

Chapter 2

How do I Care for My Stormwater Pond?

Benefits And Limitations of Pond Management

Stormwater ponds may have uses beyond simply retention and detention of water volume. The range of uses and associated benefits spans both public and personal importance. However, coupled with these benefits come some limitations.

Effective stormwater pond management can provide significant local and regional benefits by:

- lowering flood levels;
- protecting ground and surface water quality;
- recharging water supply through infiltration into the aquifer;
- providing a natural cooling system for the area, as well as cooling runoff water before it reaches a surface water body;
- providing an aesthetically attractive environment;
- providing a water storage reservoir for dry periods;
- providing recreational activities like fishing, wildlife watching and boating *although these activities include critical restrictions on swimming and consumption of fish*; and,
- enhancing wildlife habitat.

Ponds help recharge water supply through slow infiltration into the aquifer. ▼



General Maintenance Guidelines

Remember that one of the main purposes of the stormwater pond is to remove pollutants before they are transported to natural lakes, rivers and streams. They will never be pristine swimming or fishing lakes because they are designed to trap and transform pollutants before water is released downstream. Some of the algae and plants that home owners find objectionable help provide this pollution removal function.

Stormwater ponds will have to be cleaned out periodically (about every 10-25 years) to keep them functioning properly. There are things that can be done in the pond and especially in the watershed to improve water quality and extend the periods between extensive maintenance efforts. An efficient, functioning stormwater system takes as much time and energy as maintaining the rest of the landscaping. In fact, highly maintained upland landscaping is a big part of the problem in keeping stormwater systems attractive.

Many homeowners do not connect their landscape design and maintenance practices to the problems in their stormwater ponds. Highly maintained lawns and direct discharge of stormwater into ponds cause much of the weedy growth in stormwater ponds. One of the most important steps in having a more attractive stormwater pond is to form a partnership with all the people in the community that have an interest in the pond and then learn as much as possible about your particular pond.

*All ages enjoy the recreation
that a clean pond provides. ▼*



- Develop a specific maintenance plan for the entire drainage basin of the stormwater pond. Find out as much as you can about the history of the drainage basin and why your pond is important in cleaning up stormwater pollution. Enlist the help of the water management districts and the original designer to determine the best strategy for improving the aesthetics without reducing the pollution removal ability of the stormwater system.

The original developer or the Water Management District has site plans for all permitted projects which include specific details. Historic aerial photographs can be obtained through University Libraries. Soil Survey aeriels are available through the Natural Resources Conservation Service or the Soil & Water Conservation District in your county.





▲ *Neighborhood watershed and stormwater pond.*

- ▲ Follow the maintenance schedule and activities listed in Chapter 5 and keep records of all maintenance needs as well as the work done on the stormwater system. Pay special attention to the conveyance system by removing litter and other debris, repairing eroded surfaces, checking for solution holes, and collecting and disposing of grass cuttings so that they do not wash into the pond and increase algae growth.
- ▲ Use pre-settling basins (or other pre-treatment strategies) upstream of the stormwater pond to remove the largest particles and minimize the need to disturb the wet detention pond by maintenance dredging. Sediment deposition should be monitored and conditions that contribute to excess sediment transport to the pond should be corrected. If land constraints preclude the construction of a sump area in front of the pond perhaps an area near the inflow in the pond can be used instead.
- ▲ Re-suspension of sediments can be minimized by encouraging vegetation to grow in shallow littoral zones. Increased density of vegetation slows the velocity and wave action which increases settling of suspended materials. Also dense vegetation can be effective at removing floatables and litter from stormwater. On the other hand, vegetation should be harvested periodically to improve long-term performance. This can be accomplished during the normal dry season in the spring in Florida, so that vegetation has a chance to become re-established before the summer rainy season.
- ▲ Overland flow to a pond should be distributed evenly by use of a swale or a diffuse-inlet structure to minimize short-circuiting through the pond. Make sure the system is functional if it has one.
- ▲ Erosion control in the drainage basin should be a top priority. Plant bare areas in the conveyance system and along banks. Use soil stabilization techniques such as sod, straw mulch, degradable ground covering fabrics or temporary vegetative cover such as rye grass until permanent plants are established. Planting trees throughout the drainage basin can help reduce the impact of heavy rains which cause soil erosion.
- ▲ If the street is not curbed, turf should be established and maintained below pavement level so that sheet flow is not blocked and the grass can help remove pollutants and sediments.
- ▲ Designate buffer areas around the pond (at least 15 feet wide) where no fertilizers or pesticides can be applied.

Low impact parking lot design - where stormwater treatment begins as soon as rain hits the pavement in these small recessed landscape depressions. The raised inlet allows some retention and filtration before the water is routed to wet detention basins. ▼



Runoff Management

Stormwater runoff has always occurred after storms, but the difference today is that we have paved over or denuded the land that used to absorb and hold back the runoff. For example, in a natural forested landscape only about ten percent of rainfall runs off into rivers and lakes. The rest infiltrates into the soil and the underground aquifers, or evaporates into the air. As more of the land is paved over with buildings, roads, and parking lots, up to ninety percent of the water runs off. If we want to reduce the pollution going to our stormwater ponds we need to provide opportunities in the watershed for water to infiltrate much like it did in the old days. This can be accomplished by directing stormwater to ditches and swales instead of directly to storm drains, by causing roof runoff to flow to a vegetated landscaped area rather than to the driveway or street, by planting trees to absorb the impact of rainfall, by having some depression storage in landscape designs, by reusing stormwater for watering the yard, and by using permeable paving surfaces where practical. Some ex-

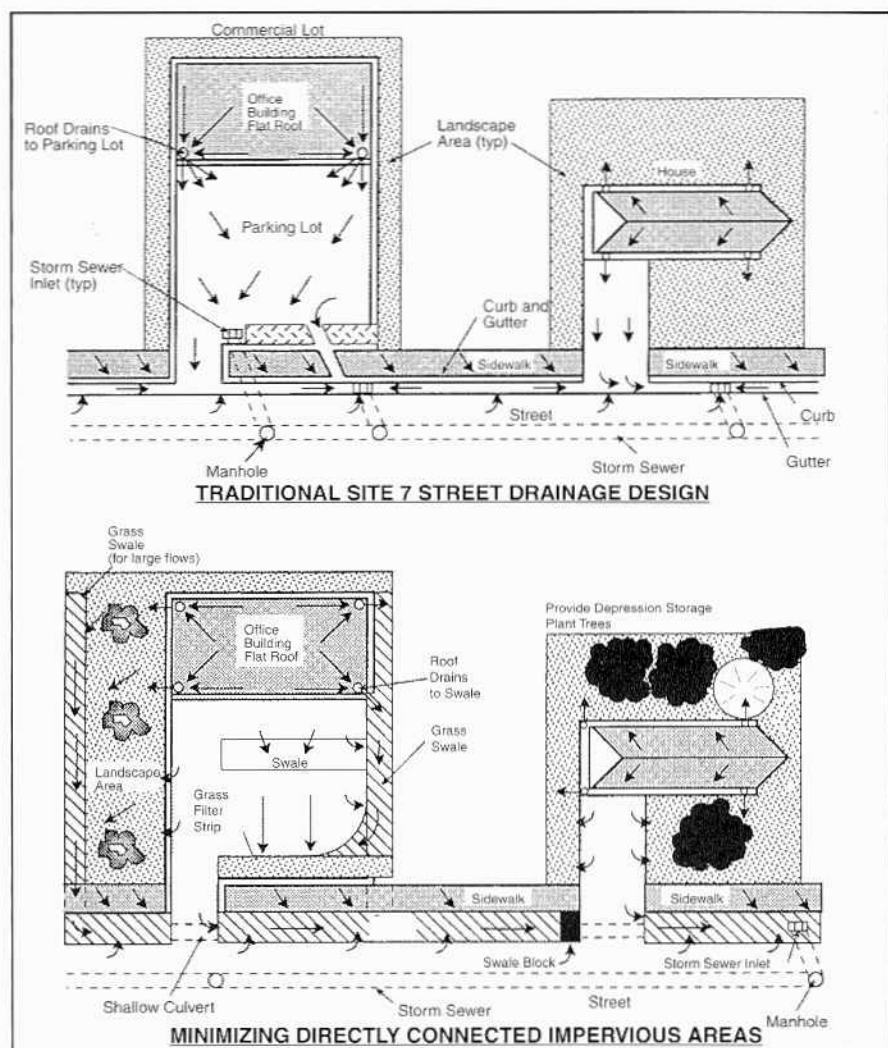
amples of how this might be accomplished are shown in Figure 4 and many more good ideas are available from the Florida Yards and Neighborhoods program.

The Wet Detention Pond design is important in maintaining its function for removing pollutants. Make sure there is an open water permanent pool deep enough to hold water all year. This aids in deposition of pollutants and mosquito control. The permanent pool water should contain adequate amounts of dissolved oxygen. If this is a particular problem then perhaps a fountain or other aeration device can be added. Aeration is often effective in reducing filamentous algae mats. Also at least one third of the pond should be maintained as a shallow littoral shelf with desirable plant species to help remove dissolved pollutants. If algae or nuisance plant species removal is part of the plan developed for your pond then work days should be organized to get as many people involved and educated as possible.

Sediment Management and Disposal

As soil is eroded and washed into stormwater treatment ponds it accumulates, becoming part of the bottom sediments gradually filling the pond. This accumulation of sediments decreases the holding capacity of the pond and results in reduced treatment efficiency for pollutants entering the system. The process of eroded soil filling in these ponds is

called sedimentation. It is the same process that physically smothers fish habitat and limits navigation in natural water bodies. When stormwater treatment systems are poorly maintained or no treatment system exists, the potential for harmful sedimentation increases in our lakes, rivers and estuaries.



▲ Figure 4. Adapted from: *Urban Storm Drainage: Criteria manual*, Denver, Colorado 1992.

To maintain maximum treatment efficiency for stormwater ponds, sediment materials must be removed periodically and disposed of off site in an uplands area. The depth and slope of the ponds must be maintained for proper treatment of sediments and other contaminants entering the system. It is critical to decrease the velocity and volume of water flowing through the system, thus providing ample opportunity for pollutants to be filtered by plants or settle out into the sediments.

Stormwater pond sediments become contaminated with heavy metals, pesticides, phosphorus, etc. as direct function of a properly designed and maintained treatment system. When sediments are removed, they should be properly disposed of. Florida's solid waste rules define stormwater pond sediments to be a solid waste. Accordingly, they must be disposed of in a Class 1 lined landfill where they can be used as daily cover material.

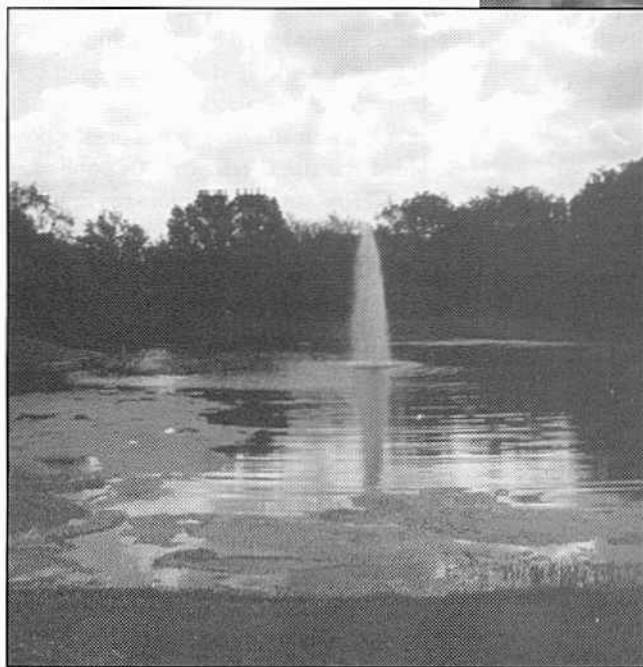
However, increased caution should be used when unusually high levels of contamination are observed or suspected. These situations can include sediments associated with treatment systems serving industrial and commercial operations and fuel transfer facilities. In these cases, sediments should be tested to determine the proper level of precaution for disposal. Excessive petroleum hydrocarbon contamination can present severe sediment disposal problems. Evidence may include strong odors of gasoline and very dark oily stains, particularly at inlet and outlet structures. The source of such inputs should be found and removed if possible.

Stormwater Pond



TIP

For more information on stormwater pond sediment disposal requirements and methods, interested parties should contact the FDEP Stormwater and NPS Management Section regarding appropriate testing and disposal methods.



Algae Growth ▲



Sediment Contamination and Disposal:

Sediments associated with stormwater treatment devices should be regarded as contaminated well beyond the levels in runoff itself. When disposed of haphazardly, this material may become a source of pollution. Pollutants associated with stormwater sediment include high nutrients and oxygen demanding substances, heavy metals, petroleum hydrocarbons and other volatile and semi-volatile organic compounds, pesticides, and infectious organisms. However, absent circumstances which would be expected to result in the regular addition of paints, solvents, cleaning agents, pesticides and spilled fuels there is little probability that the sediment would be a hazardous waste. If space is available at the stormwater system, the sediments can be stockpiled at that location and land spread on-site provided the site is restricted to public access. However, proper practices must be used to prevent wind and water erosion and off-site movement of the sediments. Off-site disposal must be to a Class 1 lined landfill where they can be used as daily landfill cover. Stormwater sediments can be used as fill material or land spread but only if they have been thoroughly tested

and they meet the soil cleanup target levels set forth in DEP's Chapter 62-777, F.A.C. Sediment from facilities serving major urban highways or industrial, commercial and fuel transfer facilities should be tested to determine the proper level of precaution for disposal. For more information, interested parties should contact FDEP Stormwater and NPS Management Section regarding appropriate testing and disposal methods for stormwater sediment.

Excessive petroleum hydrocarbon contamination can present severe sediment disposal problems. Evidence may include very dark oily stains particularly at inlet and outlet structures and strong odors of gasoline. The source of such inputs should be found and removed if possible. Otherwise, pretreatment practices should be used as necessary to insure that influent runoff water is not contaminated beyond levels normally observed in runoff from highways and parking lots.

Stormwater Pond

TIP



Off-site sediment disposal must be to an approved landfill for use as landfill cover.

▼ *Table 2.1 Planning and implementing a maintenance plan.*

PARTICIPATION

- Hold meeting for involved citizens
- Identify perceived problems
- Locate helpful reference books (see Chapter 6- Resources, References and Maps)
- Contact appropriate agency for advice (i.e. Water Management District, Stormwater Utility, Natural Resources Conservation Service, Soil & Water Conservation District, Cooperative Extension Service)

ASSESSMENT

- Request site plans and engineered drawings from appropriate entity
- Locate historic aerials of area to understand natural drainage patterns
- Identify the ultimate receiving water body (lake, river, bay or estuary) and understand the goals and objectives that have been recommended for it.

PLANNING

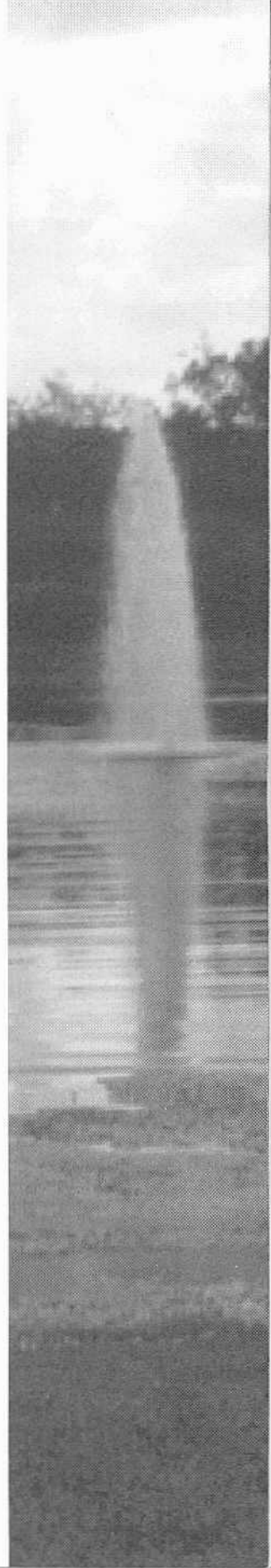
- Outline drainage basin on site plan
- Delineate the conveyance system
- Locate storm management controls
- Outline any natural areas to protect
- Indicate problem areas
- Identify potential sites where improvements can be made
- Prepare an inspection and maintenance plan
- Determine if perceived problems have practical solutions
- Seek professional advice if necessary

IMPLEMENTATION

- Designate the person or committee in charge of the plan
- Obtain approval of the plan from the Water Management District, if appropriate
- Prepare a check list and keep detailed records of work done
- Report back to original group
- Schedule work days if appropriate and seek cooperation
- Educate affected citizens about stormwater management

EVALUATION

- Receive feedback from group
- Update educational effort
- Modify plan if necessary
- Continue implementation



Nutrients

There are 16 chemical elements known to be essential for plant growth. They are divided into two main groups: non-mineral and mineral. The non-mineral nutrients, found in the atmosphere and water, and are essential for photosynthesis.

The 13 Mineral Nutrients are divided into three groups: major, secondary and micronutrients:

Major Nutrients	Secondary Nutrients	Micronutrients
Nitrogen	Calcium	Boron
Phosphorus	Magnesium	Chloride
Potassium	Sulfur	Copper
		Iron
		Manganese
		Molybdenum
		Zinc

The nutrients that are of most concern when considering non-point source (NPS) pollution that can be naturally occurring or added to the soil are Nitrogen (N) and Phosphorus (P).

Nitrogen: Nitrogen in surface waters is an issue of concern for many water quality managers because of its effect on the eutrophication of waters (productivity). Nitrogen appears in surface waters as dissolved atmospheric molecular N_2 , nitrates, nitrites, ammonia, and organic nitrogen (e.g., proteins and amino acids).

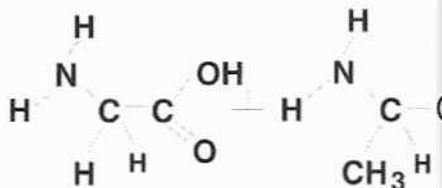
Precipitation, sewage discharges, runoff, or poor management of nitrogen fertilizers are usual sources of nitrogen. The presence of high nitrogenous compound concentrations in surface waters usually indicates organic enrichment via one or more of the sources mentioned above.

Aquatic life is significantly affected by nitrogen depending upon the concentration and form of the nitrogenous compound. Because vertebrate and inverte-

brate aquatic life do not particularly utilize nitrogen in their physiological processes, the primary effect of nitrogenous compounds is on the primary producers, algae and bacteria.

Algae and bacteria are capable of fixing, reducing, and oxidizing nitrogen through biochemical and metabolic processes. The resulting or intermediate products of these processes alternatively affect other aquatic life to varying degrees. Increased loading of nitrogen into surface waters only enhances these processes.

Of the various forms of nitrogen present in surface waters, the primary concern is with ammonia-nitrogen. Total ammonia exists in water as ionized (NH_4^+) and un-ionized (NH_3) ammonia and it is the primary end product of bacterial decomposition. Ionized ammonia (NH_4^+) is not appreciably toxic to aquatic life, but the un-ionized (NH_3) form is very toxic to fish and aquatic invertebrates. Presence of the un-ionized fraction is a function of pH. At low pH, the un-ionized ammonia molecule (NH_3) ionizes to the ammonium ion (NH_4^+). As pH increases, NH_3 increases.

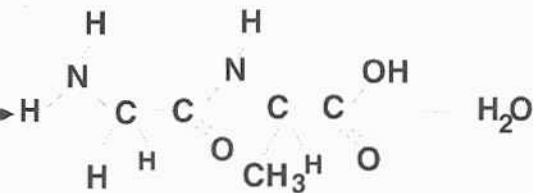


Phosphorus: Phosphorus is a macronutrient necessary for the day to day metabolic activity of aquatic organisms, especially algae and bacteria. It occurs in natural waters and wastewater's almost solely as phosphates (orthophosphates, condensed phosphates, and organically bound phosphates). Orthophosphate is the only form of soluble inorganic phosphorus directly utilized by organisms. The other phosphate compounds are highly reactive with cations, clays, carbonates, and hydroxides and quickly form insoluble compounds and/or adsorb to particulates that precipitate out of the water column.

Since much of the phosphorus potentially available in an aquatic system is adsorbed or complexed, it is often referred to as the "limiting nutrient" in aquatic systems.

Phosphorus enters surface waters primarily from fires, groundwater seepage and overland runoff. Increased phosphorus loads often result from sources such as fertilizers carried in runoff water, commercial cleaning or laundering water, and municipal waste water.

Like nitrogen, phosphorus is a metabolically necessary nutrient for bacteria and algae. And, like nitrogen, increased phosphorus in surface waters can increase algal and bacterial productivity.



Stormwater Pond TIP



Reducing pollution at the source is the best strategy for protecting your stormwater pond.

- Fertilize sparingly
- Fix erosion sources
- Keep grass clippings out of pond
- Never throw trash or oils into storm drains
- Inspect stormwater systems regularly



▲ Parking lot inlets are direct connections for pollutants to stormwater systems.



Pesticides

Pesticides are generally compounds used for pest control in agriculture, industry, and the home. They may be synthetically derived copies of naturally occurring compounds or new man-made compounds. They include insecticides, rodenticides, fungicides, algacides, miticides, herbicides, and general biocides. Pesticides may be organic or inorganic compounds and they may include simple metal mixtures or complex organic molecules.

Pesticides may undergo transformations in the aquatic environment through processes such as oxidation, reduction, hydrolysis, and photolysis. The resulting compound may be more or less toxic than its parent compound.

The modes of action in organisms vary depending upon their intended targets. For example, an insecticide may have a very different mode of action on its target (mosquito larvae) versus its non-target (frogs or toads) organisms. Generally, pesticides affect organisms through interrupting necessary metabolic or neural pathways.

Because of their widespread use, pesticides are often found in many surface waters especially those streams and rivers adjacent to farmlands, industrial areas, or urbanized areas. These areas are the primary sources of pesticides in waters via runoff and drift from aerial spraying or scattering. Aerial transport aside from direct application may also occur through wind erosion of treated soils, and volatilization.

Pesticides may affect all aquatic life through direct or indirect exposure. Direct exposure is usually the result of acute pesticide contamination. This occurs when high pesticide concentrations are present over a sufficient period of time to cause lethality. Acute effects are relatively localized to the source and area of contamination because of dilution over time and space. The primary effect is on the survival of individual aquatic organisms exposed. Acute effects may occur for all aquatic organisms. An example of an indirect effect occurred in the migrating ducks in the prairie pothole region of the US. The ducks themselves were not affected by the pesticides, but the microinvertebrates on which they were feeding, were decreasing in numbers. In turn the migration path of the ducks was altered due to the lack of available food.

Direct exposure may also occur when concentrations are low, but persistent, over a period of time. These chronic exposures not only affect survival, but also reproduction.

Chronic exposure may lead to more indirect effects such as pesticide accumulation and concentration in the tissues of an organisms, and/or magnification through the food chain. These indirect effects may lead to a breakdown in higher levels of biological organization including population and community level effects.

Stormwater Pond

TIP



Use the least toxic form of pest control first. Use more applications and less concentration of chemical whenever possible. And remember not all bugs are bad, some control the bad bugs.

—INSECTICIDE SPRAY—

1/3 cup liquid dishwashing soap

1/3 cup vegetable oil

1/4 cup baking soda

Apply from 20 gallon hose end sprayer.

Spray on plants every two weeks.

Pesticide Use:

As a rule, pesticides should be avoided in association with the maintenance of stormwater management systems. However, when necessary, use only pesticides approved by US EPA and FDACS for aquatic sites. Violation of water quality standards in receiving waters resulting from the use of chemicals within the treatment facility may be punishable under state law. Pesticide use on landscape plants often are washed off into stormwater ponds, natural areas and streams.

Herbicides:

Careful herbicide selection and application are essential to avoid harm to desirable plants and animals. Applicators must be experienced and well trained in plant identification to selectively control undesirable plants while avoiding detrimental effects on desirable vegetation and possible downstream contamination. For assistance, contact the Florida Department of Environmental Protection, Bureau of Aquatic Plant Management, regional biologist or the local County Cooperative Extension Service agent.

Insecticides:

Many types of insecticides occur including organochlorines, organophosphates, carbamates, pyrethrins, and others. From an aquatic ecosystem point of view we are concerned with how these pesticides fall into two categories, (1) those that are soluble in water, and (2) those that are highly insoluble in water.

Organophosphates such as guthion, parathion, diazanon, and malathion are typically very soluble in water. These types of pesticides are usually not very persistent in the aquatic or terrestrial environment, they become chemically unstable after a period of time and degrade. Often, they may persist for only a few days before they breakdown.

Stormwater Pond**TIP**

Less than one percent of all insects are harmful to plants and many insects are beneficial. Healthy plants can usually fend off pest attacks while predatory insects and birds may keep underivable insects under control.

Integrated Pest Management (IPM) is an environmentally friendly approach to pest control. It emphasizes the use of pest resistant plants, proper landscape management, natural enemies of pests, and the least toxic alternative if pesticides are required. Call Cooperative Extension Agents for further information.

Organochlorines such as DDT, aldrin, dieldrin, lindane, heptachlor, toxaphene, and chlordane are typically very insoluble in water. These types of pesticides, although no longer available for purchase in the U.S., are persistent because they are chemically stable and do not degrade easily. If they were used in the past in your watershed, they may persist for several weeks, months, years or decades.

Because of their insolubility in water, these types of pesticides have high affinities to bind with suspended organic material, sediments, and lipids (fish fat). Many of the more persistent pesticides are no longer used in the US because of their persistence. The reason why concentrations of these pesticides are routinely measured in aquatic organisms and sediments is because of their continued persistence and chronic affects.

Other Pollutants and Their Management

Heavy Metals:

Heavy metals have been identified as the most prevalent toxicant found in urban runoff with concentrations often at levels harmful to aquatic life. In addition, metals attach to bottom sediments where they are consumed by sediment-living organisms and become increasingly concentrated up the food chain, making even small amounts potentially toxic. The metals of concern include: Cadmium (Cd), Cobalt (Co), Chromium (Cr), Copper (Cu), Iron (Fe), Manganese (Mn), Nickel (Ni), Lead (Pb), and Zinc (Zn). Among the metals detected in stormwater, zinc, copper and cadmium are the most abundant. Although lead is sometimes still measured at toxic levels, lead was a much more serious problem before the introduction of lead free gasoline. This is one example of the potential for cleaning up pollution with source reduction.

A major source of metals in the environment comes directly from your automobile. Whenever you drive, you leave tire particles on the road and every time you touch your brake pedal, you deposit copper-laden brake residue. Even the road itself and the paint used to mark traffic lanes contribute to toxic pollutants in runoff.

Other sources of heavy metals measured in storm runoff include: Corroding metal surfaces such as roofing and gutter material, industrial processes which produce metal wastes, household chemicals such as cleaning and gardening products, and direct atmospheric deposition containing air pollution from automobiles and smoke stacks. Another major source of metal pollution comes from the improper use of chemicals to control algae and other vegetation in stormwater ponds. This subject is covered in greater detail in other sections of this report. See, for example, the pesticide and vegetation sections.

Metals are of concern in stormwater because toxic levels can pose health risks, cause genetic defects, produce reproductive abnormalities and increase mortality rates of aquatic organisms. Metals that accumulate in certain animal or fish tissues can become more concentrated (bioaccumulate) as larger organisms eat smaller ones. For example, when fish eat zooplankton the metals that have been ingested by the zooplankton are now incorporated in the fish tissues. Of special concern is the fact that the impact of metal pollution are not fully understood since their long-term chronic effects are frequently physiological and may only be manifest in an organism's susceptibility to disease or response to environmental changes such as temperature or pH. In addition, the impacts resulting from intermittent nonpoint discharges into natural waters are extremely difficult to isolate or to identify cause and effect relationships.



▲ Vehicles are a source of heavy metals in stormwater runoff.

Managing Heavy Metals:

Never pour toxic household chemicals down any drain — this includes the drains inside your house as well as storm drains or gutters that lead to storm drains. Also never pour toxic chemicals on the ground where they can seep into the water table and eventually the aquifer or a stream. Take them to hazardous waste collection centers. Some household chemicals that need to be disposed of properly include: Metal polish with solvent, furniture polish, battery acid (or batteries), automatic transmission fluid, brake fluid, car wax with solvent, paint brush cleaner with solvent, paint (oil based), paint thinner, turpentine, varnish, wood preservatives, gun cleaning solvents, ammunition, and many others.

- Recycle used oil and antifreeze by taking them to service stations and other recycling centers.
- Schedule regular tune-ups for your car to reduce deposition of toxic metal pollutants from exhaust gases and fluid drips. Reduce automobile trips. Every trip increases congestion and pollution.
- Wash your car on the grass, not the driveway. Another alternative is to use a car wash facility that captures and reuses water.
- Use chemicals properly or not at all. Inappropriate use of chemicals to control aquatic nuisance species can increase metals to toxic levels.
- Encourage government initiatives which reduce pollutant concentrations by source reduction.
- Recognize that metals are more toxic in soft water or waters that are low in dissolved oxygen or pH. Therefore manage your stormwater system for acceptable levels of these parameters.
- Provide a sediment sump and a schedule for regular maintenance.

Hydrocarbons (Fuels & Oils):

Sources of hydrocarbons to urban stormwaters include accidental spills or deliberate dumping of used oil and fuels, emissions from engines during normal operation (primarily uncombusted exhaust hydrocarbons and crankcase drippings), fallout from atmospheric particulates, and spillage of products during refining and transportation. Newspaper headlines focus on oil spills and industrial effluent, but in fact, the chronic unrecorded drip-by-drip diffuse sources deposited every day in urban runoff contribute a significant amount of petroleum-derived hydrocarbons to the aquatic environment.

Stormwater Pond



You can reduce your use of hazardous household products by choosing safer, less-toxic products.

Avoid household products with hazardous ingredients, or handle them with extreme care. Many toxic ingredients in paint thinners and drain cleaners, for example can contaminate water sources.

- **Use only enough of the product to get the job done.**
- **Never dump hazardous products down drains, the toilet, or near flowing water, ponds, or lakes.**
- **Do not dump them on the ground.**
- **Use natural and less-toxic household products whenever possible.**



As with metal pollution, our transportation system is a major contributor to hydrocarbon pollution. Hydrocarbons are found in weathered materials of street surfaces, automobile exhaust, lubricating oils, gasoline, diesel fuel, and tire particles. Probably the most visible sign of hydrocarbon pollution is that dark streak down the middle of highway traffic lanes or those dark patches left in parking lots both of which are manifestations of the oils, greases and heavy metals left by automobiles. One study documented that hydrocarbon deposition in open water bodies is derived 80% from combustion sources and 20% from used motor oil.

Hydrocarbons are of concern because many of them or their derivatives are toxic and some are carcinogenic. Also, if stormwater runoff becomes a part of the drinking water supply, the widely used process of chlorination of water supplies may render the hydrocarbons contained in the treated water much more dangerous to humans. In addition, oils and greases impair fish habitat and may cause oxygen deficiencies by limiting water-air interactions at the surface of ponds.

Managing Hydrocarbons:

Many of the methods for removing hydrocarbons in urban runoff are the same as for metal reduction.

Keep your car in good working order. The deposition of leaked fuels and fluids from vehicles are a key source of hydrocarbon contamination.

- Recycle used oil by taking it to recycling centers.
- Encourage street sweeping by your community to remove street dust.
- Wash your car on the grass or at an approved car wash facility that reuses wash water.
- Encourage government initiatives that reduces pollution at the source.
- Support the introduction of better built product that don't corrode or otherwise produce break down products that cause pollution.
- Construct a separate sediment sump and provide routine maintenance with sediment removal when necessary as a pre-treatment design element of wet-detention ponds.

A Community Approach to A Pond Management Plan

How can a pond management plan help me and my pond?

Your stormwater pond is a water treatment facility, and it performs a very important job for your drainage basin: *it cleans water*. A management plan will help you make sure that your pond is working at peak performance to keep your water as clean as possible. With a plan for future maintenance of your pond, you and your pond group will avoid spending time and money on "quick fixes" that may degrade water quality and add pollutants.

What should my pond look like?

What could my pond look like?

There are certain elements of your pond you cannot change: the shape, the depth, the surroundings, the underlying soils, the water sources (both groundwater and neighborhood stormwater runoff), and the purpose for which the pond was built. What are the elements of your pond that *can* be changed? You can change the neighborhood's attitude towards the pond, the type of maintenance it receives, the quality of the neighborhood stormwater runoff that enters the pond, the quality of the water as it leaves the pond, the types of plants that grow in and around the pond, and the kinds of wildlife that are attracted to your pond. Your pond can become a neighborhood asset, a place to play with the kids, to teach them about Florida's natural world, and watch the birds. You *can* fool mother nature by making your stormwater pond look like a natural pond, with native flowering plants, trees, and birds. A stormwater pond can have clean clear water, cypress trees, oak trees, iris blooming in the spring, and summer-blooming pickerel weed edging the shoreline.



I know what we need.
We need a pond management plan!

What is a pond management plan?

A pond management plan is a description of your pond; the problems associated with the pond and its drainage basin; a listing of people who live and work in the drainage basin; a record of meetings, pond evaluations, water quality data, as well as actions proposed and/or taken by the group. A management plan is written by consensus of the group, and is reviewed by everyone in the pond basin, or as many as you can reach. A plan includes goals for the future and helps you measure your progress in achieving those goals. It helps you make better decisions by providing a record of previous decisions and a written record of the neighborhood's vision for your pond. Any proposed actions that may impede or degrade the neighborhood's goals and vision for the pond should be turned down.

Ponds are like lakes.

Ponds and lakes in urban settings share many of the same problems, and so share many management issues. The Florida LAKEWATCH program uses a *fifteen-step process* in helping their volunteers build a lake management plan. Ponds are smaller, with fewer recreational and development issues, so we have shortened the LAKEWATCH process to six steps.



Six Steps To Building Your Pond Management Plan

1. *Form a group* made up of the people living in your pond's drainage basin.

It is important to include people who live away from the pond, but in the basin.

2. *List the problems* you are having with your pond.

Problems could include nuisance vegetation, clogged storm drains, eroding banks, litter, pet droppings, algae blooms, compost piles, etc.

3. *Collect information* about your pond and the drainage basin, including:

- an aerial photograph of the pond and drainage basin
- names and addresses of everyone in the drainage basin
- locations of drainage structures, pipes, under drains, & connections
- ownership & easements, deed restrictions, and/or homeowner's rules that apply to the pond's current maintenance procedures such as grass carp, herbicides, plant removal, water sample analysis, and Secchi disk measurement.
- identify your pond's drainage basin (which streets drain to your pond).

4. *List possible solutions* to the problems you have listed.

Solutions could include establishing a buffer of native plantings around the pond, nuisance plant removal, storm drain marking, neighborhood educational meeting, renting a dumpster for a neighborhood pond clean-up, fertilizer-free zones, or door hangers with pollution prevention instructions.

5. *Write a management plan* with all of the information you've collected.

Your management plan may have these sections:

- Section 1. Pond Background Information and Description
- Section 2. Pond Group Members
- Section 3. Aquatic Weed Control
- Section 4. Algae Control
- Section 5. Fish & Wildlife
- Section 6. Water Quality Monitoring
- Section 7. Drainage Structure Maintenance
- Section 8. Pond Group Work Days
- Section 9. Stormwater Pollution Prevention Program
 - Environmental Landscape Maintenance
 - Storm Drain Marking
 - Door Hangers
 - Pond Walk
 - Educational Meeting With Experts
 - Pond Work Days
 - Fertilizer-Free Zones
 - Pond Plantings
- Section 10. Pond Group Goals & Vision For The Future

6. *Implement your plan.*

Assign activities to members of your group. Set dates for achieving your goals. Contact local governmental agencies for educational materials, technical guidance, and assistance in managing your pond; ask for speakers to address your pond group members at a meeting or a pond walk.

Use Chapter 4.-A Pond Management Plan Workbook to help you write *Your Pond Management Plan*.

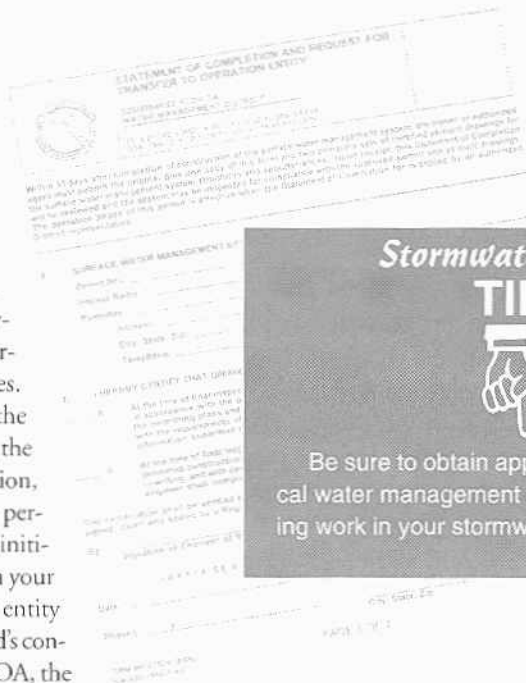
Permits

As stated in Chapter 1, **Researching Pond Ownership**, many stormwater ponds are governed by the conditions of permits issued by various agencies. Once you have investigated the background of your pond using the guidelines included in that section, you will know what permit or permits govern your pond. Before initiating any maintenance work on your pond, you must identify what entity is legally responsible for the pond's condition, be it the HOA/POA/COA, the county, or in the case of older subdivisions, individual owners. Again, this information will be revealed after you investigate your pond's history.

Once you establish your legal rights to work in the pond, study the permit issued to the developer, and the originally-permitted construction drawings, and identify the required maintenance guidelines and restrictions. The maintenance plan you develop for your pond may go beyond the basic requirements included with the permit. As long as the proposed maintenance does not conflict with these basic requirements, you may proceed. For instance, you may want to remove weedy vegetation and replace it with desirable species, however, a typical permit condition for wet detention ponds is:

The removal of littoral shelf vegetation (including cattails) from wet detention ponds is prohibited unless otherwise approved by the Water Management District. Removal includes dredging, the application of herbicide, cutting, and the introduction of grass carp.

If your proposal would not affect the water quality treatment capability of the pond, contact the permitting agency (Water Management District, Department of Environmental Regulation, County Development Review departments, etc.) for plan



Stormwater Pond



Be sure to obtain approval from the local water management district before doing work in your stormwater pond.



approval. The proposal should specify which native plant species will replace the undesirable species. Understand that if you do the work without first obtaining approval from the permitting agency, you may be in violation of the permit condition, and possibly subject to legal action.

Ponds with side-drain filters are required by permit condition and approved management plans to maintain vegetation-free zone above the filter bed. This area must **not be planted**, but the rest of the shoreline may be planted with attractive vegetation. Again, provide a planting plan to the permitting agency for approval prior to taking any action.

Protecting the Pond Watershed

Pond-Friendly Yards and Common Properties

A stormwater pond evaluation gives us a complete picture of our pond's watershed. We have mapped the homes and common property along the pond's edge. During the evaluation we have also located the storm drains that feed into the pond—and determined the type of property that is served by the storm drains.

Sometimes a pond is surrounded by a natural area, containing cypress trees and other native plants.

However, yards and community property usually make up the largest percentage of a pond's watershed. It's important to remember that developed and maintained areas do not inherently cause problems to a pond—it is the way we design and take care of them that determines whether a pond is a thing of beauty or of despair. The fact that we created our yards and community landscapes in the first place means we

can *recreate* them in a way to protect the integrity of our stormwater ponds.

The next section discusses the value of routine pond maintenance. As the adage notes, "An ounce of prevention is worth a pound of cure." In the case of pond care, preventing pollutants from entering a

pond is much easier and cheaper than continually cleaning out a pond.

Design:

1. Use the Right Plant for the Right Spot

Picking the right plant for the right spot results in less fertilizer, pesticide and water use. However, before you can choose the right plant, you have to know something about the spot—the site conditions. Is your soil sand, marl or clay, and what is the soil pH? How cold does it get during the winter? What are the rainfall patterns? Is there full sun, partial shade or full shade?

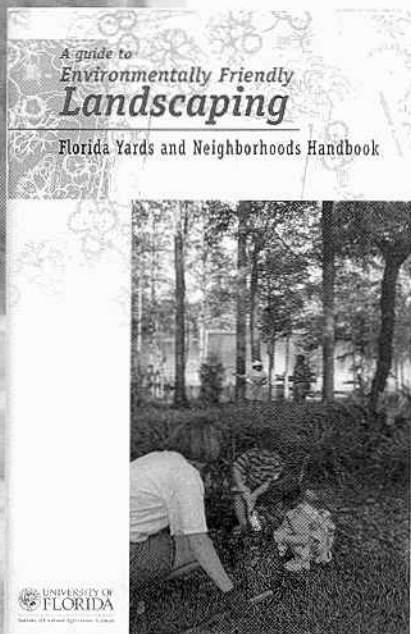
Often different conditions exist in one yard. For example, the front yard may be high and dry, while the backyard, bordered by a pond, may often be wet. Few plants will do well under both site conditions, so choose plants carefully.

If you live on a pond, incorporate this *waterscape* into the design of your backyard. Let the native aquatic and shoreline plants add color and beauty to your garden.

2. Design landscapes to control the flow of stormwater runoff.

Stormwater runoff has always existed to some extent. The difference now is that we have paved over the land that used to absorb rainfall. We have also removed the plants that helped slow runoff and disperse rain water.

In a natural forest approximately ten percent of rainfall runs off into rivers, lakes and ponds. The remaining 90 percent of the rain seeps through the soil replenishing underground aquifers or is evaporated into the air.



▲ *Florida Yards and Neighborhood Handbook.*

The reverse is true today in urban and suburban areas. As more and more of the land is paved over and covered with buildings, roads and parking lots, up to 90 percent of the rainfall runs off of the ground surface. The natural water filtering system has been lost. Now, stormwater runoff, carrying soil, pollution from our cars and fertilizers and pesticides from our yards, flows into stormwater ponds or into lakes, rivers and bays.

We can regain much of that filtering action by adding the following elements to our landscape designs to the yards and community properties in our pond's watershed area:

- Swales, ditches, terraces and shallow, depressed areas.

— These design features slow down the flow of water, allowing pollutants to settle into ground before the water reaches the pond.

- Trees.

— Trees slow rainwater before it hits the ground. A rainstorm torrent is dispersed into smaller drops that trickle down the tree, from leaf to leaf, until they reach the ground. Tree roots also help slow the flow by holding the water, allowing it to be absorbed by the soil.

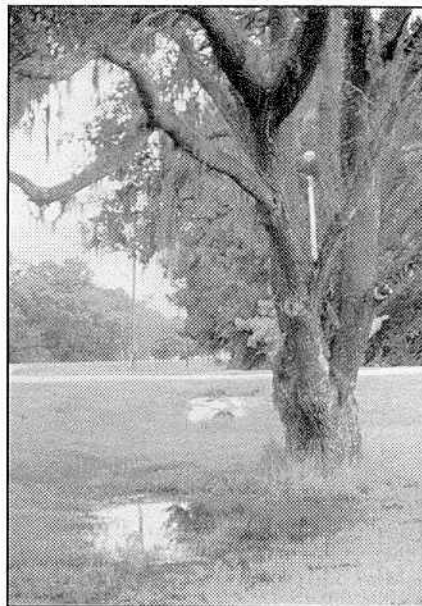
- Landscape buffers between buildings and sidewalks or roads.

— Landscape buffers, allow some of the water pouring off of a roof to get absorbed into the ground. Direct down spouts away from impervious surfaces and into lawn areas and plant beds.

- Permeable paving surfaces where practical.

— Brick patios, mulch pathways and pervious concrete are examples of permeable surfaces that add beauty to a landscapes while helping to protect the environment. Unlike standard concrete, permeable surfaces allow water to go into the ground.

Some examples of how these actions can be accomplished are shown on page 48.



Use depression storage to reduce runoff and increase infiltration. ►



Maintenance:

1. Create 15 to 30 foot buffers around the pond that receive no fertilizers or pesticides. Be careful in using herbicides in this buffer zone area.

Buffer zones of native plants create habitat for Florida's wildlife and add beauty and dimension to your landscape design. Upland areas of yards and community property can be enhanced with Muhly Grass, with its striking purple fall color, and the butterfly-attracting porterweed. The bright yellow flowers of the native canna, flanked by the purple-blue blooms of pickerel weed, are a welcome addition to the pond's edge.

Also, because native plants are adapted to the pond ecosystem, they do not need fertilizer. And in the case of plant pests, we can usually let nature's check-and-balance system of predators and prey keep plant damage to a minimum.

If your pond is surrounded by lawn grass, you can still create a fertilizer/pesticide free zone. Backyards on ponds often slope significantly down from the house. When you apply fertilizer to the upland area around your home, gravity often causes some of the nutrients to move down the slope to the grass area

close to the pond. If you need to treat for pests, practice IPM (Integrated Pest Management), discussed later in this section.

2. **Take care of your yard in a Florida-friendly way.** We often make our yards more high-maintenance than they need to be. There are four steps to having an attractive, healthy yard.

Step 1: Mow your grass at the proper height and don't take off more than 1/3 of the grass blade at a time. Longer grass blades result in longer roots and longer roots make the plant more efficient in taking up water. Also, longer grass will inhibit weeds. Practice selective pruning on your bushes. Hire a certified arborist to prune your trees.

Step 2: Use fertilizers appropriately. Over-fertilizing leads to excess plant growth. Excess growth can attract plant pests and requires additional maintenance, in terms of pruning. Don't apply fertilizers during the summer when rain will leach the nitrogen into the soil past the root zone or wash it into the street or pond. Use ferrous iron to "green-up" the lawn during the summer. Many shrubs and trees require little or no fertilizer once they are well-established.

Step 3: Practice Integrated Pest Management (IPM). Protect the good bugs. They often are hard at work behind the scenes, keeping pest populations under control. Check your lawn and plant beds regularly for pest problems. Identify the pest. Know the good bugs from the bad ones. Is it chinch bugs or big-eyed bugs? It makes a difference. Big-eyed bugs eat chinch bugs. Spot treat. For example, if chinch bugs are the problem, don't treat the entire lawn! Treat the area of infestation—and six feet beyond. If one out of ten plants has scale, treat only that plant. Try the least-toxic pesticide first, such as insecticidal soaps, Bt products and horticulture oils. Tolerate some plant damage

Stormwater Pond

TIP



Let only rain go down the stormdrains: Many people think stormwater goes to a treatment plant and so they dump trash, yard debris, paint or other chemicals down the storm drain. It is important that everyone in the pond watershed know that what goes down the storm drain ends up in the pond, and then into a river, lake or bay.

When you see aphids, wait a day before acting. You may find that ladybugs have come in and devoured the aphids for you.

Step 4: Water Wisely. Over-watering leads to lots of problems for our lawns and plants. Fungus problems are the direct result of over-watering. Many common ornamental landscape plants, such as pittosporum and juniper, also suffer when they receive too much water. Use a rain gauge to track rainfall amounts. And if you have an in-ground automatic sprinkler system, install a rain-sensing shut-off device. Set the device to shut-off your sprinkler system after 1/2 to 3/4 inch of rain. In some parts of Florida, rain shut-off devices are required by law on all systems. Let your plants tell you when they need water. There are five benefits to watering wisely:

1. Your water bills are lower.
2. You reduce the chance for pests in the landscape.
3. Your plants develop longer roots and are better prepared for dry spells.
4. You avoid washing away lawn fertilizers.
5. You allow the soil to act like a sponge during rainfall.

Think about it. When your soil is saturated, like a full sponge, it can't take up anymore water when it rains or when you irrigate. The water, instead of soaking into the ground, becomes stormwater runoff.

Stormwater Pond

TIP



Calibrate your irrigation system—whether you have an in-ground sprinkler system or use a sprinkler at the end of the hose.

Step 1. Place shallow cans or glasses of equal size around the area covered by your sprinkler or one zone of your in-ground system.

Step 2. Turn on the water for fifteen minutes.

Step 3. Measure the amount of water in each container. Add the amounts together and divide by the number of containers. That will tell you the average amount of water your yard received during the fifteen minutes.

Step 4. Calculate how long you need to run the sprinkler or zone to have your plants receive 1/2 to 1/4 inch of water per application. For example, if you collected an average of an eighth of an inch in 15 minutes using your hose-end sprinkler, you will have to run it for an hour to get one-half inch.

THE FLORIDA YARDSTICK WORKBOOK

Does your yard measure up?

By following the simple steps inside you can save time and money, make your yard the best it can be, and protect Florida's environment.

UNIVERSITY OF FLORIDA

Cooperative Extension Service

FLORIDA UTILITIES YARDS & NEIGHBORHOODS

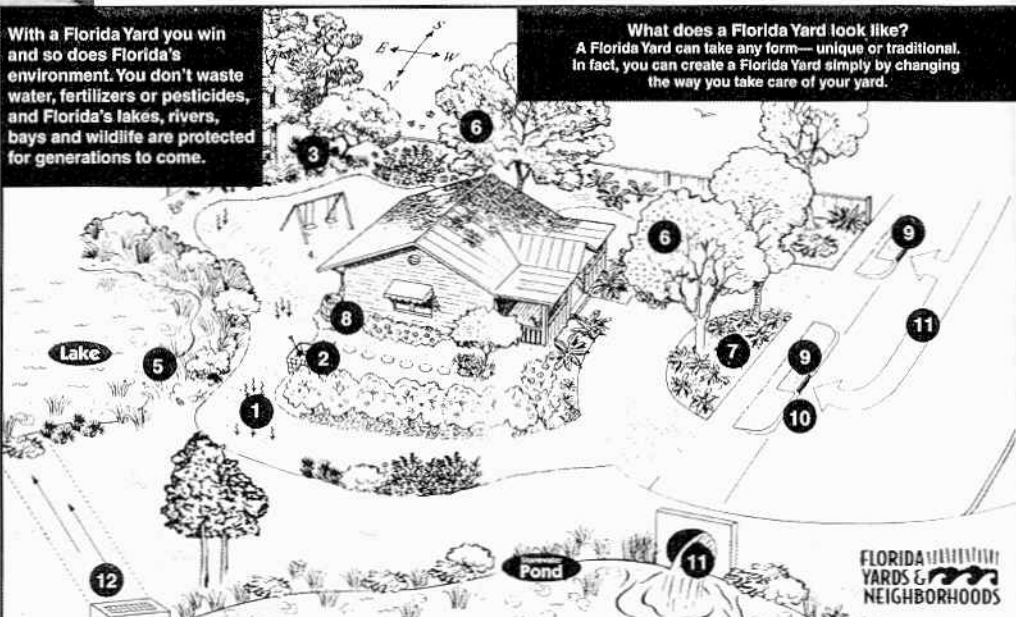
▲ By following the simple steps inside the Florida Yardstick Workbook you can save time and money. Make your yard the best it can be, and protect Florida's environment.

Fertilizers and pesticides washing off our lawns during a summer rain also become pollutants when they enter the pond system. The runoff from one yard does not make a big difference, but the stormwater runoff from many yards or a large community area can add a lot of pollutants into a pond.

- ▲ Using too much nitrogen on St. Augustine grass lawns encourages chinch bugs.
- ▲ Over-watering and under-watering the lawn results in short grass roots.
- ▲ Follow herbicide labels carefully. Note that *Atrazine* can kill trees if used incorrectly.
- ▲ Spot treat for pests—protect beneficial insects, reduce the change of insects becoming resistant to pesticides and save money.

With a Florida Yard you win and so does Florida's environment. You don't waste water, fertilizers or pesticides, and Florida's lakes, rivers, bays and wildlife are protected for generations to come.

What does a Florida Yard look like?
A Florida Yard can take any form—unique or traditional. In fact, you can create a Florida Yard simply by changing the way you take care of your yard.



1. Porous surfaces — brick driveway and mulch paths — allows water to soak into the ground
2. Compost bin
3. Wildlife habitat
4. Practical lawn area
5. Native plant buffer along shoreline
6. Trees to shade southern and western sides of home

7. Mulched plant beds
8. Rain barrel
9. Stormdrains
10. Street gutters and stormdrains clear of dirt, fertilizers and grass clippings
11. Stormwater runoff from street
12. Stormwater can flow from stormwater ponds into lakes, rivers and bays.

FLORIDA UTILITIES YARDS & NEIGHBORHOODS

▲ The Florida Yardstick Workbook shows you how to create attractive and healthy yards by working with Florida's environment, rather than against it.

Aquatic Vegetation Management

Plant life that grows in and around the water ranges from single celled algae, suspended in the water, called phytoplankton, to large woody plants, such as cypress trees. Plant life is vital to the functioning of lakes and wetlands and serves various roles such as production of oxygen and wildlife habitat. Many urban ponds are constructed as wet detention areas for surface water with the primary purpose of flood control. Secondly, surface water detention ponds are built to protect receiving waters from pollutants and may be used to mitigate destruction of wetlands. Wet detention ponds may be constructed with shallow sloping areas, called littoral shelves. The purpose of the littoral shelf is to provide habitat for rooted plant life. In small urban ponds, plant life that grows in open water or on littoral shelves serves important roles but may also interfere with certain uses and expectations of the pond and can be more of a nuisance than a benefit. Therefore, plant life often needs to be managed in urban ponds and goals of the management will depend on the intended purposes and expectations of the pond.

Roles of Plant Life in Urban Ponds

Green plants capture energy from sunlight and transform it into food through the process of photosynthesis. Plants use simple raw materials (nutrients) to produce food through photosynthesis. The most important of these are carbon, which is derived mostly from carbon dioxide in the air, and nitrogen and phosphorous, which are present in soils or dissolved in the water. By converting raw materials into plant tissues through photosynthesis, phytoplankton, which give water its green appearance, provide the base for the food chain of ponds. Tiny animals called zooplankton use phytoplankton as a food source. Larger animals including small fish use the zooplankton for food and larger animals such as fish and birds feed on these to make up the higher levels of the food chain. Phytoplankton also produce oxygen, needed by fish and other animals in pond water, through the process of photosynthesis.

Large aquatic plant life (aquatic macrophytes) can grow rooted to the bottom and supported by the water (submersed plants), rooted to the bottom or shoreline and extended above the water surface (emersed plants), rooted to the bottom with their leaves floating on the water surface (floating-leaved plants), or free

▼ *Littoral shelf overgrown with less desirable species still treats stormwater.*



▼ *Common Egret*

floating on the water surface (floating plants). Different types of aquatic macrophytes have different functions in urban ponds. Submersed plants obtain nutrients from both the pond bottom and water. When submersed plants are abundant and actively growing, pond water may be clear and free of phytoplankton because nutrients, which would otherwise be available, are tied up in the higher plants and algae that are attached to their stems. While emersed and floating-leaved plants obtain most of their nitrogen and phosphorus from the pond bottom, algae attached to their stems (called epiphytes) can also tie up some nutrients and thereby suppress phytoplankton growth. Floating leaved plants will also suppress algae growth by shading. Because rooted plants and their epiphytes can absorb nutrients and facilitate transformation of certain pollutants, such as nitrogen containing compounds, to less detrimental forms, plant life growing on littoral shelves may in some cases help protect receiving waters from pollutants present in surface water run off. Floating plants are also effective at suppressing phytoplankton because they obtain all of their nitrogen and phosphorus from the pond water and cause shading.

All types of aquatic macrophytes harbor insects. These may be insects that feed directly on plants (phytophagous) or predatory insects, which prey on other insects or small fish. In turn, these insects provide food for fish and bird life.

The presence or absence and the type of plants in urban ponds may affect the bird life that frequents ponds. Birds use large aquatic plants, including adjacent shrubs and trees for nesting, resting and refuge sites. Macrophytes are also used as food by birds and the plants provide habitat for other food items. For example, cattails are reported to be primary habitat for least terns, red-winged blackbirds, and boat-tailed grackles, whereas wading birds, rails and ducks may avoid tall and medium height (duck potato and pickerelweed) vegetation. Ducks are often found associated with lakes that contain hydrilla, a major food source for them. Trees, such as cypress and black gum provide perches and resting places for a variety of birds, which hunt for food in ponds.

Certain plants can provide ornamental and aesthetic value in urban ponds. Plants such as duck potato and pickerelweed provide showy flowers during bloom. Plants such as bulrush can provide bright green stems and foliage. All plants provide interesting shapes and screens that add aesthetic variety to the pond. And for the butterfly enthusiast, butterfly gardens can be created on pond margins and littoral shelves with proper selection of plant material. The use of aquatic plants to improve the appearance of an urban pond, or aquascaping, can be included as part of the overall landscape design. Additional information pertaining to aquatic plant identification, etc. can be obtained from the IFAS Center for Aquatic Plants (352/392-1799, <http://aquatd.ifas.ufl.edu/>) or the County Cooperative Extension Service office. See Chapter 6 Resources & References for the address and phone number in your area.

Problems Associated with Plant Life in Urban Ponds

Abundant phytoplankton in pond water will provide food to support a food chain for wildlife, such as wading birds. However, the more abundant the phytoplankton, the more green pond water will appear, and this is sometimes considered objectionable to homeowners who live on urban ponds. When very high amounts of nutrients are present in water, phytoplankton abundance can become very objectionable, and fishkills can actually occur if phytoplankton die naturally during cloudy weather. Certain types of phytoplankton, called blue-green algae, can cause blooms that result in scums on the surface of pond water and foul odors. Another type of algae, called filamentous algae because they have the form of long intertwined, matted filaments, can also cause unsightly conditions and foul odors.

Plant material produced through photosynthesis is eventually deposited to the pond bottom during a plant's life cycle. This material, called detritus, is broken down by organisms. Part of the detritus is broken down relatively rapidly, while a portion of it is relatively resistant to breakdown. Raw materials incorporated into plant tissue are released back into the pond water as detritus breaks down. Therefore, if large amounts of plant tissue are deposited in the water, algae blooms can occur as these nutrients become available, or the nutrients can be released out of the pond. Breakdown of detritus is slower when oxygen is in short supply therefore, when the pond surface is covered by dense floating plants, such as duckweed, which blocks sunlight for algal production and oxygen diffusion, breakdown of detritus is slower and accumulation of detritus is faster. When plant material is deposited faster than it

breaks down, it accumulates on the pond bottom. This accumulation can be objectionable and is often referred to as muck by homeowners. Detrital accumulation gradually reduces the volume of a pond and therefore, its ability to retain storm water. Detritus is flocculent and can easily become resuspended in the pond water, which further reduces water clarity and stimulates algae blooms.

Just as aquatic plant life provides habitat for insects that are food for wildlife, they also provide habitat for mosquitoes, which are a nuisance and health hazard in urban areas. Aquatic plant life aids mosquito survival and reproduction in several ways:

1. Mosquitoes are protected from predators, such as insect-eating fish.
2. Reduced wave action provides better survival of mosquito larvae, which breathe by sticking an air tube up through the water.
3. Detritus produced by aquatic plants provides mosquito habitat.
4. A specialized group of mosquitoes, known as mansonia, have a modified air tube that they insert into aquatic plants to obtain oxygen. These mosquitoes can use most any vegetation that occurs in pond sediments and has soft tissues.

Stormwater Pond



TIP
Maintain an open water permanent pool in stormwater ponds, and stock them with mosquito fish to reduce mosquito problems.





Certain plants grow faster, produce denser growth, produce detritus more rapidly and crowd out more desirable plants. Just as in gardens, landscapes, or crops, unwanted plants occur, which we refer to as weeds. What makes a plant a weed in a pond is that it has one or more attributes that make it undesirable. Weeds are typically more of a problem in new ponds or newly established aquascapes. New ponds are disturbed habitats, which are vulnerable to colonization by plants called pioneering species. Pioneering species are those that have attributes that facilitate colonizing new or disturbed habitats. They produce many seeds that are dispersed by wind or wide-ranging animals, such as birds. Seedlings of pioneering plants are able to grow very quickly and then become dense by spreading via underground stems and tillers. Because of their dense growth and ability to out-compete other plants that may be considered more desirable, pioneering plants are often considered weedy. In addition to natural dispersal mechanisms, weedy, pioneering plants may be introduced into the pond during construction by construction-equipment.

Certain plants may grow faster and denser than others and be considered weeds because they crowd out other plants that are considered desirable for their aesthetic value, bird or butterfly association, or for other reasons. Fast, densely growing plants may also be undesirable because they produce detritus rapidly and therefore increase the rate of muck build-up.

Management of Plant Life in Urban Ponds

Plant life needs to be managed in urban ponds to insure that the pond functions as it was intended. Ponds may be constructed in urban areas strictly for landscape purposes, but they are often constructed with the primary purpose of flood protection from storm water and for treatment of storm water to protect receiving waters. Wildlife habitat is an ancillary benefit in either case and aesthetic value can also be derived from a pond whose primary purpose is storm water detention. Storm water management ponds in which aquatic plants will occur and need management are referred to as wet detention ponds and maintenance of plant life may be regulated under the construction permit issued by the Water Management District. The ponds are often constructed with a littoral shelf that is required by the permit and a requirement for maintaining certain densities of certain plants on the littoral shelf.

An urban pond is like many other things: The more you want out of it, the more you have to put into it. Vegetation is managed differently for different benefits, sometimes called management objectives, that are to be derived from a pond. Options in unpermitted ponds range from open water reflection ponds to intense aquascaping but special practices must often be used to conform to permit requirements in surface water detention ponds. In ponds with littoral plantings, practices to selectively control problem plants without damaging littoral shelves must be implemented. Some permits will stipulate certain control methods that may not be used. Therefore, before using an algicide, herbicide, or grass carp in a permitted surface water detention pond it is necessary to check with a

water management district official to determine permit requirements. Management of vegetation for certain combinations of benefits may be mutually exclusive and certain compromises may have to be made.

An unmanaged pond will often have vegetation that is objectionable to most homeowners and will also have problems with drainage and mosquito production. Once vegetation in a pond has been allowed to get out of control it is very difficult to get it back down to a manageable level. It is much easier to keep the vegetation managed by frequently attending to problems or potential problems. It is also relatively easy to maintain a pond free of vegetation but trade-offs for certain types of wildlife habitat will be made and certain permitted ponds will have a requirement for vegetation. The most difficult, but most rewarding, situation is to maintain a pond with a population of desirable vegetation, while keeping weedy plants to a minimum.

Practices commonly used to manage plant life in ponds include modification of cultural practices surrounding the pond, hand removal of plants, triploid grass carp (a plant-eating fish), and herbicides (and algaecides). Chemicals, which are registered by the US Environmental Protection Agency for use in water should only be used as a last resort. Information on specific herbicides that are registered for aquatic use can be obtained from your County Cooperative Extension Office. The method or combination of methods to be used will depend on the management objectives. Selectivity (the ability of the practice to control certain plants and not others), secondary environmental effects to the pond, and per-

mit restrictions are the most important considerations when determining the vegetation management practices to be used.

Management of aquatic plants in urban ponds should be carried out by individuals who have been certified by the Florida Department of Agriculture and Consumer Services, as restricted use pesticide applicators in the aquatic category, after completion of University of Florida, IFAS certification training. Certification training materials can be obtained from IFAS Publications (352/392-1764). Homeowners are advised to contract a reputable pond management company for most vegetation management programs.

Stormwater Pond

TIP



Some pond weed problems can be solved by plant eating fish instead of chemicals. Triploid Grass Carp are a genetically altered variety that can efficiently control some plants when used as part of a comprehensive management plan. However, this fish is not a solution for every pond weed problem. Contact the Florida Fish and Wildlife Conservation Commission to determine if your stormwater pond is right for grass carp. You will need to obtain a permit to buy the fish and there are some guidelines to follow to assure they stay in your pond. Their phone number in Lakeland is (863) 648-3205.

Phytoplankton

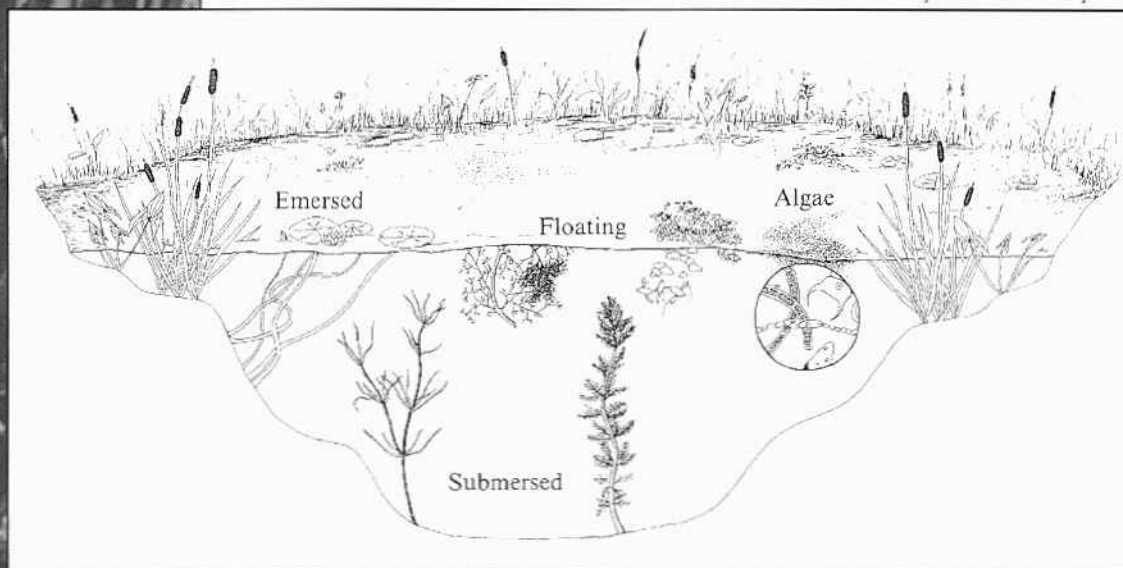
Green turbid water caused by abundant phytoplankton is the result of high levels of nutrients in pond water, particularly nitrogen and phosphorous. Nutrients may occur in naturally high amounts but they are also contained in fertilizer, which is applied to lawns in the watershed. If nutrients are naturally high in water that feeds the pond or in soils in the drainage area of the pond, the pond will be highly productive and will either have abundant growth of large plants or phytoplankton. In this situation homeowners must accept green turbid water. Where nutrients are naturally low, relatively clear water will occur unless impacted by cultural practices. In this case, it will be necessary to determine the source of nutrients and remove or minimize the source. Fertilizers used for fertilizing turf grass, faulty septic systems, or re-use water (treated sewage effluent) are common sources of nutrients in urban ponds.

Phytoplankton may occur as blooms when

optimum growth conditions occur or as a more or less continuous condition. In either case, use of algacide to reduce phytoplankton is not recommended for the following reasons: 1) Fish mortality is likely to occur as treated phytoplankton decay and are no longer producing oxygen. 2) Phytoplankton are very resilient, and will quickly re-occur if suitable conditions for growth prevail.

Aeration may help correct certain problems associated with phytoplankton. Certain blue green algae blooms will result in surface scums and aeration will help disperse these. Ponds that are heavily vegetated with macrophytes may have lower phytoplankton abundance compared to nonvegetated ponds and less frequent blooms. However, seasonal blooms may occur when macrophytes senesce and release nutrients into the pond water at the end of the growing season.

Aquatic Plant Groups ▼



Filamentous Algae

Filamentous algae are one of the most common and most difficult problems to deal with in urban ponds. Like phytoplankton, filamentous algae obtain nutrients from the pond water. Therefore, filamentous algae *may* be reduced if nutrient inputs to the pond water can be reduced and problems may be less if the pond is heavily vegetated with macrophytes. However, some problems with filamentous algae may still occur. Filamentous algae problems that cannot be corrected by reduction of nutrients can be managed by application of algicide or hand removal or a combination of both. It is best to keep filamentous algae to a minimum by frequent hand removal and/or frequent application of algicide to small areas of algae. Treatment of the entire pond with an algicide is likely to cause fish mortality due to lowering of oxygen in the water. Grass carp can be used for managing filamentous algae but high numbers are needed and they cannot be used for selective control when other plants are present.

Endothall amine (Hydrothol 191) and copper compounds are the only currently available and tested algicides. Hydrothol 191 is toxic to fish at concentrations of about 1 PPM. Filamentous algae can be controlled at concentrations less than this but extreme care must be taken if fish mortality is a concern. Copper compounds too can be toxic to fish in low alkalinity (usually indicated by low hardness) water, while the margin of safety is higher in water with high alkalinity. In addition to the concern for direct toxicity, whole-pond application of algicide is likely to result in fish mortality as a result of oxygen depletion, and this is a greater concern when water temperature

Stormwater Pond

TIP



Rake out filamentous algae, dry it on the banks on the pond, and then use it for mulch!

is high. Therefore, the key to filamentous algae control is to keep populations at a low level by frequent spot treatments beginning early in the growing season when water temperature is low. If it is necessary to get dense populations under control, some physical removal may be necessary to reduce the biomass and some fish mortality may have to be accepted. Then, keep the problem to a manageable level.

Certain species of filamentous algae are tolerant to copper. Sometimes, after repeated use of copper for filamentous algae control a population of copper-tolerant population of algae will remain. If this phenomenon is suspected, a sample of the algae population should be identified by a specialist to confirm if this is the case so alternative methods can be used.

Floating Plants

The most common floating plants that can become problems include water-hyacinth (*Eichhornia crassipes*), water-lettuce (*Pistia stratiotes*), duckweed (*Lemna* sp., *Spirodela* sp.), watermeal (*Wolffia* sp.), water fern (*Salvinia minima*), and mosquito fern (*Azolla caroliniana*). Floating plants, like algae, will be the greatest problem under high nutrient conditions. Therefore, limiting nutrient run-off from artificial sources may reduce the problem. However, under most circumstances sufficient nutrients will be available to allow for growth of floating plants to problem levels.

Small amounts of floating plants will not be detrimental to ponds but populations should be kept to a minimum. If allowed to proliferate and cover the pond, anoxic conditions will result beneath the mat and organic sedimentation will be increased. Water-hyacinth will aggressively displace other vegetation, which may be desired, in the pond. Uninformed homeowners will sometimes introduce water-hyacinth into a pond. Therefore, education is the first step toward preventing this problem. Other floating plants can be naturally introduced by wildlife.

If detected early enough, water-hyacinth and water-lettuce can be hand removed. However, once detected constant surveillance is necessary to insure that all water-hyacinth plants have been eliminated. With a doubling time of about two weeks under ideal growing conditions, the situation can quickly become out of hand. Once a water-hyacinth population is beyond the hand removal stage, spot treatments of herbicide products that contain the active ingredients 2,4-D (various products) or diquat (Reward®) can be used for selective control, or diquat for water-lettuce. Remove the dead vegetation to reduce bottom build up.

Duckweed, waterfern, and mosquitofern can be kept at low levels by frequent spot applications of Reward®. Watermeal is tolerant to Reward®. Duckweed, waterfern, mosquitofern, and watermeal can be controlled with sequential, low-dose applications of the fluridone containing herbicide Sonar® a.s. (liquid formulation). Some plants used for littoral shelf plantings, such as arrowhead (*Sagittaria* sp.), bulrush (*Scirpus* sp.), pickerelweed (*Pontederia* sp.), and soft rush (*Juncus effusus*), are tolerant to fluridone, whereas others, such as water-lily (*Nymphaea* sp.) and spatterdock (*Nuphar luteum*) may be damaged. Therefore, permit requirements or trade-offs that homeowners are willing to accept must be determined before using Sonar® to control these floating plants. Fluridone will not be effective where rapid water exchange occurs.

Triploid grass carp can be used to help keep duckweed, waterfern, and mosquito fern under control in ponds but their effectiveness is unpredictable and they may damage littoral plantings after a period of time. Therefore, if grass carp are used, littoral shelves should be monitored so that grass carp can be removed if necessary.

Stormwater Pond

TIP



Ponds require the same amount of landscape maintenance, weeding, thinning, trimming, as uplands.

Submersed Plants

While submersed plants, such as hydrilla (*Hydrilla verticillata*), provide certain wildlife values, most are objectionable in small urban ponds. Because rooted submersed plants can derive nutrients from both the water and hydrosol they can proliferate under all but the most nutrient poor conditions. Therefore, they may not respond noticeably to nutrient reductions.

Most submersed plants can be selectively controlled with herbicides without causing permanent damage to littoral shelves. Careful application of potassium endothall (Aquathol K) will control sensitive submersed plants such as hydrilla, southern naiad (*Najas quadralupensis*), bladderwort (*Utricularia* sp.), and others (refer to herbicide labels and other sources), while emergent and floating leaved plants will not be damaged. Routine applications of the herbicide will be necessary during the growing season and the frequency of application will depend on productivity of the pond and other factors.

Hydrilla, southern naiad, and bladderwort can also be controlled with Sonar®, as well as proliferating spikerush, which is tolerant to endothall. Sequential, low-dose applications of fluridone are best. Triploid grass carp will also control these submersed plants but the same precautions for both fluridone and grass carp, previously mentioned, must be taken.

Submersed weed problems can be managed with grass carp, but it is usually best to get the problem under control



with at least one herbicide application and then use grass carp for maintaining the problem. Grass carp can be used to some extent to keep submersed weeds under control with minimal damage to desirable emerged plants. However, as stated earlier, the effect of stocking grass carp in ponds is unpredictable. Desirable vegetation may be damaged or acceptable control may not be achieved. Therefore, it may be necessary to remove some grass carp or stock additional ones as time goes on.

Emerged Plants and Floating-leaved Plants

Among emergent plants are some of the most desirable and most troublesome plants in urban ponds. Maintaining a pond with a diversity of desirable plants requires selective removal of weedy plants and this is the most difficult management scenario, which will require intensive hand removal and careful herbicide applications. In ponds that are densely vegetated with emergent vegetation, it will increase the appearance of the pond and decrease the rate of detrital accumulation if senesced vegetation is removed in the fall or spring.

Cattails (*Typha* sp.) and torpedograss (*Panicum repens*) are considered to be nuisance plants in wet detention ponds. While cattails provide habitat for least bitterns, redwinged blackbirds, and boattailed grackles, their presence is usually at the expense of other emergent plants because of the cattail's prolific growth. Likewise, although torpedograss is good wading bird habitat, it is very prolific and will displace other emergent vegetation and form a floating mat over deep water.

Cattails should be managed by frequently hand pulling, cutting, treating with glyphosate (Rodeo herbicide), and combinations of these methods. Like other prolific weeds, the key is to keep the plants at a low level by frequent attention. If cattails are allowed to become the dominant vegetation on a littoral shelf, reducing their population to a manageable level is very labor intensive and damaging to littoral shelf plantings. Regrowth from rhizome fragments that are left after pulling or cutting should be treated when the shoots are no greater than one foot tall if possible.

Torpedograss is the most difficult to control emergent weed in ponds. Repeat applications of glyphosate are necessary and up to six applications per year must be made. Careful application is needed to minimize contact to nontarget littoral plantings. Maintaining torpedograss at the lowest level possible is essential. Once it is allowed to proliferate, it will be extremely difficult to get under control.

Sequential applications of low doses of fluridone can be used to control cattails and torpedograss where damage to sensitive plants such as water lily is acceptable.

Emergent littoral plantings are relatively tolerant to concentrations of endothall and copper used for filamentous algae control, especially if careful application is used to avoid contact with foliage. Over spray on to foliage may cause temporary chlorosis but the entire plant will not be killed because the algaecide does not act systemically. Newly planted emergent plants have been observed to be less tolerant.



▲ Spatterdock

Vegetation Removal

To maintain the permitted or required treatment efficiency associated with a wet detention pond, the littoral vegetation should *never* be entirely removed or eradicated with chemicals. At least 30% of the surface area of the pond must remain vegetated with appropriate vegetation. A good management plan that provides for periodic removal of aquatic vegetation at select locations on a rotational basis is strongly encouraged. This practice helps to remove accumulated nutrients that otherwise promote over enrichment diminishing the treatment capacity and aesthetic value, and increasing the need for major maintenance like dredging. When

done regularly mechanical removal by cutting, raking, hooking and/or digging can help control unwanted aquatics such as cattails and water lettuce. The harvested vegetation should be composted at an upland site and used for mulch. It should not be left in or around the pond. As a secondary benefit to harvest and removal more active growth of desired plants such as pickerelweed and arrowhead is also encouraged. Harvesting the vegetation increases the rate of assimilation of nutrients by increasing plant growth and can balance the loss of treatment associated with the reduction in plants.

Periodic removal of aquatic vegetation by cutting, raking, hooking and/or digging can help control unwanted aquatics such as cattails and water lettuce. ▼



Wildlife Management

Several factors should be considered when trying to select a site or to manage a pond area that will maximize benefits to wildlife. Pond designers and managers need to take into account the many relationships between pond systems and the surrounding uplands. For example, female turtles that live most of their lives in the water must come out of the water one day each spring to dig a hole in a sandy upland area and lay her eggs. Many amphibians spend their adult lives in upland forests. Sometimes culverts or other underpasses can serve as a means of linking surrounding habitats to ponds that may be isolated by roads.

The large scale focus should be on restoring the natural distribution and diversity of ponds within a large area that includes the project site. Some wildlife species, such as wading birds and migratory birds, are very mobile and require access to a variety of different ponds and wetlands. The variety of wildlife that use a pond at a specific location depends on

several site conditions, including the intensity of land use surrounding the pond, the size and three-dimensional shape of the pond, and how much the pond is isolated from natural habitats. Many species, especially migratory birds, may only use a pond during limited times of the year as they migrate through an area.

Seeds, fruits and tubers produced by the vegetation found in stormwater ponds are heavily used by a wide variety of insects, birds, and larger wildlife. Many of the nutrients in these plant products are then exported out of the wetland system through feces and through decay when the animal dies. For example, treefrogs leave the aquatic tadpole stage for an adult life in trees.

Wildlife are also important seed dispersers. Animals disperse seeds not only within the same wetland, but they also transport seeds to other wetlands through their migratory and dispersal movement patterns.

A mallard family of ducks enjoying a swim. ▼



Many recreational activities are dependent on wetlands and can be enhanced by improving wetland habitat and are somewhat related to stormwater ponds. Hunting, trapping and fishing are consumptive uses, although limited in stormwater pond settings, of wetland animals. These activities are important economically as well as for their recreational value. Over \$300 million is spent annually by about 2 million waterfowl hunters in the US. The nesting success of these birds is wetland dependent. At least half of all saltwater and nearly all freshwater fishing activities are dependent on wetlands to produce their catch. Annually, this provides an economic value of nearly \$20 billion dollars in the US.

Nonconsumptive uses of wetlands, such as hiking, bird watching, and photography also are important uses of wetlands. It is estimated that over 60 million Americans visit wetland areas each year for these types of uses. Almost 1/2 billion dollars is spent each year in Florida on bird watching and feeding. Many birds can be found in the vicinity of stormwater ponds.

More than one hundred species of mammals, birds, reptiles, amphibians, and fish can be found in Florida's ponds (*Table 2*, shown on pages 68 and 69).

Stormwater Pond

TIP



Do not encourage the feeding of wildlife. Waterfowl become accustomed to handouts and breed accordingly. They can overpopulate and become a nuisance.

Even in dry-down conditions, pond sites provide damp habitats required by many amphibians, reptiles, birds, and small mammals.

Negative Considerations of Designing Stormwater Ponds for Fish and Wildlife

Heavy metal accumulation and unnaturally high nutrient loads in ponds can cause unhealthy conditions for fish and wildlife. High concentrations of mercury and zinc can be lethal. Excessively high levels of nitrogen from fertilizers, sewage, or other sources can provide ideal habitat conditions for certain parasitic worms that can kill young wading birds that are fed infected fish. (i.e. eustrongylides ignotus parasitic worm.)

For these reasons, it is not recommended to design ponds for fish and wildlife if these structures will retain water runoff from parking lots, streets, and industrial parks. Ponds in residential settings with an upland vegetation buffer that filters out chemicals from the incoming stormwater are least likely to have problems. Golf courses may be acceptable sites for fish and wildlife ponds depending on the amount of pesticides, and other

chemicals which may enter ponds. High levels of nutrients from fertilizers will not directly harm fish. However, the dense algal and aquatic plant growth that is likely to result in productive water may eventually be lethal fish when much of the oxygen in the water is used to decompose large amounts of dead plant material.

In questionable situations, several ponds at different elevations connected by ditches may help to concentrate harmful chemicals in the uppermost ponds (not designed for fish and wildlife) so that the lower ponds in the chain would be the least likely to have toxicity problems. Because most (90%) of the pollutants are carried off site in the first inch of rainfall, treating this first flush is the key to pollution abatement.



*Sandhill Cranes
and their young.*

Dealing With Nuisance Wildlife Situations

Ponds attract a large variety of mammals, birds, reptiles and amphibians. Most all of them have the potential to cause at least perceived problems for people. These problems are endless and include things such as being irritated by frogs singing at night to seeing snakes that are attracted to a pond. Just as positive interactions and attitudes toward wildlife are too numerous to mention, negative encounters also do not deserve attention here. The best method for control and prevention of a wildlife-related problem, whether or not it is associated with a pond, is the same practical procedure most people follow to address problems caused by other adults, children or pets. First clearly define what situation is undesirable and then take steps necessary to reduce or eliminate the specific problem-causing situation. Contact your local extension office for information regarding problems that you are unable to resolve.

Misunderstandings are common causes of many frustrations and fears that people have about wildlife. For example, contrary to popular belief, most snakes in Florida couldn't even hurt you, let alone kill you. Most bats don't carry rabies. Separating myths from facts can alleviate many of these phobias and help you to appreciate wildlife more for their beneficial values, particularly in our urban environments.

Stormwater Pond

TIP



Learn to love your pond
dwelling critters... Snakes eat rats!

The Florida Constitution has designated the Florida Fish and Wildlife Conservation Commission as the legal steward of the native wildlife resources of the state. The mission of this state agency is to manage freshwater aquatic life and wild animal life and their habitats to perpetuate a diversity of species with densities and distributions that provide sustained ecological, recreational, scientific, educational, aesthetic, and economic benefits.

There are certain laws, rules, and regulations with which anyone who is baiting, trapping, transporting, or killing nuisance wildlife should be aware.



Nuisance Wildlife Management:

Weeds have been defined as plants whose usefulness have not yet been discovered. When growing where they are not specifically wanted, plants can become weeds. Nuisance wildlife pests are like weeds in that their usefulness has not been discovered and they often inhabit areas where they are specifically not wanted, namely, pond areas near homes. This is because stormwater ponds are sometimes the only areas left within developed area that have not been converted to pavement, buildings, or manicured landscapes. Many ponds are not maintained to be "pest free", so wildlife left in the area end up inhabiting the ponds and surrounding areas. Also, ponds may be the only source of water for wild animals remaining in preserved natural areas in the vicinity.

There are many ways to control "pests", depending on the type of "pest" and the amount of time, energy and money available to combat them. When developing a nuisance wildlife pest management plan for pond areas, determine which targets you find most irritating. These are the targets on which you may want to spend most of your resources. But before you decide to exterminate a particular "pest" from your pond site, be aware of the side effects your efforts may have on the wildlife that you

enjoy visiting your pond. Also be aware of the impacts your actions can have on the natural predators at your pond, which can provide free pest control. For example, if you want to remove all snakes from your pond site, consider that many snakes feed on mice, rats, and other snakes, so trying to eradicate all snakes may cause an increase in other pests. Also, some chemicals used to combat insects can accumulate in the fish species that feed on those insects, and can eventually kill the fish, or kill the birds that eat the fish, and so on. Finally, it may not be physically possible to eradicate a pest from your pond. The best way to combat pests is to alter their environment so that the pond site is not inviting. They'll go elsewhere.

Common Pond Pests and Ways to Combat Them:

Alligators: Alligators were once on the endangered species list in Florida due to extensive hunting and loss of habitat; now, due to hunting regulations and protection of their habitat, they are still protected, but have been placed in the less critical "species of special concern" category. Alligators feed on turtles, fish, birds, and most other small animals that cross their paths. They inhabit natural wetlands, swamps, rivers and ponds, however, where natural wetland areas have been eliminated, alligators have moved to urban stormwater ponds and canals. The best way to deal with alligators who have moved to your pond is to accept their presence and stay out of their way. According to the Florida Fish and Wildlife Conservation Commission (FFWCC), in many cases, if left unmolested, alligators three (3) feet and less in length are not aggressive or territorial and will eventually retreat to more preferred habitats away from people. However, they advise you to use ordinary common care and avoid being near thick vegetation along shore-



▲ Alligators like ponds too...

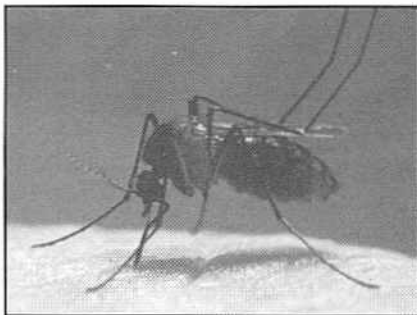
lines, do not feed alligators (feeding them will reduce their fear of humans and may encourage them to move closer, and feeding alligators is against Florida law), and do not leave pet food out, this too will attract alligators, as well as other unwanted animals and insects. The FFWCC also notes that it is a violation of state law to remove alligators from their natural habitat. If you observe an alligator greater than three (3) feet long call the FFWCC to arrange for its removal.

For removal of nuisance alligators, contact the Florida Fish and Wildlife Conservation Commission at (863) 648-3203 in Lakeland.

Snakes: You may encounter harmless black racers, rat snakes, and mud snakes near water bodies, especially if there is cover provided and sources of food such as rats and mice. So, if you don't want rodents, don't kill snakes! Poisonous cottonmouth snakes do inhabit vegetated ponds and adjacent forested areas, but again these animals feed on rodents, so don't kill them! People often confuse the poisonous cottonmouth snakes with the harmless, and protected, indigo snakes, which is a good reason why the old adage "the only good snake is a dead snake" is WRONG! Harming a protected species is illegal. The best thing to do when encountering a snake is to turn around and go the other way. The snake will usually do the same.

For removal of poisonous, nuisance snakes, contact the FFWCC at (863) 648-3203 in Lakeland. Also contact them to receive guides to venomous and nonvenomous snakes, to help you identify the snakes you encounter.

Mosquitoes: Keeping a pond well-maintained and as free-flowing as possible usually reduces the amount of mosquitoes in the pond. A "well maintained" pond includes keeping inflow and outflow struc-



tures free-flowing by removing sediment and clogging vegetation, maintaining a fringe of desirable emergent vegetation (as well as the required littoral zone vegetation in some ponds), removing as much undesirable vegetation as possible (water hyacinth, water lettuce, etc.), maintaining a stock of mosquito-fish (*Gambusia minnows*) and ensuring that a portion of the pond is deep enough to maintain a permanent pool so that the fish can live through dry seasons. Purple martin houses or bat houses can be erected near the pond; these animals feed off of mosquitoes as well as other flying insects and attracting them to your pond may help reduce the amount of mosquitoes. However, know that your pond may not be the only source of mosquito's in your neighborhood - mosquito's thrive in small puddles in flower pots, tires, kiddies pools, tree crevices, bromeliads, bottles, etc., that are left in the yard to collect rain. They survive in grass and under leaves!

In summary, the best way to deal with pests is to avoid them and to make your own yard unattractive to pests. Since we have to share the world with all sorts of animals, and since some of them provide unseen as well as known benefits to humans, keeping a secluded area away from homes in a wild state will attract the pests to that location rather than to yards and will allow us to live with, rather than try to eradicate, these animals.



Table 2. Wildlife Species List

Species — Mammals												
Habitat needs of some mammals that may be attracted to ponds.					Items					Location		
	SW	S	U	C	I	P	R	M	F	L	W	A
Least Shrew	X	X			X					X		
Marsh Rice Rat	X	X			X	X			X	X	X	
Mink	X	X					X	X	X	X	X	
Bats			X	X	X							X
Raccoon	X	X	X	X	X	X	X	X		X	X	
SW- Shallow water zone S- Shoreline zone U- Uplands away from the shoreline C- Caves and trees I- Insects and other invertebrates					P- Plants, seeds, and fruits R- Reptiles and amphibians M- Mammals F- Fish					L- Land W- Water A- Air		

Species — Birds		Nesting				Feeding							
Habitat needs of some birds that may be attracted to ponds.						Items				Location			
		SW	OS	U	C	I	F	P	O	D	S	L	A
Pied-Billed Grebe		X				X	X			X			
Wood Duck		X	X	X	X			X			X		
Green Heron		X	X			X	X				X		
Little Blue Heron		X	X			X	X		X		X		
Great Blue Heron		X	X			X	X		X		X		
Great Egret		X	X			X	X		X		X		
Least Bittern		X				X	X		X		X		
Anhinga		X	X			X	X		X	X			
King Rail		X				X	X	X			X		
Common Moorhen		X				X		X		X	X		
American Coot		X				X	X	X	X	X	X		
Belted Kingfisher				X		X	X		X		X		
Red-Shouldered Hawk				X		X			X			X	
Barred Owl			X	X	X	X			X			X	
Red-Winged Blackbird		X	X			X		X			X	X	
Purple Martin		X	X	X	X	X							X
Common Yellowthroat		X	X			X		X			X	X	
Prothonotary Warbler		X	X			X					X	X	
Green-Winged Teal		These birds do not breed in Southeastern U.S.						X			X	X	
Mallard						X		X			X	X	
Bufflehead						X	X			X			
Hooded Merganser						X	X			X			
Spotted Sandpiper						X	X		X		X	X	
Common Snipe						X		X	X			X	
Swamp Sparrow						X		X			X	X	
SW- Over shallow water OS- Over shoreline U- Uplands away from the shoreline C- In trees cavity or nest box I- Insects and other invertebrates, including: crustaceans, mollusks, snails, and spiders		F- Fish P- Plants and/or seeds O- Other food items include: mammals, reptiles, amphibians, birds, and carrion								D- Deep water S- Shallow water L- Land A- Air			

Species — Reptiles											
Habitat needs of some reptiles that may be attracted to ponds.				Items				Location			
	Li	S	U	I	F	A	P	B	D	S	L
Musk Turtle		X	X	X	X			X			
Eastern Mud Turtle			X	X	X	X		X	X		
Chicken Turtle			X	X			X			X	X
Spiny Softshell		X	X	X	X			X			
Snapping Turtle			X	X	X	X	X				
Cooters			X				X				
Sliders			X				X				
Mud Snake		X				X				X	X
Glossy Crayfish Snake	X			X	X	X				X	X
Green Water Snake	X				X				X	X	
Brown Snake	X										
Banded Water Snake	X				X	X			X	X	X
Eastern Ribbon Snake	X				X	X			X	X	X
Eastern Garter Snake	X			X	X	X			X	X	X
Li - Live-bearing S - Eggs laid in hole dug in shoreline U - Eggs laid in hole dug in upland away from shoreline I - Insects and other invertebrates F - Fish A - Amphibians and reptiles P - Plants and vegetation B - Muddy bottom D - Deep water S - Shallow water L - Land											

Species — Amphibians										
Habitat needs of some amphibians that may be attracted to ponds.				Items				Location		
	D	SW	S	I	C	A	S	W	L	T
Cricket Frog		X		X					X	
Eastern Spadefoot	X	X		X					X	
Bullfrog	X	X		X	X	X	X	X	X	
Spring Peeper		X		X					X	
Green Treefrog	X	X		X						X
Chorus Frog		X		X					X	
Eastern Narrowmouth Toad	X	X		X					X	
Pickering Frog	X	X		X					X	
Leopard Frog		X		X					X	
Fowler's Toad	X	X		X					X	
Spotted Dusky Salamander			X	X					X	
Central Newt		X		X				X		
Slimy Salamander			X	X					X	
Marbled Salamander			X	X					X	
Tiger Salamander		X		X				X	X	
Lesser Siren			X	X	X	X		X		
D - Eggs laid in deep water SW - Eggs laid in shallow water, usually attached to vegetation S - Eggs laid on shoreline or other moist areas on land I - Insects and other invertebrates C - Crustaceans A - Amphibians S - Any animal smaller than itself W - Water L - Land T - Trees										