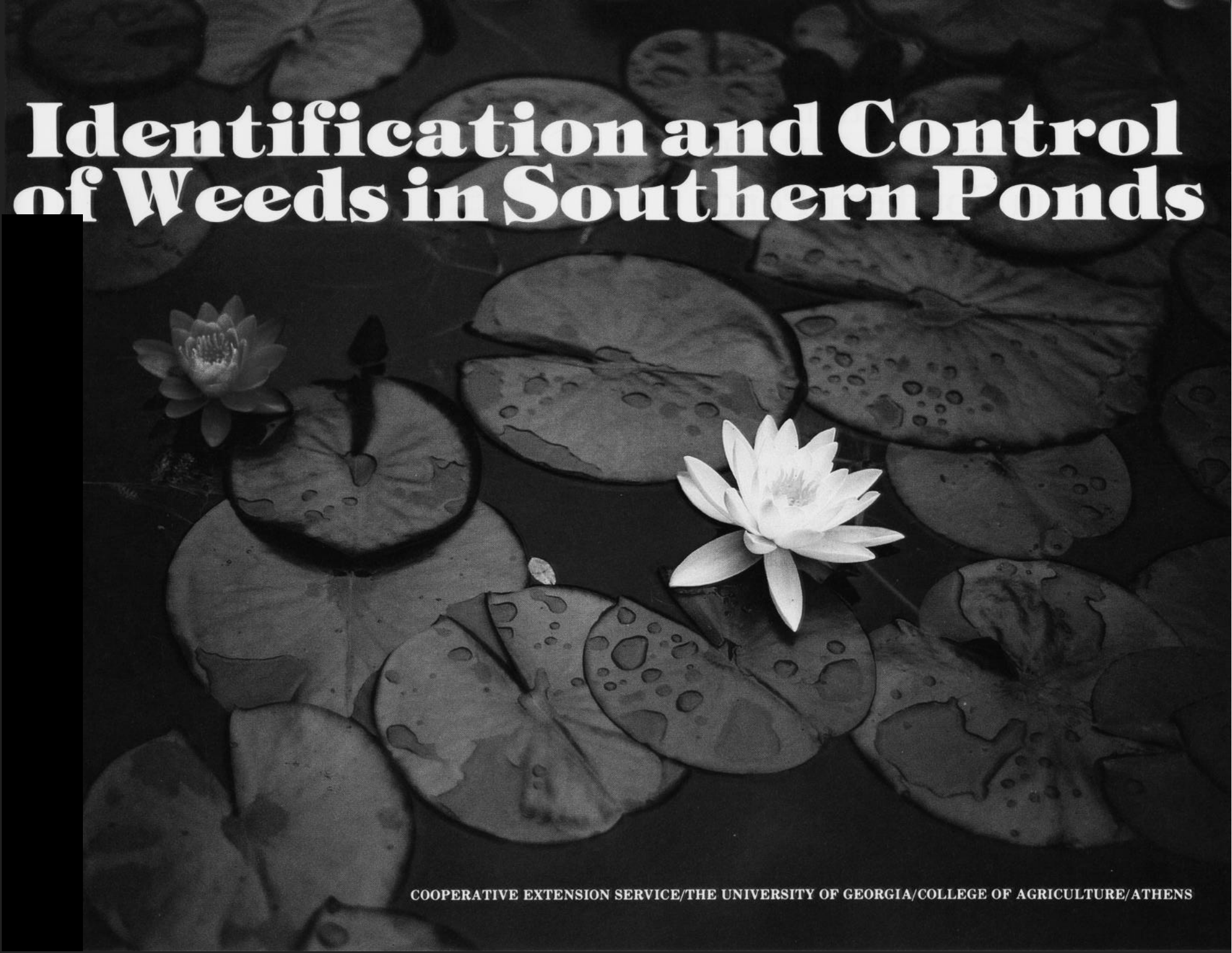
Identification and Control of Weeds in Southern Ponds



COOPERATIVE EXTENSION SERVICE/THE UNIVERSITY OF GEORGIA/COLLEGE OF AGRICULTURE/ATHENS

Identification and Control of Weeds in Southern Ponds

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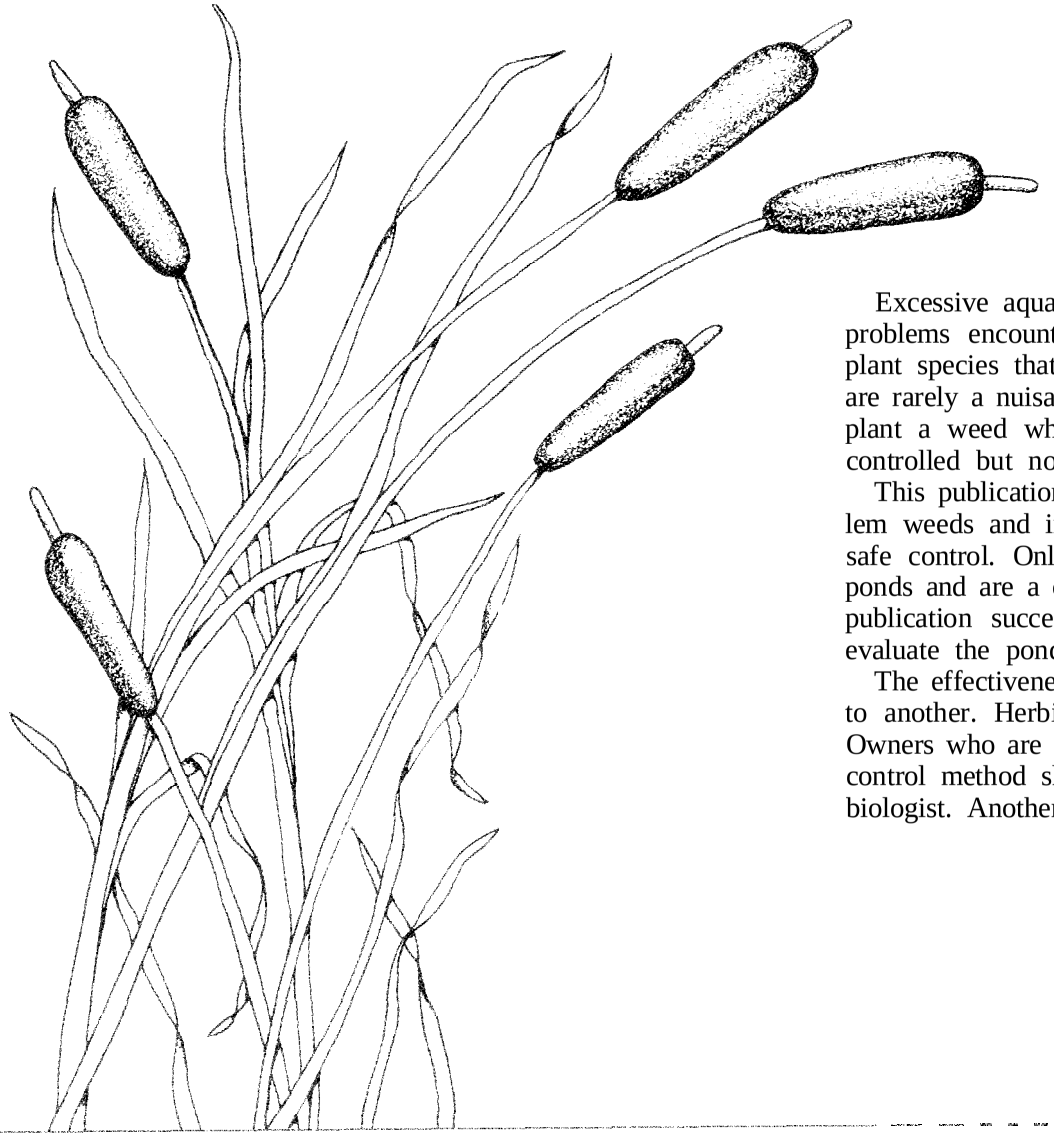

FOREWORD

Excessive aquatic plant growth is one of the most frequent and frustrating problems encountered in pond management. There are hundreds of aquatic plant species that grow in southern ponds. Fortunately, most of these plants are rarely a nuisance to pond management. Some people consider any aquatic plant a weed which must be removed. However, aquatic plants need to be controlled but not eliminated if good pond fishing is the management goal.

This publication is designed to aid the pond owner in identifying the problem weeds and in selecting the best management approach for effective and safe control. Only those aquatic plants which occur commonly in southern ponds and are a common nuisance to management are illustrated. To use this publication successfully observe the following: identify the nuisance weed, evaluate the pond, and select and use the most practical control method.

The effectiveness of control measures can be quite variable from one region to another. Herbicide use is subject to federal, state and local regulations. Owners who are not certain of the identification of the pond weed or the best control method should consult their county Extension agent or state fisheries biologist. Another solution would be to hire a qualified fisheries consultant.

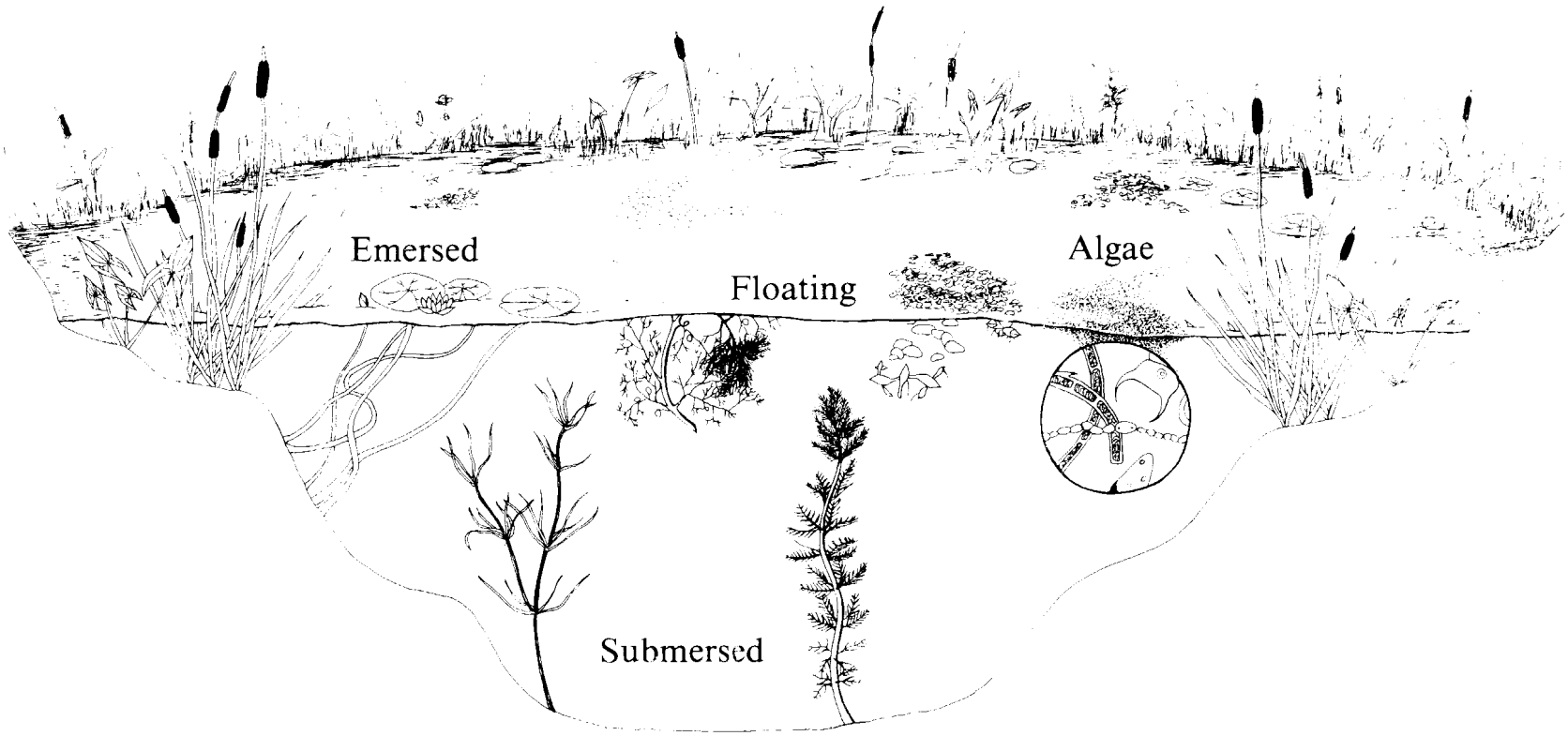

Figure 1 Aquatic Plant Groups

Identifying Common Aquatic Weeds

Aquatic plants are listed in four groups according to the habitats in which they are usually found. The four groups are algae, floating weeds, emersed (above water) weeds and submersed (underwater) weeds. *Figure 1.*

To identify the weed in question, first decide in which group it belongs, turn to that section, and use the illustrations and descriptions to make your decision. Remember, only the more common weeds are described.

ALGAE

These plants occur in most all waters exposed to sunlight. Shape and size vary from microscopic single-celled plants to branched-coarse plants resembling submerged aquatic weeds. Algae, unlike other aquatic plants, do not produce flowers or seeds. Based upon size and shape, algae can be divided into three groups: microscopic (planktonic) algae, filamentous algae, and stoneworts.

Microscopic Algae

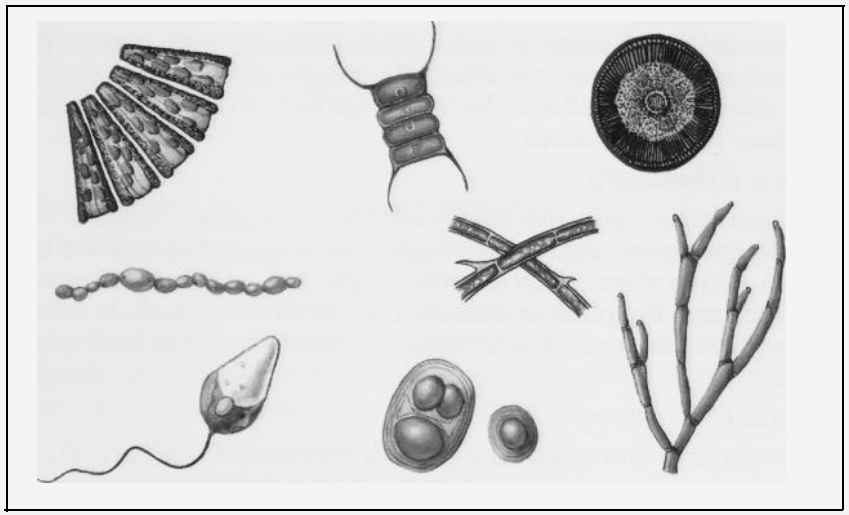

Figure 2 Microscopic (Planktonic) Algae

Microscopic (planktonic) algae are single or multiple-celled plants that cannot be identified without the aid of magnification. *Figure 2.* Specific identification is usually not essential for control. Rather, it is important to recognize the plant group and not the individual species. Most of the microscopic algae respond to the same control measures. They occur in almost all southern ponds.

Figure 3 Microscopic (Planktonic) Algae

These algae are generally beneficial to ponds. They are the beginning of the food chain in a pond, converting nutrients from the water into useable food for insects and fish. Through photosynthesis, they provide dissolved oxygen, essential to life in the pond. Pond fertilization promotes the growth of microscopic algae as evidenced by the green color of the water. *Figure 3.*

There is rarely a need to control these plants in a pond, however, excessive blooms can lead to oxygen depletion and fish kills. Excessive blooms are usually the result of over-fertilization or organic pollution (see section on Pond Fertilization). A few species, especially some of the blue-green algae such as *Microcystis,* can cause fish kills and animal and human health problems. Blooms of these algae occur occasionally and are usually associated with organic pollution. Masses of these plants appear rapidly and make the

water seem like a "soupy" bright green mass on the downwind side of the pond. These plants also give off a foul sewage-like odor and can give an off-flavor to fish caught from the pond. Fish affected by the toxins of this plant act drugged and may convulse. Fish usually show these symptoms only during the daylight hours. A rapid and complete fish kill, although rare, may occur.

Filamentous Algae

Unlike microscopic algae, filamentous algae are frequently a problem in pond management and are usually visible to the naked eye as a floating mat of thread-like filaments often called "pond moss." *Figure 4.* They usually begin growth on the pond bottom in shallow water, later float to the surface and may completely cover the pond surface.

Figure 4 Filamentous Algae

Except for a few species, all filamentous algae control methods are similar. As with microscopic algae, it is more important to recognize the plant group and not the individual species. Various species of filamentous algae occur throughout the southern states.

One group of wide-spread algae which is difficult to control is *Pithophora* spp. *Pithophora* resembles a mass of wet-green wool. *Figure 5.*

Figure 5 Pithophora

Stoneworts

This group of algae is quite often confused with underwater aquatic plants because it is attached to the pond bottom. No part of the plant extends above the water surface. Stoneworts do not produce flowers or seeds.

Chara (*Chara* spp.)

Chara has a distinctive musky odor when crushed. *Figure 6.* It is usually grey-green and has a rough texture caused by calcium deposits on the plant. This branched algae has whorled thread size "leaves" and the plant is anchored to the bottom mud. It occurs throughout the south but is more commonly found in hard water areas.

Nitella (*Nitella* spp.)

Nitella (not illustrated) is similar in appearance to Chara. However, the plant is dark green, does not have a musky odor, and does not have the texture of chara. It is more common in acid or soft-water areas of the south.

Figure 6 Chara

Figure 7 Duckweed and Waterfern

FLOATING AQUATIC WEEDS

Plants in this group float in or on the water and obtain nutrients from the water rather than the soil. They are rarely attached to the pond bottom.

Duckweeds (Family-*Lemnaceae*)

Duckweeds are small floating plants which at a distance can be mistaken for algae. *Figures 7, 8.* Depending upon the species, duckweeds may range in size from microscopic to about 1 inch in diameter. Another plant group similar to duckweed is waterfern (*Azolla* spp.) Leaves of these plants are 0.1 to 0.4 inches wide and overlap one another as scales on a fish.

Water Hyacinth *(Eichhornia crassipes)*

Water hyacinths are quite variable in size, and may range from 3

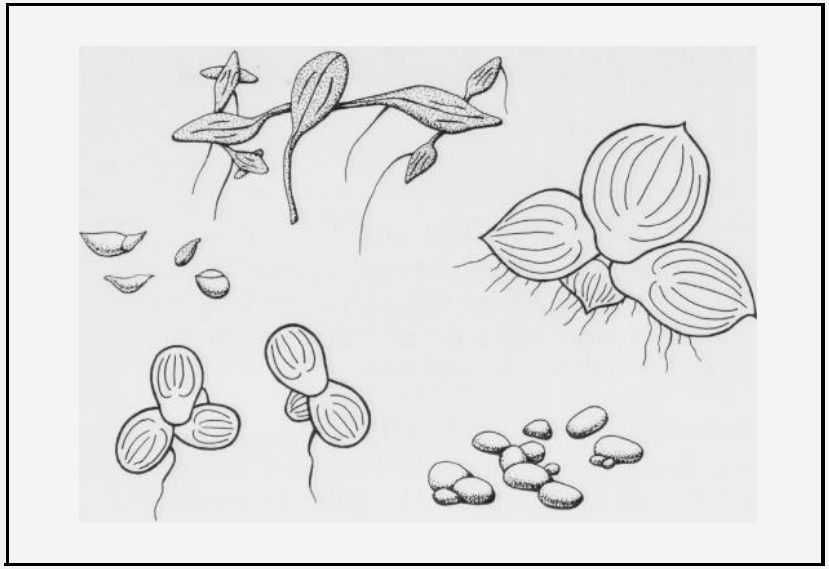

Figure 8 Duckweeds

to 36 inches in height. *Figure 9.* Flowers may be blue, violet, or white and are quite showy. They are occasionally found rooted to the bottom. The plants are a serious problem along the coastal areas of the southeast.

Figure 9 *Water Hyacinth*

Coontail (*Ceratophyllum* spp.)

The common name of this plant is very descriptive of its appearance. *Figure 10.* The leaves are 0.2 to 1.5 inches long in whorls on the stem, becoming more and more crowded near the tip. Coontail is widespread throughout the southeast.

Bladderwort (*Utricularia* spp.)

Bladderworts are identifiable by small bladders produced randomly on the plant. *Figure 11.* Leaves have many fine thread-like segments. Although bladderworts are rootless plants, stems are sometimes attached to the bottom. Flowers of many species are yellow and grow above the water surface. *Figure 12.*

Figure 10 *Coontail*

Figure 11 *Bladderwort*

Figure 12 *Bladderwort Flower*

EMERSED (above water) AQUATIC WEEDS

Plants in this group are rooted to the bottom but have several leaves or parts which extend above the water surface. Some of the plants in this group may grow in water 10 feet deep; most are shoreline or shallow water plants.

Waterlilies

Although not all the plants in this group are true waterlilies, they are often confused with waterlilies. This group of plants may also be called lily pad, cow lily, spatterdock and lotus. They are all rooted plants with floating leaves.

American Lotus (*Nelumbo lutea*)

American lotus leaves are large and circular, 8 to 25 inches in diameter. *Figure 13.* The center of the leaf is depressed, forming a cup. Leaves produced early in the season float on the water surface and as the stem grows, the leaves become suspended above the water. The flower is pale-yellow and about 8 to 10 inches in diameter. *Figure 14.* Seeds are produced in a large distinctive fleshy receptacle which is yellow as the flower opens, then turns green and later, dark brown. Unlike other waterlilies, American lotus does not have a split or notched leaf.

Figure 13 *American Lotus*

Figure 14 *American Lotus Flower*

Fragrant and White Waterlily (*Nymphaea* spp.)

Leaves of the true waterlilies are split or notched and are usually 6 to 8 inches in diameter. Fragrant waterlily, *Figure 15,* can be readily distinguished from white waterlily by its sweet-scented white or pink flowers. Flowers of white waterlily have little or no fragrance. Leaf veins of fragrant and white waterlilies originate from the leaf center and extend to the margin in a fan-like pattern. *Figure 17.*

Figure 15 Waterlily

Spatterdock (*Nuphar luteum*)

Spatterdock is also known as pond lily, cow lily, and yellow waterlily. *Figure 16.* Leaves vary from nearly round to lance-shaped and have a deep notch. The flower is yellow and shaped like a ball. Spatterdock can be distinguished from fragrant and white waterlily by the pattern of its leaf veins. *Figures 17, 18.* Spatterdock leaf veins originate from a main lateral vein and are not fan like. *Figure 18.*

Watershield *(Brasenia schreberi)*

Watershield may also be called dollar bonnet. *Figure 19.* The plants have floating oval or elliptical leaves 1 to 4 inches in size. Stems and the undersides of leaves are coated with a thick layer of gelatin-like material. This gelatinous material interferes with the uptake of some chemical treatments.

Figure 16 Spatterdock

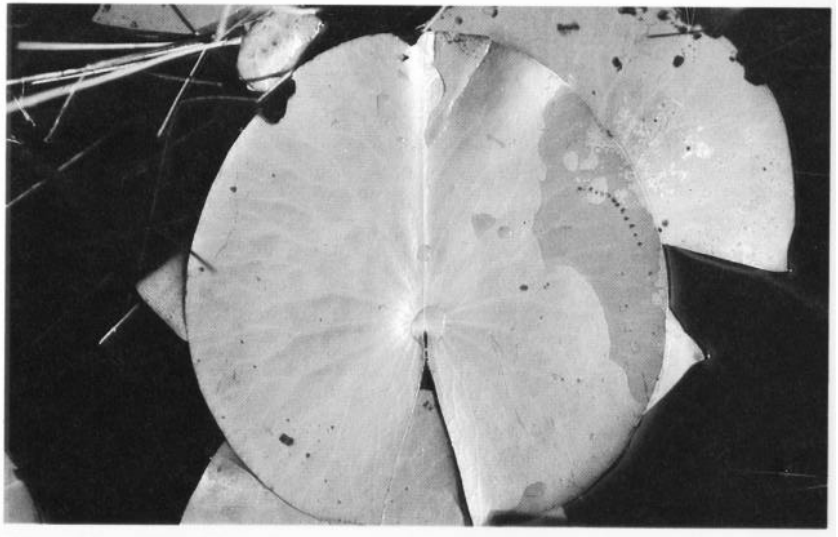

Figure 17 Waterlily Leaf

Water Pennywort (*Hydrocotyle umbellata*)

Water pennywort is usually found growing in water less than 2 inches deep. *Figure 20.* Dense stands may occasionally break loose and float in deeper water. Leaves are nearly round and are 0.5 to 1.2 inches in diameter.

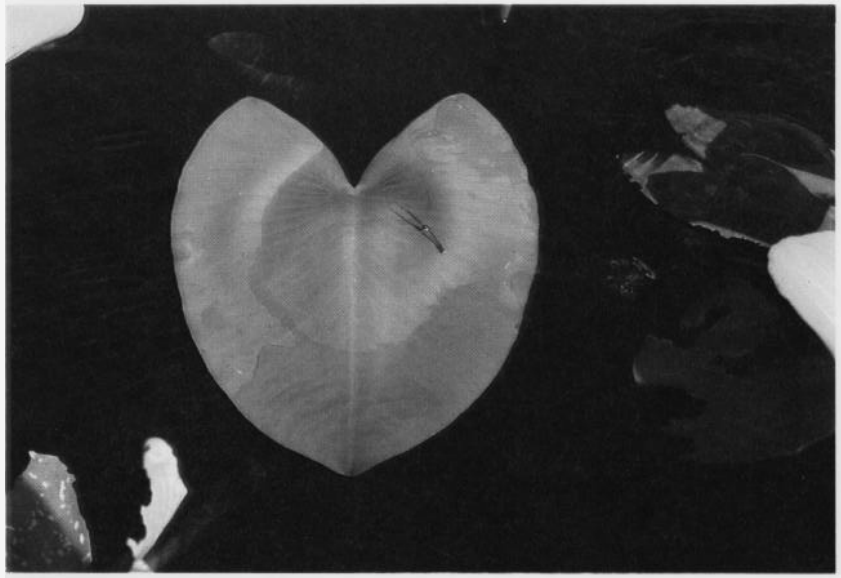

Figure 18 *Spatterdock Leaf*

Figure 19 *Watershield*

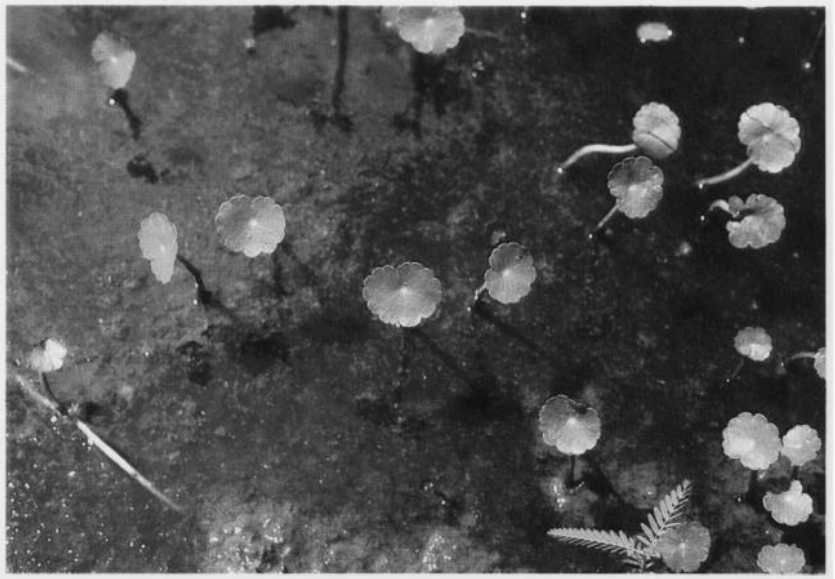

Figure 20 *Water Pennywort*

Frogbit (*Limnobium spongia*)

Frogbit has 2 leaf forms. The floating or underwater leaves are heart-shaped and have a deep notch. *Figure 21.* The underside of the leaf is thick in the center and spongy. *Figure 22.* The out-of-water leaves are also heart-shaped but not as thick in the center or deeply notched and have a leathery feel. Frogbit may be found either growing rooted to the bottom mud in shallow water or floating on the water surface. It usually grows three inches or less in height.

Pickerelweed *(Pontederia codata)*

Pickerelweed usually grows in shallow water areas and is more common in the coastal areas of the southeast. *Figure 23.* Leaves grow in clusters 2 to 6 inches wide and 4 to 12 inches long. The flowers are violet-blue in color.

Alligatorweed *(Alternanthera philoxeroides)*

Alligator weed grows in a wide range of soil and water conditions. *Figure 24.* Growing plants usually form an interwoven mat which may be free-floating, rooted and above water, or in a dry field. It is

Figure 21 *Frogbit*

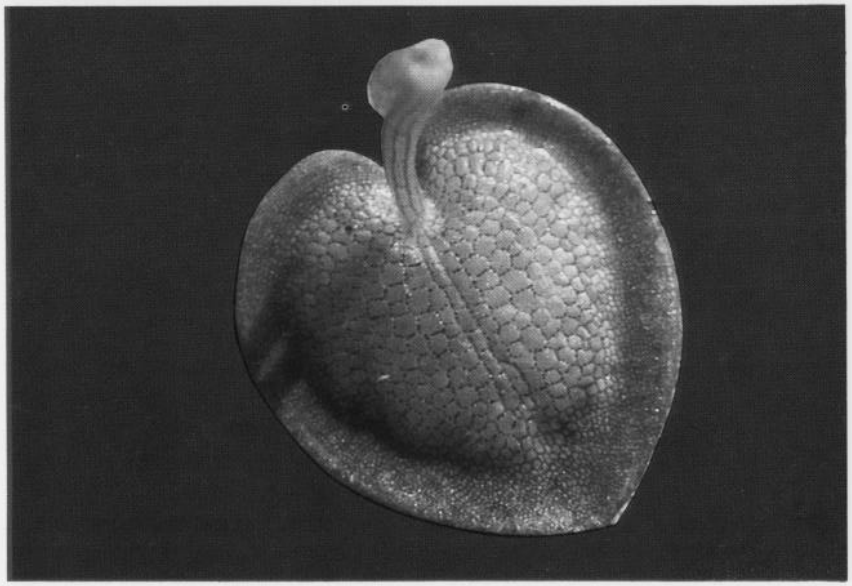

Figure 22 *Frogbit—Underside of Floating Leaf*

Figure 23 *Pickerelweed*

more common in the coastal areas. Leaves are 2 to 5 inches long, lance shaped, and have a distinct mid-rib. Flowers are white.

Smartweed (*Polygonum* spp.)

Smartweed is a shallow water plant. *Figure 25.* Each joint or node is covered by a thin white to brown sheath. Leaves are linear or elliptic and alternate. Flowers are white, pink, pinkish-white or green.

Arrowhead (*Sagittaria* spp.)

Arrowhead is a shallow water plant. *Figure 26.* Leaf shapes are highly variable; however, they are usually in the shape of an "arrowhead". Leaves are usually above the water, but they may be under the water or floating.

Water Primrose (*Jussiaea* spp.—*Ludwigia* spp.)

Water primrose grows along the shoreline and in shallow water areas. *Figure 27.* Leaves are light green, about 3 inches long, and lance-or-oval shaped. Stems may appear reddish-green. Flowers are bright yellow, about one inch in diameter and have 5 petals.

Figure 24 *Alligatorweed*

Figure 25 *Smartweed*

Figure 26 *Arrowhead*

Figure 27 *Water Primrose*

Cattails (*Typha* spp.)

Cattails usually grow along the shoreline and are sometimes found in water 3 to 4 feet deep. *Figure 28.* Plants may attain a height of 6 to 8 feet. Leaves are about 1 inch wide and ribbon shaped. Flowers are produced on the end of stalks in cylindrical clusters, whence the name "cattail".

Figure 28 *Cattail*

Sedges and Rushes

There are many species of rushes and sedges in the southeast. Few of them are ever a problem in pond management. Examples of some members of this family are illustrated. *Figure 29.*

Figure 29 *Rushes*

One species, slender spikerush (*Eleocharis acicularis*), is a major problem in some southeastern ponds. *Figure 30.* Slender spikerush plants are small and hair-like varying from 2 to 6 inches long. Leaves arise from the base of the plant in tufts. Plants grow along the bottom, but may break away and form living floating mats.

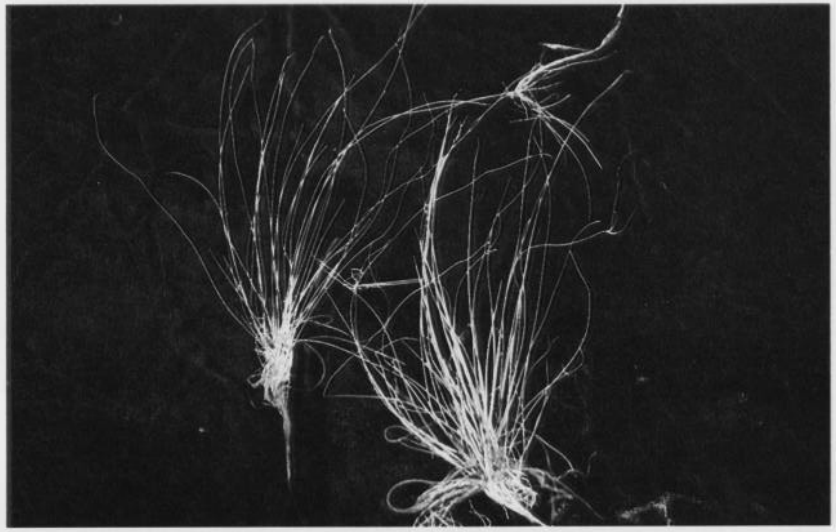

Figure 30 *Slender Spikerush*

Woody Plants

There are a large number of woody plants that may grow along the edges of a pond which are potential problems to pond management. There are 3 species in the southeast that are a common problem; buttonbush *(Cephalanthus occidentalis)*, willows *(Salix* spp.*)* and alders *(Alnus* spp.*)*

Buttonbush

Buttonbush is a small to medium sized shrub. *Figure 31.* The flowering heads of this shrub resemble buttons at a distance. Leaves are whorled, 2 to 6 inches long, elliptic or oval-shaped, and coarse-textured.

Willows

Willows are large shrubs or trees with alternate leaves which are several times longer than wide. *Figure 32.* The leaves are usually toothed on the margin. The wood is soft and light and the bark is aromatic but has a bitter taste.

Figure 31 *Buttonbush*

Figure 32 *Willow*

Alders

Alders are large shrubs or small trees whose alternate leaves are coarse-textured, heavy veined, and toothed. *Figure 33.* Flowers occur in clusters and resemble small pine cones when mature.

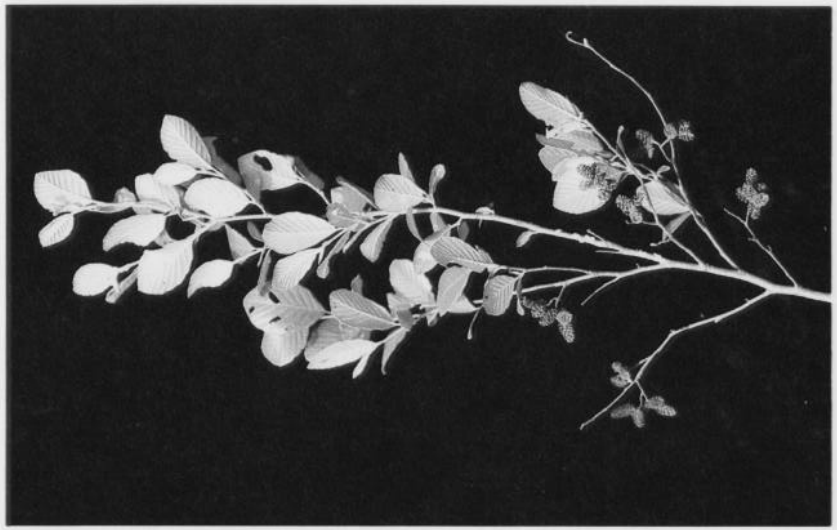

Figure 33 *Alder*

Grasses

There are many grass species that can be a management problem in ponds. Maidencane (*Panicum hemitomon*) and southern watergrass *(Hydrochloa caroliniensis)* are probably the most common and difficult to control.

Figure 34 *Maidencane*

Maidencane

The stalks are long and narrow. *Figure 34.* Stems may be 3 to 8 feet tall growing in up to 2 feet of water. Leaf blades are 4 to 10 inches long and 0.2 to 0.6 inches wide. Leaves are rough on the upper surface and smooth on the under surface.

Southern watergrass

Stems are branched and the underwater portion is usually leafless. *Figure 35.* Floating leaf blades are 2 to 4 inches long and 1/8 to 1/4 inch wide.

Figure 35 Southern Watergrass

SUBMERSED (underwater) AQUATIC WEEDS

Plants in this group grow under and up to the water surface. Some submersed plants have seed heads which extend above the surface and may be confused with emersed plants. However, unlike emersed plants most submersed weeds are dependent upon water for support. When submersed plants are removed from water they may be limp and unable to support themselves in an upright position.

Submersed weeds can be the most difficult group to identify and control, yet are some of the most common weeds interfering with pond uses.

Naiads (*Najas* spp.)

This group of plants, also known as bushy pondweed, is very common in the southeast. The margins of the leaves have a "saw-tooth" appearance but in some species these teeth are barely visible without magnification. Leaf size and appearance can vary with different species from a small threadlike (0.4-1.5 inches long and 0.1 inches wide) shape to a broader saw-like shape (0.4-1.5 inches long and 0.6-2.0 inches wide). The leaves occur opposite and some species have 3 leaves in each whorl.

One of the most wide spread species is southern naiad. This plant is dark green to purple-brown in color. Leaves are 0.3 to 1.8 inches long and 0.2 to 0.3 inches wide. Marginal teeth on the leaves require magnification to be seen. Leaves are usually opposite or in whorls. *Figure 36.*

Figure 36 Naiad

Watermilfoil (*Myriophyllum* spp.)

There are several species of *Myriophyllum* common to the southeast. Generally, this group of plants can be confused with emergent (above water) plants. In some species, the tip may extend 3 to 12 inches above the water. Also, above water leaves may appear to be different from underwater leaves. In all species, underwater

leaves are "comb-like" or "feather-like" in appearance and are whorled. Three species are a common management problem in southeastern ponds.

Parrotfeather (M. brasiliense)

Parrotfeather is rooted to the bottom but may extend 3 to 12 inches above the water surface. *Figure 37.* Underwater the stem is quite stout with leaves arranged in whorls with relatively long internodes. Each leaf is 0.8 to 2 inches long and has 10 to 18 narrow comb-like teeth on each side of the mid-rib. Above water, leaves are compacted on shorter internodes and are more delicate in appearance. Above water, leaves are also whorled and vary from yellow to green in color. Parrotfeather is found in most areas of the south.

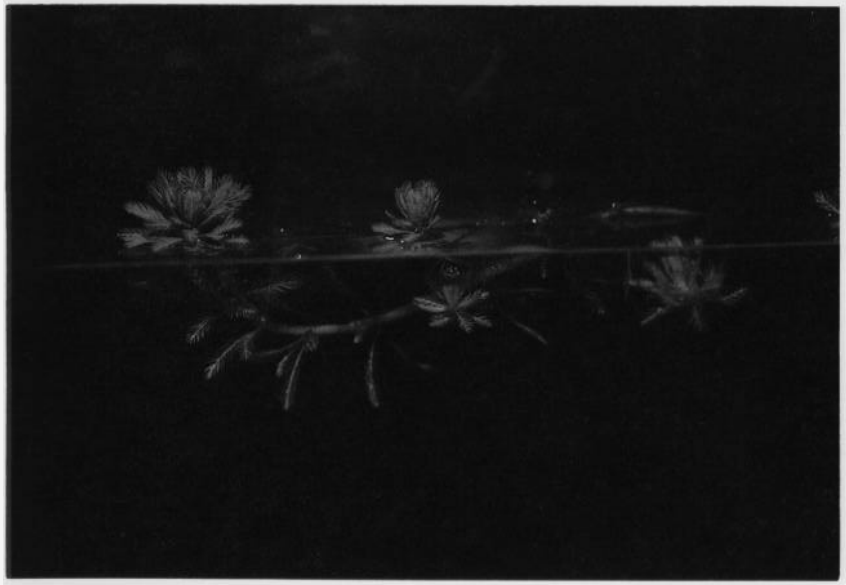

Figure 37 Parrotfeather

Eurasian Watermilfoil (M. spicatum)

This species is primarily a problem in the coastal areas of the southeast. *Figure 38.* This plant is apparently spreading throughout the southeast. The underwater leaves look like weather beaten feathers and are whorled. The above water tip has no leaves and may be 2 to 4 inches long.

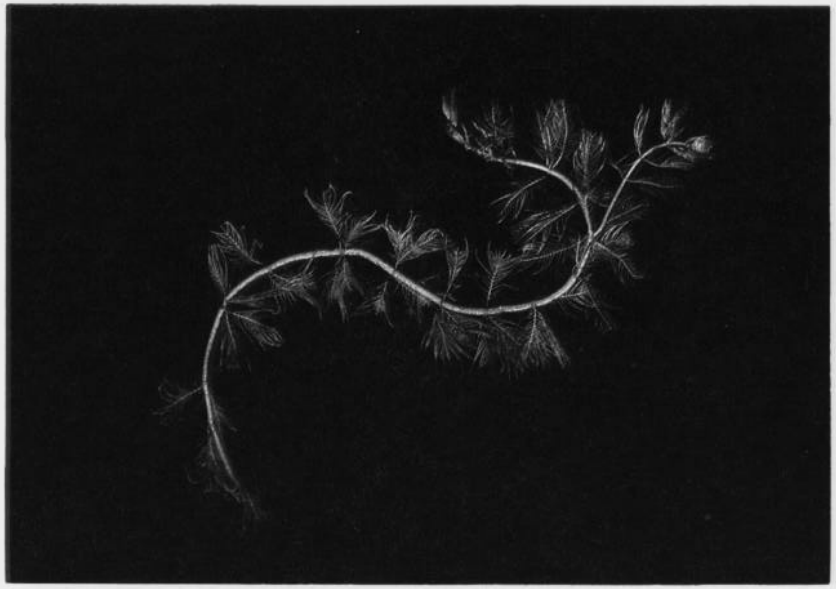

Figure 38 Eurasian Watermilfoil

Broadleaf Watermilfoil (M. heterophyllum)

Broadleaf watermilfoil (not illustrated) is more coarse in appearance than parrot feather. Underwater leaves are also whorled and sparse. Above water, the spike may be 2 to 6 inches long. Leaves are also whorled above water but do not have a feather-like appearance. They may be 0.2 to 1.2 inches long and are serrated along the edges.

Elodeas

Included in this group are hydrilla (*Hydrilla verticillata*), egeria or Brazilian elodea (*Egeria densa*) and elodea (*Elodea canadesis*). Hydrilla is a significant problem in Florida and is becoming established in many of the other southern states. *Figure 39.* Egeria is also more common in Florida but is also established in other areas. *Figure 40.* Elodea is more common to northern and midwestern states and is occasionally found in the southeast.

Hydrilla is a serious threat to fresh water habitats and for this reason it should be distinguished from egeria. The midrib of hydrilla leaves may be red. Leaf margins have strong serrations and large soft spines on the back of the midrib. Usually hydrilla has a harsh

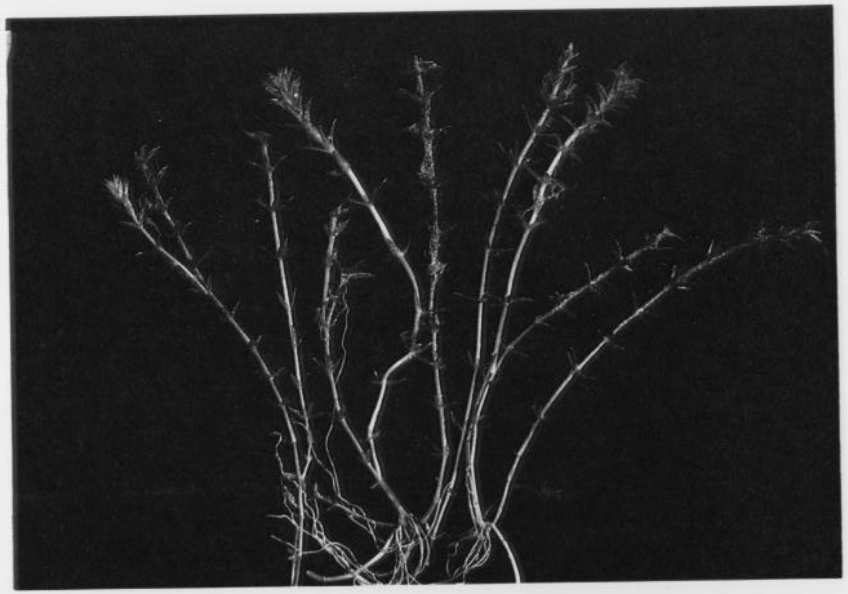

Figure 39 *Hydrilla*

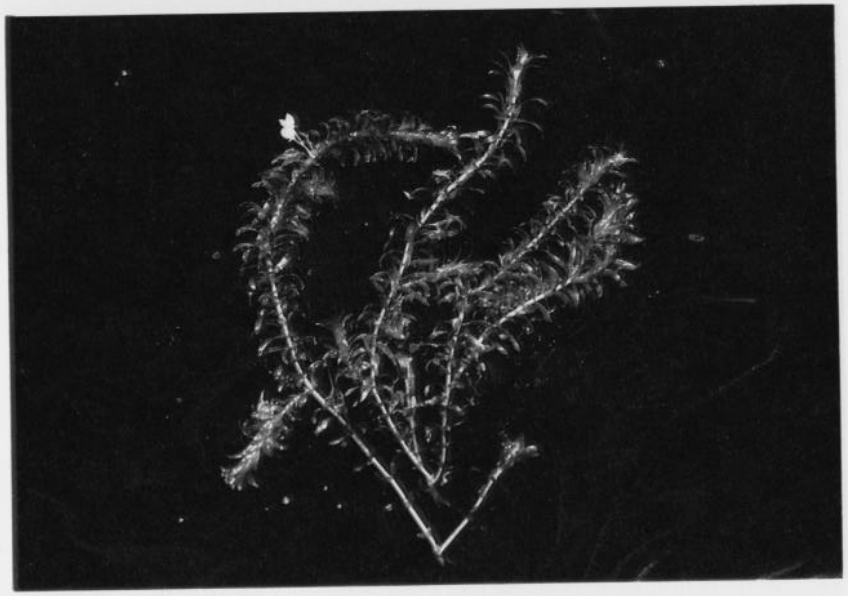

Figure 40 *Egeria*

scratchy texture while egeria lacks these characteristics. Hydrilla is very difficult to identify because of the variable characters it has in different habitats. Any aquatic plant identified as egeria, elodea or hydrilla should be sent to a specialist *for positive identification* since hydrilla is such a serious threat to fresh water habitats. It is only through early identification and concentrated control methods that there is any hope of eliminating hydrilla.

Fishermen or boaters in waters known to have hydrilla should made every effort not to accidently transport hydrilla from one lake or pond to another.

Fanwort (*Cabomba* spp.)

The submersed leaves of fanwort are "fan-like" in shape and made up of many threadlike elements. *Figure 41.* The stem may be covered with a gelatinous material. The floating leaves are few and of different shapes. Floating leaves may be long and narrow or oval in shape. Fanwort is found in most areas of the southeast.

Pondweeds (*Potamogeton* spp.)

Pondweeds are the largest group of aquatic plants. *Figures 42, 43.* Different species are quite varied in their appearance. Some

Figure 41 *Fanwort*

members of this group are very difficult to control. In many species, the leaves are usually alternate and the underwater leaves are often ribbon-like and less firm in texture than the floating leaves. The flowers and fruits are on spikes extending above the water surface. Leaves may vary from thread-like to large oval-or lance-shaped.

Figure 42 Pondweed

Figure 43 Pondweed

Pond Evaluation

Evaluating a pond is a simple, critical, and often overlooked step in the successful control of aquatic weeds. An evaluation of the pond will help the owner select and apply the most efficient, effective, and economical control measure. A pond evaluation should include the following: an inventory of pond water and watershed uses; an appraisal of the physical conditions of the pond and watershed; knowledge of some of the water chemistry; and the pond water volume.

POND AND WATERSHED USES

Most pond owners already know the various uses of their pond and watershed. However, pond and watershed uses need to be considered when attempting to control aquatic weeds. This is especially true if herbicides are used. For example, aquatic herbicides applied to a pond used for irrigation may have a disastrous effect upon the irrigated crops. In most instances a conflicting water use, such as irrigation, can be temporarily stopped until the herbicide has dissipated from the water. In other situations, this may not be practical and an alternative control measure should be used.

If herbicides are used, water uses should be compared to restrictions listed on the label. Some water uses which may interfere with aquatic weed control are: irrigation, boating, swimming, watering livestock, sportfishing and commercial fish production.

PHYSICAL CONDITIONS

Various physical conditions may contribute to an aquatic weed problem or interfere with attempts to control it.

Ponds which have extensive areas of shallow water or receive organic runoff usually have aquatic weed problems. Attempts to control weeds in these ponds are usually unsuccessful unless the pond is deepened or the source of organic runoff is removed or diverted around the pond. Deepening a pond or eliminating organic runoff can be considered control methods and are discussed in the "Methods of Aquatic Weed Control" section.

Excessive amounts of water flowing through a pond can interfere with aquatic weed control. Ponds which are constructed on constantly flowing streams, or have an excessively large watershed,

or have a large number of springs can be difficult to manage for aquatic weeds. Excessive water flow may interfere with the following weed control measures: fertilization, herbicides, and fall-winter drawdowns.

POND WATER CHEMISTRY

When controlling aquatic weeds with herbicides or fertilizer, it is important to know something about the chemistry of the water in the pond. Water hardness can affect herbicide and fertilizer applications. The water hardness also should be considered when using herbicides containing copper.

Water hardness-Generally, water hardness is a measure of the calcium and magnesium in the water. In hardwaters (above 50 parts per million hardness) it may be necessary to apply greater amounts of herbicide in order to achieve control. In softwaters (below 50 parts per million hardness) some herbicides are more toxic to fish and plants. Herbicides which may be affected by water hardness have precautions listed on their labels. Water hardness is also an indicator of the lime requirement for the pond. See section on Pond Fertilization.

Many areas of the south have softwater. Pond owners should be familiar with the water hardness of their pond. Pond water hardness can be measured by most state Extension services or state game and fish departments.

Copper-In softwater some heavy metals, especially copper, can be toxic to fish. Some herbicides contain copper and should be used with caution in softwater ponds (less than 50 parts per million water hardness).

POND WATER VOLUME

Pond owners should know the water volume of their ponds. Most chemical application rates are based upon water volume. This is true for chemicals used to treat aquatic weeds, fish diseases, and oxygen depletions.

The volume of water in a pond is usually expressed in acre-feet. An acre-foot of water is one surface acre that is 1 foot deep. A pond having three surface acres and an average depth of 6 feet has a total water volume of 18 acre-feet. Table 1 can be used to convert acre-feet to other expressions of volume and weight.

Most county Soil Conservation Service offices can assist pond owners in determining the water volume of their ponds. Assuming the surface area of the pond is known, the following method can be used to determine the average depth of a pond.

Average depth can be determined by use of a sounding line at regular intervals along several transects of the pond. Both deep and shallow areas of the pond should be included in the transects. Average depth is computed by adding all of the depth measurements and dividing by the number of measurements. The average depth multiplied by the surface area should give an accurate estimate of the pond water volume.

Table 1. Equivalents of 1 acre-foot and amount of chemical added per unit volume **to give one part per million (ppm) (Conversion Factor).**

1 acre foot = **43,560** cubic feet **325,830 gallons of water** 2,718,144 **pounds of water**	1 ppm = 2.72 pounds per acre foot

Methods of Aquatic Weed Control

Methods of aquatic weed control include preventive measures, mechanical, biological, and herbicidal controls. Each method has advantages and disadvantages. The best approach is to consider preventive measures first. If they are not practical or do not produce the desired results, then other control methods should be considered. It is always easier and more economical to prevent a weed problem than to cure one. Even when preventive measures are only partially successful, they quite often facilitate the effectiveness of other control measures.

PREVENTIVE MEASURES

Preventive measures include proper pond location and construction, fertilization and fall-winter drawdowns. If one or all of these practices were followed, the need for herbicide use in many southern ponds would be reduced.

Pond Location

Careful selection of a pond site can help prevent weed problems. A flowing stream is not a good location for the construction of a pond. Excessive water flow will prevent successful fertilization and complicate herbicide applications. This is also true of ponds with

excessive watershed-to-pond surface area ratios. The recommended watershed-to-pond ratio depends on land use, vegetative cover, soil type, and slope of the land. Generally, a watershed of 10 to 20 acres per surface acre of pond is recommended for woodland, while 5 to 10 acres is recommended for pastureland.

Construction of ponds in watersheds that have highly fertilized fields, barnlots, septic tank fields, or other sources of organic runoff should be avoided. Enrichment of a pond with organic material will promote weed growth. Existing ponds with excessively large watersheds or sources of organic pollution in the watershed may benefit from the construction of a diversion ditch to direct some of the runoff around the pond.

Pond Construction

Most algae and submersed and emersed rooted aquatic weeds usually start growing in shallow water 2 feet deep or less. Once established, they will often extend into deeper water areas. Ponds should be constructed so there is little if any water less than two feet deep. In existing ponds it may be practical to deepen shallow water areas.

Fertilization

In properly constructed ponds, establishment and growth of aquatic weeds is best prevented by fertilization. Fertilization stimulates the growth of desirable algae so sunlight cannot penetrate to the bottom and rooted aquatic weeds cannot become established. *Figures 44, 4.5.* In ponds with established aquatic weeds, these plants generally die down during the winter. If fertilization is begun before weeds begin spring growth, in most instances they will not become re-established.

If fertilization is begun after weeds have become established, fertilizer will be taken up by the weeds. This will produce heavier weed growth. Fertilization should begin as early as possible in spring before weed growth starts. Herbicidal treatment of a weed problem in the spring followed by a fertilization program is often a good weed control measure.

In some areas of the southeast, pond fertilization may not be recommended or recommendations described below may be modified because of area differences in watershed uses and fertility. For local fertilizer recommendations, consult your county Extension agent or state game and fish personnel.

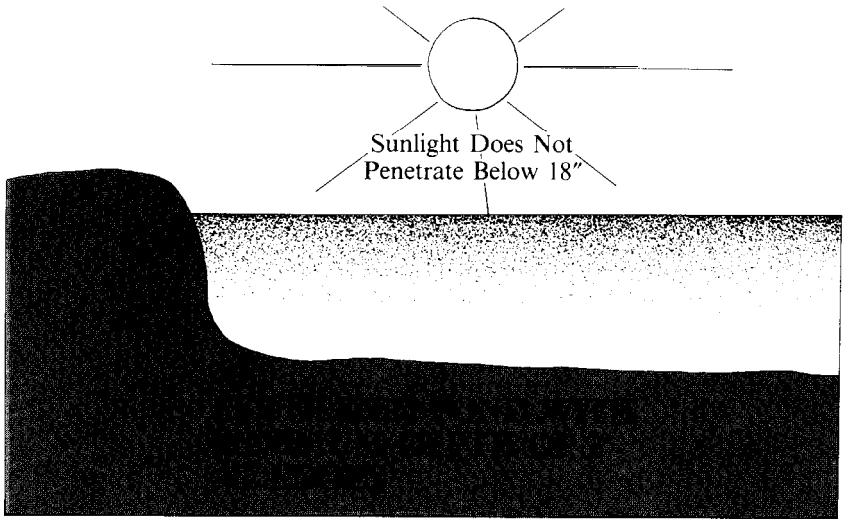

Figure 44

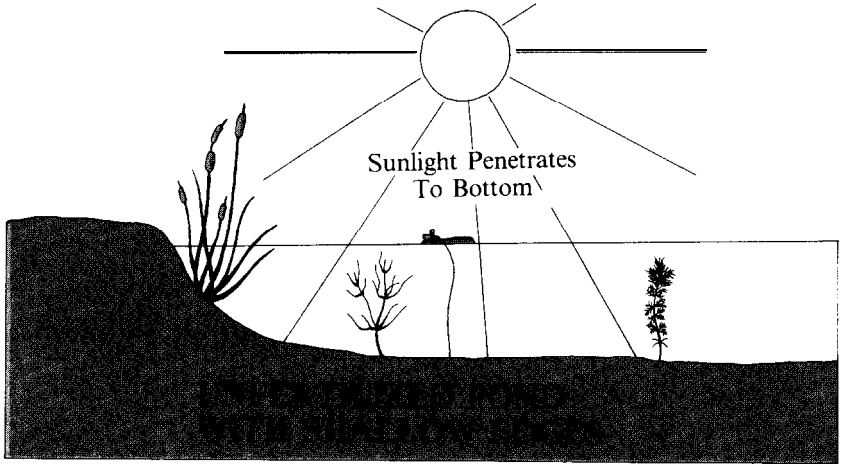

Figure 45

Fertilization Procedures

Begin fertilizing with 40 pounds of 20-20-5 per surface acre in late February or early March when water temperature stabilizes above 60°F. If after two weeks you can see a bright object more than 18 inches beneath the surface, proper water color resulting from plankton algae growth has not been developed. Fertilize again at the same rate. If proper color does not develop following the third application, test the pond for lime requirements.

Proper color can be maintained by fertilizing with 40 pounds of 20-20-5 per surface acre when a bright object can be seen more than 18 inches into the water. Fertilization will probably be necessary about once a month. Stop fertilization when water temperature stabilizes below 65°F. This is usually in October or November.

Method of Application

The most economical method of application is to pour the fertilizer on a platform constructed 12 to 18 inches below the water surface. *Figure 46.* There should be at least three square feet of platform for each surface acre in the pond. Fertilizer placed on platforms will dissolve slowly in the upper layer of water where desirable algae production occurs and be distributed by wind. Locate the platform 10 to 15 feet from the shore so the fertilizer will receive maximum wind distribution.

Other acceptable methods of application include: broadcasting fertilizer by hand in shallow water less than four feet deep, or pouring it in a line 15 feet from shore in shallow areas, or slitting fertilizer bags and placing them in shallow water.

LIMING-Lime is necessary for plant production in ponds as it is on fields. Softwater ponds should be limed before fertilization can be effective in producing a bloom of desirable algae. Many southern ponds should be limed every two to four years. Liming requirements can be determined by your county Extension agent or state game and fish personnel.

Agricultural lime is used for liming ponds. Although agricultural lime may be added at any time, it takes about three months for it to go into solution. Lime should be distributed throughout the pond during fall so it will be in solution the following spring when fertilization begins.

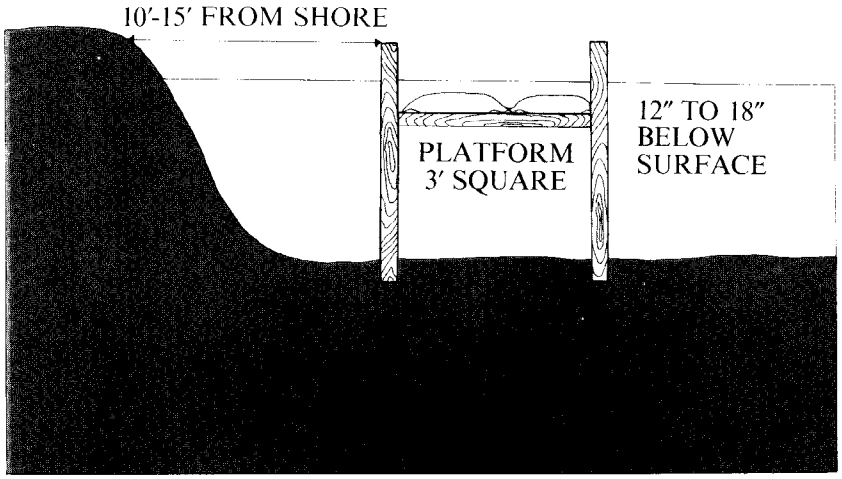

Figure 46 Fertilizer Platform

Fall-Winter Drawdown

Decreasing the water level of a pond is called a drawdown. Drawdowns are beneficial in controlling weeds and correcting mildly crowded bream populations. If a drawdown is used for two or four consecutive years, as much as 90 percent of the submerged vegetation in a pond can be eliminated. Drawdowns expose the shallow areas of a pond to winter weather and drying, thus eliminating some of the weeds. *Figure 47.* A pond should be drawn down in November and this lowered water level maintained until spring (February or March). Drawdowns should never be used in warm weather months or in ponds smaller than one surface acre. The pond water surface area should be reduced at least one-third and not more than one-half.

MECHANICAL METHODS

Some rather sophisticated machines have been developed to control aquatic weeds. These machines either cut or drag weeds from a pond. Unfortunately their operation is expensive and not practical for most privately owned ponds. Seining or raking weeds

Figure 47 Fall-Winter Drawdown

out of the water can be an effective control method in small ponds. Because of the labor involved, it is not practical in larger bodies of water. Seining or raking weeds can be used to temporarily clear small shallow bays or beach areas in large ponds.

Sun screening or shading materials have been used to successfully control weeds in some ponds. These materials either restrict or shade-out plant growth. Generally, their use is not practical in large ponds. Black plastic sheeting, for example, can be spread out and weighted down on the bottom in a swimming beach area to control submersed weeds. This plastic should be left in place for about two weeks in order to achieve temporary control.

BIOLOGICAL METHODS

Biological controls of aquatic weeds are a new and promising development in pond management. A biological control is some living agent, whether it be fish, insect, or bacteria, which is harmful to and attacks the nuisance aquatic plant. Most biological agents are organisms which are not native to this country and thus must be studied to determine whether they may have any negative effects upon the environment prior to release.

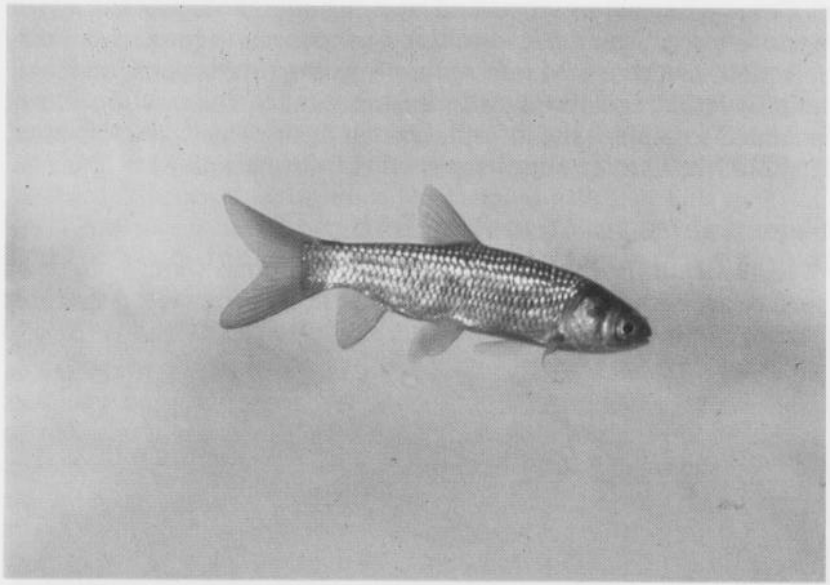

Figure 48 Grass Carp

In a few southern states, the grass carp or white amur (*Ctenopharyngodon idella*) is being used to aid in control of aquatic weeds. *Figure 48.* The grass carp is not a native fish to this country. The use of grass carp for aquatic weed control is presently highly controversial. It is the general opinion of many biologists that the grass carp is a potential hazard to our native fish and waters and not enough information is available to recommend its use. In most states it is illegal to stock this fish. Do not stock grass carp in ponds in states where their use is prohibited. And, never stock the fish without first consulting with state game and fish department personnel or a qualified fisheries biologist.

CHEMICAL METHODS

Aquatic herbicides are safe and effective if they are selected and applied properly. Choosing the right herbicide does not guarantee success. It must also be applied properly and all warnings and precautions concerning use should be understood and observed. Fortunately, all of this information is on the herbicide label. Anyone who uses an aquatic herbicide *should always thoroughly read and understand the herbicide label* before purchasing and applying the chemical.

County Extension agents and state fisheries biologists can advise pond owners who have questions concerning aquatic herbicide selection, methods and rates of application, precautions, and state and Federal regulations. The information in this section is not intended to replace the information on the herbicide label. Rather, it should be used to supplement label information.

Selection of an Aquatic Herbicide

Identification of the weed, knowledge of pond water volume or surface area, and water uses will help the pond owner select the most effective and economic aquatic herbicide.

WEED IDENTIFICATION-No single aquatic herbicide is capable of controlling all kinds of weeds that are potential problems in the management of a pond. For this reason, it is important to identify the weed before attempting to control it with a herbicide. Herbicide labels list the aquatic weeds which will respond to treatment with that particular herbicide. Table 2 lists the aquatic weeds described in this publication and the herbicides which are usually effective in their control.

POND WATER VOLUME AND SURFACE AREA-Herbicide application rates are determined either by the pond's water volume or by surface area. Most herbicide labels list application rates according to one or the other of these measures. Some herbicide application rates will vary depending upon the weed species and the extent of infestation. Prior knowledge of the pond's water volume and surface area will aid in the selection of the most economical herbicide and insure the proper amount is purchased and applied.

POND WATER USES-Restrictions and cautions of herbicide use will vary depending upon the herbicide. This information is on the herbicide label. If pond water uses are not compatible with the restrictions and cautions listed for a specific herbicide, an alternate herbicide should be selected, or another aquatic weed control measure used.

Herbicide Application

It is not enough to select the right herbicide. The herbicide must also be applied properly. The herbicide applicator must be knowledgeable of the herbicide formulation, methods and rates of application, precautions and warnings, and other information specific to the herbicide.

FORMULATION--Herbicide formulations vary in the amount of active ingredients present. The active ingredients actually are the chemicals which kill the pest or weed. Inert ingredients are added to improve the convenience, safety, and handling of the herbicide.

Herbicide application rates are based upon the active ingredient in the herbicide formulation. This is one reason why it is always important to determine herbicide application rates from information printed on the label.

METHODS OF APPLICATION-Some herbicides can be applied directly from the container (ready for use) and others need to be diluted with water or some other diluent before application. ***Always*** *follow label directions.*

Dispersion of the herbicide is also important. In small ponds, for shoreline areas or "spot treatments," many of the herbicides can be applied by simply broadcasting the chemical over the area. Most of the granular formulations can be scattered directly. In small areas, some liquid formulations can be poured over the area but others need to be diluted and may be applied with a sprinkling can.

Treatment of large areas usually require the use of mechanical sprayers or spreaders and a boat with an outboard motor to insure that the chemical is adequately dispersed. Most aquatic herbicides can be applied with a hand operated seeder, pressurized sprayer, or boat bailer. Injecting the chemical near the outboard motor prop-wash will help in dispersion.

Some herbicides are "contact killers," that is, they must come into direct contact with the plant. For this reason, contact herbicides must be evenly dispersed in or on the water to have maximum effectiveness. Other herbicides must be absorbed by the plant to be effective and are called "translocated" herbicides.

The following can be used as general guidelines for the application of herbicides to the four aquatic weed groups:

ALGAE-Since algae is usually dispersed throughout the body of water, control usually requires treatment of the total volume of water. Exceptions to this are treatments of floating (filamentous) algae mats which may be spot-treated, or treatment of small portions of the pond at two week intervals. The two week interval is necessary to reduce the possibility of a fish kill which may be caused by oxygen depletion resulting from the decomposition of dead plants.

FLOATING WEEDS—Control of floating weeds usually requires a surface spray application, as the least expensive method, as compared with treatment of the total volume of water.

EMERSED (above water) WEEDS—Control of emersed weeds may permit a choice of methods, depending upon the specific weed. If a large portion of the leaf area is above water, surface spray applications may be the most effective and least expensive method. Application of aquatic granules or pellets may also be substituted, but this is usually more expensive. Treatment of other weeds may permit gravity flow application, where the undiluted herbicide is poured slowly into the pond from a boat propelled across the surface in a regular pattern. Wind and water currents disperse and dilute the herbicide to the desired concentration.

SUBMERSED (underwater) WEEDS—Control of submersed weeds is not usually practical with surface spray applications. Gravity flow application is sometimes utilized but may be wasteful of herbicide. Herbicides are more effective in an aquatic situation if placed close to the root system or leaf area of the plant. Granule or pellet formulations are more frequently used to accomplish this.

Another variation is the use of specialized equipment, used by commercial applicators, which places liquid herbicides in the "bottom acre-foot" of water near the site of uptake by the plant. The greater specific gravity of the herbicide holds the treatment in higher concentration near the plant for improved control.

RATES AND TIME OF APPLICATION—If it is necessary to use aquatic herbicides in the management of a pond, it is best to apply them in the spring or early summer. Most aquatic herbicides can be effectively applied when water temperatures are above 55° F or when aquatic weeds show signs of new growth. Advantages of spring or early summer treatment are:

1. There is less of a chance of oxygen depletion and fish kills.
2. For some herbicides, a smaller amount of chemical is needed for control.
3. Many herbicides are more effective on plants in the early growth stages. Also, total plant mass is less, so less herbicide is required.
4. Early application of herbicides often facilitates later non-herbicide control measures such as fertilization.

Application rates should always be based upon label recommendations. However, if a pond has a heavy infestation of weeds it is wise to treat a fraction of the weeds in the pond at a time, waiting two or three weeks between applications. During the warm summer months, *never* treat the entire pond with a herbicide at one time, no matter how minor the weed infestation. Dead and decaying plants consume oxygen from the water. Treating a fraction *(Figure 49)* of the pond will allow the fish to escape to oxygenated water during the decay process and reduce the chances of a fish kill.

When using herbicides, never wait until a pond has become choked by aquatic weeds. Instead, spot treat areas of weed growth early, before they become a problem.

Figure 49 Partial Herbicide Treatment

PRECAUTIONS AND WARNINGS—Specific information concerning precautions and warnings is printed on the herbicide label. These precautions and warnings are listed to help insure that no health hazard occurs because of their use. The following are applicable to any aquatic herbicide:

ATTENTION
Herbicide Precautions

1. Observe all directions, restrictions and precautions on herbicide labels. It is dangerous, wasteful and illegal to do otherwise.
2. Store all herbicides in original containers with labels intact and behind locked doors.
3. Use herbicides at correct dosage and intervals to avoid illegal residues or injury to animals.
4. Apply herbicides carefully to avoid drift.
5. Bury surplus herbicides and destroy used containers so that contamination of water and other hazards will not result.

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Table 2. Response of Common Aquatic Weeds to Herbicides'

	Aquatic Group and Weed	Aquatic Herbicides? (Trade Name)						
		copper sulfate (various)	2, 4-D (various)	diquat (Diquat)	endothall (Aquathol)	simazine (Aquazine)	dichlobenil (Casoron)	fenac (Fenac)
Algae	microscopic (plankton)	E		F	G	E		
	filamentous	E		F	G	E		
	chara	E		G	G	E	E	
	nitella	E		G	G	E	E	
Floating Weeds	duckweeds		G	E		E		
	coontail		G	E	E	E	E	E
	bladderwort			E	G			
	water hyacinth		E	E				
Emersed Weeds	American lotus		E		G		E	
	fragrant & white waterlily		E		G		E	
	spatterdock		E		G		E	
	watershield		E		G		E	
	water pennywort			E				
	frogbit		E	E				
	pickerelweed		G					
	alligatorweed		G					
	smartweed		E		G			E
	arrowhead		E	G	G			
	water primrose		E	F				
	cattails		G	G				
	sedges and rushes		E	F				G
	slender spikerush			G				E
	buttonbush		E	F				
	willows		E	F				
	alders		E	F				
	maidencane			F				
	southern watergrass							
Submersed Weeds	naiads			E	E	E	E	E
	parrotfeather		E	E	E			E
	eurasian watermilfoil		E	E	E	G		G
	broadleaf watermilfoil			E	E	E	E	E
	egeria			G	E		G	G
	elodea			E	F		E	E
	hydrilla	F		G	G			
	fanwort				E	G		
	pondweeds (Potamogeton)			G	E	E	E	E

[1]E=excellent control; G=good control; F-fair control.

'Herbicides registered for aquatic uses by the Federal Government. States may have additional aquatic use restrictions. This list is current as of November 1980 and is subject to change.

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Tal C DuVall, Director