Water Column

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Until the *Daphnia* Come Home – Using Zooplankton as a Biomanipulation Tool

~ Karina Cardella

Who needs a lawnmower when you have . . . *Daphnia*? Well, if your lake has nutrient loading issues, which can result in excessive phytoplankton densities and algae blooms, then let those *Daphnia* chow down! You can think of *Daphnia*, specifically those filter-feeding zooplankton with a larger body size, as the aquatic equivalent to cows – they fit the same herbivorous position in the aquatic food web as do cows in a terrestrial one. They are grazers, and can have a considerable effect on algal densities, the same way a cow or a goat can do some serious damage if let loose on a patch of grass. Studies have shown that increasing the number of *Cladocera*, larger zooplankton such as *Daphnia*, can increase lake transparency, which is a result of decreased algal productivity (Figure 1; Edmondson 1978).

Using *Daphnia* (Figure 2), and other large zooplankton species, to alter phytoplankton and algal densities is not quite as simple as dumping some zooplankton into a lake, however. Top-down biomanipulation would probably be the best way to get the right zooplankton density in order to control excessive algal production. This is especially pertinent since the issue at hand is bottom-up in nature: Excess nutrients leading to an increased production in phytoplankton.

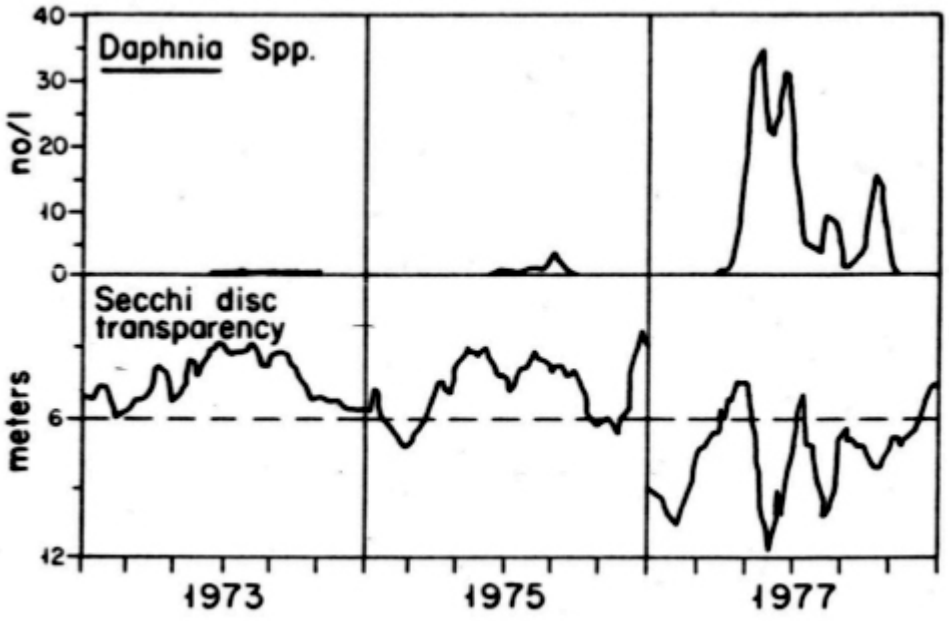


Figure 1. Daphnia *abundance and transparency in Lake Washington (source: Edmonson 1978).*

Figure 2. An image of a Daphnia *taken through a microscope at 4X magnification (source: Karina Cardella 2017)*

Since the top predator in a lake ecosystem, manipulating their populations may have a trickle-down effect that will affect *Daphnia* and other herbivorous zooplankton, and eventually algal densities. Stocking a lake with large piscivorous game fish can result in increased predation on the smaller planktivorous fish. A smaller planktivorous fish population means less predation on large zooplankton, which means their population has a chance to really grow. This now much larger "herd" of zooplankton will then graze heavily on excess algae and phytoplankton. Once *Daphnia* have a chance to eat their fill, the result can be less algae and deeper lake transparency.

Adding macrophytes to littoral zones can also help with this type of biomanipulation; macorphytes compete with the phytoplankton for nutrients, and the vegetation provides essential shelter and habitat for zooplankton.

While this seems like a great idea in theory, biomanipulation of food webs to obtain a certain result can have unintended consequences – so you might want to think twice before letting those *Daphnia* go to town on your lake's phytoplankton – until the cows come home.

If the phytoplankton density of a lake is too dense, with large floating algal mats, then biomanipulation of this sort may not be the best option. Algae and plankton that is too dense to begin with will actually clog the rakers and gills of the *Daphnia*, making this technique ineffective since this can actually kill off smaller zooplankton and have an effect on *Daphnia* populations. Also, stocking game fish may increase angling pressure of that lake, and if these large fish are caught, it can throw the whole balance off, since they are needed to create that top-down control. This biomanipulation technique may not have the long-term effects desired, because we never know how adding one organism is going to completely affect the rest of the system. For example, if the large stocked piscivore fish may consume all the planktovore fish, and with no predators, this may cause zooplankton densities to balloon, and throw off the entire balance of the food web.

Biomanipulation of a freshwater aquatic food web, with the desire of putting those zooplankton powerhouses to work, may not be a long-term substitute for controlling the forces that made a lake eutrophic to begin with. The better solution may be to address the reason behind the nutrient loading and algae issues that caused the problem. But until that solution can be reached, it's nice to know that such a small, microscopic creature such as *Daphnia* can have an overall large effect on the water quality of a lake (see Figure 3.)

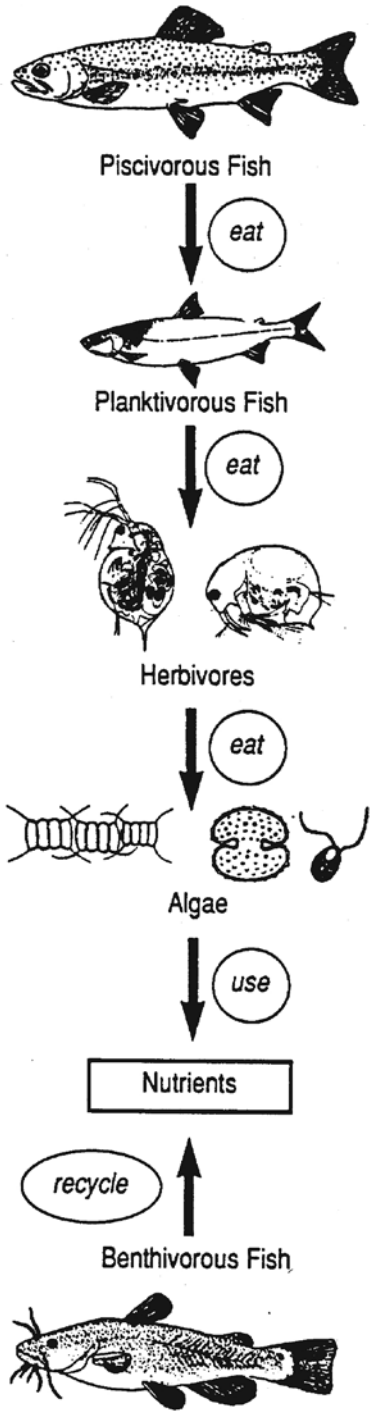


Figure 3. A simplified image of a freshwater aquatic food web (source: Melissa Laney 2016)

Have you checked out the Indiana Clean Lakes Program Web page lately? Take a look at www.indiana.edu/~clp/ and see what's new and happening with the program and with Indiana lakes!

Using "Bugs" as Water Quality Indicators

~ Cory Shumate

Most people might see bugs or other "creepy crawlers" around their house and think of them as just pests, but for lake owners, macroinvertebrates (aquatic insects, larvae, worms and other invertebrates) can serve as indicators of their lake's water quality. Macroinvertebrates can easily be found in the littoral, or shallow, zone of the lake where they have adapted to specific conditions of their habitat. The number, type, and tolerance levels of the macroinvertebrates can give a general indicator of water quality (Figure 4).

Macroinvertebrates are great indicators of water quality for several reasons. They live in the water for most, if not all, of their lives and typically stay in habitats that are suitable for their survival. They also differ in their tolerance level to pollution. Therefore, if the lake becomes polluted, less tolerant species will either move to other habitat or die off. Macroinvertebrates are also easy to collect and identify since they live the littoral zone.

Some examples of metrics used to measure macroinvertebrates include taxa composition and functional feeding group measurements. With taxa composition, you can measure the number tolerant versus intolerant species and which species are most dominant in your lake. Examples of pollution-intolerant species include stone flies, mayflies, and caddis flies, and pollution-tolerant species include aquatic worms, beetles, flies, and crayfish. Measuring functional feeding group composition can allow you to characterize trophic dynamics in the lake. Examples of functional feeding groups include filterers (clams), scrapers (snails), piercers (water striders), engulfers (dragonflies), etc. (Figure 5).

Macroinvertebrates are used as a metric in the National Lake Assessment (NLA) performed every five years by the Environmental Protection Agency (EPA). The NLA's purpose is to measure the current biological, chemical, physical, and recreational conditions of the United States' lakes, determine if lake conditions are getting better or worse over time, and what stressors are most associated with degraded conditions in lakes. This is important as lakes contribute to healthy economies via tourism and recreational opportunities and support complex ecosystems.

The 2012 NLA divided the U.S. into nine ecoregions. These ecoregions were chosen based on the regions climate, geology, soil type, and vegetation. Indiana is a part of three ecoregions: Upper Midwest, Temperate Plains, and Southern Appalachians. The Upper Midwest includes river systems that drain into the Upper Mississippi and Great Lakes watersheds. The Temperate Plains are characterized by smooth plains with a large number of lakes smaller than 100 hectares in size with river systems that empty into the Ohio River, Great Lakes, and Upper Mississippi River watersheds. The Southern Appalachians consists of hills and low mountains which have led to many man-made lakes being constructed. Benthic

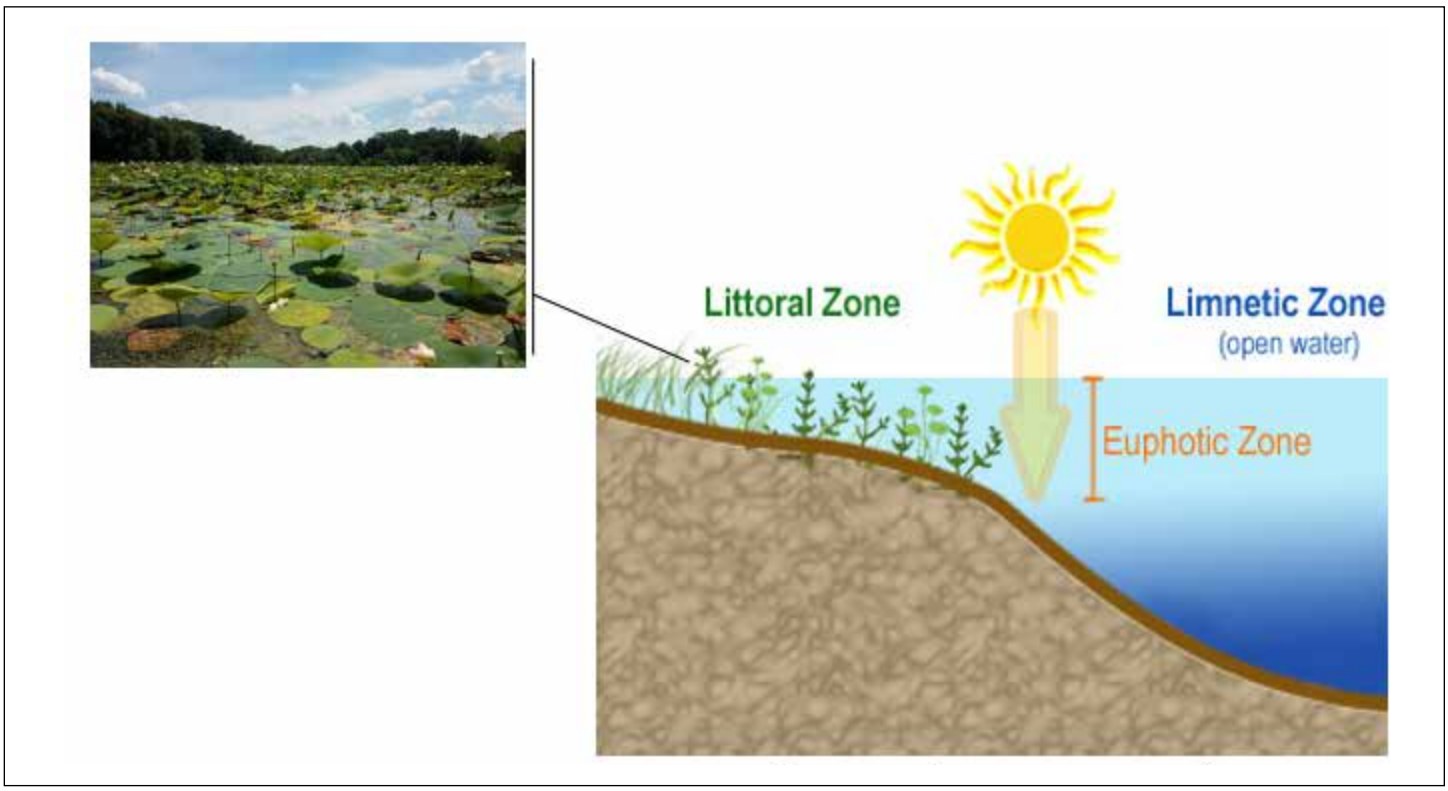


Figure 4. Littoral zone of a temperate freshwater lake.

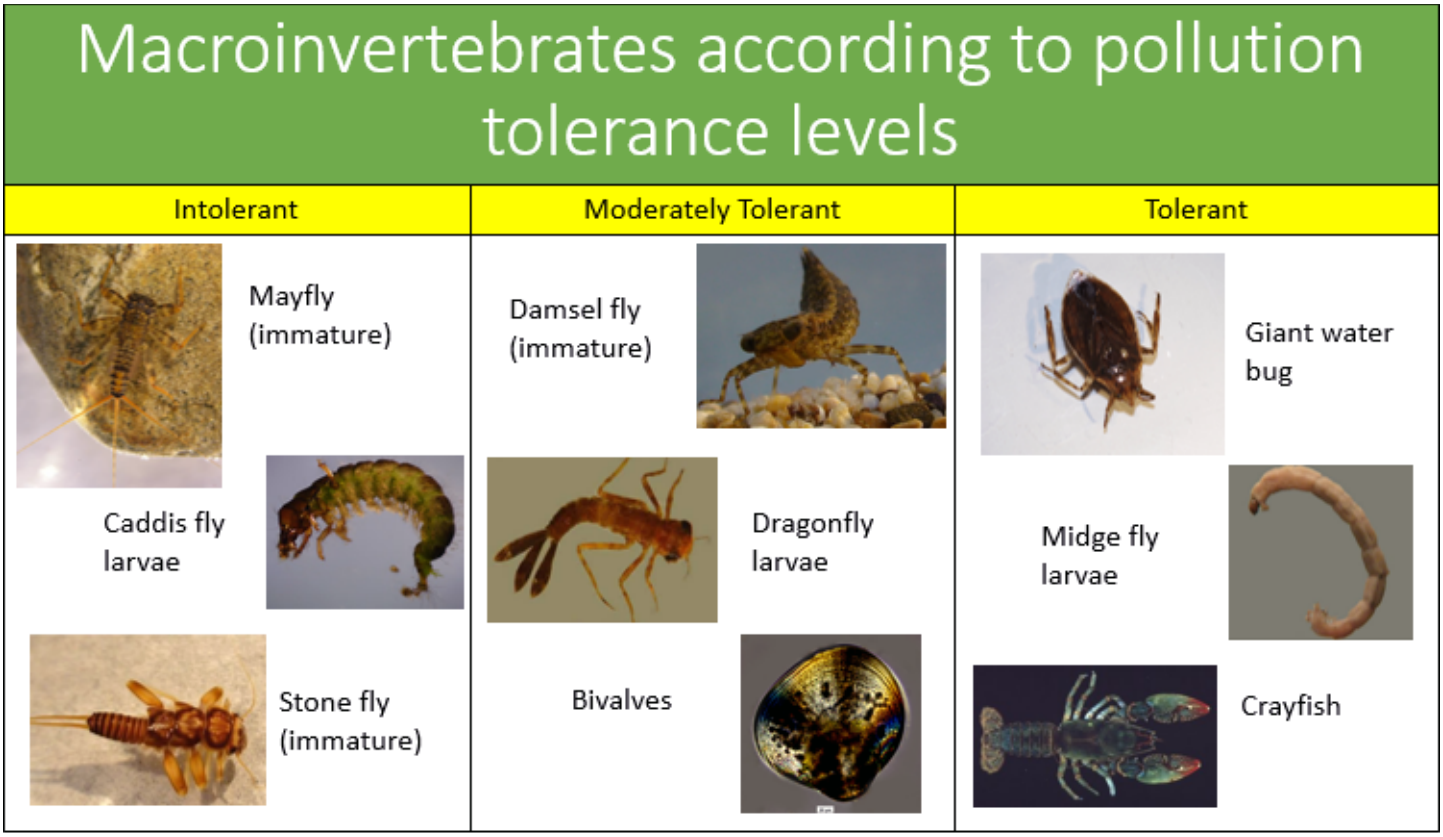


Figure 5. Examples of macroinvertebrates based on pollution tolerance levels.

macroinvertebrate samples were collected from 10 random littoral zone sites using D-frame nets at each lake sampled. The samples were then analyzed based on several measurements mentioned earlier including taxonomic composition and diversity, functional feeding groups, habitats, and pollution tolerance (Figure 6).

After analysis, each ecoregion's benthic macroinvertebrates were assigned one of the following condition categories: most disturbed, moderately disturbed, least disturbed, and not assessed. For the Upper Midwest, it was determined that 36.9 percent were most disturbed. For the Temperate Plains, 11.7 percent of lakes in the region were categorized as most disturbed. For the Southern Appalachians ecoregion, 47.2 percent of lakes were in the most disturbed category. The Upper Midwest's most disturbed condition had increase by 14.3 percent and the Temperate Plains and Southern Appalachians had decreased by 8.6 percent from

Figure 6. Ecoregions used in the National Lakes Assessment.

the 2007 NLA. These were not found to be statistically significant changes.

Two of the three ecoregions were found to have a higher percentage of lakes with benthic macroinvertebrate communities in the most disturbed category than the nation as-a-whole's percentage of 31 percent. The Upper Midwest's percentage of lakes were 20 percent lower than this. When viewing these results, they should be compared to other metrics of the

NLA including nutrient and pollutant concentrations and shoreline disturbance in order to assess the total condition of a lake.

For Indiana lake managers, macroinvertebrates can be useful and cost-effective early indicators of stressors on lake water quality. This can allow a lake manager to react early with a management plan to correct the issue. However other metrics such as nutrient, pollutant, and algal concentrations should also be sampled in order to gain a holistic view of the lake's condition and determine the best course of action.

EPA and the Army Propose to Amend the Effective Date of the 2015 Rule Defining "Waters of the United States"

~ EPA Office of Water

WASHINGTON (November 16, 2017) – The U.S. Environmental Protection Agency (EPA) and U.S. Department of the Army (the agencies) are proposing to amend the effective date of the 2015 rule defining "waters of the United States." The agencies are proposing that the 2015 rule would not go into effect until two years after today's action is finalized and published in the Federal Register. This amendment would give the agencies the time needed to reconsider the definition of "waters of the United States."

"Today's proposal shows our commitment to our state and tribal partners and to providing regulatory certainty to our nation's farmers, ranchers and businesses," said EPA Administrator Scott Pruitt. "This step will allow us to minimize confusion as we continue to receive input from across the country on how we should revise the definition of the 'waters of the United States.'"

The 2015 rule, which redefined the scope of where the Clean Water Act applies, had an effective date of August 28, 2015. Implementation of the 2015 rule is currently on hold as a result of the Sixth Circuit's nationwide stay of the rule, but that stay may be affected by a pending Supreme Court case. The 2015 rule is also stayed in 13 states due to a North Dakota district court ruling. EPA and the Army are taking this action to provide certainty and consistency to the regulated community.

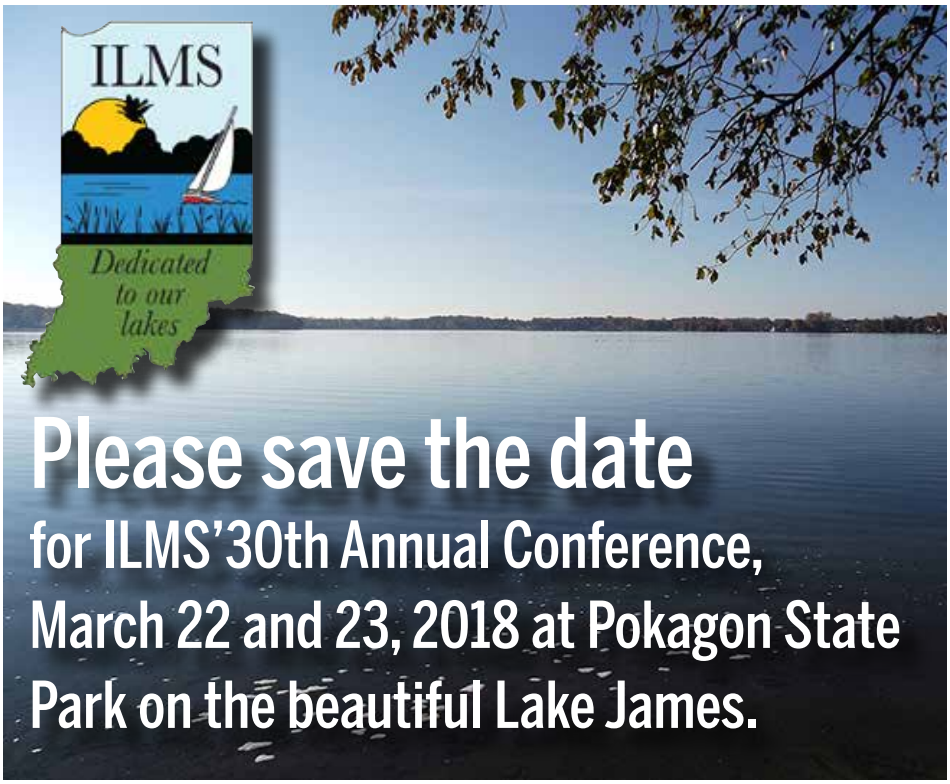
"The Army, together with the Army Corps of Engineers, propose this rule with EPA to help continue to provide clarity and predictability to the regulated public during the rule making process. We are committed to implementing the Clean Water Act Section 404 regulatory program as transparently as possible for the regulated public," said Mr. Ryan Fisher, Acting Assistant Secretary of the Army (Civil Works).

This action follows the February 28, 2017, Presidential Executive Order on "Restoring the Rule of Law, Federalism, and Economic Growth by Reviewing the 'Waters of the United States' Rule." The February Order states that it is in the national interest to ensure that the Nation's navigable waters are kept free from pollution, while at the same time promoting economic growth, minimizing regulatory uncertainty, and showing due regard for the roles of Congress and the States under the Constitution.

The agencies' proposal is separate from the two-step process the agencies propose to take to reconsider the 2015 rule. The comment period for the Step 1 rule closed in September and the agencies are currently working to review the comments received from the public. The agencies are also in the process of holding listening sessions with stakeholders as we work to develop a proposed Step 2 rule that would revise the definition of "waters of the United States."

The agencies will be collecting public comment on this proposal for 21 days after publication in the Federal Register and plan to move quickly to take final action in early 2018.

Additional information on this proposal and how to comment: **www.epa.gov/wotus-rule**.



Aquatic Invasive Monitoring Plant Highlight

This will be the 20th plant in the plant highlight series. We will be featuring one aquatic plant in each *Water Column* issue. We will feature both native and invasive plants to improve our plant identification skills.

Water Chestnut (*Trapa natans*), INVASIVE

Other common names: European water chestnut, horned water chestnut, water caltrop

DISTRIBUTION: Water chestnut is native to the tropical and warm temperature regions of Eurasia. It has also become naturalized in Australia and northeastern North America. In the United States, this species has been found in Connecticut, Delaware, Maine, Maryland, New Hampshire, New Jersey, New York, Pennsylvania, Virginia and Vermont Although not currently detected in Indiana waters, *Trapa natans* is a species that needs to be kept under close watch in order to prevent its introduction into our state.

Water chestnut can grow in wet, mucky substrates, but prefers shallow, nutrient-rich lakes and rivers.

DISPERSAL/SPREAD: The fruit of water chestnut may be dispersed when individual plants are uprooted and float downstream. *These plants can also be dispersed by fragmentation*. Due to the large size and weight of the sinking seeds, it is unlikely that waterfowl or water currents can transport seeds to any great extent.

Identification tips:

- Plant has a rosette of floating leaves, 1/2 to 1 inch long, at the tip of a submersed stem
- Floating leaves can reach over 15 feet in length
- Flowers have 4 white petals about 1/3 of an inch long
- Fruit is black, four-horned, nut-like structure

Report this plant if you find it at Indiana DNR's Aquatic Invasive Species "Report a pest" form: (**http://www.in.gov/dnr/6385.htm**)

Volunteer Corner

~ Bruna Oliveria, Volunteer Assistant Coordinator

As the 2017 lake monitoring season comes to a close, I want to thank all of our hard working volunteers for collecting valuable water quality data for the Indiana Clean Lakes Program. As you take your boats off the water and put away your Secchi discs, please don't forget to submit your final samples, data, and surveys! We would love your input in how we can improve the Volunteer Lake Monitoring Program.

So far, we have received 438 Secchi depth measurements for 57 Indiana lakes! Great work, and congratulations on a successful sampling season! We are looking forward to what your data will reveal about our beautiful lakes. We are always thrilled to add new lakes to our program, so if you are currently not a volunteer in the program and would like to participate next summer, please contact us at **indianaclp@gmail.com**. We are happy to provide training, sampling equipment, and any assistance you may need.

Again, thank you to all of our volunteers for your continued commitment to the Indiana Clean Lakes Program. Have a wonderful winter and joyous holiday season. See you next summer!

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Perspectives

I cannot endure to
waste anything as precious as
autumn sunshine
by staying in the house.
So I spend almost all the
daylight hours
in the open air.

~ Nathaniel Hawthorne