

MANAGEMENT of WARMWATER PONDS



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Table of Contents

Pond Engineering.....	2
Fish Management	
Stocking.....	3
Balance.....	4
Restocking.....	4
Fishing.....	5
Water Quality and Fish kills.....	5
Problems	
Weed Control.....	7
Predators.....	8
Other Problems.....	8
Pond Safety and Liability (From NCC NRCS Office).....	9
Appendices	
1 Sources of Information.....	11
2 Measuring a Pond.....	11
3 Swingle Determination of Balance.....	12
4 Problem Vegetation in Delaware Ponds.....	15
Figures	
Recommended Species for Stocking.....	14
Brush Shelter Design.....	14

Management of Warmwater Ponds

Warmwater ponds can provide many hours of productive fishing as well as other recreational activities. Although most ponds provide some fishing, ponds which are stocked and managed correctly will produce more fish. A suitable amount of plankton and aquatic plants, in addition to a well-balanced fish population, is a sign of a healthy pond. A well-managed fish pond is a pleasure to own and observe. The effort it takes to manage and maintain such a pond will be repaid with excellent fishing and many hours of a variety of recreational activities.

Pond Engineering

Size is an important aspect of pond design and management. Ponds less than 1/4 surface acre are difficult to manage in order to maintain a fishable population of game fish. The numbers of largemouth bass and bluegill in smaller ponds are relatively low and the potential is high for overharvesting bass and/or disrupting the fish population balance (ratio of predators to prey species of fish).

The minimum depth of a warmwater fish pond should be about two feet. This will allow nest-building by the bluegill, but prevent problem emergent weeds, such as rushes, cattails and phragmites, from becoming established. The deepest area of the pond should be at least six (6) feet to ensure plenty of water during dry summers and under heavy ice cover. Pond water levels generally reflect the water table. Usually both are at their lowest during the months of August to October, and at their highest during January to March.

The ability to regulate a pond's water level via some sort of standpipe or drain valve is an asset in managing fish and aquatic weeds. If a particular species of fish becomes too abundant, the pond can be drawn down and the concentrated fish can be removed with a seine net. Most farm ponds in Delaware, however, were not designed for water level management because Delaware's topography has too little relief in most areas.

If you have questions about where to construct a pond on your property or the correct design and engineering, it is best to consult with your county Natural Resources Conservation District Office (Appendix 1). You may also check with them about the availability of cost-sharing to construct a pond and for names of possible construction firms. The Division of Fish and Wildlife does not construct ponds on private property.

Fish Management

Stocking

In Delaware warmwater ponds where fishing is desired, largemouth bass and bluegill (Figure 1) are the most suitable species. Generally fingerling-size (1 to 3 inch) fish are stocked. The number of fish stocked is determined by the pond's surface area (see Appendix for how to measure) and the length of available fish. In Delaware, the preferred stocking rate for fingerlings is 100 largemouth bass and 800 bluegills per surface acre. For example, a half-acre pond should receive 50 largemouth bass and 400 bluegill. Although it may be tempting to stock more fish, the most productive fishing occurs using the preferred stocking rate. If larger fish are available, they may be stocked to shorten the period of time needed to produce catchable-size fish; however, the stocking rate will differ. Additional fishing opportunities can be provided by stocking 100 channel catfish fingerlings per acre. An alternative to stocking bluegill is to stock hybrid sunfish, which usually have low reproductive potential so some pond balance problems can be avoided. However they may need to be re-stocked periodically due to their low reproductive rate. Another advantage of hybrid sunfish is that they grow quickly and feed aggressively. The most common hybrid stocked in ponds is a hybrid of a bluegill and the green sunfish. Avoid stocking any non-hybridized green sunfish, however, lest they breed and fill the pond with undersized individuals. Also, stocking of hybrids if bluegill are already present would not produce the desired result. The Division of Fish and Wildlife recommends that no other fish be stocked in the pond, including those offered by well-meaning angler friends. Stocking a few adult fish may negatively affect the overall ratio of predator (bass and catfish) to prey (bluegill) resulting in imbalanced fish populations. Avoid stocking crappie or perch in farm ponds because these species almost always overpopulate the pond with stunted individuals.

Bluegill should be stocked in the fall and largemouth bass and channel catfish the following spring. When stocking a new pond or one that has no vegetation, it is a good idea to place some cut brush or evergreen trees into the pond to provide cover for the young fish (Figure 2). This will offer some protection against predation by fish and wading birds.

A partial list of fish suppliers in the Mid-Atlantic area may be obtained from the Division of Fish and Wildlife (653-2887 or 739-9914). Contact suppliers early to ensure they can meet your stocking needs. Price will vary depending on the size of the fish purchased. The Division of Fish and Wildlife does not provide fish for stocking private ponds.

Balance:

Maintaining a balanced fish population is very important. The largemouth bass is a predator and feeds on minnows, insects, frogs, tadpoles and any smaller fish such as bluegill. Bass reproduce when they reach 12 inches (generally three years old in Delaware). They reproduce only once each year, in the spring when water temperatures reach the mid-sixties. Bluegill provide most of the prey in a typical bass-bluegill pond. Bluegill feed mostly on plankton, insects and small crustaceans, although larger individuals will feed on small fish and bass eggs. Bluegill mature at one year old and can spawn from June through September. Since they are so prolific, they can rapidly over-populate a small pond to the point that they outstrip their food supply and stop growing. A population of numerous, uniformly-small bluegill indicates that crowding and stunting have occurred. Their numbers need to be reduced by predator fish and /or removal through intensive fishing or netting.

Channel catfish do well in combination with largemouth bass and bluegill. They are generally bottom feeders and prefer small fish, worms and insects. Channel catfish must be at least three years of age before they are able to spawn. However, they do not spawn in a pond unless suitable nest site, e.g. submerged barrels or large pipe, are provided. If reproduction does occur, bass and bluegill predation on the young catfish (fry) generally limits survival. Therefore, periodic stocking of channel catfish fingerlings may be necessary. Do not confuse channel catfish (forked tail and grey color) with bullheads (rounded or square tail and brown or black color) as bullheads can be a problem in farm ponds (Figure 1).

Although the bass-bluegill pond generally has enough natural food to be self-sustaining, many farm pond owners like to provide supplemental feed for their fish. Any commercially available trout or catfish chow will attract bluegill and channel catfish when used regularly. Fish should be given only as much feed as they can eat within a few minutes. Excessive amounts of uneaten feed may cause water quality problems as the feed decomposes. The use of floating, rather than sinking, feed is recommended so you can see how much is being eaten. Commercial pelleted fish feed can be purchased from many farm supply stores. Feed from the same general location each time so the fish become accustomed to the routine. Largemouth bass seldom will accept artificial feed unless they were reared on it.

Re-stocking:

It rarely does any good to re-stock fingerling bass or bluegill into a pond where populations of these species already exist. If you are having problems with poor growth or excessive or not enough reproduction, stocking usually only adds to the problem. The causes of the problem itself must be determined and addressed. Sometimes the only way to do this is to remove large numbers of the species that is over-abundant.

A simple way to determine what the problem is to use a small (20 to 35 ft long) haul or minnow seine to sample the fish in your pond during late July or August. By checking the resulting sample against the list in the Swingle Pond Balance Key (Appendix 3), you will be able to check the health of the fish population in your pond. It is easiest to correct pond problems before they become worse. Professional advice and assistance is available from the Division of Fish and Wildlife (653-2887 or 739-9914) if you feel your fish population is unbalanced. However, since Division biologists' time for private pond consultations is limited (more emphasis is placed on management of public ponds), it will be necessary for you to obtain and fill out a pond consultation request form if your question or problem cannot be addressed over the telephone.

Fishing:

Bass should not be harvested until they are large enough to have spawned at least once (12 inches/ 3 years in Delaware). This doesn't mean you cannot fish for them, but you should release them unharmed. A sufficient number of these predators must be present to control bluegill. It is a general recommendation that farm pond harvest rates should not exceed 25 bass per acre per year. When this quota of bass has been removed, fishing can continue, but all bass caught should be released. All bluegill should be removed as they are caught. At least four pounds of bluegill should be removed for every pound of bass. Small bluegill can be used as garden fertilizer if you don't want to eat them.

Largemouth bass can be caught on an assortment of live baits and artificial lures. Fishing for bass is usually most productive in April, May and June, declines during the summer months and picks up again during the fall. Live earthworms or crickets are popular baits for bluegill, although other insects as well as artificial flies and lures are effective. Bluegill may be caught from April through October.

Water Quality and Fish Kills:

Water quality includes all physical, chemical and biological factors that influence the characteristics of water and its effect on organisms. A pond with "good" water quality will produce more and healthier fish than a pond with "poor" water quality. Dissolved oxygen (DO) is a critical water quality parameter. Sufficient DO is required by plants, fish and other aquatic organisms. Most DO is produced during daylight hours by aquatic plant photosynthesis. These same plants use oxygen for respiration at night. In most cases, the oxygen produced during the day is more than enough to offset the oxygen consumed at night. Serious oxygen depletion can occur when something happens to reduce photosynthesis, to increase oxygen demand, or both. If the level of DO drops below 2 milligrams/liter, a fish kill can result. If algae becomes abundant (a condition called a bloom) and then dies off, DO concentrations can drop to critical levels at night or very early in the morning. One symptom of low DO stress is fish swimming

slowly and gulping at the water's surface.

Turbidity is a measure of the suspended material in the water that interferes with the passage of light through the water. A heavy load of silt and/or clay particles in the water affects fish in two ways. The silt may settle over the pond bottom smothering fish eggs of nest-builders such as bass and bluegill. Particles which remain in suspension (most often clay particles) restrict light penetration into the water. Less light limits the growth of planktonic plants and adversely affects all aquatic animals dependent on them. Muddiness may be caused by the chemistry of the water, excess run-off of soils, activity of aquatic organisms, or unrestricted access of domestic farm animals to the pond. Carp and/or muskrats can stir up the water and should be legally removed from a pond. Soil erosion from unvegetated banks and/or use of the pond by livestock also can contribute to high turbidity. Banks should be seeded immediately after pond construction to prevent soil run-off. If muddiness is due to soil type and water chemistry, a permanent solution may be difficult. One method that has helped in some situations is to put one bale of hay (not straw) per surface acre into a pond. The bale, broken up and spread over the water's surface, should help clear the water. Limit this application to no more than four times per year with at least 14 days between each application. The hay changes the electrolyte balance in the water causing clay particles to settle out. If the hay treatment does not work, there are chemicals like alum, that can remove suspended sediments. However, the use of these chemicals can kill fish due to abrupt pH changes and to potential toxicity from aluminum in the alum.

A few Delaware ponds suffer from low pH (less than 6.0) or acidic conditions due to the soil type at the pond location. Pond pH less than 6.0 can severely limit fish production and impair reproduction. This problem can be corrected with application of crushed or pulverized agricultural limestone. Rates vary depending on the severity of the problem, but generally one ton of limestone per surface applied in the spring will raise the pH to acceptable levels (6.5 to 8.0). This may have to be done annually and should be monitored periodically with a swimming pool pH test kit.

A fish kill in a pond can occur at any time of year, but is more common during warm summer months. There are various potential causes of fish kills: presence of toxic substances (run-off of toxic pesticides, for example), insufficient oxygen in the water, or fish diseases or parasites. If you notice more than a few dead or dying fish, the Division of Fish and Wildlife should be contacted immediately (739-9914). Failure to seek technical assistance immediately limits the ability of a biologist to determine what caused the fish kill.

Waterfowl and fish are usually not a good combination for a small pond because of the fertilizing effect of waterfowl wastes. A few ducks or geese on a small pond will not cause a problem. However, a large flock of waterfowl resting on a pond for a week or two will greatly increase the nutrient load. This may cause a fish kill due to decomposing organic matter or result in undesirable vegetation during the summer.

Problems

Many problems with farm ponds can be minimized by incorporating good management practices into the pond design. An uncontrolled flow of nutrients into a pond may trigger plant growth. Field or lawn fertilizer run-off, septic tank seepage, and livestock or waterfowl wastes all contribute to nutrient problems. As weeds die and decompose, they cause low oxygen levels in the water which can result in a fish kill. Limiting the flow of nutrients into a pond will prolong the life of the pond and prevent many weed problems. The best way to do this is to maintain an unmowed, vegetated 15 to 30-foot wide buffer strip of grasses to trap nutrients and sediment before they enter the pond. A native wildflower mix planted with the grasses will greatly enhance the beauty of the area and attract butterflies and birds. Available seed mixes and sources are listed in a separate brochure.

Algal problems occur when nutrients are available and water temperature increase. Rooted plants compete for nutrients with algae making fewer available and many also provide some shading to lower water temperatures. A Division of Fish and Wildlife brochure, *Go Native with your water garden*, lists those plants which can be used for this purpose. It is extremely important to **never** plant non-indigenous (not native to Delaware) plant species in your farm pond as many are aggressive growers and can quickly over run a small pond.

Weed Control:

An undesirable infestation of aquatic plants interferes with fishing and fish production by snagging lines and providing so much cover for small fish that larger fish are unable to eat enough of them to control their numbers. There are two general types of aquatic vegetation that can cause problems in ponds. The rooted varieties such as cattail and rushes may be controlled by pond design; ponds greater than two-foot deep with steep-sloped sides are less likely to become infested with aquatic weeds. Once weeds develop, however, there are limited options to control them. A variety of herbicides may be used depending on the species of plant causing the problem. However, the nutrients will go back into the water column after the plants decompose and another species may take over. In some cases, sterile grass carp (Figure 1) may be a viable option if the pond meets the guidelines outlined in the grass carp stocking policy and the weed is one that the fish will feed on. Because the over-abundance of aquatic weeds is merely a symptom of excess nutrients, the only long-term solution may be the removal of nutrients through dredging, a more costly and disruptive action than the use of herbicides or sterile grass carp. Keep in mind that even sterile grass carp are a restricted species in Delaware and their importation is only legal with the written consent of the Division of Fish and Wildlife. If you think your pond weed problems are severe enough to warrant stocking grass carp, request an application from the Division of Fish and Wildlife. A visit by one of the Division's biologist will be necessary before any grass carp permits can be issued. Under no circumstances will the use of fertile (genetically diploid) grass carp be permitted.

The other type of vegetation is algae, which may be either filamentous (thread-like mats) or planktonic (microscopic cells that color the water intense green or red). Algae generally can be controlled by applications of herbicides that contain copper or copper sulfate. Seek guidance on application doses because too much elemental copper may cause a fish kill.

Biologists from the Division of Fish and Wildlife should be consulted prior to any type of chemical treatment. The identification of the problem plant species is necessary to determine the most effective herbicide. Please observe any restrictions on the herbicide label or those suggested by a Division biologist, both for the health of your fish and for the safety of the herbicide applicator. If you compensate someone else to spray herbicides in your pond, they need to be certified for aquatic pest control by the Delaware Department of Agriculture. Only a few herbicides are labeled for aquatic use. If in doubt, contact the Dept. of Agriculture (739-4811) for information about what herbicides are registered for aquatic use in Delaware.

The use of barley straw, popular in England for controlling algal species in some ponds, is receiving some attention here. The barley straw bales are tied with bird netting or chicken wire to keep straw intact and floated at the rate of four bales per acre of pond. Researchers at the University of Maryland began to study the effectiveness of this method during the summer of 1997. The Division of Fish and Wildlife has not verified any results claimed. However, several local pond-owners have reported some success with this relatively low cost method.

Vegetation also can be controlled with the application of inert dyes or by installation of plastic screens or covers anchored to the pond bottom. Several products are available commercially for this purpose.

Predators:

Fish predators such as turtles, water snakes and wading birds are often found in or around farm ponds. They are rarely a threat to a pond's fish population and fill a valuable ecological niche by consuming diseased or weakened fish. The presence of fish cover will deter wading birds and limit the vulnerability of young fish to these sight feeders. Snapping turtles may be unwelcome in ponds used frequently for swimming as well as in ponds used to raise ducks, as large turtles will consume young ducklings or goslings. They may be removed by trapping, but are subject to Delaware hunting, trapping and fishing regulations.

Other Problems:

Muskrats can cause serious damage to the structural integrity of a pond by burrowing into pond banks and dams. The pond should be kept reasonable free of emergent vegetation such as cattails which provide food for muskrats. Pond banks

should be kept in good condition with solid vegetative cover. Muskrats can be removed by trapping, but are subject to Delaware hunting and trapping regulations.

Pond Safety and Liability

(From the New Castle County Natural Resources Conservation Service Office)

Common sense safety precautions should be taken while you enjoy your pond. Life saving equipment should be available and PFD's worn if fishing from a boat in the pond. A rope and throwable floatation device like a life ring should also be nearby, and in the winter a ladder or plank should be placed near the pond in case someone falls through the ice.

Ponds, like any body of water, attract people. This can lead to the possibility of an accident. The liability of a pond owner can vary depending on whether the party is an invited guest, a trespasser, or an individual who has paid a fee. Title 7 of the Delaware Code, Chapter 89 provides for limits of liability of private landowners who make land and water areas available to the public for recreational purposes. The limits of liability apply whether the recreator entered the land with or without the consent of the landowner. Many other factors can influence the pond owner's liability in case of an accident. It is recommended that pond owners consult their attorneys and insurance agents for proper protection against a lawsuit.

Acknowledgements

The Division of Fish and Wildlife wishes to express its appreciation to Mrs. Rae Chambers of the Pennsylvania State University, Department of Agricultural Communications, for many of the excellent illustrations contained in the section on aquatic plants. The North Carolina Agricultural Experiment Station, North Carolina State University, Raleigh also permitted reproduction of plant illustrations. Thanks also to the AVI Publishing Company, Westport, Connecticut for permission to reprint illustration numbers 5 and 14 from Riemer, D.N. 1984. Introduction to freshwater vegetation. AVI Publishing Co., Inc. Westport, Conn.

The pictures of all of the largemouth bass, bluegill and channel catfish are reproductions from color originals painted by Duane Raver of Cary, North Carolina. The line drawing of the grass carp was done by Christy Shaffer, DNREC.

Appendix 1

Sources of Information

Pond design/ engineering

County Conservation District/
NRCS Offices
New Castle 832-3100
Kent 741-2600
Sussex 856-3990

Fish Stocking Lists/ Pond Problems

Division of Fish & Wildlife
89 Kings Highway
Dover, DE 19901
739-9914 or 653-2887

Fish Kills

Fish Kill Coordinator
DNREC
Dover, De 19901
Days: 302-739-9914
Eve. & weekends: 302-739-4580

Pesticide Licensing

Dept. of Agriculture,
Pesticides Compliance
2320 S. DuPont Hwy
Dover, DE 19901
739-4811

Appendix 2

Measuring a Pond

Rectangular or square:

$$\frac{\text{length (ft)} \times \text{width (ft.)}}{43,560} = \text{Surface Acres}$$

Circular:

Measure distance from pond center to shoreline to get the radius

$$\frac{\text{radius (ft)} \times \text{radius (ft)} \times 3.14}{43,560} = \text{Surface Acres}$$

Acre-feet

Measure depth in ft in a grid pattern over the pond (at least 15 points):
Average the readings to get average depth
Multiply surfaces acres X average depth to get acre-ft.

Appendix 3

Swingle Determination of Fish Population Balance

Pull a haul seine at least 35 feet through one end or corner of the pond in late July or sometime in August. A net from 20 to 35 feet long will be adequate. Examine the fish collected and chose the most appropriate description below.

I. No young largemouth bass present:

A. Many newly-hatched bluegills, no or very few intermediate (3 to 5 inch) bluegills. **Conclusion:** Bass over-crowded, temporary balance.

B. No recent hatch of bluegills, many intermediate bluegills. **Conclusion:** Unbalanced, bluegills over-crowded, insufficient bass.

C. Same as above, plus many tadpoles and/or minnows and/or crayfish. **Conclusion:** Unbalanced, no bass or extremely few bass.

D. Nor recent hatch of bluegills, few intermediate bluegills. **Conclusion:** Unbalanced, due to crowding by other species, e.g. white perch, crappie or bullheads.

E. No recent hatch of bluegills, no intermediates. **Conclusion:** Water too salty, pH too low, or heavily laden with silt.

II. Young largemouth bass present:

A. Many newly-hatched bluegills and few intermediate bluegill present. **Conclusion:** Pond in balance.

B. Many newly-hatched bluegills and very few or no intermediate bluegill. **Conclusion:** Temporary balance, but bass over-crowded.

Continued

C. No recent hatch of bluegills:

a. Few or no intermediate bluegills. **Conclusion:** Bluegill absent from pond or unable to reproduce due to salinity or pH problems; occasionally due to overcrowding by other species such as white perch or crappie.

b. Many intermediate bluegills. **Conclusion:** Unbalanced, bluegills overcrowded, insufficient bass, progressing to situation I-B.

This key was developed by H. S. Swingle, Auburn University, Auburn, Alabama.

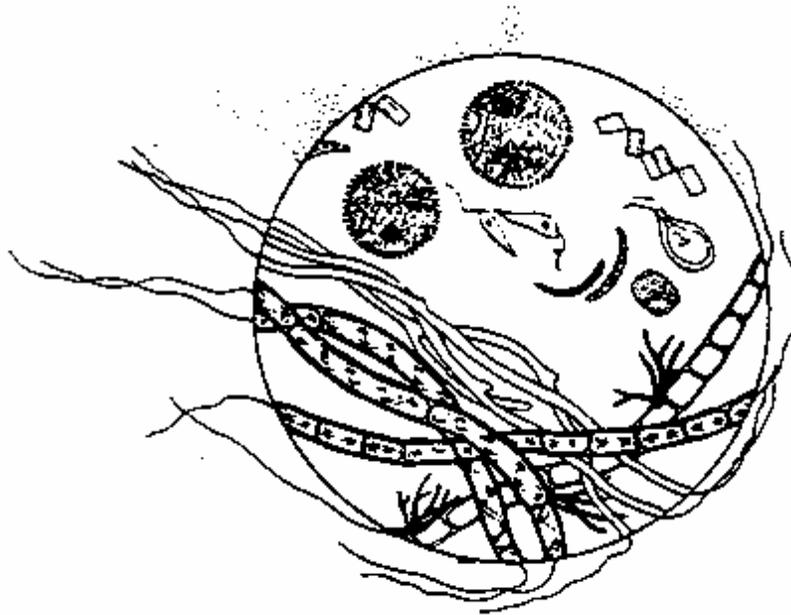
Appendix 4

Problem Vegetation in Delaware Ponds

Algal Species:

Planktonic Algae

These single-celled plants are microscopic, but when present in great numbers (called blooms), they give the water a green color that may be so intense as to resemble green paint. Occasionally a red bloom develops, but usually occurs in small areas on the water's surface. These blooms can lead to dissolved oxygen problems and rapid fluctuations in daily pH as the plants alternately produce oxygen through photosynthesis during daylight and use it up through respiration at night. These blooms usually occur during the warmest part of the summer in ponds that have an over-abundance of dissolved nutrients.



*Viewed through
a microscope*

Filamentous Algae

Any of several types of simple, unrooted plants that form thin, thread-like strands and mats are plainly visible to the naked eye. Some of these mats of algae, such as that formed by the blue-green alga, *Lyngbya*, alternately rise and sink as they are buoyed up by gases. Although many forms of filamentous algae can be controlled by treating with herbicides containing copper, others like *Lyngbya* and *Pithophora* are resistant to copper. These floating mats disrupt boat access, make fishing difficult and often give off noxious odors.

Rooted Plants

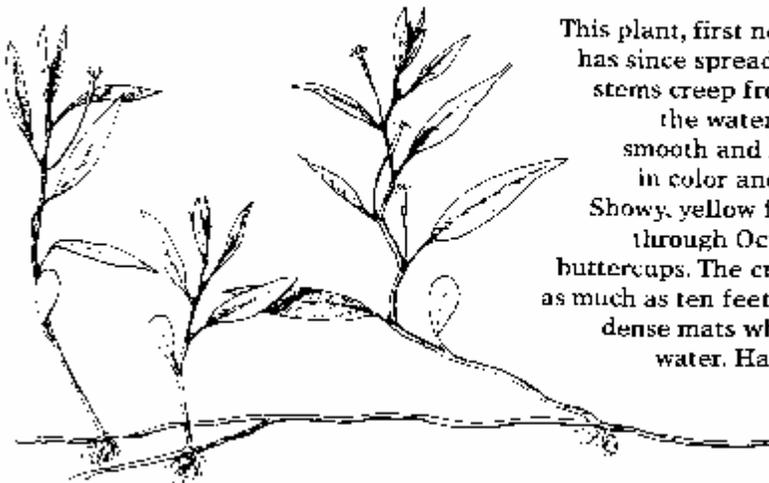
Hydrilla (*Hydrilla verticillata*)

This plant is an import from Africa or Southeast Asia that most likely arrived in Delaware in the 1970's through the aquarium trade. It has spread rapidly through many Sussex County ponds and has proven difficult to eradicate. Herbicides and, in suitable locations, sterile grass carp can provide control. The leaves are in whorls of 3 to 8 along the stem and are rough to the touch because of small serrations of the leaf edges and mid-ribs. The presence of underground tubers (like miniature bulbs) is a distinctive characteristic and one way for the plant to spread. Tubers are eaten by geese and can be distributed in their droppings, a likely source of its spread to several ponds in New Castle County. Boat trailers and live wells are also suspected of spreading this weed to many lakes in Sussex County where the water is clear enough for a rooted plant to flourish.

ANGLERS CAN HELP PREVENT FURTHER SPREAD OF THIS WEED AND OTHERS BY CAREFULLY CLEANING THEIR TRAILERS, MOTORS AND LIVE WELLS OF WEEDS BEFORE LEAVING A POND.



Creeping Water Primrose (*Ludwigia peploides*)



This plant, first noted in Delaware in 1993, has since spread to several locations. The stems creep from the shoreline out over the water's surface. The leaves are smooth and lance-shaped, dark green in color and occur on reddish stems. Showy, yellow flowers appear from June through October and resemble large buttercups. The creeping stems can extend as much as ten feet from the shore and form dense mats which restrict access to the water. Hand removal or herbicides provide the only control.

Rooted Plants

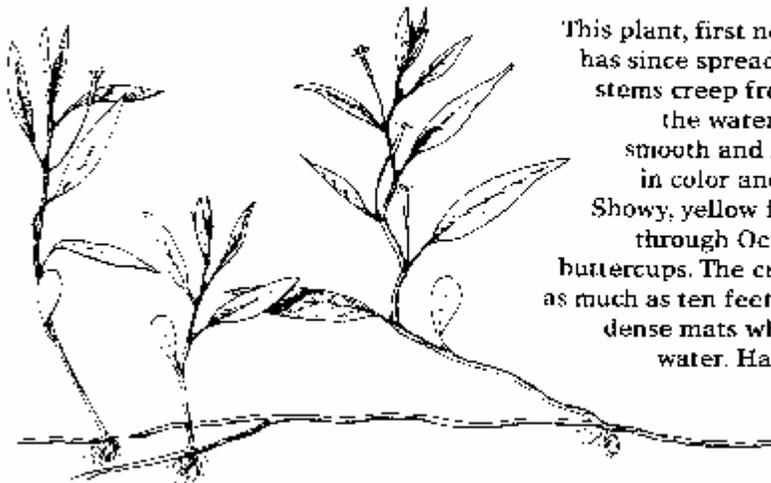
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Elodea

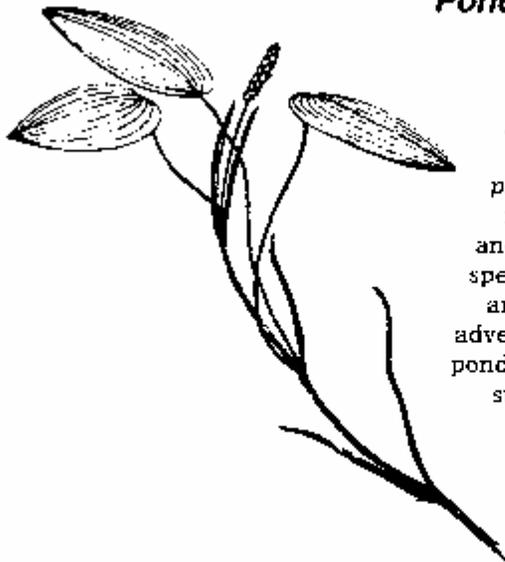
(*Elodea canadensis* and
Egeria densa)

There are two common species of elodea in Delaware ponds. Both resemble hydrilla, but are smoother to the touch and do not have underground tubers. Leaves occur in whorls of 3 to 6, depending on the species. *Elodea* is a native species but *Egeria* is from South America. A number of herbicides

have been used successfully in controlling elodea in Delaware; the plant is seldom a problem very long when under treatment.



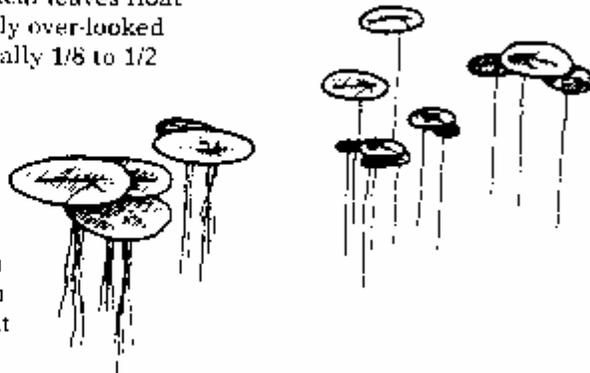
Pondweeds (*Potamogeton* spp.)



This group of plants has a variety of species that occur in Delaware, but rarely become abundant enough to become a problem. One exception is sago pondweed (*Potamogeton pectinatus*) which can cover the entire bottom in some farm ponds. It is found in both fresh and brackish waters like a very similar looking species, widgeon grass (*Ruppia maritima*). Both are known to be excellent duck foods, but can adversely impact recreational activities on small ponds when coverage is excessive. The plants are submersed, growing entirely under the water, are rooted to the bottom and appear limp when removed from the water. The two species are difficult to separate unless the small fruits are present. Herbicide treatment depends on the amount of salt present in the pond.

Duckweed and Watermeal (*Lemna and Wolffia*)

These similar species are some of the world's smallest flowering plants. Small round to elliptical leaves float over the water surface with small, easily over-looked roots dangling below. Duckweed is usually 1/8 to 1/2 inch across with leaves attached in groups of two or three. Individual plants of watermeal resemble green cornmeal and feel granular when they stick to your skin surface. The plants float freely over the water surface and often form a thick layer on the downwind side of a pond. Although several herbicides are available to treat these species, control is often difficult due to their ability to repopulate. Often the best method of control is to remove large amounts of the plant material with a pool skimmer when it is windrowed along the shoreline.



Parrot-feather (*Myriophyllum aquaticum*)

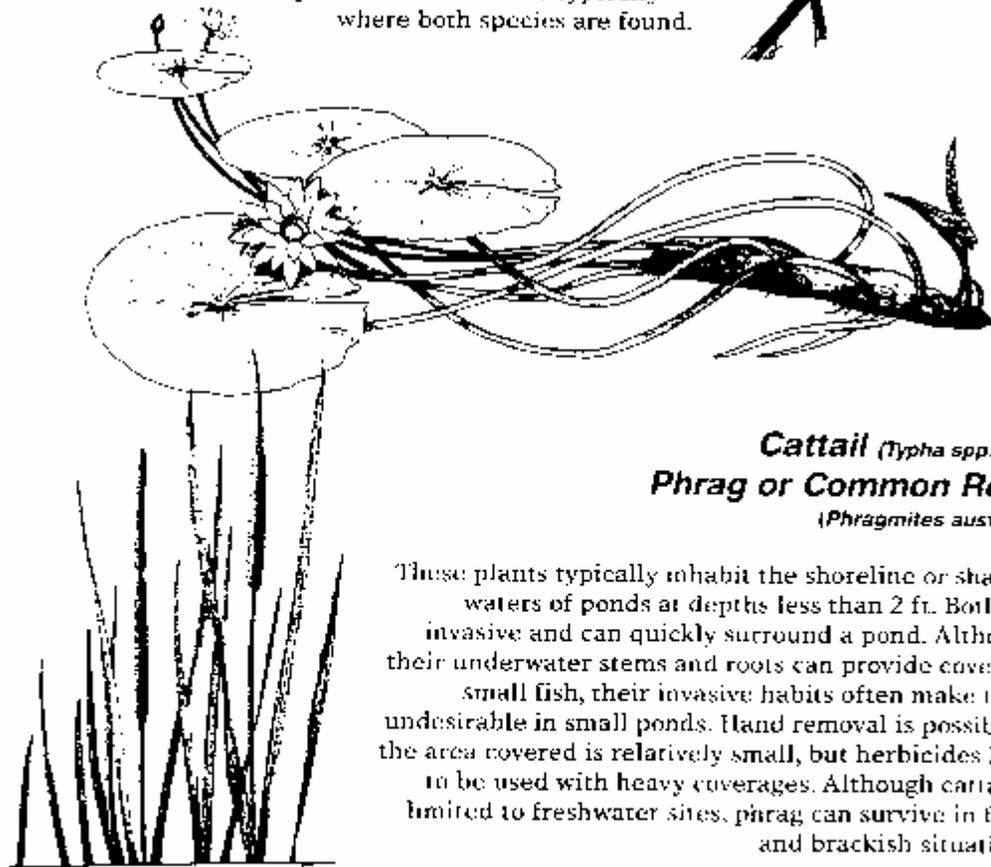
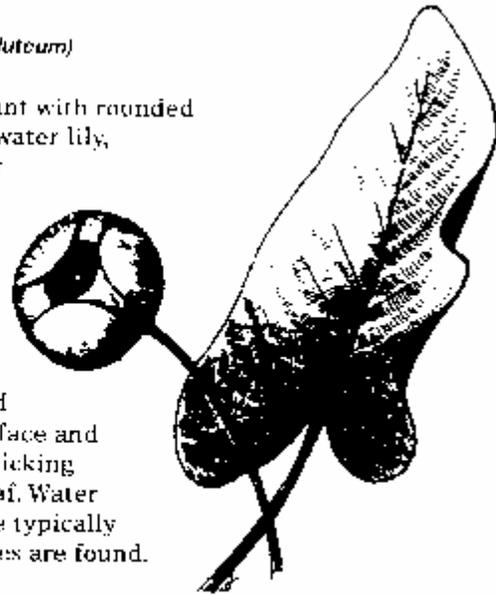
This perennial from South America is another non-native species now established in Delaware. A popular plant in "water gardens," it has been released, either accidentally or by well-meaning "gardeners," in some ponds.

The underwater leaves resemble feathers and are limp when removed from the water. Leaves at the top of the stem extend above the water surface and appear grey-green and firmer. During low water periods the plant will root along the shoreline and may lose the leaves normally below the water line.

The plant can be extremely invasive and form large extensive mats on the surface of the water. Control can be difficult so it is best to prevent its introduction to your pond.

Water Lilies (*Nymphaea odorata* and *Nuphar luteum*)

Although many people consider any plant with rounded or elliptical leaves at the water surface to be water lily, frequently the plant is actually spatterdock or cow lily (*Nuphar luteum*). The two are easily separated by the flower. Fragrant water-lily has a white, multi-petaled flower with yellow centers, while spatterdock's flower is a yellow cup shaped structure without typical petals. The rounded leaves of water lily lay flat on the water's surface but spatterdock leaves can protrude above the water and stand erect. Both have waxy coatings on the leaf surface and must be treated with herbicides mixed with sticking agents to keep the active ingredient on the leaf. Water depths of 1 to 3 feet are typically where both species are found.



Cattail (*Typha* spp.) and
Phrag or Common Reed
(*Phragmites australis*)

These plants typically inhabit the shoreline or shallow waters of ponds at depths less than 2 ft. Both are invasive and can quickly surround a pond. Although their underwater stems and roots can provide cover for small fish, their invasive habits often make them undesirable in small ponds. Hand removal is possible if the area covered is relatively small, but herbicides have to be used with heavy coverages. Although cattail is limited to freshwater sites, phrag can survive in fresh and brackish situations.

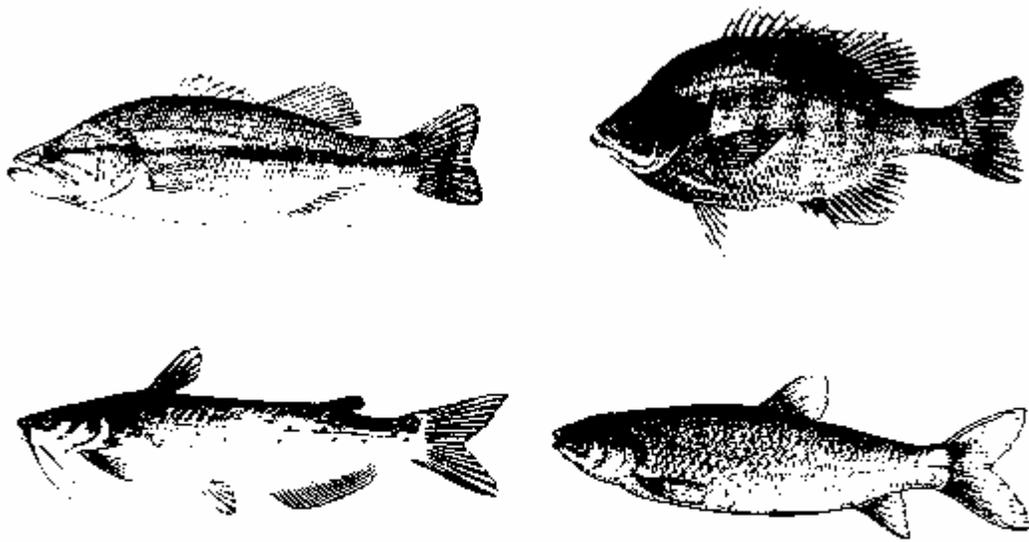


Figure 1.

Fish species for small ponds:

Top left, Largemouth bass (*Micropterus salmoides*); top right, Bluegill (*Lepomis macrochirus*); bottom left, channel catfish (*Ictalurus punctatus*); bottom right, white Amur or grass carp (*Ctenopharyngodon idella*).



Figure 2.

Brush Shelter Design.