Chapter 5 – Overview
Habitats, Wildlife, and Aquatic Plants

The vegetation of the lakes is a major part of the interlinked system that affects the health of the lakes – and the sustainability of lake uses, providing varied habitats and shade, processing nutrients, and stabilizing sediment. Aquatic vegetation is interwoven with the lake processes, using nutrients for growth and releasing them during decay, affecting growth of algae – and HABs. High levels of phosphorus in the eutrophic water and sediment drive the lush growth along the lake margins – and would grow algae/HABs if not for the plants. Invasive species, which favor eutrophic water and silt, create dense tangles. Sustaining multi-use lakes requires active management of the plants - and uses - as part of a complex system of nutrients, lake processes, plants, landscape, and people, providing for conservation and access. An aquatic plant management program integrates information about plants and the ecosystem, shared priorities, and feasibility of control measures. Increasing awareness and involvement of lakers and lake managers is essential, to build understanding of the complex system, develop shared priorities and carry out management measures. This level of management requires a greater level of coordination, resources, and focus among the lake community and managers. A partnership among communities, lakers, and agencies may help provide coordination, shared resources, and funding.

Chapter Organization

5. Habitats, Wildlife, and Aquatic Plants

As noted in Chapter 4, plants play important roles in the health and habitats of the lakes:

- Primary producers
- Habitat for fish, insects and other macroinvertebrates, birds, amphibians, reptiles, mammals, providing shelter and areas for forage and spawning.
- Nutrient processing and recycling, taking up and storing nutrients from the watershed, water, and sediment during growth, returning nutrients to the sediment and water during decomposition.
- Stabilizing sediment.
- Dampening wave action
- Adding to scenic beauty.

Also as noted, the dense growth of aquatic plants, while important for water quality, can become a nuisance to the people using the lakes. A central question of this plan is

- How can aquatic plants be managed in such a way as to protect the health and habitats of the lakes while accommodating the uses by residents and visitors?

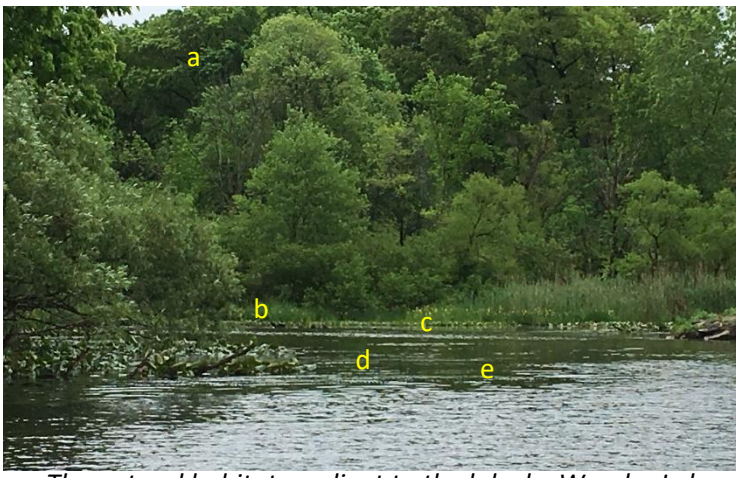
This chapter discusses the role and types of shoreline habitat; wildlife (briefly); aquatic plants and aquatic plant management considerations.

Shoreline Habitat - Background

The portion of the landscape with the greatest effect on water quality and habitat is along the water's edge, whether it is a stream or lake.

Natural Shorelines

Shoreline habitat is important for lake health. In undisturbed lakes, the habitat gradient extends from the upland woods through wetlands and shoreline, and into the littoral zone.



The natural habitat gradient to the lake by Wonder Lake Creek in Knapp Park, proceeding down from a) upland woods to b) wetlands, c) emergent, and d) floating leaved plants. Submerged plants (e) were present but are not visible in the picture

Natural shorelines provide benefits, including:[1]

- Complex habitat, supporting many species;
- Shade and cover for aquatic species;
- Allow animals to move between different types of habitat;
- Slow stormwater runoff;
- Soak up nutrients, filter out sediment; and
- Resilience to wave action, reducing erosion and sediment disturbance.

The Root of the Matter

The deep roots of the native plants do work:

- Slowing water flow from inland
- Allowing rainwater to infiltrate into the ground instead of flowing into the lake
- Taking up nutrients – especially important if nearby septic systems are releasing nutrients
- Reducing erosion – "nature's rebar"

The roots of plants are often proportional to the biomass above the soil. Lawns that are three inches tall are healthier than shorter lawns, because their roots go deeper. Lawns provide a small benefit in taking up nutrients or stormwater. Taller native plants and shrubs are much better, with much deeper roots often extending many feet into the ground, improving lake water quality.

Illustration: The roots of native upland plants, like coneflower, may grow many feet deep to reach water. Lakescaping or vegetated buffers may use upland plants farther from the water and wetland plants, like, blue flag, sedges, or pickerelweed near the water. The roots of wetland plants are not as deep as upland plants but still deeper than turf, intercepting water that would go to the lake.

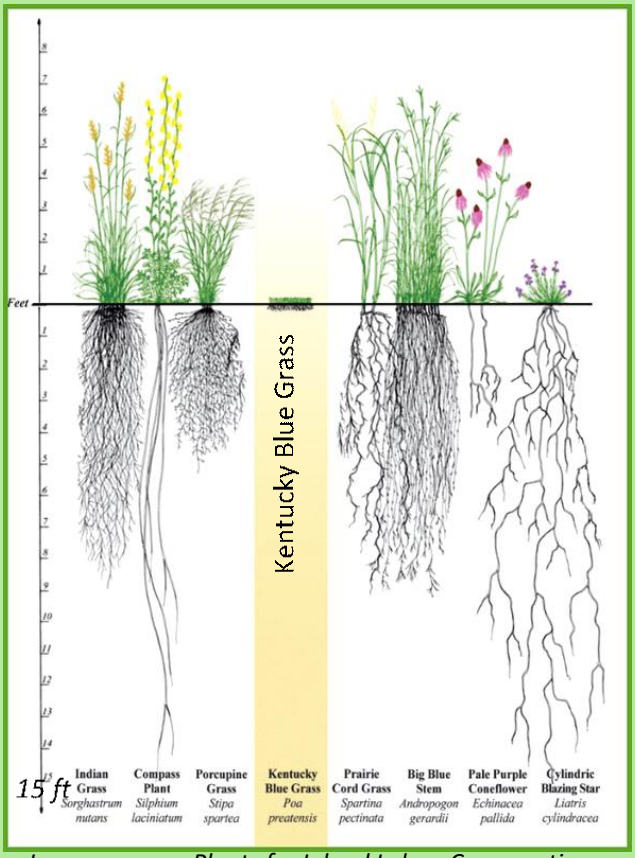


Image source: Plants for Inland Lakes, Conservation Research Institute adapted by Tip of the Mitt Watershed Council, Michigan Natural Shoreline Council.

Hardened Shorelines and Turf

In contrast to natural shorelines, hardened shorelines and turf:

- Allow storm water runoff to flow directly to the lake, carrying in all the contaminants it picks up
- Increases input of nutrients, chemicals from properties
- Reduces habitat, biodiversity, and movement of animals
- Disrupt the lake food web
- Reduces cooling of the water
- May increase erosion, as wave energy reflects back from the wall to the sediment. Turf roots are so shallow that they do little for erosion control.

Geese are attracted to large expanses of turf near the water:

- Geese forage on turf
- Geese avoid tall vegetation.
- Geese favor open sites near the water, where they have clear access to the water.

Naturalizing the Lake Shoreline – Natural Buffers/Lakescaping[2]

People living along the shoreline can improve water quality and habitat with natural buffers and lakescaping. Planting portions of the shoreline with tall native plants, shrubs, and trees instead of turf provides numerous benefits, including:

- Reducing maintenance and chemical use– watering, mowing, fertilizing, pesticide use
- Attracting pollinators and birds
- Reducing stormwater runoff into the lakes
- Improves water quality - especially where deep roots intercept nutrients from septic systems
- Improves erosion control – natural shorelines dampen waves, deep roots hold soil. Using plants to stabilize shorelines costs less than hardened materials.
- Taller vegetation discourages geese!

View of Lakescape One in summer. Stormwater retention area to the right.

Shorelines can be restored and stabilized with vegetation.

Note: It is important to use plants native to the area and appropriate for the lakeshore setting, sun, soil, wind.

Live cribwall, summer 2005.

Right: Michigan lakescaping demonstration projects. Above right example includes a shallow stormwater retention area, reducing runoff. Tall native plants intercept nutrients, provide habitat, reduce lawn maintenance, and discourage geese. Lower right example - a living cribwall is an engineered structure that reinforces the shoreline while still providing water quality benefits, habitat, cooling, and pathways for animals. Images: MI Inland Lake Shorelines, 2012.

Portage Lakes Shoreline and Habitats

Natural Lakeshores and Natural Heritage Sites

Much of the shoreline is natural in the parks. The complex habitat supports many types of animals – birds, fish, amphibians, reptiles, insects, and other invertebrates. The vegetation cools the water and provides cover, food, pathways for movement between habitat types, shoreline stabilization, and water quality benefits.

Top right, Latham Bay in Portage Lakes State Park, Turkeyfoot Lake; above left, Mud Lake near Cottage Grove Cr. Above center and right, Nimisila Reservoir, east side.

Map 5.1 shows important habitat features, including tree canopy percent coverage, wetlands, and Natural Heritage species observations.[3] Wetlands are shown as pale green, tree canopy as more intense green, developed areas as grey or other dark colors.

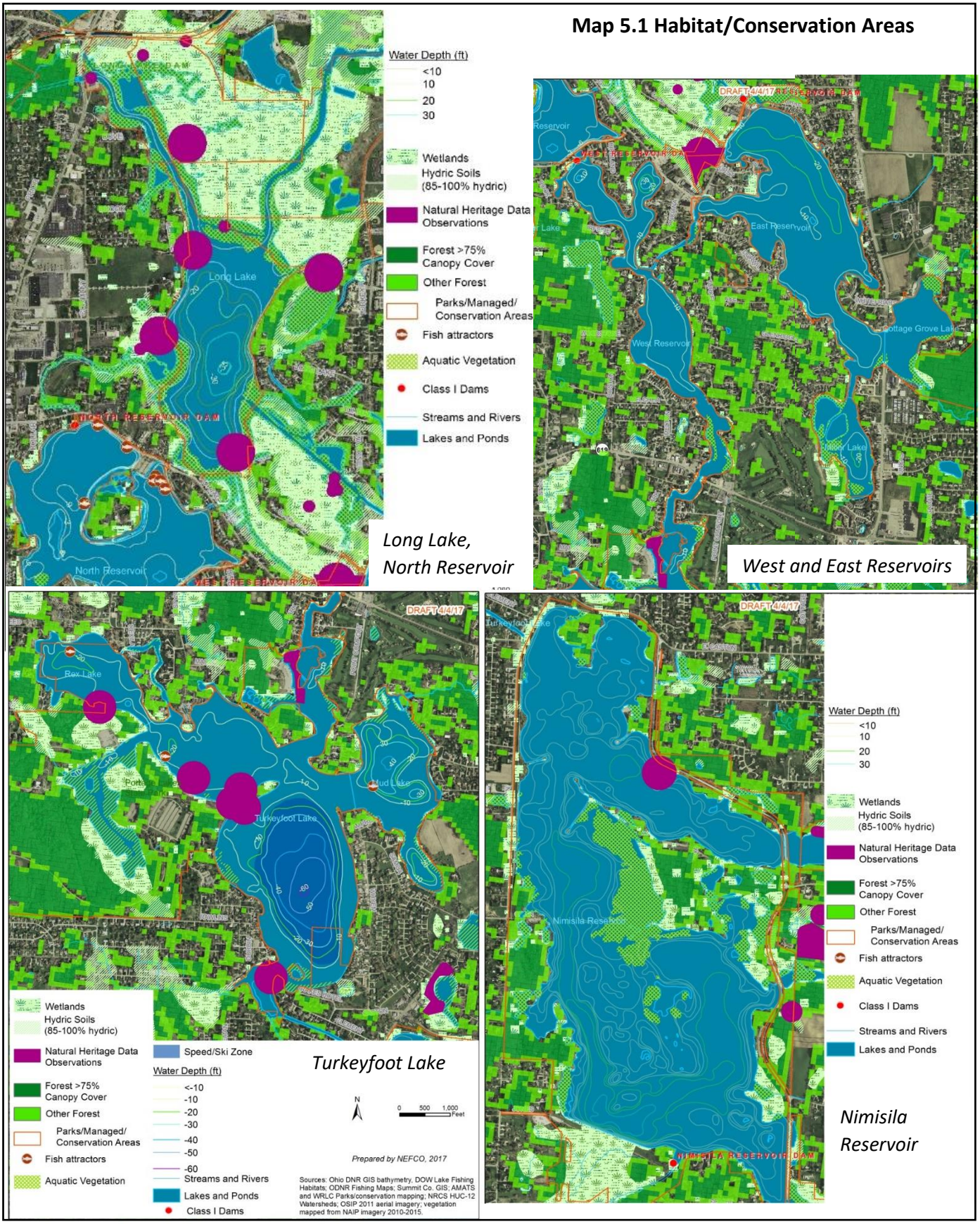
Long Lake, Turkeyfoot Lake, and Nimisila Reservoir have wetlands and 50 natural heritage database sites (Table 5.1), most of which are vascular plants . Much of the natural environment around these lakes, shown here, is protected as parks and conservation lands.

Table 5.1 Natural Heritage Database Sites Portage Lakes

	Terrestrial Community	Vascular Plant	Vertebrate
Long Lake	1	20	5
Turkeyfoot		7	2
Nimisila Res		14	2

Extensive wetlands at Long Lake are owned or managed by the State of Ohio (DNR), Summit Metro Parks or Cleveland Museum of Natural History. Above –Long Lake seen across wetlands at southeast; right – Long Lake wetland from Cove Road boat ramp.

Map 5.1 Habitat/Conservation Areas



Developed Shoreline

Map 5.1 shows that much of the shoreline outside the parks is developed, hardened, and landscaped with turf. Some property owners have retained trees, which provide shade for them and fish, and may shade out aquatic plants. Shrubs provide stormwater benefits, require less mowing watering, and lawn chemicals, and may provide habitat for birds or pollinators.


Above, uses integrated with a natural shoreline. Left, fishing dock at State Park Boat Launch is tucked in the vegetation. Right, natural shoreline along the golf course provides habitat and intercepts nutrient-laden runoff.



Above, some high visibility public lands (e.g., State Park boat launch, left, State Mill Rd. fishing access, center) would be good lakescaping demonstration sites, as at Confluence Park (right)





Various developed shorelines. Trees, shrubs, and tall grasses provide shade for people and wildlife, increase habitat, improve water quality, require less lawn maintenance, and discourage geese.

Where Trees and Shrubs Do Not Belong

Some lakeshores are not appropriate places for trees and shrubs or natural shorelines. The Iron Channel (right) is a maintained channel between East and West Reservoirs.

Tree roots damage earthen berms (Nimisila Reservoir, lower left), and the newly reconstructed dams, with concrete cores, do not support plant life well (lower right).

Fisheries[4]

Sport Fish

The Portage Lakes are known for bass fisheries, supporting a half-dozen fishing tournaments and club events per week during the open water season, with catches of 15-pound limits a frequent occurrence.[5]

The ODNR Division of Wildlife monitors fish populations through its Inland Management System and stocks channel catfish in all the lakes and walleye in Turkeyfoot Lake.[6] (ODNR formerly stocked walleye in Nimisila Reservoir, but stopped, due to low adult recruitment.)

Primary sportfish species in the Portage Lakes include:

- Largemouth Bass
- Bluegill Sunfish
- Redear Sunfish
- Pumpkinseed Sunfish
- Green Sunfish
- Black Crappie
- White Crappie
- Yellow Perch
- Channel Catfish

Non-Sport Fish

- Gizzard Shad is the primary forage (prey) fish species throughout the Portage Lakes. They are a good indicator of overall productivity and may be monitored in the future.
- Other species such as common carp, white sucker, yellow bullhead, warmouth sunfish are in the Portage Lakes but are not notable sportfish species.
- Grass pickerel and possibly chain pickerel, found in low abundance, are not targeted sportfish.
- Other species: of note White Perch have become established throughout the Portage Lakes and densely in North Reservoir. This is an undesired, invasive species, which eats eggs of other fish, competes for food and hybridizes with other fish, and can disrupt the fish community.[7]

Aquatic Vegetation and Fish

Aquatic vegetation supports fish and other wildlife in many ways, including: providing oxygen, substrate for micro-organisms and eggs, habitat for macro-intertebrates, food for herbivores, food sources for carnivores, cover for small prey like juvenile fish, and habitat for foraging fish and other animals. A diverse aquatic community provides the greatest benefit.

Invasive plants, such as Eurasian watermilfoil, often dominate the native plants and create dense tangled monocultures that shade out native plants. Such dense growth may affect fisheries by reducing predation of larger fish on smaller ones, reducing food available for larger fish and resulting in an over-population of smaller fish with inadequate food. In the Portage Lakes, dense stands of aquatic plants like Eurasian watermilfoil does not seem to have affected the sunfish or bass population size structure (with average to above average sizes of sunfish and growth rates). In smaller ponds, such dense growth may favor small fish over large predators, resulting in small sunfish size. However, the Portage Lakes system is likely large enough that the size structure of fish populations is not affected.

Canada Geese

The Portage Lakes provide an ideal situation for geese: open water on which to land surrounded by open greenery (turf) for food. Geese are unwelcome residents for several reasons:

- Goose droppings are unsightly and a source of nutrients and bacteria to the water.
- They can damage lawns, remaining and feeding in in one location during nesting and while raising goslings. This also increases erosion.
- They can be aggressive with people.
- They interfere with traffic on the roads.

Geese are protected under the Migratory Bird Act of 1918. According to the Ohio State Extension, it is illegal to pursue, hunt, wound, kill, or capture migratory birds, nests, or eggs, outside of hunting season or without a permit. Ohio has a special permit for hunting geese. (Check with ODNR Division of Wildlife.) However, hunting is not usually an option in densely settled areas.[8]

There are several strategies for reducing goose problems. The most effective approaches rely on several strategies and persistence. OSU Extension recommendations include:

- *Don't feed the geese.* Human food is not healthy for them. Feeding them encourages them to visit and nest near homes, increasing the potential for encounters with aggressive geese.
- *Barrier fencing. S*tringing taut wire or string along the water prevents access to lawns. Two lines, six and 18 inches from the ground, makes it difficult for the geese to step over or duck under the lines.
- *Use taller plants and shrubs in lakescaping*. Tall plants at the edge of the water interrupts the field of view to the water and discourages geese. The taller plants, especially native plants, provide water

quality benefits, attract pollinators, and require less maintenance once established. Lakescaping can be preserves water views and access. A buffer of 24 inches tall and ten feet wide is recommended. Shrubs that overhang the water also provide shade for fish.

- *Repellants*. OSU Extension notes two types of repellants registered with the US EPA as of 2010. These make grass unpalatable or give geese stomach discomfort (methyl anthranilate, MA, and anthraquinone AQ, respectively). The repellants remain after rain and do not degrade to harmful chemicals, but they diminish with mowing. The entire grass area must be treated, or the geese will move to untreated grass. They are expensive and best used with other strategies. Make sure they are registered with the US EPA.
- *Harassment.* People can legally harass geese. Harassment is effective against geese that are not nesting, tending young, or molting in June-July. This requires persistence and quick response:
    - Chase away the geese quickly before they nest, from February through April.
    - Harass flocks of young geese that are not nesting
    - Herd families off the property, then put up a barrier or repellant.
    - Geese that have eggs or young will not likely move from the property.
    - After chasing the geese off, use a barrier or repellant to prevent them from returning.
    - Dogs are effective at harassing geese. They have more energy and interest in harassing geese than people do. Sunset (roosting time) is a good time for chasing geese.
    - Noisemakers can startle geese when they first arrive, but they may become accustomed to the noisemakers over time. Noisemakers have little effect on nesting geese.
- *Balloons, Mylar Tape, Flags, Scarecrows.* Brightly colored objects that flap in the wind may discourage geese initially, especially highly visible objects with large prominent "eye spots."
- *Predator Decoys.* These may work if they are highly visible and are moved around frequently (e.g. weekly). Coyote decoys can be effective, as they are natural predators of geese and eggs.
- *Remove Domestic Waterfowl.* Domestic waterfowl, which attract geese may be removed.
- *Special Permits.* Goose eggs may be addled (shaken) under permit. Geese will sit on the inert eggs without realizing they will not hatch.

Other Animal Species of Note

Invasive zebra or quagga mussels have been found in the lakes for over a decade. Water transparency has been increasing, possibly due to filtering by the mussels.

Cormorants, once a threatened population due to DDT, are considered a nuisance because of their acidic waste and the damage they cause to vegetation. ODNR is considering measures to reduce their population.[9]

Image Source: ODNR Division of Wildlife.

Purple martins – Residents and parks have installed purple martin boxes. There is a Purple Martin festival each year, and volunteers conduct tours for hundreds of schoolchildren each year to view and learn about the birds.

Aquatic Plants in the Portage Lakes

The aquatic plants of the Portage Lakes are a crucial part of maintaining water quality, lake health, habitat, and fisheries and provide numerous benefits. Rooted aquatic plants have become more widespread recently, according to observations by boaters and ODNR Division of Wildlife staff. The dense growth can be a nuisance to people living on and using the lakes. Accommodating the uses of the lakes while protecting the ecosystem health, maintaining flood control and flow will require management of the aquatic plants.

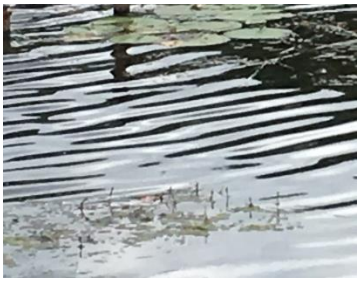
Managing aquatic plants requires knowledge of the types and locations:

- It is necessary to understand their role in the phosphorus budget. In order to be effective, management practices need to be specifically tailored to the species' growth patterns, seasons, reproduction methods, and benefits.
- Changes to aquatic plant communities must be tracked along with limnology, to determine the effect of any management measures or other changes to the system.

Eugene Braig, OSU, describing aquatic plants on a lakes visit.

During this study, NEFCO staff were able to view sites along the shoreline of most lakes by boat or from access points, over several visits. Where possible, staff determined species or species groups (e.g., pondweeds.) Over 1,200 geotagged photographs were mapped. The result gives a general sense of the type and extent of aquatic plants, but it is not an inventory:

- Certain seasonal growth was missed
- Observations were what was visible from the boat or shore.
- Plant species were identified in only some cases. Often, determining species would require more expertise, equipment, or direct access to the plants than available.



Left - "spring weeds." Curly-leafed pondweed grows densely in spring, choking passageways, and then dies back. Two spring boat trips allowed viewing of portions of the spring growth. Right – What kind of plant is it? Often several types grow together, and distinguishing them can be difficult from a distance. However, the summer flower spikes of Eurasian watermilfoil are visible above the water surface.

The extent of aquatic plants was estimated from visual observations and approximate mapping using the geotagged photos. In contrast, aquatic plant inventories sample along transects to determine species type, density, diversity, extent, and gradients.

In this study, certain plant types were grouped together due to difficulty in identifying individual species (e.g., floating-leafed pondweeds, thin-leafed pondweeds, and some similar Naiads.) In some areas, it was only possible to identify presence of aquatic plants, rather than type.

Aquatic Plants – Observations

Map 5.2 and Table 5.2 present the extent and types of aquatic plants observed mostly during the 2017 trips, as well as other visits. (See Appendix F for more maps and images of aquatic plants observed.) For the purposes of discussion, "macrophytes" or "aquatic plants" refers to rooted and floating plants, as well as filamentous algae (often *Cladophora*) and certain macroscopic algae species like chara.

The Portage Lakes produce extensive aquatic macrophyte growth. Cursory observations note aquatic plants in approximately 1,000 acres. The lakes have approximately 1,700 acres of shallow littoral/plant zone of less than 20 feet deep, 1,000 acres in 0-10 feet depth.



Left – Extensive beds of aquatic plants in northern Long Lake, likely Eurasian watermilfoil. Center – Eurasian watermilfoil (flower spikes visible) at docks. Right – eel grass

- Lake boaters and ODNR Division of Wildlife have noted an increase in aquatic plant beds, which are now growing in deeper water. Residents have noted more growth of "eelgrass," which washes up on shore. Deeper growth of aquatic plants may result from zebra or quagga mussels increasing water clari ty or other shifts in the ecosystem.

- There are large stands of native plants, e.g., eelgrass and thin-leafed pondweeds. In many areas, native plants are mixed in with invasive species. Examples include Nimisila Reservoir, the channel between West Reservoir and Turkeyfoot Lake, and portions of Long Lake.

Eel grass, spatterdock, Eurasian watermilfoil.

Invasive or Native?

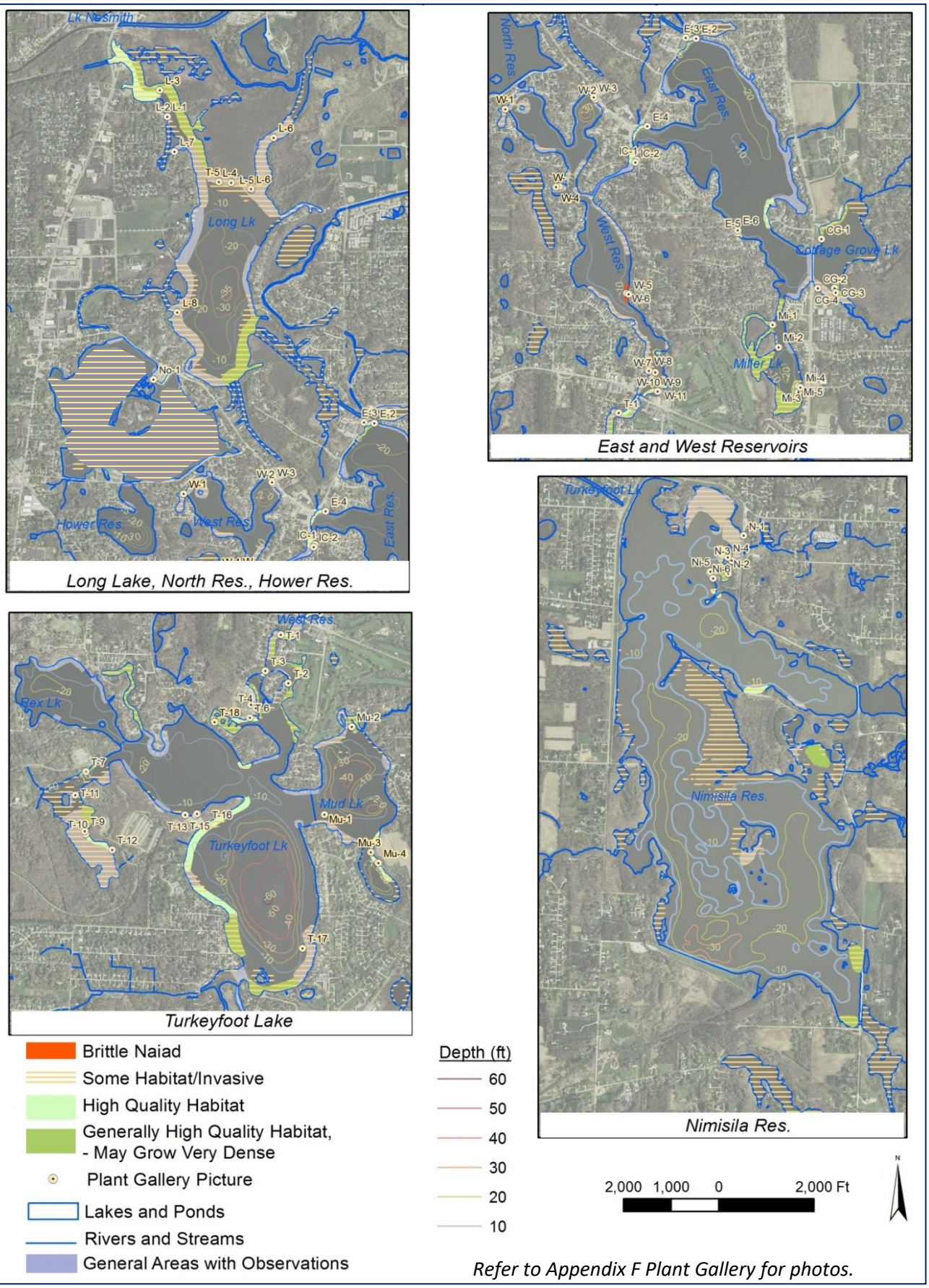
The plant observations distinguish between invasive and native plants. Invasive plants are non-native species that establish their own reproducing population and can spread rapidly, causing harm and overtaking native species. [1] These species cause harm by out-competing the diverse high-quality habitats of native species and creating dense mats that choke passageways and infest docks. They do provide some habitat value, and they use phosphorus while growing. However, they increase phosphorus available in the summer when they fragment or die off. Stagnant water created by dense stands may harbor mosquitoes or parasites that cause swimmer's itch.

These species share characteristics that make them successful in the lakes and a nuisance to lake users:

- They grow tall quickly, creating dense mats that shade out native species and impede travel.
- They tolerate disturbed settings and silt bottoms better than native plants.
- They tolerate low light, deeper, turbid water.
- They grow well in eutrophic waters.

Both native and invasive plants can be considered a nuisance. Invasive plants tend to create dense masses. Some native plants, such as water lily, can grow very densely in shallow water.

Map 5.2 Observed Aquatic Plants - Summary



Refer to Appendix F Plant Gallery for photos.

Table 5.2 Species Observed (See Appendix F for more detailed maps and Plant Photo Gallery)

Plant/Alga	Comments	Plant Gallery Photos*
Invasive/Harmful		
Eurasian watermilfoil	Found extensively along margins, by docks, in coves, Nimisila Res. Reproduces by fragments. Can grow to 30 feet tall.	L 3-8 E 4,5 CG 1-3 Mi3 W 1-4 W8 W10 T1,3,12 Mu1 Ni 1,4
Curly Leaf Pondweed	Found in several locations. Blooms early, dies off, reproduces by fragments. Can grow to 15 feet tall, boaters report some areas nearly impassable in spring.	W9 CG3
Brittle Naiad	Only observed at one location. Reproduces by fragments.	W6
Lyngbya	Small amounts found in Turkeyfoot Lake, pontoon boat pilot has found some. This filamentous cyanobacteria can be toxic, harbors e.coli, and may colonize areas where plants have been eradicated.[10]	No photo
Hydrilla	Highly invasive. NOT OBSERVED. Need to watch for it.	
Native Plants		
Water Lily/ Spatterdock	Extensive beds near golf course, W. Res., Nimisila, Long Lake wetlands. Some near dock areas and wetland/woods habitat.	L1-3 CG4 Mi 2,3 W11 T2-6 T11 Mu2 Ni2
Filamentous Green Algae	Colonizes other plants. Often found with Eurasian watermilfoil. Found in coves, near margin. *Cladophora* may be a nuisance.	L3-6 E1,2,5,6 Mi1,3 T12
Coontail	Not rooted. Found near State Park boat launch ramp, Miller Lk.	Mi5 T8,13
Eelgrass	Extensive stands near state park, s. Turkeyfoot Lake, Cat Swamp. Smaller amounts found in various areas, sometimes mixed with invasives or other species. Anecdotal reports that beds are spreading to deeper water.	E2,3,6 IC2 T3,16
Var. Thin-leafed pondweeds	Found in various locations in Turkeyfoot, Nimisila Res.	No-1 E4 W5 W10 T9,10 Ni6
Floating-leafed pondweeds	Large areas in Nimisila Res.	Ni3, 4, 6
Muskgrass (chara)	Complex branching alga. One stand observed in Mud Lake	Mu4
Duckweed	Tiny floating rooted plant. Observed in still water, and at edges.	L6
Mosquito fern	*Azolla sp.* Floating fern with nitrogen-fixing cyanobacteria. Lives in nutrient-rich water, grows rapidly into mats. Long Lake marsh.	L6
American elodea	Nimisila Res. Similar to highly invasive Hydrilla but with fewer leaflets per whorl.	
Various plants – species unknown		
Mapped from aerial images	Along margins and coves	
Visible on surface	Cat Swamp, Miller Lake, Long Lake, Turkeyfoot Lake, East Reservoir, West Reservoir, North Reservoir	Mi1,2 IC1 W7 T1,2,5,11,12,17,18 Mu3
Emergents – not a focus of the study but some were observed		
Yellow iris	invasive	
Cattails	Most likely narrow-leaved, invasive	
Common Reed	Invasive, by wetland areas	
Var. arrowhead	Native	
Var. rushes, sedges	Native plants –Near woods, marshes, state park	

Plant Gallery photos arranged and labeled by lake: L = Long No = North Res. E = East Res. CG = Cottage Grove Lk Mi= Miller Lk W- = West Res. IC = Iron Channel E&W Res. T= Turkeyfoot Lk Mu = Mud Lk Ni = Nimisila Res.

**Refer to Appendix F Plant Gallery for photos.*


Nimisila Reservoir Left – floating-leafed and thin-leafed pondweeds, right, dense growth in a cove.

- Aquatic plants in Nimisila Reservoir range from large areas of native pondweeds, to dense beds of water lilies, spatterdock, and Eurasian watermilfoil.
- ODNR staff have noted little growth in East and West Reservoirs recently.
- Filamentous green algae is widespread. This is not the cyanobacteria "blue-green" algae. It is not harmful in itself. It anchors to plants and objects. Thick mats of C*ladophora* algae can detach and rise to the surface, buoyed up by oxygen bubbles. They can be a nuisance, may smell bad and harbor bacteria during decay. Nuisance growth of C*ladophora* is an indicator of a nutrient-rich lake.
- Areas with thick growth of macrophytes include:
  - Miller Lake,
  - Portions of Cottage Grove Lake,
  - the cove near the state park boat launch,
  - coves in Nimisila Reservoir,
  - the northern and southern margins of Long Lake and channels into/out of the lake,
  - The channel between West Reservoir and Turkeyfoot Lake.
  - Boaters report such dense "spring weeds" that certain channels are nearly impassible.
  - In August, 2020, North Reservoir and southern Long Lake were covered in dense growth.

"Green" in Miller Lake. Green patches on the surface are often filamentous green algae mats (possibly Cladophora) with rooted aquatic plants, including spatterdock or water lilies in shallow water; pondweeds, eel grass, and Eurasian watermilfoil in deeper water. These areas still provide benefits but may need to be actively managed for access/aesthetics.

- Some of the especially dense plant growth seems to occur in areas where nutrient loads may be higher – e.g., where tributaries enter coves (Cottage Grove, Nimisila), and near the golf course.
- The golf course is surrounded by dense stands of water lily/spatterdock, but these seem to be well contained by the deeper water beyond the golf course area. Some of these densely vegetated areas may impede navigation, but they are mostly outside the main channels and are valuable for habitat and nutrient uptake.

Invasive Plants in Portage Lakes

Four species of invasive aquatic plants/cyanobacteria were *observed* in the Portage Lakes, and others may be present – an aquatic plant inventory would help identify them:


Eurasian watermilfoil. Left, fragment; right, with flower spikes

Eurasian watermilfoil can grow to 30 feet tall. It reproduces by fragments, autofragmenting twice per summer after flowering in June and July. It provides some benefit for habitat and phosphorus uptake, but it is not as efficient as native plants in phosphorus uptake and spreads phosphorus by autofragmenting. It is widespread in the Portage Lakes, growing deeper than other species.

Curly-leafed pondweed

Curly leaf pondweed. It grows to 15 feet tall. It acts as a winter annual, sprouting in fall from dormant turions (buds along the stem dropped in the spring), living under the ice during the winter. It grows and flowers rapidly early in the season before other aquatic plants, then dies off. It is the widespread "spring weeds" in the lakes, choking off passageways. As it dies back in the spring, it releases phosphorus, which can increase productivity.

Brittle Naiad

Brittle Naiad stems reach nine feet tall. It is similar to other naiads. It reproduces by fragments with seeds attached. It is highly aggressive. It is difficult to manage, because it is so brittle. The Brittle Naiad was observed at only one site, a fishing access on West Reservoir. It may be elsewhere, but if the population is confined, it can be eradicated.

Lyngbya (Microceiras) in Lake Erie. Source: Ohio Sea Grant, 2010.

Lyngbya wollei – this species of cyanobacteria was recently renamed to *Microceiras wollei* but retains the common name, Lyngbya. It forms dense blackish mats in sediment, where rooted plants have been eradicated. In large amounts it can smother important benthic organisms, form dense mats that float to the surface, and may generate a toxin that causes a rash, eye, or respiratory irritation on contact, and intestinal problems if contaminated meat is consumed. It grows with high nutrients. It is a nuisance in western Lake Erie. A small amount was found during boat trips to observe aquatic plants, and there are anecdotal reports of sightings.

Are there Other Invasive Plants in the Lakes?

Quite possibly. Boaters and fishermen may transport invasive plants on boats, gear or by water in the boats. These plants may arrive through affected rivers, by birds, or in dumped aquarium water.

Hydrilla in Cleveland MetroParks Lakes Image source: John Navarro.

Watch out for: *Hydrilla* has recently become an invasive species of great concern in Ohio. Found in the Ohio River and several small lakes around Cleveland, it is an extremely aggressive invasive plant that creates dense, choking mats, growing up to an inch per day. It reproduces by tubers and turions, which spread on plant fragments. Lakers should watch for it.

Aquatic Plant Management Practices

There are various types of practices to manage aquatic macrophytes at the scale of individual properties or larger areas, like channels. In a complex system like the Portage Lakes, it is likely that managers will use a combination of different approaches to manage plants (and phosphorus), depending on the circumstances, need, cost, etc.

Inventory and Monitor Before, During, and After

Aquatic plants are a living component of the lake ecosystem, habitat, and nutrient-processing. An aquatic plant inventory, which systematically documents plant types and density, is essential to developing and carrying out appropriate plant control measures:[11]

- Determine the type, amount, and extent of macrophytes being managed,
- Identify areas of native versus invasive species,
- Understand and incorporate the use, availability, and disposition of phosphorus in planning,
- Identify appropriate areas for management practices,
- Identify and implement appropriate management practices, and
- Monitor for changes in the aquatic plants of interest, phosphorus, and overall lake health.

In states with lake management/APM programs, aquatic inventories are conducted every few years. Other tools can be used before a full inventory is conducted, or to supplement information or monitor:

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

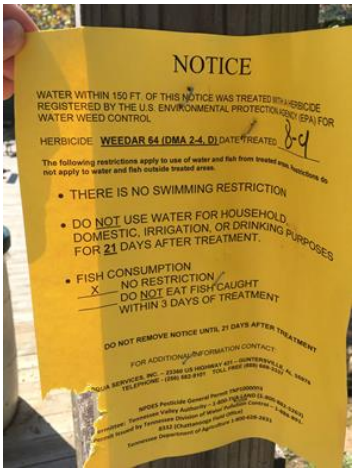
Citizen Science – there are several programs that train volunteers to collect data on aquatic plants or invasive species. For example, the New York CSLAP protocol describes a sampling program with some plant identification that can be done alongside lake scientists by citizen scientists in a localized or widespread area.[12]

Community Observation - Certain lakers, e.g., boaters, ODNR staff, boat tour operators, fishermen, hikers frequently travel or visit the same areas on the lakes and many observe conditions as they travel. Lakeshore residents, visitors, and businesses have an up-close view (and often intense interest) in vegetation. Establishing a plant observer's corps would allow those frequently on or by the lakes to submit observations about plant density, easily identifiable invasive species, other characteristics, and changes. It could include training on some easy, visual species identification. This would provide additional information to supplement existing observations and may help indicate changes over time or priority areas. In New York state, targeted community observation efforts are recommended to help determine the extent of aquatic vegetation for aquatic plant management programs.[13]

Lake managers can begin with certain practices to manage aquatic plants on a limited scale to address localized concerns before a full inventory is conducted. Citizen observations are used in some states to provide basic information on extent of invasives and other plants.[14] However, an inventory is essential early in the process to develop an effective management program that protects the health of the lakes.

This is a Job for Professionals

Do-it-yourself approaches can cause more harm than good unless done with specific direction from professional lake managers:



- A permit is required to use chemicals. The wrong chemical or the wrong application may not address the problem, can harm aquatic species, and could introduce dangerous toxins into the water where people boat and swim, or harm the person using the chemical. It is illegal to discharge chemicals into the water without a permit.
- Mechanical measures as simple as pulling out or harvesting aquatic plants could cause them to spread, if the reproductive part (floating fragment, root, or seed capsule) is left in the water or in the sediment.
- Certain measures can affect the broad ecosystem, such as alum, dredging, widespread chemical use, biological controls, or draw-downs. These should be directed and carried out by professional lake managers, with an understanding of the consequences on various aspects of the ecosystem.

Some of the aquatic plant control requires consideration of lake conditions.

- Aquatic plants have different seasonal patterns of growth, die-off, and reproduction.
- Sediment type and water level management may encourage growth of certain species.
- Aquatic plants are phosphorus processors. Eradicating species or causing large die-offs may disrupt the phosphorus balance enough to cause problems with algal blooms.
- After using a management measure, the effects and impacts should be monitored.

Aquatic Plant Management Measures

Aquatic plant management tools that directly affect the environment may be categorized as chemical, mechanical, physical, or biological. (See Appendix G for a summary of many techniques from University of Wisconsin. The permitted activities may differ from Wisconsin, but many other considerations apply equally in Ohio.) Each technique has pros and cons, and must be used with careful consideration to cost, effectiveness, and duration and reversibility (if necessary) of effects, and ecosystem impacts:

- As with phosphorus management measures, some vegetation control measures are more appropriate in small, confined ponds than in the larger, connected Portage Lakes.
- Large-scale manipulation of aquatic plant communities and their physical, chemical, and biological environment can have significant effects on the nutrients and biological aspects of ecosystem. In some lakes, major “perturbations” shift the ecosystem to algae-dominated.[15]
- Use of these tools must consider and monitor for a range of potential consequences.

Aquatic plant management in the Portage Lakes will likely require use of various tools from the toolbox of available measures, depending on the circumstances.

Conservation ("No management")

Aquatic plants that are not creating a nuisance are helping keep the lakes healthy and free from HABs. There are many locations throughout the lakes where the plants do such an important job of providing habitat, stabilizing sediment, and using nutrients, that they should be left to do their work.

Chemical

- There are a number of chemicals that are used to treat for certain species.
- They may need to be applied multiple times per season.
- Chemical applications require permits and licensed applicators, because of their potential toxic effects on swimmers, wildlife, and beneficial plants.
- The effects of approved chemicals are generally well-understood and can be part of the planning/use, including posting warnings to swimmers.
- Chemical use is one way to promote growth of native species.
- Large die-offs of aquatic plants can release phosphorus during decay, which increases if the dead plant material creates anoxic areas on the sediment.
- Chemical use can be targeted to shallow areas near docks or beaches.

Mechanical means

<u>Raking the "weeds"</u>

One rather basic approach to washed-up aquatic plant fragments is to rake it out, as one would rake leaves, and compost the material. If the plant fragments are from invasive plants, such as Eurasian watermilfoil, it may reduce their spread. This also removes some of the nutrients from the lake.

<u>Harvesting,</u> similar to mowing a lawn, clips off the top several feet. It is useful for clearing passageways. Like any aquatic plant control, over-harvesting could affect the ecosystem. Considerations include:

- Useful in monocultures, e.g., Eurasian watermilfoil – it is not meant to target certain species.
- It cuts off the dense canopy, improving passage and fisheries.
- Harvesting is very time-consuming, as harvesters travel very slowly.
- Multiple cutting is needed per season
  Many harvesters cannot operate at less than two or three feet deep.
- Harvesters require a skilled operator.
- Removing the cut material composting it on land benefits the lake:
  - Cut material may float, creating a nuisance.
  - Decay releases phosphorus, spurring growth. Large amounts of dead plants may create anoxic conditions.
  - Plants that reproduce by fragmentation may spread, although in areas infested with plants like Eurasian watermilfoil, plants auto-fragment and are also cut by propellors.

  This is time- and labor-intensive and requires off-loading sites or barges and composting sites. The large pile of cut vegetation (possibly containing animals) is unattractive but quickly dries.

ODNR Harvester, Long Lake.

Removal of the Plants and Reproductive Parts

- This is labor intensive, as it involves manual removal.
- This requires a good understanding of the plants being targeted, so as to get all reproductive parts of the plants.
- Advantages are it can target individual species, and it can be used in confined or shallow areas.

Physical Measures

Physical measures change the conditions that the plants grow in. There have been some reports of positive results with aquatic plant management, but altering physical characteristics can have widespread, potentially damaging effects on the lake ecosystem and should be used with great caution.

Water drawdown – This is often used in reservoirs to provide for maintenance. Changing the water level favors certain plants over others. It is important that drawdowns be carried out with precautions.

- Drawdowns allow deeper plants to reach the light, but dry up the shallow areas.
- Drawdowns affect sediment composition and nutrient flow from the land.
- Drawdown that extends into the winter may damage desirable plants and favor invasive species.
- Plants that reproduce by seeds may be favored during extended drawdowns.
- Drawdowns of entire lakes may disrupt the system enough to encourage algae growth.

Flow alteration – changing the residence time may reduces the time that phosphorus is in the lake.

Barriers include mats, which are hand-installed.

- These are sometimes used in swimming areas.
- They are labor intensive to install and may require maintenance to stay in one place.

Dredging - is primarily used for removing sediment, rather than controlling aquatic plants. Locally deepening the lake floor below the photic zone may prevent plant growth but not algae. Dredging removes nutrient-rich sediments from algae-dominated lakes. Large-scale dredging would be extremely disruptive to a large vegetated lake complex like the Portage Lakes, disrupting lake morphology and valuable habitat. It should be limited to where it is essential for navigation.

Effects of dredging include increased turbidity and conditions that favor invasive species:

- Disturbing the substrate, removing stabilizing plant roots, and removing more coarse sandy material than suspended silt increases the fine particles in the water, increases turbidity, and may encourage growth of invasive plants like Eurasian watermilfoil or algae over native plants.
- Increased turbidity due to sediment may be harmful to fish and shades out the important rooted aquatic plants, in favor of algae

Alum – is primarily used to coat the sediment layer, bind phosphorus and prevent its release into the water. In addition to altering the nutrients available to plants, it may affect the plant species. One study notes that after alum treatment, the aquatic plant community re-grew as a diverse native assemblage. A tool with potential ecosystem impacts should be carefully evaluated before use.

Dyes – In confined ponds, dyes are sometimes used to reduce light penetration for algae and plants.

Biological Controls

Biological measures involve engineering the species mix to alter the community. Examples include:

- Parasites, which attack the species of interest (e.g., controlling purple loosestrife with beetles.)
- Changing the nature of predator-prey communities to favor zooplankton that feed on algae
- Eradicating "rough fish," like carp, which disturb sediment, releasing phosphorus
- Introducing species that consume unwanted plants
- Killing off invasive species and replacing them with native species.

These measures may not be feasible, and some are not permitted due to potential impacts. Some may be more appropriate in confined ponds than in a system of connected lakes that feeds into two drainage basins. As with other disruptive measures, impacts need to be accounted for and monitored.

Control of Invasive Species

While it is possible to alter plant communities chemically, physically, or biologically, it may be very difficult in a connected set of lakes. Techniques include eradicating the invasive populations and planting native species, and altering the conditions that favor the invasive species (e.g., silty substrate, turbidity). Removal or chemical treatment of invasive species and altering lake conditions need to be done by professionals, with consideration to potential impacts and monitoring.

The best control is avoidance or detection and quick eradication. The lakes are affected by more than one species already. Practicing Clean-Drain-Dry techniques on boats and fishing gear can reduce further spread to or from other water bodies. Boater education is important:

- Inspect boat and gear for plant fragments
- Dry the gear.
- Don't dump the water in a storm drain or lake.
- Dispose unwanted bait in the trash.
- Some lakes have clean-drain-dry stations set up.

A plant inventory and monitoring for invasive species should be conducted. With early detection, invasive plants may be eradicated. If lakers find species that they believe are invasive, they can report it and provide a photograph and the location of where the plant was seen. [16]

Case Example: Casey Lake, MN[17]

The example of Casey Lake (next page) illustrates use of several tools to address water quality and aquatic plant concerns in a small, eutrophic headwaters lake.

Casey Lake, MN

Casey Lake is a 12-acre, eutrophic lake, 2-4 feet deep, in a developed watershed in the headwaters of the Phalen Chain of Lakes. It is adjacent to a major park in North St. Paul and is used for neighborhood recreation. In 2009 the lake had switched to a turbid, algae-dominated state, preventing recreational use due to HABs.

The watershed management district uses BMPs in the watershed. However, studies showed that the lake supported a large population of common carp, which stirred up sediment, releasing phosphorus. In 2012, the lake was drawn down, in accordance with a carp management plan, killing the carp. Sunfish and bass were introduced. The city installed an aeration system to allow the game fish to overwinter.

In 2013, the lake switched to a clear state with abundant vegetation that did not reach the surface, but it became choked with tall plants in 2014. The switch from turbid, algae-dominated to clear with vegetation is typical, the preferable choice between the two possible equilibrium states, but the dense vegetation impaired recreation.

Lake managers use harvesting instead of chemicals for plant management, to avoid creating anoxic conditions with die-off. Over two summers, their contractor removed 57 and 75 wetted tons of material for composting, (photos 2 and 3), removing 36 and 47 pounds of phosphorus, respectively. Composting the harvested material cost less per pound of phosphorus than stormwater treatment installations (an average of $230 per pound of phosphorus for composting harvested plants versus thousands of dollars per pound by using stormwater BMPs).

1) Above, vegetation before harvesting *2) Above, harvester at work*
3) Below, lake cleared of vegetation *4) Below right, 30-foot pile of harvested material was composted.*

The case example raises some considerations:

- This is an intensely managed, small headwaters lake. While a balanced, healthy ecosystem is important, a major priority is the need for an attractive recreational water body. The partners have been using a variety of techniques to reduce external and internal phosphorus loading, including stormwater BMPs, drawdown and changing the fish populations, and harvesting.
- Because the lake is small and at the headwaters, total drawdown was a feasible method to control nuisance fish populations.
- Removing the fish switched the equilibrium from turbid, algae-dominated to clear, vegetation dominated, one of the two possible equilibrium states for eutrophic lakes. In spite of the dense vegetation, it is still preferable to algae-dominated. (Vegetation can be cleared. HABs cannot.)

- Harvesting vegetation and composting it removes phosphorus from the lake system. Leaving it in place would leave about 40 pounds of phosphorus in the lakes, enough to fuel tons of growth.
- A 12-acre lake generated over 50 tons of cut vegetation, creating a 30-foot tall pile.
- This effort involved several partners (watershed district, city, MN DNR, University of Minnesota) and a contracted harvester. The partners provided technical guidance, funding, labor, fish, and a composting site, and conducted studies and monitoring.
- It would be interesting to follow up on the subsequent changes to the lake. Has harvesting been continued? Did the carp return? Did the lake retain its new clear equilibrium, or did it revert to a turbid state? Were there downstream effects?

The "Cultural" (Human) Part of Aquatic Plant Management – Lakers, Communities, Caretakers

Involving the people who live with, use, and manage the lakes is just as necessary – and part of – choosing and applying the right tools to manage aquatic plants.[18] The actions, impacts, expectations, priorities, of the lakes community members and partners affect the lakes through:

- Use of the lakes and landscape
- Impacts
- Minimizing impacts and protecting the lakes
- Supporting and participating in measures to balance use and protection,
- Paraticipating in decision making about management
- Educating and encouraging others to help with the above
- Persuading others to enact changes at all levels.

Developing an aquatic management program to balance use and protection is likely to require lake users, their communities, and agencies to:

- Establish priorities,
- Make choices,
- Establish and support programs with funding, staff, resources, technical support, guidelines,
- Increase resources, information sharing, and coordination,
- Change how or where some activities should occur, and
- Change expectations about how and where plants are managed and how people use and take care of the lakes.

In other states, lake management and aquatic plant management is a well-developed practice that involves lake users and residents, lake associations, and government agencies.[19] As a collaborative effort, the participants have developed a shared understanding about the needs, tools, balance of priorities, acceptable practices, expectations, limitations, funding, and administration. Establishing a management program in the Portage Lakes could benefit from successful models elsewhere.

Current Aquatic Plant Management – Portage Lakes

Currently, there is not a coordinated approach to aquatic plant management. ODNR and property owners are addressing individual areas perceived as problems as they can.

Chemical Application

Individual property owners contract with Aqua Doc, the only licensed applicator, to chemically treat local areas, usually within 30 feet of the property. There are discounts for group contracts, which encourages treatment of larger areas. Typical treatment is three times per growing season.

There are anecdotal reports that some property owners apply bargain chemicals that they purchase off the internet. This is dangerous. The pesticides may contain unknown toxins that could affect wildlife and people. The chemicals and application also may not be appropriate for the targeted plants.

In 2021, ODNR was authorized to contract for chemical application over approximately 12 acres in heavy use and high visibility areas (e.g., beach, boat ramps, channels).

Harvesting

ODNR Canal Lands staff conducting harvesting periodically on the Portage Lakes to maintain flow in the Long Lakes Feeder to the Canal, and to provide clear passage for navigation. Harvesting is time-intensive. The harvester travels at 2-3 miles per hour, and can harvest up to four tons of wetted material per load. In 2020, 140 loads, primarily from Long Lake and North Reservoir. Due to limitations in staff, time, equipment, and sites on land, the cut vegetation is not removed. Even though harvesting is not their primary responsibility, the small Canal Lands staff, are also requested to harvest on Mosquito Lake. Composting the harvested material would benefit the lakes by removing phosphorus and reproductive fragments of invasive species, but would require sites, equipment, dedicated harvester operators, trucks, and drivers.

Dredging

In 2021, ODNR is beginning a dredging program to remove sediment from channels in limited areas throughout the lakes. Dredging will temporarily stir up nutrients, but will also remove nutrient-rich sediment and affect plant communities by removing plants and locally deepening the water. The effort will take 5-7 years. Dredging will begin in Turkeyfoot Lake, which has a dedicated dredge material area across from the dog park in the State Park. A dredge material site must be established in each lake where dredging will occur. Some of these may be on private lands by arrangement.

Drawdown and Water Flow

ODNR draws down the lakes by 18 inches every two years for two months in autumn, exposing several feet of otherwise submerged land. Desiccation and freezing temperatures affect sediment, nutrient transfer, and may favor the return of certain species over others. ODNR's practice of limited drawdown minimizes many of the potential impacts. The effect of water management practices on various species of vegetation should be further explored.

Residence time affects eutrophication and phosphorus loading. Longer residence time means phosphorus stays in a lake longer, fueling growth. Water flow in the lakes is regulated at several locations. The feasibility of altering residence time in certain lakes could be evaluated.

Biological Controls

In response to the dense vegetation on North Reservoir, 300 triploid (sterile) grass carp were introduced. These feed voraciously on vegetation. Populations may live for decades. It will be important to monitor the lake condition over time. It is unclear whether these will have an effect downstream.

Shoreline/Land-Based Management

The ODNR is finalizing a dock and shoreline management plan that will address dock management and specifications, shoreline modifications, and aquatic plants.

The watershed management efforts focus primarily on reducing runoff, stream restoration, and addressing septic system concerns. Summit SWCD is establishing an Upper Tuscarawas watershed coordinator, will be monitoring streams, conducting outreach, including goose management and lakescaping. and monitoring streams.

"Cultural" Measures – Outreach, Involvement, Coordination

The "cultural" measures specifically focused on aquatic plant management are limited. Other related outreach and coordination efforts are scattered among many organizations but could provide a good basis and opportunities for education, outreach, involvement, and coordination focusing on aquatic plant management:

Source: Summit SWCD

- PLAC, Ohio EPA, ODNR Parks, Summit SWCD, Summit Metro Parks, regional agencies, communities, volunteers, businesses, and local organizations conduct many activities that increase awareness and stewardship. These partners can share resources and expertise.
- Coordination occurs through the PLAC and the management plan TAC, and informally, but there is no central decision-making entity or process, little staff, no dedicated technical support or guidance, and limited funds.

Putting Aquatic Plant Management Tools to Work in the Portage Lakes: Discussion

Aquatic macrophytes provide so much benefit that they should be retained, protected where feasible. However, there are locations where dense growth impedes travel and creates a nuisance for property owners and lake users.

Aquatic Plant Management Plans

In other states, aquatic plant management (APM) and lake management plans are regularly done as part of living with and protecting lakes.[20] Developing an APM plan would provide a cohesive, coordinated framework for applying tools, considering:

- Type and extent of plants,
- Goals and uses,
- Preferences of residents and visitors,
- Potential ecosystem impacts,
- Feasibility, and
- Capabilities and resources of the lake managers.

These technically-based documents have input and involvement from the lake community and agencies:

- Identifying priorities,
- Designating management zones and
- Identifying and carrying out appropriate management techniques.

Conducting an aquatic plant inventory is one of the necessary first steps.

The process of developing such plans helps to build a shared understanding and expectations among the community members and lake managers:

- Community members better understand the reasons and methods for aquatic plant management, their role in the process, the need for funding or actions.
- Lakers participate in setting priorities, help carry out the plan, knowing their needs will be met.
- Lake managers get a well-considered framework that provides guidance on decisions and impacts, and allows them to plan for projects, staffing funding, resources, and track changes.

This section is not an APM plan. There is not enough information about the types, extent, and roles of plants in the lake ecosystem to incorporate on in this plan. Nor has there been the necessary community and agency discussions to determine priorities throughout the lakes and determine willingness and ability among community members and agencies to run such a program (e.g., funding, staffing, management areas, coordination, decision making).

This section raises considerations of managing aquatic plants and offers suggestions for an approach. Lake managers will be managing plants before developing an APM plan. They can build these elements separately from or prior to developing an APM plan and use them to frame APM decisions; some already have. To protect the health of the lakes and meet the needs of lakers and communities, the APM effort needs to be comprehensive, sustainable and effective. There needs to be an institutional and community structure, funding, decision-making, technical background, coordination, and community involvement. An APM plan documents that structure, providing a guidebook for managers.

Aquatic Plant Management Decision-Making

Managing aquatic plants in a balanced way means deciding:

- Which areas to protect,
- Which areas to maintain access
- The appropriate tools to use, based on feasibility, cost, effectiveness, and ecosystem health.
- Who should pay for, coordinate, and carry them out.

In selecting a tool or tools, managers should consider:

- *Need/purpose* - Is there a need to actively manage vegetation? How much of a need? How much needs to be managed – enough for passage or clearing a broader area? Can conservation co-exist with passage and nuisance reduction?
- *What kind of plants are being managed?* Invasive/native? What do they indicate about lake conditions? What is their role in the ecosystem?
- *Feasibility, logistics* What is the feasibility for the size, configuration, location within the connected lakes? What resources, staffing, partners are needed/available? Are the logistics acceptable (e.g., dredging , temporary use restrictions)? What is the cost and funding?
- *What are the long-term impacts?* How do they affect the phosphorus budget, turbidity, lake ecosystem? Can the tool be phased in, used in a localized way, reversed or altered if needed?

This discussion should involve technical expertise, an understanding of the plant communities, and input from the lakers, communities, and agencies. It is important to monitor the effects during/after use.

The following examples illustrate considerations that would go into APM decisions in the Portage Lakes.

Case Examples: Portage Lakes

North Reservoir - In summer, 2021, North Reservoir became choked with aquatic vegetation. ODNR staff cut it but could not remove it due to limitations of staff and land disposal options.

Lake Characteristics:

- 141 acres, mean depth 4.5 feet; deepest 9 feet, larger and deeper than the Casey Lake example.
- Midway in the connected chain, which drains to the Tuscarawas River and the Lake Erie basin.
- The most eutrophic of the Portage Lakes. Future dense growth is likely.
- Residential shoreline with state park boat ramp and fishing accesses, and two parking lots.
- Water inflow is regulated by a gate on West Reservoir; outflow is over a spillway into Long Lake.

Consideration of Tools:

- Access to docks and fishing is likely not enough. The entire lake is covered, impairing recreation and aesthetics. Perhaps some vegetation can remain for habitat and phosphorus removal.
- Phosphorus management is very important in this shallow, eutrophic lake. Tools include plants, alum, dredging, altering residence time, changing plant species, shoreline/watershed practices.
- Widespread dredging, chemical use, or alum could be expensive and may affect the lake ecosystem. Chemical use and harvesting without composting may spur more growth as phosphorus is released during decay and from anoxic areas under the decaying plants.
- This lake is compact enough that If there were a site and equipment/staffing to remove the cut material, a combination of harvesting and composting might be feasible, in deep enough water. Transporting heavy, wet material requires many trips. Drying a large pile of plant material (possibly with fish in it) would likely take several days but would reduce trips on land.
- Any measure taken, especially on a large scale, needs to be monitored.

Long Lake

Long Lake has several management settings, with residential and conservation areas, and Long Lakes Feeder, in the northwest, which outlets to the Tuscarawas River and O&E Canal. Flow maintenance in the feeder is important for flood control at the dam and for diverting flow to the Lake Erie basin via the Canal. The feeder is by a wetland complex and becomes choked with vegetation. ODNR harvests vegetation in the Feeder but, due to staffing and infrastructure limitations, cannot remove it.



Left, vegetation by wetlands, where Tuscarawas enters (cleared zone); center, dense vegetation at southern end of Feeder, looking southeast toward the open lake; right, vegetation by residences.

Lake Characteristics

- 192 acres, mean depth 10 feet, deepest, 35 feet; extensive shallow areas and vegetation at the northern and southern ends.
- It is downstream of all the lakes, it also receives water from the Tuscarawas (northwest end).
- Shoreline - residential, fishing/boating accesses (northern and southern ends), wetlands/conservation lands, parks.
- Long Lake Feeder – Half-mile long by 300 feet wide, two parking lots provide boating and fishing access. ODNR launches and stores the harvester at a public access in the Feeder.

Consideration of Tools

ODNR maintains passageways at the ends by harvesting, leaves large areas undisturbed. This allows recreation, navigation, and flow, and reduces fragmentation of Eurasian watermilfoil by boaters.

It is difficult to offload cut vegetation onto the land, due to the expanse of the lake, the length of the Feeder, the amount of privately owned shoreline, density of vegetation, and speed of the harvester. Cut fragments of Eurasian watermilfoil drift and pile up. Composting material would remove phosphorus and floating vegetation, and would require staff, a barge, trucks and drivers, and composting sites.

At the residential docks, coordinating contracting for aquatic plant control at residential docks, while maintaining channels for navigation is probably ideal. This would limit disturbance, provide consistent management, while allowing navigation and assuring residents that the “weeds” will be taken care of. In addition, to the requirements of composting noted above, there would need to be an administrative structure for collecting fees and contracting with the aquatic plant control company. Outreach and signage at the boat access points would help alert boaters to conservation areas.

Conceptual Aquatic Plant Management Zones

Managing aquatic plants in the lakes is not a one-size-fits-all approach, especially on a multi-use chain of lakes. APM plans developed for lake management in other states designate management zones based on local priorities and the aquatic plant inventory. These allow uses to be accommodated while protecting the lakes, providing a common expectation of what will be managed and how.

The Portage Lakes Management Plan recommends designating such APM zones, with recommended practices, for the Portage Lakes. Some zones would be maintained for access and use, others would be set aside for protection with less aquatic plant control.

Developing a full APM plan requires an aquatic plant inventory to characterize the type of plants, their location, volume, and areas of conflict with use. This is an important element. However, even without this information, the Portage Lakes Management Plan offers conceptual recommendations for aquatic plant management zones, with input from the lakers and lake management partners, based on:

- Observations of Portage Lakes aquatic macrophytes,
- Importance for habitat and other benefits,
- Uses, need for access and clear zones, and
- Feasibility of likely tools.

Conceptual aquatic plant management zones have been identified in discussions with the plan's TAC, based on observations of aquatic plants and discussions about use/problem areas. (See Maps 5.3-5.6 after the zone descriptions). ODNR has begun using this to help direct harvesting. The zones will likely evolve with further discussion and public involvement, and as more information is available about plant communities, need for access, feasibility, effectiveness, and impacts.

Habitat Zone –Plants providing high quality habitat, areas used for fishing, and areas where plants have the most value for taking up phosphorus. Many of the areas with invasive plants should be maintained as is, if they are not impeding access, because of the water quality and habitat benefits they provide.

Residential/ Business Dock Zone – Licensed contractors could control plants in these zones as necessary/ desirable to maintain access and aesthetics for residences and businesses. Harvesting is not likely to be feasible in these areas, because of water depth and proximity to the shore and docks. Some of these areas also have native plants, requiring careful management. If dense growth farther from the docks impedes navigation or is a nuisance, channels could possibly be maintained to a band of open water near the shore, connecting to more open areas but still preserving some plants intact.

- Docks or nearshore areas could be appropriate for hand harvesting *if done correctly for the species,* removing all reproductive parts (fragments, roots, seed capsules) to avoid spread.
- Chemical treatments*, if done correctly by licensed applicators with state permits*, can be used to target certain species. Individual homeowners should not purchase and apply chemicals on their own: the chemicals can be toxic to humans and wildlife; they may target the wrong plants or apply the wrong amounts; and the chemicals may interact with each other between properties. Currently,

property owners contract with AquaDoc for aquatic plant control. A coordinated approach is more efficient, identifying and treating plants consistently across a wide area.

- Ideally, tall vegetation could be planted on the shoreline. In addition to other benefits, canopy shades the water and may deter aquatic growth.
- Currently, property owners hire contractors. Centralizing the process should be considered for consistency of treatment and expectations.

Marina Management Zone – These zones would need to be maintained for access. Some of these areas are in deeper water. As with residential management zone, chemicals may be the best way to target certain species close to the boat slips. In deeper water, it may be possible/advisable to use a harvester. Management should extend only as far as necessary to maintain access.

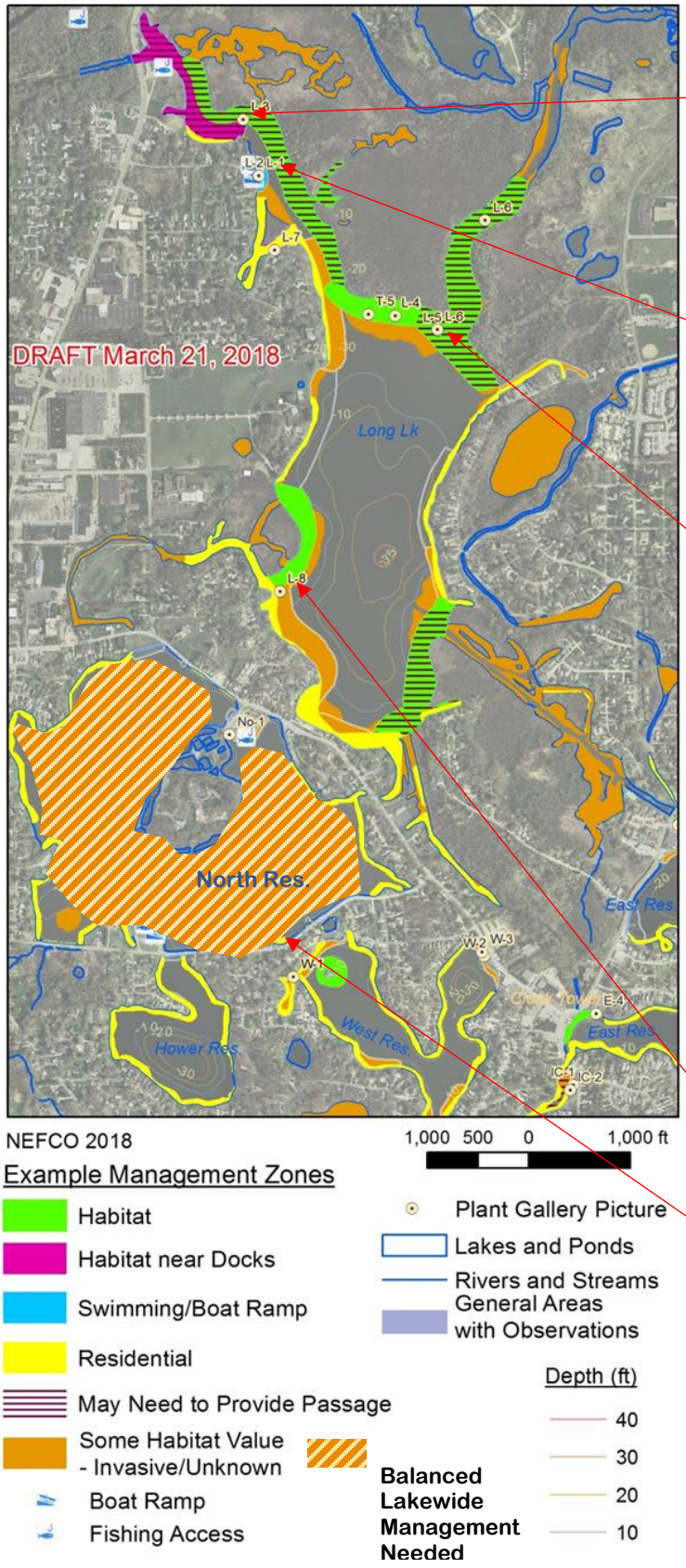
Passage Zone – Some areas with dense plant growth are important for access within the lakes. Invasive species like curly leaf pondweed and Eurasian watermilfoil, which impede access, may spread when boat propellers cut them. These areas could be appropriate for large-scale harvesting - with removal of cut material - to maintain access wide enough for residential passage, fishing, or general travel between the lakes. Passage may need to be provided offshore of docks in areas with dense growth.

Swimming Areas/Boat Launch Ramp Zone – The goal in these zones is to maintain clear lake access and remove vegetation that might entangle and discourage swimmers. Control methods could include appropriate, licensed, chemical use and possibly harvesting with removal farther from shore.

Cove Zone -*T*hese shallow areas often have dense plant growth. These areas should be protected to the extent feasible, especially if the plants are taking up nutrients from sources such as incoming streams, the golf course, or agricultural areas.

Lakewide Management –A holistic approach to APM is needed, in North Reservoir that reduces the nuisance and considers phosphorus loading and use by plants. The lake is semi-isolated within lakes. It may be suitable for lake-scale approaches, if perturbations to the phosphorus budget and ecosystem are controlled. An alternative approach would be to chemically treat residential areas and harvest and remove material from a wide, perhaps irregular buffer along the shoreline where residences and access points are. This would provide open water but retain some undisturbed areas. The harvester cannot operate in less than three feet of water, so certain areas of the lake may be inaccessible by harvester. Caution should be used in widespread use of chemicals or harvesting without removal. Cut plant fragments may float for a while, impairing travel and aesthetics, releasing phosphorus during decay, and creating anoxic zones on the lake floor. This would fuel more growth and exacerbate the problem.

Map 5.3 Example Aquatic Plant Management Zones
Long Lake, North Reservoir, Hower Reservoir



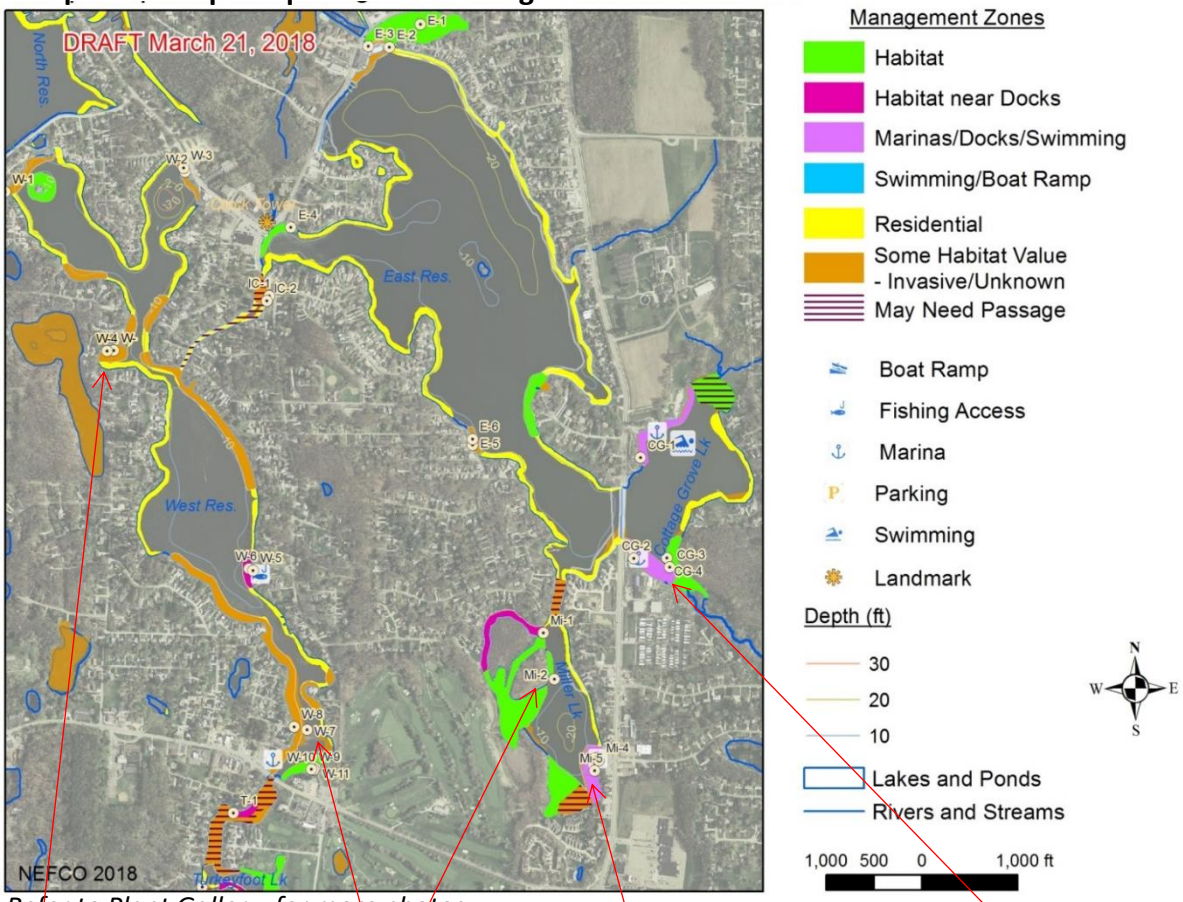
L1, L3 Spatterdock, etc. both sides of passage, Eurasian watermilfoil clogs the passage in summer

L5 Eurasian watermilfoil and other species by marsh. Note passage that has been cut.

L8 E. watermilfoil from houses to foreground.

No 2 North Reservoir choked with vegetation, summer, 2020.

Map 5.4 Example Aquatic Plant Management Zones – East and West Reservoirs



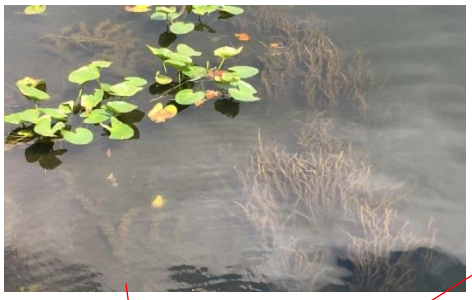
Refer to Plant Gallery, for more photos.

Top row:Mi-4 spatterdock, etc. by golf course; Mi-5 dense growth Miller Lake looking SW (similar to dense growth by marinas in Cottage Grove Lake); CG-4 C.G. Lake cove

Bottom Row W-7 – spatterdock, other growth by houses, dock, with fishermen; W-4 Eurasian watermilfoil by residence

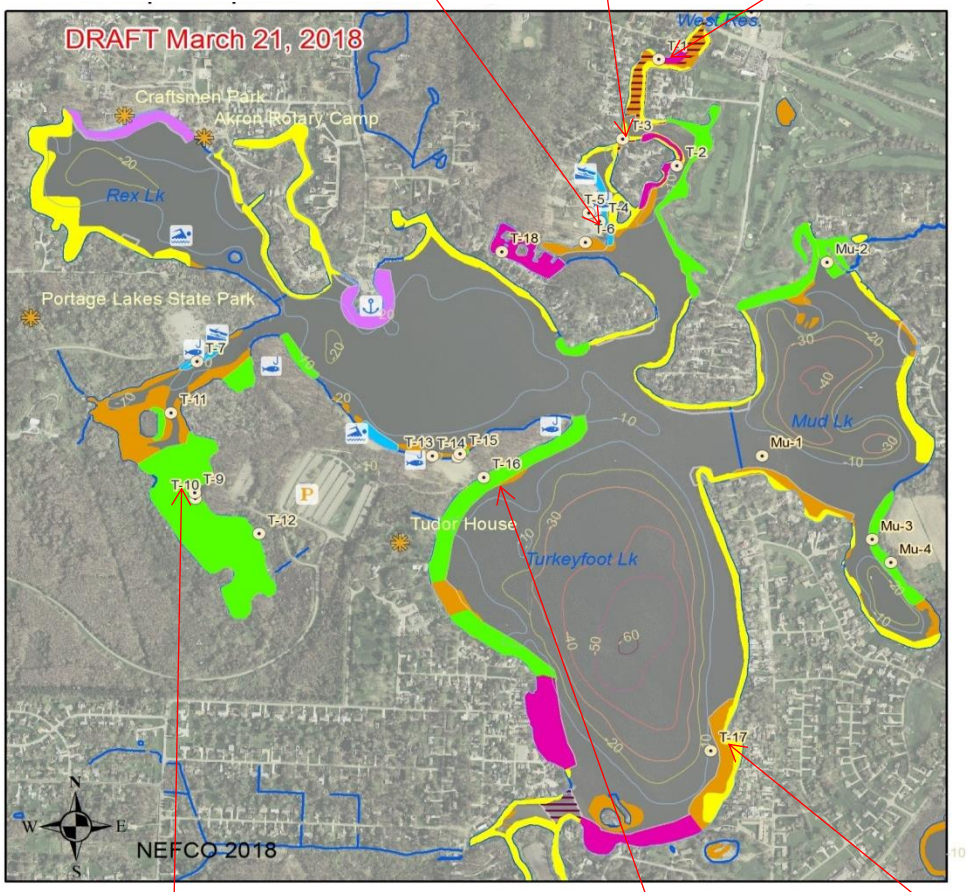
Map 5.5 Example Aquatic Plant Management Zones – Turkeyfoot Lake

T6 Spatterdock and water lilies by Old State Park boat launch



T3 Eelgrass, spatterdock, and E. water-milfoil near homes and channel

T1 Aquatic plants by home and dock along channel



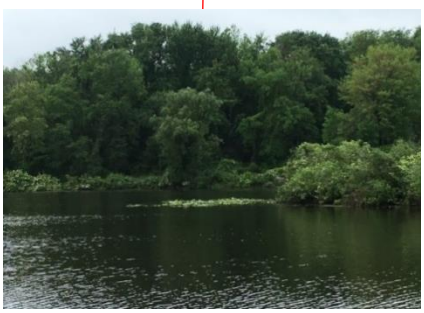
Example Management Zones

- Habitat
- Habitat near Docks
- Marinas/Docks/Swimming
- Swimming/Boat Ramp
- Residential
- Some Habitat Value - Invasive/Unknown
- May Need Passage
- Plant Gallery Picture
- Boat Ramp
- Fishing Access
- Marina
- Landmark
- Parking
- Parking
- Swimming

Depth (ft): 60, 50, 40, 30, 20, 10

- Lakes and Ponds
- Rivers and Streams

1,000 500 0 1,000 ft

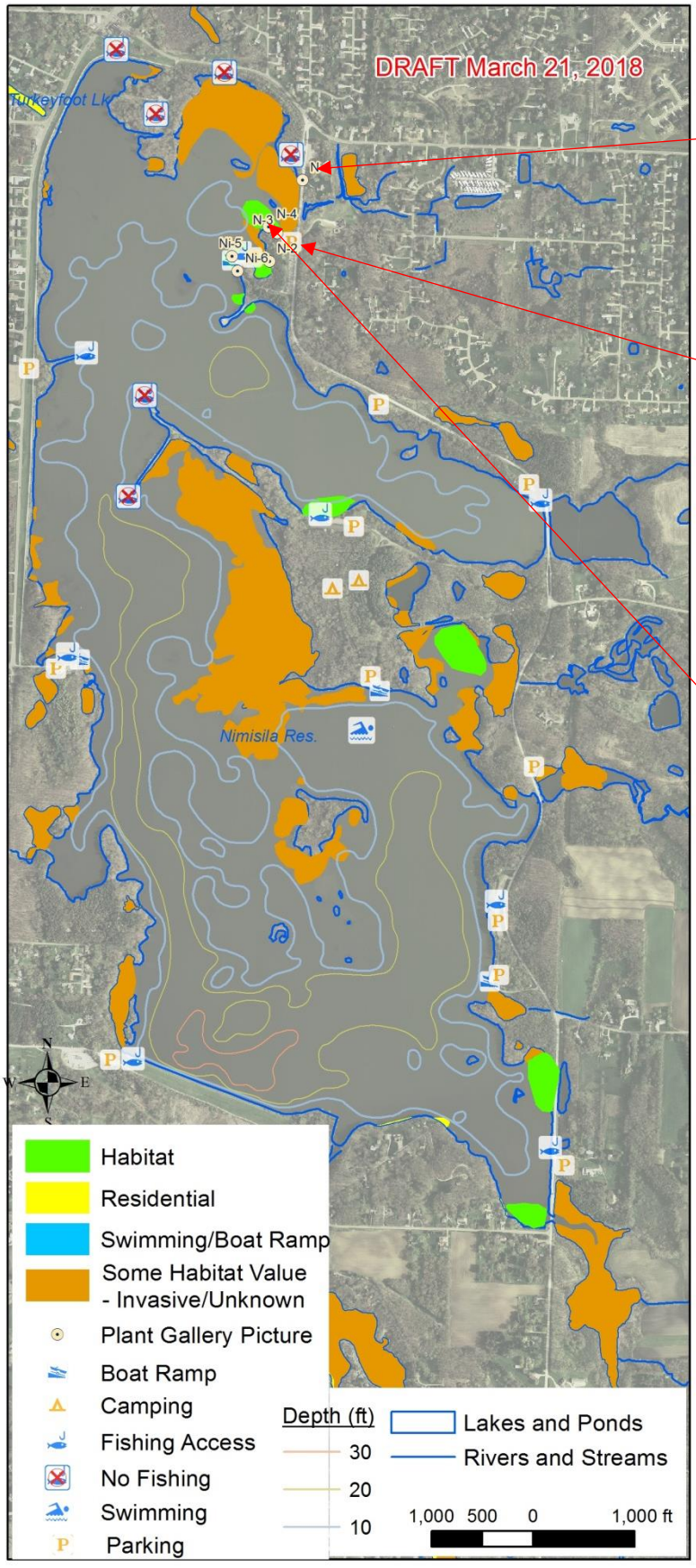


T10 Conservation area – Latham Bay

T16 Eel grass near Mosquito Point

T17 Aquatic plants by home and dock

Map 5.6 Example Aquatic Plant Management Zones - Nimisila Reservoir



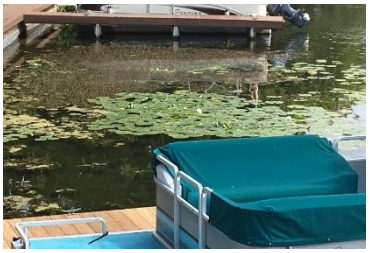
Vegetation observed in Nimisila includes extensive growth of Eurasian watermilfoil and filamentous green algae (Cladophora?) (N-1), dense growth in coves (N-2), and high quality habitat consisting of various native pondweeds and eelgrass (N-3).

-Nimisila is primarily used for recreation. All zones assumed to be managed as “habitat” zones.

What Residents Said about Aquatic Plants

Lakers at the public focus group and in other discussions shared observations and opinions about aquatic plants. Many of the questions asked by participants focuses on plants.

Many of these questions have been addressed elsewhere in this section. Some, like state-managed "weed" control, should be addressed through further discussion among the partners. The questions indicate a level of interest as well as a need for education about managing aquatic plants.



- What are the native plants in the area?
- There is a plant that looks like eel grass (which washes up on shore when cut by propellers) – what can be done to safely eradicate these weeds?
- Who can I get to remove seaweed by my dock without chemicals? Is AquaDoc an acceptable company for weed control? Are there less expensive alternatives?
- Why doesn't the state pay for weed control?
- Why can't the state charge a launch $5 fee to pay for lake maintenance?
- Certain areas get so choked with "spring weeds" that passage is almost impossible.

What suggestions do you have for thousands of feet of seawall and lakescaping?

Participants were asked if they thought aquatic plants are (multiple responses were allowed):

- A nuisance
- Important for habitat
- Important for water quality
- Affected by water quality, or
- All of the Above,

The most popular responses (about half) chose "Important for water quality," or "All of the Above."

When asked what should be done about the plants, the alternatives considered most important were:

- Harvest in certain areas
- Protect certain areas for habitat
- Protect water quality
- Increase education about aquatic plants, clean-drain-dry, best management practices
- Learning to live with plants was a less popular answer
- Almost no one favored do-it-yourself treatments.

Key Considerations

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, and chara. 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 uses available phosphorus for growth and releases it during decay.
- 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.
- 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 APM plan are important for managing aquatic plants in multi-use lakes.

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.

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
  - Potential to fragment
  - Sediment type/turbidity
  - Effect on other plants
  - 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.[21] 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 observations at certain locations.

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. The lakes should be monitored following use of the tools.

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.

- *In the Portage Lakes watershed, Summit SWCD, and watershed communities use several of these 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 as this will be a new – but necessary – approach to lake management. 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.

The lakers are the people who use the lakes and will be directly affected by management practices. They need to understand the role of plants and phosphorus in a sustainable lake. 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 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 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.

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 obsrvation opportunities
- **Develop an APM plan or program**, d 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, fishermen, 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.

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[1] The shoreline habitat discussion draws from several inland lakeshore websites from different states. The species may differ, but the concepts are widely applicable. Examples include:

New York State Department of Environmental Conservation (NYSDEC), 2005. *A Primer on Aquatic Plant Management in New York State. Draft*. Division of Water. https://www.dec.ny.gov/docs/water_pdf/ch6apr05.pdf Retrieved October, 2017.

Dixie Sandborn, 2020. Understanding Lakeshore Ecosystems Part 3 – Natural Vegetation. Michigan State University Extension https://www.canr.msu.edu/news/understanding_lakeshore_ecosystems_part_3_natural_vegetation accessed June, 2020.

[2] Descriptions from various sources. It is important to use plants native to the area and appropriate for the lake edge, sun, soil, and wind conditions. Summit County Soil and Water Conservation District, Ohio State University Extension, and ODNR are good sources of local or Ohio information about lakescaping and native plants. Wetland and lakeshore plants are often listed as native plants for rain gardens

General discussions of lakescaping and planting guidebooks include:

Beth Clawson, 2017. Making your Native Plant Choices for Michigan Inland Lake Shorelines. MSU Extension. https://www.canr.msu.edu/news/making_your_native_plant_choices_for_michigan_inland_lake_shorelines Accessed 2/2021

Federation of Vermont Lakes and Ponds, 2015. *A Guide to Healthy Lakes Using Lakeshore Landscaping.* https://dec.vermont.gov/sites/dec/files/wsm/lakes/Lakewise/docs/lp_VTlakescape.pdf accessed Feb. 2021.

Terry Gibb, 2016. *Bioengineering your shoreline can save money, improve water quality.* Michigan State University Extension. https://www.canr.msu.edu/news/bioengineering_your_shoreline_can_save_money_improve_water_quality

Patrick Goggin, n.d. *Healthy Lakes – 350 ft2 Native Planting Companion Guide.* University of Wisconsin Extension. Madison, WI. https://www.wpr.org/sites/default/files/native_plant_guide_2.0.pdf Accessed 2/2021.

Michigan Inland Lake Shorelines. http://www.shoreline.msu.edu/ Informative brochure: https://www.michigan.gov/documents/deq/wrd-natural-shorelines-inland-lakes_366530_7.pdf

Michigan Natural Shoreline Partnership. Nd. *Plants for Inland Lakes,* https://www.mishorelinepartnership.org/plants-for-inland-lakes.html Accessed June, 2020.

Minnesota Dept. of Natural Resources. 2020. Lakescaping and Shoreland Restoration. https://www.dnr.state.mn.us/lakescaping/index.html

[3] Map Sources: Base maps – ODNR GIS bathymetry, fishing maps; Summit County GIS; NHD 2016. Map 5.1 ODNR Natural Heritage Database, 2017; ODNR Division of Water Fishing Habitats map; USDA SSURGO Soils database; USGS, The National Map 2016 Canopy Cover; USDA NAIP vegetation imagery 2010-2015.

[4]C. Wagner, 2020. ODNR Division of Wildlife, pers. commun.

[5] J. Kiser, 2019. "The Portage Lakes, Akron's Bass Fishing Gem." Record-Courier. https://www.record-courier.com/sports/20190615/buckeye-angler--portage-lakes-akrons-bass-fishing-gem Accessed June, 2020.

[6] Information about fisheries from C. Wagner, 2020. ODNR Division of Wildlife District 3, pers. commun.

[7] CAB International. 2021. Morone Americana (white perch) data sheet. 2021. Invasive Species Compendium. https://www.cabi.org/isc/datasheet/74160 Accessed Feb. 2021.

[8] M. Tichnell and W. Lynch. 2010 "Coping with Canada Geese: Conflict Management and Damage Prevention Strategies*." Ohioline*. Ohio State University Extension. https://ohioline.osu.edu/factsheet/W-3 Accessed 6/2020.

[9] Cormorant image: https://ohiodnr.gov/wps/portal/gov/odnr/discover-and-learn/animals/birds/double-crested-cormorant. USDA 2020. Double-Crested Cormorant Damage Management in Ohio. https://downloads.regulations.gov/APHIS-2020-0115-0001/content.pdf Retrieved Feb., 2021.

[10] University of Florida Center for Aquatic Invasive Plants, 2021. *Lyngbya Species***.** https://plants.ifas.ufl.edu/plant-directory/lyngbya-species/ accessed Feb., 2021.

J. Chaffin, n.d. Genus: Lyngbya wollei / Microseira wollei Ohio Sea Grant, Ohio State Univ. Columbus, OH. https://ohioseagrant.osu.edu/research/plankton/lyngbyawolleimicroseirawollei Accessed June, 2020.

[11] For example, J. Hauxwell, et al., 2010. Recommended Baseline Monitoring of Aquatic Plants in Wisconsin: Sampling Design, Field and Laboratory Procedures, Data Entry and Analysis, and Applications. Wisconsin Dept. of Natural Resources (WDNR), Madison, WI. https://www.uwsp.edu/cnr-ap/UWEXLakes/Documents/ecology/Aquatic%20Plants/PI-Protocol-2010.pdf retrieved Oct., 2017.

[12] The New York State Federation of Lake Associations has a lot of good background material on aquatic plant and lake management. The CSLAP Aquatic Plant Survey protocol is a citizen science approach to monitoring aquatic plants that is more rigorous than casual observations. https://nysfola.org/cslap-aquatic-plant-survey/

[13] *The Primer for Aquatic Plant Management Plans in New York State* notes that a community plant observation program can provide a good basic foundation for APM when aquatic plant inventories are not available, although they do not identify all the species. (NYSDEC, 2005. *Op. cit.)* In the Portage Lakes citizen observations/citizen scientist monitoring could be a good start before developing an aquatic plant inventory, and a way to monitor in between inventories. The 2005 draft Primer recommends viewing the lakes from above, e.g., airplane or rooftops. In the Portage Lakes, on-the-water observations are an important tool, spotting vegetation below the surface in turbid water, or from a distance. Since 2005, the personal phone with gps and a camera has become widely available and is a powerful tool in mapping conditions at a certain date and location. The CSLAP Aquatic Plant Survey has a more rigorous sampling protocol and helps identify certain species.

[14] For example, NYSDEC, 2005, *Op. cit.;* Vermont Invasive Patrollers https://dec.vermont.gov/watershed/lakes-ponds/aquatic-invasives/monitoring/vips

[15] There are a number of case histories of unanticipated consequences of biomanipulation in lakes, including (cited in Ch. 4)

S. Fletcher, n.d. Op. cit.

Sabine Hilt et al., 2017. Response of Submerged Macrophyte Communities to External and Internal Restoration Measures in North Temperate Shallow Lakes. Front. Plant Sci., 19 February 2018 https://doi.org/10.3389/fpls.2018.00194 Retrieved Feb., 2021.

Jan J. Kuiper, et al. 2017. Mowing Submerged Macrophytes in Shallow Lakes with Alternative Stable States: Battling the Good Guys? Environmental Management (2017) 59:619–634 DOI 10.1007/s00267-016-0811-2 https://link.springer.com/article/10.1007/s00267-016-0811-2. Retrieved Feb., 2021.

M. Scheffer and E.H. van Nes, 2007. Shallow lakes theory revisited: various alternative regimes driven by climate, nutrients, depth and lake size. *Hydrobiologia* **584,** 455–466 (2007). https://doi.org/10.1007/s10750-007-0616-7 retrieved Feb., 2021.

M. Sondergaard, et al., 2007. Lake Restoration: Successes, Failures, and Long-Term Effects. Journal of Applied Ecology. 2007 44: 1095-1105. https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2664.2007.01363.x Retreived Feb., 2021

Istvan Tatrai et al., 2008. Abrupt Shift from Clear to Turbid State in a Shallow, Eutrophic, Biomanipulated Lake. Hydrobiologia 620(1): 149-161.

https://www.researchgate.net/publication/226817493_Abrupt_shift_from_clear_to_turbid_state_in_a_shallow_eutrophic_biomanipulated_lake Retrieved Feb., 2021.

[16]Two sites for reporting invasive species: Bugwood Apps, 2018. Great Lakes Early Detection Network. Bugwood Apps, 2017. Great Lakes Early Detection Network. https://apps.bugwood.org/apps/gledn/ Accessed Dec., 2017. Or

USDA Cooperative Extension, 2021. Invasive Species. https://invasive-species.extension.org/what-is-the-best-way-to-report-the-occurrence-of-an-invasive-species/ Accessed Mar., 2021.

[17] Bill Bartodziej, 2015. Aquatic Plant Harvesting and Phosphorus Reduction. Ramsey-Washington Metropolitan Watershed District, Little Canada, MN. *https://www.rwmwd.org/aquatic-plant-harvesting-and-phosphorus-reduction/, retrieved June, 2020.*

[18] One study specifically addresses the importance of public involvement in reversing an ecosystem shift: Romina Martin, Maja Schluter, and Thorsten Blenckner, 2020. PNAS The importance for transient social dynamics for restoring ecosystems beyond ecological tipping points. https://www.pnas.org/content/pnas/early/2020/01/17/1817154117.full.pdf Retrieved Feb., 2021.

[19] Programs in other states range from focusing on invasive plant control to APM plan development. State agencies perform such functions as providing technical support, requiring permits, in some cases harvesting. Plant control is handled by state or local organizations. Examples include:

Wisconsin -Wisconsin Dept. of Natural Resources, Aquatic Plants, https://dnr.wisconsin.gov/topic/lakes/plants, Aquatic Plant Management in Wisconsin https://www.uwsp.edu/cnr-ap/UWEXLakes/Pages/ecology/aquaticplants/default.aspx , https://dnr.wi.gov/lakes/plants/research/ ;

New York State Dept. of Environmental Conservation (NYSDEC) 2005. Op. Cit.

Minnesota https://www.dnr.state.mn.us/apm/index.html ;

Vermont Dept. of Environmental Conservation (VDEC) https://dec.vermont.gov/watershed/lakes-ponds/aquatic-invasives/control

[20] Examples include: Wisconsin Dept. of Natural Resources, Aquatic Plants, https://dnr.wisconsin.gov/topic/lakes/plants, *Aquatic Plant Management in Wisconsin* presents a good framework for developing an aquatic plant management plan: https://www.uwsp.edu/cnr-ap/UWEXLakes/Pages/ecology/aquaticplants/default.aspx , https://dnr.wi.gov/lakes/plants/research/ ;

New York State Dept. of Environmental Conservation (NYSDEC) Aquatic Plant Management. Op cit.

[21] For example, Hauxwell, J. et al., 2010. Op. cit.