It will take a well-balanced management approach to get this pond back into shape.

A Different Look at IPM: Integrated Pond Management

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THE MANAGEMENT of ponds on golf courses can be a complicated business. In a sense, managing a body of water can be likened to the managing of the human body. The human body is affected by the things around it and what enters it. When someone has a fever, he often treats the symptom with medicine. The medicine may work to relieve the symptom, but it may not treat the actual cause of the distress. Likewise, treating the symptoms of a pond problem may not provide a permanent resolution to the cause of the problem.

For example, if aquatic plants are determined to be a nuisance, attempts are made to control the plant with certain treatments. Aquatic weed control guides provide instructions for applying chemicals for temporarily controlling the weed, but such an approach probably would not produce a long-term cure.

The best management approach to pond problems involves managing the pond ecosystem, not just the individual organisms. An organism approach treats the symptom, but an ecosystem approach identifies and treats the cause. This concept can be called IPM: in this case, Integrated Pond Management.

Ponds and lakes serve many purposes on a golf course. They can influence the strategy of a golf hole or provide irrigation water. Ponds serve as drainage containment areas or add aesthetic value to the course. The different uses of a water body dictate the maintenance parameters that must be considered. For example, irrigation reservoirs must contain a minimum of debris, particulates, and other contaminants. Management of these water bodies is concerned mostly with water quality. Irrigation ponds are different from most ponds because the turnover of water is usually quite rapid. Other water bodies demand more complex IPM practices because the water passes through the system much more slowly.

Construction of a new pond at the Brae Burn C.C., West Newton, Massachusetts.

Pond construction at Brae Burn included protection of a nearby stream.

It is presumed that a golf course manager should have a thorough understanding of agronomy, but must he have an equal degree of understanding of lake management? Probably not, but he should be familiar with the basics of limnology (the science of fresh water bodies). After all, he is responsible for decisions made regarding pond management.

The first step is to contact experts in the field of limnology; the actual management plan should be developed by an experienced water manager. Nevertheless, a basic understanding of how a pond ecosystem and surrounding watershed operates will get you started on the right foot to successful pond management.

The dictionary defines lakes and ponds as "bodies of water." This term is very accurate. A water body is a living organism which develops from year to year and changes over time.

Knowing what goes into and comes out of a water body is an important part of understanding a pond's life cycle. The operation of a pond ecosystem depends on available energy and nutrients. Aquatic flora and fauna need nutrients to live and grow. When nutrients are limited, growth is limited.

Controlling nutrient levels in a pond can be an effective management tool for controlling nuisance weeds. Phosphorus, nitrogen, and, to a lesser extent, potassium are used by aquatic plants. Phosphorus is often the limiting nutrient in ponds. A difference as low as 10 ppb can change a pond from oligiotrophic (poorly nourished) to eutrophic (well nourished). That is a very small concentration! It is the well-nourished pond that frequently has excess plant growth.

Nutrients enter ponds in several ways (*Diagram 1*). It is here that the turf manager can minimize lake eutrophication by controlling the pond's diet. Eutrophication is a biological response to increasing nutrient inputs. Eutrophic lakes are commonly high in aquatic weed populations, and oxygen levels can be out of balance with biological oxygen demand. Even though many lakes are "choked" with weeds, however, it does not mean they are eutrophic. Most lakes are in a steady state of development and seem to buffer most effects of a mature watershed.

Lakes near heavily populated areas, including cities, towns, and agricultural lands (golf courses), are subject to outside influence. For this reason, the incoming nutrient load should be measured and monitored. Data from this testing can be used by a limnologist in developing a nutrient budget, which can provide a valuable predictive and diagnostic tool.

How can a superintendent manage the watershed so impacts on the pond are minimal? The first step is to have a lake management firm test the water for phosphorus, dissolved oxygen, volume of inflow and outflow, and a battery of other factors. This information, along with land use and watershed statistics, provides a base of information.

The second step typically involves a close review of the changes needed to reduce the negative input to the pond. The management process can be divided into two major sections: watershed, or **out-of-lake** management, and **in-lake** management.

The following are descriptions of some watershed management methods.

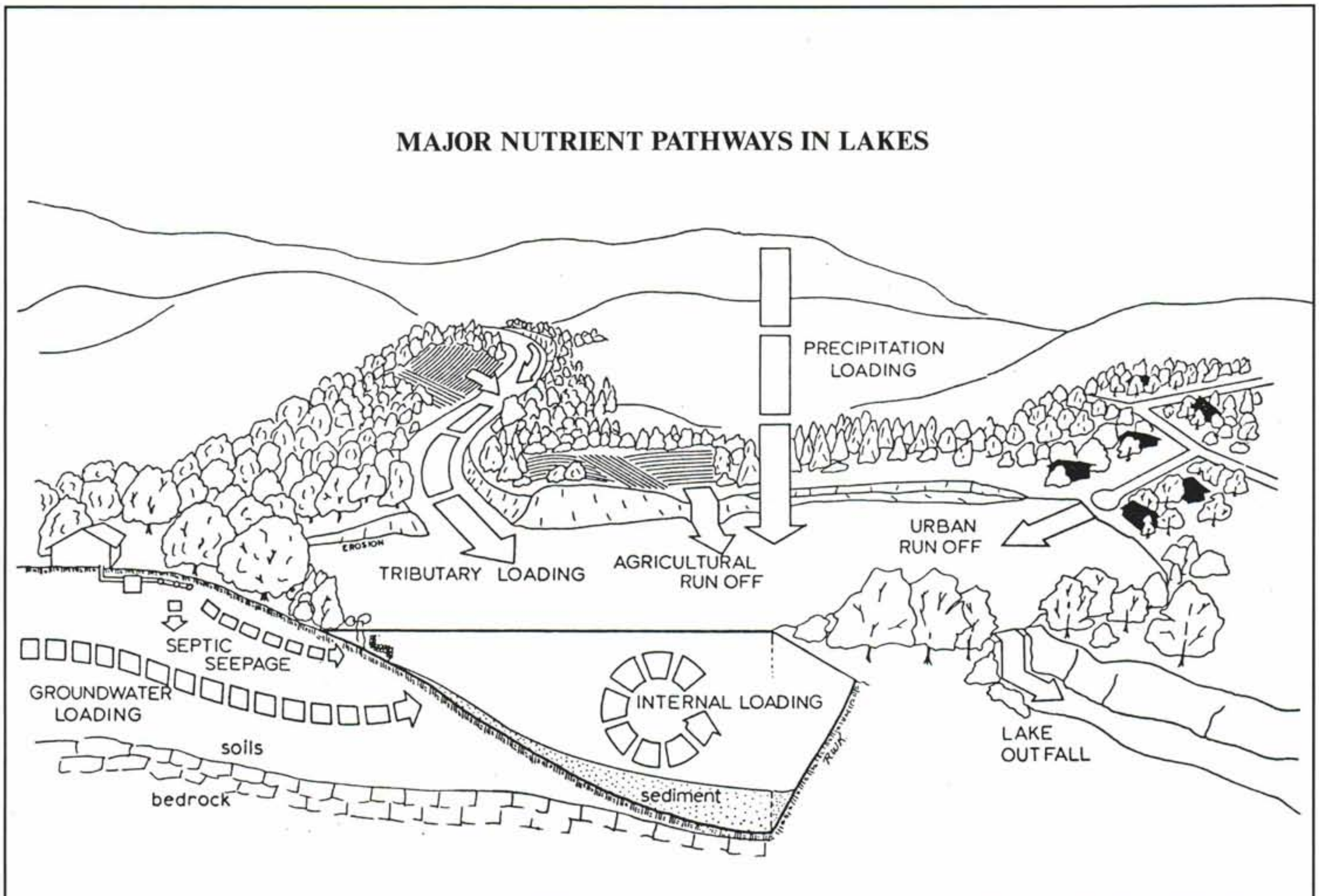
Septic Systems: Septic leaching fields are designed to allow bacteria and minerals to filter the wastewater before it enters the groundwater, stream, or lake. Golf courses commonly are affected by leach fields coming from the clubhouse or surrounding homes. Tests should be done to determine the amount of phosphorus entering the pond from septic fields.

Storm Runoff: Runoff in the form of drainage can be a source of pond contamination. Watersheds in commercial or residential areas can produce large amounts of phosphorus in runoff, especially in the first wave of runoff. One way to mitigate this effect is to have the first wave of drainage water coming into a golf course enter a dry well. This effectively catches a good portion of phosphorus in the first flush, whereas later flood water is significantly lower in phosphorus concentration and can bypass the dry well.

Agriculture: Livestock waste contains nutrients that can enter waterways, and croplands upstream from golf courses can be a source of sediment and nutrients. Your county extension office should have handbooks for calculating soil loss and quantities of animal waste nutrients.

Fertilizers: Properly managing fertilizer applications within a watershed is extremely important. Fertilizer applications within 50 feet of a water body or stream should be applied with a drop spreader. Normally, nitrogen leaching from fertilizer applied to turf is very small when slow-release sources are used, but it can be higher under optimum conditions and when soluble fertilizer sources are used. Runoff contaminants from turf are usually negligible, which makes turfgrass an excellent buffer strip.

The ability of turf to limit nutrients entering the water supply depends upon



Before (above) and after (opposite page) — The reconstruction of the dam has eased the maintenance of this pond at the Pleasant Valley C.C., Millbury, Massachusetts.

grass type and density, fertilizer source, method of application, temperature, soil type, rainfall or irrigation events, and timing of application. The turf manager can control nutrient loading into water bodies and have a dramatic effect on the health of a pond.

Following are some basic guidelines:

1. Use slow-release nitrogen sources.

2. Minimize late fall fertilization with soluble nitrogen sources, especially near watersheds and on sensitive sites.

3. Develop dense, healthy turf.

4. Apply fertilizer under carefully controlled conditions.

Wildlife: Some view birds and other wildlife as an indication that the environment is favorable to nature. The presence of wildlife gives a sense of harmony with nature. Some types of wildlife, however, can be a real nuisance.

Canada geese feed on new grass sprouts and lush turf, and golf courses are some of their favorite restaurants. The major problem with geese is their excrement. One goose can excrete 50 grams of phosphorus per month, contributing to the eutrophication of a water body; therefore, their presence should be discouraged. Deterrents include styrofoam swans, dogs, pop-guns, and yellow rope stretched across the water. Burrowing animals can break down lake and stream banks, causing erosion and sedimentation. Trapping and removing them is the most feasible control method.

Buffers: Buffer strips along ponds and waterways help filter certain types of pollutants. Buffers can be grass, brush, trees, or other vegetation. Grass buffers can be an excellent choice because of their good filtering activity and minimal litter characteristics.

Water in shallow streams and drainage ditches can heat up if exposed to intense sun. Wooded buffers along streams help minimize thermal pollution.

Channelization: Streams and drainage ditches constructed in a straight line (channelization) are subject to erosion and degraded water quality. Water can reach a high velocity of flow in these circumstances and carry silt and contaminants into ponds. Pond dredging is often a treatment of the symptom caused by channelization.

Streams and ditches should meander, thereby reducing flow velocity, and rocks can be used as rip-rip to stabilize banks. Velocity reducers, such as weirs, check dams, etc., also can be used effectively. Furthermore, sediment ponds and sediment traps can collect debris before it enters the pond.

Air Movement: Ponds that are totally surrounded by trees can become stagnant if wind movement is blocked. In response, trees can be removed to allow prevailing winds to naturally aerate ponds.

The following are **in-lake** management processes:

Nutrient Precipitation: Water bodies that are becoming or have become eutrophic may benefit from aluminum sulfate (alum) applications. This material precipitates phosphorus from the water column into chemically unavailable forms in sediment.

Aerators: Aerators influence the rate of oxygen transfer from air to water by

creating turbulence and increasing the surface area of water in contact with air. The end result is more oxygen in the water up to the point of saturation. Oxygen/water relationships are quite complex, however, and the idea of aeration as the key to lake health is much like saying orange juice is the key to good human health.

Algae Control: Much less phosphorus is released into the water from bottom sediments when the water overlying these sediments is oxygenated. Aeration can be a method of controlling phosphorus release in some lakes, and this can help reduce algal bloom.

If aeration is not carefully controlled, however, phosphorus in bottom sediments can be stirred up and may actually increase the algae population. Since the entire water column is mixed, the surface scum of algae is spread out in the water column and gives the illusion of algae control.

Some biologists state that aerators do not control algae, and may make the problem worse. Most agree, however, that careful aeration is beneficial.

A type of aeration that selectively aerates different layers of the lake is being used successfully in some situations. The term is **hypolimnetic aeration**. This, and similar selective aeration methods, show great promise and are relatively inexpensive.

Still another fairly new method actually withdraws nutrient-rich bottom water and discharges it out of the lake. Both hypolimnetic and subsurface withdrawal leave the natural stratification intact.

Ozone injection, a spin-off from water treatment plants, is making a move into lake management. Ozone, a powerful oxidant, can remove odor, color, viruses, taste, algae and organics, and helps flocculate micopollutants. This, too, offers promise as a tool, but not as a cure-all.

Biological Management

Grass Carp *(Ctenopharyngodon idella)*: Different studies reveal different opinions on this plant-eating fish. One study found that carp eat many plants with minimal effect on native fish (depending on stock rates), but waters become higher in phosphorus, turbidity, and algae.

Other reports contradict this, stating that carp eat algae and do not cause murky water. More information is needed, and each state has different guidelines regarding their legality.

Other biological agents are being tested in several states. Some weeds in the South have been reduced by using insects, but their effectiveness is limited. Researchers at the University of Massachusetts are working on a caterpillar to control Eurasian millfoil. Biological controls are not yet available on a wide scale in most areas.

Many other popular methods of treating pond problems exist: chemical applications, dredging, harvesting, lake drawdown, dyes, and screening. Each method has a specific effect on the pond ecosystem. Integrated pond management looks at watershed and lake techniques for minimizing nuisance aquatic plants. Water quality is also a consideration in pond management. The manage-

REGULATIONS FOR IMPORTATION OF GRASS CARP*

1 — Permit required
2 — Ploidy inspection required by authorized government inspector
3 — Disease inspection required
4 — All purchase of grass carp is presently for research purposes only
5 — State uses authorized dealers

ALABAMA	Diploid	—	—	—	—	—
ARIZONA	Triploid	1	2	3	—	5
	Visual disease inspection only					
ARKANSAS	Diploid	—	—	—	—	—
CALIFORNIA	Triploid	1	2	3	—	—
	Entire state may open for commercial importation in 1991					
COLORADO	Triploid (Western)	1	2	—	4	5
	Diploid (Eastern)	—	—	—	—	—
CONNECTICUT	Triploid	1	2	—	—	5
DELAWARE	Triploid	1	2	—	4	5
	State may open for commercial importation in a few months					
FLORIDA	Triploid	1	2	3	—	5
	Disease inspection only for fish going into state-owned lakes					
GEORGIA	Triploid	1	2	—	—	5
HAWAII	Diploid	1	—	3	—	—
IDAHO	Triploid	1	2	3	—	—
ILLINOIS	Triploid	1	2	—	—	5
INDIANA	Triploid	1	2	—	4	—
	State will likely open for commercial importation in 1991					
IOWA	Diploid	1	—	—	—	—
KANSAS	Diploid	—	—	—	—	—
KENTUCKY	Triploid	—	2	—	—	5
LOUISIANA	Decision to accept triploid grass carp is pending					
MICHIGAN	State may consider introduction of triploid grass carp in future					
MISSISSIPPI	Diploid	1	—	—	—	—
MISSOURI	Diploid	—	—	—	—	—
MONTANA	State may consider introduction of triploid grass carp in future					
NEBRASKA	Triploid	1	2	—	—	5
NEVADA	Triploid	1	2	3	—	5
	Visual disease inspection only					
NEW JERSEY	Decision to accept triploid grass carp is pending					
NEW MEXICO	Triploid	1	2	—	—	—
NEW YORK	Triploid	1	2	—	—	—
NORTH CAROLINA	Triploid	1	2	—	—	5
OHIO	Triploid	1	2	—	—	5
OKLAHOMA	Diploid	—	—	—	—	—
OREGON	Triploid	1	2	3	4	—
PENNSYLVANIA	Decision to accept triploid grass carp is pending					
SOUTH CAROLINA	Triploid	1	2	—	—	5
	State requires ploidy inspections by their own inspector, not USFWS unless specifically mentioned					
SOUTH DAKOTA	Triploid	1	2	—	—	—
	No shipments have yet entered state					
TENNESSEE	Triploid	1	—	—	—	—
Tennessee Valley Authority		—	2	3	—	—
	Visual disease inspection only					
TEXAS	Triploid	1	2	—	4	—
	State may open for acceptance of commercial shipments in future					
UTAH	Decison to accept triploid grass carp with disease inspections is pending					
VIRGINIA	Triploid	1	2	—	—	5
WASHINGTON	Triploid	1	2	3	4	—
	State may open for commercial importation in a few months; visual disease inspection only					
WEST VIRGINIA	Triploid	1	2	—	—	—
WYOMING	Triploid	1	2	3	—	—
	Visual disease inspection only					

*States that allow diploid grass carp also allow triploid; all states not listed ban any grass carp. Many states conduct random ploidy inspections on distributors.

Source: U.S. Fish and Wildlife Service — 6/27/90

ment plan will probably utilize two, three, or more of the techniques in this report. One control method is seldom, if ever, the total answer.

Proper Construction

Good pond management actually starts with proper construction techniques. Site selection, the size of the pond, intended use, subsoil type, and many other factors must be considered before building a pond.

The Brae Burn Country Club in West Newton, Massachusetts, recently built a four-acre-foot pond for irrigation and aesthetic purposes. The golf club has been dependent upon municipal water for years, and they wanted their own water source. A pond was proposed, and a professional engineer developed the plan.

The pond was lined with 20 mil PVC, and a ballast of sand was placed 10 inches deep on top of the PVC. A bottom outlet was installed to allow for drawdown.

A 15-foot buffer of grass was installed that pitched away from the water. The nearby stream was left undisturbed to prevent the possibility of nutrients entering the stream. The moral of this story is that ponds can indeed be built that are both functional and environmentally benign.

Water body management is complex. It involves both terrestrial and aquatic factors, internal and external nutrient sources, food chains, oxygen balances, stratification, and a myriad of influences. On top of this, cycles change during the seasons and through the years. Lake management that is comprehensive and holistic, tailored for a specific purpose, has hope for real success.

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