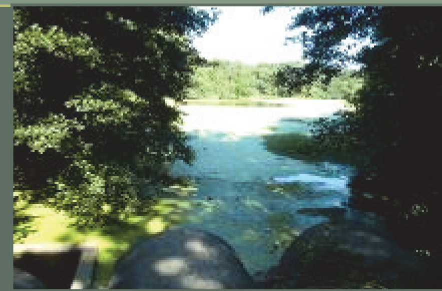
The Boone and Kenton County
Conservation Districts, Burlington, KY

The Campbell County
Conservation District, Alexandria, KY



Field guide to algae and other "scums" in ponds, lakes, streams and rivers

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Introduction

Purpose of this Guide

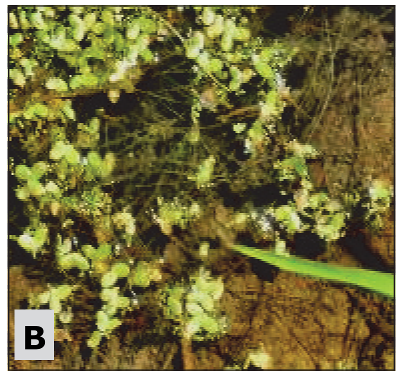
This guide is intended for individuals who work with farm ponds, for watershed groups, homeowners and anyone interested in quickly identifying an algal bloom or scum that appears in a freshwater system. Such blooms usually appear during the summer and fall in temperate regions. Most blooms are the result of nutrient enrichment of the waterway. Of significant concern are blue-green algal blooms (cyanobacteria). Some of these produce liver and/or brain toxins that can be lethal to most fish and livestock. Some of the toxins can also be carcinogenic. The macroscopic appearance of many different genera of algae can be similar and therefore field identification must be verified by using a compound microscope. A photograph of the organisms as seen under the microscope is therefore also provided. This guide includes only the most common algae and other scums found in Kentucky, Ohio and Indiana. It is not intended to be a comprehensive field guide to the algae. At the end of this guide we provide a list of common methods used to control algal blooms, and recommended readings.

How to Use this Guide

This guide is organized for ease of use. We have avoided, when possible, taxonomic jargon. It starts with the most commonly observed macroscopic plants, the duckweeds, water meal and water ferns, that although not technically "scums", are usually of concern since they can quickly and completely cover ponds. Following are algae grouped taxonomically: Cyanobacteria, *Euglena* and other flagellated algae, Diatoms, and filamentous green algae. The guide ends with photographs of bacterial, protozoan and zooplankton scums. This guide is intended to be used only as a "picture key". The organisms capable of forming scums, particularly the algae, are very diverse. Therefore, we recommend verification with microscopic examination and more complete taxonomic keys.

Floating Macroscopic Plants

The "Duckweeds", Watermeal and Water Ferns

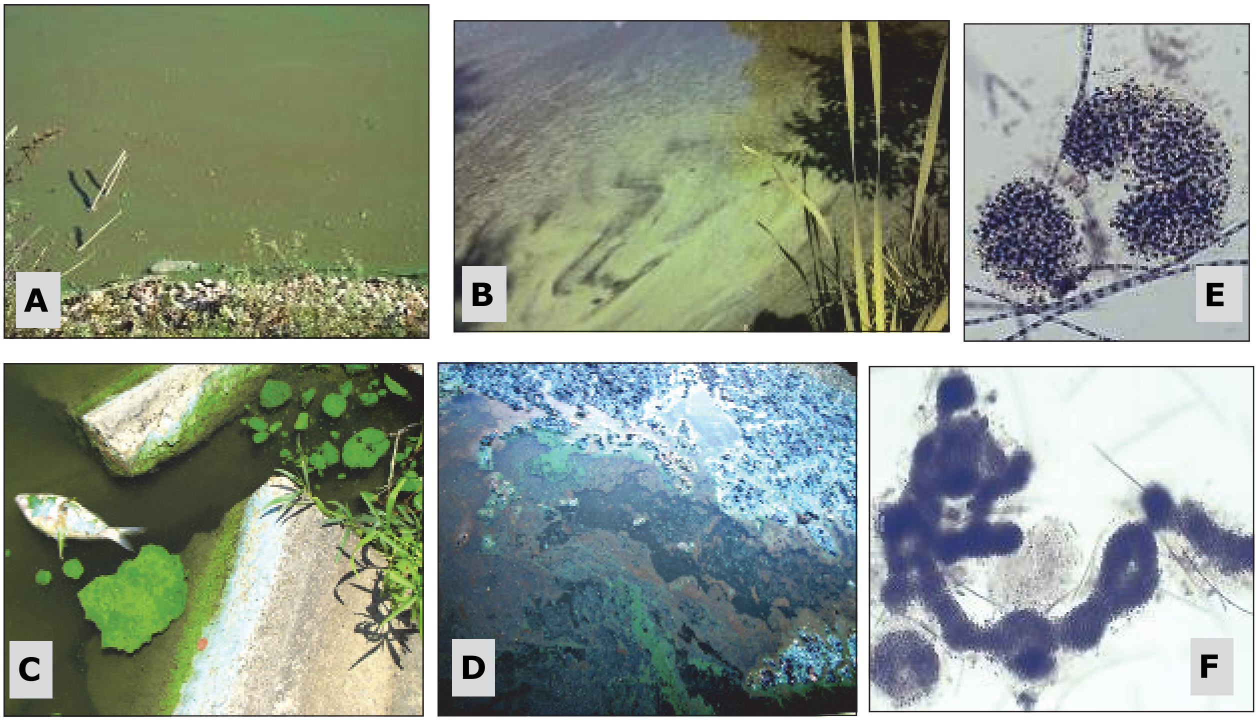


Free-floating duckweeds (*Lemna, Spirodella)* and watermeal *(Wolffia)* can attain nuisance levels in ponds (**A**). Duckweeds and watermeal often occur together. Their leaves are disc-like, 2-5 cm long with small roots on their underside. *Lemna* (**B**, **C**) is most common. *Wolffia* (**D**) is the smallest flowering plant in the world. *Spirodella* has a red underside. They require quiet, nutrient-rich water. They reproduce by a very rapid method called "budding", allowing them to cover ponds in a few weeks under summer conditions. Blooms can be reduced by aeration and nutrient reduction.

Water ferns *Azolla* (mosquito fern, duckweed fern or fairy moss) can cover farm ponds with their reddish, scale like leaves (**E**, **F**). Roots hang in the water and have a symbiotic relationship with *Anabaena azollae* that fixes atmospheric Nitrogen. In Asia it is often used as a biofertilizer for rice paddies. It cannot survive freezing temperatures.

Floating Cyanobacteria (Blue-Green Algae)

Microcystis

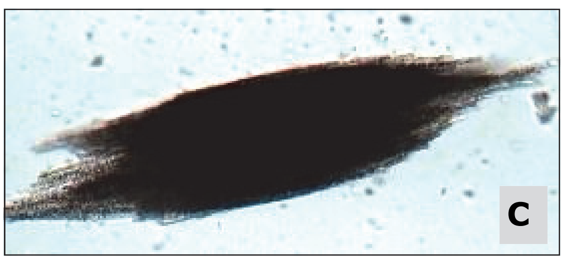


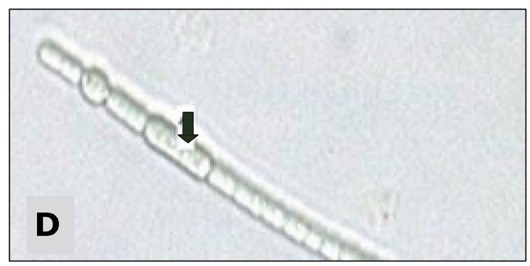
The “bloom” appears like “spilled green paint” or “pea-soup” (**A**, **B**). One local home owner described it as follows; “*It's Baaaaack!!....So, the Microcystis went away but it came crawling back up the lake yesterday. It was interesting to watch. At 2:30 everything looked normal and at 3:30 I glanced out and the whole lake looked white and soapy like someone threw detergent in it. Then at 4:30 it was bright green again. This morning it is as smelly as ever...*”

Microcystis has gas vesicles that allow it to regulate buoyancy and migrate throughout the water column. Because of this the bloom can appear suddenly or scattered (**C**). Some species produce liver toxins, called microcystins, that can be lethal to livestock, fish and humans and have been linked to liver cancer. They can also cause skin irritation. The toxins are released when the cells lyse (break apart). At that time the bloom appears as a blue-green oily scum (**D**) and has a pigpen odor. Under the microscope *Microcystis* consists of small round cells surrounded by a gelatinous envelope. The most common species *Microcystis aeruginosa* forms irregularly shaped colonies that appear almost black due to the optical effects of the gas-filled vesicles (**E**, **F**).

Floating Cyanobacteria (Blue-Green Algae)

Aphanizomenon



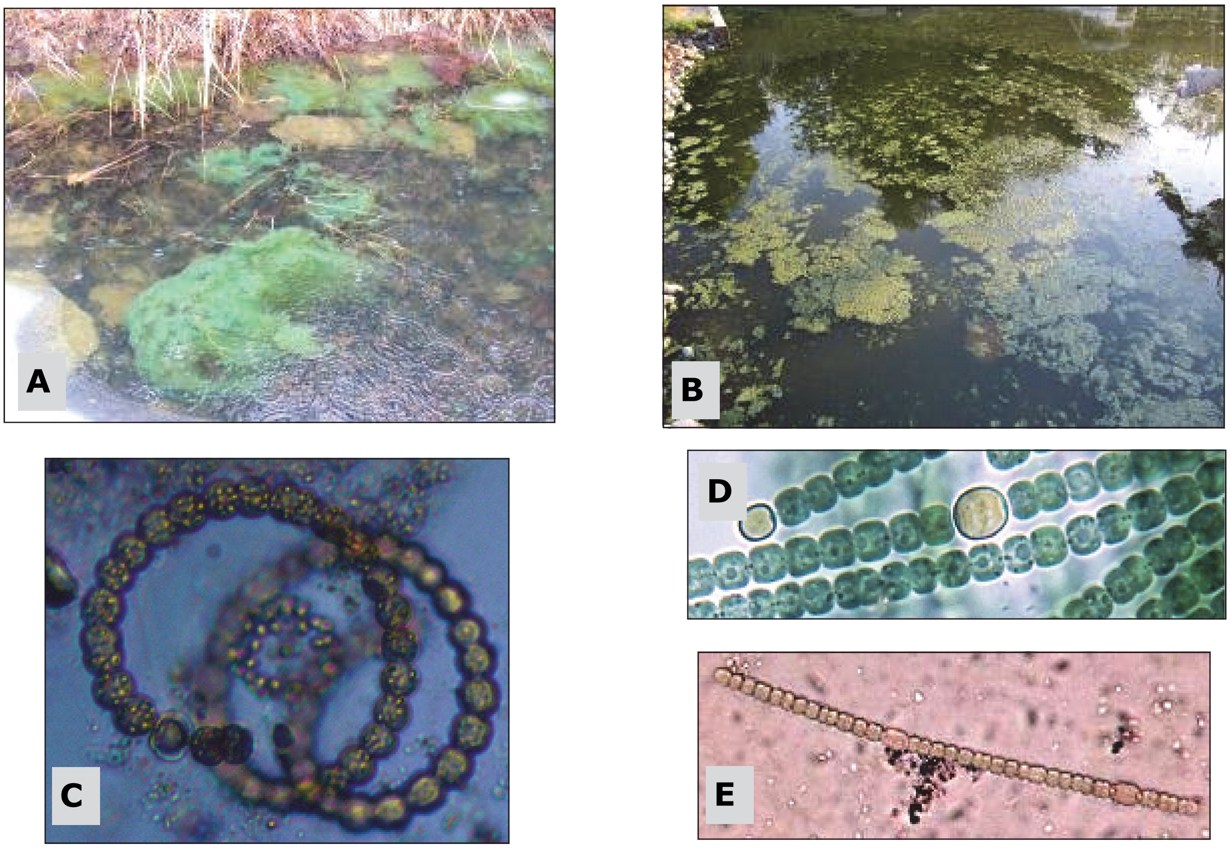


The bloom appears like grass clippings (**A**, **B**) on the water, due to the aggregation of individual filaments when they float to the surface. They have gas vesicles that allow them to regulate buoyancy and migrate throughout the water column. Colonies under the microscope may appear almost black due to the optical effects of the gas filled vesicles (**C**). *Aphanizomenon* often occurs with *Microcystis* and we have observed a “cycle” of blooms. *Aphanizomenon* has heterocysts (**D**) and fixes Nitrogen. *Microcystis* does not.

As Nitrogen accumulates in the water, thanks to Nitrogen fixation, *Microcystis* gains an advantage over *Aphanizomenon*. And, when the Nitrogen is used up, the advantage goes to *Aphanizomenon*. Some species can produce a neurotoxin called saxitoxin, similar to the paralytic shellfish poison that is found in marine environments. *Aphanizomenon* also has been reported to cause skin irritation. The blooms found in North America appear so far to be non-toxic. *Aphanizomenon* is sold as a food supplement in naturalistic food stores.

Floating Cyanobacteria (Blue-Green Algae)

Anabaena

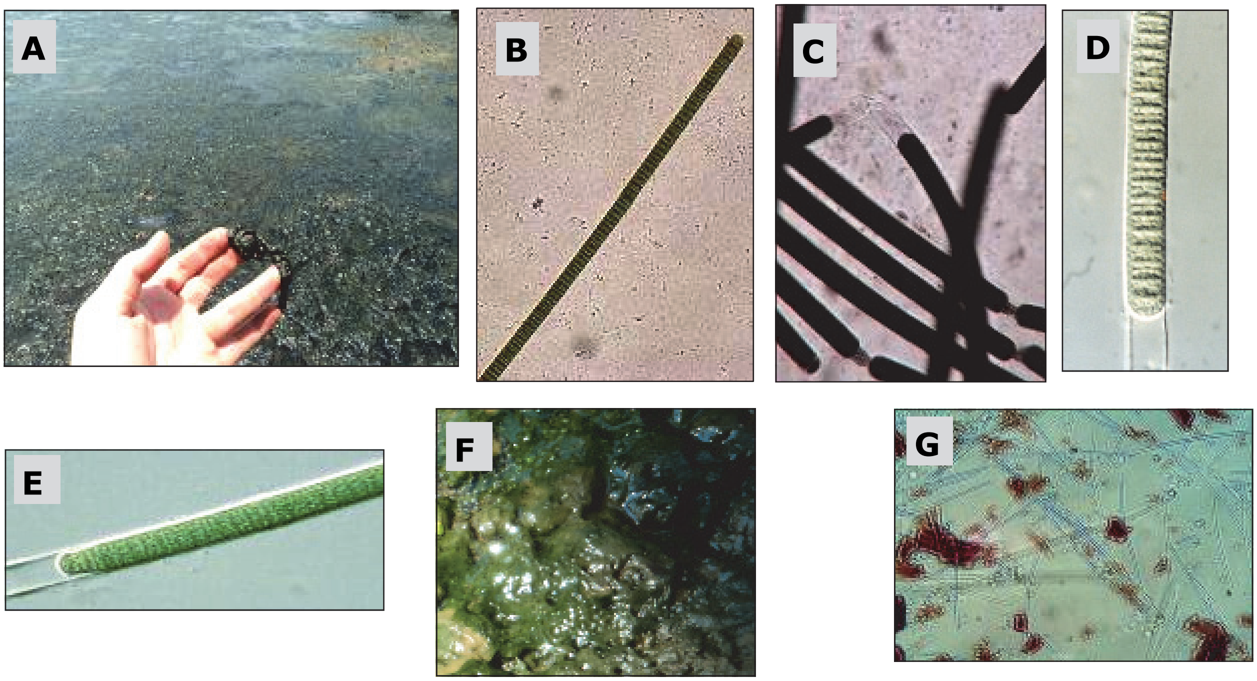


The *Anabaena* bloom may superficially resemble a *Microcystis* bloom as the pond may look like “pea-soup”. However, *Anabaena* is a filamentous algae and the bloom is often less dispersed than *Microcystis* (**A**, **B**). The bloom does not migrate through the water column like *Microcystis or Aphanizomenon*. The pigpen odor may be present like with most Cyanobacterial blooms. Under the microscope *Anabaena* consists of chains of round or sometimes barrel-shaped cells with distinct heterocysts (**C**, **D**, **E**). The heterocysts are specialized cells that fix atmospheric Nitrogen. They have a thicker wall than the other cells and are not pigmented because Nitrogen fixation is not compatible with photosynthesis.

The *Anabaena* chains can be straight or spiral. Many species of *Anabaena* are capable of producing toxins. Most produce anatoxin, which is a neurotoxin. A few produce both anatoxin and microcystin (the liver toxin). There have been many reports of deaths of pets, wildlife and livestock as a result of *Anabaena* blooms. The blooms occur in phosphorus-rich waters.

Floating or attached Cyanobacteria (Blue-Green Algae)

Oscillatoria, Lyngbya, Phormidium, Plankthotrix



Oscillatoria, *Lyngbya* and *Phormidium* are found in floating mats, as loose filaments, or attached to rocks. Blooms can range in color from dark blue-green to dark red, brown, green-black or purple (**A**). *Oscillatoria* and *Lyngbya* frequently occur together. *Phormidium* forms thin, tough sheets as compared to the "hairy" films of *Oscillatoria* and *Lyngbya*. However filaments can best be distinguished under the microscope.

Oscillatoria filaments (**B**) lack a sheath, are not branched, and have no heterocysts (specialized cells that lack pigment and fix Nitrogen). They may show an "oscillating" movement. Some species of *Oscillatoria* can produce microcystins, liver toxins and anatoxin-a, which is a neurotoxin.

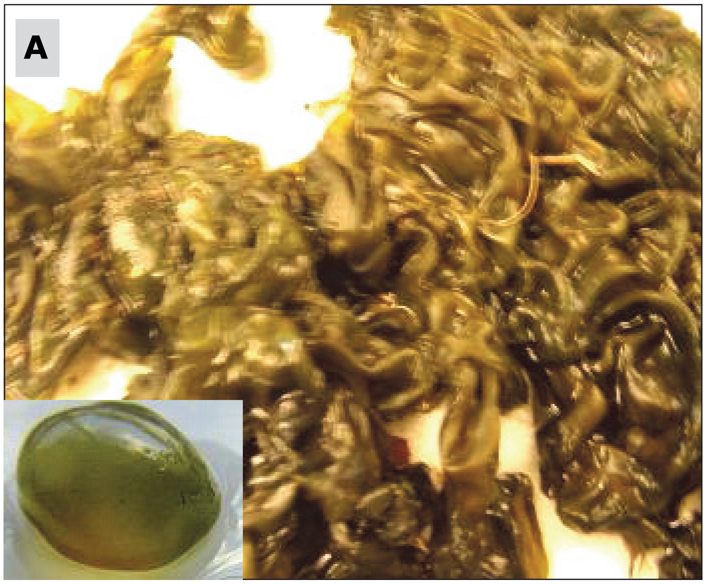
Lyngbya looks very similar to *Oscillatoria* but has a clear sheath (**C**, **D**). It is more likely to be found loosely entangled among shore vegetation.

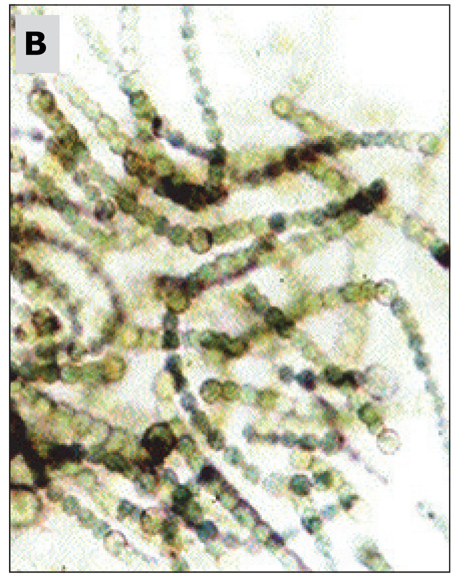
Phormidium (**E, F**), like *Lyngbya*, has a sheath. It is distinguished from *Lyngbya* by the shape of the terminal cells and the growth form of the macroscopic colony. It usually forms mats that are attached to rocks or vegetation or are "carpeting" the bottom of very shallow ponds or slow-flowing streams.

Plankthotrix (**G**) looks very much like thin *Oscillatoria*, but is entirely planktonic (free-floating).

Attached Cyanobacteria (Blue-Green Algae)

Nostoc





Nostoc forms large, dark green, yellow-green or blue-olive-green jelly-like mats or balls, making it the easiest cyanobacteria to identify macroscopically (**A**). The balls can grow to several centimeters in diameter. It has been called “freshwater grapes”. It can grow in moist soil, cracks in cement, or in the bottom of ponds, lakes or streams.

Under the microscope it reveals to be formed of filaments of spherical cells containing heterocysts (Nitrogen fixing cells) (**B**).

Recently a species of *Nostoc* has been reported to produce liver toxins (microcystins) under laboratory-induced light and nutrient stress conditions. However *Nostoc* is generally considered non-toxic and is even sold as a food supplement in naturalistic food stores.

Euglena and other flagellated algae

Euglena, Phacus, Dinobryon, Prymnesium & Dinoflagellates

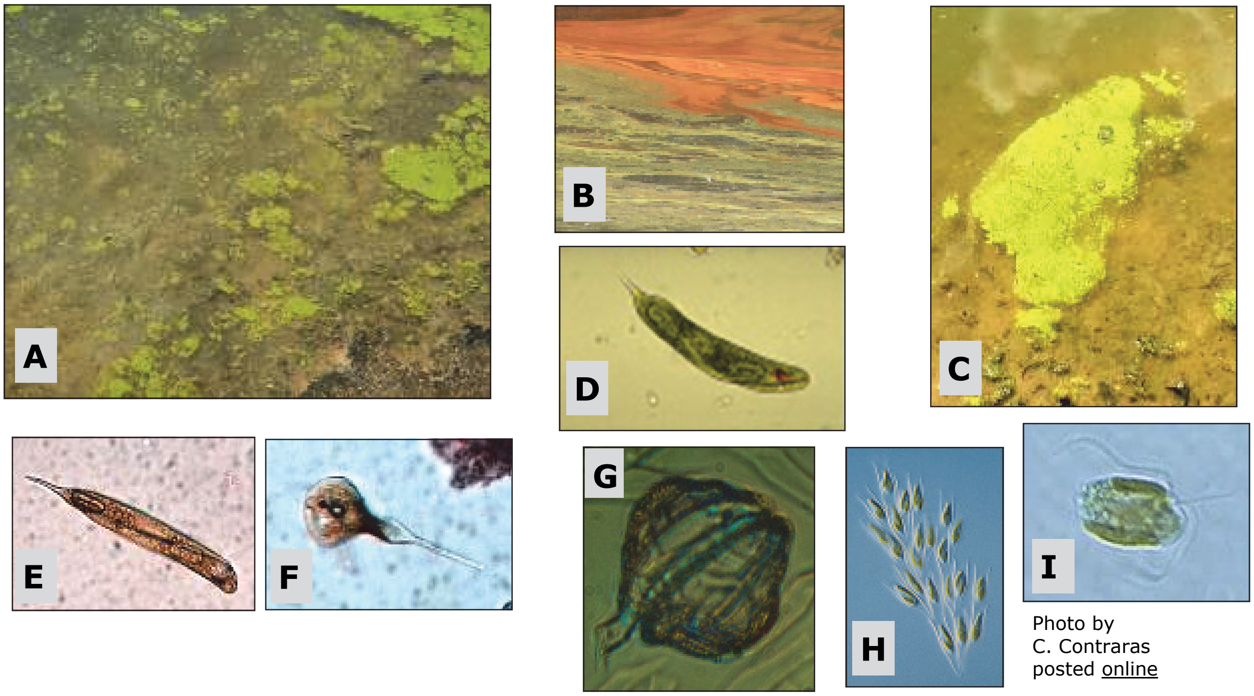
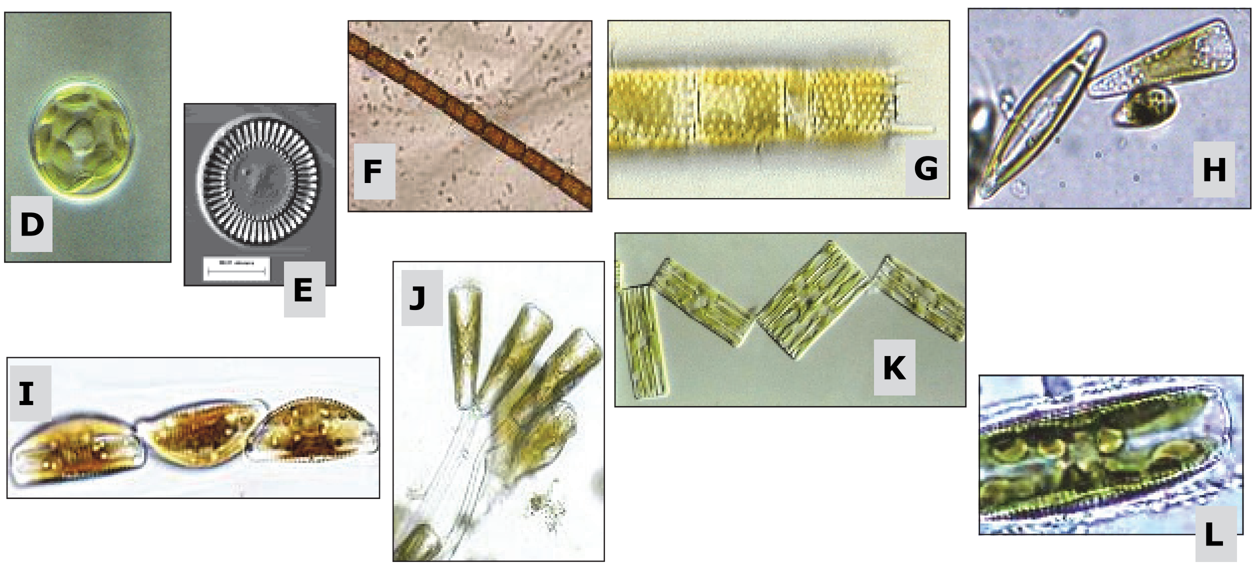


Photo by C. Contraras posted online

Euglena scums may be bright grass-green, red, or mixed red and green. Sometimes they appear, in whole or part, metallic green as a bright green foam or sharply delimited as surface film (**A**, **B**, **C**). Under the microscope *Euglena* consists of single elongated cells with one visible flagella (**D**, **E**). They lack cell walls but have a flexible pellicle (thin membrane) covering the cell. As the cell moves one can see it changing shapes, sometimes appearing almost round. A red "eye spot" is visible in each cell. *Euglena* is an indicator of organic pollution. One species (*Euglena sanguinea)* produces a neurotoxin, euglenophysin, which is an alkaloid similar in structure to fire ant venom. It can kill fish and it is also herbicidal. *Phacus* (**F**) is a close relative of *Euglena* that can be found with the *Euglena* scums.

Other flagellates usually do not produce distinct scums but color the water yellowish-brown or red. Dinoflagellates (**G**) have two perpendicular flagella inside a groove in the cell. A few can produce toxins. In marine systems they are the cause of red tides. Golden algae (Chrysophytes) such as *Dinobryon* (**H**) are notorious as taste and odor species. The water may smell like cat's urine or sometimes have a fishy odor when *Dinobryon* blooms. *Prymnesium* (**I**) is mainly a salt water organism, but recently has been reported in ponds in Pennsylvania and West Virginia. It is notable because it produces a very fast-acting fish toxin, as well as liver toxins and neurotoxins.

Diatom Blooms



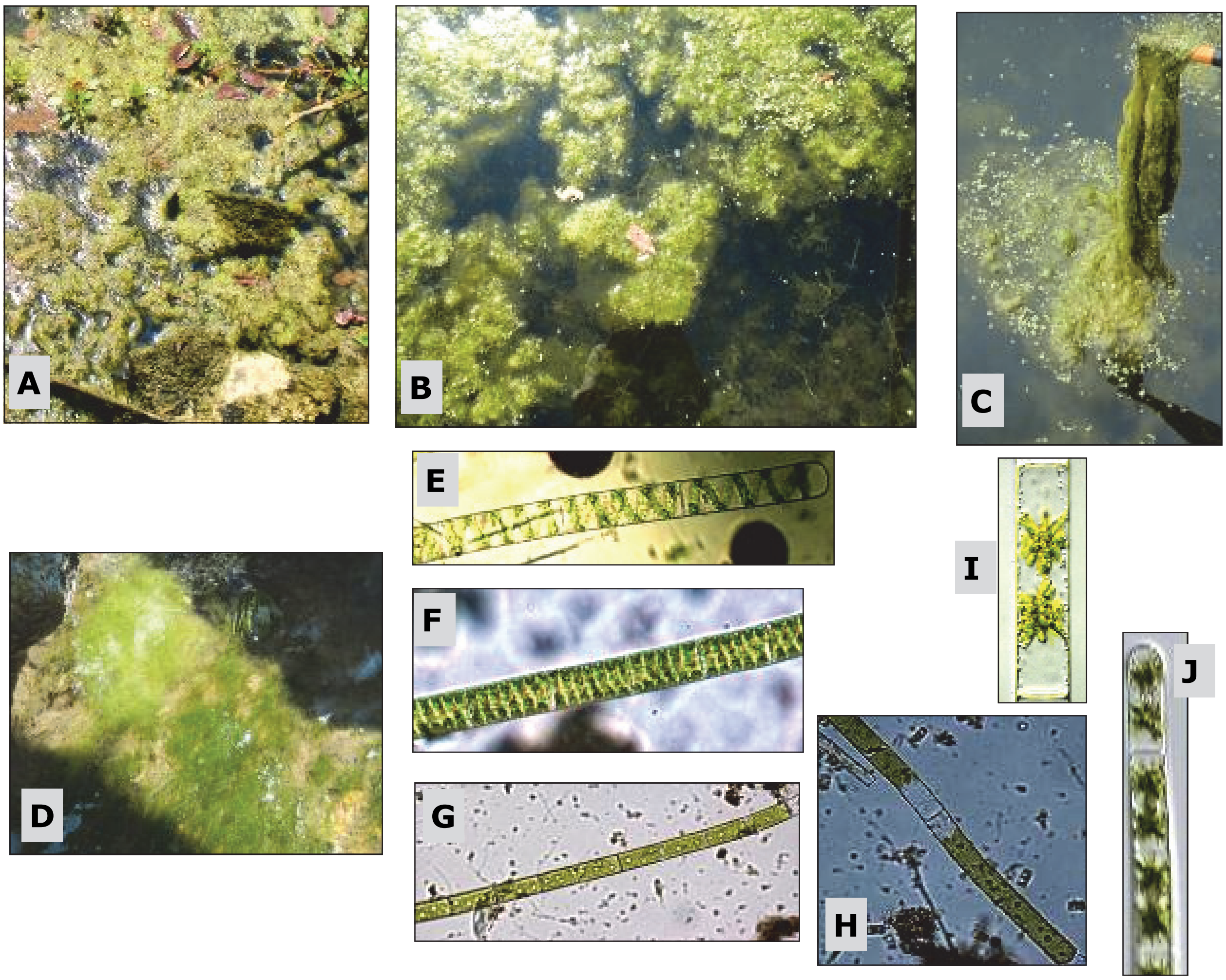
Floating diatom blooms (**A**, **B**) form a brown scum or film, often glistening, on the bottom or the surface of the water, coloring the water. Rarely is this scum evenly distributed. Most commonly diatoms are found attached to rocks or other surfaces where they appear as a glistening brown or golden brown gelatinous mass (**C**).

Under the microscope diatoms show a great diversity of shapes and sizes. (**D-L**). They have characteristic cell walls made of Silica (glass). Some genera form long filamentous colonies (**F - K**). Others have long mucilaginous stalks with which they attach to substrates (**I**, **J**). Diatoms store their food as oils that help them to float (note oil droplets in **L**). Many species have a "raphe", a slit in the cell wall through which they secrete a mucilage that allows a unique form of gliding motility.

Diatoms form the basis of aquatic food chains since they are high quality food for zooplankton. The different species are valuable environmental indicators.

Filamentous Green Algae

Spirogyra, Mougeotia and Zygnema

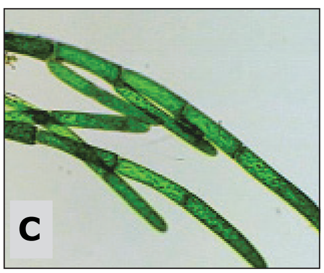


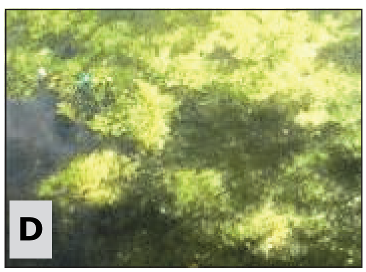
Among the most common filamentous algae found in ponds is *Spirogyra*. It is often mixed with *Mougeotia* and *Zygnema*. All three genera form thready, silky, slippery masses that are slimy to the touch and often have trapped air bubbles (**A-D**).

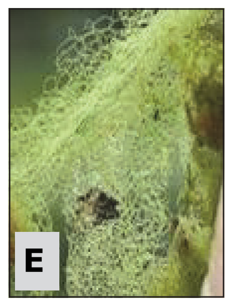
They can be distinguished under the microscope by the shape of the chloroplasts. *Spirogyra* have spiral chloroplasts (**E, F**). *Mougeotia* has ribbon-shaped chloroplasts with centrally located starch-storing granules called pyrenoids (**G**, **H**). *Zygnema* has star-shaped chloroplasts (**I**, **J**). The filaments of all three genera are unbranched.

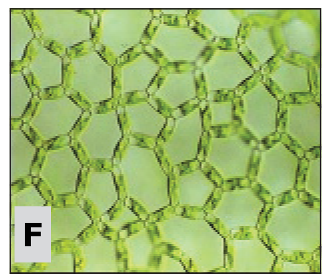
Branched Filamentous Green Algae

Cladophora and Hydrodictyon







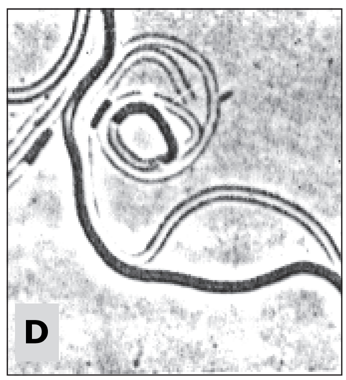


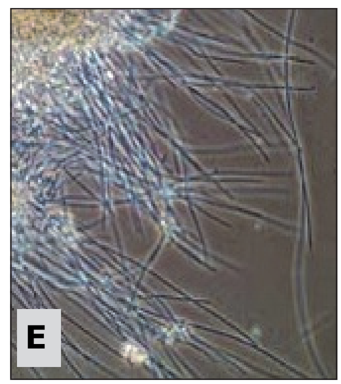
Cladophora is commonly found in running water such as streams, rivers and waterfalls. It grows attached to rocks and other substrates. The stringy mats are usually dark green although it can appear yellow-brown to orange when the mat starts to die. When picked up it is "webby", feels coarse and the branches or tufts of branches are evident. When squeezed it looks like green cotton (**A**, **B**). Under the microscope the branches are clearly visible and are shorter than the main stem. The chloroplast covers most of the cell (**C**).

Hydrodictyon, known as water net, is also common in running water although it is also found in hard-water lakes and ponds where it can form thick mats (**D**). It requires water with high alkalinity. The growth is light green and formed by filaments that are joined to form net-shaped colonies. When the water is squeezed out it clearly appears like a net (**E**). Under the microscope the net arrangement of the cells is the most obvious feature that distinguishes *Hydrodictyon* from other algae (**F**).

Bacterial Scums

Iron Bacteria -*Sphaerotilus*



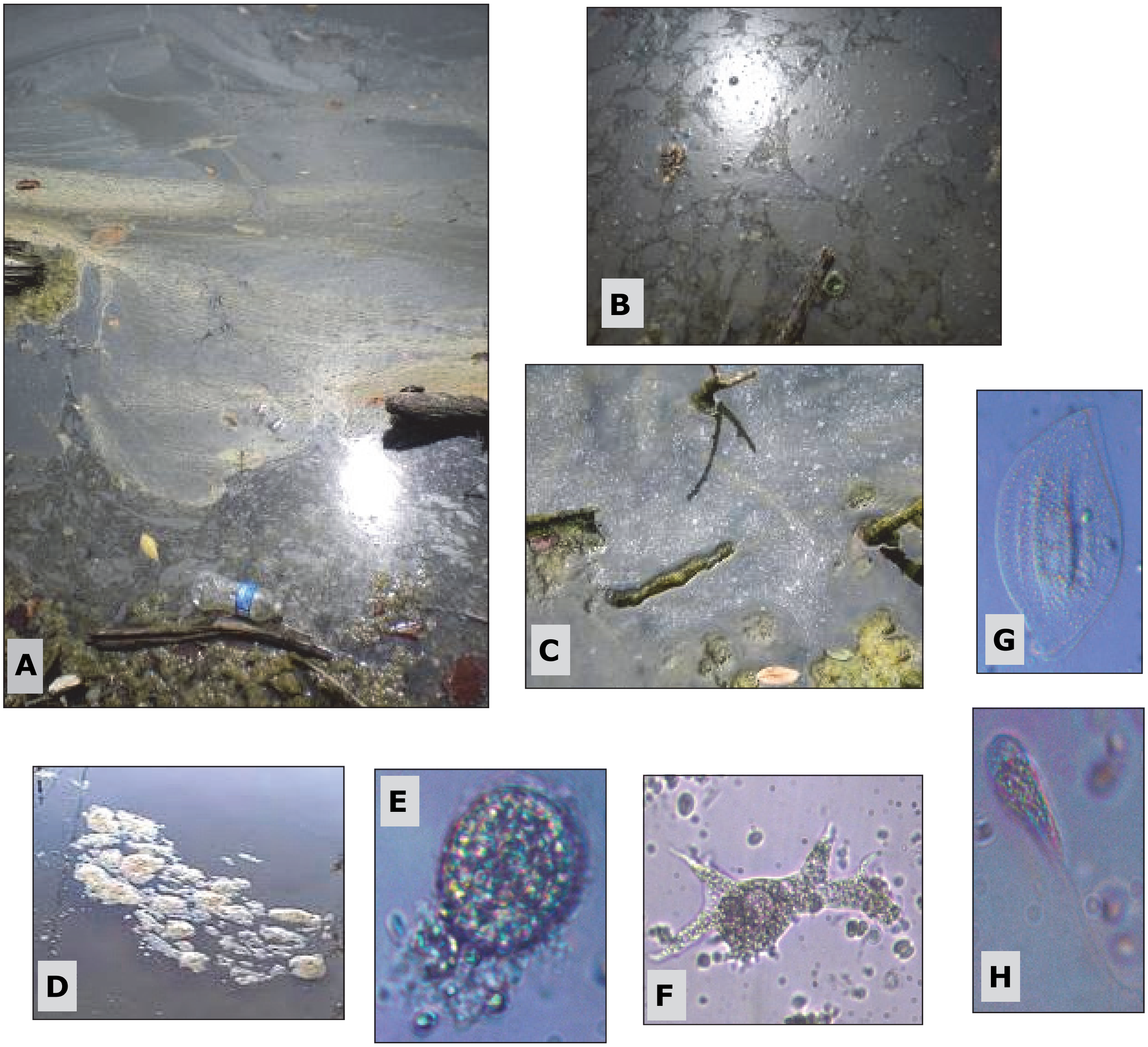


Frothy orange scums (**A**, **B**, **C**) are common in many streams, particularly in areas rich in Iron. Acid mine drainage areas are particularly susceptible to bacterial blooms. These scums are formed by sheathed bacteria, including those in the genus *Sphaerotilus*.

Sphaerotilus is also common in streams receiving de-icing fluids in the winter. De-icing fluid (ethylene glycol) is toxic to cats, dogs and some wildlife. Its sweet taste may attract them to drink the water. Therefore, although the bacteria is not toxic, never let your pet drink water that has an orange scum. *Sphaerotilus* actually helps degrade the de-icing fluid.

Under the microscope the bacteria forming these scums appear as long filaments enclosed in a stiff sheath (**D**, **E**). Iron oxide is accumulated in the sheath, giving the orange color to the scum. Often water containing these scums is very low in Oxygen. Some people refer to these scums as “sewage fungus”. This is not correct since the scums are formed by bacteria, not fungi.

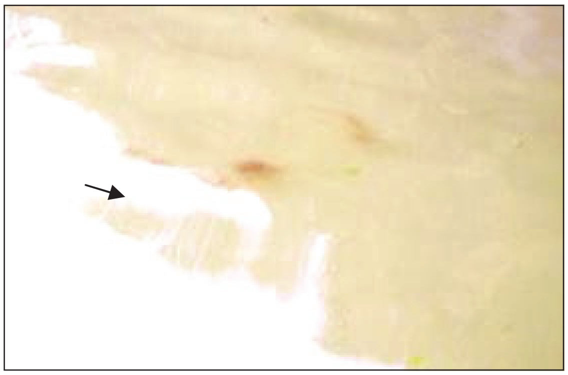
Protozoan Scums



Whitish-grey scums appear often in still waters. They form a shiny, almost oily film on the surface of the water (**A**, **B**, **C**). Sometimes they will also appear as a “foam” (**D**). When examined with the compound microscope, these scums reveal a diversity of Protozoans that include: Amoebozoans with or without shells (**E**, **F**), Ciliates (**G**) and Flagellates (**H**). These organisms feed on bacteria that have concentrated is these areas by the wind blowing over the surface of the water. Generally, unless the water is receiving a source of sewage, there are no safety issues with water that contains Protozoan scums. They can provide a good source of protozoan material for Biology classes.

Zooplankton Scums

Daphnia lumholtzi, and sometimes other zooplankton, can “swarm” producing scums that are usually brown. *Daphnia lumholtzi* was found as a swarming brown scum in Lake Cumberland on October 9, 2009.

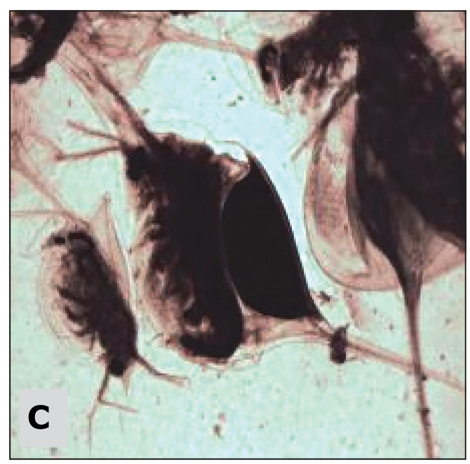


A

B

Brown scum in the water of Lake Cumberland (**A**) and in the bucket collected from this site (**B**). Note tendency of the brown organisms to become concentrated in one side of the bucket.

In the microscopic view of *Daphnia lumholtzi* (**C**)*,* note the saddle-shaped ephippium (shell that encloses the egg) on the back of the middle specimen. *Daphnia* with ephippia were more common in the scum as compared to those found isolated in the plankton. There were also small males in the scum, seen in the left specimen (**C**). This suggests swarming is an adaptation for sexual reproduction in this species, since ephippial (resting) eggs are formed only by sexual reproduction. The long tail spines often cross (bottom right of **C**) contributing to the clumping of individuals so the scum does not separate. Northern Kentucky University students baptized this brown scum full of “crosses” as “holy crap”.



C

Daphnia lumholtzi is a giant invasive Cladoceran native to Africa where it is the major zooplankter (individual organism in plankton) in Lake Victoria. The literature states that it is suspected that it may have been introduced into the United States of America with shipments of Nile Perch in the 1980’s. It has now spread to at least 56 reservoirs in mid-western and southern states. It can clog fish gills.

Algae Control Methods

Mechanical Methods

- Pumping of surface algal scums
- Aeration
- Barrier systems
- Raking

Physical/Chemical Methods

- Copper sulfate
  - Very effective in short-term use
  - Not recommended due to toxicity to fish and other organisms
  - Copper is NOT bio-degradable
- Barley straw www.btny.purdue.edu/pubs/apm/apm-1-w.pdf
- Phosphorus inactivation products
  - Aluminum sulfate (alum), sodium aluminate, calcium hydroxide, carbon dioxide
  - *e.g.* Phoslock™ www.sepro.com/phoslock/
- Shading products
  - Limits growth of organisms in the water by reducing the amount of sunlight and changes water color to blue, turquoise, or blue-green.
  - US FDA approved the dyes used in these shading products for food, drug, and cosmetic color additives
  - *e.g.* Aqua-shade™
  - *Note:* Not all shading products are registered with the EPA and those that aren't cannot, by law, claim that they affect algal growth.
- Endothall-amine salt
  - Only use in low concentrations for algae (becomes algaestat, *i.e.* stops algae growth at low concentrations)
  - High acute toxicity to fish
  - Does not accumulate in sediments and breaks down rapidly
  - *e.g.* Hydrothol 191™
- Sodium carbonate peroxyhydrate products
  - EPA registered for use in ponds, lakes, reservoirs, and drinking water sources
  - *e.g.* GreenClean™, Pak 27™

Biological control

- Microbial Products (Cyanophages for example).
- Grass Carp
  - Native to Asia and feed on aquatic plants and filamentous algae
  - Must be certified disease-free and sterile

This list is not all encompassing of the methods of controlling algae and lists only the more common and well known. Research the algaecide treatment before use and make sure it is appropriate for the situation.

Recommended Web sites

River on the Web, The website of the Ohio River STEM Institute:
https://row.nku.edu

Algal Toxins in Pond Aquaculture (2008)
https://srac.tamu.edu/index.cfm/event/getFactSheet/whichfactsheet/207/

Harmful Algal Bloom Management and Response: Assessment and Plan (2008) (Chapter 2 specifically)
http://www.whitehouse.gov/sites/default/files/microsites/ostp/jsost_hab0908.pdf

Review of Harmful Cyanobacterial Toxins (2010):
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2885083/

Ohio Sea Grant Fact Sheet:
http://www.ohioseagrant.osu.edu/_documents/publications/FS/FS-091-2011%20Harmful%20Algal%20Blooms%20In%20Ohio%20Waters.pdf

Aquatic Plant Management by Carole A. Lembi of Purdue University
http://www.extension.purdue.edu/extmedia/ws/ws_21.pdf

Center of Excellence for Great Lakes and Human Health:
http://www.glerl.noaa.gov/res/Centers/HABS/habs.html

Center for Disease Control (CDC) – Facts About Cyanobacteria & Cyanobacterial Harmful Algal Blooms
www.cdc.gov/hab/cyanobacteria/pdfs/facts.pdf

Ohio EPA Harmful Algae Blooms Web page www.epa.ohio.gov/dsw/HAB.aspx

Impacts of Deicing Fluids on Elijahs and Gunpowder Creeks Boone County, Kentucky by Kentucky Department for Environmental Protection Division of Water: http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/upload/2002_07_16_tmdl_examples_organics_ky_elijahgunpowder.pdf

Additional Publicly Available Field Guides

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

Algae Identification Lab Guide by Agriculture and Agri-Food Canada Agri-Environment Services Branch
http://publications.gc.ca/collections/collection_2011/agr/A125-8-1-2011-eng.pdf

A Field Guide to Common Aquatic Plants of Pennsylvania
http://pubs.cas.psu.edu/FreePubs/pdfs/agrs110.pdf

Managing Aquatic Vegetation by Ohio Department of Natural Resources
http://www.dnr.state.oh.us/wildlife/Home/fishing/pond/aquatic_veg/tabid/6216/Default.aspx

Although these guides come from different areas of the United States of America and Canada, the information in these guides is relevant for the Kentucky, Ohio and Indiana.

Acknowledgements

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