historical, and cultural resources*
   5. Protect natural and cultural resources
D. *Provide ecosystem and economic benefits*
   6. Maximize economic benefit (concessions in particular)
   7. Maintain water quality for its intended use (class A[T])
E. *Minimize costs*
   8. Minimize cost
F. *Communication*
   9. Maximize public trust through communication
G. *Learning opportunity*
   10. Promote learning that is valuable to other lakes

# Alternatives

There is a range of management actions that the park could take, potentially involving upstream management, in-lake treatment, communication, and research and monitoring. A full management strategy would consider the combination of actions from all categories that could best balance all the objectives.

## Action Elements

The individual management actions that the park potentially could take (action elements) fall into 4 categories: watershed options, in-lake options, mitigation and communication, and research and monitoring (table 2.1). A brief description of those options follows.

A common way to manage and even prevent CyanoHABs is to address conditions in the watershed that contribute to the environment that promotes bloom formation, particularly when nutrient runoff is a causal factor. An analysis of the watershed of a lake can provide estimates of the leading sources of nutrient loading to the lake. In watersheds where nutrient runoff is the largest source of contributing nutrients, watershed nutrient-reduction strategies are a common way to treat and try to prevent CyanoHABs. Although the Moreau Lake watershed seems an unlikely source for major nutrient contributions, it is possible that it could be contributing enough nutrients to increase the likelihood of a CyanoHAB. Implementing stormwater controls is a low-cost, low-risk, potentially high-reward action with multiple positive benefits for the park and the lake. The park has already implemented some green infrastructure, notably rain gardens that intercept water from roofs and impervious surfaces, filtering it or allowing infiltration before it flows into the lake. The park has also invested in some erosion management in the intermittent streams that sometimes flow into the lake, reducing the amount of sediment that is washed downstream. As an additional step, the OPRHP could work with the NYSDEC and other partners to develop a Nine Element (9E) Clean Water Plan (New York State Department of Environmental Conservation, 2021), which would include a thorough waterbody modeling assessment, identification of best management practices, and an implementation plan.

Depending on the causes of the CyanoHAB, in-lake management options can be used to either address the cause or treat the symptoms. A short summary of CyanoHAB control measures that can be considered for New York State is provided in table 1 of Graham and others (2022). Detailed summaries of in-lake management options are available in the literature (for example, Osgood and Gibbons, 2017; Burford and others, 2019) and online (for example, U.S. Environmental Protection Agency, 2020). Options discussed for Moreau Lake are briefly described herein. Floating wetlands provide both nutrient absorption and light shading, possibly altering the conditions that promote CyanoHABs. A bubble curtain would involve using pumped air to create a ring of bubbles around the bathing beach, in an effort to at least prevent CyanoHABs from entering the area where most of the swimming occurs. Nanobubbles are an emerging technology that produces sub-micrometer-sized bubbles, which are not buoyant and so remain in the water column longer than larger bubbles, increasing oxygenation and preventing cyanobacterial growth. Ultrasonic treatment applies 20 kilohertz–1 megahertz

**Table 2.1.** Strategy table for developing cyanobacterial harmful algal bloom management alternatives at Moreau Lake State Park, New York.

[Each column represents a category of potential action elements; a full strategy needs to identify at least one item in each column. Ongoing management actions through 2019 are shown in blue and followed by an asterisk (*). CyanoHAB, cyanobacterial harmful algal bloom; USGS, U.S. Geological Survey]

| Watershed | In-lake | Risk mitigation and communication | Research and monitoring |
|---|---|---|---|
| · No management<br>· Green infrastructure*<br>· Erosion management*<br>· Develop a Clean Water Plan (9E) | · No treatment<br>· Floating wetlands/light shading<br>· Bubble curtain<br>· Nanobubbles<br>· Ultrasonic treatment<br>· Flow manipulation<br>· Biomanipulation<br>· Algaecide<br>· Selective dredge | · No communication<br>· Temporary beach closure (and communication)*<br>· Signs and risk education*<br>· Communication about causes and actions<br>· Alternate swim options* | · No monitoring or research<br>· Nutrient monitoring<br>· CyanoHAB and toxin monitoring<br>· Sediment cores<br>· Partnership with USGS for comprehensive plan |

sound waves, which disrupt the cell walls of cyanobacteria. Flow manipulation would involve changing the physical environment of the lake and related waterbodies to alter the flow; there is a hypothesis that backflow from the wetland at the north end of the lake may have changed the conditions within the lake. Biomanipulation involves changing the aquatic species composition in the lake, notably the fish community, in an effort to alter the food web to favor species that feed on cyanobacteria. Application of algaecide kills algal cells through cellular toxicity (for example, copper-based products) or oxidation (for example, peroxide-based products). Finally, if the cyanobacteria, particularly the akinetes (resting stages) that provide a permanent source, are localized within the lake, selective dredging could be used to remove them.

Regardless of the ability to treat the CyanoHABs themselves, mitigation measures can be taken to preserve some of the desired outcomes. Beach closures could protect public health when CyanoHABs are present and were used in 2018 and 2019. The park has invested in signs and risk communication to educate the public about the possible presence of cyanobacteria, ways to avoid it, and the consequences of contact. Stakeholders have indicated a desire for communication about the causes of the CyanoHABs in Moreau Lake and information about what the park is doing to address them. One of the ways the park has preserved the opportunity for recreational swimming when the lake has been closed is by providing alternate swim options, such as free passes to the nearby Saratoga Spa State Park.

Both the long-term search for ways to prevent, treat, and manage CyanoHABs in Moreau Lake and the opportunity to provide information valuable to other parks may involve research and monitoring. One option is standard nutrient monitoring, to track the levels of nitrogen, phosphorus, and other nutrients in the lake. More extensive cyanobacterial and toxin monitoring would provide information about the density of cyanobacteria and whether any toxins produced by them were at levels of concern. Sediment cores could be taken to test for reservoirs of cyanobacterial akinetes (resting stages), possibly allowing both diagnosis of the cause of the blooms and a potential treatment. Finally, a partnership with the U.S. Geological Survey (USGS) to develop a comprehensive monitoring and research plan could allow identification of the potential causes of CyanoHABs.

## Alternative Strategies

In a workshop with local and regional park staff in February 2020, four alternative strategies were developed by selecting combinations of action elements from table 2.1. The four strategies were designed to span the range of strategies possible but are not an exhaustive set.

Alternative 1 (“Let it Be”) is similar to the approach the OPRHP took in 2018 and 2019, focused on responding to the blooms as they appeared. Under this strategy, the beach would be closed when there were active cyanobacterial blooms, and alternate swim options would be provided to visitors. Effective communication to inform the public about the risks would be emphasized. Enhanced monitoring would be added to help determine the cause of the blooms, and the results from the monitoring would be used as part of the communication effort.

Alternative 2 (“Day Tripper”) would emphasize day-use visitation, focusing on keeping the beach open. New technology would be installed around the swimming area. A bubble curtain could keep wind-blown cyanobacteria from entering the swimming area, and nanobubbles would be introduced around the perimeter of the swimming area to prevent wind-blown cyanobacterial accumulations. Communication with the public would emphasize the actions being taken to protect swimmers in the beach area but would also focus on the risks of open swimming in the rest of the lake. Monitoring would focus on evaluating the effectiveness of the bubble curtain and nanobubbles, as well as trying to determine the cause of the CyanoHABs.

Alternative 3 ("Long and Winding Road") would take the long-term approach of managing the watershed and lake environment to reduce the conditions that may enable cyanobacteria to grow. The OPRHP would develop a 9E Clean Water Plan with partners in the watershed. Flow manipulation would be undertaken to change the flow in the lake, to discourage or prevent backflow from the wetland at the north end of the lake. Biomanipulation would be undertaken to change the aquatic community within the lake to further discourage cyanobacteria. Research would be undertaken to understand the food web in the lake so that management actions could be implemented adaptively.

Alternative 4 ("Get Back") would combine watershed management with an in-water "system reset" in an effort to restore the lake ecosystem. As in alternative 3, the OPRHP would work with partners to develop a 9E Clean Water Plan. The in-water treatments would include selective dredging to remove sediments with cyanobacterial akinetes (assuming such sediments are located); regular and aggressive application of algaecide (using hydrogen peroxide) to treat any blooms; and biomanipulation to discourage reestablishment of cyanobacteria. Throughout this process, a bubble curtain would be used to protect the swimming area. Research would be undertaken to understand the food web, identify where there were akinete deposits, and assess the effectiveness of treatments.

# Analysis of Consequences

The four alternatives range from a low-cost maintain current management actions strategy that mitigates the public health risk and affords visitors swimming opportunity but does not address the underlying cause (alternative 1) to an expensive, intensive strategy that intervenes significantly in the watershed and lake to identify and change the conditions that promote CyanoHABs (alternative 4).

All four alternatives are designed to protect public health (objective 1) by either mitigating or removing the risk posed by CyanoHABs. All four alternatives seek to preserve day-use swimming opportunity (objective 2), although alternative 1 would include offering passes to swim at nearby parks during beach closures. In alternatives 1 and 2, swimming outside the beach area would be affected during cyanobacterial blooms. Two of the strategies (1 and 2) would preserve current fishing opportunities (objective 3), whereas the other two (3 and 4) might change the nature of the fishing, owing to changes in the fish community. Camping opportunities (objective 4) would remain the same under all strategies, although the demand for camping might be reduced when there are CyanoHABs in the lake (notably under alternatives 1 and 2). The degree to which natural and cultural resources would be protected (objective 5) under the four alternatives was not discussed; further consideration of this objective would be needed in a more detailed analysis. The economic benefit provided by concessions (objective 6) is most affected by beach closures, so the economic benefit under alternative 1 is less than under the other strategies; the economic benefit to the larger community may be more closely related to demand for camping than to day use. All four alternatives seek to maintain water quality (objective 7), but the alternatives with intensive in-water treatment (2 and 4) would need careful monitoring to make sure there were not unintended effects on the water quality. The costs to the OPRHP for the four alternatives vary, with alternative 1 the least costly, alternative 4 the most costly, and the other two strategies in between. All four strategies are designed to maintain and build public trust through communication (objective 9). Finally, the alternatives that involve implementing more novel treatments and extensive research (2, 3, and 4) provide an opportunity for learning that might be valuable to other parks facing similar problems (objective 10).

## Critical Uncertainty

One of the challenges to more precisely forecasting the outcomes associated with each strategy is that the efficacies of the interventions may depend on the underlying cause of the CyanoHABs in Moreau Lake. Four potential hypotheses were discussed at the workshop.

*Hypothesis 1*.—The blooms seen in 2018 and 2019 were part of a natural pattern. Under this hypothesis, cyanobacteria have been present for a long time, and CyanoHABs occurred in the past, sometimes without being noticed. The CyanoHABs in 2018 and 2019 were only particularly large episodes.

*Hypothesis 2*.—There is a new set of environmental conditions being driven by climate change that favors CyanoHABs. This set of conditions could arise from warmer average temperatures, increased frequency of microbursts, a change in seasonal precipitation patterns, or a combination thereof. Under this hypothesis, the conditions that promote CyanoHABs are likely to persist.

*Hypothesis 3*.—A one-time combination of events led to the establishment of cyanobacteria in Moreau Lake, and, once established, the CyanoHABs will persist unless treated. As one possibility, for example, there was a drought of several years prior to 2018 that could have led to a one-time reversal of flow between the lake and a neighboring wetland, perhaps providing an inoculation of cyanobacteria to the lake.

*Hypothesis 4*.—Historical construction and park management changed the water flow and the aquatic community, which created conditions that promote CyanoHABs. The history of some of the changes to the lake and how they might have affected lake ecology is unclear. For example, did construction of the bridge that now connects the west and east sides of the lake change the flow patterns substantially? Have various introductions of game fish changed the aquatic community?

The current state of knowledge about Moreau Lake can provide some insights about these hypotheses but cannot resolve the uncertainty at this time.

## Tradeoffs

There are two types of challenges in choosing a strategy to implement. First, multiple objectives are sought, and choosing a preferred strategy requires deciding how to balance those objectives. Second, critical uncertainty impedes the choice of a preferred strategy—the alternative that is best may depend on which hypothesis about the cause of the CyanoHABs is true.

The OPRHP staff at the workshop (from Moreau Lake State Park and the regional and Albany offices) judged that the multiple objectives were not the hard part about this decision—they felt like they knew how to navigate the tradeoffs among the objectives. The harder part was knowing what to do in the face of uncertainty.

The uncertainty about the cause of the CyanoHABs is known as *critical uncertainty*—it is uncertainty that matters to the choice of action (Runge and others, 2011). If hypothesis 1 is true (the CyanoHABs are natural), then perhaps alternative 1 is the best option; the park just needs to figure out how to mitigate the effects of the blooms on the rare occasions when they occur. If hypothesis 2 is the true (climate change), then perhaps alternative 2 is the best option; the park needs to adapt to the new conditions, using technological advances to preserve the day-use swimming opportunities and mitigating other effects through public communication. If hypothesis 3 is true (there was a one-time combination of events that established the CyanoHABs), then the aggressive system reset (alternative 4) may make sense to return the lake to its previous condition. Finally, if hypothesis 4 is true (a long history of anthropogenic changes to the watershed and lake), then the committed effort to change the watershed and lake conditions (alternative 3) might be warranted. Thus, knowledge of the cause of the cyanobacteria blooms is not only of scientific interest; it matters to the decision maker.

Considering this critical uncertainty, an adaptive management approach might be warranted (Williams and others, 2007). The workshop participants proposed the following steps:

1. Initially, implement alternative 1, including ongoing green infrastructure and erosion control projects. Continue the policy of closing the beaches when there are harmful blooms and offering swimming passes at nearby facilities. Continue ongoing data collection. At the same time, local park staff would work with regional, Albany office, and partner staff to develop a communication effort that conveys both the short- and long-term elements of the adaptive strategy.
2. Begin investigating and testing the elements of alternative 2, especially the bubble curtain and nanobubble technologies. This work would include exploring the permitting process with the NYSDEC. There would be benefit in this research for other parks.
3. Establish a research partnership with the USGS to investigate the causal hypotheses.
4. The other elements of a long-term strategy would likely depend on what is found during research into the cause of the blooms.

## Implementation Questions

Workshop discussions did not focus on implementation, and several questions will require additional consideration, including the following:

- What funding is needed, and how could that funding be acquired? Several of the items in the proposed plan would not be covered by the normal operating budget, so funding would need to be sought. A research partnership, watershed management, and installation of some of the new technologies would require funding.
- What needs to be done to obtain the necessary permits? Some of the treatments being considered (bubble curtain, nanobubbles) are not standard interventions for the OPRHP, so work with the NYSDEC and other relevant permitting agencies would need to be initiated to examine how to undertake a permitting process to test and implement these treatments.
- What partners need to be engaged? Local landowners, the concessionaire, and other State agencies may have a vested interest in the path forward and may wish to be involved in future deliberations.
- What is the timeline for implementation and for benefit be observed? If the proposed plan, or something like it, is adopted, it would be valuable to include a timeline for implementation, as well as a timeline that establishes expectations for achieving various milestones.

## Next Steps

This framing of the decision about harmful cyanobacteria blooms at Moreau Lake was developed by local, regional, and Albany office OPRHP staff during a workshop with several partners in February 2020. The discussion and conclusions included here have not been formally adopted by the OPRHP. Further discussion within the agency would allow it to decide whether to pursue this proposed adaptive plan or take another approach.

If the OPRHP decides to adopt the approach outlined in this report, then the immediate next step is simply to continue to implement the current management strategies (alternative 1), with the added ability to communicate how this fits within a long-term strategy designed to determine, then remove or mitigate, the causes of the blooms. The second step is to establish a research partnership with the USGS to investigate the causes. The third step is to begin conversations with the NYSDEC and other permitting agencies about the permits needed to test new technologies.

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