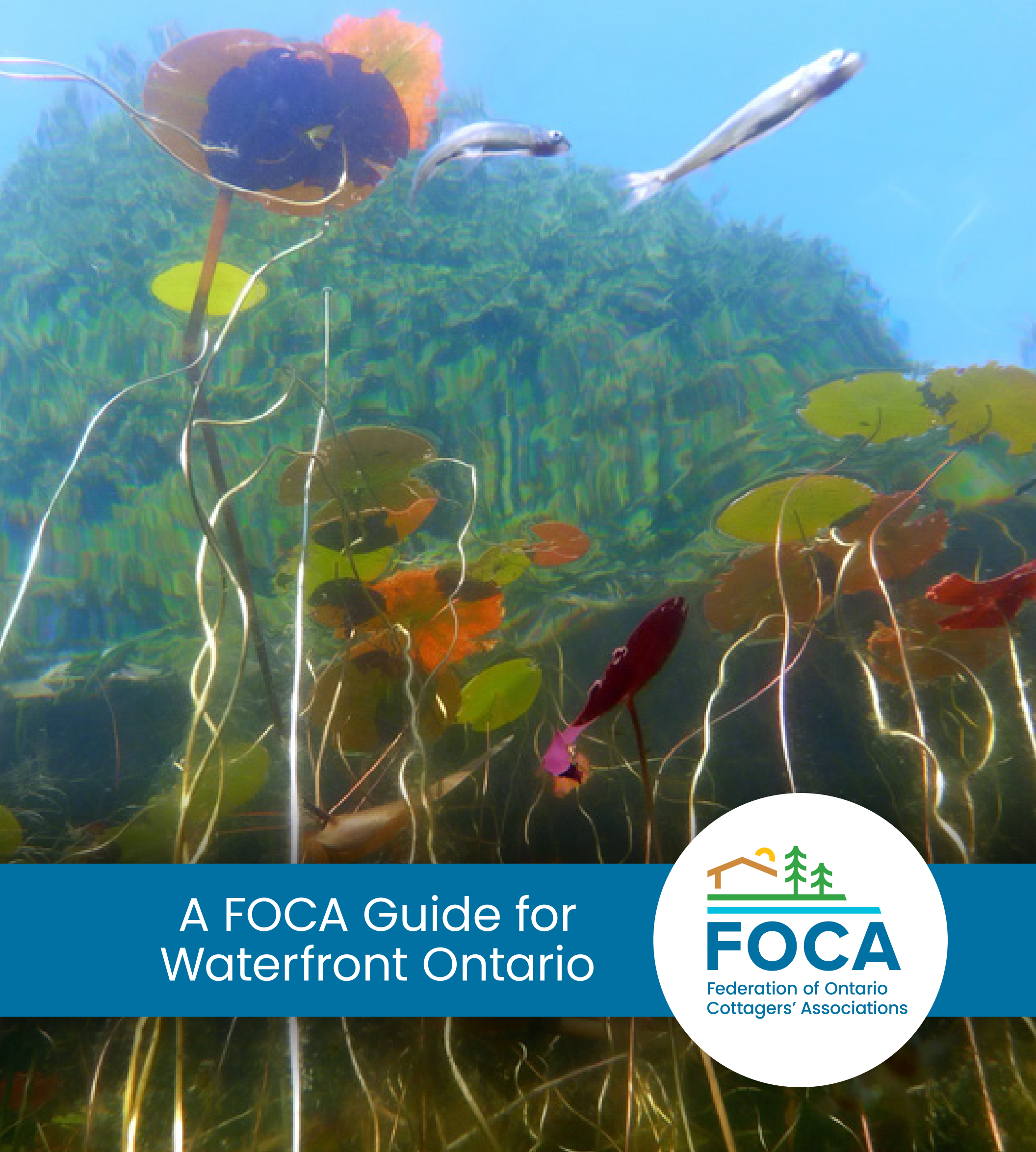
Understanding the Underwater World of Plants



A FOCA Guide for Waterfront Ontario

FOCA
Federation of Ontario Cottagers' Associations

As a member of the Green Shovels Collaborative, FOCA gratefully acknowledges financial support for this project from the Invasive Species Centre.

GREEN SHOVELS COLLABORATIVE

Photos by Kaleigh Mooney or FOCA, except where otherwise indicated, with special thanks to Andy Metelka for his spectacular underwater photography, including the cover image.

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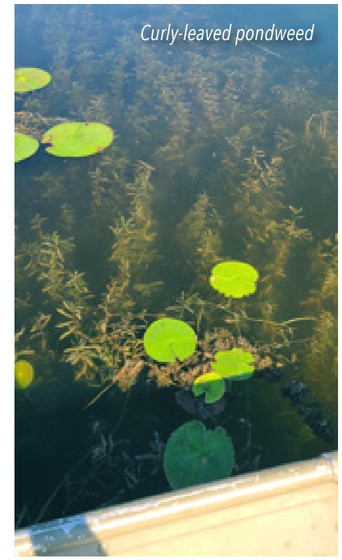
Kaleigh Mooney with water marigold

Disclaimer: Information in this guide is current as of June 2024 but should not be taken as a replacement for professional or scientific guidance about any specific situation, management advice, or permitting requirements in your area. This resource serves as an introduction to the topic of aquatic plants, offering a compilation of information on their biology and best management practices. While not exhaustive, it is intended to provide a starting point for understanding your specific circumstances.

Foreword

Bladderwort



Curly-leaved pondweed

About This Guide: An Overview From FOCA

"What's this weed in my water?" is something we hear often at the Federation of Ontario Cottagers' Associations (FOCA). This guide was created to help you answer that question on your own Ontario waterfront.

Chapter 1 provides an overview of plant ecology – why particular aquatic plants are located where they are, and what they do for us and for the ecosystem.

Chapter 2 includes descriptions, photos, and illustrations to help you identify common aquatic plants in Ontario.

Chapter 3 discusses what to do about these 'weeds' when you find them. **In many cases the answer is: do nothing – that plant is meant to be there, and it has an important role!**

In some cases, the answer is: that plant is non-native and could have negative impacts; however, **there may be specific restrictions on what can be done to manage it, depending upon where you are located**.

Sometimes even a native aquatic plant – one naturally found there – can become so prolific that it makes it more difficult to swim or boat nearshore. Learn more in Chapter 3 about what ***can*** and ***should not*** be done if there are abundant in-water plants in your area.

It is important not to remove aquatic plants from your waterway without first determining what they are, as most of them are integral to the functioning of shallow lake ecosystems. It can be difficult to distinguish one plant from another and to recognize the roles they play. The Fisheries Act protects fish habitat from harmful alteration, disruption, or destruction, therefore indiscriminate removal of aquatic vegetation could be **illegal**.

We hope this guide will help you understand and respect the organisms in your local lake or river, and will give you the information needed to make responsible decisions when you encounter them.

Please share these resources with others on the waterfront and help us to spread the word about the importance of aquatic plants!

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1.0 Aquatic Plants In Lake Ecology

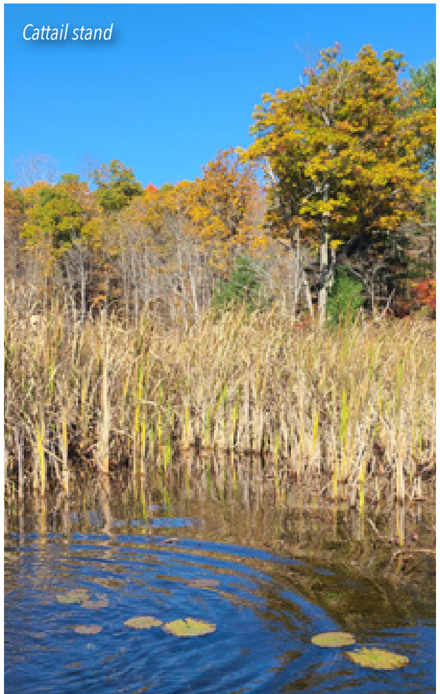
So, what's living in your lake?

Lots of things do! Insects, fish, frogs, turtles, ducks, muskrats and other creatures, together with rooted and floating pants, algae, fungi, bacteria and larger invertebrates make up an **ecosystem**, the web of interactions between living organisms and their physical environment.

Limnology is the study of the interactions between all the living and non-living elements of a lake system. The creatures found in and around lakes are affected by things like water chemistry, hydrology (water inputs and outflows) and interactions with other **biota** (life forms), including us.

Swimming snapping turtle - Andy Metelka

Aquatic plants are also called **macrophytes** by scientists. Macrophytes grow in or near the water and are sometimes generically called 'weeds'. They range in shape and size, can be seen with the naked eye (no microscope needed), and have vascular systems – like humans do – that transport oxygen, carbon dioxide and nutrients to all parts of the plant. Macrophytes are photosynthetic, meaning they use energy captured from sunlight to produce the sugars they need to live.



Cattail stand

If you've ever waded into an Ontario lake, you've likely come into direct contact with macrophytes!

Some people are perturbed when the aquatic leaves tickle their feet from beneath the surface of the water; others of us don't mind so much because – regardless of some of their perceptually 'icky' attributes, these plants are harmless to touch and are essential to life in the lake.

1.1 Lakes of Ontario

Ontario is home to several hundred thousand freshwater lakes, situated in a wide array of landscapes. Each landscape has a range of characteristics that we enjoy. These characteristics help define the type of lakes found there.

Types of Lakes in Ontario

We can expect lakes of a similar type to have generally similar physical, chemical, and biological components.

The three basic types of lakes are **oligotrophic**, **mesotrophic**, and **eutrophic**:

- **Oligotrophic lakes** are generally deeper lakes with low nutrient levels and minimal aquatic plant growth, except along shorelines. The low nutrient status, and greater depths prevent abundant plant growth. They tend to have low levels of phosphorus (an important nutrient) and chlorophyll (the majority from floating algae), and they support cold-water fish such as trout and whitefish.
- **Mesotrophic lakes** tend to have a medium depth and be good for fishing as they support a wide variety of fish such as walleye and bass. With more nutrients than oligotrophic lakes (but less nutrients than eutrophic lakes) they will support higher abundances of rooted aquatic plants in the shallower regions, and they will occasionally experience algae blooms.
- **Eutrophic lakes** are generally shallow with abundant rooted aquatic vegetation and high phosphorus and chlorophyll concentrations. They support warm-water fish, like perch, bass and pan fish. However, due to their high nutrient status, eutrophic lakes may experience frequent or recurring algae blooms. These blooms can lead to oxygen depletion because the bacteria responsible for the breakdown of the algae consume much of the oxygen store. When these plants occur at greater abundances, the demand for oxygen for their break-down also increases, leaving less for the fish to use. This can ultimately have a negative impact on the fish population.


Muskoka aerial - Terry Rees

Though we can label lakes under the three categories above, lake type exists on a broad spectrum. For example, one oligotrophic lake will be more or less oligotrophic than other oligotrophic lakes. Another important note is that eutrophic lakes can have two stable states. In a clear water state, the plant biomass is dominated by macrophytes. The alternative is a turbid state, which is dominated by algae. Both states are considered ecologically stable, however, the clear water state is certainly more desirable for human use of the lake.


Northern lakescape (Lake Nipissing) - Liz Favot


Southern lakescape (Rice Lake)

Generally, lakes in southern Ontario tend to be more eutrophic, while lakes found on or north of the Canadian Shield tend to be more oligotrophic. This is a result of the different soil chemistry associated with southern limestone bedrock versus northern granite bedrock. It is important to understand this difference when it comes to assessing the health of your lake, because the standard of 'healthiness' is unique for each lake. If your lake is on the Canadian Shield, it is less likely to be shallow, warm, and filled with pan fish, for example.

Additionally, the characteristics of any given lake can be expected to change over time, and eutrophication is actually a lake's natural aging process. Sediments, erosion, and the growth and decomposition of aquatic plants could eventually fill a lake bottom in shallower lakes, ultimately converting it to a marsh, fen or bog over tens of thousands of years.

Human activity can accelerate the process of eutrophication, by contributing excessive nutrients to a lake over a much shorter period of time. This can be seen by the increased number of algal blooms occurring on our Canadian Shield lakes in recent years.

Factors Influencing Lake Characteristics

Lake characteristics are largely – but not solely – influenced by the watershed, the geology, the lake's bathymetry, and human disturbance, each described below.

A **lake's watershed** is the area of surrounding landscape that captures water (like rainfall and snowmelt) and channels it into the lake. It influences the amount and type of inputs that flow into a lake.

During a rain event, rainwater falls onto the land and will either percolate down into the soil or flow across the surface. **Surface water** will pick up material along its journey, and will transport these materials into the nearest body of water, such as a lake or river.

Rainwater that percolates through the ground (**groundwater**) interacts with the soil it passes through, picking up new properties as it goes – mainly nutrients like nitrogen and phosphorus, but also potentially metals or other contaminants.

The normal amount and type of inputs to a lake will differ depending on where the lake is located. For example, a lake in southern Ontario, where the soil is deep and rich with nutrients, will likely contain lots of organic and nutrient-rich material from surface and groundwater inputs. In contrast, a lake in a more northern region with shallower soil will likely receive fewer nutrients from surface or soil inputs.

The geology of an area is also important when it comes to the chemical characteristics of freshwater lakes. The type of bedrock that a lake rests on will add to ongoing chemical interactions within the lake. Runoff deposits new chemicals into the lake, but minerals and chemicals from the bedrock can also dissolve into the lake water over time. For more about bedrock, visit: https://www.hub.geologyontario.mines.gov.on.ca/.

The water's interaction with the surrounding watershed and the bedrock will determine certain properties of a lake, like its '**pH**' – a measure of the acidity or alkalinity of the lake. Measured on a logarithmic scale of zero to 14, a pH reading is considered neutral at 7. A pH reading below pH 7 is considered acidic and a pH reading above pH 7 is considered alkaline (or basic). Because the scale is logarithmic, each pH unit is 10 times more acidic than the one above it (for example, pH 5 is 10 times more acidic than pH 6). As a point of reference, rainwater tends to fall between pH 5 and pH 5.5.

Bancroft-area geology

Limestone (calcium carbonate) has capacity, or the ability to neutralize acidic inputs. Most lakes in southern Ontario are found on limestone bedrock and so have a more neutral pH. In contrast, northern lakes found on granite bedrock have a lesser capacity to buffer acidic inputs, so they tend to be more acidic with a lower pH. As a result, plants that tolerate more acidic environments are more likely to be found in lakes on granite bedrock. Read more on page 11 about how these differences influence plant community.

Bathymetry refers to the underwater topography of a lake. The shape and depth of each lake will determine how chemicals can move within the water column, the amount and type of underwater habitat, and lake temperature.

Deep lakes often experience **thermal stratification**, where water forms three distinct layers: a warm, well-mixed surface layer (**epilimnion**), a cold bottom layer (**hypolimnion**), and a transition zone (**thermocline**) where you can feel the quick drop in water temperature. This occurs because colder water is more dense than warm water, so it sinks to the bottom of the lake. These layers remain during the summer because sunlight cannot warm the deeper water, and wind cannot mix the full water column. In the spring and fall, seasonal turnover occurs when surface water temperatures warm or cool to match the deeper temperatures, making the different layers the same density and allowing the entire lake to mix. However, in very deep lakes, the hypolimnion may not experience this turnover creating sinks (zones of deposition) in the deepest regions that capture certain compounds. Groundwater seepage can also influence the chemistry of these areas by adding cool, oxygenated water.

In contrast, shallow lakes are evenly warmed by sunlight and continuously mixed by wind, preventing stratification. This allows heat, oxygen, and nutrients to circulate from the surface to the bottom, resulting in consistent water chemistry throughout the lake.

Fragrant water lily stand

Plants require light for photosynthesis and light penetration is dependent on water clarity. Deep, clear lakes may have rooted plants at 30 metres depth, while lakes with cloudy (turbid) water may only have rooted plants growing at less than 1 metre depth. Plants will be distributed about the lake according to the amount of sunlight a species requires, and the strategies they possess to access it.

Shoreline modification from human development will also affect the way the lake, and its organisms, behave. Changing the way the shore looks, in turn, will change the way the lakes look. Removing vegetation, bringing in new materials, creating new structures in and around the waterline will all greatly affect the amount of nutrients and sediment entering the lake. Removing vegetation destabilizes the sediment and hinders the nutrient buffering capacity that plant life provides. Bringing in new building material – like sand or topsoil – increases the amount of loose material that can erode into the lake during rain or wind events. New structures – hardened shorelines, boat houses, docks, etc. – can change how the water flows around your property. This can create more or less favourable conditions for plants and animals using that area.

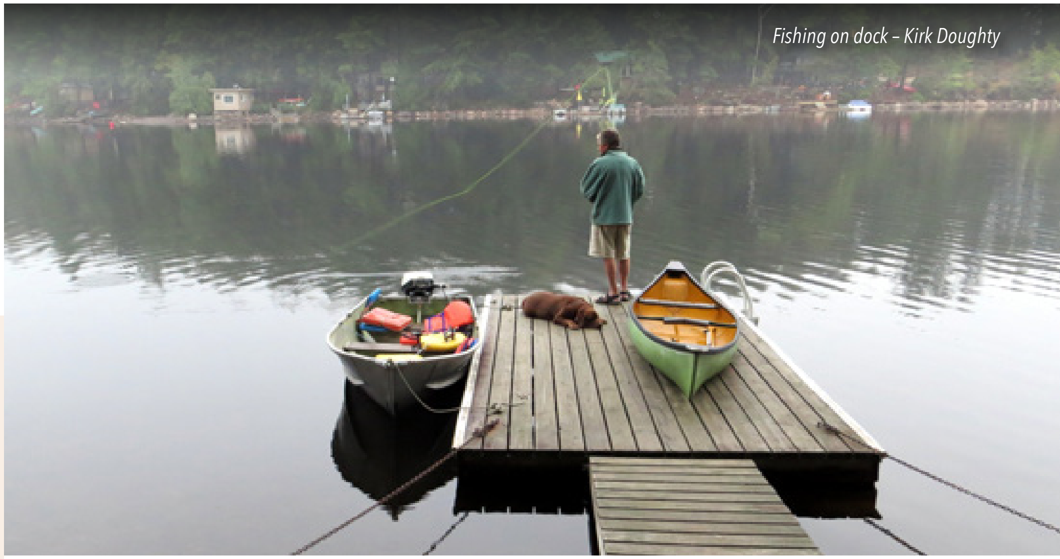
If your family has had a home, camp or cottage on a particular lake for generations, and you notice that it now looks different from memories or pictures from your youth, it is not always a cause for concern, but the rate of change is certainly something to note.

If you are someone who spends time on or near an oligotrophic lake, and you suddenly notice that the water is green and murky rather than the dark water characteristic of northern lakes, it is likely worth questioning and investigating further. See chapter 2 for assistance with common aquatic plant and algae identifications, and chapter 3 for management considerations.

1.2 Benefits and Roles of Aquatic Plants

Many of us use lakes as a place of recreation – whether that be for fishing, swimming, bird watching, or any of the other joys of being in a lake or at the water's edge. ***The community of aquatic plants plays a large role in providing the conditions that allow us to enjoy these activities.***

The following chapter outlines some of the functions (jobs) performed by aquatic plants in our lakes and shows how we depend upon the many **ecosystem services** they provide. Ecosystem services are benefits that we obtain from ecosystems.



Fishing on dock – Kirk Doughty

Food

Aquatic plants, together with **phytoplankton** (microalgae), are a source of primary production in lake ecosystems. These organisms transform energy from sunlight into sources that other organisms can use as food energy.

Aquatic plants are a source of food for insects, fish, waterfowl, and a variety of other animals. From tiny snails to the mighty moose and everything in between, living and dead aquatic plants provide an essential source of energy for herbivores (plant eaters), omnivores (plant and animal eaters), and detritivores (organisms that feed on dead organic material) that frequent our lakes.

Habitat & Shelter

A stand of aquatic plants not only provides food, but also shelter and breeding habitat for an array of organisms.

A wide array of invertebrates – like larval insects or snails – use stands of aquatic plants as their home, finding shelter among the leaves or burrowing into the sediment. Fish that prey on invertebrates visit these stands for food, while piscivorous fish – like pike – wait at the edges to ambush smaller fish as they come and go. Emergent stands of aquatic plants (those that have their leaves above water) also serve as nesting grounds for some bird species, while simultaneously providing material for animals like muskrats to make their dens.


Frog in shoreline plants


Shoreline illustration - Jackie Donaldson

Erosion Control

The structure of a stand of aquatic plants aids in the prevention of shoreline erosion.

Waves generated by wind or boat wake will lose some of their velocity and impact when they reach a stand of aquatic plants on the way to shore. Not only does this allow floating particles time and space to settle down in the water column, it protects the shoreline from the direct impact of big waves that can drag soil back out into the lake, increasing the rate of erosion.

The roots of these stands of aquatic plants create a web that holds sediment in place, further stabilizing the shoreline over time.

Water Quality

Nutrient cycling in a lake system is important, so that there are enough nutrients for organisms to use, but ideally never so much that it leads to lake eutrophication, as described in chapter 1.1.

Aquatic plants contribute to nutrient cycling in several ways.

Aquatic plants take up nitrogen, phosphorus and other nutrients from the sediment and water column and store them in their tissues, thereby improving water clarity. When these plants die back, their tissues break down and return the nutrients to the sediments, so other organisms can take them up. During **photosynthesis**, aquatic plants produce oxygen which stimulates the growth of microorganisms and encourages the decomposition of organic matter, which supports the lake ecosystem.

Aquatic plants can also play a role in **pollution control** by physically immobilizing or chemically changing a contaminant. The roots of aquatic plants provide a stabilizing structure in the sediment, which can be beneficial in reducing the resuspension of pollutants including excess nutrients, but also potentially heavy metals or organic pollutants in a waterbody. The aquatic plants can also store (and sometimes transform) contaminants within their tissues, removing it from the immediate environment. Especially, microorganisms found near plant roots (requiring the oxygen the roots produce) can break down some contaminants to a form that is less harmful for other organisms, providing a built-in water purifying system.

Air Quality

During the photosynthetic process plants absorb carbon dioxide (CO_2). This can occur directly from the air for plants with aerial leaves, or from CO_2 that has diffused into the water. Macrophytes use the carbon to produce tissues like stems, leaves, and roots. The amount of carbon sequestered by aquatic plants is dependent on a variety of factors, including species and environmental conditions. For example, plants that have large, perennial root systems can store more carbon than annual plants with smaller root systems.


Wetland - Tracy Logan

Some freshwater systems, like marshes and bogs, do this particularly well and are therefore considered an important **carbon sink** (an environment that absorbs more carbon from the atmosphere than it releases). This reduction of CO_2 in the atmosphere helps to keep the temperature of our planet from rising further.

1.3 Conditions for Establishment

Despite their many different forms, all aquatic plants require a set of conditions to become established, to grow and to reproduce.

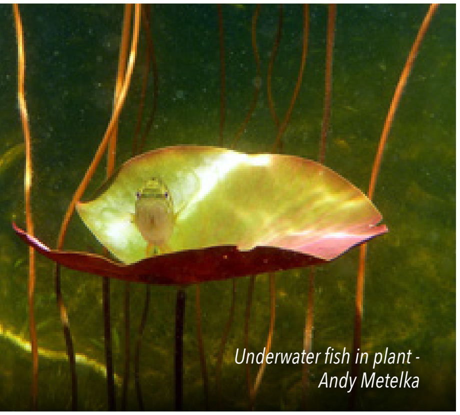
A plant needs physical **space** to exist, with its preferred amount of **exposure**, **light** and **CO_2** to photosynthesize, and **nutrients** to grow. Each species can tolerate a range of these conditions and other environmental impacts, such as herbivory, disease, and disturbance. If a particular location falls within this range, and other negative impacts are not too severe, the plant will happily exist there. Each condition is explained briefly below.

Space

First there needs to be physical space for a plant to establish.

There are several means by which a plant could become established, including dispersal by seed, or via plant fragments or rhizomes; nevertheless, all aquatic plants require 'real estate' to start their growth. For this reason, removing 'nuisance' or even invasive plants from your waterfront can have the unintended consequence of opening up such space for new plant establishments! Learn more about this negative cycle in chapter 3.2.

This space also needs to be protected from exposure to wind and wave action. These mechanical stresses on plants make it difficult to root and stay rooted. Areas that offer protection from prevailing winds will often be home to a wide variety of submersed, floating-leaved, and – especially – floating macrophyte species. These species are able to tolerate more mechanical stress than others, but the vast majority prefer areas that are sheltered by surrounding land masses.


Underwater fish in plant - Andy Metelka


Fragrant water lily with Canada waterweed and starry stonewort below

Light and CO_2


Sunlight on Anstruther Lake

As photosynthetic organisms, aquatic plants require sunlight and CO_2 to carry out photosynthesis to produce carbohydrates (sugars) used as plant food.

Aquatic plants have the same challenges in obtaining sufficient light as terrestrial plants do. They are affected by cloudy days, too much shading from shoreline trees, structures like boathouses or docks, or other plant species. However, aquatic plants also have additional constraints beyond those experienced by terrestrial plants. Light can only penetrate down the water column so far from the surface. The deeper the water, the less light reaches the leaves of submerged plants trying to grow there.

This is compounded in some cases by suspended particles in the water like sediment or algae that create **turbidity** (making the water cloudy and hard to see through). These particles block sunlight coming through the water column and reduce the amount that is available to aquatic plants growing there. Tea-coloured waters, rich in dissolved carbon, can also limit light penetration.

As discussed on page 5, the bedrock a lake sits on influences pH. The pH influences the dominant form of carbon available for aquatic plants to use for photosynthesis, which in turn shapes the diversity and composition of the plant community. In **soft water** lakes (low in mineral content of calcium and magnesium), like those on the Canadian Shield, CO_2 is the primary form of carbon. However, CO_2 diffuses slowly into the water from the atmosphere which limits the amount available to be used by the plants growing there. This limitation favours smaller species (like pipewort), slower growing plants (like fern pondweed), and plants that have access to atmospheric CO_2 through emergent leaves (like bur-reed).

In contrast, lakes situated on limestone bedrock, such as those south of Stoney Lake to Lake Ontario, and south of the Ottawa River, have a higher pH (more neutral to alkaline). The weathering of limestone produces bicarbonate (HCO_3), which plants can use as an alternative carbon source for photosynthesis. Submerged plants, which rely on dissolved carbon, have adapted to utilize bicarbonate, enabling them to thrive despite the slow diffusion rate of atmospheric CO_2. This adaptation reduces the competition for a single carbon source and allows a greater diversity of plants to grow in hard water (high mineral content) lakes.

Sediment and Nutrients

Nutrients are the building blocks that organisms use to grow and perform their functions. Like terrestrial plants, aquatic plants receive a portion of their nutrients from the lake sediment by absorbing them through their root systems. Just like garden vegetables, some plants (like carrots) prefer sandier soils, while others (like pumpkins) prefer soils with more organic material. Aquatic plants are no different.

Some **sediments** hold nutrients much better than others. Sandier sediments, for example, are mineral based and have very low organic content. Because of this, they do not provide many usable nutrients for plants, nor do they capture and hold free-floating nutrients well. Fewer plant species have adapted to these conditions, and so you will likely find a lower diversity of macrophytes on sandy substrate – though you might see an increase in algae at certain times of the year.

Sediment with more organic content (think of back bays where your feet sink in up to your knee with each step) supplies plants with a much higher, readily available nutrient concentration. As the organic matter breaks down, it releases nutrients for growing plants to use. The nature of this material also provides more bonding sites for nutrients flowing in the water, so other dissolved nutrients are stored in the muck until they can be used.

Aquatic plants tend not to establish on logs, coarse woody debris, or bare rock. Each species has a range of substrate it prefers, from muck to sand. As a result, the type of sediment or substrate present at your location will dictate the types of plants you can expect to see established there.

Have you ever noticed a rough, crystalized substance on the surface of submersed aquatic plants?

It is not a disease, and it is not harmful to plants. It is **marl**, a deposit made of calcium carbonate. In lakes with limestone bedrock, there is a higher concentration of dissolved calcium compounds in the water. A reaction between one of these compounds (calcium bicarbonate) and dissolved CO_2 at the leaf interface allows for the precipitation of marl. If you find that the plants near your cottage have a rough crust on them, chances are there is a limestone deposit nearby!

Marl on water soldier leaves

Additionally, some aquatic plants have evolved to receive some of their nutrients directly from the water. Free-floating species and algae do this particularly well, as it is their only source of nutrients since they lack roots. Algae also pulls its nutrients directly from the water and in more eutrophic (nutrient-rich) environments it can become prolific when there is excess nutrient input.

The primary elements required by aquatic plants are **nitrogen** and **phosphorus**, although there are another dozen micronutrients and minerals needed for healthy plant growth.

Grassy shoreline

Healthy shoreline

Aquatic plant growth is typically limited by the amount of phosphorus available, even if light and temperature remain optimal. **For this reason, we often see plenty of aquatic plants in the lake next to a shore with a big green lawn on the shoreline!** Lawn or garden fertilizers run off with rain events and find their way into the lake, increasing the phosphorus available, which can lead to more aquatic plants, and even algae growth. Learn more about algae in chapter 2.5.

FOCA suggests that waterfront property owners avoid bringing in topsoil for landscaping, using fertilizers, or keeping manicured green spaces at the lake (image at the left, above). Lawns not only have poor root systems for nutrient buffering, they also attract Canada geese (*Branta canadensis*). **Geese** tend to defecate on these lawns, creating a source of excess nutrients that negatively affects water quality. Instead, establish naturally vegetated shorelines (image at the right) which can deter geese while buffering runoff of sediment or other substances that could negatively impact water quality.

To sum up:

Aquatic plants will grow in areas where there is available space, light and nutrients. Over-managing or developing lake shorelines creates more 'resources' that enable aquatic plants to thrive.

Some examples of potentially problematic actions that could impact your own waterfront:

- removing fallen logs and rocks from the water's edge creates more space for aquatic plants to establish and removes essential habitat for aquatic animals
- clearing trees along the shoreline allows more light to penetrate the water, encouraging aquatic plant growth
- nutrient-rich runoff or sewage discharge from improperly maintained wastewater systems promotes the rapid growth of both aquatic plants and algae
- intensive landscaping or shoreline development can increase erosion and sedimentation rates, leading to more substrate available for plants to take root and reduced water clarity that can favour algae growth

Being mindful of these considerations, and how our shoreline and near-shore actions can cause a chain reaction in the plant community, are important steps in being a good steward of your own waterfront.


Canoeing through pickerelweed - Tracy Logan

If you are considering managing an existing stand of aquatic plants, read onwards about the importance of community dynamics, learn to identify plants and understand their roles (see chapter 2), and read about important management considerations (see chapter 3) before proceeding.

1.4 Community Dynamics

The **macrophyte community** is the group of aquatic plant species present in any given lake, and every lake is unique.

Freshwater lakes are extremely dynamic systems. The aquatic plants in these lakes are in constant competition for resources, so much so that a slight change in one environmental condition can cause a shift in the community by favoring the traits of one species over another.

While we often focus attention on non-native, invasive plant species, it is important to have a sound understanding of the native plant community as well.

Having a sense of the plant community of your lake, including how the populations tend to shift between seasons, provides the baseline from which you can begin to assess the impact of disturbances – like an introduced species, shoreline development, or climate change.

Diversity describes the number of species in an area, and the relative variety or uniformity of those species determines if a system is considered diverse, or not. There are several different ways to measure diversity in a plant community: by diversity of species, groups, functions, and so on. Ecosystem managers tend to consider high diversity to be a metric of success and a sign of a more resilient system.


Community diversity

Diversity of services is an important consideration in lake management. When we use functional diversity as a measure of success, we are ensuring that the services aquatic plants provide will remain, even if the species that are present in the lake change.

For lake health, it is important to have several species that perform the same or a similar function. If several species have the capacity to fill a certain role (like producing a dense network of roots), it is more likely that benefit (increased erosion control) will still be experienced if the conditions of the lake change in a way that negatively impacts some of those species.

The dominant species performing the function has a particular range of conditions that suits them, but having additional minor species within the community is also key. If conditions (e.g., water temperature or ice on-off conditions) no longer fit within the preferred range for the dominant species, minor species can potentially step up and continue to provide that service.

The more species present that can perform the same function, the more capacity a system has to adapt to disturbances and the changing conditions they bring, without changing the overall state of the ecosystem in the process.

Over time, all ecosystems experience external disturbances that challenge the current community of plants and animals. These disturbances could be caused by changes in climate, competition between species, or impacts from other creatures in the ecosystem such as a new beaver dam that changes local water levels. Disturbances can also include human impacts from shoreline development or recreational activity.

Beaver dam – Kirk Doughty

These disturbances are what build **ecosystem resilience**, a term that describes the amount of disturbance a system can absorb before being pushed into an alternate state. Too much or too frequent disturbances can hinder the system's performance.

In freshwater systems, the alternate state might be an algae-dominated eutrophic lake where a mesotrophic lake had once existed. (Learn more about algae in chapter 2.5.) Once a system has tipped into such a state, it can be extremely difficult to reverse it, and we may lose the services we have valued and expected from the system, such as the ability for us to swim or fish comfortably or safely in the water.

2.0 Aquatic Plants of Ontario

This chapter provides key identifying information about some of the more common plants in our province, including species that are found in northern and southern Ontario lakes.

The plants in this chapter were chosen based on the author's experience surveying aquatic plant communities in lakes across Ontario. The species listed here were some of the more common species found in those surveys or species of greater interest, but that is not to say they are the most common and there are certainly many, ***many*** more.

Before we dive in, we need to define a few terms:

Native plant species are those that have been found historically within a certain geographic range.

Non-native plants are species that have not been found historically within the range of interest but have become established and are able to successfully reproduce without human assistance. Not all non-native plant species are problematic ecologically or economically.

Invasive plant species, as defined by the **Ontario Invasive Species Act**, are non-native plants that have the potential to cause environmental and/or economic harm if they become introduced and established here.

Look for this icon throughout chapter 2; it indicates an invasive plant species

It is important to note that the term 'invasive' is sometimes used to describe the behaviour of a plant that is highly competitive with its ability to proliferate and spread. This type of 'invasive' behaviour can apply to both native and non-native species. In this guide, when we refer to invasive species, we are using the definition provided above to refer to species that the Ontario government has specifically identified as problematic, non-native species. For an up-to-date list of invasive aquatic plant species in Ontario, visit: https://www.ontario.ca/page/invasive-species-ontario.

In this chapter, plant descriptions are divided into sections by **emergent**, **floating-leaved**, **free-floating**, and **submersed** plants. The chapter ends with an additional discussion of **algae**, which are not aquatic plants but are often a subject of great interest to waterfront users, and in some cases (such as starry stonewort) can look like a plant!

Important Notes:

- This is not a comprehensive catalogue of all species but is instead meant to provide a starting point for observing the different species found off your own dock, or in your favourite back bay. We hope this will help you develop a stronger understanding of what you can expect to find there, and what typical changes in the community might look like.
- There are many other great resources about aquatic plants available online, including:
  - *Aquatic Plants Guide* from the **Kawartha Lake Stewards Association** (https://klsa.ca/wp-content/uploads/2023/11/klsa-aquatic-plant-guide-2023_web.pdf)
  - digital invasive species IDs posted by the **Ontario Invasive Plant Council** (https://www.ontarioinvasiveplants.ca/invasive-plants/) and the **Invading Species Awareness Program** (https://www.invadingspecies.com/downloads/aquatic-plants/)
  - **Province of Ontario** invasive species fact sheets (https://www.ontario.ca/page/invasive-species-fact-sheets).

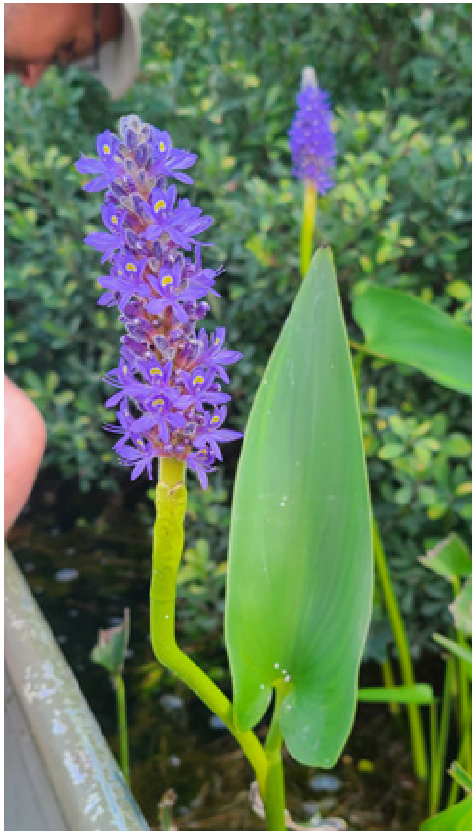
Happy plant detecting!

2.1 Emergent Plants

Emergent plants are those that are found most frequently at the water's edge. The roots of emergent species establish in soils that are permanently or seasonally saturated with water, while the leaves, stems and flowers stand up above the water line. Typically, emergent plant species establish in water depths up to 1.5 metres, in areas where they are protected from high wind and current.

Emergent plants provide habitat for waterfowl, mammals, and insect species, while also providing a source of food for many types of animals. Additionally, they help improve water quality by filtering runoff water and provide erosion control by trapping soil in their root systems.





Emergent plant habitat (wild rice, top left; pickerelweed, bottom left) and flowers (pickerelweed, right)

Broad-leaved Arrowhead
(Sagittaria latifolia)

Arrowhead species are found in muddy, shallow areas of lakes, marshes, ponds, or ditches. Broad-leaved arrowhead prefers full sun and can tolerate lakes with high calcium content. This plant is most often found in shallow, sunny back bays, adjacent to the shoreline or in wet ditches along roads.

Key ID features:

- distinct arrowhead-shaped leaves emerging from the water surface that are up to 40 cm long, but highly variable in width; shallower, drier environments produce wider leaves, while plants established further into the water have narrower leaves
- ribbon-like submersed leaves growing in a rosette formation around the base of the flower stem
- complex rhizome and tuber (underground stem parts; **rhizomes** grow horizontally under the ground and sprout new growth along the underground stem as they grow, whereas **tubers** grow in any direction) that allow the plant to spread and store carbohydrates
- small white flowers with three petals, occurring in several sets of whorls of three

Arrowheads have starchy tubers growing in the sediment that serve as a tasty treat for ducks, turtles, muskrats, and others – including humans! Other arrowhead species include floating arrowhead (*S. cuneata*) that can be distinguished by its leaves that are usually floating rather than emergent, and stiff arrowhead (*S. rigida*) whose leaves are variable, but usually more lance shaped than arrowhead shaped.

Broad-leaved arrowhead (left to right): plant; flower; and leaf

Canada Rush
(Juncus canadensis)

Rushes – like grasses – are very common, but individual species can be difficult to identify, especially when they are not flowering. To distinguish between grasses, sedges, and rushes refer to the mnemonic phrase, "grass is flat, sedges have edges, and rushes are round."

The leaves of Canada rush are round and can be rolled between your fingers. Canada rush is found bordering lakes in sunny areas where the sediment is permanently or seasonally wet. It is known to be a particularly variable species.

Key ID features:

- leaves have a rounded cross section, and are between 1.5 and 3 mm in width
- flowers are found at the tip of the plant in clusters of at least five

There are dozens of species of rush in the genus *Juncas*, many of which require the seed head present to make an accurate identification. We focus here on Canada rush as a starting point, but utilizing online tools or mobile applications like https://www.inaturalist.org/ can help narrow your search of plants on your waterfront. Canada rush and its relatives create a calm micro-environment within moderately dense stands where you can find many animals like spiders and other bugs – plus the frogs that eat them!

Canada rush (left to right): illustration; habitat; flower; and plant

Common Cattail

(Typha latifolia)

Common cattail can be found in shallow, flooded areas whose water levels are relatively stable. They occur in dense patches with a complex rhizome system bordering ponds, marshy areas, and ditches.

Key ID features:

- a single flower stalk topped with a dense, large, brown flower cluster, followed by a spike at the very tip of the plant
- leaves are long, flat, fibrous, and around 10-25 mm wide; they wrap around the stem at the base and have a pointed tip

Common cattail is an integral part of marsh ecosystems for a variety of wildlife. Birds use materials found in cattail stands to build nests and as a food source. Muskrats also mound leaves to create dens on the sides of marshes and ponds. All parts of the cattail plant have been used by First Nations like the Anishinaabeg peoples. The tuffs of seed can be used to stuff pillows and blankets, while the entire plant is edible (and pretty tasty!).

There is another species of cattail found in Ontario: *Typha angustifolia*. It can be distinguished from common cattail by its longer, slimmer leaves, and a small gap between the male and female flowering structures. The two species can hybridize, and the hybrid thrives in areas where human activity has altered nutrient cycles and hydrology, often out-competing its parent species. Cattails and phragmites compete for similar habitats; however, cattails tend to be able to establish stands in deeper water than phragmites.

Common cattail (left to right): habitat; flower; and flower in autumn

Large-fruited Bur-reed

(Sparganium eurycarpum)

This emergent species creeps into the shallow water of lakes from the shoreline, in sunny areas usually less than 1 metre deep. It can form bright green stands that can become dense or grow among other species in crowded back bays. This species can be seen growing in the spaces between rocks in rocky areas where other plants have a hard time establishing.

Key ID features:

- tall (1.2 metres), stout stems grow in a slight zig-zag pattern
- long (80 cm), narrow leaves grow alternately off the stem, and are stiff with a V-shaped keel
- distinctive burs are 3-4 cm wide and grow in the upper parts of the plant
- flowers found mid-season on the bur structures have two **stigmas** (in this case, small hair-like structures that grow out from the flower and capture pollen falling from the flowers above it)

Bur-reeds, though possessing distinctive spikey, circular burs, can be difficult to distinguish from one another without the mature bur for precise identification. Common bur-reed (*Sparganium emersum*), among other bur-reeds, is very similar to large-fruited bur-reed but is not quite as tall (usually less than 30 cm), its leaves can sometimes be floating rather than erect, and the female flowers found on burs will only have one stigma.

Large-fruited bur-reed (left to right): illustration; habitat; flower; and plant

Pickerelweed
(Pontederia cordata)

Pickerelweed can be found by wading out to your knees in the still waters of a sunny back bay – its typical habitat, as it prefers sediments that are loamy with lots of organic matter. You will know you are in the right habitat, if a plume of fine material kicks up when you take a step!

Key ID features:

- large (5-25 cm long, 2-15 cm wide), glossy, heart-shaped leaves with parallel veins and blunt tip
- round, hollow stems can stand 1 metre tall from the sediment to the above-water tips of its stems, leaves, and flowers
- flowers are violet-blue and clustered around the tip of a spike

Pickerelweed is an integral part of the ecosystem, providing food for waterfowl and structure for fish and invertebrates. It is thought to co-occur with northern pike (or pickerel fish) from whom it gets its name. The entire plant is edible, either raw or cooked, with a slightly nutty flavour and can be added to salads or sauteed as a side dish.

Pickerelweed (left to right): illustration; habitat; plant; and flower

Wild Rice
(Zizania palustris)

Wild rice (*Manoomin* in Anishinaabeg) is an emergent aquatic plant that has been traditionally harvested by First Nations in Ontario. It is a wild grass that grows annually in patchy bunches from seed.

Key ID features:

- long (up to 60 cm), narrow (1.5 to 4 cm wide), and flat leaves float on the water's surface in the early summer, then become erect midway through the summer
- the erect plant can grow to be up to 2 metres tall
- erect leaves have a strong midvein
- the large **panicle** (flowering structure) has many branches, with the upper-most branches being stiff and dense (like a broom) and the lower branches sparser with small male flowers hanging on them (like lanterns)
- long, dark brown seed is produced within the broom-like portion of the panicle towards fall

Wild rice can be found along the shores of many of our shallower lakes in Ontario. In the Trent Severn and Rideau Waterways, First Nations communities still actively gather and process the seeds for food. The plant also provides food for moose, deer, beavers, swans, and other herbivores. The rice beds attract fish, ducks, migratory birds and muskrat, as it is a great source of habitat. Wild rice filters the water and provides erosion control, binding loose soil and buffering wave action. Wild rice can be mistaken for floating-leaved bur-reed (*S. fluctuans*), eelgrass (*V. americana*), and its relative, wild oats (*Z. aquatica*). There are mandates in place for Wild Rice Protection Zones where it is illegal to boat, illegally harvest, or otherwise disturb the wild rice beds. Consult Parks Canada's online information for details: https://parks.canada.ca/lhn-nhs/on/trentsevern/info/riz-rice.

Wild rice (left to right): Rice Lake; habitat; panicle; and leaf

Common Reed

(Phragmites australis subsp. australis)

This subspecies of common reed, also known simply as Phragmites, is commonly found in ditches along Ontario's highways and roads, as well as bordering wetlands. It occupies habitats similar to cattails, generally thriving in areas with wet soil or shallow water, but not venturing very deep into waterbodies. The non-native subspecies (*australis*) is highly competitive for resources and can create large, dense stands that may displace some native plants and animals. This is particularly true in roadside environments that are already stressed by high concentrations of salt from de-icing measures and runoff containing pollutants. Non-native phragmites is a brackish (salt-tolerant) species with mechanisms to withstand these harsh conditions, whereas most of our native roadside species find such conditions inhospitable, making it easier for the non-native species to establish and spread.

Key ID features:

- grows very tall (can exceed 5 metres) and forms dense patches
- stems are a yellow-green colour
- large, feathery seed head with darkened tip
- new leaf growth is blue-green, turning a golden colour in late fall and over winter

There is also a native subspecies of common reed (*Phragmites australis subsp. americanus*) that resembles the non-native common reed and the two can hybridize, making identification challenging. Native common reed will have stems that are reddish-brown at the base, a seed head that is less feathery and more branched looking, and leaves that are green rather than blue-green, while also being thinner and shorter.

Before attempting any management, ensure that the species you are concerned with is actually the non-native subspecies, as management of the native common reed will require different permitting and can have ecological consequences.

Additional resources:

- the **Great Lakes Phragmites Collaborative** has produced an excellent resource to help distinguish between native and non-native varieties
- particularly in northern regions of Ontario, you may be able to apply for DNA screening through the **Invasive Species Centre**'s *Phragmites DNA Screening Program* to confirm the variety
- for detailed management information, consult the ***Province's Best Management Practices Guide***

Get links to these and other partner resources on our website: https://foca.on.ca/phragmites




Common reed (left to right): habitat; plant; seed head; and phragmites management

Purple Loosestrife

(Lythrum salicaria)

Purple loosestrife is a non-native wetland plant that can commonly be found in areas with moist soil such as meadows, wetlands, and ditches, but it can grow on a variety of landscape types. It does tolerate drought conditions, so it can also be found in sandy or gravel shorelines and roadways. It can often be seen mixed in with cattails along roadsides, in wet fields, and bordering lakes. This species will begin its growth in the early spring, but the showy purple flowers usually begin to emerge in July.

Key ID features:

- vibrant, spiked clusters of many pink-purple flowers
- square, woody stems growing in groups of 1-15 on average and reaching heights of 0.6 to 1.2 metres height
- opposite, stalkless, lance-shaped leaves growing in pairs or whorls of 3

Purple loosestrife is a non-native species that has been in North America since the 19th century. It has been identified as invasive and has been the focus of management programs that utilise beetles as a biocontrol method, with varied levels of success. It tends to be more prevalent in summers with more rainfall, and less so in dry summers.

Consult the Province's **Best Management Practices Guide** for information on management: https://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/07/Purple-Loosestrife-BMP-April-2016-final.pdf

Purple loosestrife (left to right): habitat; and flower

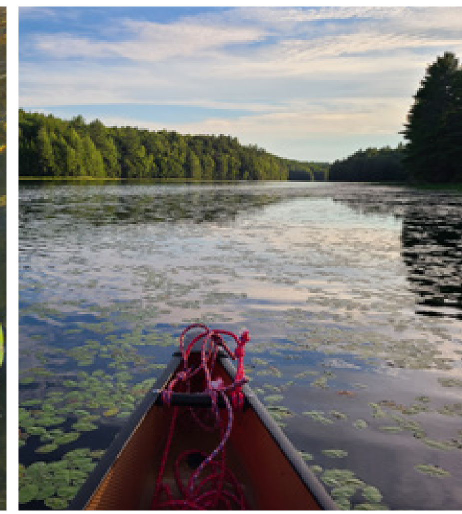
2.2 Floating-Leaved Plants

Floating-leaved plants are rooted in the lake sediment but produce leaves that float along the top of the water. They typically establish in water 0.5 to 3 metres in depth, with long stems that are built to withstand the stress of wave action of the water column.

Floating-leaved plants tend to have thick leathery leaves that protect them from being eaten or being torn apart by wave action.

These plants are superior at competing for light and will create a shaded environment below, forming a canopy on the water surface. Because of this, any submersed plants coexisting with floating plants tend to have some shade-tolerant traits.

The environment created by floating-leaved species is ideal for predatory fish, like pike and musky, because there is usually less plant matter occupying that zone in the water column, allowing the fish to swim freely while the floating leaves shield them from being spotted by predatory birds.



Floating-leaved plant leaves (water lily, left); and habitat (water-shield, right)

Floating-leaved Bur-reed
(Sparganium fluctuans)

Floating-leaved bur-reed is most commonly found in the calmer regions of soft water lakes. It tends to grow in sunny areas and can establish in water nearly 2 metres deep. Plants often grow in patches, with the long grass-like leaves all pointing the same direction.

Key ID features:

- floating leaves are long (up to 1 metre from sediment), slender (3-10 mm wide), flat, and translucent at the edges
- distinctive globe-shaped spikey bur (1.5-2 cm) emerges from the water's surface with multiple smaller male flowers occurring above the female burs on the same stem
- seeds have a strongly curved beak (the shape of the seed's tip resembles a cat claw)

This species can sometimes be mistaken for eelgrass (*V. americana*) and wild rice (*Z. palustris*) from which it can be distinguished by the size, shape, and appearance of its leaves. It can also be mistaken for other species of bur-reed with floating leaves, like least bur-reed (*S. natans*) and northern bur-reed (*S. angustifolium*), but floating-leaved bur-reed can be distinguished by having more than one male flower, and the strong curve of the seed's beak.

Floating-leaved bur-reed (left to right): illustration; flower and leaves; and habitat

Fragrant Water Lily
(Nymphaea odorata)

Also known as beaver root, this plant is commonly found in shallow lakes, ponds and slow-moving waters.

Key ID features:

- floating leaves are heart-shaped with a V-shaped split and veins that extend from where the stem attaches to the leaf
- picturesque white flowers with many petals and a yellow center, 7-20 cm wide, that open from morning to afternoon and have a fragrant smell

Fragrant water lily provides a source of food and shelter to fish and waterfowl, while offering humans a beautiful floral display for our morning paddles.

Fragrant water lily (left to right): leaves; flower; and leaves showing underside

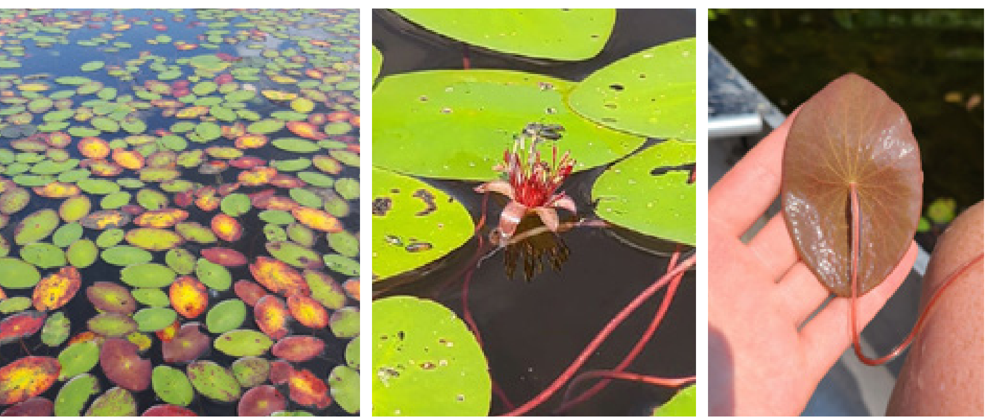
Water-shield
(Brasenia schreberi)

Water-shield is commonly found in areas with slow moving water and mucky, organic soils. It is often found scattered among other floating-leaved species like yellow or fragrant pond lily. Water-shield can establish in water just over 2 metres deep.

Key ID features:

- floating leaves are whole and oval with the stem attached to the center of the underside of the leaf
- underside of leaves is a reddish colour, coated with a clear jelly-like substance
- flowers consist of three petals and three sepals that are both purple-red in colour and nearly identical
- many pistils are present on the first day of blooming, while many stamens replace them on the second day

Water-shield produces a large overwintering tuber (starchy root) that provides the initial resources the plant requires for new growth in the spring. This tuber, along with the plant's younger leaves, are edible (though they might make for a slimy salad).



Water-shield (left to right): habitat; flower; and underside of leaf with mucus-covered stem

Yellow Pond Lily
(Nuphar variegata)

These lilies are typically found in the shallow areas of lakes, right before the lake turns to shallower marsh land. They often occur in large circular patches, sprouting from tubers buried under the sediment in calm areas. These tubers can sometimes become dislodged and float on the surface, which can sometimes be mistaken for a large snake!

Key ID features:

- large, heart-shaped leaves with rounded lobes (10-25 cm long) and veins running out from the main vein
- thick stems with one flat side
- large, scaled tubers that sometimes become dislodged and create large floating masses
- vibrant yellow flowers (4-6 cm wide)

Yellow pond lily is the preferred food for moose and is an important source of food and shelter for waterfowl, muskrats, beavers, and fish.

Yellow pond lily (top left to bottom right): habitat; tubers; leaves; leaf; and flower

European Water Chestnut
(Trapas natans)

European water chestnut is an invasive plant that prefers shallow, slow moving water with sediments rich in organic material. Currently, European water chestnut is only found in the Ottawa River and Wolfe Island in southeastern Ontario. It is very competitive for resources, and like other floating-leaved species (e.g. *Ceratophyllum demersum*), receives its nutrients directly from the water column and creates large amounts of biomass when there is an excess of phosphorus.

Key ID features:

- leathery floating leaves are diamond-shaped with sharply-toothed edges; leaves grow in a rosette formation around a hard stem
- floating leaves are attached to long stems with a spongy segment that gives buoyancy
- submersed leaves resemble a feather with fine leaf segments
- small white flowers (8 mm long) have four petals
- produces hard seeds with sharp barbs on them

Under **Ontario's Invasive Species Act, 2015**, European water chestnut is listed as a prohibited invasive species, meaning it is illegal to be in possession of it or transport it over land in Ontario.

Consult the **European Water Chestnut Rapid Response Program**: https://www.invasivespeciescentre.ca/take-action/european-water-chestnut-rapid-response-program/

European water chestnut (left to right): illustration; habitat; leaves; and flower – above photos courtesy Leslie J. Mehrhoff, U. Connecticut, Bugwood.org

Water Soldier
(Stratoides aliodes)

Water soldier is an invasive species that can grow in water that is 1 to 5 metres deep. It is an evergreen perennial that has two different growth forms: it begins its season submersed and attached to the sediment, but later in the season it can elongate its roots and float towards the surface, sometimes detaching entirely. It can be found in dense patches, typically in more stagnant bays.

Spread occurs by mature plants or their **offsets** (small clones growing from the mother plant) travelling with water currents or unintentionally moved by boats. Water solider produces **turions** - bud-like structures that detach and become buried in the sediment over winter, germinating in the spring.

Key ID features:

- long (40 cm) sharply serrated leaves that tend to scratch skin when handled
- leaves are a bright green color and grow in a rosette
- when the plant is buoyant, the leaves are stiff like an aloe plant, but submersed leaves or older leaves more closely resemble a household spider plant

Under **Ontario's Invasive Species Act, 2015**, water soldier is listed as a prohibited invasive species, meaning it is illegal to be in possession of it or to transport it over land in Ontario. To help reduce its spread, avoid boating in areas where it is established, as boat wake can dislodge plants and their offsets causing them to drift downstream to new areas.

Water soldier (left to right): illustration; habitat; and plant with offset and turion

2.3 Free-Floating Plants

Free-floating aquatic plants do not have roots attached to any substrate, although they sometimes get partially buried.

These species are unique in that they obtain all their required nutrients from the water column, as opposed to other types of plants that tend to receive at least a portion – often the majority – of their nutrients from the sediment in which they root.

For this reason, free-floating aquatic plants can be found in more eutrophic lakes where there is an abundance of nutrients, or in soft water lakes where there are fewer nutrients available in the sediment, so accessing them from the water is an asset. Free-floating plants will most often be found where they have drifted to and are sheltered from wind.

Free-floating species like duckweed provide food for waterfowl, while simultaneously removing excess nutrients from the water column, improving water clarity and light penetration for other submersed aquatic plants.

Free-floating bladderwort (left); duckweed leaves (right)

Common Bladderwort

(Utricularia vulgaris)

Common bladderwort is usually found floating just below the surface in still or slow-moving shallow waters of inlets or back bays. They may come up on your paddle if you are canoeing through these areas.

Key ID features:

- tiny bladders scattered between finely divided leaves
- yellow flower grows up above water on a tall stalk

Bladderworts are omnivores that capture in their bladders detritus, algae, and zooplankton as they float by in the water. When the bladders are empty they are translucent, but they turn black when they are filled with prey. There are several species of bladderwort in Ontario, some with root-like branches that become buried in the sediment, and they all feature these bladders somewhere on their anatomy. Bladderworts are found in both soft and hard water lakes. Towards the fall, common bladderwort will form a turion that will drop into the sediment to overwinter. In the spring, the plant regrows from this specialized bud.

Common bladderwort (left to right): plant; full bladders; empty bladders; and turion

Coontail

(Ceratophyllum demersum)

Coontail floats in still or slow-moving water at depths up to 5 metres. It has a range of light and salinity tolerances, so can be found in a range of habitats but is generally confined to shallow, nutrient-rich lakes. It can grow in large mats and often will be pulled up on anchors.

Key ID features:

- leaf segments grow in whorls of 5-12, becoming denser towards the branch tip to resemble a raccoon's tail
- leaf segments are 1-3 cm long, forked at the tip, and rough to the touch
- inconspicuous flowers

Coontail provides habitat for young fish and supports insects that ducks and fish like to eat.

Coontail (left to right): illustration; plant; leaves; and flower

Duckweeds

(Lemna spp., Spirodela spp.)

Duckweeds are a group of species of floating plant that consists of floating **fronds** (leaf-like structures) and a root or roots hanging below, depending upon the particular duckweed species. They can grow prolifically, covering a large area, especially in nutrient-rich areas but are native and not considered problematic. They are usually found in stagnant and nutrient-rich water, caught up among other vegetation. As their name suggests, they are a favourite food of waterfowl but also of fish, and they provide habitat and shelter for fish and benthic invertebrates. These plants have also been used in restoration activities, where practitioners will use them to remove pollutants in settling ponds as a form of water treatment.

Two common types of duckweed found in Ontario are greater duckweed, and star duckweed.

Greater Duckweed *(Spirodela polyrhiza)*

Key ID features:

- many roots attached to a solid red underside
- rounded fronds

Star Duckweed *(Lemna trisulca)*

Key ID features:

- single root
- branched, pointed fronds attached by stalks

Duckweed (left to right): illustration of star duckweed (above) and greater duckweed (below); star duckweed plant; greater duckweed plant; greater duckweed habitat - Claire Holeton

European Frog-bit

(Hydrocharis morsus-ranae)

European frog-bit is an invasive species usually found in sheltered areas with slow-moving water and lots of organic sediment. It somewhat resembles native water lilies but is smaller with a heart-shaped leaf.

Because it is a free-floating species, it tends to form dense patches in areas where it becomes tangled up with other vegetation like cattails or other emergent species. It does not tend to do as well in lakes found on the Canadian Shield, as it prefers the higher nutrient status of mesotrophic and eutrophic lakes.

Key ID features:

- leathery heart-shaped leaves about the size of a Canadian one-dollar coin, with a darkened, spongey underside
- leaves grow on long (4-6 cm) stalks in a rosette formation
- small white flowers with three petals and a yellow centre that attracts pollinators
- long (up to 50 cm) roots hanging underneath the floating leaves, with root hairs developing on mature plants

European frog-bit primarily reproduces vegetatively from **stolons** (horizontal stems from which a new plant grows) and forms large floating mats of plants with intertwined roots. It also produces many turions.

Consult the Province's **Best Management Practices Guide** for more information: https://www.ontarioinvasiveplants.ca/wp-content/uploads/2021/01/EuropeanFrog-Bit_Edn1.0_March2020.pdf

European frog-bit (left to right): illustration; turion; plant; and flower

2.4 Submersed Plants

Submersed plants are rooted on the lake bottom and grow up through the water column. Though these species will sometimes produce leaves or flowers that break the surface, most of the plant exists underwater.

A stand of submersed plants creates a complex and dynamic underwater forest that fish and other aquatic creatures use as habitat. Additionally, submersed plants are superior at absorbing energy from waves and slowing them down before they hit the shore. This creates a calm environment for sediments to settle to the lake bottom, resulting in clearer water in the immediate vicinity.

There is a wide range of species in the submersed aquatic plants group, with a wide range of adaptive mechanisms to secure valuable resources such as light, nutrients, and space.

One feature that most submersed plants share is how flexible the stems and leaves are. This flexibility allows them to roll with the waves instead of snapping and breaking. Being able to tolerate more wave action allows this group to extend their habitat beyond the calmer back bays to which floating and emergent species are restricted.

Submersed plant habitats, including pondweeds

Canada Waterweed

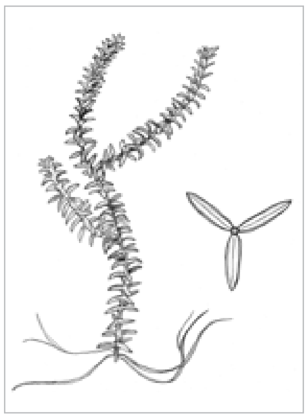
(Elodea canadensis)

Canada waterweed can tolerate a wide range of habitat conditions. It can be found in shallow and deep waters, still or slowly flowing waters, and in a range of pH. It can often be found growing in dense, underwater thickets and in sediment deposits between large rocks.

Key ID features:

- small oval leaves occur in whorls of three along a brittle, pale-coloured stem
- white roots may grow from places where leaves are missing
- resembles a succulent

This species breaks easily when touched and can reproduce through fragmentation. This property (among others) makes it a good competitor for resources in a lake. In calcareous lakes, the plant will often feel crusty from marl deposits on its leaves (see page 12 for more about marl).



Canada waterweed (left to right): illustration; habitat; plant; and upper leaves

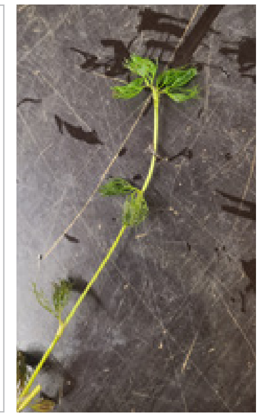
Crowfoot

(Ranunculus longirostris)

Also sometimes called water buttercup, crowfoot is most commonly found in shallow back bays with minimal wave action and fine textured sediment. It has some shade tolerance and can often be found in calcareous lakes.

Key ID features:

- stalked, segmented leaves grow up the stem alternatively, in a stepwise pattern
- leaves are finely segmented
- small white, five-petaled flowers float on the water's surface



Crowfoot (left to right): illustration; plant; and flower

Northern Star-grass

(Heteranthera dubia)

Northern star-grass is found primarily along muddy or sandy shorelines in areas that receive full sunlight, though it can grow at greater depth as well (an individual can grow to be nearly 2 metres long).

Key ID features:

- long flat alternating leaves with no pronounced midvein
- stem is swollen at base and where leaves attach, in other places can feel flattened
- yellow star-shaped flowers in summer, above the surface of the water

Star-grass can be confused with flat-stemmed pondweed but is differentiated by its swollen stem where leaves are attached.

Northern star-grass (left to right): habitat - Donald Cameron; plant; and flower

Pipewort

(Eriocaulon aquaticum)

Pipewort is most often found in the nearshore areas of soft water lakes with sandy or peaty sediment. It tends to form tufted mats right near the water's edge, so you are likely to find it as you wade into open, sunny areas at the shoreline. It can also be found at greater depths of up to 4 metres.

Key ID features:

- flower resembles a small white button, and is raised above the water on a long, singular stalk
- small, slender leaves arranged in a dense rosette
- roots are distinctly segmented and unbranched
- the roots and the leaves almost mirror each other

Pipewort (left to right): illustration; habitat; plant; and flower

Pondweeds

(Potamogeton spp)

Pondweeds are the most diverse and abundant type of plant in Ontario lakes. This great variety allows them to live in a wide range of environments. Pondweeds usually grow submerged in the water, though some also have leaves that float.

The plants provide food for animals and cool habitat to fish and aquatic insects. Pondweeds can limit the growth of harmful algal blooms by filtering excess nutrients from shallow water areas in conditions where algae might otherwise establish, namely hard water lakes.

Several pondweeds you might encounter in Ontario lakes are described on the following pages.

Pondweed (left to right): habitat; and seeds

Fern Pondweed

(Potamogeton robbinsii)

Fern pondweed is a low-growing species found blanketing the lakebed in water between 0.5-4 metres in depth. It can be found growing in clear or dark water lakes, in areas with plenty of detritus.

Key ID features:

- leaf pattern growing alternately from the stem resembles that of a fern
- flat leaves are 3-8 cm wide and 3-10 cm long
- the plant remains entirely submersed with no floating leaves

Fern pondweed (left to right): habitat; and plant on a water rake

Flat-stemmed Pondweed
(Potamogeton zosteriformis)

Tolerant of lower sunlight conditions, flat-stemmed pondweed can be found in shaded or sunny areas and – in comparison to some other pondweeds – in deeper regions of lakes.

Key ID features:

- flat stem (as implied by the name) that cannot be rolled between the fingers
- long (10-20 cm) flat leaves with stipules

Flat-stemmed pondweed (left to right): plant - Donald Cameron; and leaves – Donald Cameron

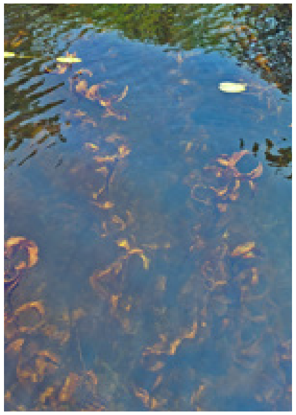
Large-leaved Pondweed
(Potamogeton amplifolius)

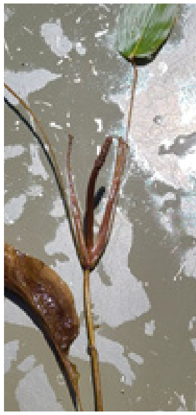
You will find large-leaved pondweed across much of Ontario, as you take your watercraft out toward open water. It is a submersed species that grows in deeper water than some other pondweed species. It enjoys deep, nutrient-rich sediments.

Key ID features:

- large leaves (3-7 cm wide and 8-20 cm long)
- submersed leaves alternate, with wavy edges and brownish colour
- floating leaves present later in the season

This species occupies a similar habitat to Eurasian watermilfoil (EWM), so the two are often competing for resources. Studies have shown that in ideal conditions this plant can outcompete EWM; large-leaved pondweed can grow 10-fold in its first season.





Large-leaved pondweed (left to right): illustration; habitat; submersed leaves; and floating leaves

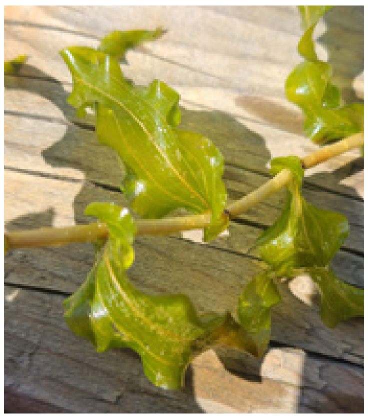
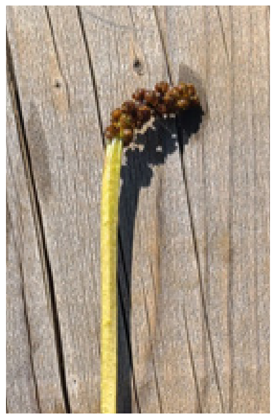
Richardson's Pondweed

(Potamogeton richardsonii)

A towering submersed species, Richardson's pondweed is found in areas of lakes with water less than 4 metres deep.

Key ID features:

- clasping leaves grow alternatively up a round stem
- leaves grow up to 10 cm long and 2 cm wide, with wavy edges and prominent veins
- no floating leaves present

Richardson's pondweed (left to right): plant; leaf; and flower

Variable-leaved Pondweed

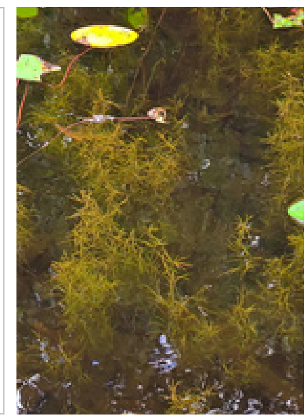
(Potamogeton gramineus)

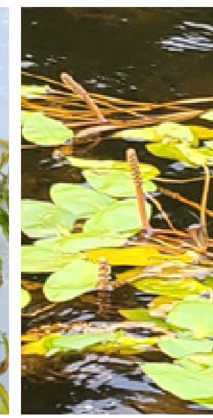
You can find variable-leaved pondweed by wading into the water up to your knees, or by looking off the side of your dock. It generally prefers calmer waters and will establish in stands with other species.

Key ID features:

- produces both submersed and floating leaves
- thin submersed leaves are 0.5-1 cm wide and 3-9 cm long
- floating leaves are oval with the stem attached to one end, and veins running the length of the leaves

The two distinctive leaf forms of this species allow it to receive sunlight from two different avenues: on the surface, the floating leaves capture direct sunlight, while the submersed leaves access the light that filters down through the water column. If variable-leaved pondweed finds itself in a competitive stand with other aquatic plants, it can put more emphasis on one of these strategies or the other, in order to fill the niche that will give it the best energy option.



Variable-leaved pondweed (left to right): illustration; habitat; leaves; and flower

Curly-leaved Pondweed
(Potamogeton crispus)

Native to Eurasia, curly-leaved pondweed is now found in nutrient-rich Ontario lakes with high levels of calcium, magnesium and other minerals. Curly-leaved pondweed is often found further out in the lake than other submersed species, because it has a better tolerance for low light conditions and low water temperatures. It also has a greater tolerance to conditions associated with high nutrient inputs.

This species begins its growing season early in the year and is one of the first to emerge in the spring. While it provides early food and habitat for lake organisms, its timing can disrupt the ecosystem's dynamics.

Key ID features:

- very distinctive crinkled leaf margins that feel a little rough (finely serrated)
- leaves grow in an alternate pattern along the stem
- small emergent flowers (not pictured here) are red brown in colour, each with 4 petal-like lobes, clustered on a stalk
- turions (over-wintering buds that resemble small brown pinecones with serrated edges) are produced in early summer, after which the plant usually dies off, with most turions remaining dormant under the ice through winter until water temperatures are around 5° C when they will sprout and plants will grow quickly

Curly-leaved pondweed (left to right): illustration; habitat; leaves; and turion

Tape-grass
(Vallisneria americana)

Also known as eelgrass or wild celery, tape-grass can grow into extensive beds in slow-moving water. It can tolerate low light conditions, and therefore is often found growing underneath other aquatic plants such as floating-leaved plants.

Key ID features:

- long (up to 1 metre), flat, rounded, tape-like leaves growing in a rosette formation from **stolons** (creeping horizontal plant stems that take root to form new plants)
- flowers grow up from the base of the plant on spiral stalks

Tape-grass may resemble other aquatic plants like floating-leaved bur-reed and wild rice but can be distinguished by its flowering structure. Additionally, a blade of tape-grass, when broken in two, will reveal a string of mucus momentarily connecting the two segments.

Tape-grass (left to right): illustration; plant; leaves - Donald Cameron; and flower

Water Marigold

(Megalodonta beckii)

Water marigold is not as common as some other species, especially in more northern lakes. It can be found in amongst other submersed and floating-leaved species in slow-moving, sunny waters.

Key ID features:

- submerged leaves are opposite, 2-4 cm long, and finely segmented
- towards the tip of submersed portions, leaves are densely bunched with a flat top
- vibrant yellow flowers with 6-10 petals begin their growth underwater and emerge from the water's surface in shallower areas

Water marigold also has the appearance of underwater pipe cleaners (recall the growth of fanwort), but while it can be abundant in some areas, it does not grow as densely as fanwort and the flower looks quite different. The late-summer flowers above the water's surface attract insects.

Water marigold (left to right): illustration; plant; emergent leaves; and flower

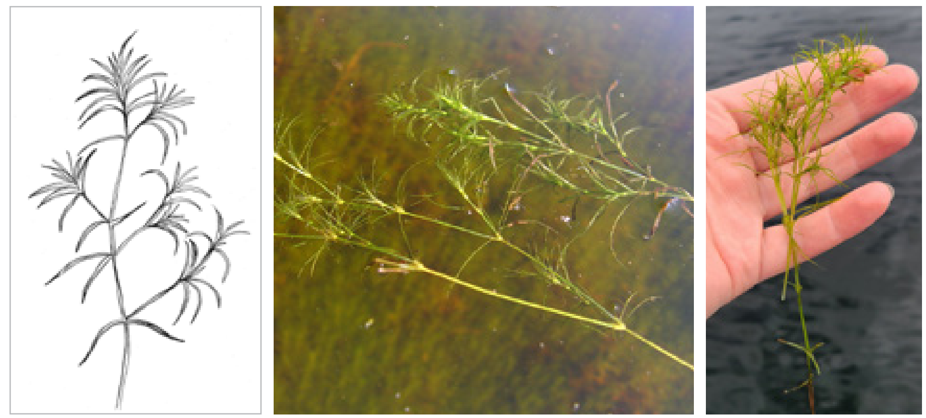
Water Naiad

(Naja flexilis)

Water naiad (or water nymph) has two growth forms: tall and slender, or short and bushy. Which form it takes is dependent on its environmental conditions. When it is in more productive lakes where water clarity is low, it takes on the taller form as it reaches towards the surface for more light. In less productive lakes it takes on the bushier form, as it does not need to put as much energy into growing up to the light.

Key ID features:

- very slender (less than 1 mm wide) pointed leaves with tiny teeth around the margin
- the leaf is not divided; the blade is in one segment
- leaves grow oppositely along the stem



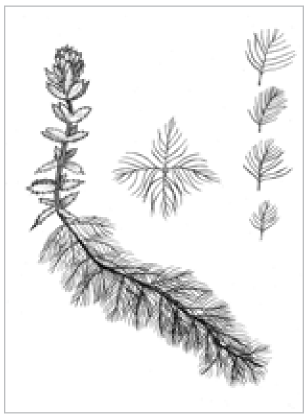
Water naiad (left to right): illustration; habitat - Donald Cameron; and plant

Watermilfoils
(Myriophyllum spp.)

With their tall flexible stems, most watermilfoils can tolerate more wave action than other aquatic plants, and so can be found in more open water than some other submersed plants.

There are several species of native watermilfoils in Ontario including northern watermilfoil, alternate-flowered watermilfoil, and variable-leaved watermilfoil. Native varieties are usually found in water that is 1-3 metres deep. Though perhaps not as common, these species were included in this guide to show the difference between the native species and the non-native species - Eurasian watermilfoil - that is often the subject of management efforts for invasive species.

Each of these species is described on the following pages.



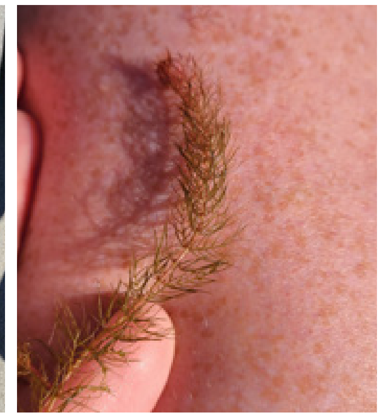

Watermilfoils (left to right): illustration (top right, from top to bottom: variable-leaved, Eurasian, northern and alternate-flowered leaves); and habitat

Alternate-flowered Watermilfoil
(Myriophyllum alternifolium)

Key ID features:

- slender stems, green to dark red in colour
- distinguished from other milfoil species by its small leaves which are less than 1 cm long and have fewer than ten segment pairs
- flowers (not pictured here) grow alternately along the plant's spike, giving this species its name

This species is often confused with Eurasian watermilfoil because of its reddish color, but grows much shorter than the invasive species, and its mature leaves are much smaller

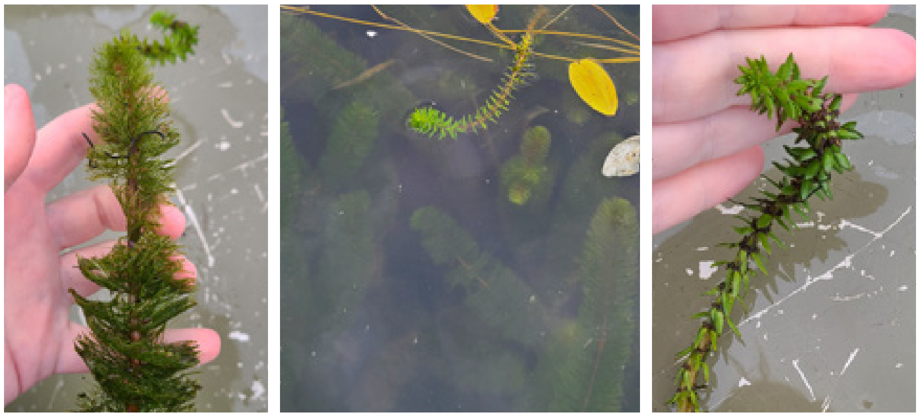

Alternate-flowered watermilfoil (left to right): plant; leaves; and stem

Variable-leaved Watermilfoil

(Myriophyllum heterophyllum)

Key ID features:

- leaves that grow at the tip of the plant and often above water are distinctively different than those that grow further down the stem
- submerged leaves are between 2-4 cm long, with 7-11 leaf segments arranged into whorls of 4-5 leaves each
- bright green leaves grow on spikes (5-15 cm) at the tip of the plant that may become emergent later in the growing season



Variable-leaved watermilfoil (left to right): plant; habitat; and leaves

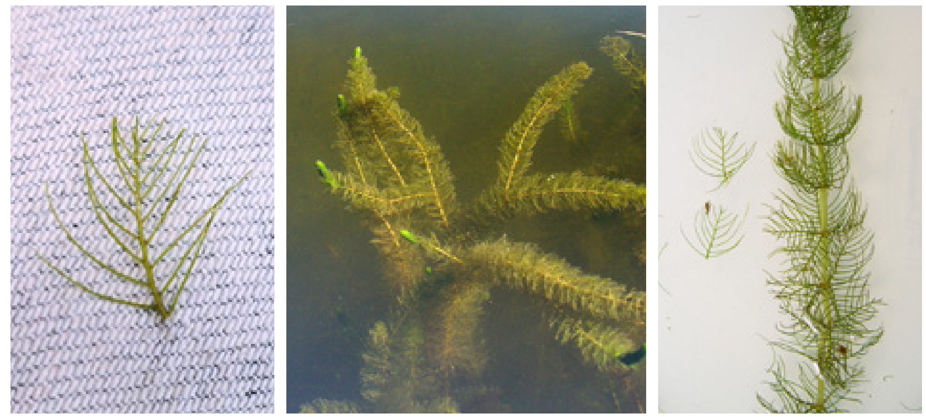
Northern Watermilfoil

(Myriophyllum sibiricum)

Key ID features:

- less than 10 leaflet pairs
- stems vary in colour but are typically green
- leaf shape is wide and rounded, compared to Eurasian watermilfoil (EWM)

The leaf of northern milfoil is wide and round like a spoon, compared to EWM that has more of a canoe paddle shape. Northern watermilfoil and EWM have been known to hybridize, and in locations where there had traditionally been northern milfoil and there has been an introduction of EWM, it is likely that the current species is a hybrid rather than a distinct species.



Northern watermilfoil (left to right): leaf; habitat – Donald Cameron; and plant – Donald Cameron

Eurasian Watermilfoil

(Myriophyllum spicatum)

Eurasian watermilfoil (EWM) is an invasive species that can be found in water up to 6 metres deep. EWM has been known to grow in dense mats that can crowd out some native species. As it grows, like all plants, EWM oxygenates the water as a biproduct of photosynthesis. However, as is the case with all plants that create high biomass, the breakdown of this plant when it occurs in great abundance requires a greater amount of oxygen, which can affect water quality.

Human use of the lake can sometimes be impeded by dense stands of EWM, whether it be for swimming or boating.

Key ID features:

- feather-shaped green leaves have 12 or more thread-like leaf segments on slender stems up to 2.5 metres long
- leaves are whorled around a reddish pink to green stem
- raspberry-red flower spike can be 5-20 cm long, and can grow erect above the water surface, blooming in late July and early August

EWM is an excellent competitor that tends to do well in areas of high disturbance. Management of this species is difficult as it can spread through plant fragments. Management efforts risk creating more fragments and perpetuating the issue.

Read about management do's and don'ts in chapter 3, and consult the Province's **Best Management Practices Guide** for more information: https://www.ontarioinvasiveplants.ca/wp-content/uploads/2021/01/Eurasian-Water-Milfoil_Edn1.0_March2020.pdf

Eurasian watermilfoil (left to right): leaf; flower; and infestation – Leslie J. Mehrhoff, U. Connecticut, Bugwood.org

Fanwort

(Cabomba caroliniana)

Fanwort prefers soft water lakes, so is most likely to be found in areas on the Canadian Shield. It grows in shallow, slow-moving areas with plenty of sunlight, usually where water is less than 3 metres deep. Fanwort grows and spreads through fragmentation and rhizome production. This can cause it to form dense mats under the surface of the water that resemble large green 'pipe cleaners' looking down on it.

Key ID features:

- submersed feather-like leaves are finely segmented and grow oppositely along the stem
- floating leaves are very small and oval shaped
- small, white to pale yellow flowers emerge from the water from late spring to early fall

Currently, there are only a few locations in Ontario where fanwort is found, including Lake Kasshabog and connected parts of the Crowe River watershed in central Ontario. Recent studies have shown that when left undisturbed the plant community diversity will recover after the initial introduction as fanwort becomes integrated into the local system.

Consult the Province's online information: https://www.ontario.ca/page/fanwort

Fanwort (left to right, top to bottom): habitat; stand; flowers - Terry Rees; and leaves – Leslie J. Mehrhoff, U. Connecticut, Bugwood.org

2.5 Algae

Unlike the aquatic plants described above, **algae** are a group of photosynthetic organisms that do not have a vascular system. Instead, each cell can perform the basic functions of respiration, photosynthesis, and metabolising nutrients. Reproduction often occurs asexually through cell division and fragmentation.

Algae are critical to the life cycle in lakes. They are the base of the food chain, convert nutrients to organic matter, and oxygenate the water. Fish production relates directly to the amount of algae in a lake; if there were no algae, there would be no fish.

While algae are normally present in most lakes, an increase in nutrients (like phosphorus and nitrogen) is directly correlated with an increase in algae. As is the case with most organisms, too much algae can alter lake function and greatly reduce the space and resources available for fish and other organisms.

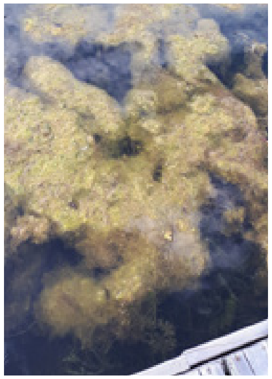
Excess algal growth is referred to as an **algal bloom**, which can occur as a result of warmer water, more sunlight, an increased concentration of available nutrients, and other larger ecosystem changes over time, like shorter periods of ice cover, and other system imbalances.

Algae come in all shapes and sizes. **Macroalgae** is a colony of single-celled organisms that group together in a form that can resemble a plant. Other types, like **filamentous** or **blue-green algae**, do not have as much structure and are commonly seen attached to underwater structures, floating on the surface, or washed onto shore.

Most algae are harmless to humans and pets, although it may form clumps that make wading in shallow water unpleasant or produce an odour that is displeasing to us.

Some species of a particular kind of algae – blue-green algae – can harm humans and animals, and suspected sightings should be reported and the water avoided until a determination can be made.

Read onward for more details about some common types of algae you may see in Ontario lakes.



Algae (left to right): algal bloom; dock-side algae

Blue-green algae

(Cyanobacteria spp.)

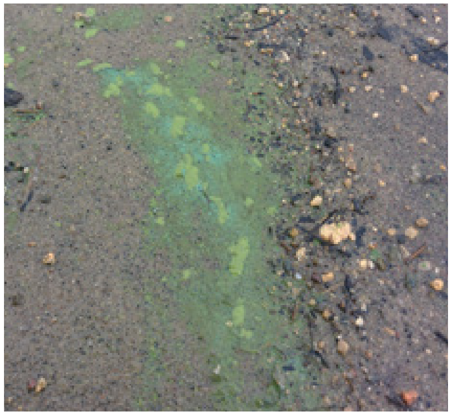
Blue-green algae are microscopic organisms that occur naturally in ponds, rivers, lakes and streams. Although often blue-green in colour, they can also be olive-green or red.

Blue-green algae are almost always present in lakes, but some conditions can trigger increased growth to the point where blooms occur. In instances such as these, the water can look like pea soup or turquoise paint. These algae are most often found in areas where the water is shallow, slow-moving and warm, but can also be found in deeper, cooler waters. Fresh blooms have the smell of freshly mown grass, while older blooms may smell like rotting garbage.

Some varieties of this algae can produce toxins that are harmful to humans and pets if they are consumed. Blue-green algae are sometimes referred to as Harmful Algae Blooms (HABs). If you see a blue-green algal bloom, assume toxins are present and avoid drinking, swimming, or allowing pets in the water. Importantly, note that boiling water does not remove the toxins and in fact intensifies them!

It is always best to act with caution and report suspected blue-green algae blooms to the proper authorities so appropriate actions are taken and public advisories are circulated. To report a suspected blue-green algae bloom, contact the **Spills Action Center**: 1-800-268-6060.

The Province posts additional information about blue-green algae online here: https://www.ontario.ca/page/blue-green-algae.



Blue-green algae (left to right): bloom – Ontario Ministry of Natural Resources; on shoreline – Claire Holeton

Muskgrass

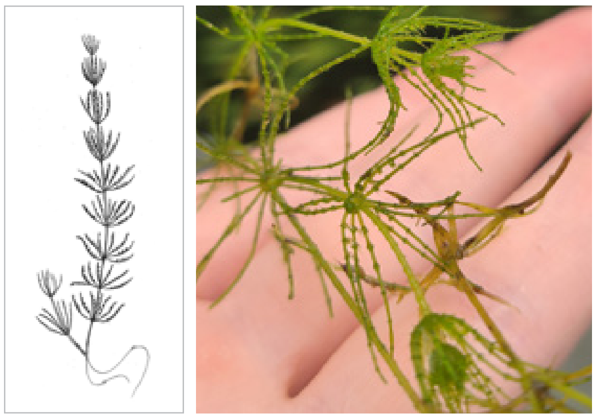
(Chara spp., Nitella spp.)

Muskgrass is most commonly found in calcium-rich lakes particularly in calm, shallow, and sunny regions. However, some species have adapted to living in deeper regions or in soft water lakes.

Key ID features:

- distinctive musky smell
- barbed, brittle branch-like structures grow in uniform whorls with no flower
- dries out very quickly when removed from water

Fragments of muskgrass can be spread by the current or by waterfowl. Many species of ducks feed on muskgrass, and it provides habitat or shelter for invertebrates and small fish. This is especially important when *Chara* is established at greater depths, as it provides habitat for organisms where few other algae or plant species can survive.



Muskgrass (left to right): illustration; and plant-like structure

Starry Stonewort

(Nitelopsis obtusa)

Starry stonewort (SSW) is an invasive macroalgae that looks like a submersed plant. Tolerating both high and low light conditions, it can be found growing in distinct pillowy mounds anywhere from 0.25 to 10 metres in depth.

Key ID features:

- bright green, brittle, and smooth branchlets occur in whorls of 4-6
- transparent root-like filaments with attached star-shaped **bulbils** (resembling beads)
- branchlets appear similar to the stems and leaves of vascular plants, but are much less complex and have less distinctive features

Only male SSW specimens have been documented in North America; thus, its reproduction and dispersal here has only been through clonal fragmentation.

It can be easy to confuse *Chara* with SSW; however, the illustration and the image below show the differences, with SSW on the right, in each case.

Left to right: Comparing chara (on left) and starry stonewort (on right) – illustration; and plants; starry stonewort whorl

Starry stonewort (left to right): bubils; habitat; plant; and growth

Filamentous algae

(Spirogyra, Cladophora, et al)

Filamentous algae are often found growing on underwater structures like rocks, plants, or logs.

Key ID features:

- most often appears as a dark green scum
- feels like they are made of threads or mesh, when touched

Though they most often attach to surfaces, high growth rates can cause them to form floating mats that the current may wash into back bays or onto shore. Filamentous algae tend to break off from surfaces in the late summer. They do provide habitat for amphipods, insects, and other small organisms in otherwise exposed areas.

Filamentous algae (left to right): algal growth amid wave action, St. Lawrence Seaway - Claire Holeton; algae from excess nutrients

3.0 Management Considerations

Did you just jump directly to this chapter? If so, you might have missed an important earlier message, so we want to restate it here:

FOCA is often asked what should be done about all the so-called 'weeds' on a waterfront. In many cases the answer is: do nothing – that plant is meant to be there, and it has an important job to do!

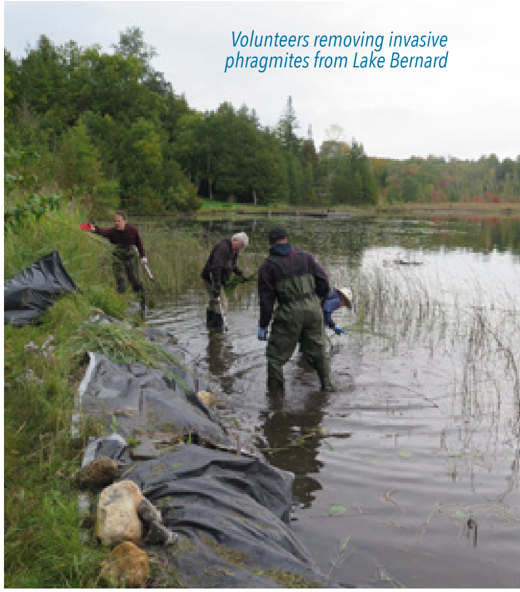
In some cases, the answer is: that plant is non-native and has the potential to disrupt the natural system. However, there may be specific restrictions on what can or should be done to remove or manage it, depending upon where you are located and the plant in question.

Sometimes even a native aquatic plant – one that's meant to be there – can become so prolific that it affects your ability to swim or boat near shore.

This chapter is meant to help you decide what you might consider doing next.

Above all, the best move when it comes to invasive species is prevention and monitoring, as management can be challenging, and eradication may be impossible.

Take the time to get to know your lake, and the normal cycles it displays. Having a good knowledge of the baseline aquatic plant community will help with early detection of new arrivals, and in creating an effective action plan to address shifts away from this baseline community.



Volunteers removing invasive phragmites from Lake Bernard

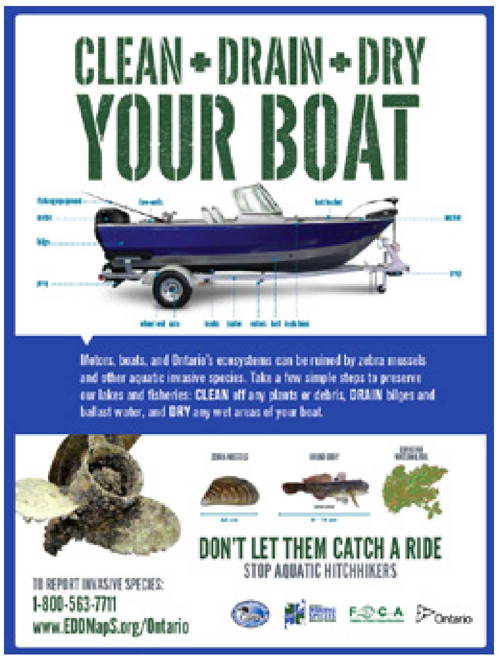
3.1 Best Management: Spread Prevention

There are many ways that a new aquatic species can become introduced into a waterbody including boat ballast discharge, release or escape of aquarium species, and boat movement between waterbodies.

Lake users can help reduce the potential for invasive introductions by being mindful of the species already present in the lake, and by removing any organisms from their equipment before visiting a new lake.

Knowing what existing invasive plants are in a lake, and where, can help reduce their spread. Avoid boating near patches of species that are known to easily fragment like Eurasian watermilfoil, Carolina fanwort, and starry stonewort. This can decrease the number of fragments that become lodged on watercraft and are subsequently transported through the water system.

The **Clean + Drain + Dry** initiative encourages boaters moving between waterbodies to be active in reducing the potential for unwanted 'hitch hikers' on their equipment. It takes only a few moments to remove organisms that get caught on boats, trailers, or gear to prevent delivering them to a new lake.



In Ontario, it is now the law for boaters to remove or open all drain plugs in their watercraft before transporting over land, and to take all reasonable measures to clean their watercraft and trailer of plants, animals, or algae. Cleaning, draining, and drying your boat (or canoe, kayak, paddleboard, etc.) as soon as you get ashore ensures that invasive species are not moved to a location where they have not yet been introduced.

Some aquatic plants can survive over a week out of water, so best practice is to leave a boat to dry for two to seven days before launching it at another lake, to ensure any hidden plant fragments are completely dried out and no longer viable.

The gold standard for 'best practices' includes washing boats and trailers with pressurized or hot water, and rinsing live wells with a 10% household bleach and water solution between uses.

For more Clean + Drain + Dry tips, visit: https://foca.on.ca/invasive-species/

Additionally, the Province of Ontario has published a series of **'action plans'** outlining tips for gardeners, anglers, cottagers and other groups to prevent the introduction or spread of invasive species. Access them here: https://www.ontario.ca/page/invasive-species-action-plans.

Clean + Drain + Dry in action

Sign at public launch

– Invasive Species Centre

3.2 Risks of Management: Perpetuation of a Problem

Once a stand of unwanted plants has become established, there are usually some options to manage or remove them; however, it is important to understand the consequences of inappropriate management or control efforts first.

Non-selective control measures – meaning plant removal efforts that do not differentiate between plant species – lead to native plants in the area being harmed even if they are not the target of the removal effort.

Additionally, all plants need space to become established, and one of the qualities of an invasive species is the tendency for quick establishment and a fast growth rate. A disturbed aquatic environment is an ideal location for invasive plant growth.

So, you've removed one 'weed', but have you just made space for another? You have created an open space or niche, with available resources for new plants to utilize. Native plants, although they may not be desirable, are a better option than open space, which can quickly become occupied with another species – more than likely a non-native or invasive species.

The same can be said for aggressive landscape management choices at the water's edge, like removing downed logs in the littoral (near-shore) zone or cutting back trees along the shore. These actions will deliver more sunlight to areas that would otherwise be shaded, in turn encouraging new plant establishment there.

All empty space in the nearshore will quickly become occupied by something, and with competitive reproduction strategies, fast growth rates, and a greater tolerance for disturbed conditions, invasive species are most often the first to establish.

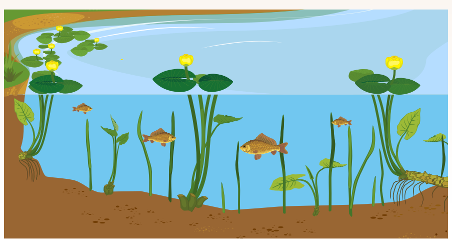
Finally, some control methods like the use of mechanical harvesters generate more plant fragments that can reestablish in the same area, or just move a little further down the system to establish in a new location, increasing the spread.

By reducing the fitness of native plants in a stand, we risk removing diversity and function from the area, which in turn reduces the system's resiliency and increases the community's susceptibility to invasion. Interrupting natural processes through over-management can, in some cases, create a perpetual cycle where the goal of management is never really met.

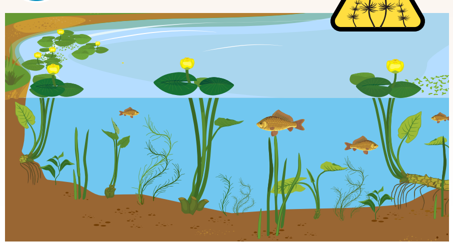
This negative cycle is illustrated in the figure below: **Understanding the Lifecycle of Plant Introductions.**

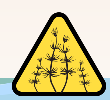
Understanding the Lifecycle of Plant Introductions

1 Preexisting Lake Community

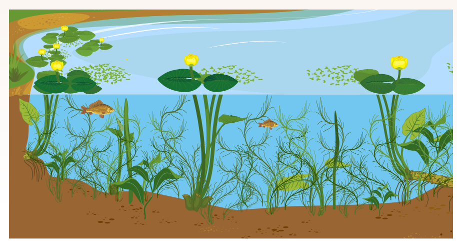


2 Introduction of AIS

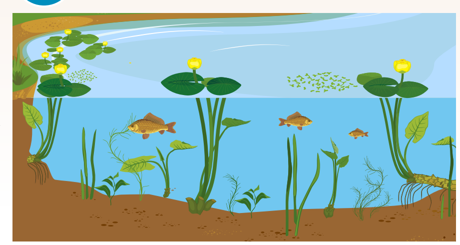




3 Nuisance



5 Naturalization

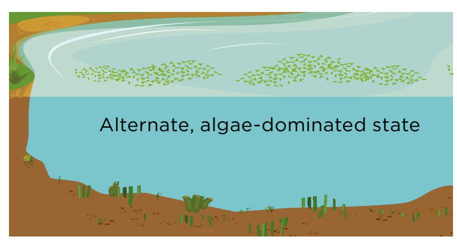


The natural balance of plants and animals (1) is disturbed by the introduction of aquatic invasive species (AIS) (2). This can create **a nuisance situation of too much plant growth** in one area (3).

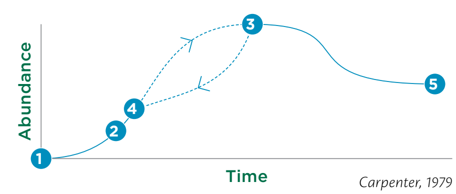
Cutting/over-management (4) can be a **costly process** and makes it more likely that AIS will in-fill the space. Research has shown that an infestation of AIS will often hit a plateau, then a die-off period, then naturalization (5).

In some situations, it is better to let nature take its course.

4 Cutting/ Over-Management



The best opportunity to minimize the spread of invasive plants is **prevention**. Always clean, drain and dry your boat.



Carpenter, 1979

3.3 Naturalization

Naturalization is the process by which an introduced species becomes a component of an ecosystem over time. A species that has become naturalized is self-sustaining in that location, and efforts to eradicate it at this stage are often infeasible.

Overall, not all introduced species behave invasively, and even a known invasive species may not behave invasively in every lake.

Even if there are periods of high plant density where some disruption of normal functioning is observed, it does not mean that our system is irreparably damaged. It just may take some time for the various species to balance out and come into a new equilibrium.

Habitat and naturalization of purple loosestrife among cattails

The current framework on which most invasive species management planning operates does not anticipate naturalization after periods of high density; however, there are mechanisms in place within our ecosystems that help regulate introduced species, and in some cases, they become incorporated into the system itself.

One example of naturalization is **purple loosestrife**. It has long been touted as a scourge of wetlands, and many control efforts and financial resources (both at the individual and government level) were directed at stemming its 'take-over'.

Despite its notoriety as a problematic invasive species, purple loosestrife is now often studied in co-existence with many wetland plant species. It serves birds, bugs, and other animals as food and shelter.

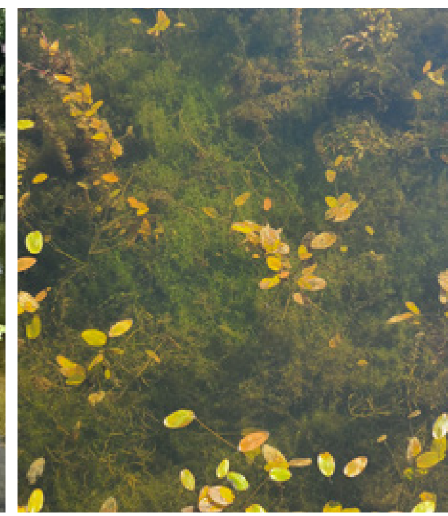
This is not to say that its presence will have no influence on a wetland, but there is little scientific evidence to suggest significant negative ecological consequences. In certain instances, purple loosestrife forms large stands not unlike cattail, but these tend to be disturbed areas (ditches, drained wetlands, flooded woodlands, pastures, etc.) and usually where several other species of plants are found growing as well.

In such instances it is worth asking if this plant is worth the considerable amount of negative attention and management resources it has received over the past four decades.

If we understand that the existence of some invasive species may not necessarily result in ecosystem collapse, management decisions in the later stages of invasive species establishment may adjust accordingly.

There are very few examples of successful large-scale invasive species eradication in freshwater lakes, so it becomes pragmatic to learn how macrophyte communities change over time after the introduction of a new species.

We should continue to direct our attention to the pressures humans can place on aquatic systems, and consider how our disturbances as described above change the environmental conditions that affect the native plant community. Otherwise, our actions may inadvertently create the very conditions that favour invasive species.



Two images at the same location over time (left to right): starry stonewort in high abundance in 2020; and notable resurgence of native plants and improved diversity in 2024

3.4 Control Options

There are various ways to manage the control or removal of aquatic plants, but consultation with the Department of Fisheries and Oceans, Ministry of Natural Resources, your local municipality and Conservation Authority, and/or Parks Canada should precede any actions to ensure management falls within the restrictions and guidelines, and has proper permitting. General contact information can be found in chapter 3.5.

Options described below include **physical removal** by various manual or mechanical means, introduction of a physical **barrier** to prevent plant growth in a particular area, **herbicide** treatments, and **biocontrols**.

Not every option is a good solution for every plant or ecosystem.

Established best management practices for many aquatic invasive species in Ontario will help guide you to make informed decisions for management and control plans appropriate to your situation. Consult the many guides that have been published by the Province, here: https://www.ontarioinvasiveplants.ca/resources/best-management-practices/.

Read onward for more about various control methods.

Physical Removal Options

Hand Pulling

Hand pulling is the most selective method of macrophyte removal and is also the cheapest!

Consider hand pulling if you are confident that you can distinguish the target plant from others in the stand. Consult the identification section of this guide (chapter 2), or others available in print or online to properly identify the species you intend to manage. Then, research that particular species to understand the best management practices. Determine if it is regulated and will require special permits or procedures. (See chapter 4.6 for more information.)

Hand pulling is useful if you want to manage individual plants or a small, localized area; it can become overly labour-intensive to hand pull if the amount of biomass to be removed is too great. Be especially mindful when hand pulling plants that spread via fragments – it is important that the entire plant is removed, and no fragments remain in the water; otherwise, pulling may actually increase the abundance of the species in that and adjacent areas.

One additional benefit of hand pulling is that it can strengthen your relationship with the ecosystem. You can do it whenever you are at the lake, and it can feel very rewarding to steward your own waterfront!

Harvesting

Harvesters act like large, floating lawnmowers in the water. They cut off the parts of plants that are above the sediment, leaving the base and roots intact. Behind the cutters there is a conveyor belt to collect and transport the clippings to an attached barge. The resulting biomass can be disposed of, when the barge returns to land.

Harvesters are very effective at clearing large areas quickly, but they are non-selective and expensive. Although there are companies you can hire to provide harvesting services, you will likely need to apply for a work permit to have this type of work done on your waterfront.

Because harvesters do not collect the plant roots, regrowth can occur relatively quickly. The effects may only last for a few weeks or one season, depending on the environmental conditions of the area and the plant in question.

Phragmites ready for proper disposal

Harvesters – Brett Tregunno

Raking

Rakes can be used to remove aquatic plants that are growing at your waterfront, as well as those that may wash up on the shoreline. This control method is only effective in the nearshore area where you can easily access the targeted plants.

An advantage of raking over hand pulling is that you can be selective in removing only certain patches of plants with a rake, while still bringing up a reasonable amount of biomass at a time.

Take great care to collect the floating fragments produced by raking, and to properly dispose of the plants removed on land away from the water's edge. Failure to do so can result in regrowth in the immediate area, and new growth in adjacent or downstream areas.

It is important to note that raking can disturb substrates important for fish spawning, so should not be done during fish spawning seasons; avoid removing rocks and gravel in the process. For more about spawning seasons, consult: https://www.ontario.ca/page/water-work-timing-window-guidelines.

Suction Harvesting (DASH)

DASH is an acronym for "**diver assisted suction harvesting**" – a control method that involves sucking up plants using an underwater vacuum directed by a SCUBA diver. The diver directs the vacuum towards patches of the target species, which is then sucked up into storage on a nearby boat, for later disposal.

This method is considered somewhat selective and is certainly fast, in comparison to others. A trained diver can remove around 2 cubic metres of plant material in five minutes.

However, there are some drawbacks. Even if the operator is diligent, there is a risk of harming native plants and other organisms in the treatment area.

Sediment type can also influence the effectiveness of suction harvesting, as roots are more difficult to remove from some types of heavy, mucky sediment. At the other end of the spectrum, silty sediment gets easily suspended using this method, and may be removed along with the plants during the suction process.

DASH is quite expensive as this method requires hiring a specialized team and equipment.

Raking up Eurasian watermilfoil

Installing a benthic mat to control fanwort

Physical Barriers

Benthic Mats

Benthic mats are blanket-type materials that are laid out along a lake bottom, right over a stand of plants to be controlled. This method functions by blocking plants' ability to access sunlight, therefore hindering growth. This is a non-selective means of plant suppression, meaning the mats will simultaneously reduce the ability for any native plants underneath them to photosynthesize, as well. Keep in mind that this can create the blank slate that favours competitive – often invasive – species, which could create a new problem on your waterfront.

Benthic barriers work well for small dense areas of aquatic plants, particularly around docks or swimming areas. They can be cumbersome to install and require maintenance throughout the season as they can shift when disturbed or bubble-up because of released gases from the decaying plants underneath.

Benthic barriers also tend to accumulate algae. Once a sediment layer accumulates on top of the benthic barrier later in the season, or in future years, it may be beneficial to transplant native plants onto the mats to reduce this concern for algal growth, or the potential for invasive species establishment over the mats.

Parks Canada, which has jurisdiction on lakes located along the Trent-Severn or Rideau Canal waterways, prohibits the use of benthic barriers on those waterways, and anyone on Provincial Crown land requires prior permissions from the Ministry of Natural Resources to place them. (See chapter 4.6 for more.)

Shade Tarps

Shade tarps are suspended above a stand of plants to reduce the amount of sunlight available to the target species underneath, inhibiting plant growth. Like benthic barriers, shade tarps are non-selective, affecting both invasive and native species below them. However, depending which target species is being controlled, tarps that shade out more or less light may help to mitigate the negative effects on native species.

Parks Canada, which has jurisdiction on lakes located along the Trent-Severn or Rideau Canal waterways, prohibits the use of shade tarps on those waterways, and anyone on Provincial Crown land requires prior permissions from the Ministry of Natural Resources to place them. (See chapter 4.6 for more.)

Herbicide Treatments

The **Pest Management Regulatory Agency** is responsible for granting registration for the sale and use of herbicides in Canada, under the Pest Control Products Act (SC 2002, c.28). There are hefty fines for causing harm to the environment in failing to comply with the regulations of the Act, which can be read online: https://laws-lois.justice.gc.ca/eng/acts/P-9.01/page-8.html#h-419055.

Before buying or applying any product on your property or to a waterway, consult Health Canada's pesticide label search tool for product information: https://pr-rp.hc-sc.gc.ca/ls-re/index-eng.php.

Currently, there are only two types of herbicides approved for use in aquatic environments in Ontario: **Reward** and **ProcellaCOR FX**, as described below. For each, there is a series of conditions to be followed, and permits and licensing required for the person doing the application.

It is crucial to the health of the environment that these products are used only as outlined on their product labels.

The labels are specific about the approved concentrations, appropriate target species they can control, personal protective equipment required to be worn when using them, and other important safety information.

Reward®

Reward® is a contact herbicide that uses the active ingredient **diquat** to hinder the metabolism of plants. Its restricted uses include the control of some aquatic plants including coontail, duckweed, canada water weed, pondweeds, water soldier, water chestnut, flowering rush, and watermilfoil in the early stages of growth. Some types of algae may be temporarily controlled with its use. It is not permitted to be used for aesthetic purposes.

This product is not effective on dense, mature stands of aquatic plants, so it is most effective early in the season as plants begin to grow. It functions by dehydrating any plant tissue, causing damage that disrupts photosynthesis. However, it only affects the parts of the plant it comes into contact with, and the growth-inhibiting effect is often only temporary if the chemical has not made contact with the whole plant. The chemical also binds with other suspended materials in the water and thus its efficacy is reduced in turbid waters. Reward® must be applied in the correct concentration and have enough contact time with the target plant to be effective. For in-water use, the strength of the water's current and depth of the target area must be carefully considered before application, as it is most effective on slow-moving, shallow waters that allow for the most contact time.

The use of Reward® can pose risks to the environment and human health. It can affect non-target species of aquatic plants and algae, potentially disrupting local fish populations due to changes in habitat structure and water chemistry. If it is used in a high-flow area, the product can be washed downstream causing harm to native plants. Human contact with the herbicide is also hazardous. Areas used for drinking water should not be treated with Reward®. Treated water should be avoided for swimming and fishing within 24 hours of the application, and not used for drinking or irrigation for five days. It is poisonous, so requires immediate attention if it is ingested, inhaled, or comes in contact with skin or eyes.

Read the details in the Reward® aquatic herbicide label: https://assets.syngenta.ca/pdf/ca/labels/REWARD_26271_en_pamphlet.pdf and review pages 70 to 73 of this guide before proceeding to use this herbicide only as permitted in Canada.

ProcellaCOR™ FX

ProcellaCOR™ FX is an herbicide with the active ingredient **florpyrauxifen-benzyl**, a compound that enters the plant's system through the leaves or roots and mimics a natural plant hormone to disrupt growth and nutrient transport throughout the plant.

It has only been registered for aquatic use in Canada since 2023, having been used in the United States since 2018. Other products containing florpyrauxifen-benzyl that have been recently registered for use in Canada include Milestone™ NXT and Restore™ NXT (which is an herbicide used to control several terrestrial species, including purple loosestrife).

ProcelllaCOR FX is most effective in slow moving waters. To ensure only the area of concern is affected, great care must be taken by the applicator to assess the risk of the product drifting. There is potential for unintended effects if irrigation systems draw water downstream from the application area.

ProcellaCOR™ FX is the more expensive option for herbicide control, but it is credited with being much more selective to control targeted aquatic plants such as various watermilfoil and water soldier. **While it is marketed as a target-specific herbicide for Eurasian watermilfoil, it may affect native watermilfoils as well.** It appears to present fewer health risks to fish, reptiles, amphibians, or mammals than some other herbicide options; however, it is still a relatively new restricted product with significant regulations surrounding the conditions of its permitted use, and the qualifications of the applicator. Its use requires a permit from Fisheries and Oceans Canada.

Visit Health Canada's pesticide label webpage and 'search' for the ProcellaCOR™ FX herbicide label: https://pr-rp.hc-sc.gc.ca/ls-re/index-eng.php and review pages 70 to 73 of this guide before proceeding to use this herbicide only as permitted in Canada.

Biocontrols

Biocontrol is the process of using one living organism to control the growth of another, and can be an effective management solution. Biocontrol can be accomplished through the introduction of plant herbivores, predators, disease, or a fungal pathogen to reduce the biomass or viability of target stands of plants.

For instance, the release of leaf-eating **loosestrife beetles** (*Galerucella spp.*) has been employed for the control of purple loosestrife in Ontario since the early 1990s. These beetles have successfully established in desired areas and create pressure on purple loosestrife, their primary food source.

Similarly, the **milfoil weevil** (*Euhrychiopsis lecontei*) has been used more recently in Ontario for managing Eurasian watermilfoil. The larvae of this native insect bore into the plant's stem, disrupting the flow of gases and nutrients, while the adults graze on the plant's leaves. Because these weevils spend their entire lifecycle using the milfoil plants, they are an ideal candidate for biocontrol and have demonstrated an ability to reduce the density of milfoil stands.

Although biocontrol agents can effectively damage localized populations of purple loosestrife and Eurasian watermilfoil, their success can be inconsistent and depends on site conditions. Particularly, it is important for the surrounding area to be a suitable habitat for the new or augmented populations of biocontrol agent. In order for biocontrol to be successful, these agents need to be maintained at population levels that exert sufficient pressure on the plants to prevent rapid growth and spread. Continuous stocking to maintain these densities can be costly, and with so many environmental factors influencing their success, results are often highly variable and temporary.

Milfoil weevil (left to right): weevils on milfoil; close-up of weevil - Kyle Borrowman; evidence of weevil bore; and evidence of weevil grazing

3.5 Regulations for Management

This chapter outlines some general regulatory considerations for aquatic plant control projects. We offer some information on who to contact for permissions and required permits; however, each situation is unique, and you should always check with your local authorities prior to commencing any in-water work, to ensure you are following all applicable regulations. Contact information provided below is current as of June 2024.

List of Governing Bodies

When considering managing aquatic plants, it is essential to consult the appropriate authorities based on the nature of your project. Below is a summary of relevant agencies and their current contact information.

Important note: It is your responsibility to ensure that you are properly permitted, have completed all the required protocols, and have notified the appropriate authorities. **While this document can help guide the process, you must do your own due diligence to ensure your activities comply with all current legislation in your region.**

Transport Canada (TC)

Purpose:	Work that involves erosion protection works, dredging, or other major work that may affect waterway navigability or aquaculture
Consult:	https://tc.canada.ca/en/programs/navigation-protection-program/apply-npp

Department of Fisheries and Oceans Canada (DFO)

Purpose:	Projects that could impact fish or species at risk, or their habitat (like wetlands) require a DFO permit
Contact:	**Phone:** 1-855-852-8320 **Email:** fisheriesprotection@dfo-mpo.gc.ca
Website:	https://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html

Parks Canada

Purpose:	Activities on the Trent-Severn Waterway or Rideau Canal, Ottawa River, or national parks.
Contact:	Trent-Severn Waterway **Phone:** 705-750-7900 **Email:** trentsevern@pc.gc.ca Rideau Canal **Phone:** 613-283-5170 **Email:** rideau@pc.gc.ca Ottawa River (Infrastructure Ontario) **Phone:** 1-877-863-9672 **Email:** info@infrastructureontario.ca
Consult:	https://parks.canada.ca/docs/r/poli/page01

Ontario Ministry of the Environment, Conservation and Parks

Purpose:	Projects that aim to apply herbicide treatments
Contact:	**Regional Office:** https://www.ontario.ca/page/ministry-environment-conservation-and-parks-district-locator

Ontario Ministry of Natural Resources

Purpose:	Projects involving lake and river beds and shorelands, including the removal of native aquatic plants (excluding federal lands and private property).
Consult::	https://www.ontario.ca/page/crown-land-work-permits

Local Conservation Authority

Purpose:	All projects considering aquatic plant management should consult these authorities for information regarding local planning regulations
Website:	https://conservationontario.ca/conservation-authorities/find-a-conservation-authority

Local Municipality or Township

Purpose:	All projects considering aquatic plant management should consult these authorities for information regarding local planning regulations
Website:	https://www.ontario.ca/page/list-ontario-municipalities

Ontario One Call

Purpose:	Report suspected or potential impact to hydro or gas lines
Website:	https://ontarioonecall.ca/about-us/contact-us/

Native Plant Management Permits

In addition to the jurisdictions listed above, this section provides extra detail to help you determine if you will need a **Work Permit** from the Ontario **Ministry of Natural Resources (MNR)** for in-water work. Consult the MNR's online webpage for the rules for removing native aquatic plants that occur naturally in Ontario: https://www.ontario.ca/page/remove-native-aquatic-plants.

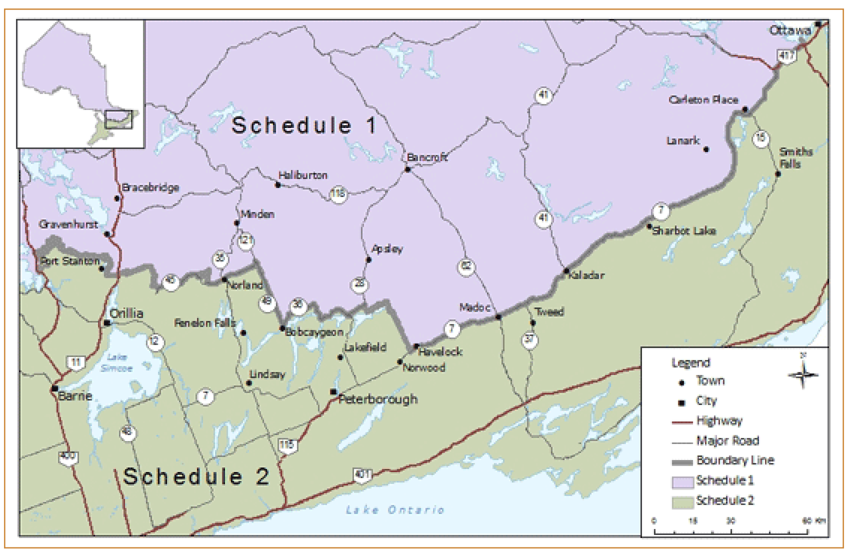
In summary:

You do not need a permit from MNR if…

- your property is south of the Schedule 2 boundary line (see map) and you can follow all the rules listed (e.g., only clear an area that is within the dimensions listed, etc.)

You do need a permit from MNR if…

- you cannot follow all the rules listed on that webpage (e.g., the work you intend to do is not directly in front of your own property; you intend to use a mechanical harvester, suction harvesting, or herbicides to remove plants, etc.)
- your property is located north of the boundary line, or on the shorelines of Georgian Bay or Lake Huron
- your property is located within the boundaries of a provincial park, conservation reserve, federal lands, or is on the Trent Severn, Rideau Canal or Ottawa River



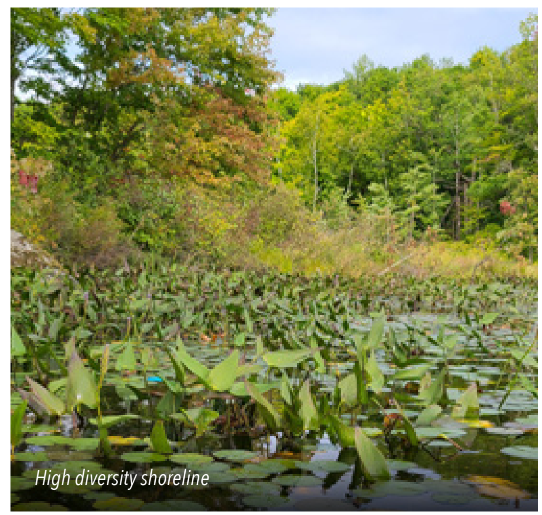
Ontario map schedule boundary – source: https://files.ontario.ca/schedmap_largescale.png

If you determine that you do need a work permit, download the application forms on that same MNR webpage and follow the submission instructions. Allow time for your application to be processed! Consult Ministry staff for approval timeline estimates.

If you cannot follow the rules, or if you conduct work without having a work permit where one is needed, you can be charged and fined by MNR.

A final note about timing: Be aware that in-water works are not permitted during fish spawning season or other critical fish life stage periods. Generally speaking, the period from mid-July to the end of August is unrestricted; however, dates vary based upon the location of your lake and the fish species in it. Consult MNR's online listing of timing window guidelines, posted to this webpage: https://www.ontario.ca/page/water-work-timing-window-guidelines.

These rules are in place to balance property owners' rights with the ecological integrity of Ontario's precious waterbodies. It is important to respect the rules and the spirit of their intentions so we can continue to enjoy the lakes we love, and the services they provide, while protecting them for generations yet to come.



High diversity shoreline

Water naiad stand in shallow water

Algae Reporting

If you have concerns or suspect your waterbody may have cyanobacteria (blue-green algae), contact the Ontario **Spills Action Center** by calling 1-800-268-6060, or visit https://www.ontario.ca/page/report-pollution-and-spills for more information.

Invasive Plant Management & Permits

If you believe you have found an invasive plant in Ontario, please report it to the **Invasive Species Hotline** by calling 1-800-563-7711 or online using **EDDmapS** – the "Early Detection and Distribution Mapping System" – at https://www.eddmaps.org/.

The most effective way to manage invasive plants is to limit their spread to new areas. Help spread the word about **Clean + Drain + Dry** principles (see chapter 3.1) to help boaters avoid becoming a pathway of spread. Awareness is key to protecting our precious waterways!

If you are planning on removing certain invasive plants from your waterbody – including curly-leaved pondweed, Eurasian watermilfoil, European frog-bit, fanwort, phragmites, water soldier and others – you will need to consider the same list of authorities mentioned in chapter 3.5 for permissions. You may also need to apply for permits, depending on your circumstances and the plant in question.

You will not need a permit from MNR to remove certain invasive species if you can follow all the rules outlined on this webpage: https://www.ontario.ca/page/remove-invasive-aquatic-plants. If you are unable to comply with these rules, you must apply for a permit before taking any action.

Herbicide Application Permits

In Ontario, all herbicides registered for use in aquatic environments have a restricted status, and therefore require a licensed exterminator for their application. It is the responsibility of the property owner to ensure that any products used are registered, and the applicator has the appropriate certifications. In order to legally use an aquatic herbicide, permits and permissions need to be obtained from the Ministry of Environment, Conservation and Parks (in compliance with the Pesticides Act), Fisheries and Oceans Canada (in compliance with the Fisheries Act), local conservation authorities, and local municipal authorities. Consult chapter 3.5 for contact information.

4.0 Final Thoughts

We live in the Anthropocene, an era where every environment on earth has felt the impact of human influence. Between land-use changes, pollution and climate change, the earth's systems have been thrown off balance and are settling into a new regime.

It may be best to accept that the natural areas we are familiar with will start to look different, because they are different than what they were. This is not meant to be a doomsday message, but rather a message to offer some perspective when it comes to management decisions.

Left to right: Fish in nearshore plants – Andy Metelka; pipewort habitat with cottage; and healthy shoreline diversity

We can be in a constant battle trying to manipulate the environment back to what we expect it to be, or we can take a step back and see where it is going and offer our help in easing the transition. The changes in the lake are a reaction to a changing environment.

The first step is to take a step back and to assess what can be controlled. Often, the answer is: our own actions on shore.

5.0 Index of Terms and Plant Names

General Terms:

[see separate plant names list, below]

Plant & Algae: