Golf Course Water Features Need Management

Well-designed water features that receive basic management will attract more than errant golf shots.

BY JIM SKORULSKI

While traveling across New England, I come across good, bad, and downright ugly ponds and lakes. The good ponds appear to be healthy, vibrant systems that serve many functions while complementing the landscape. On the other hand, bad ponds and lakes may be functional but are usually disfigured with deteriorating banks and seasonal algae and weed problems. The design of ugly lakes and ponds is often about as inspiring as stock farm ponds (no offense to stock-farm-pond owners who may read this).

How do water features at your facility rate? Are they assets or liabilities to your facility? What level of management do they receive? This article provides an overview of typical golf course water features, including techniques and practices that are used to evaluate and manage them.

The staff cuts and pulls phragmites, or the common reed, from the edge of a golf course pond to slow the spread of the invasive weed and encourage the growth of native emergent plants.

Filamentous green algae extends to the surface of this shallow pond. Increasing the pond depth, circulating the water, and creating a vegetative buffer around the pond edges could help reduce the nutrients available to the algae and produce a more pleasing and natural-looking body of water.

POND ECOLOGY

Ponds are complex, living systems composed of bacteria, algae, plants, insects, amphibians, crustaceans, fish, and mammals. Bacteria and algae are the most abundant organisms and most important components of pond ecosystems. Bacteria act as decomposers in aquatic systems and break down organic substrate into inorganic material. Most bacteria require oxygen to survive, but some, the anaerobic bacteria, actually thrive in the absence of oxygen. Algae are mostly microscopic, single-celled or multicelled, plant-like organisms found floating in the water or attached to substrate. There are many species of algae in pond and lake systems. Furthermore, algae are the primary food producers in aquatic systems. Similar to vascular plants, algae consume carbon dioxide

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Some ponds are designed with water-filtration systems to circulate and filter water in hopes of reducing algae and keeping the water pristine.

and produce oxygen. Certain species of algae flourish or "bloom" under certain environmental conditions and when nitrogen and phosphorous are abundant in water. The blooms can discolor water, create unpleasant odors, become unsightly, and endanger aquatic wildlife. Certain species of blue-green algae (cyanobacteria) can produce toxins that are injurious or even deadly to animals. Algae are susceptible to even small environmental changes, and a change in sun or temperature can produce rapid fish kills during an algal bloom. Furthermore, the massive dieback of algae can lead to fish kills when oxygen in the water is consumed by the decomposing algae.

Aquatic plants are also important components of pond systems. Most aquatic plants are rooted, but several species are free-floating. Plants provide habitat for young fish, aquatic insects, and other animals. Plants also produce oxygen in the water column and help trap and filter suspended sediments. Aquatic plants can adapt to a variety of conditions, but they thrive in shallow, nutrient-rich bodies of water. However, invasive plants introduced into ponds and lakes can be especially problematic and difficult to manage. Plants such as hydrilla, alligatorweed, common reed, Eurasian milfoil, water chestnut, water hyacinth, Brazilian waterweed, and curly pondweed are some of the invasive plant species that have changed the landscape and ecology of ponds and lakes in North America. Once introduced, invasive plant species, which oftentimes have few or no natural pests once removed from their native environments, can readily outcompete native plant species.

The biology and appearance of a pond or lake are impacted by factors such as age, water source, depth, nutrients, oxygen content, circulation, and flush turnover rate. Younger ponds and lakes, ponds fed by natural springs, and probably some irrigation ponds recharged with wells may remain pristine in appearance with clear water and lower levels of algae and plants. Older ponds tend to have more nutrients, algae, and aquatic plants; therefore, water clarity in these systems will be lower. Mature ponds can often be classified as eutrophic or even hypereutrophic, depending algae content, nutrient levels, and water clarity.

Water temperature in ponds and lakes also plays a role in the biology of the system and ultimately the appearance of the water body. Water in deeper ponds and lakes stratifies in summer when surface waters warm and float above the cooler water below. Temperature stratification affects nutrient cycling and oxygen distribution in the water column, which in turn impacts the aquatic organism populations and

A golf course pond built with a littoral shelf extending out from the pond's edge provides an area for emergent plants that create a buffer, provide habitat for aquatic organisms, and help reduce bank erosion.

how the pond should be managed. Temperature stratification is much less of a factor, or may not even be present, in very shallow ponds where water temperatures are warmer and more likely to support larger populations of algae and plants.

DESIGN IMPACTS MANAGEMENT

A water feature's design and purpose influence how it should be managed. Ponds with the primary function being irrigation are usually designed to provide maximum storage capacity, and their banks will probably be steeper and more uniform. Ponds designed to store irrigation water are often lined and usually have high water turnover rates. Multipurpose ponds may be used to retain stormwater, provide secondary water storage, create water hazards, and provide habitat. Multipurpose ponds often vary in depth and may include large littoral shelves extending outward from the banks. Pond depth beyond littoral shelves should be a minimum of 6 feet, with a depth of 8 feet preferred. The deeper depth will shade out emergent plants in those areas. Furthermore, temperature stratification will occur in deeper areas, which can be helpful in suppressing algae.

Water features fed by wells or springs are typically clearer and lower in nutrients than those that are stagnant. Recharged bodies of water will have algae but are less likely to experience algal blooms. However, ponds that are recharged with stormwater runoff will likely contain high levels of nutrients and sediments and will probably require more management inputs. Also, water features created by impounded streams are prone to constant siltation, which may necessitate more frequent dredging. Furthermore, ponds used to store effluent water are often high in nutrients and salts and thus likely to experience algal blooms.

Seldom do we have a choice but to manage what is provided to us. Therefore, it is important to evaluate water features effectively to determine an appropriate management program. The initial evaluation may be fairly simple and include a determination of the pond's size, depth, water source, use, water turbidity, and the extent of the algae and aquatic plants that are present. Water tests for nutrients, dissolved oxygen and chlorophyll content, i.e., algal biomass, may be done if there is a specific need. Understanding basic pond ecology and having the ability to identify common aquatic plants, invasive plants, and algae are critical for those who plan to self-manage ponds. A professional pond manager can complete a more extensive and thorough survey of the plants and algae present. The information gained from pond evaluations should be used to formulate an integrated management plan for the water body. Follow-up evaluations are helpful to measure the success of management programs and treatments that have been made.

MANAGING ALGAE

Algae are a major component in all freshwater and saltwater systems and are nearly undetectable until they multiply or bloom, at which time they can be very problematic. The types of algae found in ponds include single-celled, free-floating, microscopic algae (e.g., phytoplankton); stringy, filamentous algae (e.g., Spirogyra); and algae that closely resemble plants (e.g., Chara or Nitella algae). Blue-green algae, or cyanobacteria, are actually bacteria but act very much like algae. The various types of algae have different requirements for growth, but all require nitrogen (N), phosphorous (P), and sunlight to bloom. Reducing nutrients in the water is a key management objective used to reduce algal blooms. Nutrient reduction and inactivation methods are listed in Table 1.

Water circulation can play an important role in managing algae and maintaining good water quality. Bubblers circulate cooler water from the bottom of the pond upward, where it is intermixed with more oxygen-rich water near the surface. The circulation process disperses oxygen through the water column. The higher levels of oxygen help transform phosphorus into forms that cannot be utilized by algae. Aeration also supports beneficial aerobic bacteria as well as fish and other aquatic organisms. Bubblers

Table 1
Nutrient Reduction and Inactivation

Reduce outside sources of nutrients	**Reduce outside sources of nutrients entering pond**
	Use of vegetative buffer strips around ponds and streams
	Judicious use of fertilizers around water bodies
	Eliminate direct discharge from storm-drain pipes
	Prevent grass clippings from entering system
	Manage waterfowl populations
Nutrient inactivation	**Amendments**
	Alum to precipitate phosphorous and suspended solids to bottom substrate
	PhosLock® to bind and make phosphorus unavailable
	Water circulation
	Bubblers for circulation/aeration to oxidize and precipitate phosphorus
	Support aerobic bacteria that utilize nutrients and decompose organic matter

Even a small naturalized-grass area around the edge of a pond provides an effective buffer that can prevent runoff water from entering the pond. Buffer strips like this are used to reduce nutrients that would otherwise be used by algae and aquatic plants in the pond.

Bubblers circulate and help oxygenate water in ponds. Both actions help reduce phosphorus that is available to algae, improve water quality, and benefit fish and other organisms.

and water-circulating pumps are very efficient at moving and oxygenating water, but fountains are not. Fountains are best-suited for ornamental purposes as the circulation they provide is of marginal benefit.

Another practice that can be used to suppress algae involves the use of EPA-registered dyes. The dyes can be added to ponds to reduce light penetration in the water, which impacts the ability of algae to absorb sunlight and multiply. Using dyes can be a successful strategy if initiated early in the season before the algae proliferate. Unsightly mats of filamentous algae can sometimes be manually removed from smaller ponds with rakes. However, manual removal is usually a wind-aided procedure that produces temporary results. There are no biological control agents currently available for algae in golf course ponds. Tilapia fish are the only registered agent that feed on algae directly, but they are not available for public use at this time. Although efficient grazers of many aquatic plants, grass carp, or white amur, do not feed on algae. Furthermore, the use of barley straw as a control agent has provided inconsistent results at best. There are a number of bacteria and enzyme products marketed to inactivate nutrients and digest organic matter, but there is little research to support the claims of their effectiveness.

Heavy infestations of algae will usually require treatment with an algaecide. Copper-based algaecides remain popular in pond-management programs, with copper sulfate and chelated copper products providing selective control of algae. The copper dissipates quickly from the water as it binds with organic matter in substrate at the bottom of the pond. More recently, peroxide products have also become available to treat algae. The peroxide-based products are selective against algae they come in contact with, and they leave no residue following treatment. Shallow and nutrient-rich bodies of water will always be susceptible to algal blooms and will likely require an ongoing, integrated management approach to reduce their occurrence.

MANAGING AQUATIC PLANTS

Aquatic plants are also a major component of most shallow ponds and lakes. The growth requirements of aquatic plants are the same as terrestrial plants: sunlight, water, carbon dioxide, oxygen, and nutrients. There are submersed plants that can grow from depths of 30 feet or more in clear water, emergent plants that are limited to littoral zones and bank areas, and floating plants. Plant growth is typically more vigorous and problematic in shallow or nutrient-rich ponds where the primary limiting factor for plant growth is sunlight. The introduction of invasive plants into water systems creates even greater management challenges in ponds and lakes. Invasive plants can quickly dominate a lake or pond, crowding other plants while severely impacting fish, birds, and other organisms. Unfortunately, the list of invasive plants and other organisms associated with ponds, lakes, and wetlands is large and growing.

There are several techniques available to manage aquatic plants. They include numerous cultural practices, mechanical harvesting, the use of biological control agents, and herbicide programs. Table 2 lists these techniques.

Table 2
Aquatic Plant Management

Cultural-management options	Hand-pulling, suction
	Dredging
	Screening, shading
	Water drawdown
	Circulation and aeration
	Nutrient reduction
Mechanical removal	Mechanical harvesters
Biological-control agents	Grass carp (white amur): Most plants
	Insect agents: Alligatorweed
	Eurasian milfoil
	Purple loosestrife
Chemical	Contact and systemic herbicides
	Registered pond dyes

Physical removal of unwanted plants via hand pulling, suction, and raking can be a useful tactic for emergent and submersed plants in shallow areas and around pond banks. The success of this practice depends on the plants being targeted. Aquatic plants are like other perennial plants in that the entire plant and root system must be removed for successful eradication, and the removal process will likely have to be repeated. Physical removal of weeds from deeper and larger

A bloom of filamentous algae discolors the water and creates floating mats that are unattractive.

ponds requires divers and comes at a cost that may be prohibitive for some.

Dredging is often used to remove nutrient-rich sediments and increase the depth of a water body. The dredging process is also an effective means to remove emergent plants from shallow water areas. Dredging may also reduce submersed plant populations while providing other benefits such as increased water storage. However, dredging costs are high and dealing with removed sediments can be a challenge. Pond drawdown is another cultural practice used in more northern areas where water levels can be manipulated. Drawdown involves lowering the water level of a pond before winter to expose shallow-rooted plants to freezing temperatures and desiccation. The pond-drawdown technique can work well against certain plant species, but the pond bottom must remain exposed for six to eight weeks.

Mechanical harvesting with specialized motorized equipment is a technique that is most practical for large bodies of water. The harvesting is done with large, complex harvesting equipment that cuts and collects problematic plants. Mechanical harvesting is an expensive process, and disposing of the harvested plants can be challenging. However, mechanical harvesting can provide in-season relief from aquatic vegetation where chemical control is not an option.

Biological control agents are available to suppress some aquatic plants. One biological control agent that many are familiar with is the grass carp, or white amur, which has a voracious appetite for most aquatic plants. Unfortunately, grass carp are not fond of filamentous algae, cattail, fragrant water lily, sawgrass, and other large plants. Sterilized grass carp are being used successfully in many pond systems where they are permitted. However, the nonselective feeding habit of grass carp can impact the ecology of small ponds and may not be desirable in all situations. The use of sterilized grass carp is illegal in some states, so check with your state conservation agency to learn more about their availability and required permits.

Although fountains do circulate water, they are not nearly as efficient as bubblers and should be used more for decorative purposes.

Several species of insects have been used as plant-control agents. The most successful introduced insect agents have been the alligatorweed flea beetle, purple loosestrife beetle, and milfoil weevil. The insects are often plant pests in their native range and are well-suited against invasive plants that have no other natural enemies. Unfortunately, the process to develop and safely release insects to control invasive plants is a lengthy one and often not successful. Populations from earlier releases of the insect agents may already be established in your area, or the insect agents may be available for release from your state conservation agency or commercial laboratories. Contact your state conservation agency or speak with a pond specialist if you are battling one of the invasive plants that might be controlled by one of the aforementioned insects.

Biological agents, nutrient reduction, cultural practices, and mechanical removal are useful pond management tools. However, herbicides may be needed in ponds with extra-heavy plant growth or where invasive plants have become established. Herbicides provide rapid control of target plants and are often a more affordable option. Many herbicides available for managing aquatic plants are familiar to turf

Aquatic plants are a healthy addition to all pond systems. However, populations often need to be managed, including the lily pads, milfoil, and fanwort pictured above.

managers and include common names such as glyphosate, carfentrazone, 2,4-D, bispyribac-sodium, endothal, diquat, and trichlopyr, along with other chemistries that are specific to aquatic environments.

Herbicide selection and application can become fairly complex, depending on the plants being controlled, pond size, intended use, flushing rate, downstream users, and other special conditions or regulations. Obtaining permits to apply control products can be difficult, time consuming, and usually requires an aquatic pesticide applicators license. For these reasons, it is often more practical to work with a pond-management company that has the expertise to complete an evaluation of the pond, determine what the best control options are, and obtain the permits necessary to carry out the application. Pond-management companies also have specialized application equipment and the means to implement other cultural and mechanical practices to manage ponds effectively.

COSTS

Pond systems generally do not manage themselves. That is to say, even the most natural systems usually require some degree of management to maintain an acceptable appearance throughout the season. The performance and appearance of many ponds can be improved significantly by increasing pond depth to a minimum of 6 to 8 feet, lining or sealing permeable soils, installing water-circulation/aeration equipment, and adding vegetative buffer strips. Ponds overrun with algae and aquatic plants will probably need chemical intervention, at least until conditions that favor algae and problematic plants can be addressed. Many golf facilities will pay an annual fee to a pond-management company to take care of their on-property water bodies. Pond-management companies will evaluate and treat ponds depending on their condition and needs. The cost of annual pond-maintenance contracts can range anywhere from $200 to $2,000 per acre, depending on the frequency and type of treatments necessary.

CONCLUSION

If nothing else, I hope this article will garner additional attention to the water features on your golf course. Water features are complex, living systems influenced by many factors, some of which cannot be easily controlled. The more you can learn about pond ecology, aquatic plants, and algae, and the impact of light, temperature, and nutrients, the better equipped you will be to manage a sustainable pond system.

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SUGGESTED RESOURCE

Gettys, L. A., W. T. Haller and D. G. Petty (eds). 2014. Biology and Control of Aquatic Plants: A Best Management Practices Handbook, 3rd Edition. Aquatic Ecosystem Restoration Foundation.

USEFUL POND/LAKE MANAGEMENT SITES

Aquatic Ecosystem Restoration Foundation http://www.aquatics.org/

National Invasive Species Information Center http://www.invasivespeciesinfo.gov/aquatics/main.shtml

North American Lake Management Society http://www.nalms.org/

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