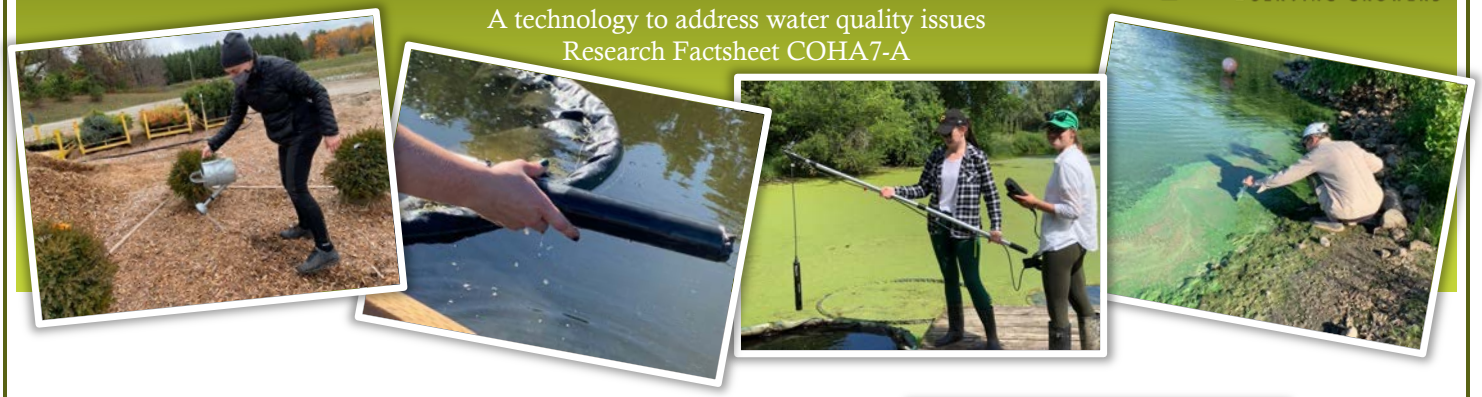
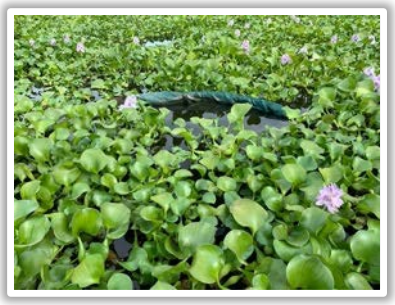
AQUATIC VEGETATION

A technology to address water quality issues
Research Factsheet COHA7-A



What kinds of aquatic vegetation are there?

Macrophytes are large, multicellular vascular plants, growing either on the surface or underwater. There are also algae that grow in ponds and photosynthesize, but they are not plants: they lack the vascular structure of true plants. Common examples of aquatic vegetation that are found in ponds are *Chara spp.* (green charophyte algae), *Lemna spp.* (duckweed plant), and *Eichhornia crassipes* (common water hyacinth plant). These organisms are different than phytoplankton, which are small, often unicellular organisms that can photosynthesize. Phytoplankton is a general term, can include algae or even bacteria (e.g., cyanobacteria) species, which can be the cause of unsightly blooms.

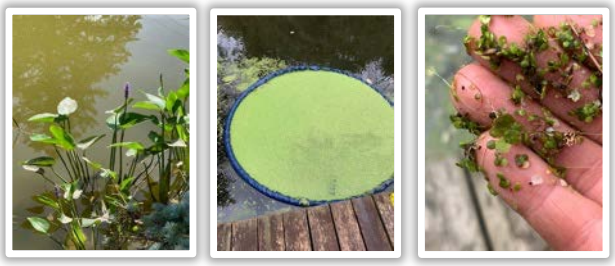


Water hyacinths covering a pond.

Submerged macrophytes in a very clear pond.

When is aquatic vegetation useful?

In some cases, macrophytes/algae can be a good thing! These organisms take up nutrients and add oxygen to your pond, improving water quality. They can also provide a healthy habitat for fish and prevent undesirable plants and algae from overtaking your pond. In recent research, whole pond covering with water hyacinths improved water quality in an irrigation pond by blocking light, preventing serious cyanobacterial blooms. Pickerelweed (*Pontedaria cordata*) is an attractive native plant that can decrease turbidity, filter out nutrients, and improve overall pond water quality.



Pickerelweed, duckweed covering trial, a close-up of duckweed.

What are the drawbacks?

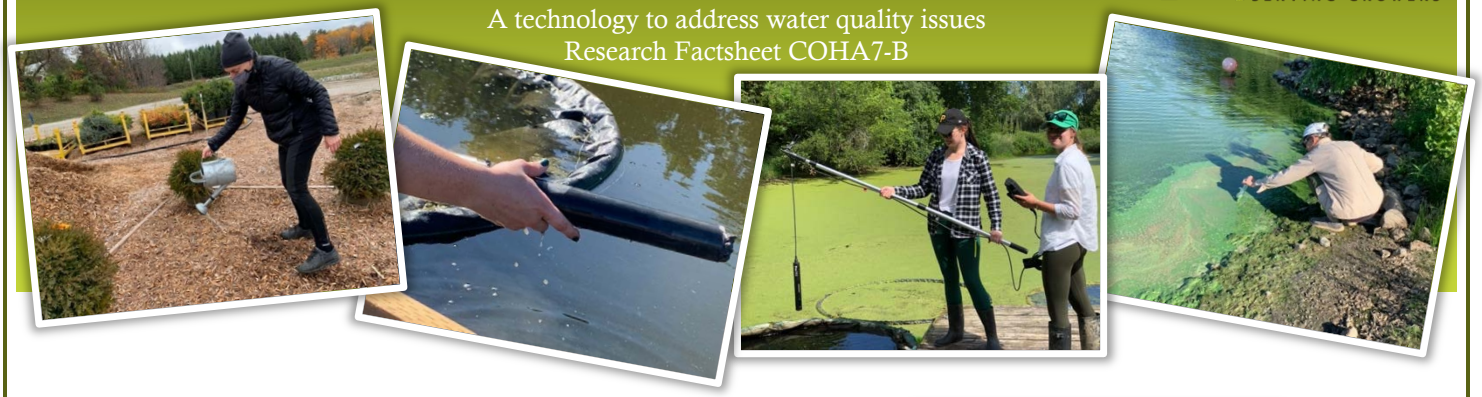
Macrophytes and algae can overtake a pond, and there are a couple of issues with this: first, there may be filter or intake clogging if the wrong species of plants take hold (e.g., filamentous types). Second, to remain effective, the plants should be harvested regularly, or decaying plant material can put the nutrients back into the pond. Some species can be invasive under certain conditions (e.g., water hyacinth), so make sure the chosen plants will not cause a problem with downstream waters.

This factsheet was developed as part of the Accelerating Green Plant Innovation for Environmental and Economic Benefit Cluster and is funded by the Canadian Ornamental Horticulture Alliance (COHA-ACHO) and by the Government of Canada under the Canadian Agricultural Partnership's AgriScience Program.

For more information, contact jwest@phytoserv.com.

HYBRID TREATMENT SWALES

A technology to address water quality issues
Research Factsheet COHA7-B



What is a Hybrid Treatment Swale?

A combination of a woodchip bioreactor plus other media components to treat water quality is termed a Hybrid Treatment System or Swale (HTS). If the system is deep and flow between cells is pumped, it is referred to as a system, but recent research has shown that a passive shallow swale with woodchips and other media in sections (or cells) can also be effective at removing selected nutrients. The swale installations are useful at edge of a field or where container nursery leachate/runoff is routed to a collection pond so that any residual fertilizer in the water can be removed before the it reaches the pond.

When is a HTS useful?

Runoff from fertilizer applications contains nutrients including nitrogen and phosphorus. These elements are known to contribute to eutrophication of ponds. The woodchips are very effective at removing nitrate (N), and in some cases can remove phosphorus as well. Where water-soluble or slow-release fertilizers are used, phosphorus levels reaching ponds can easily result in algal or cyanobacterial blooms. In this case, slag (high in iron, with lots of P binding sites) can be used in one of the sections. Polishing the water afterwards can be valuable, as both biological oxygen demand and pH of the water rise after going through the woodchips and slag.

A passive woodchip bioreactor swale.

A hybrid treatment swale at a container nursery.

Three 'cells': woodchips, slag, and gravel.

What are the drawbacks?

A hybrid treatment swale isn't magic – it can't remove all nutrients (e.g., potassium or salts), and it does take a significant area to have a large enough system to ensure sufficient contact time between the runoff and the media. Volume calculations must be done to determine the correct sizing, and selecting media cell components is based on the water quality and particular contaminants that it's designed to remove.

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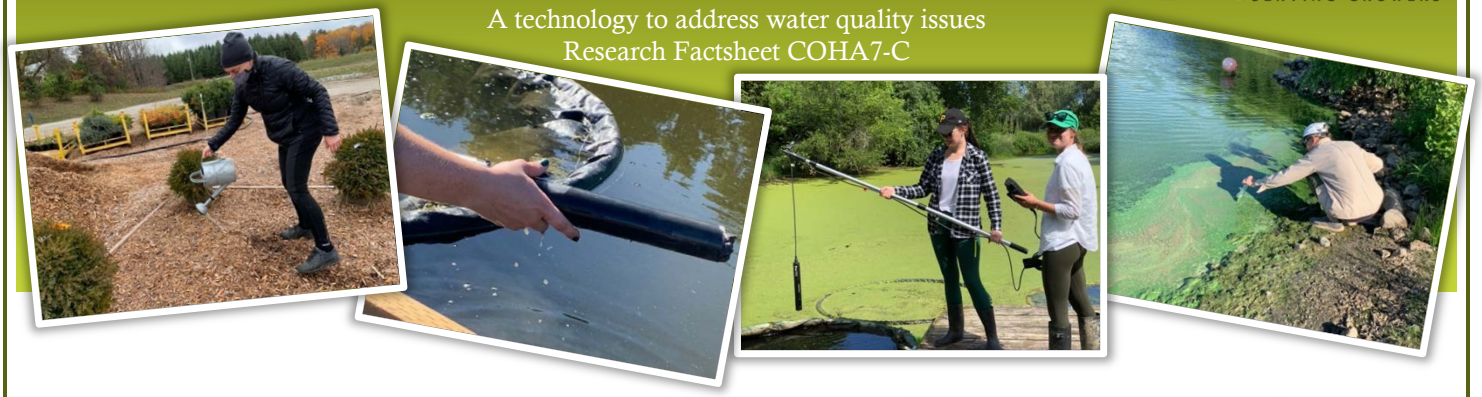
AERATION OPTIONS

A technology to address water quality issues
Research Factsheet COHA7-C



What kinds of aeration are available?

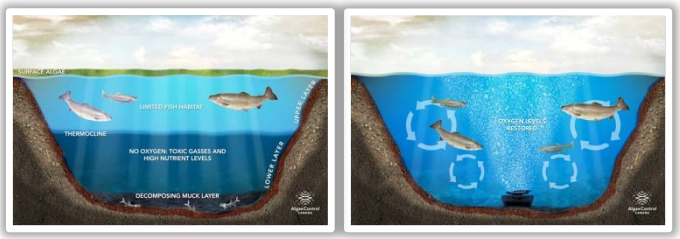
Aeration is one of the most common treatments for ponds, and many farms use diffuser airstones to generate small bubbles that help turn over and de-stratify ponds. These stones can be powered by either wind or electricity, although wind-powered systems tend to be less effective. However, newer technology uses nano-sized bubbles that are less visible to the eye but can be far more effective in deeper water as there are billions of them generated, resulting in a significantly greater air-water interface area per unit volume.

Traditional aeration using a diffuser airstone.

Nanobubbler aeration (Moleaer Clear 150).

When is aeration useful?

Older ponds with a build-up of sediment and organic matter benefit from aeration. Aeration essentially brings additional oxygen to the bottom of the pond, which is usually fairly low in oxygen. Despite the obvious turbulence caused by adding bubbles, long-term, aeration will support the degradation of organic matter in the sediment and prevent anaerobic digestion (which results in that dirty water smell). Increased oxygen at the bottom of ponds also supports a healthy zooplankton habitat (zooplankton consume phytoplankton, a group of organisms that cause blooms). Preventing a pond from having 'layers' with differing water quality is important. Note that aeration is still recommended for new ponds to help keep them healthy.



The aerated pond on the right has oxygen throughout the water column (images courtesy of Algae Control Canada).

What are the drawbacks?

Aeration does not solve all pond water quality issues, although it is an important tool in pond management. The deeper the pond, the more challenging it is to have effective aeration. However, using nanobubblers can offset this issue. It is critical to keep the equipment in good repair – regular cleaning and maintenance is needed to ensure the proper generation of bubbles. Time is another factor – long term improvements to sediment quality will take more than one summer!

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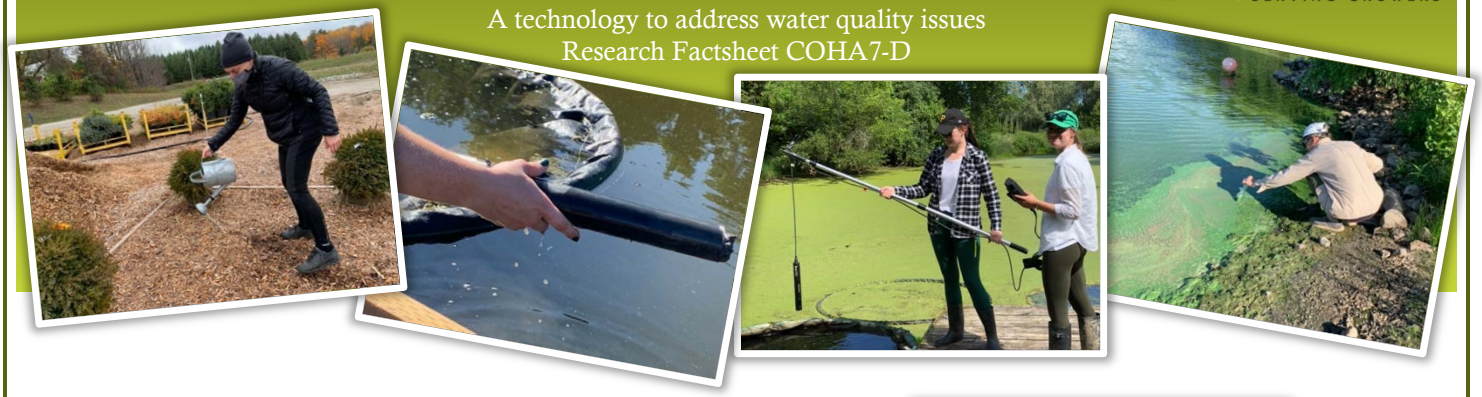
SONICATION

A technology to address water quality issues
Research Factsheet COHA7-D



What is sonication?

Sonication is also called ultrasonic irradiation. It involves using high frequency ultrasonic waves that, in water, result in the generation of bubbles that burst (from cavitation) releasing energy and intense local heat. When millions of these small bubbles implode, the cells walls and membranes of cyanobacteria and algae floating in the water are damaged, and ultimately, can 'clear' a pond. The power, frequency and duration of exposure are important factors in determining how well a sonication unit will perform.

When is sonication useful?

Most studies indicate that sonication is most effective against cyanobacteria, or 'blue-green' blooms. These bacteria have gas vacuoles, and are particularly sensitive to the imploding bubbles generated by the units. The units have also been shown to be effective against filamentous green algae that can cause clogging of irrigation lines. The units may be useful in cisterns or storage tanks as well.

Not all sonication units are created equally. In-pond treatments often have lower power and lower frequency options compared to bench-scale 'theoretical' models. It's important to make sure the chosen unit is adequate for the size of pond. Note that these units are safe for storage ponds and for fish and have very low maintenance!

Ultrasonic Single Transducer (60Watt) from Ultramins.

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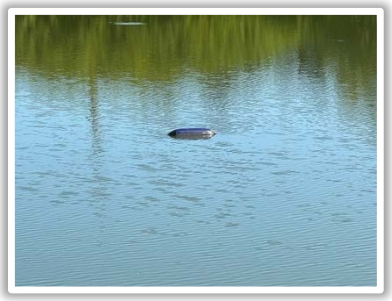

A sonication unit in a treatment pond.

Cyanobacterial bloom along the shoreline.

What are the drawbacks?

Farms with mixed blooms (less cyanobacteria and filamentous green algae) may not have success with sonication for management of these blooms. Further, long term management of water quality needs to be addressed with other tools – the broken cells of the bacteria and algae will settle to the bottom, and residual nutrients will be available for future blooms. Cyanobacteria also have vegetative spores or resting stages that can survive in the sediment that are not affected by sonication. These can generate new blooms when conditions are right.

The units will need to run continuously to have a more 'permanent' impact on visible water quality.

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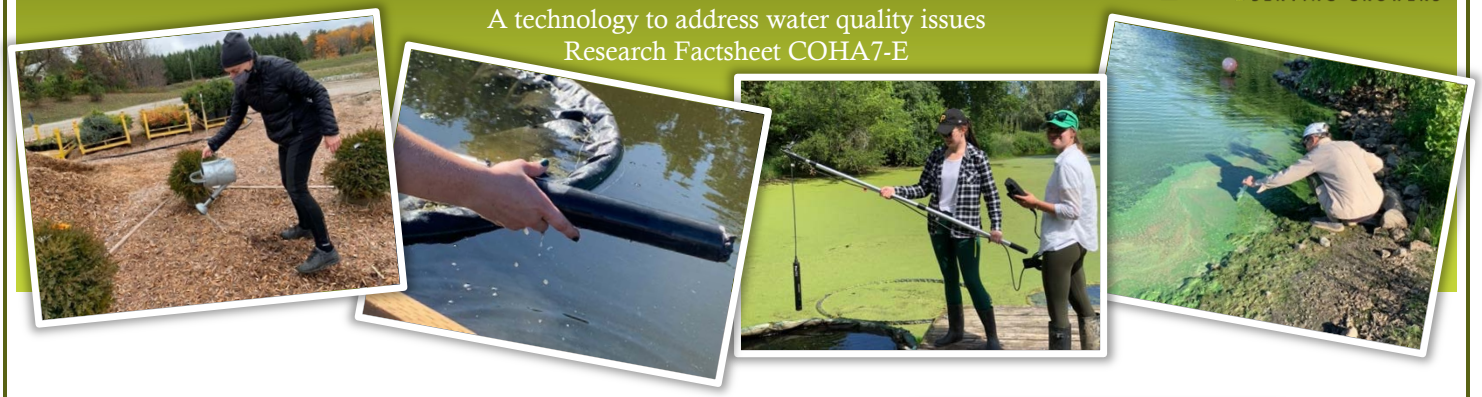
COVERING YOUR POND

A technology to address water quality issues
Research Factsheet COHA7-E



What kinds of covers are available?

Traditionally, ponds were not covered. But covers or shading/netting are available to prevent waterfowl and debris from entering ponds and reduce light that encourages phytoplankton growth. Covers can be supported or floating solid geotextiles, plants, floating islands with plants, and floating covers comprised of a customized number of individual abutting plastic balls or discs (e.g., Bird-X bird balls). Floating islands can be hexagonal in shape, with multiple units fitting together to effectively cover ponds.

When is covering useful?

Not only does covering a pond prevent birds from landing (and therefore, from depositing their wastes in your pond), covering also prevents light from entering the water column. Cyanobacteria and algal blooms depend on warmth and high light levels, so covering ponds is very effective in decreasing the likelihood of a bloom. Research has demonstrated that even with higher nutrient levels present in outdoor return silos, using bird balls significantly prevented algal and cyanobacterial growth. A pond covered with water hyacinths also showed significant improvement in turbidity and cyanobacterial levels within one season. Note that aeration is still recommended for covered ponds to help keep them oxygenated.

The same pond on the left with minimal coverage at mid-summer, compared to late summer when plants fully covered the surface.

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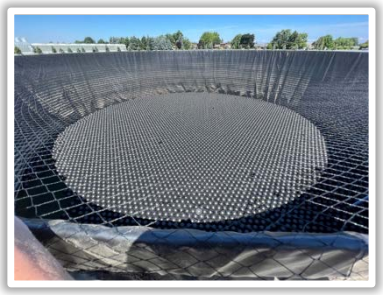

Bird Balls covering a silo surface.

Floating island (PhytoLinks™) in spring, before plant growth evident.

What are the drawbacks?

Floating islands may be more effective in ponds with high nutrient content, and it is important to harvest excess plant biomass each year to ensure there is room new growth to continue nutrient uptake.

If surface plantings like water hyacinth are used, ensure there is no risk of spreading the plants to other surface waters. While these plants generally don't overwinter well in Canadian climates, some regions may be warm enough for these plants to be invasive. Again, biomass will need to be harvested to prevent re-introducing nutrients from decomposition into the pond.

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