Southeastern Aquatic Plants

Identification, Control, and Establishment

MISSISSIPPI STATE UNIVERSITY
EXTENSION

Southeastern Aquatic Plants: Identification, Control, and Establishment

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Suggested Citation

Neal, J.W., G. Turnage, & D. Riecke. 2023. Southeastern aquatic plants: Identification, control, and management. Publication 3735. Mississippi State University Extension Service.

First Edition

ISBN 978-1-7354103-4-0

Copies may be obtained from:

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Acknowledgments

The authors thank the individuals who contributed to this reference guide. Numerous people provided photos and support, and each name is listed when appropriate.

In addition, we thank Drs. P. J. Allen and G. N. Ervin with Mississippi State University, who provided timely peer review of all content. We also thank the Agricultural Communications team with the Mississippi State University Extension Service for their expertise in editing and formatting our content for print and digital purposes.

Funding provided by the Aquatic Nuisance Species Program of the U.S. Fish and Wildlife Service, Grant Award F18AP00260 and the Mississippi Department of Environmental Quality. Additional funding and support provided by the MSU Extension Service.

Introduction

Mississippi is home to extensive surface water resources. There are 81,316 miles of rivers and streams ranging in size from small, intermittent headwater streams to the Mississippi River. There are natural lakes, reservoirs, and more than 190,000 acres of ponds, most of which are privately owned. These resources support numerous uses, including water withdrawal for municipal, industrial, and agricultural purposes, electric power generation, and recreation.

Plants fulfill many natural functions and are vital in aquatic and wetland environments. They provide food, shelter, and reproductive habitat for fish and other aquatic and terrestrial species and help regulate water quality and produce oxygen. However, they can become overabundant and interfere with fishing, swimming, and boating in public and private waters. They also can disrupt ecosystem dynamics and interfere with fish management. This is particularly true with non-native (or exotic) species, which can be especially invasive and lack natural controls to limit their populations.

Purpose and Approach

This book differs from many similar publications on aquatic plants because it does not label all aquatic plants as inherently undesirable. Traditionally, aquatic plants were considered obstacles to fishing or deterrents to swimming, unsightly, or damaging to water control structures and intakes. Therefore, most publications focus on removing plants. While this can be the case and this book provides significant discussion of control methods, it also indicates which plant species can be used to provide habitat and aesthetic enhancement with proper management.

Recommendations presented in this book take a new approach to aquatic plant control. Most herbicide recommendations from other sites and publications rely on old reports (which may be outdated and often do not include newer herbicides) or herbicide label recommendations. While older data may still be valid, there are better options that have become available in recent decades, and some previously recommended herbicides in older resources are no longer available for aquatic use. Likewise, herbicide labels often test dosages in laboratory settings without verification in field applications, recommend dosages that are higher than required, and may not represent objective assessment by a third party. There are often more effective, more species-specific, and cheaper herbicide options available than what has been traditionally recommended.

In response to these situations, herbicide recommendations provided in this guide are based on peer-reviewed literature, real-world applications when available, technical reports, and other agency or third-party studies or documented applications. References are provided at the end of the book for further exploration. Further, because this book is intended for private landowners and others with limited herbicide application experience, limited financial means, and simple application equipment, the recommendations provided are limited to the most effective and affordable options whenever possible.

Finally, aquatic herbicide application amounts are often presented as the amount of chemical to mix with 50 or 100 gallons of water. Since most landowners do not require such quantities, the mixing amounts have also been simplified for easy use with smaller volume application equipment, reducing the need to perform chemical quantity recalculations. In most cases in this text, quantities of herbicides are given on a per gallon of water mixture basis. These recommendations are not intended to replace detailed label instructions—**always read the label; it is the law.**

Federal and State Listed Noxious Weeds

The federal and state noxious weed programs are designed to prevent the introduction of nonindigenous invasive plants. A noxious weed is a plant species that has been designated as damaging to agricultural or horticultural crops, natural habitats or ecosystems, humans, or livestock. The United States Department of Agriculture requires permits for the importation and/or interstate movement of plants listed as noxious weeds by the federal government. The Mississippi Department of Agriculture and Commerce prohibits the sale, distribution, and movement of plants listed on the State of Mississippi Noxious Weed List unless a special permit has been issued for research purposes.

Federal Aquatic Noxious Weed List

Common Name	**Scientific Name**
Ambulia	*Limnophila sessiliflora*
Anchored water hyacinth	*Pontederia azurea*
Arrowhead	*Sagittaria sagittifolia*
Arrowleaf false pickerelweed	*Monochoria hastata*
Chinese water spinach	*Ipomoea aquatica*
Duck-lettuce	*Ottelia alismoides*
Exotic bur-reed	*Sparganium erectum*
Giant salvinia (4 species)	*Salvinia auriculata*
	Salvinia biloba
	Salvinia herzogii
	Salvinia molesta
Heartshape false pickerelweed	*Monochoria vaginalis*
Hydrilla	*Hydrilla verticillata*
Killer algae	*Caulerpa taxifolia*
Melaleuca	*Melaleuca quinquenervia*
Miramar weed	*Hygrophila polysperma*
Mosquito fern	*Azolla pinnata*
Oxygen weed	*Lagarosiphon major*
Wetland nightshade	*Solanum tampicense*

Mississippi State Aquatic Noxious Weed List

Common Name	Scientific Name
Giant salvinia	*Salvinia molesta*
Hydrilla	*Hydrilla verticillata*
Torpedograss	*Panicum repens*

Other Aquatic Species of Concern in Mississippi

Common Name	Scientific Name
Water hyacinth	*Pontederia crassipes*
Alligator weed	*Alternanthera philoxeroides*
Egeria	*Egeria densa*
Eurasian watermilfoil	*Myriophyllum spicatum*
Water lettuce	*Pistia stratiotes*
Crested floating heart	*Nymphoides cristata*
Brittle naiad	*Najas minor*
Common salvinia	*Salvinia minima*
Cuban bulrush	*Oxycaryum cubense*

Plant Identification and Management

What Aquatic Plants Need

Aquatic plants require sunlight, nutrients (especially nitrogen and phosphorus), carbon dioxide, oxygen, and water. Sufficient sunlight must penetrate through the water column and reach the bottom substrate for submersed and emergent plants to establish. Aquatic plants often cannot establish and grow in deeper waters when there is not enough sunlight. Therefore, most aquatic plants grow in shallow waters near the shoreline, and turbid or muddy waters tend to have fewer aquatic plants than clear water. Likewise, waters containing low nitrogen and phosphorus concentrations will have fewer aquatic plants than fertile waters with high concentrations of nitrogen and phosphorus.

The overall biological productivity of water depends on its trophic state, which is controlled by the abundance and availability of biologically useful nutrients. For example, a lake with few nutrients tends to be clear, while a lake with many nutrients may have green water because of an abundant phytoplankton population. When nutrients are too abundant, phytoplankton populations dominate the plant community, reducing light penetration, which results in fewer or an absence of other types of aquatic plants.

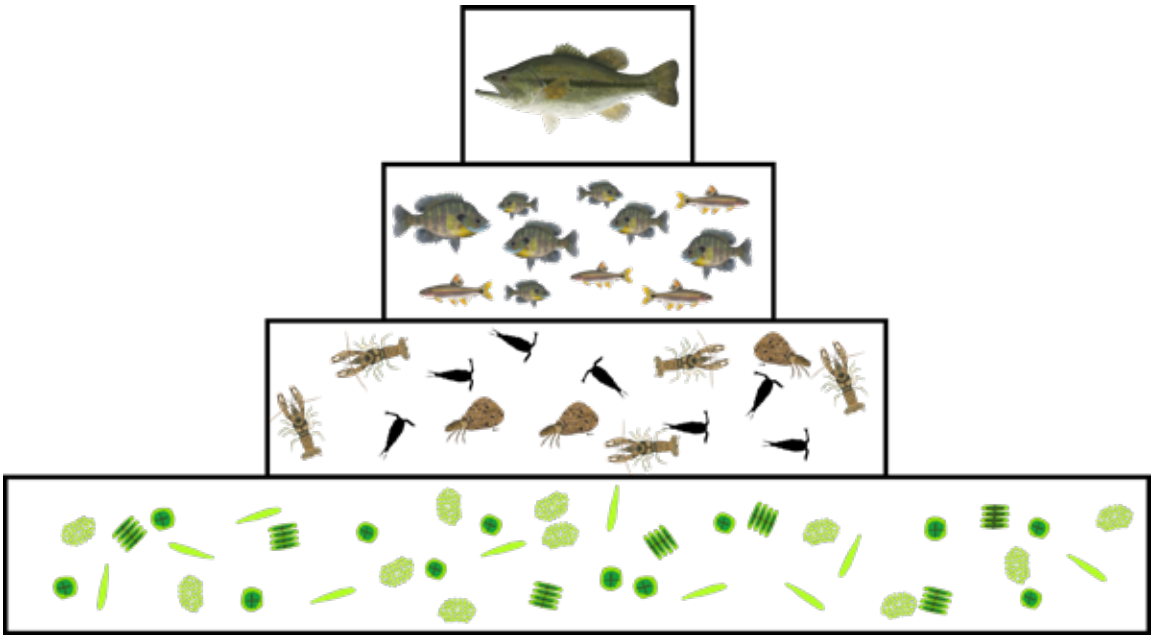
Further, overabundant phytoplankton populations may produce harmful algal blooms. In such cases, the water surface may be covered by what looks like foam, mats, scum, or paint. Blooms can cause the water to appear green, blue, red, brown, or another color. Conversely, rooted plants can thrive in ponds with low nutrients in the water because the water is clear, allowing ample sunlight penetration, and they get their nutrients from the soil.

Benefits of Aquatic Plants

Phytoplankton are the primary producers at the base of the aquatic food chain. This means phytoplankton production controls production of higher trophic levels, such as sport fish populations. Through photosynthesis, phytoplankton produce most of the energy for higher levels in the food chain and the dissolved oxygen critical to life in natural waters. In photosynthesis, plants use the energy in sunlight to convert water and carbon dioxide into sugar and oxygen.

Aquatic plants are a food source and provide attachment sites and habitat for other organisms. Many species of fish feed on the invertebrates (i.e., zooplankton, insects, snails) that live on and around aquatic plants, and turtles and crayfish eat various parts of the plants. Aquatic plants increase habitat complexity, provide shade, and furnish cover that young fish use to hide from predators. Aquatic plants can improve spawning success by protecting fish nests from wave action and sedimentation, which are harmful to fish eggs and small fish. Some popular sport fish, such as bluegill and largemouth bass, have a strong affinity for aquatic plants.

Aquatic plants provide habitat for other wildlife such as aquatic insects, fur-bearing animals, frogs, turtles, reptiles, amphibians, waterfowl, and water birds. Some aquatic plants have colorful flowers that are aesthetically pleasing and attract pollinating insects, while others are food sources for a variety of wildlife species. Aquatic plants can also improve water quality, reduce shoreline erosion by limiting wave action, and stabilize bottom sediments.



The simplified food chain of a small water body. Phytoplankton at the bottom grow using sunlight and nutrients. They are eaten by invertebrates like zooplankton and insects, which are eaten by small fish, and then bigger fish.

Considerations for Aquatic Plant Control

The decision on whether to control the amount of aquatic plant coverage in a water body depends on several factors, including how the landowner uses the water body, if fish are present, where the plants are located, water chemistry, and if invasive species are present. Each landowner should decide which aquatic plant species they are willing to accept, where those plants are located, and how much plant coverage they want or can tolerate.

How the water body is used will determine if aquatic plants are desirable. If the appearance of a golf-course pond is important, then all aquatic plants should be treated until they are eliminated. If plants interfere with or prevent a preferred water use such as swimming, skiing, or boating, treat the plants with the appropriate herbicide to restore those uses. If aquatic plants prevent bank fishing from some preferred locations, treat the plants in those areas. On the other hand, if fish production and habitat diversity are valued, then some aquatic plants are beneficial. Always control invasive species because failure to do so may result in total coverage of the water body, which could cause a fish kill.

Plant control can be expensive and carries inherent risks, so financial and biological factors must be considered. Does the landowner have the money, ability, and equipment for the recommended aquatic herbicides, or can they afford to hire a consultant to treat their aquatic plants? Several treatments and herbicides may be necessary to eliminate all plants, so it is common to underestimate the total cost of treatment. Further, once plants are treated, they will decompose. This uses dissolved oxygen, and a dissolved oxygen depletion may result if aquatic plants are abundant and treated simultaneously. A consequence can be a fish kill, which begs the question: Are the risks worth the reward?

Treatment methods also depend on how quickly plant control is desired. Chemical herbicides usually provide plant control in a short period, often days or weeks. An alternative to chemical control for many submersed aquatic plants is biological control with grass carp. However, this is a much slower process because plant coverage reductions depend on several factors, including the feeding rate of the grass carp, the number of grass carp stocked, the age of the grass carp, the amount of plant coverage, and the growth rates of the plant species. Stocking rate is particularly difficult to estimate. In most cases, grass carp will either eliminate all aquatic plants (too many) or have minimal control (too few). Too many stocked requires the landowner to remove excess grass carp by fishing (with plants or grapes for bait), bowfishing, or seining. Too few stocked wastes time and requires additional stocking.

Other control methods can also be considered. Physical methods include shading (e.g., dyes), using synthetic liners, deepening ponds, draining/scraping, and more. Mechanical methods include harvesting, raking, seining, removing by hand, or other forms of physically removing plants from the water body. Some of these approaches can be extremely expensive, time consuming, and often incompatible with the intended uses of the water body.

Considerations for Establishing Aquatic Plants

Aquatic plants serve many ecological roles and can be desirable to some landowners. Aquatic plants help attract wildlife by providing a diversity of habitats beneficial for both aquatic and terrestrial wildlife species. They provide oxygen, food, shade, shelter, and reproductive habitat for many aquatic species. Some species have large, colorful flowers that are visually appealing.

Landowners may choose to introduce aquatic plants for a variety of reasons. Some plants can be very attractive and are added to improve aesthetics. While many attractive plants can be invasive under the right conditions, there are some species that are unlikely to be problematic. Plants may also be introduced to provide fish habitat, serve as forage for waterfowl, or stabilize shorelines. In all cases, choosing the best species is important.

It is illegal to release any non-native aquatic plant species into a public or private water body in Mississippi. Only native aquatic plant species may be introduced. However, many native plants can exhibit invasive tendencies under ideal conditions. Only species that are less likely to become invasive are recommended in this text; even then, some control may be required.

Plant Growth Forms

Aquatic "plants" generally include two groups: algae and vascular plants. The algae are primitive species lacking true roots, stems, or leaves, and they do not produce flowers or seeds; however, algae are often included with aquatic plants because both groups use photosynthesis. Vascular plants are a higher, more advanced group of species that have roots (usually), stems, and leaves, and produce flowers and seeds.

Algae come in many forms but can be generally classified as:

- planktonic – single- or few-celled organisms suspended in the water or floating on the surface as "scums."
- filamentous and colonial – long strands, mats, clumps, or webs of algae that may start growing from the pond bottom and then rise to the surface to form mats.
- macroalgae – a more advanced group that resembles vascular plants in growth habits.

Vascular plants typically exhibit one or more of three potential growth forms—submersed, emergent, and floating. This reference book uses these criteria to categorize vascular plants.

Submersed plants spend their entire life cycle at or below the surface of the water. The flower parts of the plants will extend above the water surface during the reproductive season. Submersed plants are often rooted in the soil, but masses of plants may tear loose and float free in the water. Some submersed plants may appear to be emergent or floating plants, particularly when support structures for flowers are present. Some of the most noxious exotic plant species are submersed.

Emergent plants are rooted in the bottom soil, and their leaves, stems, and flowers will extend above the surface of the water. Many can grow in both aquatic and terrestrial environments. These plants are often rigid and do not require the water for support. Many emergent plants may appear as submersed plants during the early growing season before they reach the water's surface, and a few species may remain submersed indefinitely. In addition, some species may form extensive floating mats and appear to be floating plants. Emergent plants are typically found in marginal or shoreline areas except in water bodies that have extensive shallow water, or in cases where they form mats that extend out to deeper water. Some species have leaves that float on the surface and long stems that attach to roots in bottom sediments (sometimes called *floating-leaved* plants). These can have characteristics similar to submersed plants, although a few species may mature to have leaves that extend well above the surface, making them appear more like emergent plants.

Floating plants are species that are not rooted or attached to the bottom soil and draw their nutritional needs directly from the water. These plants float freely on the surface and are not restricted by sunlight penetration; thus, they can often form nuisance mats capable of covering entire water bodies.

Herbicidal Control

Aquatic plants provide many valuable services to aquatic ecosystems. However, when aquatic plants become a nuisance, control is warranted. The extent of control and options available for control will depend on the specific management goals for the water body. For example, plant management in a fishing pond will be very different from management in an irrigation pond.

When planning to treat an aquatic plant infestation, the first step is to accurately identify the plant, usually to the species level. Herbicides can have different activity with different species and can be very expensive, so it would be unwise to randomly select an aquatic-approved herbicide. Success of other control methods, such as physical, mechanical, or biological approaches, can be equally species-specific.

MSU Extension has resources to help identify aquatic plant species. An Extension professional or other biologist can identify species and select the most appropriate and cost-effective treatment. If you are introducing aquatic plants to improve aesthetics or as habitat, make sure you correctly identify the plant. Two species may look similar, but their suitability for your stream, lake, or pond may be quite different, and some species are illegal to import or move.

Next, the extent of the infestation and the overall size of the water body needs to be determined. See Important Measurements and Conversions on page 18 for calculations of pond mean depth, volume in acre-feet, and surface area estimation. These measurements will be critical in determining herbicide application rates.

The next step is to choose the most appropriate approved aquatic herbicide. This requires a working knowledge of the herbicide label, application rates, mixing instructions, and application techniques. More details on these considerations are presented below. Keep in mind that some herbicides are fast-acting, while others may take up to 60 days to elicit a response. Monitoring is needed to determine if management is progressing as desired or if an alternative strategy should be implemented to achieve control objectives. Repeat applications may be necessary.

Herbicide Labels

One of the most common and effective tools to reduce aquatic plant abundance is herbicides that are labeled for use in aquatic environments. As of July 2023, there were 17 herbicide chemistries labeled for general aquatic use compared to hundreds available for terrestrial settings in Mississippi. Before selecting an herbicide, confirm the identity of the target plant, as herbicides have different levels of activity on different species.

Because one herbicide can be sold by various companies under many different trade names, this book usually refers to herbicides by the active ingredient (e.g., glyphosate) that causes damage to plants, rather than trade names used by different chemical companies. A list of common trade names is provided in the following tables. Keep in mind that different trade names with the same herbicide active ingredient may have different inert ingredients, and these may or may not be appropriate for aquatic use. If an herbicide is not explicitly labeled for aquatic application, do not use it in a water body.

Additionally, not all trade names for a given herbicide contain the same amount of active ingredient. For example, the herbicide imazapyr is sold in formulations with 2 pounds and 4 pounds acid equivalent (a.e.) per gallon of product. An herbicide applicator would need half the volume of the 4-pound formulation when following the directions for mixing a tank of herbicide solution using 2-pound instructions. Always check the formulation against the recommendation and adjust treatment rates accordingly.

Approved aquatic herbicides in Mississippi, some example common trade names, and treated water use restrictions.

Common Name	Trade Name	Drinking (Human)	Fish Consumption (Human)	Drinking (Animal)	Turf Irrigation	Forage Irrigation	Food Crops Irrigation
2,4-D	*DMA 4 IVM, Hardball, Navigate, AquaKleen, Aquacide, Weedar 64*	-[ab]	0	0	21[bc]	21[bc]	21[bc]
Bispyribac-sodium	*Tradewind*	0	0[d]	-[e]	-[e]	-[e]	-[e]
Carfentrazone-ethyl	*Stingray SC*	1	0	-[f]	14[g]	14[g]	14[g]
Copper Complexes Copper Sulfate	*Algimycin PWF, Captain, Clearigate, Current, Cutrine-Plus, Cutrine-Ultra, Harpoon, Komeen, K-Tea, Nautique, Symmetry*	0[h]	0	0	0	0	0
Diquat	*Harvester, Redwing, Reward, Weedtrine-D, Tsunami DQ*	1–3	0	1	1–3	5	5
Endothall	*Aquathol K, Aquathol Super K, Hydrothol 191, Hydrothol Granular*	7–25[i]	0	7–25	0	7–25	7–25
Florpyrauxifen-benzyl	*ProcellaCOR SC*	0	0	-[t]	0	-[t]	-[t]
Flumioxazin	*Clipper, Clipper SC, Propeller, Schooner*	0	0[d]	0	0.5–5[j]	0.5–5[j]	5
Fluridone	*Avast, Sonar A.S., Sonar One, Sonar PR, Sonar Q, Sonar SRP, Whitecap, Alligare*	0	0	0	30	30	30
Glyphosate	*Avocet, Aquapro, Rodeo, Shore-Klear, Shore-Klear Plus, Touchdown Pro, Roundup Custom*	0	0	0	0	0	0
Imaxamox	*Clearcast, Top Deck, Imox*	-[k]	0	0	-[k]	-[k]	-[k]
Imazapyr	*Aquapier, Gullwing, Habitat, Ecomazapyr*	2	0	0	120[l]	120[l]	120[l]
Penoxsalum	*Galleon SC*	0	0	0	-[m]	-[n]	-[o]
Sodium Carbonate Peroxyhydrate	*Pak 27, Phycomycin SCP*	0	0	0	0	0	0
Topramezone	*Oasis*	-[r]	0	0	-[s]	-[s]	-[s]
Triclopyr	*Navitrol, Navitrol DPF, Renovate 3, Renovate OTF*	-[p]	0	0	-[q]	120	120
Acid Blue #9 & Yellow #23 Dyes	*Aquashade, Enviro-Blue*	0	0	0	0	0	0

NOTE: Not all herbicides are aquatic approved, and some may contain different formulations. There are many more trade names available that are not listed here, and trade names are constantly changing; further, some trade names are only listed for use in some states, so check the legality in your state before purchase.
In Mississippi, consult the latest addition of Publication 1532 ***Weed Control Guidelines for Mississippi*** for a current list of approved herbicides. Similar guides are available for other states. Check label formulation against formulations recommended in this reference manual and adjust accordingly. ***Always follow label instructions and recommendations—it is the law***.

[a]See the label for distance allowed from potable water intake.

[b]A shorter interval may be used if an approved assay indicates less than 0.1 ppm 2,4-D.

[c]Do not use in ditches where water will be used to irrigate highly susceptible crops, such as cotton, grapes, and tomatoes, unless an approved assay indicates that 2,4-D concentrations are less than 100 ppb.

[d]Do not apply to waters used for crayfish farming.

[e]Do not use for livestock watering or irrigation until residues reach 1 ppb or less.

[f]Treated water may not be used as a source for livestock until an approved assay indicates that carfentrazone-ethyl and degradate is below 0.2 ppm.

[g]This is the interval for applications made to more than 20 percent of water surface. Consult label for reduced restriction criteria.

[h]Drinking water restrictions are product-specific; read the label carefully.

[i]The manufacturer suggests a 600-foot potable water application setback.

[j]See the table on the label.

[k]Water can be used when an approved assay indicates imazamox concentrations are less than 50 ppb.

[l]Use restrictions can be reduced if an approved assay indicates imazapyr concentrations are less than 1 ppb.

[m]Water treated with penoxsulam can be used for turf irrigation if concentrations are less than 30 ppb.

[n]For other nonfood crop irrigation or for other irrigation uses, contact SePRO Corporation before irrigation if concentrations exceed 1 ppb.

[o]Do not irrigate established food crops, other than rice, until penoxsulam concentrations are no more than 1 ppb in the irrigation water source. Do not irrigate established rice if concentrations in the treated water exceed 30 ppb.

[p]Drinking water can be used only when triclopyr concentrations are less than 0.4 ppm by an approved assay.

[q]If triclopyr residues are determined to be nondetectable by an approved assay, there is no restriction for use of irrigation water on established grasses.

[r]Do not use treated water with a concentration above 45 ppb (50 is maximum use rate) for potable use/human consumption.

[s]Irrigation use requires monitoring of concentrations. For hydroponics, greenhouses, feed crops, and golf course turf, concentration must not exceed 1 ppb. Corn may be irrigated when concentrations are less than 25 ppb. Other non-food/non-feed uses should not exceed 30 ppb. See label for more information.

[t]Irrigation restrictions depend on application method, application rate, and percent of water body treated. Monitoring is required. Animal drinking restrictions apply if manure is composted. See label for more information.

Approved aquatic non-ionic surfactants in Mississippi and their supplier or manufacturer.

Product Name	Supplier
Activator 90	Loveland Products
AirCover	WinField
Alligare 90	Alligare
Brewer 90-10	Brewer International
Cide-Kick	Brewer International
Cide-Kick II	Brewer International
Crystal Blue Plex Mate	Sanco Industries
Dyne-Amic	Helena
Induce	Helena
MSO Aquatic Surfactant	SePRO
Non-Ionic Surfactant	Liquid Harvest
Sunenergy	Brewer International

> **NOTE:** Not all non-ionic surfactants are approved for aquatic use. There are many more trade names available that are not listed here, and trade names are constantly changing; further, some trade names are only listed for use in some states, so check the legality in your state before purchase. In Mississippi, consult the latest addition of Publication 1532 ***Weed Control Guidelines for Mississippi*** for a current list of approved surfactants. Similar guides are available for other states. Check label formulation against formulations recommended in this reference manual and adjust accordingly. ***Always follow label instructions and recommendations—it is the law***.

Once an herbicide has been selected, the applicator should read the label carefully and follow all safety guidelines and instructions; the label is the law. Using an herbicide in an off-label manner is a violation of state and federal law. This reference book is meant to be an aid for landowners managing aquatic plants, not a replacement for herbicide labels. After the label has been read and all necessary safety equipment is in place, the applicator will need to select the appropriate application rate and possible adjuvant/surfactant rates. Herbicides that are legal for use in aquatic environments should have an aquatic use section to aid applicators targeting aquatic vegetation. This section of an herbicide label usually has a table with recommended use rates for that specific chemical/product.

Herbicide Types

Herbicides can be classified by how they kill the plant. Contact herbicides are fast-acting and kill the plant at the location of contact, but they do not move around inside the plant like systemic herbicides. With contact herbicides, it is important to fully wet as much of the plant as possible, as only the wetted area will be affected.

Because contact herbicides kill the plant quickly, be careful not to kill too much of the plant at once. Dead plants will decompose, and decomposition uses oxygen, so a large amount of decomposition can deplete dissolved oxygen in water bodies. Lack of oxygen in the water body causes fish kills. When plants are abundant, it is best to treat about one-third of the infestation at a time and let that material decay before applying another treatment (about 2 weeks between applications). Also, supplemental aeration can be a good idea to prevent dissolved oxygen depletion issues.

Contact herbicides include carfentrazone-ethyl, copper sulfate and chelated copper, diquat, endothall, and flumioxazin.

Systemic herbicides are taken in by the plant and moved by the vascular tissue to their site of action within the plant. This can effectively kill the entire plant, including the roots, even when the plant is not fully wetted. This process usually takes longer than contact herbicides, sometimes a month or more. The slow death means less risk of oxygen depletion. With some very slow-acting systemic herbicides, the whole pond can be treated in a single application.

Systemic herbicides include 2,4-D, bispyribac-sodium, glyphosate, florpyrauxifen-benzyl, fluridone, imazamox, imazapyr, penoxsulam, topramezone, and triclopyr.

Dyes

Dyes are another chemical used to control submersed aquatic plants and some algae, but they do not work in the same way as contact or systemic herbicides. Dyes absorb and/or reflect sunlight to inhibit plant and algae growth by blocking sunlight needed for photosynthesis. Dyes only control plants and algae growing in water depths of approximately 2 feet or more and will not control submersed plants if applied after the plants have reached the upper 2 feet of the water column. Dyes also inhibit photosynthesis of phytoplankton, and, therefore, may impact water body productivity.

Adjuvants/Surfactants

Most emergent and floating vegetation has a waxy layer on leaves called a cuticle that can slow or prevent herbicide uptake. Additionally, plant structure (i.e., vertical versus horizontal leaves) and wave action can cause plants to take up less herbicide. As a result, many herbicide applicators include additives, broadly called adjuvants, to herbicide solutions that aid herbicide uptake.

The most common ways adjuvants increase herbicide uptake are by:

- breaking down the cuticle (penetrants)
- helping the herbicide solution stick to leaves (sticking agents)
- causing solution droplets to spread out and cover more of the leaf surfaces (surfactants)
- increasing the time it takes to dry out the solution on leaves (wetting agents)

There are many different types of adjuvants commercially available, but those most used in aquatic herbicide applications are non-ionic surfactants and crop/seed oils. Ionic surfactants can attach to the gills of fish and cause suffocation. Only non-ionic surfactants (including crop/seed oils) are safe, legal, and recommended for aquatic applications.

Adjuvants are usually added as a percentage of total solution; the recommended percentage is found on the adjuvant label. The adjuvant amount is easily calculated by multiplying the total gallons of solution by 128 (number of ounces per gallon), then multiplying again by the percentage (as a decimal) needed. For example, for an herbicide solution containing 1 percent non-ionic surfactant in a 25-gallon sprayer:

$$25 \text{ gal/tank} \times 128 \text{ oz/gal} = 3{,}200 \text{ oz/tank} \times 0.01 = 32 \text{ oz surfactant/tank}$$

The specific plant treatment pages in this book provide the amount of non-ionic surfactant to add to each gallon of the herbicide-water mixture.

It may take weeks or months for plants to show effects from herbicide treatment. The label will indicate the time required for these effects to be visible so that monitoring can be conducted at the correct time. Follow-up monitoring is a crucial yet often overlooked step in any herbicide application. Monitoring allows the landowner or applicator to determine if control has been achieved and, if not, conduct necessary retreatment. Monitoring is required with some herbicides, especially when the water body is used for other purposes, such as irrigation, animal or human drinking, swimming, and fishing (for fish that will be consumed by humans).

See the table on page 13 for water use restrictions for each herbicide.

Treatment Steps

When issues with aquatic plants require treatment with herbicides, the following steps will help to ensure success:

1. Accurately identify the plant.
2. Determine the extent of infestation.
3. Select the appropriate aquatic herbicide.
4. Determine the quantity of aquatic herbicide to purchase per treatment area.
5. Mix herbicide solution to apply to plant surfaces or to put in the water.
6. Re-treat as necessary (within legal limits).

Tips for Effective Mixing

1. Make sure the equipment is clean and working and that the spray nozzle is not clogged.
2. Always follow herbicide label instructions. The label is the law.
3. When unsure if two products can be mixed, mix a small amount in a sealed jar, and then gently shake to test for a reaction. If lumps, precipitates (separate layers), or foam form, the products should not be mixed. Incompatible herbicides should be applied separately.
4. Agitate (stir or shake) well to make sure the components of the mix are well dispersed.
5. Empty the tank as much as possible before mixing a new batch.
6. Rinse and clean spray equipment after each use.

Note that mixing recommendations given in this reference manual are usually based on a single gallon of mixture. A recommendation will be, for example, "For each gallon of mixture, mix 2 ounces of chemical, 1 ounce of non-ionic surfactant, and the rest water."

For larger volumes, increase each ingredient respectively. For example, for a 20-gallon sprayer, mix 40 ounces of chemical, 20 ounces of surfactant, and fill the tank with water (about 19.5 gallons of water).

Foliar Spray Treatments

Foliar sprays apply herbicide solution to the plant leaves until all foliage has been wetted. Wind will carry spray away from target areas and can cause spray to contact desirable plants that are not meant to be treated; this is referred to as herbicide drift and should be minimized to reduce herbicide waste and potential harm to non-target species.

It is best not to spray herbicides on windy days. Consult the product label for advice on how to minimize herbicide drift.

Submersed Injection Treatments

Herbicide injection refers to mixing the herbicide into the pond water instead of spraying exposed aerial plant surfaces. This is best achieved using a boat and motor. Mix the herbicide according to label instructions and deploy drop hoses or mount the sprayer wand under the water surface so that the herbicide solution is applied under water. Navigate back and forth across the water body until the recommended rate of herbicide has been evenly applied in the specified area.

Important Measurements and Conversions

Many herbicides require the applicator to determine the area or volume of the water body or plant community to be treated. The following calculations and conversions may be helpful.

Acre-feet = surface acres × average depth in feet

Average depth can be estimated by measuring depth at 20 points spaced evenly across the surface of the pond. Add all these depths (in feet) together. Divide this number (total depth) by 20 (number of readings) to get the average depth in feet:

(Depth 1 + depth 2 + ... + depth 20) / 20 = Average depth

Properly constructed ponds in Mississippi usually average 5–6 feet deep. Keep in mind that ponds get shallower over time due to sedimentation, or they may have less water during periods of drought. For these reasons, it is imperative to calculate average depth before implementing management strategies rather than assuming depth is constant over time.

1 acre = 43,560 square feet

Length of plant area (in feet) × width of plant area (in feet) = total square feet to treat

Total square feet / 43,560 square feet = acres to treat

1 gallon = 4 quarts

1 quart = 2 pints

1 pint = 2 cups

1 cup = 8 ounces

Species Descriptions

On the following pages, the individual species descriptions are organized as algae and the three vascular growth forms of s*ubmersed, emergent,* and *floating*.

Filamentous Algae | Including Colonial Forms

Pithophora forming mats on the water's surface may look like balls of cotton.

Hydrodictyon mat.

Partial coverage of a pond with a filamentous algae bloom in the spring.

Colonial algae have a variety of forms, ranging from thin, fragile filaments or nets to large, gelatinous "blobs." Four common genera are *Pithophora, Lyngbya, Hydrodictyon,* and *Spirogyra*.

Pithophora

Pithophora is an alga that forms major surface infestations made up of small to medium colonies that resemble dark to lime green cotton balls. Its filaments are large and distinguishable but, unlike other algae, **are difficult to tear apart and coarse to the touch**. Pithophora is most common in spring and summer but may persist year-round.

Lyngbya

Mats of this cyanobacteria are typically black in the spring, becoming mottled **(black, brown, green, and white)** in late summer and fall. Extensive mats on pond bottoms persist during all seasons, making *Lyngbya* difficult to control. Blooms (population explosion) occur in elevated calcium or phosphorus levels. *Lyngbya* has a strong musty odor and coarse filaments. It is known to produce neurotoxins capable of killing fish, livestock, and pets.

Hydrodictyon

This green alga may form surface colonies that appear frothy and medium to pale green. Mats readily break apart when handled. Blooms occur in protected hard-water environments with elevated nutrient levels, typically during midsummer. Close inspection of Hydrodictyon reveals **a fine, net-like structure.**

Spirogyra

This green alga forms bottom and surface mats that are initially bright green, then fade to yellow in the summer. Individual strands of *Spirogyra* run parallel and **have a smooth, silky feel.**

Filamentous Algae | Including Colonial Forms

Management Value

None. Filamentous algae do not significantly add to the food web and can quickly reach problematic levels. Blooms should be dealt with swiftly upon identification.

Recommended Controls

Treatment is based on acre-feet or surface area. Acre-feet is calculated as average depth multiplied by surface acres. Most Mississippi ponds average about 5 to 6 feet deep and have 5 to 6 acre-feet per surface acre. For surface area, use the area of the whole pond, not just the area of plant coverage.

Species other than *Pithophora* or *Lyngbya*: Chelated copper complexes. Use 1.5 gallons of chelated copper (0.9-pound formulation) per acre-foot. Determine pond volume prior to algaecide application. Dilute each part of chelated copper with 9 parts water and spray to wet all surface mats. Injection (subsurface application using a wand or hose) of diluted liquid chelated copper or broadcasting granulated chelated copper can be used to kill algae growing on the pond bottom. Granular rate is 1 pound per 720 square feet or 60 pounds per surface acre. Copper can be toxic to fish when water alkalinity is low. Do not use copper in catfish or koi ponds when alkalinity is less than 50 ppm. Do not exceed annual herbicide rate limits as stated on the product label.

For *Pithophora*: Mix 1 gallon of chelated copper liquid (0.9-pound formulation), 1 gallon of diquat (3.73-pound formulation), and 9 gallons of water for each acre-foot to be treated and spray to wet all surface mats. Determine pond volume prior to algaecide application. Injection (subsurface application using a wand or hose) of the mix above or broadcasting granulated chelated copper can be used to kill algae growing on the pond bottom. Granular rate is 1 pound per 720 square feet or 60 pounds per surface acre. Copper can be toxic to fish when water alkalinity is low. Do not use copper in catfish or koi ponds when alkalinity is less than 50 ppm. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

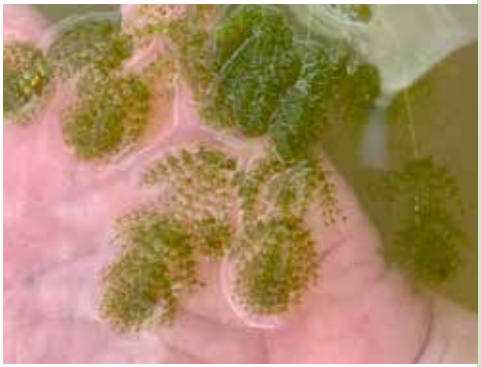
For *Lyngbya*: Apply peroxide (e.g., Phycomycin) at a rate of 75 pounds per treated surface acre. Wait 48–72 hours for the *Lyngbya* mat to detach from the lakebed and float to the surface. Once the mat detaches, apply a chelated copper compound containing D-limonene (e.g., Cutrine-Ultra) to the surface of the waterbody at 2 gallons per surface acre.

Apply on sunny days when water temperature is above 60°F. Use of copper when alkalinity is less than 50 ppm may kill fish. For heavy blooms, treat only one-third of the pond at a time during the early morning hours. Wait 1 week between treatments of filamentous algae.

Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.

Macroalgae | *Chara* and *Nitella* spp.

Chara lacks secondary branching.



Close-up of *Nitella* showing the bushy appearance created by secondary branching.

At first glance, the macroalgae appear more like vascular plants than algae, but closer inspection reveals a lack of defined root, stem, or leaf structures. Two genera are common in Mississippi: *Chara* and *Nitella*. Both groups are highly desirable forage for grass carp, and this is the preferred method of control.

Chara

Commonly called "musk-grass," *Chara* can form extensive beds of "moss" in clear, shallow water. Beds may be a few inches to several feet deep. Plants are anchored to the substrate by false roots, or rhizoids, which are typically colorless. *Chara* is easily distinguished from other macroalgae by **its rough texture and strong musty or garlic-like odor**. Individual internodes, or false stems, will have whorls of six to eight branchlets that do not have further branching. *Chara* prefers hard water. It is usually one of the first species to colonize newly constructed waterbodies (i.e., farm ponds).

Nitella

Nitella is closely related to Chara but prefers deeper water. *Nitella* is **smooth to the touch** and does not emit a musty or garlic odor. *Nitella* also has six to eight branchlets along the internodes, but these branchlets will have additional lateral and terminal branches that create a bushy appearance.

Macroalgae | *Chara* and *Nitella* spp.

Management Value

Macroalgae are only a problem if their density reaches levels that interfere with aquatic activities like fishing and swimming. They are eaten by ducks, provide habitat and food for invertebrates, and provide some cover for fish.

Recommended Controls

Option 1: Triploid grass carp are the best, long-term solution. Stock five to ten grass carp per acre for moderate infestations. Use 15 or more per acre for severe problems. Triploid grass carp will not reproduce in ponds.

Stock 8- to 10-inch triploid grass carp in ponds that have established largemouth bass populations.

Option 2: Copper sulfate. If water alkalinity is at least 50 ppm, copper sulfate (pentahydrate) is the most economical solution. Treatment rate varies by species and alkalinity. Five pounds per acre-foot controls most infestations, which is about 30 pounds per surface acre for the average Mississippi pond. Dissolve at a rate of 1 pound per 5 gallons of water, and spray uniformly over the pond surface.

Option 3: Chelated copper. Apply a liquid chelated copper (0.9-pound formulation) at a rate of 0.5–1.0 ppm (1.5–3.0 gallons per acre-foot), depending on depth, plant height, and plant density. Determine pond volume prior to algaecide application.

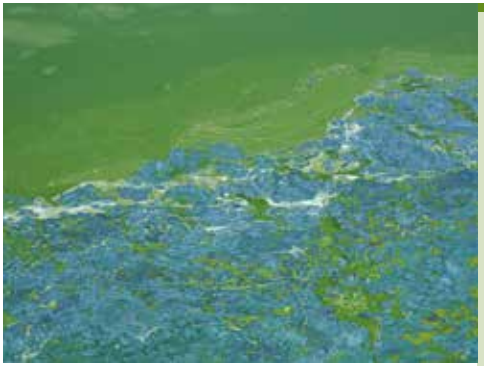
Dilute 1 part chelated copper with 9 parts water and spray uniformly over the pond surface or use bottom injection (subsurface application using a wand or hose) to place the diluted liquid chelated copper where the algae grow. Copper can be toxic to fish when water alkalinity is low. Do not use copper in catfish or koi ponds when alkalinity is less than 50 ppm. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Apply on sunny days when water temperature is above 60°F. Use of copper when alkalinity is less than 50 ppm may kill fish. For heavy blooms, treat only one-third of the pond at a time during the early morning hours. Wait 1 week between treatments of filamentous algae.

Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.

Planktonic Algae



Blue-green algae surface scum showing paint-like accumulations.

Green water is the sign of a productive pond.

Reddish *Euglena* bloom.

There are several hundred species of planktonic algae that comprise the algal communities in Mississippi. Most problems are caused by planktonic algae that's classified as cyanobacteria, green, or Euglenoid. All are an important part of the ecosystem, but when conditions are optimal for growth, they can experience population explosions known as "blooms." Blooms can have a nuisance odor and appearance. They may lead to serious water-quality problems.

Cyanobacteria (Blue-Green Algae)

This group of simple organisms is a common component in most waters. Blooms may be lime-green, blue-green, red, or brownish. Individual alga will aggregate together into small "flakes" that may turn into thick surface "scums" on calm days. Blooms are especially common during hot summer days and **can form bright blue, gelatinous clumps with a putrid odor.**

Green Algae

Green algae **are a critical part of the aquatic food chain**, and blooms are often encouraged using fertilization. Blooms (population explosion) appear bright green to olive-green. They are most common in late-spring or early summer.

Euglenoid Algae

Euglena is a genus of algae that includes many species. Blooms form a surface scum that may vary in color from lime-green to dark red. Individual cells are motile and **may migrate down in the water column during the afternoon.** Intense blooms indicate organic enrichment. Blooms occur year-round but are most common in summer and fall.

Planktonic Algae

Management Value

Planktonic algae, particularly diatoms and green algae, are the base of the aquatic food web and promote a healthy ecosystem. In moderation, these species are essential.

Fish management often includes the use of fertilizer to promote a healthy bloom of plankton. Ideally, the visibility of the water with a healthy plankton bloom should be about 18 inches. Less than 12 inches indicates a higher risk of an oxygen crash, and greater than 24 inches suggests productivity is too low and can allow submersed vascular plants to establish.

Species of planktonic algae cycle during the year. Often, diatoms bloom in late winter, followed by green algae, and then cyanobacteria dominate during the warm summer. Red Euglena blooms can happen any time but are less common.

Cyanobacteria can release toxins that are harmful or fatal to fish, reptiles, mammals, birds, and humans. Occurrence of toxic conditions is rare, but it is best to avoid swimming in ponds when a cyanobacteria bloom is present.

Recommended Controls

It is not normally necessary to treat planktonic blooms, as they will go away on their own and treatment can cause other issues. For chronic blooms that require control, partial control can be achieved using the following recommendations.

Option 1: Copper sulfate (pentahydrate) is the most economical solution for ponds with alkalinity at least 50 ppm. Treatment rate varies by species and alkalinity. Five pounds per acre-foot controls most planktonic species. Determine pond volume prior to algaecide application. Dissolve at a rate of 1 pound per 5 gallons of water and spray uniformly over the pond surface. Not recommended for cyanobacteria. Do not use copper sulfate in ponds when alkalinity is less than 50 ppm. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Chelated copper. Apply a liquid chelated copper (0.9-pound formulation) at a rate of 1.5 gallons per acre-foot. Determine pond volume prior to algaecide application. Dilute 1 part chelated copper with 9 parts water and spray uniformly over the pond surface. Copper can be toxic to fish when water alkalinity is low. Do not use copper in catfish or koi ponds when alkalinity is less than 50 ppm. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Apply on sunny days when water temperature is above 60°F. Use of copper when alkalinity is less than 50 ppm may kill fish. For heavy blooms, treat only one-third of the pond at a time during the early morning hours. Wait 2–3 days between treatments of plankton.

Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.

Bladderwort | *Utricularia* spp.

Underwater view of the many bladders (small hollow sacs).

Subsurface bladderwort with flowers above water.

Bladderwort flowers display a bright yellow hue.

Bladderworts (*Utricularia*) are a large, varied group of aquatic plants characterized by **many small bladders** formed from leaf segments. The bladders are traps to capture small invertebrates, which are digested and their nutrients used by the plant, making this plant carnivorous.

They are rootless plants with **alternate, finely dissected leaves**. In some species, the leaves may be whorled.

Although roots are absent, some species have modified stems that anchor to the bottom of the water body. Flowers extend above the water surface on tall stalks and are usually purple or yellow but can be white or blue.

Bladderworts are common in some areas of Mississippi but usually do not cause problems except in stagnant water conditions. They occur mainly in acidic water with a silty or sandy bottom.

Management Value

Bladderwort is a native plant that provides food and habitat for invertebrates and habitat for fish. In small quantities, it is part of a healthy pond ecosystem, although it grows quickly, which may require some control. In small areas, like around beaches or boat docks, it can be physically removed by raking.

Bladderwort | *Utricularia* spp.

Recommended Controls

Option 1: Diquat (3.73-pound formulation). Diquat should be applied as a submersed injection (subsurface application using a wand or hose) at 0.5 gallon per acre-foot of water. Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Fluridone (4.0-pound formulation). Fluridone should be applied as a submersed injection (3.8 ounces per acre-foot of water); reapply at the same rate 30 days after initial treatment. Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by the pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

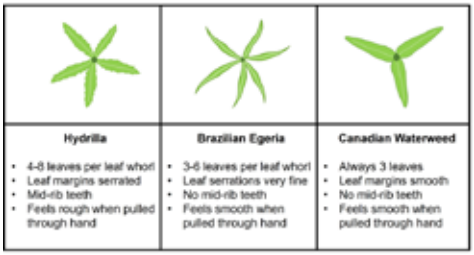
Do not apply fluridone to water bodies with high flow rates; the herbicide will be flushed from treatment sites before it can control plants. Stock three to five triploid grass carp per acre to prevent re-infestation. Stock 8- to 10-inch triploid grass carp in ponds that have established largemouth bass populations to avoid predation by bass.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Brazilian Egeria | *Egeria densa*

Egeria growing tip displaying crowded leaf whorls.

Five-leaf whorl of egeria.



Comparison of *Hydrilla verticillata*, *Egeria densa*, and *Elodea canadensis*.

Brazilian egeria, or Brazilian elodea, is an invasive species to North America. Like native elodea, it is soft to the touch, with medium to dark green leaves that are flexible and narrow at the tips. The edges are finely serrated, but a magnifying glass may be necessary to see serrations. **Leaves grow in whorls of three to six around the stem** and are noticeably more crowded near the water surface.

This species is easily confused with two other species: Canadian elodea (*Elodea canadensis*) and hydrilla (*Hydrilla verticillata*). Elodea has three leaves per whorl and is smooth when pulled through the hand (no midrib teeth), while hydrilla has four to eight leaves per whorl and one or more teeth along each midrib, making it feel rough when pulled through the hand. Hydrilla has tiny flowers, egeria has larger flowers, and elodea flowers are intermediate.

The plant roots in muddy bottom sediments and sends stems toward the surface. Stems can be very long in clear water. Growth is submersed, but plants can top out on the surface and form mats.

Plants reproduce sexually by flowering or vegetatively by fragmentation. **A single fragment can quickly expand asexually to fill a pond**. Floating fragments can grow vigorously without rooting.

Management Value

Egeria is an invasive species. There is no known wildlife value for this species. Although this species can provide habitat for some aquatic species, it will quickly become abundant and should be eradicated on first detection.

Brazilian Egeria | *Egeria densa*

Recommended Controls

Option 1: Triploid Grass Carp. Stock 5 to 10 grass carp per acre to reduce moderate egeria infestations; stock 15 or more per acre for severe infestations. Note that abundant grass carp can impact other fish and can survive 20 years.

Stock 8- to 10-inch triploid grass carp in ponds that have established largemouth bass populations.

Option 2: Chelated copper. Apply a liquid chelated copper (0.8-pound formulation) at a rate of 1.5 gallons per acre-foot. Determine pond volume prior to application. Copper can be toxic to fish when water alkalinity is low. Do not use copper in catfish or koi ponds when alkalinity is less than 50 ppm. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: Diquat (3.73-pound formulation). Diquat (0.5 gallon per acre-foot of water) should be applied as a submersed injection (subsurface application using a wand or hose). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 4: Endothall (4.23-pound formulation). Endothall should be applied as a submersed injection (3.2 gallons per acre-foot of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 5: Fluridone (4.0-pound formulation). Fluridone should be applied as a submersed injection (5.1 ounces per acre-foot of water); reapply at the same rate 30 days after initial treatment. Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

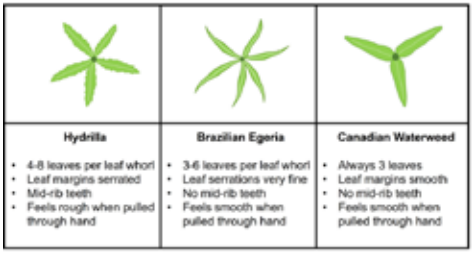
Treat ponds when the plants are actively growing and the water temperature is at least 60˚F. It would be best to treat one-third of the pond at a time for larger water bodies, with 2 weeks or more separating applications. After the entire pond has been treated, a repeat whole-pond application may be necessary to eliminate remaining plants.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Canadian Waterweed | *Elodea canadensis*

Elodea canadensis.

Pond full of *Elodea canadensis*.



Comparison of *Hydrilla verticillata*, *Egeria densa*, and *Elodea canadensis*.

Elodea, or Canadian waterweed, is a native species to North America but is frequently moved to new locations both locally and globally. It is soft to the touch, with medium to dark green leaves that are long, flexible, and narrow at the tips. **Leaves are in whorls of three** around the stem.

This species is easily confused with two non-native species, Brazilian egeria (*Egeria densa*) and hydrilla (*Hydrilla verticillata*). Elodea has three leaves per whorl and **feels smooth** when pulled through the hand (no midrib teeth).

The plant roots in muddy bottom sediments and sends stems toward the surface. Stems can be up to 5 feet in length. Growth is entirely submersed. However, in some situations, plants can form nuisance mats of vegetation at the water surface.

Plants reproduce sexually by flowering, with separate male and female plants, and produce small seeds in oval capsules. Elodea can also reproduce by fragmentation, and a single fragment can quickly expand asexually to fill a pond with a male- or female-only infestation. Floating fragments can grow vigorously without rooting.

Management Value

This species is important as a food and substrate for insects and invertebrates, which are important to higher order species like fish, mammals, and birds. In moderation, this species can provide good habitat for ambush species like largemouth bass; however, it can quickly become too abundant.

Canadian Waterweed | *Elodea canadensis*

Recommended Controls

Option 1: Triploid Grass Carp. Stock 5 to 10 grass carp per acre to reduce moderate elodea infestations; stock 15 or more per acre for severe infestations. Note that abundant grass carp can impact other fish and can survive 20 years.

Stock 8- to 10-inch triploid grass carp in ponds that have established largemouth bass populations.

Option 2: Diquat (3.73-pound formulation). Diquat (0.5 gallon per acre-foot of water) should be applied as a submersed injection (application using a wand or hose). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: Endothall (4.23-pound formulation). Endothall should be applied as a submersed injection (1.9 gallons per acre-foot of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 4: Flumioxazin (4.0-pound formulation). Flumioxazin should be applied as a submersed injection (1.5 pints per acre-foot of water). Determine pond volume prior to application. Use a buffering agent when mixing with water with pH greater than 7.0. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Treat ponds when the plants are actively growing and the water temperature is at least 60˚F. It would be best to treat one-third of the pond at a time for larger water bodies, with 2 weeks or more separating applications. After the entire pond has been treated, a repeat whole-pond application may be necessary to eliminate remaining plants.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Coontail | *Ceratophyllum demersum*

Coontail feels rough to the touch and resembles the tail of a raccoon.

Abundant coontail in a clear water body.

Coontail ends appear bushy under water.

Coontail, sometimes called hornwort, is a rootless submerged plant that often forms dense growth in clear water. The **leaves are completely submerged** and never emergent.

It has dark green, **relatively stiff, whorled leaves with many forks and small teeth** along one edge. They are whorled around the stem with up to 12 leaves per whorl. Leaves are generally less than 0.6 inch long.

Stems can be long, up to 10 feet or more, and are branching, rope-like, and flexible. Coontail stems can be brittle and break easily. The tips of branches near the surface are crowded with leaves, making them **resemble the tail of a raccoon**. The plant is very rough to the touch.

Fruits are very small, less than 0.2 inch. They are smooth, tightly packed, and elliptical in shape.

Management Value

Coontail is a native plant that provides habitat to invertebrates and fish. Ducks eat the fruit. In small quantities, it is part of a healthy pond ecosystem, although it grows quickly and can take over aquatic habitats, even in deeper ponds.

Coontail is not generally recommended for establishment in small recreational ponds.

Coontail | *Ceratophyllum demersum*

Recommended Controls

Option 1: Endothall (4.23-pound formulation). Endothall (0.75 gallon per acre-foot of water) should be applied as a submersed injection (subsurface application using a wand or hose). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Flumioxazin (4.0-pound formulation). Flumioxazin should be applied as a submersed injection (2.1 pints per acre-foot of water). Determine pond volume prior to application. When mixing with water with pH greater than 7.0, use a buffering agent. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Treat ponds when the water temperature is at least 60˚F and the plants are actively growing. It is best to treat one-third of the pond at a time for larger water bodies, with two weeks or more separating applications. After the entire pond has been treated, a repeat whole-pond application may be necessary to eliminate remaining plants.

Option 3: Triploid Grass Carp. Grass carp will eat coontail, but it is not a preferred food item. However, if no other food is available, stocking 10–15 fish per acre may provide control when herbicides are not an option. Stock 8- to 10-inch triploid grass carp in ponds that have established largemouth bass populations to avoid predation by bass. Note that abundant grass carp can impact other fish and can live up to 20 years.

If herbicides are used to control coontail, consider stocking three to five triploid grass carp per acre to prevent re-infestation. Stock 8- to 10-inch triploid grass carp in ponds that have established largemouth bass populations to avoid predation by bass.

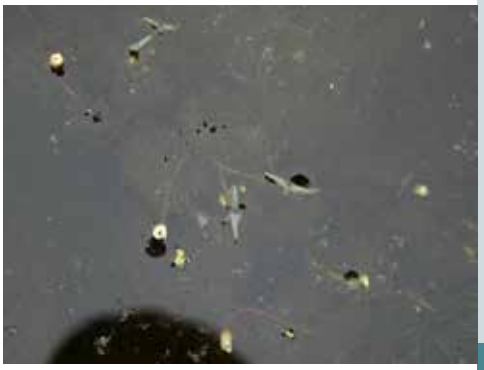
■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Photo Credits Top: A. Merkulova, Creative Commons

Fanwort | *Cabomba* spp.

Fanwort fan-shaped leaves.

Infestation of fanwort.



Fanwort flower.

Fanwort is a rooted submerged plant with leaves that usually grow opposite on the stems, but sometimes are whorled. Submerged leaves are thread-like, somewhat flattened, and are finely **dissected to form a characteristic fan shape**, usually 0.5 to 1.3 inches wide. Floating leaves may occur in the uppermost leaf axis on the stem. They are narrow and nearly diamond shaped, and about 0.5 to .75 inch long.

Stems are slender and may be covered with a thin slime. The roots are fibrous and silvery. Fanwort features small flowers that are white to pinkish with yellow centers. They are attached to the same upper leaf axis as the floating leaves, and are less than half an inch wide.

Fanwort is abundant in ponds, lakes, and slow-flowing streams and rivers. However, **it does not tolerate a wide range of physical and chemical factors**.

Fanwort seldom causes any problems in recreational fishing ponds. It generally cannot establish where grass carp are present.

Management Value

Fanwort is rarely a problem species, yet it has little known value as a food for wildlife. It may be used by invertebrates that in turn feed fish, but, overall, it is not a particularly useful species in pond management.

Fanwort | *Cabomba* spp.

Recommended Controls

Option 1: Endothall (4.23-pound formulation). Endothall (3.2 gallons per acre-foot of water) should be applied as a submersed injection (subsurface application using a wand or hose). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Flumioxazin (4.0-pound formulation). Flumioxazin should be applied as a submersed injection (2.1 pints per acre-foot of water). Determine pond volume prior to application. When mixing with water with pH greater than 7.0, use a buffering agent. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: Carfentrazone-ethyl (1.9-pound formulation). Carfentrazone-ethyl should be applied as a submersed injection (42.6 ounces per acre-foot of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 4: Triclopyr (3.0-pound formulation). Triclopyr should be applied as a submersed injection (2.3 gallons per acre-foot of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Treat ponds when the water temperature is at least 60˚F and the plants are actively growing. It is best to treat one-third of the pond at a time for larger water bodies, with two weeks or more separating applications. After the entire pond has been treated, a repeat whole-pond application may be necessary to eliminate remaining plants.

Option 5: Triploid Grass Carp. Carp will eat cabomba, but it is not a preferred food item. However, if no other food is available, stocking 10–15 fish per acre may provide control when herbicides are not an option. Stock 8- to 10-inch triploid grass carp in ponds that have established largemouth bass populations to avoid predation by bass. Note that abundant grass carp can impact other fish and can live up to 20 years.

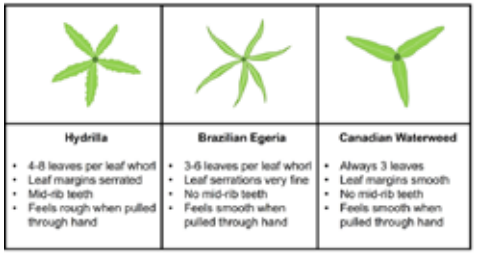
If herbicides are used to control fanwort, consider stocking three to five triploid grass carp per acre to prevent re-infestation. Stock 8- to 10-inch triploid grass carp in ponds that have established largemouth bass populations to avoid predation by bass.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Photo Credits Top: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org; Bottom: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.

Hydrilla | *Hydrilla verticillata*

A pond with thick hydrilla growth.



Comparison of *Hydrilla verticillata*, *Egeria densa*, and *Elodea canadensis*.

Hydrilla leaves are serrated and feel rough when pulled through the hand.

This highly invasive species from Asia first appeared in Florida n the early 1950s. It has quickly spread across the United States; it is listed on the federal noxious weed list and many state-level noxious weed lists. Leaves often have one or more midrib teeth, making the **plant feel rough when pulled through the hand**. Leaves are medium to dark green in color, have **finely serrated edges**, and grow in **whorls of four to eight** around the stem.

This species can easily be confused with three other species in the U.S.: Canadian elodea (*Elodea canadensis*), bog moss (*Mayaca fluviatilis*), and Brazilian egeria (*Egeria densa*). Elodea has only three leaves per whorl (node), bog moss leaves aren't arranged in whorls, and egeria has three to six leaves per node. Additionally, elodea and egeria feel smooth when pulled through the hand (no midrib teeth), while hydrilla feels rough. Hydrilla has tiny flowers, egeria has larger flowers, and elodea's blooms are intermediate.

Hydrilla roots in bottom sediments with small (quarter-inch) bud-like structures called turions and sends up stems through the water column. Stems can be very long in clear water (>25 feet). Growth can be mostly submersed, or plants can top out on the surface and form mats.

Plants mainly reproduce and spread via fragmentation and turion production. A single fragment can infest a new water body as floating fragments can grow vigorously without rooting.

Management Value

Hydrilla is highly invasive and outcompetes native submerged aquatic vegetation. It can quickly fill a water body, obstructing boating, fishing, swimming, and other recreational uses. Although it provides habitat for fish and some water quality benefit, this species should never be introduced and must be controlled at first detection.

Hydrilla | *Hydrilla verticillata*

Recommended Controls

Option 1: Triploid Grass Carp. Stock 5 to 10 grass carp per acre to reduce moderate hydrilla infestations; stock 15 or more per acre for severe infestations. Note that abundant grass carp can impact other fish and can live up to 20 years.

Stock 8- to 10-inch triploid grass carp in ponds that have established largemouth bass populations to avoid predation by bass.

Option 2: Flumioxazin (4.0-pound formulation). Flumioxazin (2.1 pints per acre-foot of water) should be applied as a submersed injection (application using a wand or hose). Determine pond volume prior to application. Use a buffering agent when mixing with water with pH greater than 7.0. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: Endothall (4.23-pound formulation). Endothall should be applied as a submersed injection (1.92 gallons per acre-foot of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 4: Florpyrauxifen-benzyl (2.5-pound formulation). Florpyrauxifen-benzyl should be applied as a submersed injection (5.4 ounces per acre-foot of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 5: Fluridone (4.0-pound formulation). Fluridone should be applied as a submersed injection (2.56 ounces per acre-foot of water); reapply at the same rate 30 days after initial treatment. Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 6: Chelated Copper (0.8-pound formulation). Chelated copper should be applied as a submersed injection (3.3 gallons per acre-foot of water). Determine pond volume prior to application. Copper can be toxic to fish when water alkalinity is low. Do not use copper in catfish or koi ponds when alkalinity is less than 50 ppm. Do not exceed annual herbicide rate limits as stated on the product label.

Option 7: Diquat (3.73-pound formulation). Diquat should be applied as a submersed injection (0.5 gallon per acre-foot of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Treat ponds when the plants are actively growing and the water temperature is at least 60˚F. It is best to treat one-third of the pond at a time for larger water bodies, with 2 weeks or more separating applications. After the entire pond has been treated, a repeat whole-pond application may be necessary to eliminate remaining plants.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Pondweeds | *Potamogeton* spp.

American pondweed (*P. nodosus*).

Leafy pondweed (*P. foliosus*).

Flower of *Potamogeton.*

There are native and non-native pondweeds in Mississippi, and both can interfere with pond use. Known by the common name "pondweed," there are many species, and they are **quite varied in appearance**. The leaves may be submerged or floating on the water surface.

One confusing characteristic of pondweeds is that submersed leaves are thinner, somewhat translucent, and positioned alternately along the stem, while floating leaves are more elliptical, oval, or lance-like, leathery, and sometimes positioned somewhat opposite of one another. When visible, veins on the leaves are parallel and run the length of the leaf.

The flowers are a key characteristic yet often overlooked. Flowers are greenish-brown and composed of **four rounded segments that form an oblong or ball-like spike**. The fruits are round, green or brown, and tiny, usually less than 0.3 of an inch.

Some species, like leafy pondweed (*P. foliosus*), are mostly submerged and can be confused with southern naiad (*Najas* spp.). Other species, like American pondweed (*P. nodosus*), can cover the water surface with leaves up to 8 inches long.

Management Value

This family of plants can be an important part of healthy ecosystems. Pondweeds are an important food for ducks, beavers, snails, insects, and other animals. Because most species remain at relatively low densities, they provide important habitat for fish and are a favorite location for anglers.

Many management agencies have programs to establish *Potamogeton* in large reservoirs that lack aquatic plants. Likewise, some of these species can be advantageous to establish in private waters.

Under most conditions they do not cause problems, but some species can be problematic (e.g., curly-leaf pondweed; *P. crispus*). American pondweed is a good candidate for introduction and can be easily managed with herbicides.

Pondweeds | *Potamogeton* spp.

Recommended Controls

Option 1: Triploid Grass Carp. Stock 5 to 10 grass carp per acre to reduce moderate pondweed infestations; stock 15 or more per acre for severe infestations. Note that abundant grass carp can impact other fish and can live up to 20 years.

Stock 8- to 10-inch triploid grass carp in ponds that have established largemouth bass populations.

Option 2: Endothall (4.23-pound formulation). Endothall (1.92 gallons per acre-foot of water) should be applied as a submersed injection (application using a wand or hose). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: Fluridone (4.0-pound formulation). Fluridone should be applied as a submersed injection (0.85 ounce per acre-foot of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 4: Penoxsulam (2.0-pound formulation). Penoxsulam should be applied as a submersed injection (3.5 ounces per acre-foot of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Treat ponds when the plants are actively growing and the water temperature is at least 60˚F. For larger water bodies, it is best to treat one-third of the pond at a time. There should 2 weeks or more separating applications. After the entire pond has been treated, a repeat whole-pond application may be necessary to eliminate remaining plants.

Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.

Slender Spikerush | *Eleocharis* spp.

Submerged growth form of slender spikerush that has been pulled from a pond.

Slender spikerush is branching and hair-like.

Spikerush emergent growth form around the edges of a pond.

There are several species of spikerush that can occur in Mississippi waters. Some species grow on the water margins as emergent plants, similar in appearance to other rushes and sedges. However, the submersed version that commonly causes problems in ponds is the **fully aquatic, free-floating growth form**.

Although the two growth forms can co-occur, they often are found separately. Do not use one as a diagnostic for the other.

The submersed form that is commonly found, E. vivipara, is a tangle of long, thin branches. This **hair-like appearance** gives it the common name "hair-grass."

The submersed growth form is viviparous, meaning that new plants grow directly from the submersed spikelets. For this reason, slender spikerush can grow in dense mats very quickly and take over water bodies.

Management Value

Slender spikerush is a native plant, and its seeds, leaves, and rhizomes are eaten by some species of waterfowl and possibly other wildlife. While it does provide habitat for fish, it is highly invasive and usually takes over. Slender spikerush is not recommended for pond management.

Slender Spikerush | *Eleocharis* spp.

Recommended Controls

Option 1: Diquat (3.73-pound formulation). Diquat (0.5 gallon per acre-foot of water) should be applied as a submersed injection (application using a wand or hose). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Option 2: Triploid Grass Carp. Stock 5 to 10 grass carp per acre to reduce moderate pondweed infestations; stock 15 or more per acre for severe infestations. Note that abundant grass carp can impact other fish and can survive 20 years.

Stock 8- to 10-inch triploid grass carp in ponds that have established largemouth bass populations.

Treat ponds when the plants are actively growing and the water temperature is at least 60˚F. It would be best to treat one-third of the pond at a time for larger water bodies, with 2 weeks or more separating applications. After the entire pond has been treated, a repeat whole-pond application may be needed to eliminate remaining plants.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Photo Credits Middle: D. Waldrop

Southern Naiad | *Najas guadalupensis*

Tangled mass of southern naiad in a pond.

Southern naiad serrated leaves.

Southern naiad features opposite leaves.

Southern naiad is a submersed plant that is a common Mississippi pond problem. It has **long stems with many branches**.

Leaves are narrow (one-sixteenth of an inch) and about an inch long. They are **arranged oppositely on the stem**. The leaf margins have tiny teeth that require magnification to see. They may sometimes be arranged in whorls of three, but two opposite leaves are more common. The leaf color is usually green to slightly purple.

Southern naiad is a flowering plant, but the flowers are very small and easily overlooked. Seeds are elliptical in shape and inconspicuous.

This species may be confused with sago pondweed (*Stuckenia pectinata*), bushy/leafy pondweed (*Potamogeton foliosus*) or widgeon grass (*Ruppia maritima*). Sago pondweed, however, has alternate leaves, and both similar species have leaves that are several inches or more in length.

Management Value

Southern naiad is a native species and a primary food source for waterfowl. The plant provides habitat for invertebrates, which feed fish, reptiles and amphibians, and bird species. Small and large fish use the dense growth as cover.

However, this species grows rapidly and can quickly become a problem in small waters. It interferes with human activities, prevents predator-prey interactions, and can reduce oxygen levels at night or during die-offs. It is not a recommended plant to establish in small ponds and should be controlled at first sign of becoming a problem.

Southern Naiad | *Najas guadalupensis*

Recommended Controls

Option 1: Triploid Grass Carp. Stock 5 to 10 grass carp per acre to reduce moderate pondweed infestations; stock 15 or more per acre for severe infestations. Note that abundant grass carp can impact other fish and can survive 20 years.

Stock 8- to 10-inch triploid grass carp in ponds that have established largemouth bass populations.

Option 2: Diquat (3.73-pound formulation). Diquat (0.25 gallon per acre-foot of water) should be applied as a submersed injection (application using a wand or hose). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: Chelated Copper (0.8-pound formulation). Chelated copper should be applied as a submersed injection (3.3 gallons per acre-foot of water). Determine pond volume prior to application. Copper can be toxic to fish when water alkalinity is low. Do not use copper in catfish or koi ponds when alkalinity is less than 50 ppm. Do not exceed annual herbicide rate limits as stated on the product label.

Option 4: Penoxsulam (2.0-pound formulation). Penoxsulam should be applied as a submersed injection (1.75 ounces per acre-foot of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Treat ponds when the plants are actively growing and the water temperature is at least 60˚F. It is best to treat one-third of the pond at a time for larger water bodies, with 2 weeks or more separating applications. After the entire pond has been treated, a repeat whole-pond application may be necessary to eliminate remaining plants.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Photo Credits Middle: Timothy W. Wilson, UF-IFAS Bradford County Extension

Watermilfoil | *Myriophyllum* spp.

Variable-leaf watermilfoil.

A close view of Eurasian watermilfoil.

Eurasian watermilfoil in water.

Watermilfoils are rooted, submersed plants with **characteristic feather-like leaves** under the water. There are several species, including native (e.g., variable-leaf watermilfoil; *Myriophyllum heterophyllum*) and non-native (Eurasian watermilfoil; *M. spicatum*), but **all have potential to be invasive in Mississippi ponds**. Milfoil species can easily hybridize, which complicates identification efforts.

Variable-leaf watermilfoil has leaves in whorls of four to six, with submersed leaves exhibiting a feathery appearance. Emergent leaves are solid, sword-shaped, and firmer. Submersed leaves are usually spaced about 0.75 inch apart, and stems are thicker than *M. spicatum*. Fruits are disk-shaped.

Eurasian watermilfoil has leaves in whorls of three to five and much more tightly packed than *M. heterophyllum* (spacing less than 0.1 inch between whorls). It does not have emersed sword-shaped leaves. Fruits are four-lobed and spherical.

Eurasian watermilfoil is the more likely species to cause problems for Southern landowners. It is highly aggressive and forms dense colonies that create surface mats in ponds, clog intake pipes, and interfere with dissolved oxygen production.

Management Value

Highly invasive and aggressive. Eradicate on first detection.

Watermilfoil | *Myriophyllum* spp.

Recommended Controls

Option 1: Florpyrauxifen-benzyl (0.0052-pound formulation). Florpyrauxifen-benzyl (9.6 ounces per acre-foot of water) should be applied as a submersed injection (application using a wand or hose). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Endothall (4.23-pound formulation). Endothall should be applied as a submersed injection (1.92 gallons per acre-foot of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: 2,4-D (3.8-pound formulation). 2,4-D should be applied as a submersed injection (0.75 gallon per acre-foot of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 4: Diquat (3.73-pound formulation). Diquat should be applied as a submersed injection (0.25 gallon per acre-foot of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Treat ponds when the plants are actively growing and the water temperature is at least 60˚F. It would be best to treat one-third of the pond at a time for larger water bodies, with 2 weeks or more separating applications. After the entire pond has been treated, a repeat whole-pond application may be necessary to eliminate remaining plants.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Photo Credits Top: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org; Middle: U.S. Geological Survey.

Alligator Weed | *Alternanthera philoxeroides*

Alligator weed profile showing opposite leaves and pink stems.

Clover-like flower with leaves.

Close-up of alligator weed flower.

Alligator weed is a non-native species originally from South America. It was first reported in Alabama in the late 1800s. Thick mats of alligator weed form at the shoreline and can extend many feet across the water's surface.

Alligator weed has elliptical to lanceolate (sword-shaped) leaves that are paired opposite of each other on the stem. The stem is pale green to pink. Alligator weed can be mistaken for water primrose; however, **the stems of alligator weed are hollow, while primrose stems are solid.**

Flowers are small, round, white, and **similar in appearance to terrestrial clover flowers.** The petals are thin, and the flower is on a stem that is 3–5 inches in length.

This species outcompetes most native species with a similar growth form, and can reduce or eliminate shoreline access to anglers and wildlife. Alligator weed can also form floating islands that block sunlight from the water and phytoplankton. It is invasive and can spread easily from plant fragments left during control efforts.

Management Value

Alligator weed is highly invasive and not recommended for any application. This species should be eradicated on first appearance. Alligator weed is listed as a Class C noxious weed in Alabama.

Alligator Weed | *Alternanthera philoxeroides*

Recommended Controls

Glyphosate, imazamox, imazapyr, and triclopyr can provide control of alligator weed for 2–3 months. Repeat applications may be necessary in areas with longer growing seasons or in very dense plant stands. Be sure to wet 100 percent of the exposed plant material.

Mixing imazapyr or imazamox with either triclopyr or glyphosate may provide better control than any single herbicide applied alone. Use the full recommended rate of each herbicide. Apply herbicide when temperatures are at least 60˚F, and spray all exposed plants.

Option 1: Glyphosate (5.4-pound formulation). For each gallon, mix 3.8 ounces of glyphosate, 1.3 ounces of surfactant, and the rest water. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Imazamox (1.0-pound formulation). For each gallon, mix 1.2 ounces of imazamox, 1.3 ounces of surfactant, and the rest water. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: Imazapyr (2.0-pound formulation). For each gallon, mix 0.6 ounces of imazapyr, 1.3 ounces of surfactant, and the rest water. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label. Multiple applications will be required.

Option 4: Triclopyr (3.0-pound formulation). For each gallon, mix 5.1 ounces of triclopyr, 1.3 ounces of surfactant, and the rest water. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

The best approach to control this species is to treat ponds with herbicides when the water temperature is at least 60˚F and the plants are actively growing. For options 2 and 3, it is best to treat one-third of the pond at a time, with a week or more separating applications.

After the entire pond has been treated, a repeat application for the entire pond may be necessary to eliminate remaining plants. Following treatment, stock three to five triploid grass carp per acre to prevent infestation by other species. Stock 8- to 10-inch triploid grass carp in ponds that have established largemouth bass populations to avoid predation by bass.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

American Bur-reed | *Sparganium americanum*

Close-up of flowering American bur-reed stems.

The spherical, bur-like structure of American bur-reed.

Dry bur-like structures of American bur-reed.

American bur-reed is a perennial plant native to the eastern half of the United States. Leaves are bright green, long, strap-like, and up to 1 inch wide.

Flowers are up to 1 inch in diameter, formed from a **spherical bur-like structure** that starts off green and becomes brown. Flowers are found in loose clusters. The seeds are dry with one seed per flower structure, which does not open to release the seed.

The overall plant stands upright and can be up to 2 feet tall. It grows in calm, shallow waters with partial shade. This plant can form dense stands along shallow shorelines.

Management Value

This plant rarely causes problems in recreational ponds and is an important food source for many marsh bird species, including waterfowl. Muskrats can eat the entire plant. The flowers attract many species of insects, including butterflies and other native pollinators.

The plant can provide shallow water habitat for juvenile fish and invertebrates, which are eaten by larger fish.

American Bur-reed | *Sparganium americanum*

Recommended Controls

Herbicide efficacy is not listed for American bur-reed, but the following have been most successful in controlling this species.

Option 1: Diquat (3.73-pound formulation). Diquat (0.25 gallon per acre-foot of water) should be applied as a submersed injection (application using a wand or hose). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.

Photo Credits Top: Robert H. Mohlenbrock. Provided by USDA NRCS Wetland Science Institute, Fort Worth; Middle: Jeff McMillian. Provided by Almost Eden, Louisiana; Bottom: Milo Pyne. Provided by USDA NRCS Wetland Science Institute, Fort Worth.

American Lotus | *Nelumbo lutea*

Mixed stand of American lotus, water lily, and other species. Round American lotus leaves are floating on the surface and emergent.

American lotus seed pod.

Round American lotus leaf showing the central stem insert, radiating veins, and lack of notch.

American lotus is found throughout Mississippi and is easily recognizable by its large, round leaves with central stem insertion, large, yellow single flower, and unmistakable seed pod.

Leaf stems extend to the pond or lake bottom, where the plant is rooted in the sediment and has rhizomes that store nutrients.

Leaves can reach diameters of 2.5 feet or more and may float on the water surface. Some leaves may emerge several feet above the water; these are referred to as umbrella pads. Flowers can be as wide as 10 inches.

The seed pod, or receptacle, is **shaped like an inverted cone and contains acorn-like seeds** within individual cavities.

Management Value

American lotus is a native plant, and its seeds are eaten by some species of waterfowl and possibly other wildlife. The rhizomes are eaten by beavers and muskrats, while the leaves and stalks provide habitat for fish. In small quantities, it is part of a healthy pond ecosystem, although it is highly invasive and usually takes over shallow ponds. American lotus is not recommended for pond management.

American lotus roots, leaves, and seeds are edible. Native Americans were known to eat the starchy rhizomes, and young leaves can be cooked and eaten like spinach. Immature seeds can be eaten raw, and the seed pods are commonly used in floral arrangements.

American Lotus | *Nelumbo lutea*

Recommended Controls

Option 1: 2,4-D (3.8-pound formulation). For each gallon of water, mix 5.1 ounces of 2,4-D, 1.3 ounces of surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Diquat (3.73-pound formulation). Diquat (0.25 gallon per acre-foot of water) should be applied as a submersed injection (application using a wand or hose). Determine pond volume prior to application. Dilute 1 part diquat with 9 parts water. Inject the formula using a boat and motor. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Option 3: Triclopyr (3.0-pound formulation). For each gallon of water, mix 5.1 ounces of triclopyr, 1.3 ounces of surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

For heavy coverage, treat one-third of pond at a time with 1–2 weeks between applications for both Options 1 and 2.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Arrowhead | *Sagittaria* spp.

All arrowhead species have showy, vibrant flowers with three petals.

Delta arrowhead (*Sagittaria platyphylla*).

Stand of broadleaf arrowhead (*Sagittaria latifolia*).

There are at least seven species of *Sagittaria* in Mississippi. Most species of this attractive plant resemble the common garden species taro, elephant ears, and caladiums in shape. However, shape is variable among species.

The leaves can be found both above and below the water surface, and they can grow high above the water on long stalks. **They are shaped like a spade, deeply notched like an arrowhead, or lance shaped.**

Flowers are produced during the summer and are usually white with three petals. Pink flowers can occur but are less common.

Giant arrowhead, *Sagittaria montevidensis*, is non-native and invasive and can be identified by the brownish-purple spot at the base of each flower petal. Although uncommon in recreational ponds, this species should be eliminated upon first detection. Other Mississippi species are native and rarely become a problem in ponds.

Management Value

Giant arrowhead, *Sagittaria montevidensis*, is **non-native** and invasive, and should be eradicated upon first detection.

Other Mississippi species of this plant are native and important for wildlife. The tubers are eaten by people, muskrats, and waterfowl. In fact, one common name for *Sagittaria* is duck potato. Arrowhead tubers are considered an important part of the Native American diet—the Cree tribe called them *wapato*. Some raw tubers are edible but become less bitter when cooked. The seeds also provide food for different wildlife species.

It is important to note that another native species, *Peltandra virginica*, which is very similar in appearance to some species of *Sagittaria*, can be poisonous if not prepared properly before eating.

Arrowhead | *Sagittaria* spp.

Arrowhead are a species that can be introduced around shorelines to improve aesthetics and provide habitats for wildlife and fish. They spread relatively slowly, allowing for both mechanical and herbicidal control when necessary.

Recommended Controls

Option 1: Glyphosate (5.4-pound formulation). For each gallon of water, mix 3.8 ounces glyphosate and 1.3 ounces surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Imazamox (1.0-pound formulation). For each gallon of water, mix 1.2 ounces imazamox and 1.3 ounces surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: 2,4-D (3.8-pound formulation). For each gallon of water, mix 5.1 ounces 2,4-D and 1.3 ounces surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

For some arrowhead species, multiple applications may be necessary to achieve eradication.

The best approach to control this species is to treat ponds with herbicides when the water temperature is at least 60˚F and the plants are actively growing. For options 2 and 3, it would be best to treat one-third of the pond at a time, with a week or more separating applications.

After the entire pond has been treated, a repeat application for the entire pond may be necessary to eliminate remaining plants.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Bald Cypress | *Taxodium distichum*

Bald cypress tree.

Close-up of bald cypress leaves and fruit.

"Knees" of bald cypress.

This native tree is an iconic lowland species in Mississippi. It is one of the few deciduous conifers in North America. Bald cypress can reach 100 feet in height and have trunk diameters of up to 8 feet. In wet areas, **they develop distinctive woody "knees" from their root systems**, which can protrude from the trunk.

The thin, light-green leaves can appear feather-like. They are tightly and oppositely arranged along both sides of small branchlets (2 to 4 inches in length). In autumn, the trees turn copper to reddish-brown before the entire branchlet falls to the ground with some leaves still attached.

This tree species is monoecious, which means that each tree has both male and female reproductive parts. The male catkin is about 4 inches long with clusters of small, purplish conelets. The female conelets feature one to three clusters. They turn from green to brownish-purple as they mature, and reach about 1 inch in diameter.

Management Value

Bald cypress is a beautiful tree that can improve the aesthetics of aquatic wetlands and ponds. It prefers full sunlight. If planted in pond environments, avoid areas near the levee, as the roots can destabilize water seal. Keep in mind that these trees grow very large, and the knees may obstruct some pond and shoreline use.

Many bird species use individual and groves of bald cypress for roosting and nesting habitat, especially bald eagles, ospreys, and prothonotary warblers. Squirrels, turkeys, wood ducks, and other bird species eat the seeds. The trunks and knees make excellent fish habitat when flooded. Hollow areas and fallen logs are often used by catfish species as nesting cavities.

The wood from bald cypress is very durable when exposed to the elements. It is popular for exterior trim, shingles, boat building, fence posts, and shredded mulch.

Bald Cypress | *Taxodium distichum*

Recommended Controls

Some consider pond cypress to be a different species, but its value and controls are the same as bald cypress.

Killing large trees is best achieved by felling the tree with a chainsaw, followed by applying a systemic herbicide solution to the root stump immediately after the tree is felled. This will allow the tree to take up the herbicide and distribute it to the root system.

Option 1: Imazapyr (2.0-pound formulation). For each gallon of water, mix 12 ounces imazapyr. Spray or brush solution on the cambium of the cut stump. Cambium is the wood immediately under the bark at the outer edge of a stump. Take note of nearby tree species (specifically oaks) as imazapyr is soil active. This means that imazapyr can travel through the stump to roots and release into the surrounding soil, harming any nearby trees. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Glyphosate (5.4-pound formulation). For young trees and seedlings: for each gallon of water, mix 1.9 ounces of glyphosate and 1.3 ounces of surfactant; apply solution to leaves. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.

Bulrush | *Schoenoplectus* spp.

Close-up of bulrush flower spikes.

A dense stand of bulrush.

Juncus is similar to bulrush, but its flower spike is lower on the side of the stem.

Bulrushes are a group of common native species in the sedge family that grow in damp areas and along the shallow shorelines of ponds and wetlands up to a depth of 3 to 4 feet. Some species can grow to heights of 5 to 10 feet.

Bulrushes usually have **round stems that are hollow** and are thicker at the base. Most species have a **loose cluster of brownish flowers at or near the tip of the stem**, which bloom in late spring to summer.

Bulrushes are similar to Juncus in appearance, but Juncus is usually shorter with flowers appearing to be more on the side of the stem. Bulrush flowers are more terminal. Each flower produces one seed, which has a flat surface on one side and a convex surface on the other.

Management Value

Bulrushes are native and an important part of natural ecosystems. The seeds are consumed by ducks and other birds; several bird species nest in bulrush stands; and a variety of species, including geese and muskrats, eat the early growth and rhizomes. Bulrushes can make excellent fish habitat, with some species spawning on or among bulrush stems and roots. Bulrushes can hinder wind and wave activity, increasing sediment stabilization and slowing shoreline erosion.

Bulrushes can become problematic, and introducing them to managed ponds is not recommended. However, when present, control is only necessary when they become too abundant or hinder use of the water body.

Bulrush | *Schoenoplectus* spp.

Recommended Controls

Glyphosate (5.4-pound formulation). For each gallon of water, mix 5.1 ounces glyphosate and 1.3 ounces surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Multiple herbicide applications are likely necessary to achieve eradication. The best approach is to treat ponds with herbicide when the plants are actively growing and water temperature is at least 60˚F.

Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.

Buttonbush | *Cephalanthus occidentalis*

A buttonbush tree.

A buttonbush flower.

Buttonbush buttons from old flowers.

Buttonbush is a marginal and shallow water woody bush common in wetlands, lakes, and ponds. Although normally relatively small, buttonbush can reach 45 feet in height with trunk diameters up to 1 foot.

Buttonbush leaves are shaped like wide swords and are up to 5 inches long and 2 inches wide. They are arranged oppositely on the stem. Healthy and growing leaves are usually bright green, while the leaf stalk may be pink to red.

Flowers are in globe-shaped clusters, with four to five small, white petals forming the sphere. Flowers turn brown after maturing.

Management Value

Buttonbush seeds may be eaten by ducks, and the flowers are popular with butterflies, bees, and other pollinators. Bird species frequently use this species for nesting. Buttonbush is usually in areas too shallow to provide fish habitat, but can be important during periods of high water.

Buttonbush is a good natural backdrop and mid-height plant that can be used to provide aesthetic benefits. However, it can interfere with pond access. Use with caution and be prepared to control unwanted expansion.

Buttonbush | *Cephalanthus occidentalis*

Recommended Controls

Option 1: Killing buttonbush is best achieved by felling with a chainsaw.

Option 2: Imazapyr (2-pound formulation). For small plants, mix 2.6 ounces imazapyr and 1.3 ounces non-ionic surfactant per gallon of water. Spray to wet all leaves.

Option 3: Glyphosate (5.4-pound formulation). For small plants, mix 2.0 ounces glyphosate and 1.3 ounces non-ionic surfactant per gallon of water. Spray to wet all leaves.

Treat with herbicides when plants are actively growing; tank mixing imazapyr and glyphosate may be more effective than using either option alone.

Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.

Cattail | *Typha* spp.

A cattail flower spike.

Cattail leaves.

A dense stand of cattails.

Although 5–6 feet is the typical height for this well-known native species, cattails can stand up to 8 feet high. The two species in Mississippi are the common cattail, *Typha latifolia*, and the southern cattail, *Typha domingensis*.

Cattails have stout stems, broad, linear leaf blades, and the **characteristic cigar-like flowering spike**, which is dense and brown before erupting into a white, downy mass in the fall.

The horizontal belowground stems, or rhizomes, expand and send up new vertical growth, which allows cattails to form dense stands that creep laterally along the shallow shoreline. Although this is important habitat and a food source for wildlife, these stands can reduce shoreline access in recreational ponds.

Cattails have a long history of human use, and many parts of the plant are edible. The starchy rhizome was ground into meal by Native Americans. Young shoots can be eaten like asparagus, while the sprouts can be served in salads or boiled and served as greens. The immature flower spikes can be boiled and eaten like corn on the cob, and even the pollen has been used as a flour substitute.

Medicinally, Native Americans used the pounded roots as a dressing on wounds. Young flower heads were eaten to treat diarrhea, and the flowery down was used to dress burns. The down has also been used as padding in mattresses, pillows, and diapers. The U.S. Navy used the water-repellent seeds in life vests.

Management Value

As mentioned, cattails can be eaten, but their greatest value is for aesthetics and habitat. They are often used in water gardens and small ponds as an accent or as a privacy screen, and the flower spikes are often incorporated into dried flower arrangements.

Cattail | *Typha* spp.

Many species of fish and wildlife use cattail stands. Red-winged blackbirds, waterfowl, and fish will nest in the stands; beaver and muskrats eat the shoots and roots; and a variety of bird species eat the seeds.

When incorporating cattails into a natural management plan, care must be taken to prevent uncontrolled expansion. Cattails can have aggressive growth, so frequent control will be needed. Alternatively, the species can be planted in large containers and any adjacent plants removed on first appearance.

Recommended Controls

Option 1: Glyphosate (5.4-pound formulation). For each gallon of water, mix 5.0 ounces glyphosate and 1.3 ounces non-ionic surfactant. Spray to wet all leaf surfaces. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Imazapyr (2.0-pound formulation). For each gallon of water, mix 2.6 ounces imazapyr and 1.3 ounces non-ionic surfactant. Spray to wet all leaf surfaces. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: Imazamox (1.0-pound formulation). For each gallon of water, mix 1.5 ounces of imazamox and 1.3 ounces non-ionic surfactant. Spray to wet all leaf surfaces. Do not exceed annual herbicide rate limits as stated on the product label.

For these herbicides, multiple applications may be needed to achieve eradication. The best approach is to treat with herbicides when plants are actively growing.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Creeping Burhead | *Echinodorus cordifolius*

Two creeping burhead leaves.

Complete creeping burhead plant with roots.

A mixed stand of plants including creeping burhead float in shallow water.

Native to the eastern United States, creeping burhead is an annual or short-lived perennial species that is in the same family as arrowhead (*Sagittaria*) and may be confused with that genus. Creeping burhead can grow as high as 4 feet and prefers damp or lightly flooded habitats.

The leaves are glossy green and somewhat egg- to spade-shaped. There is a shallow notch where the stem inserts, and they grow in a clump with other leaves on long, rough stems called petioles, which are spongy toward the base. Each leaf has **parallel veins with cross venation.**

The flower stalk can be long, has no leaves, and will contain many whorls of white, cupped flowers with yellow to green centers. Each flower is about a half-inch in diameter.

Flower stalks grow in length until they **bend over to the ground, take root, and form new plantlets,** giving the plant its "creeping" characteristic and name.

The small, dry fruits contain only one seed that is not released from the fruit. The seeds are bur-like and usually brown.

Management Value

Creeping burhead is a native species and an attractive plant that is recommended for use in pond and water garden management. Although wildlife benefits have not been documented, it likely provides structural habitat for smaller terrestrial and aquatic species.

This plant species can become weedy under ideal conditions and must be controlled. To prevent uncontrolled growth, only plant in areas with limited shallow water habitat and surrounded by water that exceeds 1 foot deep.

Creeping Burhead | *Echinodorus cordifolius*

Recommended Controls

Herbicide efficacy is not listed for creeping burhead, but glyphosate will control this species. Hand pulling is an option for small stands.

Option 1: Glyphosate (5.4-pound formulation). For each gallon of water, mix 5.1 ounces glyphosate and 1.3 ounces surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: 2,4-D (3.8-pound formulation). For each gallon of water, mix 0.5 ounce 2,4-D and 1.3 ounces non-ionic surfactant. Spray to wet all leaf surfaces.

Multiple applications will likely be necessary to achieve eradication. The best approach is to treat ponds with herbicides when water temperature is at least 60˚F and the plants are actively growing.

Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.

Cut Grass | *Leersia* and *Zizaniopsis* spp.

Stand of southern cut grass, *Leersia hexandra*.

Hairy node of cut grass.

Cut grass with flower spike.

Cut grass can grow along shorelines or as a floating mat in calm water. It can be problematic and is a pest in many agricultural settings.

The leaves are flat, thin, and sword-like. **They are rough to the touch and have sharp edges**. Stems are wire-like, often leaning, **with hairy nodes where the leaves join the stem**.

Flowers are located at the tip of the branch in clusters. Cut grass primarily reproduces via its creeping rhizomes, but it can reproduce by seed.

Management Value

Cut grass is a native species that can be a valuable food source for ducks and other birds. Mats may provide some cover to aquatic species. However, due to its mat-forming characteristics, this species is not recommended for introduction into water bodies of any size.

Cut Grass | *Leersia* and *Zizaniopsis* spp.

Recommended Controls

Option 1: Glyphosate (5.4-pound formulation). For each gallon of water, mix 1.0 ounce glyphosate and 1.3 ounces nonionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Penoxsulam (2.0-pound formulation). For each gallon of water, mix 0.1 ounce penoxsulam and 1.3 ounces nonionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: Bispyribac-sodium (80 percent active). For each gallon of water, mix 0.04 ounce bispyribac-sodium (by weight) and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Bispyribac-sodium is a powdered formulation that is measured by weight rather than volume. Multiple applications may be needed to achieve eradication.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Frog's-Bit | *Limnobium spongia*

Heart-shaped leaves of frog's-bit.

Dense coverage of frog's-bit.

Comparison of invasive water hyacinth (left) and native frog's-bit (right). Veins of water hyacinth run parallel, while frog's-bit veins expand outward.

This frog's-bit species is native to Mississippi and is characterized by small, thick, leathery leaves that are rounded and heart shaped. They are shiny and bright green on the upper surface and reddish on the underside. **The leaves feel spongy.**

The leaf stalk is slender and has ridges. Its roots are white. The plant produces a flower with three white petals and a yellow center.

Frog's-bit can be found rooted in shallow marginal areas or free-floating in deeper areas. When floating offshore, it often co-occurs with other species, which it uses to maintain position without being blown to shore.

This species is often confused with the invasive species water hyacinth (*Pontederia crassipes*). However, water hyacinth has parallel vein structure compared to **expanding veins on frog's-bit**. When water hyacinth flowers are present, the species can easily be distinguished by its showy purple flower stalks.

Management Value

The seeds of frog's-bit are eaten by ducks and possibly other animals. The plant serves as habitat for invertebrates. Frog's-bit rarely causes problems as a shoreline species; however, its floating growth form can create dense mats that may block sunlight, which causes an oxygen depression and has the potential to kill fish. It is not recommended as a beneficial addition to pond management.

Frog's-Bit | *Limnobium spongia*

Recommended Controls

It is best to apply herbicides when plants are actively growing.

Option 1: Imazapyr (2.0-pound formulation). For each gallon of water, mix 2.5 ounces imazapyr and 1.3 ounces non-ionic surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Imazamox (1.0-pound formulation). For each gallon of water, mix 2.0 ounces imazamox and 1.3 ounces non-ionic surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: Triclopyr (3.0-pound formulation). For each gallon of water, mix 2.5 ounces triclopyr and 1.3 ounces non-ionic surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.

Iris | *Iris* spp.

Native iris variety blue flag.

Rhizome of yellow flag.

Non-native iris variety yellow flag.

The iris is a well-known horticulture plant in Mississippi, but there are wild iris species that can inhabit natural waters, as well. These include native blue flag *Iris virginica* and non-native yellow flag *Iris pseudacorus*.

Blue flag has **characteristic blue to purple flowers with distinct yellow midrib** on each of the three outer petals. The flower is quite showy and attractive. Blue flag leaves are sword-shaped, several feet in length, and relatively limp, bending to the ground.

Yellow flag has larger, yellow flowers that form in multiples on a more rigid stem than blue flag. Leaves are more rigid and longer, and they grow from a thick rhizome. Yellow flag irises were introduced from Europe.

Management Value

Irises can be important to pollinators and hummingbirds, and submerged plants likely provide some habitat to fish and other aquatics. Blue flag is native and less aggressive than yellow flag, and this species can be introduced to ponds and wetlands for aesthetic improvements. Yellow flag can be toxic to humans and animals if sufficient quantities are ingested.

Irises will spread, so some control may be necessary. Using ceramic or cement containers to reduce lateral spread may be a good approach to preventing problems. Yellow flag is not recommended.

Iris | *Iris* spp.

Recommended Controls

Covering with plastic tarps or landscape fabric has been an effective method of controlling small iris patches.

Option 1: Glyphosate (5.4-pound formulation). For each gallon of water, mix 5.0 ounces glyphosate and 1.3 ounces non-ionic surfactant, and the rest water. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Imazapyr (2.0-pound formulation). For each gallon of water, mix 3.75 ounces imazapyr and 1.3 ounces non-ionic surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Treat with herbicides when plants are actively growing. Tank mixing imazapyr and glyphosate may be more effective than using either option alone.

Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.

Photo Credits Top: Keith Meals, MDWFP; Bottom: USDA.

Juncus | *Juncus* spp.

Juncus stem with small, dry, brown flower clusters.

Juncus roemerianus growing along a tidal area.

Juncus with drying, browned flowers along a pond edge.

Rushes of the genus *Juncus* are flowering plants that grow along the margins of many slow-moving water bodies. They are commonly confused with grasses or sedges.

Juncus is characterized by round, hollow, and pointed stems with leaves that form a sheath around the stem. Stems grow in groups and create dense clumps of foliage.

The flowers are small and usually brown. Many seeds form in a pod on the flower structure and are dry.

The flower is terminal but **often appears on the side** of the stem because the subtending bract extends farther than the flower. This appearance of being on the side and the round, hollow stems make *Juncus* easy to identify.

Management Value

The seeds of *Juncus* are consumed by songbirds, waterfowl, muskrats, rabbits, and quail. Many species use rushes for nesting and concealment habitat. Rushes rarely take over a pond but can interfere with shoreline access. This species can be planted or encouraged to diversify habitat and provide a more natural aquascape. Containment can be easily achieved by limiting shallow water and moist soil areas and with spot-spraying herbicides.

Juncus | *Juncus* spp.

Recommended Controls

Option 1: 2,4-D (3.8-pound formulation). For each gallon of water, mix 0.6 ounce 2,4-D and 1.3 ounces non-ionic surfactant. Spray to wet all exposed leaves. Do not exceed annual herbicide rate limits as stated on the product label.

Multiple applications are likely necessary to achieve eradication.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Photo Credits Middle: Scott Rush, Mississippi State University Department of Wildlife, Fisheries, and Aquaculture.

Lemon Bacopa | *Bacopa caroliniana*

Yellow-green lemon bacopa (*Bacopa caroliniana*).

Mixed stand with lemon bacopa with one blue bloom.

Tiny, light-blue flowers emerging from lemon bacopa stems.

Also known as blue waterhyssop, lemon bacopa is a succulent species with a **distinct lemony scent** that is released when the leaves are crushed.

This species prefers moist shorelines where it can form a creeping mat. In clear water, it grows as a submersed plant with the tips of shoots emerging from the water column.

The leaves are relatively thick, and darker green when submerged and pale green or yellow when in air. They are paired and opposite of one another, oval to mildly triangular, and about a half-inch in length. **The leaves are covered in fine hairs.** The upper stems of bacopa are covered in hairs.

The flowers are small and present throughout the summer. They are pale to dark blue.

Management Value

The wildlife value of lemon bacopa is not clear. Although not a known primary food source of many animals, it likely serves as habitat for invertebrates, which feed higher organisms.

Lemon bacopa is rarely a problem species that requires treatment, as it does not expand rapidly or grow in deeper areas. However, since it does not offer significant value as habitat or as an ornamental plant, it is not a recommended species for management.

Lemon Bacopa | *Bacopa caroliniana*

Recommended Controls

Option 1: Florpyrauxifen-benzyl (2.5-pound formulation). Florpyrauxifen-benzyl (6.75 ounces per acre-foot of water) should be applied as a submersed injection (application using a wand or hose). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Diquat (3.73-pound formulation). Diquat should be applied as a submersed injection (0.25 gallon per acre-foot of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

The best approach is to treat ponds with herbicide when the plants are actively growing, and the water temperature is at least 60˚F. For both options, water bodies should be treated in thirds with 1 to 2 weeks between treatments to prevent oxygen depletion.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Photo Credits Middle: Jeff McMillian, USDA. Provided by Almost Eden. United States, Louisiana.; Bottom: Larry Allain, USDA.

Lizard's Tail | *Saururus cernuus*

Lizard's tail growing along a shoreline.

Lizard's tail leaves.

Bottle brush-like lizard's tail flower spikes.

Lizard's tail is an attractive native species with an erect growth form that reaches 1–2 feet in height.

Leaves are rich green and typically shaped like **stretched hearts** or arrowheads. They are sharply pointed with obvious palmate veins radiating out from where the stalk joins. Usually there are five primary veins that divide into smaller branches much like a tree. Leaves are typically 4 inches long and 2 inches wide.

The flower spike is a showy spire of many small, crowded, white flowers that **resembles a bottle brush**. It is usually 4–8 inches in length and extends higher than the leaves.

Lizard's tail is primarily a shoreline or shallow water plant, although it can grow in strictly terrestrial areas. It spreads via underground runners and can expand quickly once established.

Management Value

Lizard's tail has little known wildlife food value. The foliage is toxic and avoided by mammals, but some insect species consume the roots. Despite the lack of wildlife food value, the species likely provides habitat to young fish and other species. It will typically stay on the shore or in shallow areas, and although it can spread rather quickly, it can be easily controlled.

Lizard's tail alone rarely causes significant management issues, and it is a beautiful backdrop to many water bodies. Thus, this species can be used as an ornamental addition to ponds and water gardens, with periodic control of its spread as needed.

Lizard's Tail | *Saururus cernuus*

Recommended Controls

Glyphosate (5.4-pound formulation). For each gallon of water, mix 5.0 ounces glyphosate and 1.3 ounces non-ionic surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Lizard's tail is usually not in water more than a foot deep. If the majority of the plant is on the shoreline, it does not represent a significant threat of oxygen depletion and can be treated at one time.

The best approach is to treat ponds with herbicides when water temperature is at least 60˚F, and the plants are actively growing. Multiple applications are likely necessary to achieve eradication.

Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.

Parrot's-feather | *Myriophyllum aquaticum*

Dense stand of parrot's-feather.

Parrot's-feather leaves.

Light green parrot's-feather emerging from the water.

Parrot's-feather is a non-native species from South America that can be invasive and has been widely spread around the southern and western United States.

Leaves are a **pale green to blue green** and grow in whorls of four to six. Each leaf is about 1–2 inches long and divided into 10 or more thread-like filaments. This gives the leaves a **feather-like appearance**.

Although the species produces flowers, which are non-showy, white or pinkish branches that look like leaves, there are only female plants in the United States. Without a male to fertilize flowers, this species is infertile and does not produce viable seeds. Spread occurs via plant fragments.

Parrot's-feather normally occurs in low densities but, under certain conditions, can become a significant problem. It can clog waterways, interfere with recreational water use, and displace native plants.

Management Value

Parrot's-feather is an invasive, non-native species and should be eradicated when detected.

Parrot's-feather | *Myriophyllum aquaticum*

Recommended Controls

Option 1: Diquat (3.73-pound formulation). Diquat (0.25 gallon per acre-foot of water) should be applied as a submersed injection (application using a wand or hose). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Option 2: 2,4-D (3.8-pound formulation). For each gallon of water, mix 0.6 ounce 2,4-D and 1.3 ounces non-ionic surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: Triclopyr (3.0-pound formulation). For each gallon of water, mix 2.5 ounces triclopyr and 1.3 ounces non-ionic surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 4: Imazapyr (2.0-pound formulation). For each gallon of water, mix 0.25 ounce imazapyr and 1.3 ounces non-ionic surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

For option 1, the best approach is to treat ponds with herbicide when the water temperature is at least 60˚F and the plants are actively growing. Water bodies should be treated in thirds with 1–2 weeks between treatments to prevent oxygen depletion.

For smaller ponds, check dissolved oxygen levels first to make sure they are high enough to ensure decaying plant matter will not cause a fish kill, then treat the whole pond at once.

For options 2–4, multiple applications may be needed to eradicate the plant.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Photo Credits Top: Robin R. Buckallew, USDA.

Phragmites | *Phragmites australis*

A fluffy *Phragmites* flower spike.

A dense stand of *Phragmites*.

A stand of *Phragmites* along a shoreline.

Phragmites (or common reed) has native and invasive sub-species in the U.S. The invasive sub-species are most likely European in origin and exhibit aggressive growth in wetland and shoreline areas.

Common reed can reach heights exceeding 15 feet and have dozens of stems per square meter, creating a wall that prevents shoreline access, obscures views, and displaces native plant and animal species. Phragmites can grow densely, and the sharp leaves make it difficult and dangerous to walk through. It also poses a late summer and fall fire risk, as it becomes fuel for fire in its dried state.

The leaf blades of phragmites are long, flat, and between 0.4 and 1.5 inches wide. Phragmites stems are hollow and topped with a characteristic fluffy flower spike, making them easily recognizable from a distance.

Genetic studies have not identified the native species of phragmites in Mississippi ponds, suggesting only the invasive species is present in the state. If encountered, it should be eradicated immediately.

Management Value

Although some bird species use phragmites for nesting, perching, and feeding from the seeds, the negative impacts greatly outweigh any positive value. Phragmites should be eliminated on first detection.

Phragmites | *Phragmites australis*

Recommended Controls

Option 1: Imazapyr (2.0-pound formulation). For each gallon of water, mix 0.9 ounce imazapyr and 1.3 ounces non-ionic surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Imazamox (1.0-pound formulation). For each gallon of water, mix 2.5 ounces imazamox and 1.3 ounces non-ionic surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: Glyphosate (5.4-pound formulation). For each gallon of water, mix 6.0 ounces glyphosate and 1.3 ounces non-ionic surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

For all options, multiple applications may be necessary to achieve eradication. The best approach is to treat plants that are actively growing.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Photo Credits Top: USDA

Pickerelweed | *Pontederia cordata*

Heart-shaped pickerelweed leaves.

Pickerelweed mixed with yellow flag iris.

Pickerelweed flower spike.

Pickerelweed is an emergent aquatic plant that grows in shallow, calm water. Plants can reach 3 feet in height, and have glossy green, heart- or sword-shaped leaves with parallel veins on spongy stems.

The flowers are very attractive and **resemble hyacinth.** Blooming occurs all summer and produces a flower spike with blue, white, and violet flowers that rises above the leaves with a single leaf attached to the flower stalk.

Management Value

Many species eat or use pickerelweed in natural systems. Deer enjoy the tender plant, waterfowl eat the seeds, butterflies and bees use the pollen, and dragonflies use plants as a hunting perch. Muskrats eat the rhizomes and base. It creates shallow water structure for fish and aquatic insects. In fact, it is named pickerelweed because pickerel are known to ambush prey from between the plants.

Humans use pickerelweed for more than aesthetics. The starchy seed can be eaten fresh or dried like nuts and added to granola or cereal, or can be boiled, roasted, or ground into flour. The young leaves can be eaten raw in salads or sauteed in butter, and the stalks are often cooked and served as a green vegetable.

Pickerelweed is a beautiful plant that spreads slowly and rarely causes problems in ponds. It is recommended for habitat enhancement and can be planted directly in shallow water or placed around the pond in pots.

Pickerelweed | *Pontederia cordata*

Recommended Controls

Option 1: Glyphosate (5.4-pound formulation). For each gallon of water, mix 1.0 ounce glyphosate and 1.3 ounces non-ionic surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Imazamox (1.0-pound formulation). Imazamox (52 ounces per acre-foot of water) should be applied as a submersed injection (application using a wand or hose). Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

For submersed injections, the best approach is to treat ponds with herbicides when water temperature is at least 60˚F.

Submersed injection means that the herbicide solution should be applied below the water surface directly into the water.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Smartweed | *Polygonum* and *Persicaria* spp.

Dense stand of *Polygonum*.

The distinctive enlarged joints where leaves meet stem on knotweed.

Close-up of a smartweed flower spike.

Polygonum is composed of two groups, smartweed and knotweed, which are both common plants in Mississippi's terrestrial and aquatic settings. However, most *Polygonum* species prefer moist-soil habitats.

Polygonum is an erect plant that has simple, alternating, sword-shaped leaves of glossy green. Each leaf has a central vein and secondary veins that extend from the central vein at roughly a 45-degree angle. Where the leaf stalk joins the stem, **there are distinctive enlarged joints, or knots**, from which the knotweed name is derived. There is also a **membrane around the stem above each node** (called an ocrea) that is distinctive to plants of this genus.

This species can flower between May and November. Depending on the variety, the blooms range in color from white to pink to green. The two groups can sometimes be differentiated by the flower type: smartweed has a terminal spike of flowers, while knotweed has a cluster of flowers in the leaf axil. However, it is typically unnecessary for the pond owner to distinguish between the two.

Management Value

Polygonum is a very important plant to many species of wildlife. It attracts pollinators including bees and butterflies. The seeds are a critical part of the diet of waterfowl, upland game birds, songbirds, and small mammals. The plants are browsed by deer and other species.

Dense stands of *Polygonum* species provide nesting and cover habitat for birds and mammals, and submerged plants provide fish habitat. Humans have historically used it for dyeing fabric and in holistic medicine. The seeds are also edible.

Polygonum establishment and growth is encouraged in moist-soil habitats that are flooded for waterfowl, as it attracts migrating birds. However, it is not typically encouraged in recreational pond management, as it spreads quickly and interferes with pond access and use.

Smartweed | *Polygonum* and *Persicaria* spp.

Recommended Controls

Option 1: Glyphosate (5.4-pound formulation). For each gallon of water, mix 0.5 ounce glyphosate and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Imazapyr (2.0-pound formulation). For each gallon of water, mix 0.25 ounce imazapyr and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: Imazamox (1.0-pound formulation). For each gallon of water, mix 1.0 ounce imazamox and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 4: 2,4-D (3.8-pound formulation). For each gallon of water, mix 1.0 ounce 2,4-D and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

The best approach is to treat ponds with herbicides when the plants are actively growing. If more than one-third of the pond is covered, treat one-third of the pond at a time, with a week or more separating applications. After the entire pond has been treated, a repeat application may be needed to eliminate remaining plants.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Spatterdock | *Nuphar advena*

Spade-shaped leaves and yellow flowers of spatterdock.

Spatterdock flowers.

A dense stand of spatterdock.

Spatterdock, also known as cow lily, is an attractive native species of rooted lily pad. It is a perennial plant that has **spade- to heart-shaped leaves with a deep notch** where the stem joins the leaf. Leaves are arranged in a spiral at the base.

Leaves can be up to 16 inches in length but are more often half that length. Leaves may be submersed, float on the surface, or emerge above it. Surface leaves are shiny green, while submersed spatterdock leaves can be almost transparent.

Flowers are small and round and extend just above the water's surface. The petals are yellow and less showy than white water lily, *Nymphaea* spp., or American lotus, *Nelumbo lutea*. The latter two species have more circular leaves, as well.

Spatterdock fruit is egg-shaped and contains many seeds. Seeds are generally less than one-fourth inch long and slightly narrow.

Management Value

Spatterdock is an important native species in natural environments. Deer eat the leaves, beavers and muskrats will eat the rhizomes, and ducks eat the seeds. It can make excellent fish habitat in moderate densities.

This plant has been used in traditional medicine to treat a variety of conditions. People also eat the seeds or grind them into flour. The root is edible but can be quite bitter.

Spatterdock can be problematic in shallow ponds. However, for those who like aggressive management, it makes excellent fish habitat and can be introduced on small, shallow areas adjacent to deeper water. Address unwanted expansion early before the problem gets too severe.

Spatterdock | *Nuphar advena*

Recommended Controls

Option 1: Flumioxazin (4.0-pound formulation). Flumioxazin (1.1 pints per acre-foot of water) should be applied as a submersed injection (application using a wand or hose). Determine pond volume prior to application. Use a buffering agent when mixing with water with pH greater than 7.0. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: 2,4-D (3.8-pound formulation). 2,4-D should be applied as a submersed injection (1.4 gallons per acre-foot of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Submersed injection means that the herbicide solution should be applied below the surface directly into the water. The best approach is to treat ponds with herbicides when the water temperature is at least 60˚F and the plants are actively growing.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Photo Credits Middle: U.S. Fish and Wildlife Service

Torpedograss | *Panicum repens*

A torpedograss stem.

A dense stand of torpedograss.

Expanding root system of torpedograss.

Torpedograss, which is also called panic grass, is an aggressive and difficult to control invasive grass species originally introduced from Australia. It has taken over 70 percent of Florida's public waters and represents a significant threat to Mississippi waters.

This species grows in moist-soil and shallow-water habitats, and will quickly displace native vegetation. It can form dense mats that restrict water flow and clog intake pipes.

It has sharply pointed (torpedo-like) growing tips that can reach heights of 3 feet. The upper margins of leaves **have small hairs and may have a waxy or white coating**. Leaves alternate along the stem, are flat to folded and stiff, and grow at a **45-degree angle from the stem**.

Torpedograss develops tremendous root/rhizome systems that are difficult to kill. Herbicides may kill the surface plant, but it can return from the root system. Repeated treatments are often required to deplete root energy reserves.

Management Value

Highly invasive and destructive. Eliminate on first detection.

Torpedograss | *Panicum repens*

Recommended Controls

The most effective herbicide for torpedograss is glyphosate.

Option 1: Glyphosate (5.4-pound formulation). For each gallon of water, mix 1.0 ounce glyphosate and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Imazapyr (2.0-pound formulation). For each gallon of water, mix 2.0 ounces imazapyr and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: Flumioxazin (4.0-pound formulation). Flumioxazin (2.2 pints per acre-foot of water) should be applied as a submersed injection (application using a wand or hose). Determine pond volume prior to application. Use a buffering agent when mixing with water with pH greater than 7.0. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-feet = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Submersed injection means that the herbicide solution is applied below the water surface directly into the water. Multiple applications may be necessary to achieve eradication.

The best approach is to treat with herbicides when water temperature is at least 60˚F and the plants are actively growing. Glyphosate and imazapyr can be tank mixed and applied to torpedograss foliage. Alternating between foliar (glyphosate and/or imazapyr) and submersed (flumioxazin) herbicide treatments may enhance torpedograss control. There should be 8 weeks between each treatment.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Photo Credits Bottom: Samantha Bergeron, MDWFP

Water Lily | *Nymphae* spp.

Water lily compared to smaller frog's-bit and water shield leaves.

Mixed stand including water lily taking over a shallow lake.

Water lily flower.

Water lily is a common calm-water plant that has been extensively added to water gardens and ponds for aesthetics. Some species are native, while others are cultivars or introduced from elsewhere.

The leaves are **round to oval and have a deep notch** where the leaf stalk inserts. Leaves and stems are spongy, green on the upper surface, and purple or red underneath. The plants grow from rhizomes on the lakebed, with the leaves forming a mat on the surface or emerging just above.

The flowers are very showy. Many are white or yellow, but cultivars and non-natives can be many colors. There are three common types: yellow flowers (*N. mexicana*), light purple and yellow flowers (*N. elegans*), and white and yellow flowers (*N. odorata*).

Management Value

Water lily makes excellent habitat for fish and other aquatic animals in moderate densities. The flowers attract pollinators, and some mammals, turtles, and birds eat parts of the plant.

People have used the rhizomes to make medicine for gastrointestinal issues, sore throats, or dressings for burns. The flowers, seeds, and rhizomes are edible raw or cooked.

Water lily can be used to provide fish habitat and to give ponds a more natural appearance. It can take over shallow lakes, so this plant should be considered for deeper ponds with an understanding that a management plan is necessary. Planting in large containers or on isolated shallow islands is a good approach, with spot treatment of unwanted plants on first appearance.

Water Lily | *Nymphae* spp.

Recommended Controls

Option 1: 2,4-D (3.8-pound formulation). 2,4-D should be applied as a submersed injection (1.75 gallons per acre-foot of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Endothall (4.23-pound formulation). Endothall should be applied as a submersed injection (1.3 gallons per acre-feet of water). Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-feet = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Submersed injection means that the herbicide solution is applied below the water surface directly into the water. For larger water bodies, treat one-third of the water body at a time and wait 2 weeks between applications. Then, treat the next one-third of the water body.

The best approach is to treat ponds with herbicides when water temperature is at least 60˚F and the plants are actively growing. Multiple applications may be necessary to achieve eradication.

Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.

Water Pennywort | *Hydrocotye* spp.

Infestation of water pennywort and other species.

Water pennywort leaf and flower.

Mass of water pennywort and organic matter from shallow margins.

Water pennywort is a member of the carrot family (Apiaceae) and is commonly found growing adjacent to or floating as a mat on the surface of slow-moving and calm waters. It is typically less than a foot tall.

The **circular, slightly lobed leaves** are deep green, shiny, and leathery. There is a **pale dot in the middle where the stem attaches** on the leaf underside. **Faint veins radiate out from the center like spokes of a wheel.** Leaves can be up to 3 inches in diameter but are usually about the size of a silver dollar coin.

Stems are pale green to brownish white. These round stems are thick and spongy, allowing them to float on the water's surface. Short flower stalks can form on the horizontal stems, giving rise to a small cluster of pale flowers.

Management Value

Water pennywort seeds are occasionally eaten by ducks, and leaves and stems are eaten by some insects. However, it can form dense stands that interfere with recreational use, so it is not recommended for pond management.

Water Pennywort | *Hydrocotye* spp.

Recommended Controls

Option 1: 2,4-D (3.8-pound formulation). For each gallon of water, mix 1.25 ounces 2,4-D and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Glyphosate (5.4-pound formulation). For each gallon of water, mix 0.5 ounce glyphosate and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

The best approach is to treat ponds with herbicide when the water temperature is at least 60˚F and the plants are actively growing. Multiple applications may be necessary to achieve eradication.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Water Primrose | *Ludwigia* spp.

Immature plant with oval leaves and characteristic red stem.

Mature water primrose with lance-shaped leaves and characteristic yellow flower.

Water primrose's tendency to creep can create mats that extend from shore.

Water primrose is very common in Mississippi and has many species. It grows on the shore or in very shallow water. Over time, it will form a floating mat that is rooted near shore but may stretch out into more open water.

This species has **alternating leaves** that are arranged in a rosette at the stem tip. Leaves are covered on both sides by small, soft hairs.

Leaves of immature plants are typically oval and on the water surface, while mature leaves become more lance-shaped and emergent. Immature leaves are small, while mature leave can be 5 inches in length.

Stems are usually reddish and may be covered in long hairs. Subsurface stems have a spongy feel. Primrose foliage and growth form can be mistaken for the invasive plant alligator weed; however, alligator weed stems are hollow, while primrose stems are solid.

The flowers (*Ranunculus repens*) are **bright yellow and resemble a terrestrial buttercup**. Flowers may be present the entire growing season and have **four or five petals**.

Management Value

Water primrose is a food source for many animals. Waterfowl eat the seeds, and several insects consume the leaves. The plants provide habitat for juvenile fish and ambush locations for predators.

However, planting this species is not recommended because it can become problematic. Further, water primrose is very common and will usually establish naturally. In moderation it is not a problem, but it should be treated if it interferes with other water uses.

Water Primrose | *Ludwigia* spp.

Recommended Controls

Option 1: Glyphosate (5.4-pound formulation). To each gallon of water, add 0.75 ounce glyphosate and 1.3 ounces non-ionic surfactant. Spray to wet all plants.

Option 2: Flumioxazin (4.0-pound formulation). To each gallon of water, add 0.05 ounce flumioxazin and 1.3 ounces non-ionic surfactant. Spray to wet all plants.

Option 3: 2,4-D (3.8-pound formulation). To each gallon of water, add 1.0 ounce 2,4-D and 1.3 ounces non-ionic surfactant. Spray to wet all plants.

Option 4: Triclopyr (3.0-pound formulation). To each gallon of water, add 1.25 ounces triclopyr and 1.3 ounces non-ionic surfactant. Spray to wet all plants.

The best approach is to treat ponds with herbicides when water temperature is at least 60˚F and the plants are actively growing. Following treatment, stock three to five triploid grass carp per acre to prevent reinfestation.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Water Shield | *Brasenia schreberi*

Floating leaves of water shield with characteristic oval shape.

Mixed stand of water shield and water lily.

Red underside and gelatinous coating of a water shield leaf.

Water shield, or dollar bonnet, is a floating-leaf plant. Its **small, oval leaves** are attached to long stalks that connect the plant to the roots on the pond bottom. Water shield leaves are smaller than similar species, never exceeding 4 inches long. The smooth, pale green leaves do not have a notch where the stalk attaches.

A key characteristic is the **red to burgundy color of the stalks and undersides of floating leaves**. The **thick, gelatinous coating** found on the undersides of the leaves can be up to one-fourth inch thick.

Flowers are very small and often overlooked. They are dull purple and usually about a half-inch or smaller in diameter. These blooms produce a leathery, club-shaped fruit that is smaller than the flower.

Water shield is rooted in the bottom soil, and the species can grow about 6 feet deep into a water body.

Management Value

Water shield is a native plant, and its seeds are eaten by waterfowl. The leaves and stalks provide habitat for fish. In small quantities it is part of a healthy pond ecosystem, although it is highly invasive and usually takes over all but the deepest ponds. Water shield is not recommended for pond management and should be controlled at first appearance.

Water Shield | *Brasenia schreberi*

Recommended Controls

Option 1: Flumioxazin (4.0-pound formulation). Flumioxazin (1.1 pints per acre-foot of water) should be applied as a submersed injection (application using a wand or hose). Determine pond volume prior to application. Use a buffering agent when mixing with water with pH greater than 7.0. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a water body and averaging the values.

Option 2: 2,4-D (3.8-pound formulation). For each gallon of water, mix 1.28 ounces 2,4-D and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

The best approach is to treat ponds with herbicides when the water temperature is at least 60˚F and the plants are actively growing.

Treat one-third of the pond at a time, with a week or more separating applications. After the entire pond has been treated, a repeat whole-pond application may be needed to eliminate remaining plants. Following treatment, stock three to five triploid grass carp per acre to prevent re-infestation. Stock 8- to 10-inch triploid grass carp in ponds that have established largemouth bass populations to avoid predation by bass.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Water Taro | *Colocasia esculenta*

Water taro stand along a river bank.

Water taro rhizomes are a popular root vegetable.

Water taro leaf.

Water taro is a non-native, water-tolerant plant that can grow and survive in water up to 1 foot deep. This species is native to Asia but has been introduced to multiple countries globally for ornamental use and as a food crop.

The leaves grow from long stalks and are **arrowhead-shaped, very large** (up to 3 feet long), and dark green. It is **often called "elephant ear"** due to its resemblance and size. Stems are up to 4 feet long and grow from large rhizomes.

Taro is an important root vegetable and is cooked much like potatoes in many countries. It is often boiled, baked, mashed, or sliced thin and made into a snack chip.

Management Value

Water taro is an attractive garden and ornamental pond species. It has a tropical appearance that many landowners desire. The tubers are popular as a human food when prepared correctly, which generally involves a quick boil followed by a slow simmer submersed in water in a covered pot.

This species provides little wildlife value; on the contrary, it tends to disrupt natural ecosystems and displace native species. Water taro can be invasive to riparian habitats and shallow waters. It should be eradicated upon first detection.

Water Taro | *Colocasia esculenta*

Recommended Controls

Option 1: 2,4-D (3.8-pound formulation). For each gallon of water, mix 1.28 ounces 2,4-D and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Triclopyr (3.0-pound formulation). For each gallon of water, mix 1.28 ounces triclopyr and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: Glyphosate (5.4-pound formulation). For each gallon of water, mix 1.28 ounces glyphosate and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Multiple applications will likely be needed to achieve eradication; combining any two of the listed herbicide treatments may enhance control.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Waterleaf | *Hydrolea* spp.

Hydrolea flowers.

Hydrolea spine.

Individual *Hydrolea* plant with flower.

Also known as blue waterleaf, ovate false fiddleleaf, or waterpod, this native species is a sprawling and sturdy marginal plant that can grow up to 3 feet high. It is characterized by hairy, ovate leaves, blue flowers, and spines on the stem.

Multiple stems grow from the base and branch toward the top of the plant. Leaves grow alternately on the stem and are an inch wide and 2 to 3 inches long. **A heavy spine, up to a half-inch long, is located just below most leaves.**

Flowers grow in clusters of hairy buds at the ends of stems, and buds open to reveal **bright-blue flowers with five lobes**, long, blue to purple stamens, and yellowish centers and pistils. Flowers are about 1 inch wide.

Management Value

Waterleaf is a native species but has no known food value for wildlife. It may provide physical habitat for fish when flooded, but it is generally not a valuable species in pond management. It can form dense stands that interfere with recreational use, and spines can be harmful to livestock, wildlife, and humans. It is not recommended for establishment in ponds.

Waterleaf | *Hydrolea* spp.

Recommended Controls

Option 1: Glyphosate (5.4-pound formulation). For each gallon of water, mix 1.0 ounce glyphosate and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Multiple herbicide applications may be necessary to eradicate plants.

Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.

Photo Credits Top: Larry Allain, United States Geological Survey

Water-willow | *Justicia americana*

Floating stand of water-willow.

Line drawing of water-willow.

Water-willow stem and flower.

Water-willow, also known as American water-willow, is found throughout the eastern half of the United States. This species grows from slender rhizomes that expand over time to form large stands. You will most often find this plant along the shoreline, in shallow lakes and ponds, or in the shallow riffles of flowing water.

Stems may emerge 3 feet above water and have simple leaves that **are arranged oppositely along the stem**. Leaves are normally 3 to 6 inches when mature, sword-shaped, and medium-green.

Water-willow is sometimes confused with alligator weed, but it can be distinguished by its **single showy, white and/or violet iris-like flowers**. Alligator weed typically has spherical, clover-like, white flowers. Water-willow flowers produce dry, highly polished seeds in groups of four, and each seed is about one-tenth of an inch in length.

Management Value

Water-willow is a native species and an important component of natural waterbodies. Deer will eat the leaves, beavers and muskrats will eat the rhizomes, and bees and other insects use the pollen. In moderate densities, it makes excellent habitat for fish, amphibians, and aquatic invertebrates.

The growth rate of water-willow is moderate to rapid, quickly forming large colonies. It can be problematic in shallow ponds and should not be encouraged by most pond owners. However, for those who like aggressive management, it makes excellent fish habitat and can be introduced on small, shallow areas adjacent to deeper water. Take care to control any unwanted expansion early before the colonies grow to nuisance levels.

Water-willow | *Justicia americana*

Recommended Controls

Option 1: 2,4-D (3.8-pound formulation). For each gallon of water, mix 1.0 ounce of 2,4-D and 1.3 ounces of non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

The best approach is to treat ponds with herbicides when the plants are actively growing and the water temperature is at least 60˚F. Multiple applications may be necessary to achieve eradication.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Photo Credits Top: Mike Cline, Creative Commons; Middle: N. L. Britton and A. Brown, USDA.

Duckweed | *Lemna* spp.

Leaf-like petals of common duckweed.

Comparison of common and giant duckweed.

Duckweed is usually found in sheltered areas in shallow water, but it can take over larger, nutrient-enriched ponds.

Several species of duckweed can often be found growing together. Common duckweed (*L. minor*) is found throughout Mississippi. Although a native species to the state, it can be highly invasive and problematic. Duckweed draws nutrients directly from the water; therefore, fertilizing waterbodies that contain duckweed is discouraged.

Common duckweed has one to three leaf-like petals in its body, called a thallus. Thalli petals are **pale green, flat, and round to oval**. They are about 1/16 to 1/8 inch long. Each plant has a single root that may hang an inch or more below the leaf. Several to many plants may cluster together, **forming a floating mat on the water surface**.

Another species that might be encountered is giant duckweed (*Spirodela polyrhiza*), which has larger leaves that are darker and often have a small purple dot on the upper surface.

Duckweed will mix with mosquitofern (*Azolla* spp.) and watermeal (*Wolffia* spp.), as these species prefer similar conditions (low flow, high nutrients).

Having some duckweed in very shallow shoreline areas around a pond is normal and no cause for concern. Wind action usually keeps it from taking over. However, when duckweed begins to cover the open water surface, it should be immediately treated. It has the potential to eliminate sunlight to the pond, causing an oxygen depletion that can kill fish.

Management Value

Many species of ducks eat duckweed and are responsible for moving this species between waterbodies. However, because duckweed can quickly cover a pond and block out the sun, it is not recommended for any management purpose.

Duckweed | *Lemna* spp.

Recommended Controls

Option 1: Diquat (3.73-pound formulation). For each gallon of water, mix 1.28 ounces diquat and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Flumioxazin (4-pound formulation). For each gallon of water, mix 0.1 ounce flumioxazin and 1.3 ounces non-ionic surfactant. Use a buffering agent when mixing with water with pH greater than 7.0. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

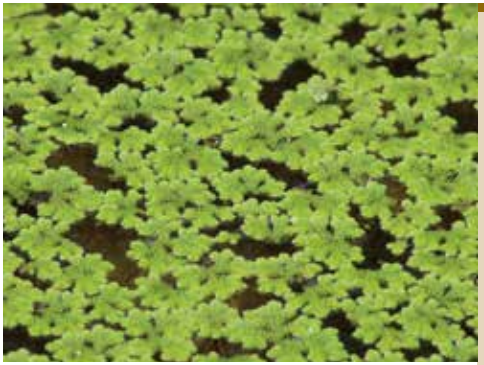
Option 3: Fluridone (4-pound formulation). Fluridone (2.5 ounces per acre-foot of water) should be applied as a submersed injection (application using a wand or hose). Herbicide should be re-applied at the same rate 30 days after initial treatment. Determine pond volume prior to application. Do not exceed annual herbicide rate limits as stated on the product label.

NOTE: Acre-foot = average depth of pond multiplied by pond acreage; average depth is calculated by taking the depth at 20 points across a waterbody and averaging the values.

Fluridone requires a contact time of at least 60 days and is not appropriate for waterbodies with low water retention times.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Mosquito Fern | *Azolla* spp.



Mosquito fern.

Mixed stand of mosquito fern and duckweed.

Stressed mosquito fern turns reddish.

Mosquito fern is a tiny native aquatic fern that floats on the water surface. It is most common in sheltered ponds with limited wind exposure. Under optimal conditions, it can completely cover a waterbody and eliminate sunlight penetration.

Individual plants of mosquito fern are generally less than 1 inch wide. The leaves are in **two alternating rows along the stem**, and are divided into an upper green lobe that floats and a lower white to transparent lobe under the water.

Mosquito fern is green when actively growing and is easily mistaken for duckweed (*Lemna* spp.) or watermeal (*Wolffia* spp.) when viewed from a distance. When it is stressed, mosquito fern turns **red or brown** and is easily distinguishable.

Management Value

Mosquito fern is a native species and has some value as wildlife food and habitat. Fish, amphibians, reptiles, and ducks may eat the plants on occasion, and dense colonies provide habitat for some insect species. However, because mosquito fern can quickly cover a pond and block out sunlight, it is not recommended for any management purpose.

Mosquito Fern | *Azolla* spp.

Recommended Controls

Option 1: Flumioxazin (4-pound formulation). For each gallon of water, mix 0.1 ounce flumioxazin and 1.3 ounces nonionic surfactant. Use a buffering agent when mixing with water with pH greater than 7.0. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Diquat (3.73-pound formulation). For each gallon of water, mix 1.28 ounces diquat and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Multiple herbicide applications may be necessary to eradicate plants.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Salvinia | *Salvinia* spp.

Common salvinia.

Giant salvinia.

Heavy coverage of salvinia.

Common salvinia (*Salvinia minima*) and giant salvinia (*Salvinia molesta)* are non-native invasive plant species that are problematic in Mississippi. Salvinia are **aquatic ferns that float** on the water's surface in calm areas.

The leaves of common salvinia are relatively small, ranging from one-fourth of an inch to no more than 1 inch. Giant salvinia is roughly twice as large. **Leaves are hairy** and may be flat, slightly bent, or heavily folded. The "roots" are modified leaves.

Both species are invasive and should be eliminated. Giant salvinia is one of the worst invasive plants worldwide. Under ideal conditions, it can form mats up to 3 feet thick that negatively impact aquatic biota and human uses of aquatic resources.

Management Value

This plant is non-native and highly invasive. Eradicate on sight.

Salvinia | *Salvinia* spp.

Recommended Controls

Option 1: Flumioxazin (4.0-pound formulation). For each gallon of water, mix 0.05 ounce flumioxazin and 1.3 ounces non-ionic surfactant. Use a buffering agent when mixing with water with pH greater than 7.0. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Glyphosate (5.4-pound formulation). For each gallon of water, mix 1.0 ounce glyphosate and 1.3 ounces non-ionic surfactant. Spray to wet all exposed plants. Do not exceed annual herbicide rate limits as stated on the product label..

In cold temperatures (less than 50 degrees), apply flumioxazin. In warm temperatures, use glyphosate or a glyphosate plus flumioxazin tank mix.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Water Hyacinth | *Pontederia crassipes*

Water hyacinth plant with vegetative new plant forming on the right.

Enlarged, hollow stems allow water hyacinth to float.

Floating water hyacinth plants.

Water hyacinth is a non-native, highly invasive species from Brazil. It has both free-floating and rooted forms. The floating growth form is particularly aggressive and can rapidly cover the water's surface in a thick, heavy mat that can stand 3 feet tall.

This species is easily identified by its leathery, **spongy, spoon-like leaves that feature parallel striations** (wrinkles or ridges) along their length. Stems are spongy and buoyant, and smaller plants often have enlarged bulbous areas on stems that provide buoyancy. Young colonies can be misidentified as frog's-bit; however, major veins will be evident in frog's-bit leaves and will be absent in water hyacinth leaves.

The roots are purple to black and feathery. During the summer, the plant produces very **showy, light-purple flowers with darker purple and yellow highlights**.

The species can reproduce by seed but more commonly uses vegetative reproduction. Stolons (runners) extend horizontally and form new plants. This mode of reproduction is rapid and quickly produces mats that obstruct both human and wildlife use of water resources.

Management Value

Water hyacinth is extremely invasive and should never be introduced. It is not known to provide wildlife or fisheries benefits and can quickly cover the water's surface and eliminate nearly all light penetration. Eradicate at first sight. Luckily, although it is very aggressive, it is also easily controlled in small ponds.

Water Hyacinth | *Pontederia crassipes*

Recommended Controls

Option 1: 2,4-D (3.8-pound formulation). For each gallon of water, mix 0.75 ounce 2,4-D and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Triclopyr (3.0-pound formulation). For each gallon of water, mix 0.5 ounce triclopyr and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 3: Imazamox (1.0-pound formulation). For each gallon of water, mix 0.5 ounce imazamox and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 4: Glyphosate (5.4-pound formulation). For each gallon of water, mix 1.0 ounce glyphosate and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

When treating severe water hyacinth infestations, treat one-third of the pond at a time, with at least 2 weeks between applications. After the entire pond has been treated, a repeat whole-pond application may be necessary to eliminate remaining plants.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Water Lettuce | *Pistia stratiotes*

Individual water lettuce plant mixed with duckweed.

Water lettuce showing pale roots.

Pond covered in water lettuce.

Water lettuce is a highly invasive species that floats on the water's surface. It is thought to have been introduced to Florida before 1765. Typically, it grows no more than 9 inches above the water, but it can completely cover a waterbody and prevent sunlight penetration.

This species **resembles a floating head of lettuce**, with leaves arranged in rosettes. It has very thick, **hairy, light dull green leaves with parallel ridges** and no leaf stalk. The roots are pale and feathery, and the root system can grow deeply into the waterbody. Flowers are tiny and inconspicuous.

The species can reproduce by seed but more commonly uses vegetative reproduction. Stolons (runners) extend horizontally and form new daughter plants. This mode of reproduction is rapid and quickly produces mats that obstruct both human and wildlife use.

Management Value

Water lettuce is extremely invasive and should never be introduced. It can quickly cover the water's surface and eliminate nearly all light penetration. Eradicate on first sign.

Water Lettuce | *Pistia stratiotes*

Recommended Controls

Option 1: Flumioxazin (4-pound formulation). For each gallon of water, mix 0.1 ounce flumioxazin and 1.3 ounces non-ionic surfactant. Use a buffering agent when mixing with water with pH greater than 7.0. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Diquat (3.73-pound formulation). For each gallon of water, mix 1.28 ounces diquat and 1.3 ounces non-ionic surfactant water. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

When treating severe water lettuce infestations, treat one-third of the pond at a time, with at least 2 weeks between applications. After the entire pond has been treated, a repeat whole-pond application may be necessary to eliminate remaining plants.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

Photo Credits Top: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org; Middle: Russell Engel, Arizona Game and Fish Department

Watermeal | *Wolffia* spp.

A pond covered in watermeal and water lettuce.

Watermeal and duckweed comparison.

Watermeal leaves feel gritty in the hand.

Watermeal is a group of native plants and contains several species. Individual plants are a single, tiny, oval leaf (frond) with no roots. It is often found together with other floating or emergent plants.

Often mistaken for a "scum" of planktonic algae, watermeal can be differentiated by its **gritty texture** when rubbed between the fingers. It **looks and feels like green cornmeal**. These species are the world's smallest flowering plants. The flowers are miniscule and rarely observed. Fragmentation and budding are the most common form of reproduction.

Watermeal is often present in shallow, weedy shorelines of ponds but can become problematic under certain conditions. Excessive nutrients in small, wind-protected ponds often lead to problems.

Management Value

Even though watermeal is eaten by ducks and other species, its ability to quickly cover the water's surface and eliminate nearly all light penetration prohibits any value it may provide. Eradicate on first sign of excessive growth.

Watermeal | *Wolffia* spp.

Recommended Controls

Option 1: Flumioxazin (4.0-pound formulation). For each gallon of water, mix 0.2 ounce flumioxazin and 1.3 ounces non-ionic surfactant. Use a buffering agent when mixing with water with pH greater than 7.0. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Option 2: Diquat (3.73-pound formulation). For each gallon of water, mix 1.28 ounces diquat and 1.3 ounces non-ionic surfactant. Spray to wet all plants. Do not exceed annual herbicide rate limits as stated on the product label.

Multiple herbicide applications may be necessary to eradicate plants.

■ **Read and follow all chemical label instructions, especially the section on the use of personal protection equipment.**

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On the cover: (Clockwise from top left) A stand of American lotus; flower of water primrose; showy flower of white water lily; and pickerelweed.

Publication 3735 (10-23)

Produced by Agricultural Communications.

Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Published in furtherance of Acts of Congress, May 8 and June 30, 1914. STEVE MARTIN, Interim Director