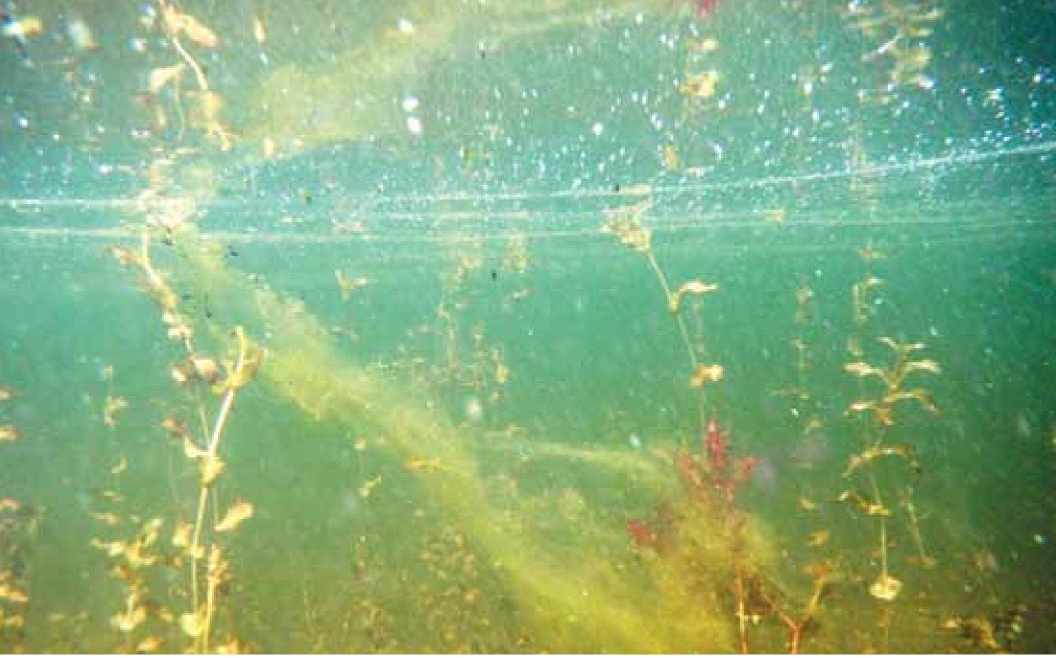

The Algae of the Kawartha Lakes

Their place in the ecosystem, when they become a hazard, and what controls their growth

KLSA

Kawartha Lake Stewards Association
2012

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A publication of the Kawartha Lake Stewards Association

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A message from the Kawartha Lake Stewards Association President

In his book *The Algal Bowl: Overfertilization of the World's Freshwaters and Estuaries*, scientist David Schindler draws a parallel between the eutrophication of freshwater lakes such as our Kawartha Lakes and the droughts that caused the Dust Bowl during the "dirty thirties". The Dust Bowl resulted from mismanagement of the land; the Algal Bowl is resulting from mismanagement of both land and water. Improved farming and irrigation practices have greatly reduced the dust bowl conditions. Now it is time to improve our watershed land and water management practices to avoid excessive nutrient enrichment of our waters.

To help Kawartha property owners better understand the issues involved, KLSA conducted a research study that investigated the growth, importance and management of aquatic plants in the Kawartha Lakes. The research was carried out by the Biology Department of Trent University and the results were published in our 2009 Aquatic Plants Guide. This project was made possible by a grant from the Ontario Trillium Foundation, which in 2010 supported KLSA in yet another water quality collaboration: a three-year program of research and education concerning algae in the Kawartha Lakes. This project was designed to increase our communities' knowledge and capacity to protect the Kawartha watershed.

In recent years an overgrowth of algae in some lakes has become a problem, concerning shoreline residents and visitors, so the time seemed right for this study. The project included several public workshops, the preparation and publication of this algae guide, and eventually a peer-reviewed scientific paper. The project was headed by Dr. Emily Porter-Goff, post-doctoral fellow at Trent University under the supervision of Dr. Paul Frost, the David Schindler Professor of Aquatic Science at Trent University in Peterborough.

I hope you will enjoy this booklet, *The Algae of the Kawartha Lakes*. Algae are unusual organisms that we sometimes need a microscope to see, that have no leaves or roots but produce oxygen as a by-product of photosynthesis. At the bottom of the food chain, algae are an important food source for the smallest shrimp and the largest whale. You know the taste from your last swim in the lake when you accidently breathed in instead of out. Would you believe research now suggests that algae may eventually become a commercially viable source of biofuel? Read on to learn more about this fascinating indicator of lake water quality.

Mike Stedman
President, Kawartha Lake Stewards Association

Introduction to *The Algae of the Kawartha Lakes*

By the scientific team

Algae are all around us. They occur in all sorts of environments, including on land, in water, and even in snow and ice. Algae are widely known for their role in lake foodwebs. Like an aquatic canary, they can also serve as an indicator of a changing environment, given their acute sensitivity to ambient conditions. We also are well acquainted with algae due to their ability to proliferate to levels beyond what we desire. Large mats of bubbling algal blooms can mar our enjoyment of the lakes and blue-green algae can be a health concern. Despite the important ecological role of algae, surprisingly little is known about them by swimmers, cottagers, and fishermen who frequent lakes and rivers. Common questions include: What are algae? What do they do? What do they look like?

We hope this guide will provide some answers to questions about algae for those who live, work and play around the Kawartha Lakes. To create this guide, we have combined our academic knowledge of algal communities with local information based on research conducted here in the Kawartha Lakes. All of this is summarized in this guide, which includes a general introduction to the ecology of algae and a brief summary of our study findings. We provide additional information about how to keep our lakes clean and our algal communities healthy. We have also included a list of common algae in the Kawartha Lakes, which is accompanied by photographs, some at normal-eye view and some at 400X magnification. It is our hope that this topical treatment of algae in the Kawartha Lakes will generate a better understanding of their place in healthy ecosystems. Perhaps this guide will even spark an interest in the omnipresent world of our tiny and important friends, the algae. You never know what you might find the next time you look closely into the water.

We would like to acknowledge the financial assistance provided by the Ontario Trillium Foundation, without which this work would not have been possible. Throughout it was a pleasure to work with the Kawartha Lake Stewards Association, who helped organize sampling adventures and assisted with our algal workshops in the summer of 2011. They also contributed significantly to this booklet both in its preparation and publication. Finally, we would thank all of the members of our lab at Trent who helped over the course of the study, including Emily Malcolm, Ryan Little, Ana Morales and Andrew Scott.

Dr. Paul Frost, Dr. Emily Porter-Goff and Colleen Middleton

Trent University, Peterborough

Algae in the Lake Environment

What are algae? Algae are extremely diverse in their size, cellular structure and biology, making them a difficult group to describe. They range in size from single cells that are scarcely visible under a common microscope (microalgae) to large multicellular forms such as kelp (macroalgae). Aquatic algae can be found attached to various substrates or floating free in oceans, lakes, ponds, streams and rivers. There are species that live in the soil, on snow, on the backs of turtles and even in the cells of coral. Some species reproduce sexually, other species reproduce asexually, and many do both. As some of the first oxygen-producing organisms to appear more than 1.5 billion years ago, it is no wonder that algae have diversified into thousands of unique species.

Algae are often confused with plants, as they both contain green pigments and use sunlight to obtain energy. The primary difference is that plants are made up of cells that differentiate into specialized tissues such as roots, stems and leaves, whereas algae lack these structures. Large groupings (colonies) of algal cells may result in forms that appear plant-like, but on a microscopic level, we can see that these shapes are due to the same type of cells being stacked in different ways. For example, *Chara* (also known as muskgrass) is common in the Kawartha lakes that have hard water, can grow up to 100 centimetres and is often misidentified as a plant. On the other hand, the simple, free-floating plant species of the genus *Lemna* (duckweed) is often confused with algae. Upon close examination, the tiny roots on the underside identify these organisms as vascular plants.

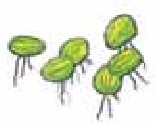


Figure 1. *Chara* (left) and duckweed (*Lemna*; right) both look like plants but only duckweed has different tissues (leaves, roots and stem) characteristic of vascular plants.

A place in the Kawartha Lakes ecosystem. Algae are an essential component of lake ecosystems because they take the energy from the sun and convert it into a form that can be used by other organisms. This process is known as photosynthesis. Algae are food for invertebrates and small fish, which are then fed on by larger fish, and eventually top predators, such as ospreys and humans (Figure 2). Thus, algae are a significant source of energy that supports the entire lake food web.

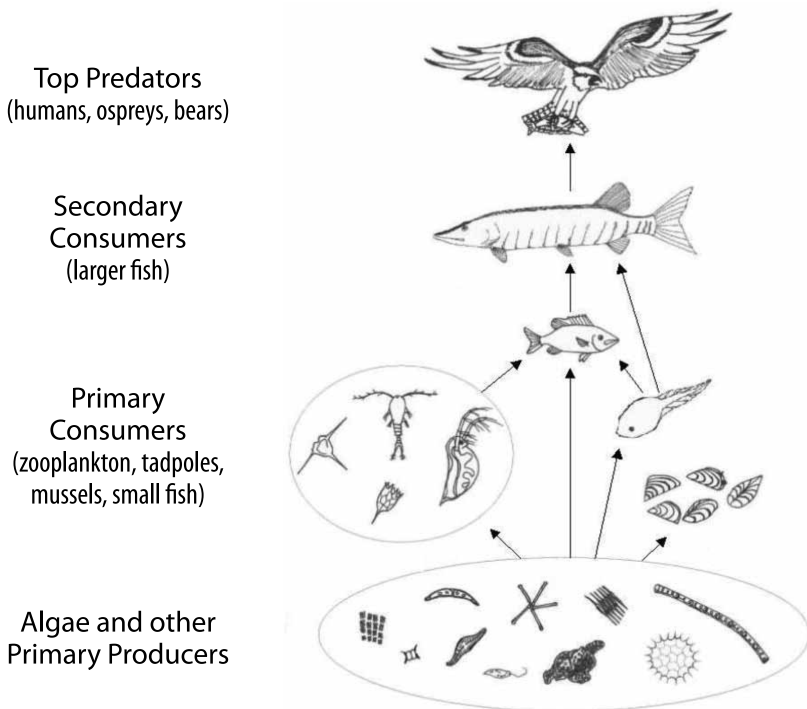


Figure 2. Kawartha lake food web. Algae are a primary source of energy for the lake ecosystem and can support all organisms above them.

Algal ecology. Algae need sunlight and moisture to grow and thrive. They also need nutrients, such as nitrogen and phosphorus, which are referred to as macronutrients because they are needed in relatively large amounts. There are about a dozen other nutrients that are required in smaller amounts (for example: iron, selenium, potassium, calcium, sodium and copper). The supply of nutrients controls how quickly algae can grow. If any one nutrient is not provided in adequate supply, algal growth will slow. However, if all required nutrients are supplied in excess at the same time, algae grow very quickly (See the section on algal blooms, p. 9). Algal growth can be further altered by environmental conditions. For example, low water temperature can slow algal growth even if all other conditions are optimal. Ultimately, the maintenance of a healthy algal community in our lakes depends on understanding how the environment shapes algal communities.

Freshwater ecosystems are often classified by the amount of nutrients and algae in the water. This is known as the trophic state of a body of water. The trophic state is determined by measuring water clarity, nutrients and the amount of algae. Oligotrophic lakes are generally quite clear, low in nutrients, and have little algae. Mesotrophic lakes are often less clear, have somewhat higher nutrient concentrations, and more algal biomass. Eutrophic lakes usually are very turbid, have very high nutrient concentrations, and much more algal growth. Generally, the Kawartha Lakes fall within the mesotrophic category with occasional periods of excessive algal growth typical of eutrophic lakes.

The current state of the Kawartha Lakes is partially a result of cultural eutrophication, which occurs when nutrients are added through human activity. In the past, the main source of nutrients was point sources such as sewage treatment plants that contained high-phosphorus laundry detergents. Their nutrient contribution was then greatly reduced due to improved sewage treatment and a ban on laundry detergent phosphate. Now, relatively more nutrients arrive from non-point sources such as runoff from agriculture, lawns and gardens, and urban stormwater. Nutrient management and sustainable living practices are key to maintaining lake ecosystem health.

Diversity and sensitivity. Over time, many algal species have evolved in the aquatic environment. One result of this evolution is that some species are very sensitive to environmental factors and can only live in specific conditions. Other species are very tolerant of a wide range of environmental conditions. Generally, healthy lakes support more diverse algal communities, containing both sensitive and tolerant species, whereas impaired lakes contain only more tolerant species.

A wetland virtually covered with mats of algae

Algal communities reflect the environmental conditions where they are found and are therefore very useful tools for monitoring water quality. Because algal communities change over days to weeks, the species and numbers present reflect water chemistry over longer time periods. This provides different information than that obtained from taking water samples for water quality analysis. "Snapshot" sampling, of one place at one time point within the lake, provides valuable information but is susceptible to considerable fluctuations. By monitoring the algae over time and identifying the sensitive and tolerant species in the community, scientists can better understand how water quality also changes over time.

Did you know?

Researchers are working to use algae as a source of biofuel. Algae can be grown in non-potable water and don't require much more than sunlight and carbon dioxide to grow. Currently, the most efficient way to grow algae commercially is in photobioreactors. Growing algae in outdoor ponds is generally less efficient. Harvesting wild algae from natural lakes is not a viable option because far more fuel is needed to collect and process wild algae than would be produced. Although there are still many hurdles to overcome, as fossil fuels are a non-renewable resource and CO_2 levels in the atmosphere continue to rise, algae may become an important energy source in the future.

ALGAE ARE A COMMUNITY. When you pick up a rock from your beach and it is covered with a brown-green slime, what exactly are you looking at? You are seeing an entire algal community made up of many organisms all living together. On that slimy rock, you are likely holding dozens of kinds of algae of all different types, bacteria, and fungi mixed with detritus (decaying bits of dead plants). This is all stuck together in its own little mini-ecosystem, neatly self-contained upon that rock. In the open water, planktonic, or free-floating, algae are just one part of a tiny community too.

While you look at the rock, you would not likely be able to identify any particular algae. This is because very few species of algae can be identified by the naked eye; what you are looking at may be composed of many different organisms living together. The composition of the community is affected by many things, such as seasons or disturbances such as severe storms. When the community changes, it behaves much like the succession observed as cleared fields transition back to forested land. Algal communities are also ever changing. Some algae will disappear while others become more numerous. These die-offs can create a vacancy for a new type of community to develop. This means that the algal community in the lake is not the same from week to week and from month to month. The algal community you see in the spring may not be the same as what you see in the fall, even if the communities may appear nearly identical to the naked eye.

ECOSYSTEM SERVICES. Algae play an important role in the ecosystem. As primary producers, they convert inorganic elements into biomass that is available for other creatures to consume, while recycling carbon dioxide and turning it into oxygen. Some scientists suggest that the algae in our lakes and oceans produce up to 80% of the world's oxygen. Algae benefit humanity in many other ways. Due to their high nutritional content, algae have been used in bioremediation to fertilize unproductive land. Algae are grown for use in commercial products, including pharmaceuticals, cosmetics and food. Algae, particularly kelp, are also used widely as a food source. The "seaweed" that is used to wrap sushi rolls is actually a type of red algae (although it is green in colour) that people have consumed for centuries.

ALGAL BLOOMS

NATURAL, HARMFUL, OR SIMPLY A NUISANCE? Algae are always found in lakes and ponds. Sometimes the amount of algae increases to a level that results in poor water quality. At the simplest, overly green water is the hallmark of an algal bloom. This can happen quickly as algae grow very fast and increase their population rapidly if provided with enough nutrients. The green waters of a lake experiencing an algal bloom bring with them uncertainty about whether to swim, beach advisories and taste and odour problems. They also negatively affect the healthy functioning of the lake ecosystem through reduced light penetration, low oxygen in bottom waters, increased internal nutrient loading and occasional fish kills.

Alga, algae, algal – what do we call them?

Throughout this guide we have tried to be consistent. "Alga" comes from the Latin word for seaweed. **Alga** is the singular noun form, as in "*Mougeotia* is a common alga in our lakes." **Algae** is the plural noun form, as in "Algae are abundant in the summer." **Algal** is the adjective, as in "Algal blooms are not flowers."

There are several species of algae that most commonly form blooms. There are different floating algae that can turn surface water green and opaque. This can give the appearance of "pea soup" from afar but upon closer inspection may look like lawn clippings or small green balls floating in the water. There can also be big clumps of filamentous algae that together form "blobs" that can be seen floating under the water surface. The species and amount of algae contributing to a bloom depend on a variety of factors including the nutrient supply, water temperature, light conditions, and the amount of grazing from small zooplankton.

One of the most widely known aspects of algal blooms is that they can present a hazard to human health. This is because some blue-green algae produce potent toxins that accumulate in the water. These toxins likely reduce grazing by zooplankton but also can cause harm to fish, waterfowl, pets and humans. Because of this toxic threat, it is advisable to avoid swimming in or drinking from areas of lakes experiencing algal blooms. Pets should be prevented from drinking the water or swimming in it.

WHAT ARE CYANOBACTERIA? Blue-green "algae" are actually prokaryotes (bacteria). Eukaryotes, the group that "true algae" belong to, contain membrane-bound organelles including a nucleus and mitochondria, whereas prokaryotes do not. Therefore, at a microscopic level, blue-green algae and true algae are quite different. However, from a broad perspective, they are similar in their ecological roles and functions. They both contain green pigments and have the ability to photosynthesize. Blue-green algae are more properly known as cyanobacteria.

The only way to know for sure that you are looking at cyanobacteria is by seeing what it looks like under a microscope. To the naked eye, they are usually slightly blue relative to most algae. They can form a "scum" on the lake surface, but are often simply suspended in the water. The most common bloom-forming blue-green algae in the Kawarthas float in and on the water, giving water the appearance of pea soup. These include *Microcystis, Gloeotrichia* and *Anabaena*. Another common blue-green alga is *Oscillatoria*. It can grow as hair-like filaments attached to rocks.

ARE CYANOBACTERIA DANGEROUS? Cyanobacteria have potential to cause harm because they can produce toxins. In Ontario, the most common toxin-producing genuses are *Anabaena, Aphanizomenon, Microcystis* and *Oscillatoriales.*

While cyanobacteria can produce toxins, they do not always do so. Toxin production varies with lake conditions. Health effects depend on the type of toxin that the species produces, the concentration of the toxin in each cell, the concentration of cells in the water, and the degree to which a person was exposed. There are several chronic and acute effects from toxin exposure. No human deaths have been attributed to cyanobacteria exposure; however there have been reports of mild (skin irritation, headaches, fever, gastrointestinal problems) and major symptoms (including damage to the liver and nervous system) affecting humans, pets and wildlife.

What should I do if I see an algal bloom? If you suspect a blue-green algae bloom is occurring, avoid using the water. Do not drink from it, cook with it, shower in it, or swim in it, and keep your pets away. Contact the ***Ministry of the Environment's Spills Action Centre at 1-800-268-6060***. They may collect a sample to check the type of algae or cyanobacteria to determine if it is hazardous. Your local Health Unit will then issue an official water-use warning, which will recommend the most appropriate action to take. Note that boiling the water will not destroy cyanobacterial toxins. In fact, it may release them. As municipal water treatment appears to remove most of the toxin, drinking water obtained from this source is safe to use.

Reasons that algae bloom. A diverse algal community is an essential part of a properly functioning ecosystem. A water quality problem can be identified when algae are growing in ways that they did not grow before. Abnormal or frequently occurring algal blooms should be viewed as a water quality problem. Algal blooms are a symptom, and not generally the proximate cause, of water quality issues.

In the Kawartha Lakes watershed, water generally flows from west to east. Southern parts of the watershed are heavily used for agriculture, and along the way through the lake system, water passes urban centres and shoreline residences. All of these different land uses can add significant quantities of phosphorus, mostly from fertilizers and sewage waste from humans and pets. As one might expect, phosphorus concentrations generally increase along a downstream gradient (Figure 3). This distinct gradient in nutrients is not always accompanied by expected changes in algal biomass or water quality. However, areas of highest phosphorus concentrations or closest to human land use typically experience more algal growth and poorer water quality. These connections between human land use and water quality suggest that we must control the inflow of external nutrients carefully to ensure healthy and vibrant Kawartha Lakes in the future.

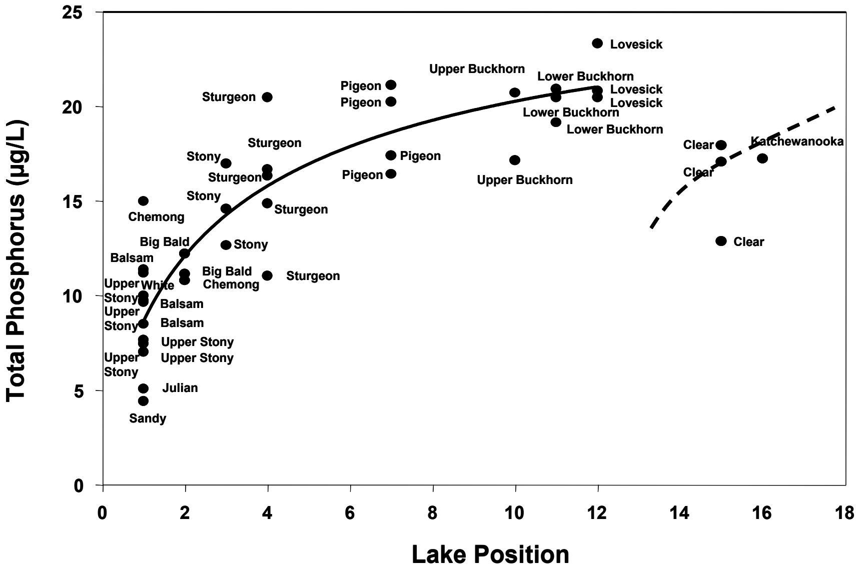


Figure 3. Phosphorus (P) concentrations in the Kawartha Lakes in August 2005. Lake position is defined as 1 plus the number of upstream lakes that feed into it. Note the general increase in P from west to east as the water moves through successive Kawartha Lakes. The drop between Lovesick and Clear Lakes is associated with lower P concentrations contributed by Upper Stoney Lake. Original source: White, M. 2006. *Phosphorus and the Kawartha Lakes*. (http://www.lakefieldherald.com/KLSA/MikeWhitereport.pdf)

WHAT CAN WE DO ABOUT ALGAL BLOOMS? Simply put, more phosphorus input into lakes means more algal growth. Therefore the best way to maintain healthy levels of algae in a lake is to avoid contributing phosphorus to the water. This means using phosphorus-free fertilizers and cleaning products, avoiding in particular the use of tri-sodium phosphate (TSP), removing organic wastes such as dog and goose excrement from your lawn, and maintaining your septic system appropriately. If you are a shoreline property owner, allow plants to grow on your property, especially along the shoreline. Erosion can be a significant source of nutrients and should be minimized. A naturalized shoreline helps trap sediments and dissolved nutrients. These nutrients are then used by land plants instead of being washed into the water. This "buffer zone" is also low-maintenance, stabilizes your shoreline, deters geese, provides habitat for birds, butterflies and other wildlife, and can be quite attractive.

If you live in a town or in the country, other precautions should be taken. Minimize fertilizer use or use no-phosphorus fertilizer. Don't dump anything down storm drains or wash your car on the driveway, as all the dirty wash-water drains either to a ditch or a storm sewer that empties to the lakes.

Federal, provincial and municipal agencies also have an important role to play in maintaining good water quality in our lakes, through controls over sewage treatment plant effluents, stormwater runoff and agricultural practices.

It may be possible to remove algae manually from your shoreline. This "algae control" method is most effective for filamentous forms of algae, which clump together and become entangled in plants. In this case, "sweeping" with a rake or cutting algal-covered plants at their roots and removing them from the lake could help. Unfortunately this type of removal is labour intensive, temporary and does not address the phosphorus problem. Do not use herbicides to combat algae. Not only does herbicide treatment decrease plant and algal diversity and kill many of the beneficial species, but it is also only temporary. The nutrients that are causing the excessive algal growth will remain, and when the herbicide is exhausted, the algae will return. In addition, adding other household chemicals, such as soap or bleach, would not be effective at controlling either suspended or attached algae. Aeration or bubbling devices in the nearshore area can be quite expensive and will not affect the growth or persistence of algae.

When you see excessive algal growth, do not think of the algae as the problem. Irregular and excessive algal blooms are an indication of a greater problem: decreased water quality due to excessive nutrient loading. Addressing the sources of nutrient addition into a water body is therefore the most effective and sustainable way to decrease the growth of algae.

Study: Algal Response To Nutrients

Researchers at Trent University undertook a study on algae in the Kawartha Lakes in the summer of 2010. This work was primarily aimed at learning more about the algae living in our lakes and what controls their abundance and distribution. The project was completed with much assistance from the Kawartha Lake Stewards Association (KLSA) and was funded in large part by the Ontario Trillium Foundation (OTF).

To answer questions about algal growth in the Kawartha Lakes, we completed several experiments involving natural algal communities. One set of experiments placed lake water in small plastic bags and provided different types of nutrients for the planktonic, or free-floating algal community. A similar experiment studied the benthic algal community that lives on the lake bottom and its growth responses to nutrients. This was done with clay pots (used to simulate natural rock) that were filled with nutrient-rich gelatin. These experiments allowed us to see whether the growth of the algal community would increase with more of a particular nutrient.

In the lakes that we studied (Upper Stoney, Balsam, Sturgeon and Pigeon), we found that the growth of the benthic and planktonic communities of algae was usually limited by nitrogen (N) or phosphorus (P). In other words, the addition of N or P would make more algal growth accumulate over the duration of our experiment. However, the algal response to any one nutrient (N or P) was generally small, which indicates that another nutrient quickly became growth limiting with the increase in the other. When all nutrients were added simultaneously, we found a large increase in algal growth rates (Figure 4).

The results of this study suggest that, in theory, the reduction of any nutrient could reduce the growth and proliferation of algal communities. This is because no single nutrient appears to be most

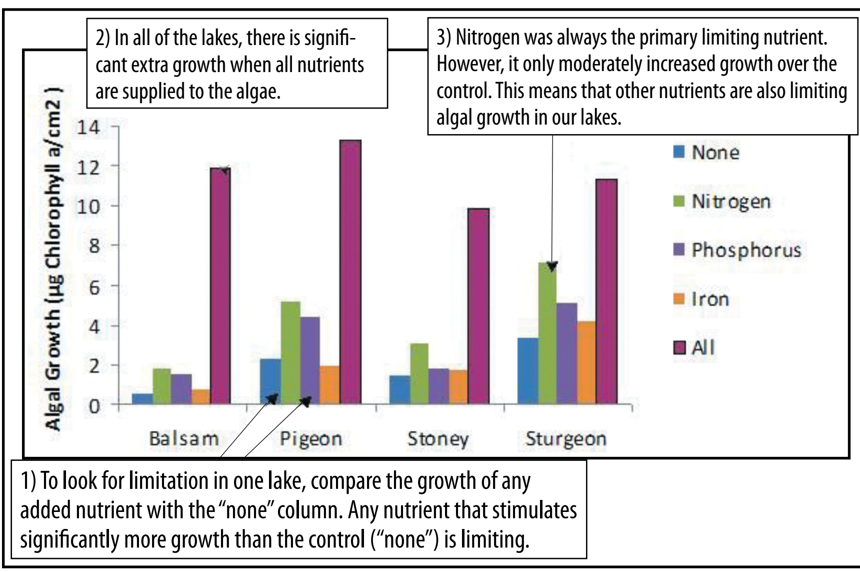


Figure 4. Nature of nutrient limitation of benthic algae on shorelines of the Kawartha Lakes

growth limiting in the Kawartha Lakes. We suggest continued focus on phosphorus reduction because this nutrient is often limiting in lake ecosystems, it is fairly easy to measure and track, and we know where many of its sources are in the Kawartha Lakes watershed.

The study results also show the importance of limiting human impacts to the lakes and their watersheds. Simply cutting back on fertilizers in your garden is not enough because these nutrients are not the only ones contributing to algal growth in the lakes. We must minimize all impacts on lake water quality from agriculture, urban runoff, roads, sewage treatment plants and shoreline development. The Kawartha Lakes currently support a dynamic and flourishing algal community that sometimes exceeds desirable levels. The occurrence of unwanted blooms will become more common and severe if human nutrient inputs to the lakes and their watersheds increase in the future. Reducing the human footprint in the watershed through a multi-pronged approach would help limit the occurrence of future blooms.

For more information on the KLSA/Trent University/OTF algae study, visit the KLSA website (http://klsa.wordpress.com) and click on the 2011 Annual Report (*Algae: Too Much of a Good Thing?*).

Identifying Algae

You might be curious to know which algae are living in the lake. Unfortunately, identifying algae is difficult and can require considerable training. Many algae require a microscope for proper identification. Some are actually so small and lacking in distinguishing features that even a microscope is not particularly helpful. For these, genetic testing is required to make a definitive identification. However, from your shore or boat, you can sometimes observe distinctive traits to give you a general idea of the resident algae. There are three main ways to describe and identify algae, by 1) their colour, 2) the shape or form they take on, and 3) the habitat in which they grow.

Classification by colour. Algae are usually classified into several divisions based on the colour pigments within the organism (Figure 5). These pigments contribute to the colour appearance that you see. The differences in colour can be subtle and may change as algae become more brown with age.

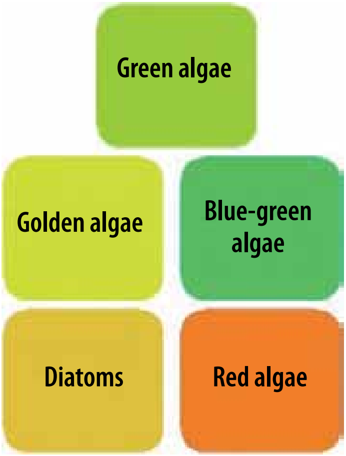


Figure 5. Algae are usually thought of as simply being green, but if you look closely, there are many variations of green. This colour chart shows the colours usually associated with different divisions.

Most clumps that you can see are a mix of dozens of different kinds of algae that form a community. Algae can come in a wide range of colours. To be considered an alga, it must contain a pigment called chlorophyll *a*, which appears a vibrant grass green. Additional pigments modify or occasionally mask this bright green, such as with brown or red algae.

Although algae are classified based on their colour pigments, identifying algae based on colour is challenging. A single species of alga can range in colour depending on many factors, such as age, health, time of year, hours of sun exposure and temperature. Even the bright green chlorophyll pigments turn brown and yellow as they begin to degrade (Figure 6). This may lead to misidentifying a green or blue-green alga as a golden or brown alga. Watching algae over the course of a few days may help you determine if the colour is degrading.

Figure 6. Filamentous green algae from good health to dying and decomposing (photo by Mallory Nadon)

Since the 19th century, algae have generally been split into four groups: Green (*Chlorophyta*), Brown (*Phaeophyta*), Red (*Rhodophyta*) and Diatoms (golden-brown). Since then, several other divisions have been added: *Cyanophyta* (blue-green), *Euglenophyta*, *Cryptophyta*, *Chrysophyta* (golden algae), *Haptophyta*, *Xanthophyta* (yellow-green algae), *Dinophyta*, *Raphidophyta* and *Chloarachniophyta*. Some groups can be distinguished by colour with the naked eye, whereas other divisions appear similar in colour (Table 1).

Table 1. Classification of algae by colour (division) and form

Division	Form	Microscopic	Description
Green	Filamentous	No	Woolly or hair-like
	Single-celled	Yes	Microscopic dot
	Colonial	Sometimes	May be visible to the naked eye
	Flagellated	Yes	Has a tail, may be single-celled or a colony
Diatoms	Filamentous	Yes	Only a few kinds, some form filaments by sharing a gelatinous sheath
	Single-celled	Yes	Most diatoms
	Aggregated	Yes	May stick together with gooey pads to form all sorts of shapes
Blue-green	Filamentous	No	Woolly or hair-like
	Single-celled	Yes	Microscopic dot
	Colonial	Sometimes	May be visible to the naked eye
	Flagellated	Yes	Has a tail, may be single-celled or a colony
Red	Plant-like	Usually	Often branched and plant-like
Golden	Scaled	Yes	Scales remain in fossil record
	Flagellated	Yes	Usually can swim
	Sheathed	Yes	Surrounded by mucous
Golden-brown	2 Flagella	Yes	Shaped like a tadpole
Dinoflagellate	Flagellated with red-brown shell	Yes	Often resembles a little spaceship

Classification by form. Within the divisions of algae based on the pigments they contain, we can also describe the form taken on by the algal cells, as seen in Table 1. Algae can be free-living as single cells, cells stacked one on top of another to form a hair-like filament or colonies of dozens of cells aggregated together. Some colonial algae are even mistaken for plants as they can form stalks and branches, as seen with *Chara*, or muskgrass. Single cells or colonial varieties may have one or more tails or flagella that can be used for swimming. (The presence of flagella is common in single-celled organisms and is not a definitive characteristic of plant or animal.) Some divisions have scales or a crusty shell to protect their cells. Algae that are plant-like in structure are comprised of sheets or branching filaments of stacked cells.

Classification by habitat. In addition to colour and form, algae can also be classified by their habitat. Within the depth of the lake, there are many places that algae will grow. Algae are generally split into

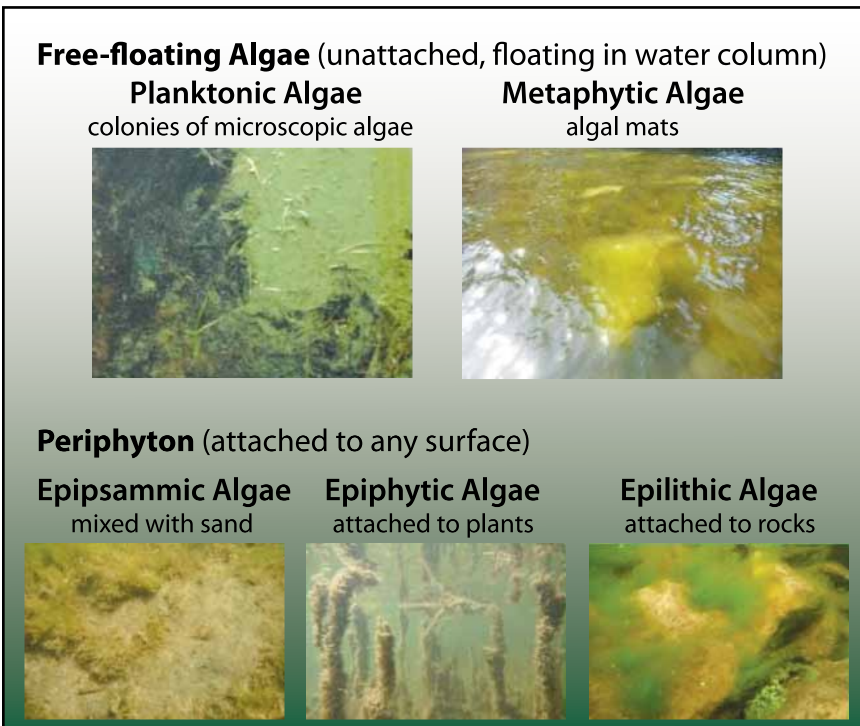
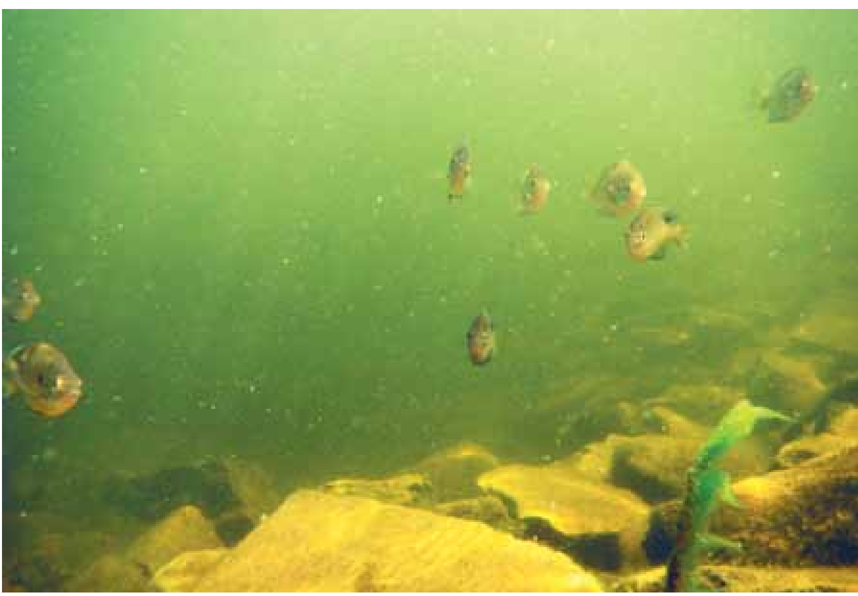


Figure 7. Algae living in different lake habitats

two groups: planktonic (free-floating algae) or benthic (growing on the bottom or attached to rocks). Algae can be motile (able to move or swim) or may be firmly attached to a surface (Figure 7). Based on where you find the algae and whether they move or are attached, you can describe their functional habitat.

Table 2. Commonly used terms in the description of algae

Term	Meaning
Epi-	Attached to something
Peri-	Growing around
Meta-	Adjacent to
Plankton	Wandering
-Phytic	Plant
-Lithic	Rock
-Psammic	Sand



TYPICAL ALGAE IN THE KAWARTHAS. Although most algae can only be identified under high magnification, there are several types that can be identified by sight and feel. When a colony of algae becomes so large that it can be seen without a microscope, it is known as macroalgae.

Cladophora (100x magnification) is a filamentous green alga. It can form fern-like shoots growing 10 to 15 cm long. The appearance, colour and form of a *Cladophora* bloom can vary dramatically with slight changes in habitat, making it easily confused with other algae. *Cladophora* is non-toxic and is even eaten in some Asian countries (when properly grown and prepared). It is often referred to as nuisance algae because large blooms of the stringy wool can entangle paddles and swimmers and clog pipes. *Cladophora* blooms make great habitat for many kinds of invertebrates and are eaten by some fish. They are frequently found in healthy lakes and rivers, but will appear as large persistent mats in waters high in nutrient pollution, or on shallow rocky flats in the lower Great Lakes where nutrient levels are only moderate. This problematic alga washes ashore in great quantities from time to time, and leads to stinking, rotting masses on beaches.

Mougeotia and *Spirogyra* are filamentous green algae that grow in fluffy clumps in the water column, usually near shorelines. They can also be found entangled in plants, floating on the water's surface or decomposing on the lake bottom. Depending on their life stage (in other words, if they are healthy or dying) they can take on lighter or darker hues of green. Since *Mougeotia* and *Spirogyra* appear identical to the naked eye, they often get grouped together under the same common name "elephant snot". They are also commonly referred to as "filamentous green algae". Under a microscope, one can make out strings of columnar cells, with green shapes inside each cell, which are the chloroplasts. In *Mougeotia*, the chloroplast appears flat and rectangular whereas *Spirogyra* shows a distinct spiralling chloroplast.

Exercise question:

Now that we can describe algae based on their habitat, form and colour, try describing the alga that is being examined by Colleen. Note that it is usually found free-floating, but coagulated into cotton-candy-like blobs (or mats) of stringy green strands.

Answer: This alga would be described as a metaphytic filamentous green alga. This would narrow the possible species to a few different genres that are found in the Kawartha Lakes: *Mougeotia, Spirogyra or Zygnema*. If it were attached to a hard surface, it is more likely to be *Cladophora*.

Chara is a species of macroalgae that is composed of branching thalli (stacked cells). These thalli are visible to the naked eye, making these algae appear plant-like. *Chara* feels rough to the touch and emits a skunky odour. *Chara* grows best in hard (calcareous) water, which explains why it is frequently observed in Sandy Lake.

While it may grow abundantly on lake bottoms, it is rarely considered a nuisance because it does not grow very tall (up to 12 cm) and is an important food source for waterfowl. *Chara* is commonly referred to as "stonewort" or "muskgrass". *Chara* is particularly common in Lake Simcoe and, like *Cladophora*, can wash ashore in large stinking masses on beaches.

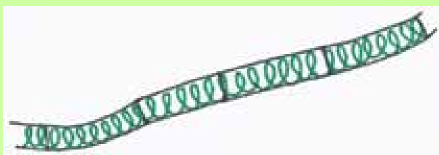
Gloeotricia is a blue-green alga that grows in colonies forming small fuzzy-looking, free-floating balls. It can be common in the Kawartha Lakes during the summer. Although occasionally reported to cause slight skin irritation to swimmers (in very dense blooms), it is not generally considered a health concern. *Gloeotrichia* is not a good indicator of water quality, as blooms have been documented in lakes of all conditions.

Did you know?

Some algae are known to produce a flame retardant. Dried mats of *Cladophora* that have washed ashore cannot be disposed of by burning. It is not understood why an alga that lives underwater needs to produce a flame retardant.

Exercise 2: Referring back to Exercise 1, let's try to further classify the algae we formerly described as a kind of filamentous green algae. Note that our description narrows the possible species to a few different macroscopic, filamentous types that are commonly found in the Kawartha Lakes.

Colleen brought the metaphytic, filamentous green algae back to the lab to view it under a microscope at 400X magnification. Further examination showed that the cells of this alga are stacked together, forming a continuous column. Inside each cell, green chloroplasts could be seen twisting around like a spiral staircase. What genus do you think this alga belongs to?



Answer: Microscopic examination confirmed the species to be *Spirogyra*.

IS THIS ALGAE? There are several organisms throughout the lakes that are often mistaken for algae. In the spring and early summer, **pollen** can collect on the surface of the water in a greenish-yellow hue, looking somewhat similar to blue-green algae.

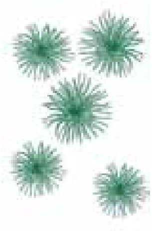
There are also several small floating plants, such as **duckweed**, that can make slow moving water appear bright green. Duckweed however is a true plant, containing distinct tissue types, and not an alga.

Photo by James Wilkes

Freshwater sponges are also fairly common in the Kawartha Lakes. These sponges are usually white in colour but are often host to symbiotic algae, which can make them green. These sponges are puffy and "sponge-like" in appearance and texture, and you may find the green colour drains out when squeezed.

Bryozoa are common in the Kawartha Lakes. They are actually animals. They are usually brown to white in colour and go through several life stages with drastically different appearances. They can be found floating through the water like a whitish balloon or growing on a stick, looking like brown squishy corals. Others form root-like mats on boat hulls. To be a kind of algae, a specimen must contain that bright green pigment. If it is clear or whitish, it's not algae.

LITTLE GREEN DOTS. At different times of the year, you may notice little green dots in the lake. What are they? It is a simple question, with a not so simple answer. There are dozens of things that could appear as little green dots in or on the lake, many of which are algae. Many kinds of trees release pollen in the mid-spring. This pollen is usually greenish-yellow in colour and may collect on the surface of the water. Pollen is occasionally reported to health officials as a misidentification of a blue-green algal bloom. There should be no blue tint to a collection of pollen, but they both will float on the surface and collect in eddies.



Gloeotrichia, which is not an uncommon blue-green alga in the Kawartha Lakes, also appears as "little green dots". *Gloeotrichia*, upon closer examination, is larger than many other green dots and may appear almost brown in colour. It can be found anywhere the light penetrates through the water column, as opposed to floating on the surface.

Any number of different kinds of colonial green and blue-green algae may also appear as "little green dots". If it is large enough to see without a microscope, you are looking at a colony. Some examples of the many algae found in the Kawartha Lakes that may appear as little green dots are: *Aphanocapsa, Coelosphaerium, Microcystis, Botryococcus* and *Anabaena*.

Floating pollen

Common Microscopic Algae of the Kawartha Lakes

At any one time, any of the Kawartha Lakes will have a diverse community of algae. However, without a fairly powerful microscope, it would be difficult to see and identify these little primary producers (Figure 8). We have compiled a list of the more common algae found in the Kawartha Lakes. Each alga is described and accompanied by a magnified photo. Note that the scale in each photo is in micrometres, which is one thousand times smaller than a millimetre. Consequently for most algal cells, a microscope that magnifies 100 to 400 times is needed to see the cells and their important features clearly.

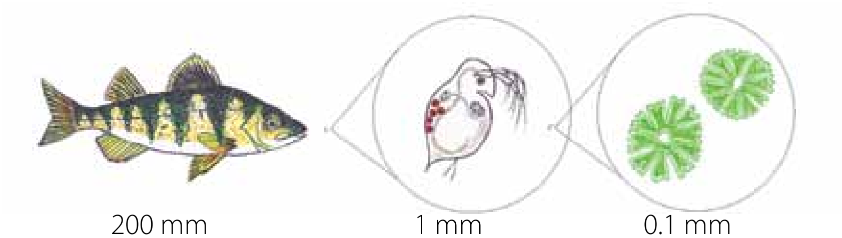
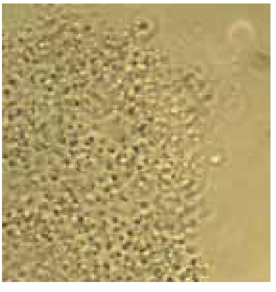


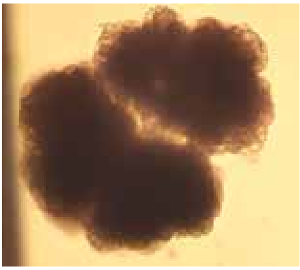
Figure 8. Relative size of a yellow perch to *Daphnia* to one alga, *Pediastrum*

Anabaena is a kind of filamentous blue-green alga. It usually appears as a spiraled string of pearls. There are over 110 species known globally, some of which are the documented cause of toxic blooms, including some in the Kawartha Lakes. *Anabaena* is a planktonic free-floating alga, which can form floating mats. It is commonly present in the phytoplankton community and generally benign in low numbers. When in a large-scale bloom, lake water can turn chalky blue-green in colour or form a "scum" layer floating on the top of the water.



Aphanocapsia is a colonial coccoidal (spherical) blue-green alga. Colonies are comprised of tiny balls surrounded by mucilage. There are over 50 described species that are found in a wide range of habitats, from the Arctic to thermal springs, from lakes to streams.

Botryococcus is a coccoidal colonial type algae. It is composed of small round to oval cells surrounded by golden-brown mucilage. Mature cells contain reserves of oil, which makes this alga of some interest for biofuel potential. This free-floating alga is found across North America but is rarely abundant.

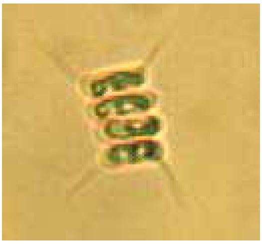


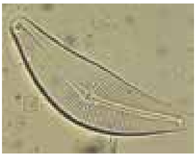
Ceratium is a dinoflagellate. Dinoflagellates are characterized by their reddish colour. Each cell contains two flagella, one wrapping around the middle and the other trailing as a tail, which allows for good mobility. *Ceratium* is quite common during the summer. In some places, it is responsible for taste and odour issues in drinking water.

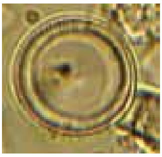
Coelosphaerium is a coccoidal colonial cyanobacterium. It is found free-floating in groups of cells surrounded by colourless mucilage. Worldwide there are about a dozen species known, which are found in lakes and reservoirs.

Cryptomonas is a common type of Cryptophyte, or golden algae. However it is less frequently found in preserved samples as its delicate cells tend to burst when preserved. *Cryptomonas* is typically a motile single cell that is propelled with flagella. It can also form colonies of cells embedded in mucous.

Desmodesmus is a colonial green alga, which is usually composed of four pancake shaped cells with spines protruding from the end cells. It is extremely common, found throughout North America, frequently in higher nutrient waters.





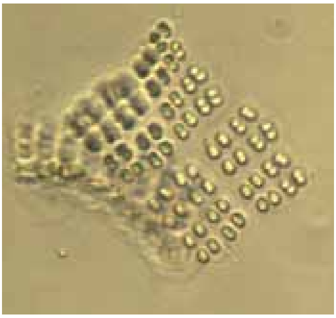


Diatoms (*Cymbella, Epithemia, Cyclotella, Melosira, Tabellaria*)

Diatoms are a diverse group of algae, which are characterized by their cells made of glass (silica). They are usually unicellular, but some kinds can form colonies (e.g. *Melosira*). They can vary in structure from the shape of an orange slice to a banana or even a can of soup. Diatoms make excellent indicators of water quality and are an important food source for many invertebrates. When diatoms die, their silica shells sink to the bottom of lakes and oceans and become covered with sediment. These buried caches of ancient diatom shells are what is known as diatomaceous earth. The KLSA has proposed a diatom-based paleolimnological study, including sediment core sampling, to assess long-term changes in the trophic state condition of the Kawartha Lakes.

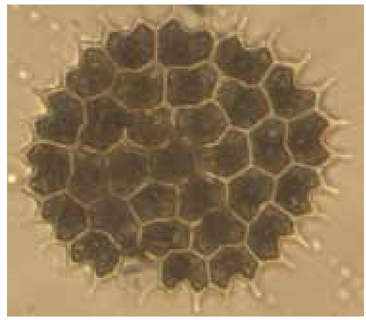
Dinobryon is a type of golden-brown alga composed of a colony (rarely solitary) of single cells encased in a vase-like lorica (case composed of cellulose). Each cell has two unequal chloroplastsand animal-like eye spots. Colonies have a stacked and branch-like formation. *Dinobryon* is planktonic, and the entire colony swims by means of flagella. It is very common and widespread in freshwater lakes and ponds. It is both plant and animal-like in that it produces its own food (autotrophy) but also can consume bacteria for nutrition (heterotrophy).

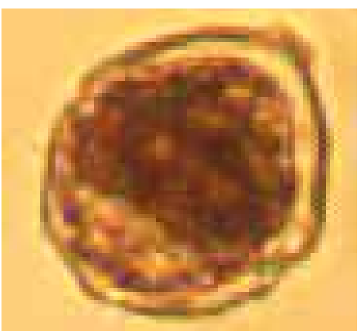
Merismopedia is a coccoidal colonial blue-green alga. The colony is formed by single sheets of cells, which divide evenly in pairs, maintaining a rectangular colony shape. The more than 30 species of *Merismopedia* are planktonic and occur across North America in mesotrophic and eutrophic waters.



Microcystis is a blue-green alga that is frequently associated with toxic blooms. It forms irregularly shaped colonies, which can float on the surface of the water. Individual cells can be round to oblong. It is most common in eutrophic waters.

Pediastrum is a colonial green alga that forms flat circular colonies. It can be found as phytoplankton in lakes, rivers and ponds. It is very common in eutrophic water but can be found in a range of aquatic habitats.





Peridinium is a dinoflagellate with a red cellulose theca (armour), one flag-ella around the middle, and another forming a tail. There are several species of *Peridinium*, which are fairly common and found in both hard and soft water habitats. It is a motile free-floating alga.

All algae photographed at 400x magnification

GLOSSARY

Algal bloom – a large amount of algae in one area; may become a nuisance

Benthic algae – algae found on lake bottoms and sediments

Biomass – the mass of living things, in this case, algae

Biovolume – the volume of living things

Buffer zone – an area between two zones (such as land and water) that acts as a buffer; a 1-metre wide area of natural shoreline vegetation can be helpful in reducing nutrient loading due to runoff.

Chlorophyll – a green pigment produced by plants and algae; it is able to absorb energy from light and is a vital part of photosynthesis.

Chloroplast – the part of a cell, found in plants and algae, that contains chlorophyll and where photosynthesis occurs

Colonial algae – algae growing in dense groups of cells

Coccoidal – being spherical or nearly so

Cyanobacteria – blue-green algae

Epiphytes – algae that grow on another alga or plant

Eukaryote – an organism that contains membrane-bound organelles

Eutrophic – a term referring to a lake that is high in nitrogen and phosphorous (more than 24 micrograms per litre) and has a high algal content

Eutrophication – the process by which a lake becomes eutrophic; generally associated with high loading of phosphorus, resulting in a large amount of algae that may alter the ecosystem function

Filamentous algae – algae that come in the form of filaments, long and rod-like

Flagella – small, hair-like structures used for mobility and swimming

Free-floating algae – algae that are not affixed to any surface and float freely in the water column

Macroalgae – algae that grow large enough to be seen with the naked eye, such as kelp

Macronutrients – nutrients, such as nitrogen and phosphorus, that are needed in relatively large amounts to support algal growth and survival

Mesotrophic – a term referring to a lake with a moderate amount of nitrogen and phosphorus (between 12 and 24 micrograms per litre) and moderate algal content

Metaphyton – algae that grow in floating mats in nearshore areas of lakes

Microalgae – algae that are difficult to see without the use of a microscope and are scarcely visible to the naked eye

Micronutrients – nutrients that are needed in small amounts such as iron, selenium, potassium, calcium, sodium and copper

Mitochondria – the "powerhouse" organelles in eukaryotic cells that control respiration and energy use

Motile – a term referring to algae that are able to move, usually with the use of flagella

Mucilage – a thick, mucous-like substance produced by algae for protection around cells

Nuisance algae – a subjective term for algae that are undesirable

Nutrient loading – the addition of large amounts of nutrients, often as a result of runoff from roads, parking lots, fields, shoreline residences, etc.

Oligotrophic – a term referring to a lake with little nitrogen and phosphorus (less than 12 micrograms per litre) and with low algal content

Organelle – a specialized subunit inside cells usually enclosed by its own membrane

Photosynthesis – the process by which inorganic compounds are converted to organic compounds using energy from sunlight; more specifically, carbon dioxide and water are broken down to form oxygen and sugar according to the following reaction: $6\ CO_2 + 6\ H_2O \xrightarrow{\text{sunlight}} C_6H_{12}O_6 + 6\ O_2$

Prokaryote – an organism that lack organelles

Runoff – precipitation that ultimately makes its way back to a waterway on various surfaces; can be contaminated or carry nutrients from land to water

Sensitive algae – algae that are sensitive to changes in environmental conditions

Tolerant algae – algae that are able to tolerate a wide range of environmental conditions

Trophic state – a term referring to the level of essential biological nutrients in lakes, particularly nitrogen and phosphorus

Reading List

Books

Schindler, David W. and John R. Vallentyne. *The Algal Bowl: Overfertilization of the World's Freshwaters and Estuaries*. The University of Alberta Press. 2008

Rodney Barker. *And the Waters Turned to Blood*. Simon and Schuster, 1998.

Fact Sheets

Algae. Federation of Ontario Cottagers' Associations (http://www.foca.on.ca/xinha/plugins/ExtendedFileManager/demo_images/test/algea.pdf)

Natural Shorelines. Federation of Ontario Cottagers' Associations (http://www.foca.on.ca/xinha/plugins/ExtendedFileManager/demo_images/test/Natural_Shorelines.pdf)

Septic Systems. Federation of Ontario Cottagers' Associations (http://www.foca.on.ca/xinha/plugins/ExtendedFileManager/demo_images/test/septic_systems.pdf)

Source Protection. Federation of Ontario Cottagers' Associations & Water Guardians Network (http://www.foca.on.ca/xinha/plugins/ExtendedFileManager/demo_images/cottagers source protection fact_1.pdf)

Identifying Algae

Algae Identification Field Guide. Agriculture and Agri-Food Canada (http://publications.gc.ca/collections/collection_2011/agr/A125-8-2-2011-eng.pdf)

Blue-Green Algae Photo Gallery. Health Vermont (http://www.cdc.gov/nceh/hsb/hab/default.htm)

Identifying Common Freshwater Algae. Microscopy UK (http://www.microscopy-uk.org.uk/index.html?http://www.microscopy-uk.org.uk/pond/algae.html)

Blue-Green Algae

Algal Toxin (Microsystin) Study. Lake of the Woods District Property Owners Association (http://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=7&ved=0CFwQFjAG&url=http%3A%2F%2Fwww.lowdpoa.com%2Fdownloads%2F91&ei=Y_fVT8PLNIf96gHlwtCCDg&usg=AFQjCNHFWbJ8Q4L8LbZn_mMmhQ9SHuUSpQ)

Blue-Green algae (Cyanobacteria) and Their Toxins. Health Canada (http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/cyanobacter-eng.php)

Blue-Green Algae: information for cottagers and home owners. Ontario Ministry of the Environment (http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/std01_079455.pdf)

Blue-Green Algae and Pet Safety. Pet Poison Hotline (http://www.petpoisonhelpline.com/poison/blue-green-algae/)

Blue-Green Algae Safety Poster. Washington State Department of Public Health (http://www.co.thurston.wa.us/health/ehadm/swimming/pdf/BGAlgae.pdf)

Harmful Algae. Woods Hole Oceanographic Institute (http://www.whoi.edu/website/redtide/home)

Harmful Algal Blooms. US Department of Health/Centers for Disease Control (http://www.cdc.gov/nceh/hsb/hab/default.htm)

Naturalized Shorelines

Free Shoreline Advisory Program. Lakeland Alliance (http://www.lakeland.greenup.on.ca/advisor/index.html)

Shoreline Naturalization Program. Kawartha Conservation (http://www.kawarthaconservation.com/shoreline/index.html)

Algae and Biofuels

Is Algae the Biofuel of the Future? Scientific American (http://www.scientificamerican.com/article.cfm?id=algae-biofuel-of-future)

Algae: Biofuel of the Future? Science Daily (http://www.sciencedaily.com/releases/2008/08/080818184434.htm)

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We value your feedback

KLSA would appreciate your opinions about this publication, which can be given in a brief survey that is posted at: klsa.wordpress.com

KLSA cares about the future of our precious Kawartha Lakes. We would appreciate your support for our work. Completely run by volunteers, KLSA provides excellent value for every dollar it receives and gratefully acknowledges every donor.

Personal donations of $40 or more qualify for a charitable tax receipt, issued by our friends at The Stony Lake Heritage Foundation. Make cheques payable to the Foundation and note “for KLSA” on the cheque. Donations of less than $40 are payable to the Kawartha Lake Stewards Association. Please send all donations to: KLSA, 24 Charles Court, RR#3, Lakefield ON K0L 2H0.

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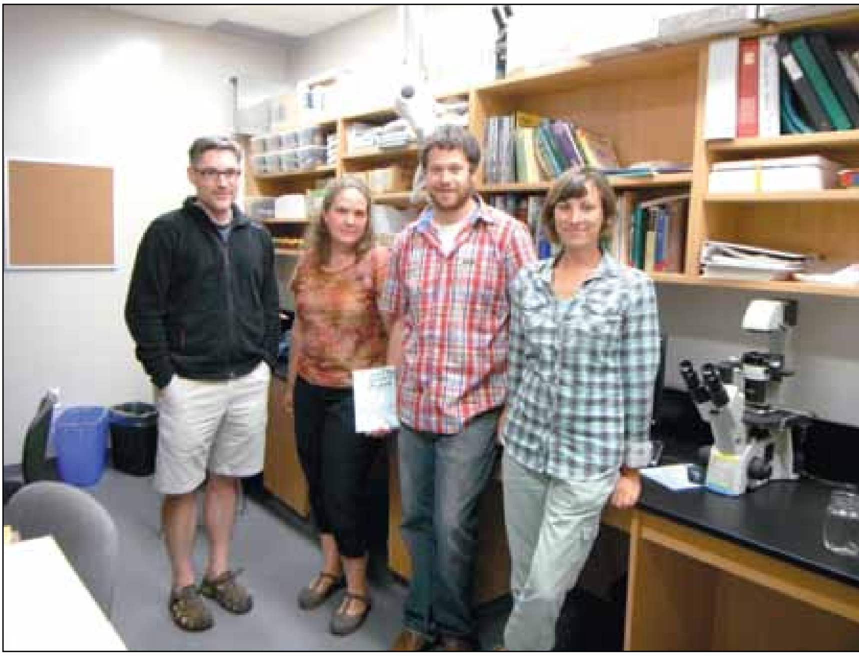
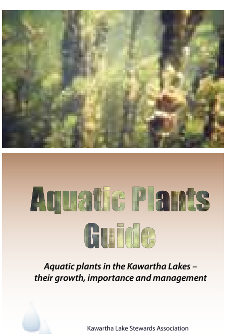
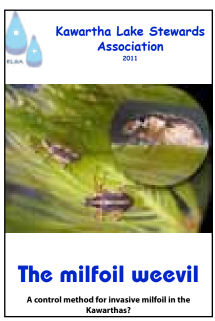


The Algae Team. From left to right: Paul Frost, Emily Porter-Goff, Andrew Scott, and Colleen Middleton





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