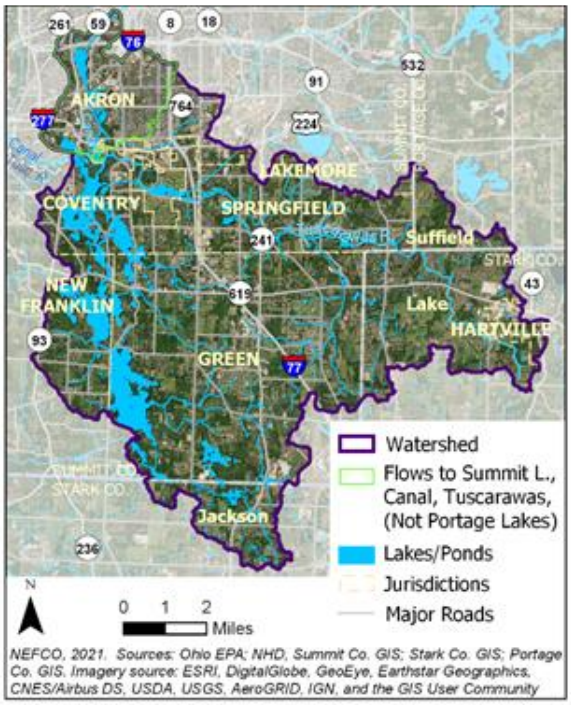
Portage Lakes Management Plan - Summary, Key Considerations

Chapter 1 - Introduction

Map 1 – Portage Lakes and the Upper Tuscarawas River Watershed



The Portage Lakes is a chain of connected lakes and reservoirs in southern Summit County, within the communities of New Frankliln, Coventry Township, and Green (Map 1). It is a natural system, regional recreational and economic resource, part of the Portage Lakes State Park, and the center of a thriving community. It draws hundreds of thousands of visitors each year for boating, fishing, swimming, festivals, and other outdoor activities. It is surrounded by thousands of homes and businesses. The lakes get their water from a 74-square mile watershed and are influenced by that landscape.

The use and enjoyment of the lakes is intertwined with the water quality and health of the lakes. The intense activities affect the lake system, and the natural lake processes affect ativities.

The lakes are eutrophic, enriched in nutrients from decades of development along the shore and in the watershed. The nutrients drive dense growth of rooted aquatic plants and floating photosynthesizers like algae and the cyanobacteria that can cause “Harmful Algal Blooms” (HABs), which generate powerful toxins.

The dense growth of aquatic plants is often perceived as a nusiance by visitors, businesses, and residents (“lakers), because it impedes access and creates unsightly mats where people live and visit. However, the plants provide important benefits for the health of the lakes, water quality, and uses of the lakes:

- Generating oxygen
- Stabilizing sediment
- Habitat, food, and cover for fish, birds, and other wildlife, and
- ***Protecting against HABs*** by using nutrients that would otherwise fuel growth of HAB organisms.

Currently, plants – and the lake system – are managed by individual organizations and property owners addressing isolated situations on their own. Aquatic plants are part of a complex, interconnected lakes system. Their growth is driven by and affects lake conditions, their management must occur within the context of the lakes system.

A piecemeal approach to plant and lakes management does not address the conditions that cause – and spread – the plants or the impacts of management tools. The wrong approach may not address the

problem, or may cause more harm than good, spreading invasive species, decimating habitat, or increasing growth of the cyanobacteria that cause HABs.

Sustaining the uses of the lakes requires good water quality and a balanced approach to managing the lakes and aquatic plants: Providing for access and use while protecting the benefits that the plants provide. Managing plants must occur within the context of the lakes system.

Managing the lakes to sustain their health, habitats, and the many activities on and around them requires a coordinated, concerted effort, with adequate staff, funding, resources, and a shared understanding of lake conditions and priorities. Involvement of "lakers" is important, as they are so closely connected with the condition, use, and care of the lakes.

In order to identify strategies and policies to protect the lakes' ecosystem while supporting their uses, Ohio Environmental Protection Agency provided funding for five years of lakes management studies and planning to NEFCO. NEFCO staff have worked closely with representatives from the Portage Lakes Advisory Council (PLAC), community members, and a Technical Advisory Committee (TAC) that included agency staff, lake scientists, and volunteers.

For the past five years, partners from various state and county agencies, local governments, the lakes community, and the lakes management profession have built a partnership and a shared understanding of lake conditions and various approaches. This partnership is the beginning of a collaborative approach to understand and manage the lakes system, but it requires additional support:

- Funding
- Staff with a lakes management focus
- Monitoring
- Equipment
- Involvement and support of the lakes community

It is a large commitment to holistically manage the lakes. It is a new approach for the Portage Lakes, but there are many other successful lake management programs elsewhere. They demonstrate that systematically managing complex lake systems in a balanced way provides for continued use and protection of lake health and habitats. Such programs create shared understanding, expectations, and guidelines for sustaining the lakes for sustaining activities in the future.

The Portage Lakes Management Plan has involved five years of studies and plan development:

- Year 1 – Watershed characteristics, updating the 2000 Upper Tuscarawas Watershed Plan.
- Year 2 – Study of aquatic plants in the lakes, generally identifying types and extent from boat trips and shoreline visits, noting conflicts with uses, and exploring management strategies.
- Year 3 – Public and community engagement to help identify priorities and concerns, including focus groups, a lake monitoring workshop, boat tours of the lakes with community representatives, and various meetings and discussion groups.
- Years 4 and 5 – Developing a draft plan, using materials from the previous years, with the addition of materials on lake and community characteristics and recommendations developed through numerous discussions with the TAC members and others. Following release of the draft plan, partners will seek public input and endorsement and move toward carrying out recommendations. More detailed studies toward implementation are already under way.

Throughout the process, NEFCO staff presented findings to the PLAC, TAC, and other partners, and benefitted from numerous discussions during boat trips and meetings in the communities.

This summary includes highlights and Key Considerations modified from the plan chapters:

1. Introduction
2. Portage Lakes Setting
3. The Portage Lakes and their People: Community; Uses and Users; Balancing Priorities; Caretakers
4. Limnological Characteristics, Productivity and Eutrophication of Portage Lakes
5. Habitat, Wildlife, and Aquatic Plants
6. Water Quality and Portage Lakes Watershed
7. Recommendations and Management

Important Note: Recent Developments and the Plan

Recent developments at the lakes and nearby emphasize the needs for:

- Coordinated, collaborative approach, sharing new information;
- Urgent need for inventory/monitoring of aquatic plants and lake conditions; and
- Developing effective, appropriate methods soon to manage aquatic plants in a balanced way that protects lake health while supporting uses.

Between 2020 and 2021 the following events highlighted and affect the findings and needs included in the report. Some are addressed in the plan, some occurred too recently to be included and will be addressed in future work:

- Exceptionally dense growth in North Reservoir in 2020 and 2021 affects use of the lake;
- Floating plant material clogging Long Lake Feeder and other water control structures;
- Cyanobacteria bloom early in the season in Nimisila Reservoir points to nutrient enrichment and possibly climate conditions;
- Recent research on HABs highlight new factors in the severity and toxicity of blooms: lake temperature gradients and nitrogen as well as phosphorus.
- Hydrilla found in Mosquito Lake highlights the need to monitor for this highly invasive plant and prevent its spread by visitors or staff harvesting plants.

Chapter 2 - Setting

The Portage Lakes began as a few small kettle lakes left by glaciers. The lakes were transformed during the 1800s and early 1900s into an interconnected system controlled by dams, supplying the canal water for transportation and industrial water supply. Today, the lakes are used for flood control and to maintain flow to the Great Lakes, as well as supporting recreational use and thriving communities.

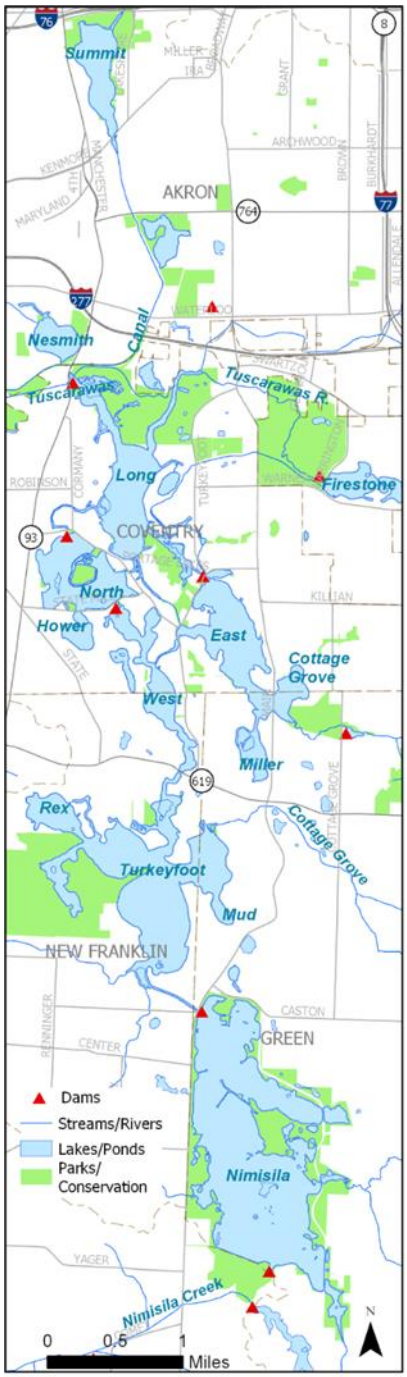
Map 2 shows the Portage Lakes as they are today. Where the water in the lakes comes from, how it moves through the system, and how it is controlled affects lakes conditions and management.

Watershed – The watershed affects the quantity and quality of the water entering the lakes. The characteristics of each lake depend on the individual watersheds as well as the upstream lakes. Protecting water quality requires understanding which areas contribute to each lake and taking care of the upstream lands of the watershed that feed the lakes. Best management practices, reducing non-point source pollution and protecting or restoring certain landscape features helps reduce the amount of runoff and the pollutants, and improves the quality of the water entering the lakes. This is discussed further in Chapter 6.

Dams – The dams and their control structures provide flood control, are necessary for maintaining flow to the Great Lakes Basin, and are used to manage lake levels. A small Ohio Department of Natural Resources (ODNR) staff maintains lake levels and flow as required. This critical, labor-intensive task involves monitoring water levels, adjusting gates, and clearing vegetation and debris from waterways and drains.

Flow – The "Main Chain" – Turkeyfoot Lake, West and East Reservoirs, and their components, are connected by channels, allowing boats and water to pass between them. From the Main Chain, flow is generally down and north, controlled by dams and gates. Most water flows from East Reservoir to Long Lake. Smaller amounts are let out of West Reservoir into North Reservoir and then Long Lake. Nimisila Reservoir is drains south except when it is occasionally used to refill the Main Chain lakes after drawdown. Long Lake receives water from the other lakes, and the Tuscarawas River. Long Lake outlets to the Tuscarawas River the Ohio and Erie Canal to flow north to Lake Erie via Summit Lake or south into the Tuscarawas River.

Map 2 – The Portage Lakes



Management Concerns - This plan recommends additional management measures in the lakes to better understand current and changing conditions in the lakes and watersheds, manage aquatic plants in a balanced way with residents' and visitors' concerns, reduce nutrients and contaminants within the lakes and coming from the watersheds, and protect the lakes from further eutrophication. Managing the lakes as a multi-use resource and ecosystem will require a coordinated, concerted effort, consistent management, partner assistance, and more staffing and resources than are currently available.

Chapter 3. The Portage Lakes and their People: Community, Uses and Users, Balancing Priorities, and Caretakers

The Portage Lakes system is a natural system within a state park and community that supports multiple uses by hundreds of thousands of residents and visitors. The lakes provide a home, natural refuge, recreational resource, community focus, and economic opportunities, that all depend on good water quality and a healthy lakes system. Each participant has priorities and expectations and can affect lakes' health. Protecting the lakes' health requires everyone's help in managing the different priorities, increasing understanding of the lake system, and minimizing impacts. These are highlighted below and discussed further in Chapter 7.

- The lakes provide an economic and recreational resource for the region, supporting:
  - Over a thousand private and commercial docks;
  - Thousands of residents along the shore and within a mile of the lakes;
  - Tens of thousands of boats, at docks and marinas, and brought in by car;
  - Hundreds of thousands of boaters and other visitors;
  - Other uses, including festivals and camps;
  - All contributing to and part of the lakes communities and businesses.
- All the uses of the lakes require good water quality, free from harmful chemicals, bacteria or viruses, and HABs. Aquatic vegetation is essential for good water quality and habitat.
- The lakes are affected by the communities and land uses surrounding them, including older and on-going development, conservation and natural areas, and agriculture.
- All users can affect the lakes and reduce impacts by practicing and encouraging stewardship.
- Clear access to properties and destinations within the lakes is important for lake uses.
- Aquatic vegetation, in addition to its value for water quality, habitat, and lake uses, hinders travel and access in certain areas and may be unappealing for residents, businesses, and visitors.
- Aquatic plants can -and should be managed to allow access, passage, activities, but protect habitat and water quality, in ways that are safe for swimmers, property owners, and recreational uses. This may involve establishing maintenance procedures, zones of more intensive use and maintenance, and areas to leave undisturbed.
- It is important that management be implemented with professional expertise, rather than do-it-yourself approaches, to protect water quality for users and wildlife.

Several organizations are directly involved in managing the lakes environment, including:

- Small staffs at ODNR Parks and Watercraft (O&E Canal Lands, Wingfoot and Portage Lakes) are responsible for managing the lakes, park facilities and experience, including:
  - Flood control,
  - Maintaining flow
  - Maintaining navigation channels
  - Maintaining facilities in the parks
  - Deploying buoys
  - Maintaining beaches, fishing accesses, and boat ramps
  - Coordinating and implementing maintenance or improvement projects in the water and on land
  - Providing naturalist services for hikes, nature education, fishing and paddling instruction
  - Assisting at other parks

- Initiatives planned for the Portage Lakes park include:
  - Dredging areas in the lakes
  - Managing aquatic plants
  - Completion of the docks and shoreline management plan for the lakes
- ODNR Division of Wildlife stocks fish, monitors fish populations and some limnological data.
- Summit Metro Parks manages parks on state land on Long Lake and Nimisila Reservoir.
- PLAC is the primary point of contact for residents interested in the lakes, representing the three communities surrounding the lakes and lake matters with residents and visitor, fielding questions, coordinating with ODNR, promoting recreation, environmental protection, safety, and education.
- The level of resources available to ODNR and others (staff, funding, equipment, outreach technical support, materials), should be appropriate to an increased level of management of the lake resources.
- Many other organizations serve as caretakers of the lakes and surrounding lands. Other partner organizations can provide valuable roles within their mandates or mission. Lake management needs to be coordinated, build and include participation among lakers, have a decision-making authority, and have adequate staff, funding, technical support, and other resources to manage a complex ecological and multi-use system.
- Managing the lakes to sustain uses will require land-based and lake-based efforts, and making choices to maintain certain areas for use versus conservation.
- It is important for residents and visiting lakers, communities, and lake managers to build awareness of lake systems, participation, stewardship, and advocacy to encourage others – lakers, communities, agencies - to take steps to protect the lakes.
- The lakers will be carrying out the recommendations of the plan and should contribute to determining priorities.

➢ *Aquatic plants should be managed to provide access and passage, and reduce nuisance growth, in a way that is safe for swimmers and recreational uses and protects water quality and habitat essential for healthy lakes and the community of people using them.*

4. Limnological Characteristics, Productivity and Eutrophication of Portage Lakes

Summary of the Portage Lakes Limnological Conditions

- 86 percent of the lakes area is in the littoral zone – the shallow, productive area with rooted plants and intense human activity. In these areas, uses are affected by aquatic plants, and habitat areas are subject to disturbance from land- and water-based activities.
- The Portage Lakes include shallow reservoirs, and other, deeper lakes. The lakes are all stratified by temperature in the summer, limiting mixing of oxygen-rich surface waters and deeper nutrient-rich, oxygen poor (anoxic) waters. The lakes mix in fall and spring, but the deepest waters may not mix.
- The lakes are considered shallow urban lakes, because their hydrology is managed with dams, they have relatively large development factor (perimeter versus area) and large, developed watersheds. Urban lakes have an increased potential for land-based impact and eutrophication.
- Turbidity, which often reflects algae growth and suspended sediment, increases in the summer.
- The lakes are highly nutrient-enriched and highly productive. They are classified as eutrophic using the Carlson Trophic State Index, based on turbidity, phosphorus, chlorophyll, except for Nimisila Reservoir, which is mesotrophic. This classification is consistent with the volume of plants and nuisance algae and is a result of high nutrient (phosphorus) levels.
- North Reservoir is the most eutrophic and has shown less improvement since the 1990s than other lakes. None of parameters measured in North Reservoir meet the state inland lakes criteria. In 2020, North Reservoir had extensive, nuisance growth (likely Eurasian watermilfoil).
- In the other lakes, some of the turbidity and chlorophyll measurements meet the state criteria, but phosphorus does not and generally has the highest trophic state index of lakes indicators.
- Comparing recent data with records from the 1990s, turbidity has improved in all lakes, chlorophyll has improved in all lakes except North Reservoir. Some phosphorus levels have improved, some are higher.
- Phosphorus is the critical nutrient for photosynthesis, driving plant and algae growth. Recent studies indicate that both phosphorus (P) and nitrogen (N) affect HAB growth and toxicity. P and N enter as ***external*** loading from the watershed. They are recycled with growth and decay for years as ***internal*** loading within the lakes, from decay of organic matter – including aquatic plants. P is also released from sediment in anoxic water. Internal P loading occurs in the deep anoxic water and throughout the lakes at the sediment-water boundary. The volume of plants indicates a great store of nutrients in the lakes and sediment, typical of urban, eutrophic lakes.
- In shallow lakes, like much of the Portage Lakes, phosphorus release in anoxic water at or within the sediment may mix throughout the lakes and continue to generate plant or algae growth during the growing season. Sediment disturbance can release dissolved phosphorus.
- Die-off of early season aquatic plants like the abundant, invasive, curly-leafed pondweed releases phosphorus and spurs new growth. Chemical application may have similar effects.

Lake Management Considerations

Nutrient-rich lakes may switch from a plant-dominated (“clear”) to algae-dominated (“turbid”) state, with frequent HABS. Perturbations to lakes ecosystems (e.g., removing large amounts of plants) may trigger such shifts. The presence of rooted plants in the Portage Lakes is a positive sign that the lakes

ecosystem is still healthy. However, eutrophic lakes with continued high phosphorus levels, as in the Portage Lakes, could become algae-dominated. This undesirable, harmful condition is difficult and expensive to reverse. Climate change impacts favor HABs.

The key to protecting the future of the lakes is to reduce both the external nutrient loading from the watershed and the internal loading within the lakes, involving land-based and in-lake actions. Protecting the lakes requires:

- **Watershed management**, which reduces *external* loading, is a well-developed discipline, with resources available to carry it out, and watershed partners already involved in the task. There is still a substantial need for documentation, external funding for projects, establishing priorities, project management and coordination by partners and, ideally, a coordinator.
- ***Commitment to managing the lakes as a multi-use natural system,*** including adequate staffing, equipment, monitoring, funding, and coordination at higher than current levels. Reducing internal loading is a complex, developing discipline, that involves integrating many elements, including water and sediment chemistry, aquatic plants, other biological components, as well as lake users. Lakes management is not the primary focus of the Parks and Watercraft offices involved with the lakes, who are responsible for managing the water levels and flow, the park facilities and visitor experience, docks, and maintaining navigation. The staff and volunteers are dedicated and do what they can to address lake/plant management concerns around their other responsibilities. However, since it is not a focus of their responsibilities, they lack staff, expertise, time, and resources to add lakes and aquatic plant management to current efforts - to carry it out, coordinate efforts, provide technical expertise and guidance, obtain or analyze data to characterize the lakes***.***
- ***Developing and implementing monitoring program(s) and guidelines based on them***, for limnology, stream characteristics, aquatic plants, and phosphorus cycling in the lakes. Volunteers and ODNR Division of Wildlife staff μμμμμhave collected limnological data occasionally, which provides a snapshot of lake conditions. Consistent, seasonal limnological data for each lake is needed, at different locations throughout the lakes to determine phosphorus loading, patterns, and changes. Monitoring streams will help determine input (e.g., phosphorus or bacteria), and an aquatic plant inventory with occasional monitoring is essential for characterizing the aquatic plant community, manage the aquatic plants and internal loading, and detect changes.
- The ODNR Wingfoot and Portage Lakes have the benefit of a boat, a naturalist, and at least for 2021, a naturalist intern, who could *assist* with monitoring. However, monitoring needs to be consistently done, with dedicated staff, time, and equipment from a partner agency/agencies.
- ODNR is beginning dredging and may contract for control of aquatic vegetation in limited areas with heavy traffic and intense use. This may help in certain areas and should be done in coordination with lake advisers.
- ***Managing plants and internal loading is likely to require a multi-pronged approach.*** Managing aquatic plants may be one tool that can achieve two goals – improving conditions for lake users and residents, as well as reducing internal loading. Any solution should be carefully considered, as manipulating ecosystems may have unintended consequences.

- Control of nuisance vegetation and dredging should be done in such a way as to reduce nutrient loading and harmful effects to the ecosystem as much as possible. Use of chemicals and mowing without removing cut material generates decaying vegetation, which releases phosphorus and fuels growth, dredging stirs up fine sediment, which carries nutrients and increases turbidity, even excessive harvesting may alter the plant-phosphorus balance.
- Harvesting and on-land disposing/composting of plants would remove phosphorus from the lakes but should be evaluated in terms of resources needed and impacts to the plant-phosphorus balance, as well as other impacts (e.g., removing animals living within the stands of vegetation). This is a substantial effort, requiring adequate staffing, funding, disposal/composting sites, background information on phosphorus uptake and impacts, and transportation. It should not be done exclusively, as excessive harvesting could disrupt the ecology and phosphorus-plant balance.
- A more diverse, native plant community would allow plant growth to better span the growing season and could reduce nuisance tangles of certain invasive species.
- Other techniques, such as alum or manipulating biological communities may be appropriate in places but should be carefully evaluated. Aeration can be useful in small isolated deep lakes but is unlikely to be beneficial in the linked shallow lake system of the Portage Lakes.

Recommendations:

Reduce external (watershed) and internal (in-lake) nutrient loading to decrease the risk of further eutrophication. This first requires an in-depth understanding of lake conditions and the biological communities in the lakes, feasible approaches, benefits, impacts, and the resources to implement them.

Safeguarding the lakes, protecting them from further eutrophication, while addressing residents' concerns, requires increased emphasis, a stronger framework for lake management, including:

- Lakes management partnership and a decision-making process to provide for consistent direction, technical expertise, community engagement, a forum for discussion and outreach, coordination of efforts, and sharing resources.
- Coordinator(s) who work with the partners to identify and implement priorities, integrate efforts, provide technical background, seek funding, share resources, build partnership opportunities. Managing the lakes involves both a *land-based approach* to watershed/shoreline management and reducing external loading, as well as *a water-based approach* to coordinate monitoring, data management, aquatic plant/phosphorus loading management, and other in-lake activities. Ideally a single coordinator could address both areas.
- A structure that provides for funding source(s), coordination of responsibilities, a shared understanding and expectations among the Portage Lakes communities of what areas will be managed regularly, opportunities for community input and involvement in lake management, how decisions will be made. Lake management programs in other states operate this way.
- Consistent, seasonal monitoring of lake and stream conditions, an aquatic plant inventory and monitoring, and phosphorus budget to characterize the lakes, identify changes, and determine appropriate measures. Lake management staff need to keep abreast of current research, share information, and use the information to direct lake management efforts.

- Adequate staff, resources to carry out specific lake management measures in partnership with other agencies, partners, and volunteers.
- Increased awareness in the lakes community about the lakes system, needs, responsibilities, and opportunities.

Some of these efforts are underway already. Others that can be started soon include:

- Public outreach programs/workshops/tours/displays/website focusing on topics like lake ecology, plants, minimizing impacts, property management, lakescaping, geese. Potential audiences can include property owners, residents, boaters, anglers, community officials, and other visitors. Various partners can contribute. PLAC and SWCD already do similar work.
- Build a partnership that meets periodically to choose priorities, coordinate, review technical materials, and address concerns of the lakes community.
- Hire a coordinator for the watershed and/or lakes
- Bolster, build on existing monitoring efforts, develop preliminary guidelines, and identify resources and partners for monitoring lake and stream conditions
- Research lake management programs, funding, and in-lake phosphorus management options
- Continue to develop a coordinated aquatic plant management for docks and navigation areas, to manage plants to protect the habitat, water quality, and functions they provide, reduce internal loading of phosphorus, and accommodate the uses of the lakes, addressed further in Chapter 5.
- Along with wastewater management agencies, identify remedies.
- Continue discussions among Department of Health, wastewater treatment Management Agencies concerning the best wastewater treatment practices and feasibility for the area to eliminate nutrients and pathogens associated with discharging or nuisance septic systems.

5. Habitats, Wildlife, and Aquatic Plants

The plants and other photosynthesizers on land and in the water are a crucial part of the land and water habitats of the lake system, providing such important functions as:

- Oxygen
- Shade
- Shelter, nurseries
- Foraging
- Food
- Nutrient flow and cycling
- Stabilizing sediment and soil
- Water quality protection

However, dense aquatic vegetation can impair use and aesthetics in certain areas. Sustaining the lakes as a multi-use resource requires a commitment to actively managing the aquatic plants - and uses - to accommodate priorities of lakers while protecting the benefits that the vegetation provides. The observations and considerations discussed below should help shape the management efforts.

Habitats Observed in the Portage Lakes

Land habitats around the lakes include:

- Natural areas – woods, wetlands, floodplains, and stream channels protected as conservation areas, primarily around Long Lake, Turkeyfoot Lake, Nimisila Reservoir, and Wonder Lake Creek.

- Development – Developed parks, residential areas, businesses, and some farmland – is much of the landscape surrounding the lakes, especially East, West, and North Reservoirs. Tree canopy is sparser in developed landscapes – trees are interspersed with lawn and hard/altered surfaces.
- The shoreline, the important margin between land and water, has been altered and hardened in many places.

A cursory survey of aquatic vegetation during several boat trips and shoreline visits, and conversations with ODNR staff have indicated that:

- Dense aquatic growth occurs along many of the shallow areas, including coves and lake margins. Especially dense growth occurs in Nimisila Reservoir, Miller Lake, the northern and southern ends of Long Lake, and North Reservoir. The latter was choked with plants in summer, 2020.
- ODNR staff who work on the lakes, have noted less vegetation in East and West Reservoirs.
- There are areas of native aquatic plants, including eelgrass, pondweeds, coontail (a floating plant) and chara (a large, branching algae species). Native plant communities tend be diverse and provide high-quality habitat for fisheries. Lakers are noticing greater extent of eel grass.
- Invasive species, which take over and create tangled monocultures, are found throughout the lakes, especially:
  - Curly-leafed pondweed ("spring weeds"), an early-season plant that chokes passages in the spring, dying off by mid-summer.
  - Eurasian watermilfoil, which grows taller than most other species, creating tangled masses. It reproduces by fragmentation, autofragmenting twice each summer.
  - In addition, Brittle naiad was observed in one location. If caught early, it could be eradicated, otherwise, it could become an infestation.
- Filamentous algae is widespread. It is not harmful by itself but can create nuisance mats.
- Small amounts of *Microceiras*, a mat-forming species of cyanobacteria, have been observed.

The observations reflect only what was visible and readily apparent during the boat trips and shoreline visits, which covered portions of the lakes during some of the growing season. Many species could not be determined, due to a lack of access, clear visibility, or expertise. An aquatic plant inventory is necessary to determine the extent and type of aquatic plants, as well as identify changes.

Aquatic Plants and the Lakes Ecosystem

The dense growth of aquatic vegetation is woven into the functioning of the lakes, the nutrient flow and use. The urban, altered, manipulated Portage Lakes are more susceptible to eutrophication from excessive nutrients. High levels of nutrients affect the growth of rooted and floating photosynthesizers and, thus, the water quality. Management measures should include these considerations:

- The dense vegetation is a direct result of high phosphorus levels from external (watershed) and internal loading (recycling during decay and from sediments).
- Rooted aquatic vegetation competes with HABs for phosphorus. During growth, phosphorus used by macrophytes is not available for phytoplankton like algae and the cyanobacteria that cause HABs. When the plants are removed or decay, the phosphorus is available and can be used by algae and cyanobacteria for growth. (Phosphorus stored in sediment can also be

released in anoxic conditions and mixed into the water as sediment is disturbed, available for plant growth or algae/HABs.)

- Early die-off of certain species, widespread use of chemicals, or harvesting without removing cut material, releases phosphorus from decay during the growing season, spurring algae growth for a couple of weeks afterward. These die-off events can also create anoxic zones under the matted vegetation, releasing more phosphorus from the sediment, leading to more growth.
- Highly turbid water shades out plants and favors algae/HABs. Dense algae growth or disturbed sediment increase turbidity. Fine-grained sediment is more easily disturbed than sand. Plants help anchor sediment.
- Perturbations in eutrophic lakes that affect plant growth can trigger a switch from the "clear" state, dominated by rooted vegetation to a "turbid" state, dominated by floating algae and HABs. These conditions shade out rooted vegetation, cause health risks, affect property values, and are difficult and expensive to remedy. Changes that have caused perturbations in other lakes include removal of aquatic plants, drastic drawdowns, populations of "rough" fish like common carp that stir up sediment in the bottom.

An aquatic plant inventory and aquatic plant management (APM) plan are important for managing aquatic plants in multi-use lakes. These can be incorporated into nutrient management as well.

Aquatic Invasive Plants

Aquatic invasive plants often cause the greatest nuisance – tangles of vegetation at the surface, where boats go, along docks, and choking fishing areas. Changing the conditions that favor them may help reduce their number. Several invasive species are already found throughout the lakes. It is important to reduce their initial and further spread in or to other water bodies.

- The invasive plants identified in the lakes favor disturbed sites, high nutrients, and turbid water. Dredging only where necessary, protecting native aquatic plants, and reducing nutrient input may help encourage growth of native species instead of invasive ones.
- Identifying and treating aquatic invasive plants also requires an inventory and monitoring for existing and new invasive species. If such species are detected quickly, they may be eradicated.
- In some cases, lake managers have eradicated invasive species and replace them with native species. This could be difficult in the connected Portage Lakes with high visitation. Impacts could be severe and should be evaluated.
- Boaters should use Clean-Drain-Dry practices to reduce spread of aquatic invasive species to other areas.

The Need to Characterize the Plant Communities

The plant information presented in this chapter is from observations from several boat and shoreline trips. It is not comprehensive in extent or seasonality, and species identification is cursory. There is a need to characterize the plants in the lakes.

- Managing them requires knowing what kind of plants are in the lakes, their location, and extent.
- Because the aquatic plants are such an integral part of the nutrient cycling of the lakes and the habitats, management decisions must consider the effects on those roles, including:
  - Nutrient use
  - Seasonal characteristics
  - Effect on other plants
  - Habitat value

- Potential to fragment
- Sediment type/turbidity
- Resistance to perturbations
- Habitat Value

Ohio EPA's stream/river monitoring program includes biological, chemical and physical characteristics, because of the importance of biota to ecosystem health.

Aquatic plant inventory – systematically documents plant types and density. In states with lake management/APM programs, aquatic inventories are conducted every few years.

Citizen Science/Community Observations – Community observation/citizen scientists can provide information before or after an aquatic plant survey is completed to supplement existing information. This also increases participation.

Citizen Science – there are several programs that train volunteers to collect data on aquatic plants or invasive species. This would likely result in structured, consistent observations at certain locations. Volunteers must be willing to commit the time needed for training and sampling.

Community Observation – Many lakers, certain boaters and fishermen, and agency staff regularly view certain areas and are often keenly aware of the aquatic plants. Community observations, either as a concerted effort or as individual observations, would be less time-consuming and less involved than an inventory or citizen science. The data collection would not be as rigorous, but it could be done throughout the growing season and throughout the lakes. Boaters or other visitors could submit comments and possibly photos on an on-line map maintained by one of the partners. Comments would remain private until reviewed. This could be linked with workshops, a lakes plant guide, boat tour or park activities, public forums like the PLAC website, and other outreach.

Aquatic Plant Management Tools

A variety of tools that can be used to control aquatic vegetation. Each has pros, cons, and effects on the ecosystem. An APM program will likely use various tools in response to different conditions. The methods should be evaluated based on feasibility (location, resources needed/available, cost, acceptability within the community); effectiveness; potential long-term effects – local and lakewide; and ability to modify or reverse the results if needed. The lakes should be monitored to determine effects.

In the Portage Lakes, the ODNR staff are using conceptual management zones as guidance for plant control and are using several tools to address focused concerns, as described below. However, technical support, equipment, and staff for some efforts are limited. A holistic APM program that integrates habitat, phosphorus cycling, plant types, lakers' concerns, feasibility, and available resources, would provide consistent guidance and allow lakers and lake managers to plan for, budget, and carry out aquatic plant management effectively. Some of the most commonly used tools include:

Conservation – One of the most important tools, where feasible, to protect the benefits provided by plants (e.g., habitat, phosphorus cycling, sediment stabilization, food, etc.)

- *ODNR is using the conceptual management zones to focus harvesting on high use areas, letting vegetation remain for habitat and nutrient uptake.*

Chemical – Toxins can be targeted to species, applied near docks. Applicators must have permit for use, because applying toxic chemicals to water can create health risks. Large-scale use may cause vegetation die-offs that release phosphorus or create anoxic zones.

- *In the Portage Lakes, residents contract individually with AquaDoc to treat docks. (Some may be applying their own chemicals.) ODNR will be hiring a plant control company to treat approximately 12 acres of high-use/high visibility areas in the lakes.*

Mechanical

- Manual removal – remove plants, including reproductive parts. This needs professional guidance and is labor intensive.
- Barriers – installed in high use areas, may need to be maintained.
- Harvesting – removes the top two feet of plants, preserving the rest. It is time-consuming and cannot be used in shallow water or too close to shore. Removal of cut material is recommended, because cut material may create nuisance mats or reproduce, and it releases phosphorus with decay. Removal requires dedicated staff, trucks, and a site but benefits the lake by potentially removing many pounds of phosphorus and fragments that could reproduce.
- *ODNR harvests for navigation and water flow. Due to limitations in staff, equipment, composting sites, and transportation, ODNR staff cannot remove the cut material. Most is harvested from Long Lake and North Reservoir.*

Physical – Altering conditions of lake chemistry, water level, or bottom, e.g., alum, dredging, drawdown. Some of these are used for other lake management purposes, e.g., water flow. Widespread use should be done with consideration to broad-scale ecological impacts.

- *ODNR conducts short-term drawdowns of 18 inches during fall every two years. This reduces impacts of large-scale drawdowns on plants during freezing conditions.*
- *ODNR will be conducting limited dredging for navigation for several years, starting in Turkeyfoot Lake. Each lake will require a dredge material recovery site.*
- *ODNR regulates how much water enters or leaves lakes with gates and drains. Residence time affects how long incoming phosphorus is available for growth.*

Biological – Replacing invasive plants with native plants; Introducing pests or species that change the structure of predators and herbivores. This can result in significant changes to the ecosystem and should be done with caution and monitored.

- *ODNR released 300 sterile grass carp into North Reservoir for plant control.*

Land-based – Watershed and shoreline measures to reduce phosphorus and sediment coming in, including: stormwater BMPs; addressing discharging septic systems; discouraging geese; lakescaping; restoring wetlands, floodplains, stream corridors; planting trees and native plants (Chapter 6).

- *In the Portage Lakes watershed, Summit SWCD, and watershed communities use several of these techniques and conduct activities and outreach. SWCD is establishing a watershed coordinator position for the Upper Tuscarawas. PLAC members have expressed interest in lakescaping and goose control. However, many lakers are likely unaware of these measures.*

Cultural – Aquatic plant management can only be accomplished with involvement and understanding by lake users and managers.

Needs of Lake Managers

- Technical information about plant control tools, impacts, and effects that considers the interconnected lakes system, nutrients, and aquatic plants.
- Institutional structure for an APM program with a focus on aquatic plant management and lake management, providing decision-making process, funding, staff, resources, guidelines, expertise, and expectations. This could be composed of elements from various organizations, but it needs to be coordinated and a long-term priority.
- *In the Portage Lakes, the roles of the park manager and most of his small staff focus primarily on the visitor experiences and park facilities. They also coordinate permits, contracts, and projects related to the lakes. The small Canal Lands staff focuses on flood control and maintaining flow; they also conduct harvesting to provide for navigation. There is little time to evaluate limnological aspects of plant control. The Management Plan TAC provides a forum for technical coordination and sharing of resources and should continue in some form. Summit SWCD is establishing a watershed coordinator position for the Upper Tuscarawas. These measures are a good start but should be coordinated and enhanced to increase awareness and participation among lakers and lake managers.*

Needs of Lakers

Outreach and involvement are key, because actively managing lakes, aquatic plants, and uses is a new a new – but necessary – focus in the Portage Lakes. A lake management program will follow guidelines developed to protect the lake ecosystem and lakers' concerns. Involvement of a well-informed community in developing and carrying out the management plan is especially important because of the large and diverse population of lakers, with varied interests.

As the people who use the lakes and will be directly affected by management practices, the lakers need to understand the importance of plants, phosphorus, balancing uses, and minimizing impacts in sustaining healthy lakes. They can contribute knowledge about problem areas and should participate in setting priorities, considering, and carrying out solutions. Lakers can also be important advocates for change.

Efforts should range from raising awareness to building stewardship and advocacy.

- *Raising awareness* - topics include: providing information, about the lakes' habitats and ecosystem, the benefits of aquatic plants, the reason for management zones, appropriate means of managing nuisance aquatic macrophytes, the role of nutrient management, lakers' opportunities to improve water quality, opportunities for stewardship and involvement, and recognizing and reducing the spread of aquatic invasive species.
- *Participation* –stewardship, developing and carrying out priorities, support for new approaches, and increasing advocacy for a dedicated, coordinated aquatic plant management effort.
- *In the Portage Lakes, there are a many disparate efforts and opportunities for increasing awareness, including activities and information offered by ODNR, Summit SWCD, PLAC, and local communities. There has been local interest in goose management, lakescaping, a public forum*

about HABs, and developing informational material for boat tours. The efforts need to be coordinated and targeted to specific lake/plant management topics.

Management

Sustaining multiple uses on urban lakes is complex and challenging. It requires active management of conditions, aquatic plants, and uses. (In contrast, lakes with single uses are simpler to manage, as with public water supplies that severely restrict other uses to protect water quality). This is a new way to think about use and management of the lakes, but it is an approach used successfully in many parks, to allow both use and protection of a natural system. The connected chain of the Portage Lakes in a heavily settled area provides opportunities for supporting the multiple uses but also complicates management.

An APM program would integrate several elements, developed with technical input and community involvement to learn about and set priorities for APM. The public process helps build a shared understanding of the concerns, priorities, and actions. The elements below could be developed as part of an APM plan or individually and used together in coordination with the lake management partners.

Management Structure

Currently APM in the Portage Lakes involves individual decisions by lakers and lake managers. The decisions are often isolated responses to situations, with limited understanding or consideration of the lake system, and limited staff, guidance, or resources. Managing aquatic plants to support both lake ecology and multiple uses requires:

- Commitment to providing adequate staff, resources, and support.
- Technical support in understanding lakes and plant ecology
- Coordination of efforts, sharing information and resources and, through participation, developing a common understanding of priorities, tools, and effects
- Decision making process
- Funding source(s)
- Increased education and participation among lakers, communities, agencies, and lake managers is key to developing and carrying out an APM program.

A comprehensive APM program would allow lakers and lake managers to share expectations, improve decision-making and stewardship. Managers would be able to plan for expenses, staff, resources.

Other states have well-established lake or aquatic plant management programs that involve technical support, guidelines, permitting requirements, funding, or even lake-specific assistance (e.g., harvesting). These would provide good examples of practices that a Portage Lakes partnership could strive for. Ohio does not have such a program. Portage Lakes partners are taking on certain roles and responsibilities, but they will likely need additional support, coordination, a decision process, guidance, and outside funding. These are discussed further in Chapter 7.

APM Plans

APM plans are an important part of managing lakes, providing a framework for management decisions:

- Address areas of use, management, conservation, and invasive species.

- Based on aquatic plant inventories, an understanding of lake ecology, community priorities, management capabilities and resources, and potential impacts.
- Developed with the participation and involvement of lake users and managers to determine the priorities, tools, and management zones. The planning process could develop new management zones or refine preliminary ones.
- Because they specify plant types and amounts, they can be used to track changes and help reduce phosphorus.

Development of management plans requires adequate staffing, time, and technical support to complete the task, which is often done with external assistance.

Management Zones

Designating management zones and appropriate measures, in coordination with lakers, PLAC, agencies, and communities, is a way to accommodate different uses, allow management and conservation measures to be targeted. These can be developed separately or as part of an APM plan. They should involve a good understanding of the type and extent of plants, how that part of the lakes work, stakeholders' priorities, and capabilities and shared/available resources of the lake partners. The conceptual zones suggested in this report are based on limited reconnaissance and input, but could provide a starting point.

Coordinate contracts for APM at docks.

It is important to develop a vegetation control program at the docks to provide for consistent management, build common expectations among property owners that "weeds" will be addressed, and discourage property owners from applying their own chemicals to plants. Currently, the dock fees that residents pay go to the Ohio general fund, and residents manage nuisance vegetation on their own. There needs to be coordinated approach and a way to collect fees for the APM at docks. This will require establishing a fund for APM, staff commitment to focus on handling the contracts and fees, and communication with property owners.

Harvesting Program with Removal of Cut Vegetation

Harvesting with removal, as part of an APM program, could provide important benefits for managing the Portage Lakes (and others), improving conditions in the lakes and for lake users. ODNR Canal Lands staff conduct harvesting, in the Portage Lakes and others, in addition to their primary focus. Lacking staff, time, equipment, and resources, they cannot remove cut material.

Harvesting with removal is a substantial enough effort that it should be a focus rather than an additional task for a staff with other primary tasks. It may be possible to share tasks, responsibilities, resources with other partners. Establishing a program, e.g., within ODNR or another organization, would allow management of harvesting and composting that fulfills the guidelines of an APM program or plan.

- Harvesting with removal requires additional equipment on the lakes (e.g., barge) and on land (trucks), staff on land and on the harvester, and a site for off-loading, drying and composting. The pile of drying vegetation may be unattractive for several days at a time.
- The staff and equipment could be housed within ODNR, contracted out, or shared with other partners. Communities may be able to assist with transportation to compost facilities.

- It may be possible to use dredge material receiving areas to store and dewater harvested material, at least temporarily.
- The harvesting operations would need to be coordinated with the APM program and partners, not only to provide navigation but also to provide for water flow from the Feeder Canal. If there were a coordinated program, ODNR Canal Lands staff could integrate harvesting for water flow with the other harvesting priorities.
- Funding would be needed for a new program. US Coast Guard and ODNR have grant programs for improving navigation, which may be available for sites, equipment, or labor. In addition, projects that remove substantial amounts of phosphorus may be eligible for water quality improvement funding.
- Effects on the lake ecosystem should be monitored.
- An established program could more efficiently serve other lakes, improving the lakes for visitors and residents. The Canal Lands staff would be able to focus on flood and flow management.

APM Recommendations Summary

Sustainably managing aquatic plants and lake uses requires additional commitment on many levels, from individual lake owners through agencies, to be effective:

- A new focus, funding, coordination, decision-making, and some changes to the way the lakes are used and managed.
- Advocacy and creativity in obtaining/sharing resources, and coordination to integrate technical understanding with lakers' priorities and organization capabilities.

Until an APM plan is developed for the Portage Lakes, or as phased parts of its development, ODNR and other Portage Lakes partners can coordinate efforts and evaluate the need, feasibility, resources, impacts, and costs of APM measures. With input from the lakers, communities, and agencies, the partners can identify priorities, management zones and practices, and apply management techniques to some degree. The recommendations discussed in this chapter include:

- **Develop a management structure for APM**
  - Within an organization or as a partnership
  - Consistent, defined roles, purpose, and funding
  - allowing for technical input, coordination, sharing of resources and opportunities, decision-making, and funding.
- **Develop a more thorough understanding of the plant communities -** type, extent, seasonality, and changes in the aquatic plant communities, role within ecosystem, how users and plants affect each other. Tools could include:
  - An aquatic plant inventory
  - Developing a guide to lake plants
  - Citizen science plant surveys
  - Community observation program
- **Seek input and involvement from stakeholders** to identify problem areas and priorities, providing a context of lake ecology
  - PLAC and the Portage Lakes TAC/Partners
  - Public forums

  - Volunteer observation opportunities
- **Develop an APM plan or program**, with input and involvement from lake scientists, residents, users, partners, and communities. Many of the elements can be phased in, which would set up a comprehensive framework for understanding, decision-making, applying plant control measures, and allocating resources.
- **Identify Management Zones, specifying level of management, appropriate tools, cost, equipment, and guidelines** based on observed plants, priorities, involvement and discussion with lakers, community representatives, and agency staff. Preliminary zones, similar to those shown in the chapter, could be based on available observations and input and refined after an aquatic plant inventory is completed.
- **Coordinate contracts for APM at docks**, and establish a funding mechanism.
- **Develop a harvesting program with removal of cut material.** This requires coordination, staff, equipment, and on-land sites for storing/composting material. This effort would probably need outside resources. Grants and sharing resources with partners may help meet the needs.
- **Minimize the spread of invasive species.**
  - Encourage boaters, anglers, and visitors to use Clean Drain Dry practices. The PLAC webpage has information. There could be more posters and videos at marinas.
  - Consider establishing Clean Drain Dry stations. External funding may be available.
  - Monitor for invasive species.
  - Develop rapid response program for new or isolated invasive species.
  - Evaluate a demonstration project to replace invasive plants with native ones.
  - Minimize disturbed sites, protect native plants, dredge only where necessary.
- **Outreach and involvement** targeted to lake/aquatic plant management, with the purpose of raising awareness, stewardship, participation in decision making and plant management, and advocacy. There are a lot of individual efforts under way, and the PLAC, SWCD, and ODNR have programs but there needs to be a coordinated approach. Ideas that have been discussed among partners for early efforts focused on plants include:
  - Information columns in local news media and on the PLAC website.
  - Guidebook or information sheet about aquatic plant types in the lakes.
  - Information sheet for boaters about lake management zones, display at boat ramps/marinas; informative menus for restaurants
  - Workshops and demonstration projects on lakescaping and goose management
  - Public workshops focusing on HABs and the dock/shoreline management plan (postponed due to COVID)
  - Developing a lake management display and suite of information brochures for use at public gatherings.
  - Trivia night at local restaurants.
  - Homeowner's guide to the lakeshore
  - Frequently asked questions, facts of the month on the PLAC website or in other community messaging.
  - Signage describing BMPs or conservation areas
  - Others as discussed in Chapter 7.

Chapter 6 Water Quality and Watersheds

The lakes and streams of the Portage Lakes watershed are affected by the watershed landscape. Development and alteration affect stream function, floodplains, riparian zones, and water quality.

There is a considerable amount of loading of stormwater, nutrients, pathogens, sediment, and other contaminants from the land uses, septic systems, and altered stream channels. Nutrient loading from the watershed begins as external loading but then is recycled within the lakes as internal loading, which can last for years. It is important to reduce both sources of nutrients. BMPs, conservation, restoration, and plantings will help reduce flooding and input of nutrients and other contaminants.

- The lakes are in the upper Tuscarawas River watershed. The Tuscarawas flows into northern Long Lake. The Tuscarawas River and Nimisila Creek are the only water courses that have been monitored in the watershed, and they have minimal to no effect on the Main Chain lakes. Water quality monitoring indicates that attainment of Aquatic Life Use standards ranges from non-attainment to a few sites in full attainment. The two water courses have been affected by flow alteration, habitat alteration, siltation, organic enrichment, pathogens and nutrients, from channelization, suburbanization, and failing septic systems. Nimisila Creek and the Tuscarawas River represent approximately three-fourths of the modeled pollutant loading, but their effect on the Main Chain lakes is minimal to none. The tributaries primarily affecting the Main Chain have not been monitored, but because of landscape similarities, it is likely they exhibit similar impacts from these sources. They need to be monitored to determine what is entering the lakes.
- Lake conditions should be evaluated in light of the watershed characteristics, land cover, and the presence of small lots with septic systems. Intact stream channels, floodplains, vegetated riparian buffers, and wetlands help protect water quality, reduce flooding problems, and improve stream resilience to high flows. The riparian buffer analysis, resource mapping, and review of aerial photographs indicates that some of the stream and river segments appear to be intact, flowing through vegetated buffers, wetlands, and low-lying floodplains. Some of these are within parks and conservation areas. Many areas have been disturbed, which harms stream function and water quality, increasing loading of nutrients, sediment, bacteria, and other contaminants to the lakes.
- The numerous small unsewered lots makes nutrient loading and pathogen input from septic systems extremely likely. Several swim areas are located near unsewered neighborhoods, which should be monitored for bacteria. Some of these neighborhoods are near lakes with dense aquatic vegetation, possibly contributing nutrients to the eutrophic conditions. Discussions among representatives of wastewater management agencies, communities, and health districts that were started during development of this plan should continue concerning the need and feasibility of various wastewater treatment measures. The focus should be on reducing phosphorus loading and pathogens in a way that is acceptable to the MAs and communities.
- The imperviousness (hard surfaces) of the watersheds affect runoff and stream quality. The watersheds generally range between 10 and 20 percent, which is high enough to cause stream degradation. The watershed of Nimisila Reservoir is 8 percent impervious, and of Brewster Creek is 45 percent impervious. Vegetated riparian buffers can reduce stream damage.
- An analysis of potential pollutant loading indicates that urbanized landscapes are a major source of nutrient loading into the lakes, followed by septic systems and agricultural land.

Reducing the external loading coming from the watershed is an important part of protecting lake health.

- There are many practices available to reduce the impacts and protect and improve water quality in the streams, river, and lakes. Protecting and restoring riparian buffers, stream corridors, wetlands and floodplains is an important part of watershed protection. Conservation, protection, and BMPs can and should be widely used by individuals, organizations, and communities. These can be individual activities, like planting deep-rooted vegetation or reducing materials that can enter water, to large-scale stormwater management BMPs and restoration efforts. Small efforts and demonstration projects can be tried and scaled up.
- Public sites, like the State Park and Tudor House, are well-suited for demonstration projects and restoration of stream-side and lakeshore vegetation and other important habitats. Some large private landowners, e.g., churches, golf course, may be open to increasing the use of BMPs.
- An innovative approach to reducing nutrients from the watershed is to harvest and compost aquatic plants. This requires additional staffing and location(s) to off-load harvested materials.
- Where possible, communities and organizations should continue to protect and restore important landscape features, such as wetlands, riparian corridors, floodplains, and streams. The mapping in the chapter of important natural features and the riparian buffer quality could help identify target sites for acquisition or restoration. The Summit County Environmental Viewer is a good online tool for viewing environmental data on an aerial photo base. It also has topography and an elevation profile tool.
- Watershed streams should be monitored, to determine substances are entering the lakes.
- Altering wetlands, streams, and floodplains is regulated by federal, state, and county laws, many of which require undisturbed buffers around resources. Summit County has adopted riparian setbacks. In many cases, parcels either pre-date the regulations or are not covered by them, and streambanks lack vegetated buffers. Landowners should be encouraged to plant deep-rooted plants along streams.
- There are many land use regulations that can encourage practices that protect water quality, such as buffer guidelines and ordinances concerning roof drains. These regulations should be reviewed to encourage “green” practices that reduce runoff and increase vegetated buffers.
- The City of Green has developed NPS-IS documents for certain streams in the Portage Lakes watersheds. These documents, which are required for certain external funding, can be amended to address additional streams in each watershed.
- Many of these efforts rely on and can encourage public stewardship and partnerships. Events like creek clean-ups and planting events (trees or other native species) would build public involvement and understanding, and would improve conditions in the streams feeding the lakes.

Chapter 7 – Recommendations and Management

Sustaining the Portage Lakes as a multi-use resource is a challenge, requiring careful management. A new systematic, collaborative, supported approach is needed to sustain uses and lake health over time.

- The urban eutrophic lakes support dense plant growth and intense use by lakers and visitors. The plants are important to lake health, habitat, water quality, but impede uses.
- Reducing phosphorus, sediment disturbance, and other contaminants from both the watershed and lakes/lakeshore are important for improving water quality. Isolating problems, causes, management measures, and effects is difficult in connected lakes.
- It is essential to characterize and monitor internal and external loading, nutrient cycling, and interactions of lake processes and people.
- Aquatic plant and lakes management should be conducted in a coordinated way that supports uses while protecting water quality and habitat. Sustaining this balance requires careful management, consideration of impacts, and evaluation (and re-evaluation).
- It is important to involve lakers in determining APM priorities and measures, as they are most affected by lake conditions and management.
- The large number of visitors each year increases potential impacts and need to raise awareness of the lakes system and foster stewardship.
- Managing the lakes will require coordination, consistent direction, technical expertise, involvement of lakers, and more resources than are currently available. The partners, representing varied interests, can coordinate and share expertise, insights, and resources to assist with lakes management. However, sustaining the lakes over time will require dedicated funding and staff, and long-term decision mechanism, as well.

Summary of Goals and Recommendations

The overall goal is to manage the Portage Lakes as a sustainable multi-use resource, in a way that protects the natural lakes system in balance with the needs and interests of lake/watershed users, community, and organizations. Five topical goals have been identified, which are linked. Recommendations for each should be carried out in conjunction and coordination with the others.

1. **Water Quality** – **Lakes and Shoreline**. Protect and improve the water quality of the Portage Lakes by reducing factors of eutrophication and other contaminants within the lakes and along the shoreline.
2. **Manage Aquatic Plants** in a way that accommodates property owners and visitors while protecting habitat and water quality.
3. **Water Quality – Watershed**. Improve stream function and reduce loading of sediment, pathogens, stormwater, nutrients from the watershed.
4. **Long-term Management**. Establish a long-term multi-disciplinary management program to provide technical expertise, coordinate efforts, and ensure there are adequate resources to sustain the multi-use, connected, urbanized Portage Lakes resource.
5. **Understanding/Stewardship**. Increase understanding and stewardship by lake/watershed residents, visitors, businesses, and communities.

As shown in Table 1, the recommendations include characterizing the lakes, plants, and streams; developing guidelines for APM and lake management; creating a management structure; establishing an APM program; and raising awareness/stewardship.

Table 1 Summary of Recommendations

Goal	Recommendation	Time Frame (yr.)
Use Improved Knowledge of Lakes to Guide Decisions		
1	Seasonally monitor limnology throughout lakes	1, ongoing
1, 3	Monitor incoming streams for phosphorus, sediment, bacteria	1, ongoing
1, 3	Characterize phosphorus sources in the lakes	2-3
2, 4, 5	Community survey/monitoring of aquatic plants – interactive website with map	1, ongoing
1, 2	Aquatic Plant Inventory	1-3
1,2	Monitor aquatic plants to detect change	periodically
1, 2	Monitor bacteria in streams, at swim areas during summer, after storms if possible	1-2, ongoing
Reduce Nutrients/Sediment, Other Contaminants in Lakes and from Shoreline		
1	Develop phosphorus, sediment reduction guidelines for lake/plant management	1-4
1, 2, 4	Protect rooted aquatic plants where feasible as part of lake management activities	ongoing
1, 2	Develop a harvest and removal program for aquatic plants where feasible	2-4
1, 2, 3, 5	Encourage participation in programs, e.g., Audubon golf course, Clean Marinas, Clean Boater, and LEED certification to reduce contaminants through BMPS/design	1-5, ongoing
1, 5	Workshops/demonstration projects to discourage geese	1-2, ongoing
1, 2, 3, 5	Lakescaping demonstration projects, workshops	1-2, ongoing
Manage Aquatic Plants to accommodate users' needs while protecting water quality and habitat		
1, 2, 4, 5	Hold charrette style public workshops to identify priorities for APM and conservation	1-2
1, 2, 4	Develop comparison of lakes management/APM - benefits, costs, impacts, logistics	1-2
1, 2,4, 5	Develop and carry out coordinated APM program for docks, outreach	1-2, ongoing
1,3	Investigate ways to reduce invasive species, increase native species	3-5
1, 2	Special focus: North Reservoir, Miller Lk, Cottage Grove Lk, Long Lake Feeder	1-4, ongoing
Reduce Contaminants from the Watershed		
1, 3	Work with wastewater management agencies, communities, and Departments of Health to identify appropriate solutions for discharging HSTS, including sewer service	1-2, periodically afterward
1, 3, 5	Demonstration project(s) at park/public site – BMPs, native plants, lakescaping, etc.	2-4, ongoing
1, 3, 4	Identify areas for restoration or protection (stream channels, wetlands, buffers)	2-4
3	Develop NPS-IS documents for areas not already addressed (e.g., Brewster)	2-4
1, 3	Stormwater/stream projects to reduce sediment, phosphorus	1-2, ongoing
1, 3, 4, 5	Review land use measures to make sure they encourage BMPs	2-4
1, 3, 5	Outreach HSTS maintenance	1-2, ongoing
3, 5	Outreach to farmers – cover crops, easements, buffers, etc.	
1, 2, 3, 5	Outreach to become "green" certified e.g., Clean Marinas, Audubon Sanctuary, LEED	2-4
Management – Goals 1, 2, 3, 4, 5		
	Establish partnership to coordinate and share technical information, direction	1
	Establish full- or part-time staff position for lakes management	1-2
	Establish management structure with funding, decision-making mechanism	1-2
Outreach		
1, 3, 5	Signage at BMPs	2-4
1, 2, 3, 5	Articles, brochures about living with the lakes, BMPs, HSTS maintenance	1, ongoing
1, 2, 3, 5	Volunteer opportunities - Clean-ups, planting trees, rain gardens, monitor, etc.	1-2, ongoing
1,2, 5	Guidebook to Portage Lakes Plants and Ecology	1-2
1, 2, 3, 5	Displays, brochures for kiosks, events – aquatic plants, lake ecology, stewardship, etc.	Ongoing
1, 2, 3, 5	BMP outreach – property owners, agricultural	Ongoing
1, 2, 3, 5	Lakes-centered events, kiosks, tours, tour information, other as noted in Goal 5	1-4, ongoing

Goals: 1 – Water quality lakes/shore 2 – Plants 3 – Watershed 4 – Manage 5 - Outreach

Priorities for Getting Started

Tasks to start working on soon include foundational work and items that could generate early success, including:

- Establish a partnership to provide coordination, guidance, share resources
- Establish a management structure with staff, funding, resources, decision-making
- Inventory and monitoring of limnology, streams, aquatic plants
- Work with lakers to identify APM needs, priorities, APM zones and management measures – could include community surveys/submissions of geotagged photos and observations
- Characterize phosphorus sources in the lakes
- Develop coordinated APM at docks, including a fee structure
- Develop guidelines for lake/aquatic plant management measures that allow use of the lakes and minimize phosphorus release and sediment disturbance and protect habitat and ecosystem
- Start the process for developing a harvest and removal program
- Outreach, including goose management, lakescaping, lake ecosystem, aquatic plants, clean-ups