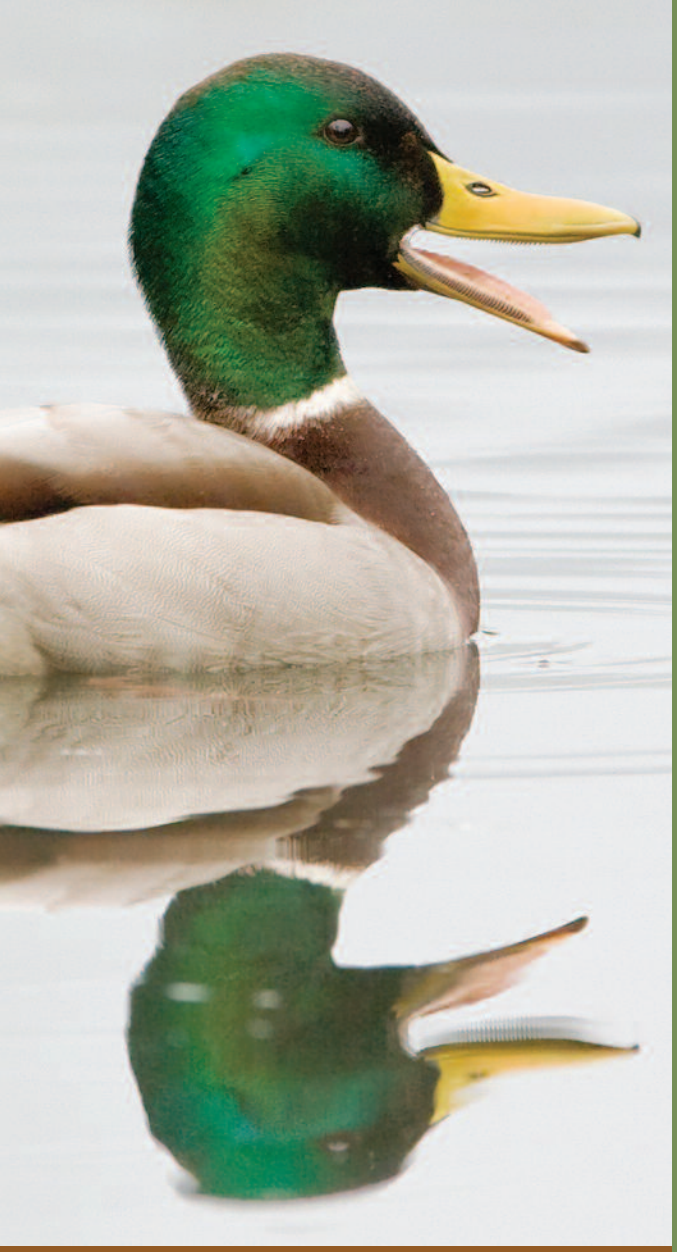
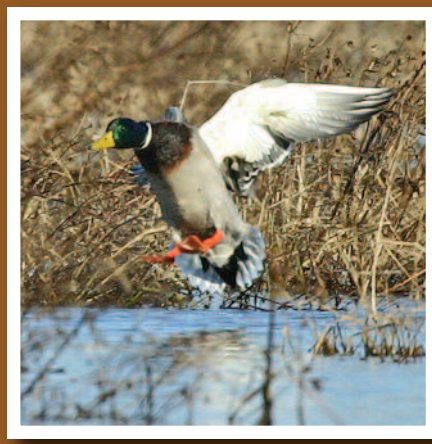


Waterfowl Habitat Management Handbook

for the Lower Mississippi River Valley



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To sustain waterfowl populations at levels of the 1970s, as prescribed by the North American Waterfowl Management Plan (1986), private landowners must continue to provide habitat for wetland wildlife. Private landowners oversee the majority of wetlands remaining in the United States, so their cooperation is essential to any major conservation effort to restore and sustain waterfowl populations in the Mississippi Flyway.

Many groups have worked together since the 1980s to develop waterfowl habitat on private lands. Much progress has been made, and this publication helps guide continuing efforts. This publication is for private landowners in the Lower Mississippi Flyway who want to improve their lands for waterfowl. It is a reference landowners can use for information about particular aspects of waterfowl management. For example, the publication answers questions such as these:

- *How does managing my land benefit waterfowl?*
- *Who is available to help me manage my land for waterfowl?*
- *How do I manage soil, water, and plants to improve my land as waterfowl habitat?*

Knowledge is the first requirement for success in any venture. This is especially true when managing waterfowl on private lands.

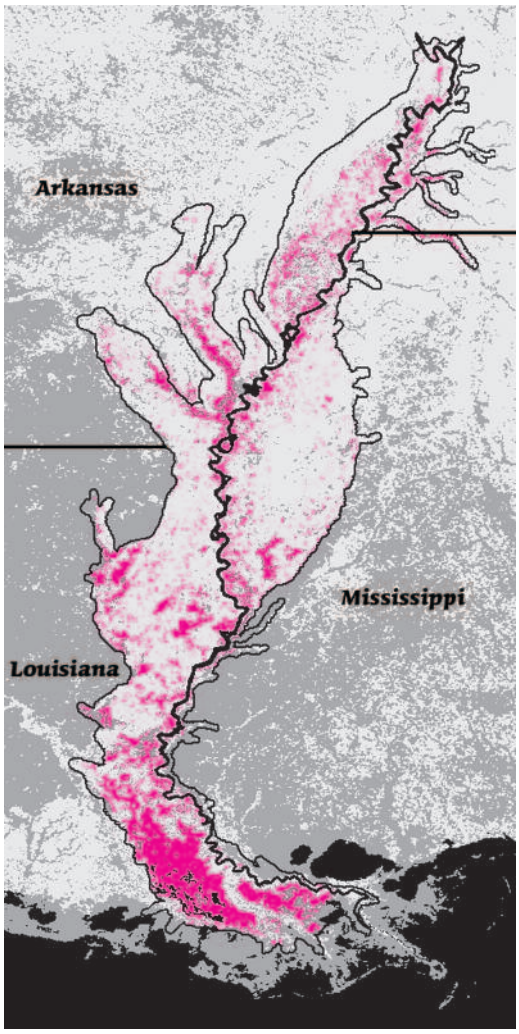

Figure 1. The Lower Mississippi River Valley Alluvial Plain (the Delta) showing remaining forested areas as of 1992. Map provided by the Lower Mississippi River Valley Joint Venture, U.S. Fish & Wildlife Service, Vicksburg, Mississippi.

The Mississippi Alluvial Valley (MAV) or Delta was created by flooding of the Mississippi River, which drains 41 percent of the land mass of the continental United States. The Delta extends 500 miles from Cape Girardeau, Missouri, to southern Louisiana, and it comprises more than 24 million acres in seven states. The Delta ranges from 20 to 80 miles wide and once contained the largest spread of forested wetlands in the United States.

Large-scale land clearing of seasonally flooded wetlands did not occur in the Delta until the 1960s, and about one-third of the original wetland acreage was converted to farmland from 1950 to 1976. By 1991, only 4.9 million acres (20 percent) of forested wetlands remained, mostly in Arkansas, Louisiana, and Mississippi. The Delta is one of the most productive agricultural regions in the world because of its fertile soils, subtropical climate, abundant rainfall, and long growing season. The Mississippi Flyway is frequently referred to as the "mallard flyway," because hundreds of thousands to more than a million mallards typically winter in the Delta. The majority of these mallards are produced in the Canadian provinces of Saskatchewan, Alberta,

Manitoba, and the prairie-pothole region and upper midwest of the United States. Mallards fly along two major migration corridors in the Mississippi Flyway to reach important wintering grounds in the Delta states of Arkansas, Illinois, Kentucky, Mississippi, Louisiana, Missouri, and Tennessee. Historically, mallards wintering in the Delta depended primarily on acorns and other natural seeds and aquatic invertebrates found in extensive hardwood bottomlands to meet their nutritional needs. As red oak, acorn-producing forests were cleared, mallards began feeding in croplands, especially soybean and rice fields. Although mallards have adapted their feeding and other behaviors to the loss of more than 80 percent of the forested wetlands in the Delta, their physiological condition and winter survival and perhaps even spring reproduction depend upon continued flooding and food availability in agricultural and natural wetlands in the Delta.

In the 1980s, populations of several waterfowl species, including mallards, declined because of extensive and long-term drought on the breeding grounds and loss and degradation of habitat throughout North American flyways. In the Delta, changing bottomland hardwood systems to croplands and other land uses and flood control projects have decreased waterfowl habitat. Public wildlife management areas and refuges continue to provide an important "safety net" of habitat for waterfowl, especially during winter-drought periods. But federal and state wildlife conservation agencies don't have adequate funding nor support to purchase and manage extensive waterfowl habitat on public lands in the Delta. This dilemma and research indicating that mallards and likely other waterfowl species use private land in the Delta in proportion to its availability (more than 90 percent in private ownership) underscore the need to manage private lands for migrating and wintering waterfowl and provide management information for landowners.

Figure 2. The migration route, known as the Mississippi Flyway, used by waterfowl to reach the Lower Mississippi River Valley (the Delta) and other areas along the Gulf of Mexico coast. From the North American Flyway Directory, 1996, U.S. Department of Interior, Fish & Wildlife Service.

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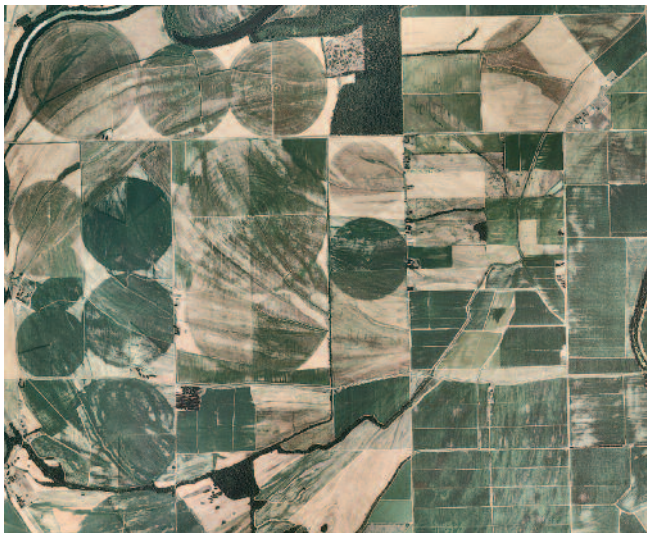

Benefits of Habitat Management

Waterfowl

Frequency and intensity of precipitation generally increase in the Delta in winter. When private lands flood, waterfowl spread from refuges and other public lands and use newly flooded agricultural land and wetlands. There they feed on waste agricultural seeds, natural seeds and tubers, and aquatic invertebrates. Waterfowl and other wetland-dependent wildlife benefit when this additional wetland habitat and resources become available on managed private lands. Waterfowl survival and body condition tend to increase when extensive flooding occurs in winter. Birds returning to the breeding grounds in an improved condition may have increased reproductive potential and increased production. Managing private lands for migrating and wintering waterfowl is critical to sustaining viable and harvestable populations of waterfowl.

Landowner and Landscape

Landowners are increasingly aware that wise stewardship of natural resources is in their best economic interests. Here's what protecting and restoring seasonal or permanent wetlands can do:

- *Decrease soil erosion;*
- *Enhance soil tilth and moisture retention;*
- *Enhance ground-water stores;*
- *Decrease winter weeds, crop pests (such as red rice), and later crop-production costs;*
- *Lessen rice straw and other crop residues;*
- *Improve quality of discharge waters;*
- *Improve water management capabilities;*
- *Provide food and habitat for waterfowl and other wetland wildlife;*
- *Provide valuable recreational opportunities; and*
- *Generate on-site and local revenues.*

Although soil loss from fall-tilled croplands in the Delta averages 3 to 4 tons per acre per year (based on estimates from the USDA, Agricultural Research Service), managed flooding of agricultural lands outside the growing season can greatly reduce erosion. For example, research conducted by Mississippi State University (MSU) in the Delta of Mississippi revealed that rice fields disked after harvest and left to drain during winter lost nearly one-half ton of soil and organic matter per acre compared to only about 30 pounds per acre for harvested rice fields left in standing stubble and allowed to flood during winter.

When you operate water control structures to provide winter wetlands for waterfowl, soil and organics settle out, clearing water through the settling process and releasing "clean" water when you drain fields. Also, surface water in agricultural fields can percolate through soil and help recharge aquifers. Impounded and winter-flooded croplands help ease flooding during wet winters. You can improve soil texture when you incorporate crop stubble into the soil by light disking or rolling followed by flooding fields in winter. Winter flooding also increases soil moisture, enhances seed germination in spring, and lets young plants establish stronger root systems.

Waterfowl eat seeds, roots, and foliage of many agricultural pest plants, including red rice and various grasses. Ducks and geese eat about 10 percent of their body weight daily in plant matter. Research indicates that large seeds with fairly thin seed coats (such as red rice) generally do not pass through the digestive system of waterfowl. Also, research by MSU scientists has revealed that rice fields left in standing stubble after harvest instead of being disked can reduce red rice infestations in production fields. In fields with standing stubble and "red rice," red rice seed on the ground may germinate among the stubble during fall but then die after freezing temperatures. In contrast, disking can bury red rice seed and keep it viable for later germination.

If you winter flood rice and other croplands, you may not have to "burn down" early season weeds with herbicides before planting. MSU researchers found you can reduce weed-control costs by flooding rice production fields during winter months. You reduce planting costs this way because typical "winter weeds" do not grow on flooded landscapes. So, less land preparation is required in spring. Many farmers

Waterfowl survival and body condition tend to increase when extensive flooding occurs in winter.

find they can use no-till or reduced-till planting during the following crop year, decreasing equipment use and fuel, labor, and herbicide costs.

Landowners also can benefit by marketing hunting and other recreational activities (such as bird watching). Additionally, landowners and local economies can gain valuable public relations benefits from allowing outdoor activities on private lands.

Assistance to Landowners

As part of a national cooperative effort to restore continental waterfowl populations, public and private conservation agencies and organizations have implemented private lands programs in several states in the Delta region. These partners provide wildlife management technical assistance and infrastructure for developing wetlands for wildlife. In some cases, where potential benefits to waterfowl are great and resources permit, an organization or agency may provide incentives to landowners willing to provide habitat for waterfowl.

Contacts for waterfowl conservation assistance on private lands:

Delta Wildlife

Ducks Unlimited

Mississippi Department of Wildlife, Fisheries and Parks

Mississippi State University
College of Forest Resources
and
Extension Service

United States Fish and Wildlife Services

USDA Natural Resources Conservation Services

Wildlife Mississippi

MSU researchers found you can reduce weed-control costs by flooding rice production fields during winter months.

Waterfowl Feeding Habits

Ducks in the Mississippi Flyway fall into two major groups: 1) dabbling and perching ducks and 2) diving ducks. Dabblers and perching ducks (mallard, gadwall, blue-winged and American green-winged teals, northern pintail, American wigeon, northern shoveler, wood duck, and others) can walk well on land. They "tip-up" or dabble along the water surface to feed rather than dive, and they can fly up from land or water. Their feeding habitats in the Delta primarily include flooded (6 to 12 inches deep) agricultural lands and natural wetlands (such as hardwood bottomlands and moist-soil wetlands). They feed on agricultural seeds (such as rice, soybean, corn, and milo), natural seeds, and other parts of a variety of native plants (see Appendix and the "Wetland Management for Waterfowl Handbook" in the references section of this publication or at http://www.ms.nrcs.usda.gov/technical/NRCS%20Wetland%20Mgt%20for%20Waterfowl.pdf) and aquatic invertebrates (such as snails, scuds, crayfish, isopods, and insects). Some species of dabbling ducks, such as the gadwall and American wigeon, feed heavily on aquatic vegetation.

Diving ducks (such as lesser scaup, ring-necked duck, bufflehead, canvasback, redhead, goldeneye, hooded mergansers, and ruddy duck) cannot walk well on land. They dive to feed and run along the surface of the water to get airborne. Some species may congregate in large flocks and frequent lakes, rivers, coastal estuaries, reser-

Feeding

Rising

Figure 3. Dabbling Ducks.

Feeding

Rising

Figure 4. Diving Ducks.

voirs, and aquaculture ponds. Diving ducks eat a variety of aquatic invertebrates, plant seeds, and tubers but only rarely agricultural seeds. Lesser scaup, goldeneye, ruddy ducks, bufflehead, and mergansers feed primarily on animal matter (mollusks, crustaceans, fish), while canvasbacks, redheads, and ring-necked ducks eat aquatic plant parts.

Private landowners in the Delta usually do not develop waterfowl habitat specifically for diving ducks because large, deep impoundments are required. Wintering diving ducks frequently use complexes of catfish and bait-fish ponds, though. Also, many projects developed for dabbling ducks often have deep areas that are suitable habitat for diving ducks.

Four migratory species of geese winter in the Delta: Canada, white-fronted (specklebelly), snow, and Ross's geese. In the 1990s, rapidly growing and spreading populations of these species, especially snow geese, have resulted in great abundances of these birds in the Delta in winter. Also, locally established populations of Canada geese live year round in the Delta and elsewhere in the Southeast. Geese eat plant parts, such as seeds of waste wheat, rice, and corn, natural seeds, tubers, green browse, and roots. Favored foraging areas of all species of geese are harvested and unharvested croplands, cool-season grass fields (such as winter wheat), and moist-soil areas.

Waterfowl Habitat Complexes

Waterfowl use and need different habitats and foods in winter and before spring migration. Habitat complexes (several habitat types close together) provide more suitable habitat than single habitats. MSU researchers found that the largest groups of mallards and other dabbling ducks (more than 100 birds) in the Delta were associated with large tracts of flooded cropland (50 percent), natural emergent wetland (such as 15 to 20 percent moist soil), forested/scrub-shrub wetland (20 percent), and permanent wetlands (such as 10 to 20 percent catfish ponds).

Food availability, habitat diversity, and sanctuary are keys to retaining waterfowl in an area during winter. Frequent disturbance reduces waterfowl use. Usually you should try to maintain at least 20 to 25 percent of managed waterfowl habitat as sanctuary. Restricting the number of days and hours of the day the areas are hunted also may decrease disturbance. Such management options let waterfowl use sites and prevent areas from being "shot out." Some insightful managers do not let waterfowl hunting begin until an hour or so after sunrise so waterfowl can feed in habitats managed specifically for waterfowl. Even ATV and other vehicle traffic along roads and levees next to managed habitats should be avoided to minimize disturbances.

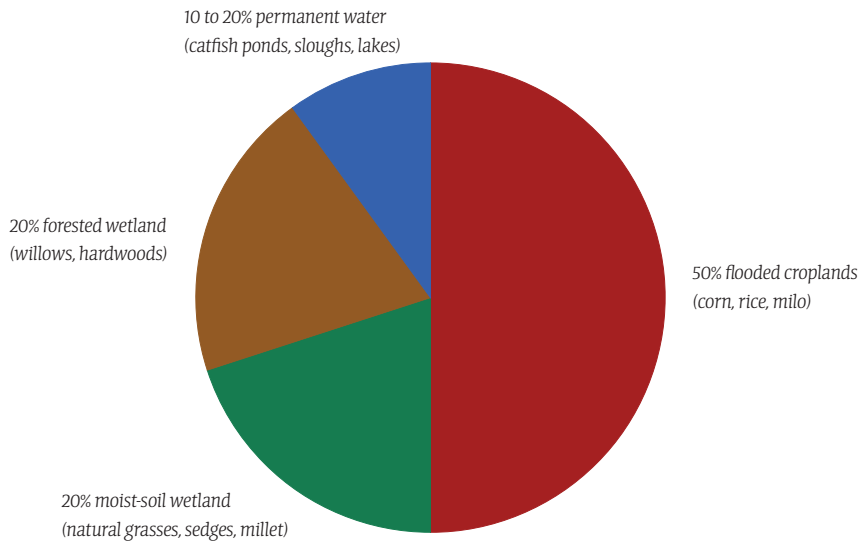

Figure 5. Mallards and other dabbling ducks are found in Delta landscapes containing mixtures of habitats.

Site Selection

Poorly drained areas are usually chosen for developing wintering waterfowl habitats. Consider factors such as long-term land use objectives, soil type, flooding frequency, accessibility, and freedom from disturbances, when selecting an area for development. It is especially important to determine long-term objectives for your property, because you should not develop an area you can't flood frequently or that you may convert to an alternative use in the near future.

Give special attention to the soil type in any area you are considering for development into waterfowl habitat. Clay soils, commonly found at lower elevations in the Delta, are best suited for constructing levees because they tend to seal quickly when flooded. Soil surveys of each county are available at your USDA Service Center. These surveys indicate soil types and provide other valuable information on proposed sites. Consult private and public conservation agencies or organizations for help in developing managed wetlands. When selecting a site for development, choose areas subject to regular, shallow flooding during the winter. Do not develop sites prone to deep flooding or flooding for a long time, because they will not produce waterfowl foods reliably, and maintenance to repair levee damage may be costly. Habitat sites should be accessible by farm equipment so you can produce food for wildlife, repair damaged levees, and maintain water control structures and levees. Areas away from actively traveled roads are preferred for development, and you will generally find it easier to control. Marginal agricultural lands, crop production fields, and forested wetlands are often suited for development as seasonally flooded waterfowl habitat.

Open Lands

Habitat Development

Developing waterfowl habitat usually doesn't conflict with USDA program regulations. But agricultural and other lands may contain wetlands protected under wetland conservation provisions of the Food Security Act, often called Swampbuster. The USDA National Resources Conservation Service (NRCS) will help you

determine if any Swampbuster or Clean Water Act (CWA) permitting issues apply. You will also be referred to the U.S. Army Corps of Engineers (COE) district office if you need a CWA 404 permit. Many agricultural activities are exempt from permit requirements. Cost-share for waterfowl habitat development and enhancement on agricultural lands is often available through USDA conservation programs. Contact your USDA Service Center for more information. NOTE: Waterfowl habitat development by private landowners normally does not require wetland permits or affect participation in USDA programs. But always check with the FSA, NRCS, and COE district offices before starting any activities within an existing wetland to ensure you comply with federal regulations, especially if you intend to do any earth-moving work or clearing.

Levee Construction

On lands not already leveled and surrounded by levees, construction of low levees is often necessary to create seasonal wetlands for waterfowl and other wildlife. Before you move any soil to construct a new levee, either disk or strip the vegetation from the right-of-way to assure the new levee will form a tight seal with the soil already there. Also remove all woody vegetation in the right-of-way. Apply the same treatment to borrow areas if they are not within the right-of-way. If water is standing on the right-of-way, drain it so equipment can operate efficiently. Next, put fill material in lifts approximately 6 to 8 inches thick and compact it by running over the entire surface with the earth moving equipment. Continue this process until you reach the levee height you want. Build the levee 5 to10 percent higher than design height to make up for settlement. You can use various equipment to construct levees: bulldozers, draglines, trackhoes, rubber-tired backhoes, motor graders, terrace plows, self-propelled scrapers, and dirt pans pulled by tractors. When site conditions are good, tractors pulling dirt pans generally are the most economical way to build levees, and you can minimize borrow areas. You can level adjacent fields by moving soil from higher elevations to form the levee or grade borrow areas to drain to existing ditches or pipes. Also, loaded dirt pans provide excellent soil compaction when you put soil in 6- to 8-inch lifts.

"When site conditions are good, tractors pulling dirt pans generally are the most economical way to build levees, and you can minimize borrow areas."

You can build small levees with any of the equipment mentioned above. You can build medium-sized levees with bulldozers, trackhoes, or terrace-building machines. Include a heavy disk or sheepsfoot roller for compaction. After the fill material has dried, bulldoze the levee for final shaping. You can use this method for small- to medium-sized levees, but operating costs generally prohibit its use on larger projects.

If soil is borrowed next to levees during construction, the borrow areas should be situated no closer than 10 feet away from the base of the levee to prevent sloughing or caving of material away from the levee. The side slopes of the borrow area should be no steeper than the slopes of the levee for easier maintenance. Wide and shallow borrow areas are much easier to drain and are less likely to attract burrowing animals such as beavers, nutria, and muskrats.

Levees with 4:1 slopes or flatter (side slope of levee extends 4 feet for each foot of drop in levee height) are recommended to provide safe operating conditions for grass-cutting and maintenance equipment. The top width or crown of the levee should be at least 10 feet wide for maintenance equipment. Levees impounding more than 3 acres of water should have at least a 2-foot freeboard (the height of levee above highest planned water level). In most cases, you should build an emergency spillway at one end of the most downstream levee to reduce damage from overflow. Do not build the spillway in the levee. Instead, dig it in the existing ground (at least 25 feet wide and 1 foot below settled height of the levee) where the slope of the ground is as flat as possible (5 percent or less is preferred). Cover spillways with deep-rooted vegetation or rock riprap to prevent erosion. Also seed levees with dense sod-forming grasses you can regularly mow to prevent willows and other trees from becoming established. Never let trees establish on levees, because the trees weaken levees and can cause breaching. Contact your NRCS office for assistance when constructing levees and spillways.

Water Control Structures

Flashboard risers made from steel or corrugated metal are commonly used to manage water levels on fields by installing or removing boards. Although water control structures fabricated from steel pipe are generally more expensive than corrugated metal, they last a long time and are less

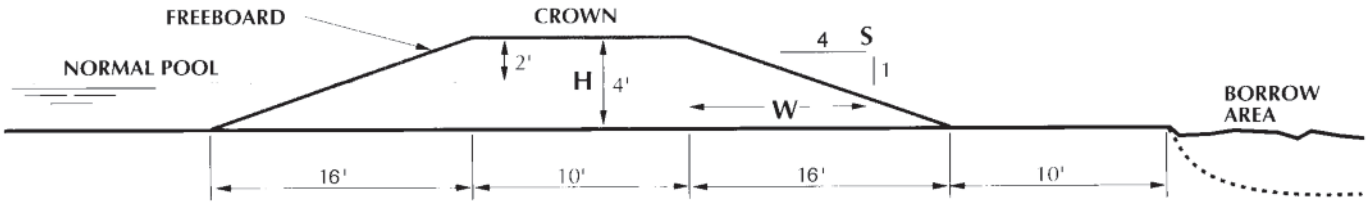

Figure 6. Cross section on an impoundment levee with a 4:1 slope used to hold water on areas managed for waterfowl.

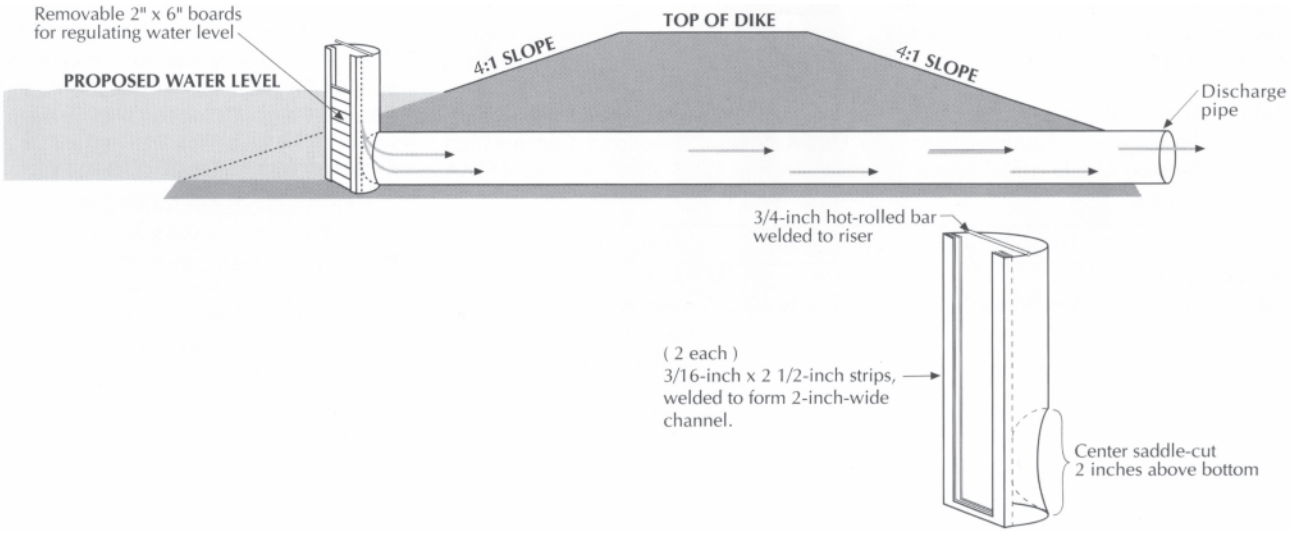

Figure 7. Half-round flashboard riser used to control water levels in open wetlands.

likely to be damaged by farming or maintenance equipment. Another advantage of using the steel pipe is that you don't need a concrete base to anchor the riser. Water control structures fabricated from corrugated aluminum pipe or corrugated steel pipe with a protective polymer coating (you have to be careful not to damage the coating during installation) also have a long life expectancy. Flashboard risers are generally preferred to other types of water control structures because they are self-regulating when you know the correct elevation of the boards in the control structure. One more choice of materials for pipes and flashboard risers is HDPE (high-density polyethylene) pipe. Except for a steel pipe and flashboard riser combination, all these structures must be anchored (usually in concrete) to prevent flotation.

Full-round risers are an alternative to flashboard risers and are generally preferred in locations where beavers are a problem. The initial cost of full-round risers is greater than flashboard risers, but these structures are equipped with features to prevent beavers from entering the pipe or getting to the boards in the riser. For more information on full-round risers and their benefits, refer to Water Control Structures in the Forested Lands section of this publication on page 15.

Habitat Management

Harvested Fields

Winter flooded croplands, both harvested and not, can provide important forage and habitat for wintering waterfowl, and crop lands are one of the most prevalent land uses in the Lower Mississippi Flyway. But, waste agricultural seeds (such as those accidentally lost during harvest) potentially available for waterfowl have declined significantly since the 1980s. Recent estimates by the Waterfowl Working Group of the Lower Mississippi Valley Joint Venture of the North American Waterfowl Management Plan indicated that harvested soybean fields contain about 50 lbs/acre of waste seed, rice fields about 70 lbs/acre, and corn and milo fields about 130 lbs/acre.

MSU researchers have determined that more than 70 percent of the waste rice from harvest operations decomposes, germinates, or is eaten by birds and rodents after harvest between early fall and early winter. Clearly, availability of waste agricultural seeds for wintering waterfowl is markedly less nowadays. Nevertheless, harvested croplands provide important habitat for migrating and wintering waterfowl if the fields are not disked after harvesting and are shallowly flooded during winter (6 to 18 inches).

SELECTED SPECIFICATIONS FOR STRAIGHT-PIPE WATER CONTROL STRUCTURES EQUIPPED WITH SLOTTED-BOARD RISERS*

Round Pipe diameter *(inches)*	Drainage Areas (0.0 foot head)		Riser Specifications	
	4 inches/24 hr *(acres)*	6 inches/24 hr *(acres)*	Half-round Riser diameter *(inches)*	Box Riser L x W *(inches)*
12	12	8	18	9 x 18
15	21	14	24	12 x 24
18	34	23	30	15 x 30
21	49	33	36	18 x 36
24	68	46	42	21 x 42
30	119	80	54	27 x 54
36	190	127	66	33 x 66

EXAMPLE: *A 12-inch-diameter pipe with an 18-inch half-round riser drains 4 inches of water in 24 hours from a 12-acre field. You can also use schedule 80 PVC (polyvinyl chloride) water control structures (pipe drops) equipped with a drainage valve to control water levels. PVC pipe is widely available, requires little maintenance, and can be put together on the construction site. But it is easily damaged by farming equipment or fire.*

**Reprinted from the USDA NRCS, Grade Stabilization Structure Design, Data Sheet MS-Eng-410AA (Delta).*

Moist-soil wetland

Rice fields are especially important to waterfowl. Harvested rice fields are among the most economical areas to manage for waterfowl, because often you can repair existing levees after harvest and shallowly flood the rice stubble to create waterfowl habitat. In many areas, farmers have installed permanent levees that let rice fields be flooded again after harvest. MSU scientists have determined that the most waste rice in late autumn was in fields left in standing stubble, followed by burned, mowed, rolled, or disked stubble. The scientists also found on a large rice production farm near Stuttgart, Arkansas, that mallard and other dabbling duck use was greatest in rice paddies burned or rolled after harvest and flooded in winter, and duck use was least in paddies containing standing stubble. The scientists recommended leaving stubble or burning fields to save waste rice and create a mix of stubble and water after flooding. Also, research indicates waterfowl feeding in rice fields also reduces red rice and other weeds the next production cycle.

Agricultural seeds decompose at different rates when flooded. Milo and corn kept above water and rice either above or below water persist well during winter compared to soybeans, which break down rapidly when they absorb water. Also, soybeans contain a biochemical that inhibits use of protein by waterfowl, and the needed energy ducks get from soybeans is lower than other agricultural seeds and many other natural seeds and tubers. Ideally, 10 percent of the waterfowl management area should be flooded from mid- to late August to late September 2 to 6 inches deep to provide habitat for early migrants such as blue-winged teal, shorebirds, and other waterbirds.

Waterfowl benefit most when you gradually increase flooding rather than covering management areas quickly and completely. By increasing water levels slowly, you flood new areas, and more food becomes available to waterfowl. This helps save food during winter and provides a range of water depths that attract a variety of waterfowl. You can plant tall and robust grain crops (corn or milo) in areas where water will be deeper. Flood fields from late October to mid-November, and maintain them at least until early March the next year. Gradually drain managed areas in the spring to concentrate aquatic invertebrates and make it easier for foraging by ducks and other waterbirds.

Moist-Soil Wetlands

Although croplands are important foraging habitats for waterfowl, agricultural seeds do not provide a nutritionally complete diet for waterfowl. Managed moist-soil areas are natural wetlands with a wide variety of plant species but are usually dominated by grasses and sedges that produce lots of seeds and tubers. Also, moist-soil wetlands harbor diverse aquatic invertebrate communities. MSU scientists determined that managed moist-soil areas in the MAV average more than 12 times greater duck foraging potential (such as indexed by duck use days) than harvested rice fields in this region. Managed moist-soil areas can provide rich and complete foraging habitats and cover for waterfowl and can make up for the lack of waste agricultural seeds nowadays. Also, moist-soil wetlands are fairly economical to establish and manage because plant communities emerge from natural "seed banks," and other typical costs of crop production are greatly reduced or gone (such as irrigation, herbicide, fertilizer, and the like).

Two of the most important things to consider when managing moist-soil units are the timing of the annual drawdown and the number of years since soil disturbance (such as disking). Total seed production from grasses and sedges is generally greater when moist-soil units are drained in early to mid-growing season. Early season drawdowns occur within the first 45 days of the growing season, midseason within the second 45 days, and late-season drawdowns during the remainder of the growing season at specific locales. To get a diversity of habitats for waterfowl and other wetland wildlife, try to develop a complex of multiple units that enable various drawdown dates and rates, intervals between soil disturbance, and habitat manipulations (such as mowing, burning, and disking). Research has shown that wetlands with a 50:50 interspersion of vegetation to water ("hemi-marshes") are attractive to waterfowl and other birds on both breeding and wintering grounds. So, autumn mowing or light disking of dense moist-soil vegetation to create a "hemi-marsh" after flooding may help attract waterfowl, especially in early winter before vegetation naturally topples. Manipulating natural vegetation is legal and does not create a "baited" site, but a "baited" site is created by manipulating crops in the year of planting. If earlier planted vegetation "volunteers" (such as naturalized vegetation) in later growing seasons, as millets and rice sometimes do, it is legal to manipulate this naturalized vegetation if no planting was done within the naturalized vegetation in the current year.

Two of the most important things to consider when managing moist-soil units are the timing of the annual drawdown and the number of years since soil disturbance (such as disking).

To produce the most seed, keep native plant communities in an early successional stage, that is, plants dominated by seed- and tuber-producing annual grasses and sedges and not perennials, such as rushes, cattails, and woody vegetation. The percentage of nonfood-producing-plant species generally tends to increase in each consecutive year when you don't disturb an area. Soil disturbance greatly affects the response of native plants to different management techniques. Generally, you need to disk moist-soil units every 1 to 3 years to control perennial forbs, trees and shrubs, and other unwanted vegetation. Frequently, entire fields or parts of them that are cropped in one year produce excellent stands of moist-soil plants the next year. Disk as early as possible in spring for seeds to germinate and plants to grow. But if moist-soil units stay wet and a tractor can't get to them until late summer or fall, MSU scientists have shown that soil disturbance at this time prepares the site and promotes moist-soil vegetation next growing season. Sometimes deep disking or plowing is needed to bring deeply buried seeds and tubers near the surface to promote germination and growth.

Inspect areas managed for native plants or agricultural crops weekly. Nuisance plants, such as cocklebur, sicklepod, morning glory, coffeeweed (Sesbania), and vines, can quickly germinate and compete with desirable plants. Several small (1/4 to 1/2 acre) patches of coffeeweed comprising less than 10 percent of the total area to be flooded actually can be beneficial because they provide cover for waterfowl and hunters. If coffeeweed or other potential nuisance plants invade 50 percent or more of a management area, control them with herbicides or by mowing and flooding the stubble. Chemical control is better if lots of desirable grasses and sedges are already on the area. Controlling undesirable plants by disking, mowing, herbicides, or flooding takes only about one-third as much fuel as conventional row cropping for domestic small grains.

ACTIVITY SCHEDULE FOR MANAGING MOIST-SOIL AREAS FOR WATERFOWL

Activity	Timing	Management Recommendations
Early season drawdown	First 45 days after last killing frost.	Slow drainage (decrease water levels in 6-inch increments every 2 to 4 weeks until area is drained); permits wildlife to use food resources and young wood ducks to fledge.
Midseason drawdown	46 to 90 days after last killing frost.	Slow drainage as described above.
Late-season drawdown	More than 91 days after last killing frost.	Slow drainage as described above.
Vegetation monitoring	About 14 days after drawdown.	Monitor the occurrence of cocklebur, coffeeweed, and woody plants every 14 days, and implement control when these species cover more than 50 percent of the ground.
Weed control	After monitoring and as needed.	After cocklebur, coffeeweed, and other broadleaves have emerged, control with an appropriate selective broadleaf herbicide (see Table on page 19 for specific herbicide recommendations).
Fertilization (not required)	When desirable grassy-weedy plants are 2 to 6 inches high.	75 to 100 pounds of urea/acre; or for maximum seed production, conduct a soil test and follow recommendations.
Flooding	August 15 to September 30.	Shallowly flood (2 to 6 inches) 10 percent of the total managed area to provide habitat for early migrants, such as blue-winged teal.
	September 30 to November 15.	Increase water levels slowly until entire area is flooded by November 15.
	December to Early January.	Some managers save several moist-soil areas for flooding in December through January when more waterfowl are present.

Japanese Millet

Browntop Millet

Grassy Corn

Agricultural Plantings

You can also plant fields or food plots with agricultural seeds such as Japanese millet (Chiwapa millet), browntop millet, corn, milo, and rice. These plants typically produce lots of seeds for waterfowl. Landowners considering planting agricultural crops in waterfowl management areas should consult Extension offices or farm cooperatives to determine the best planting date and strategies for specific geographic locations and soil and water conditions.

In establishing food plots, remember to plant large enough areas (at least 10 to 20 acres, for example) to increase the probability that agricultural seeds will be available when waterfowl arrive in early winter, because some crop loss is likely to occur in summer-fall by blackbirds, deer, hogs, raccoon, and/or coyotes. As said before, it is illegal to manipulate in any way (such as disk, roll, bush-hog, burn) planted crops in the year of planting. For example, you may have a dense stand of rice or some other crop in front of a duck blind and you want to create an opening to set decoys for waterfowl hunting. If the crop is manipulated in any way in the year of planting, you have created a baited site and are subject to a "baiting" violation. Clearly, landowners and lessees should contact law enforcement personnel to answer specific questions about baiting.

You can broadcast browntop or Japanese millets (12 to 25 lbs/acre) directly on a well-prepared seedbed and harrow to assure good germination. Because millets are in the grass family, they are hardy plants and normally require little care. Japanese millets are adapted to the heavy, wet soils commonly found in the Delta. Although Japanese millets cannot establish themselves on a flooded seedbed, they will tolerate several inches of flooding after they reach about 4 inches tall. You can direct seed Japanese millets on mud flats, such as in drained management units or beaver ponds. Browntop millet is better suited for drier sites.

You can also mow millet before they produce seed heads to set back their date of maturity. This strategy is valuable when you have to plant millets early (as in May-June) to take advantage of soil moisture. If you mow millet to set back its maturity date, leave 6- to 12-inch stubble to provide enough "green stem" for plant regrowth. Control heavy infestations of armyworms and other pests in crop fields with appropriate insecticides. See your county Extension agent for insecticide information.

Rice also is an excellent crop to plant and enrich waterfowl foraging habitats:

- It is a wetland grass adapted to clay soils and flooding;
- It produces hundreds, possibly thousands, of pounds of seed per acre; and
- Its seeds persist well when flooded during the winter.

Rice seed planted for waterfowl does not have to be certified or treated with a fungicide, but we recommend treated seed to prevent decomposition during the cool, moist, spring planting period. To prevent straight heading (blank seed heads) and ensure best seed production, plant rice where you can irrigate by pumping or where you can catch rain and runoff. Sheath blight is the common cause of blank seed heads in rice, so be sure to use blight-resistant varieties and fungicides for control.

When rice plants are 6 inches tall, you can shallowly flood (2 to 4 inches) to keep down weed growth. Rice survives and forms seeds under moist-soil conditions. These moist-soil conditions also will promote growth of native vegetation. Some managers refer to a mixture of rice and moist-soil vegetation as "dirty rice." This mixture does provide excellent foraging habitat for waterfowl. Varieties of rice are available that you can plant in the Delta in early spring (April) and harvest in August. This may allow enough time for the rice to produce a second seed head (or ratoon crop) for wintering waterfowl to use. Results from USGS and MSU scientists indicate that irrigation after the first harvest is critical for ratooning. You cannot manipulate ratoon crops in hunted areas, because this is baiting. Although rice is an excellent food for waterfowl, blackbirds also exploit rice and can deplete a field of rice before waterfowl have a chance.

Corn and milo also are excellent crops for waterfowl because they are high in energy. Although corn and milo do best on well-drained loam or light-clay soils, you can grow them on moderately drained soils. Early drawdowns (during the first 45 days of the growing season) are necessary when planting corn because of its long maturation period, intolerance of heat and drought, and susceptibility to insect and other pests. However, varieties called "tropical corn" are readily available and adapted to late- and warm-season planting. Plant or drill corn in rows about 36 inches apart, with about 8 to 10 inches between plants (about 18,000 to 20,000 seeds/acre), on well-prepared seedbeds, or broadcast and cover it with 1 inch of topsoil. You can apply a preemergent herbicide or apply herbicide to glyphosate-resistant corn after plants are about 10 inches tall. Then you can halt later herbicide use to allow grasses and other desirable moist-soil vegetation to grow with the corn. This combination of corn and moist-soil grasses, often termed "grassy corn," provides high energy ("hot") grain, natural seeds, and aquatic invertebrates after flooding.

A particularly good waterfowl foraging habitat and hunting area is 18 or more rows of "grassy corn" adjacent to natural moist-soil vegetation where "grassy corn" was grown the previous year. Annual rotation of "grassy corn" and moist-soil patches is an excellent strategy to provide a diversity of "hot" and natural foods in managed habitat and hunting units. You can produce "grassy milo" similarly to "grassy corn" by widely spacing planted rows of milo to let sunlight promote grass cover between rows. Also, if you harvest milo by early August, a ratoon milo crop may be produced from cut stubble.

ACTIVITY SCHEDULE FOR PRODUCING AND MANAGING SMALL GRAINS FOR WATERFOWL

Activity	Timing	Management Recommendations
Spring drainage	*About 2 weeks before planting dates recommended by Extension for crop grown.*	*Hold water on cropland until near planting time to control weeds and to encourage use of food by waterfowl and other wildlife.*
Ground preparation	*14 days or more after drawdown.*	*Disk as needed to prepare a seedbed or use "burn down" herbicides and plant using no- or reduced-till.*
Planting	*After seedbed preparation or best planting dates in your area; consult your Extension agent.*	*Recommended seeding rates:* *• rice - 90 lb/acre* *• Japanese and browntop millet - 12 to 25 lb/acre* *• corn - 18,000 kernels/acre*
Fertilization	*Consult Extension agent for dates to apply.*	*For best results, soil test and follow recommendations.* *General applications:* *• rice - up to 180 lb/acre of nitrogen and up to 40 lb/acre of phosphorus and potassium. If you apply a blend, use 20-10-10 at a rate of 800 lb/acre. For rice, divide the nitrogen into two applications - one pre flood, one midseason.* *• millets - up to 60 lb/acre of nitrogen and up to 40lb/acre of phosphorus and potassium. If you apply a blend, use 300 lb/acre of 20-10-10 or 450 lb/acre of 13-13-13.* *• corn - up to 200 lb/acre of nitrogen and up to 60 lb/acre or phosphorus and potassium. Apply one third of the nitrogen and all of the phosphorus and potassium at planting. Apply the remaining nitrogen at six-leaf stage. If you apply a blend, use 400 lb/acre of 13-13-13 and 350 lb/acre of 34-0-0 at six-leaf stage. Or apply 800 lb/acre of 20-10-10 all at once.*
Weed control	*Early part of growing season.*	*Selectively treat areas with herbicides, bushhog, or disk when infestation levels of cocklebur, coffeeweed, or other undesirable broadleaved plants cover more than 25 percent of the ground. Review the "Herbicide Recommendations" section for a more thorough review of this topic. Be sure to read and follow all the labeled instructions when applying herbicides.*
Flooding	*May to June.*	*For rice production, flood rice when plants are 5 to 6 inches tall, and keep 2 to 4 inches of water throughout the growing season.*
	August 15 to September 30.	*Shallow flood (2 to 6 inches) 10 percent of the total managed area to provide habitat for early migrants, such as blue-winged teal.*
	November 15 to January 1.	*Increase water levels gradually to flood entire management area between November 15 and early January.*

Forested Lands

Habitat Development

Forested and other wetlands with woody plants meet special habitat needs for waterfowl that wetlands with herbaceous vegetation or flooded croplands don't provide. Woody habitats produce nutritious plant and animal foods for waterfowl and provide them with roosting and loafing sites, cover from predators and bad weather, and isolation for courtship and pair bonding.

Two broad categories of forested wetlands are frequently managed as waterfowl habitat: 1) greentree reservoirs (GTR), which are tracts of bottomland hardwood forest that can be flooded in winter by pumping or gravity flowing water or by natural flooding, and 2) bald cypress-tupelo brakes, other swamp-tree brakes (such as willow, green ash, and red maple), shrub-scrub sloughs (buttonbush, privet), and beaver ponds. MSU scientists discovered the greatest densities of mallards and other dabbling ducks were associated with landscape complexes of several habitats, including about 20 percent forested or scrub-shrub wetlands.

Regarding GTRs, they may not be needed in lowland forested areas that flood naturally every year or frequently. If you are considering construction of a GTR, you should contact the Army Corps of Engineers to determine if you need a section 404 permit to begin construction in your wetland areas.

Forest Habitat Management

Waterfowl management plans for GTRs should maintain or increase the number and quality of red oaks (such as water, willow and Nuttall) in the stand and encourage crown development that increases acorn (mast) production. Selectively applying herbicides by injection (known as "hack and squirt") to remove some non-mast-producing tree species can be used to alter stand composition and release mast-producing species, possibly increasing acorn production and availability for ducks and other wildlife.

Creating small openings of three acres or less in forested wetlands can provide entry points into these wetlands for waterfowl and enhance hunting opportunities. These openings can be created by conventional timber harvest or by using a small bulldozer-like implement (such as skid-steer loader) with mulching head. This device has been used effectively in Delta forests to fell and mulch densely overgrown areas (with trees up to 6 inches in diameter), understory trees and scrub-shrub (such as green ash, red maple, privet, swamp elms), and create individual openings or reduce dense understory to establish a more open "park-like" habitat. Once created, these openings typically are maintained as hunting sites by regular mowing or disking to limit woody regeneration.

If mast-producing red oaks are scarce within lowland forests, managers may plant red oak seedlings adapted to the site conditions to increase availability of mast-bearing trees. You may have to inject mid- and under-story trees to make sure there is enough sunlight for seedling establishment and growth. Plant Japanese or browntop millets in areas open to sunlight to supplement natural food availability in forested wetlands. Because of the potential value of timber involved, it is always advisable to use a professional forester before managing lowland forests.

Based on estimates by the Lower Mississippi Valley Joint Venture, average acorn production in red oak stands (about 110 lbs/acre) is similar to estimated availability of waste seeds remaining in harvested rice, soybean, corn, and grain sorghum fields in late fall (about 100 lbs/acre). Research indicates that mallard ducks stop feeding in rice fields when waste rice declines to about 45 lbs/acre. If this "giving-up" threshold for waterfowl feeding is similar for bottomland hardwood forests, there may be a fairly small foraging "buffer" in these habitats. But oaks with a diameter at breast height of 14 to 30 inches can produce lots of acorns. So, you need to keep a basal area of 40 to 80 square feet of desirable species per

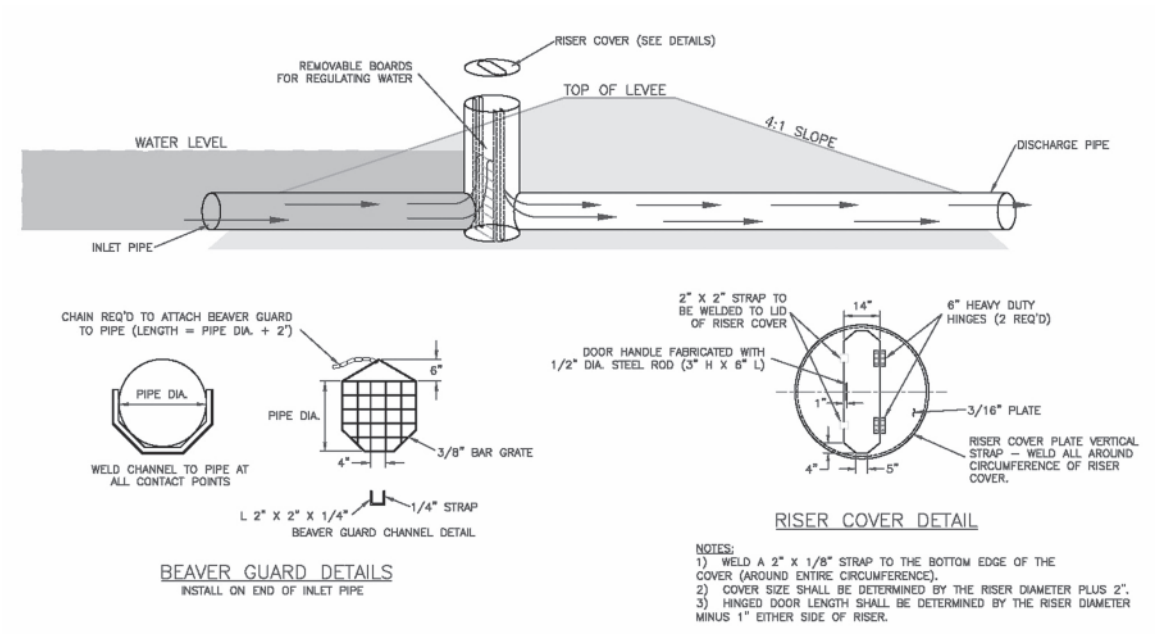

Figure 8. Full-round flashboard riser used to control water levels in forested welands or other areas where beavers may cause problems..

acre. Also, try to keep a good age-class distribution (seedlings, young trees, and mature timber) of a variety of oaks to ensure continued mast production. Also keep large trees with cavities at a rate of one cavity per acre for cavity-nesting wildlife.

Water Management

Prolonged annual flooding of bottomland hardwood forests in winter and into spring often causes changes in the forest type. In such stands regeneration by desirable mast-producing oaks is generally reduced, and mature trees may be replaced by more water-tolerant species such as willow, bald cypress, green ash, red maple, water locust, and overcup oak. Although permanent timber damage may occur within 1 to 2 years when forests remain flooded after trees leaf out in the spring, you may not see it for 4 to 5 years.

Don't flood hardwood forests until their leaves change color in the fall. Some managers flood GTRs in late summer with water drained from rice fields and other harvested croplands. But we strongly advise against flooding GTRs while trees are photosynthesizing, because flooding can halt this process, harm forest health, and eventually cause trees to die.

Also, GTRs should be drained in winter before tree buds begin to swell. A general guideline for the Mississippi Delta and neighboring states is that dormancy for bottomland hardwoods is mid November through February, so managers should strive to have GTRs drained by late February to avoid timber damage and enhance regeneration of desirable tree species. GTRs should not be flooded more often than every other year or every two years. If red oak and other desirable hardwood seedlings regenerate from acorns or other seeds, GTRs should remain unflooded for at least 2 years to let the seedlings grow higher than typical flooding within the GTR.

It is important for seedlings not to be flooded outside the winter dormancy period to prevent killing seedlings. When you do flood GTRs, do it gradually to imitate natural, local water flow patterns. Don't flood GTRs deeply. Suitable foraging depths for mallards and wood ducks are less than 18 inches and preferably 4 to 12 inches. Consider the depth a duck can forage, given the distance between its bill and its feet when tipping up, and gauge flooding depths accordingly instead of flooding deep enough for hunters operating boats and motors.

Don't flood hardwood forests until their leaves change color in the fall. Also, drain GTRs in winter before tree buds begin to swell.

Wooded brakes and shrub-scrub sloughs that are permanently flooded produce less food for waterfowl than GTRs. When these flooded habitats naturally dry or are drained in the summer (mid-June to early July), they can produce good natural waterfowl food plants such as grasses, sedges, smartweeds, and duck potato. You also can seed mudflats of these drawn-down wetlands with commercially available millets.

Wood Duck and Beaver Pond Management

In flooded areas with dense stands of scrub-shrub thickets or robust emergent plants, you can increase waterfowl use by using chemicals to create small openings (1 acre or larger) and "hemi-marsh" conditions. You must use herbicides approved for aquatic application in these wetlands. Research has revealed that wood duck duckling survival tends to be greatest in scrub-shrub wetlands, perhaps because predation on ducklings is less in these wetlands. You can put wood duck boxes in scrub-shrub wetlands to enhance production of wood ducks and other cavity-nesting birds. But don't put wood duck boxes in or around water bodies you manage for largemouth bass, because these aquatic predators eat ducklings. For further information on managing for wood duck production, see "Wood Duck Broods in Dixie: Striving To Survive Early in Life" at http://fwrc.msstate.edu/pubs/ducklings.pdf.

Beavers can provide waterfowl habitat in areas where landowners are willing to manage them and tolerate some damage from their activities. Beaver ponds provide nest sites (in cavities of live and dead trees), brood habitat, and roosting cover for wood ducks and other cavity-adapted birds and wildlife. Permanently flooded beaver ponds frequently do not provide abundant food for waterfowl. If you are willing to manage water levels by breaking dams and installing water-management devices, you can improve beaver pond wetlands for waterfowl.

In July to early August, you can break beaver dams where the water is deepest and install a three-log drain or Clemson beaver pond leveler to manage water levels. Then you can drain beaver ponds and let mud flats vegetate naturally or plant

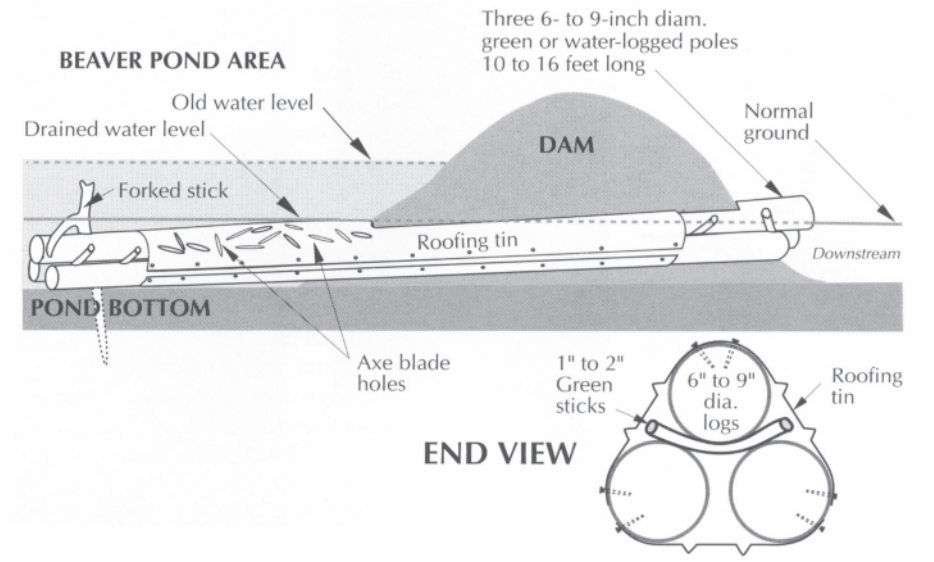

Figure 9. Three-log drain used to help control water levels in beaver ponds. Reprinted from Arner et al (1966).

with Japanese millet. Although Japanese millet will not establish itself in standing water, good stands often result when soil is moist during the growing season.

Check drains in beaver ponds frequently during the growing season to be sure they are not plugged and water is accumulating and overtopping desired vegetation. You can let beavers rebuild dams in October through November to create winter wetlands.

Levee Construction

Developing habitat for waterfowl in forested wetlands poses unique challenges. Habitat development in forested areas is generally much more costly and complex than developing in croplands or open wetlands. If not planned, constructed, and managed properly, these projects often hurt forest stand health and vigor.

The first step is to get a 404 permit from the U.S. Army Corps of Engineers (contact your NRCS office for help) before constructing waterfowl habitat projects in forested wetland areas. Site conditions typically are much more challenging in these habitats because of wet conditions and the presence of standing timber. As with levee construction in any type of habitat, remove all vegetation and woody material from the levee right-of-way before placing any fill material. Next, it is important to be sure the soil beneath the levee can support the additional weight of new fill material. If the area beneath the new levee is soft or has a high organic content, you may have to excavate some of the existing soil and backfill the area with suitable material before building the new levee. Many times suitable borrow material is not readily available in forested areas, making it necessary to transport off-site material to lessen project impacts. For more information on levees, refer to Levee Construction in the Open Lands section of this publication.

Water-Control Structures

Because water control structures in forested wetlands are subject to damage from beavers, control structures should be made from steel pipe. We recommend a full-round riser equipped with an intake trash rack to prevent beavers from impacting the inside the water control structure with mud and debris. You can also install trash racks on the outlet end of pipes to prevent beavers from getting to the riser structure. But you have to check these racks often to be sure debris does not collect on the inside and restrict water flow through the pipe.

Beavers are attracted to the sound and sight of running water. To reduce the noise created by water running, full-round risers are equipped with a solid steel lid with an access door. Inlet and outlet pipes should sit below ground level so the pipe is not exposed until most or all of the water is drained from the impoundment. Sometimes beaver deterrent pits are dug at the pipe inlet. These pits are excavated 2 to 3 feet beneath the pipe inlet. Despite all these safeguards, beaver activity around the structure will usually require periodic maintenance. The inlet pipe should be where you can reach it by hand or with a backhoe or similar equipment to remove beaver debris.

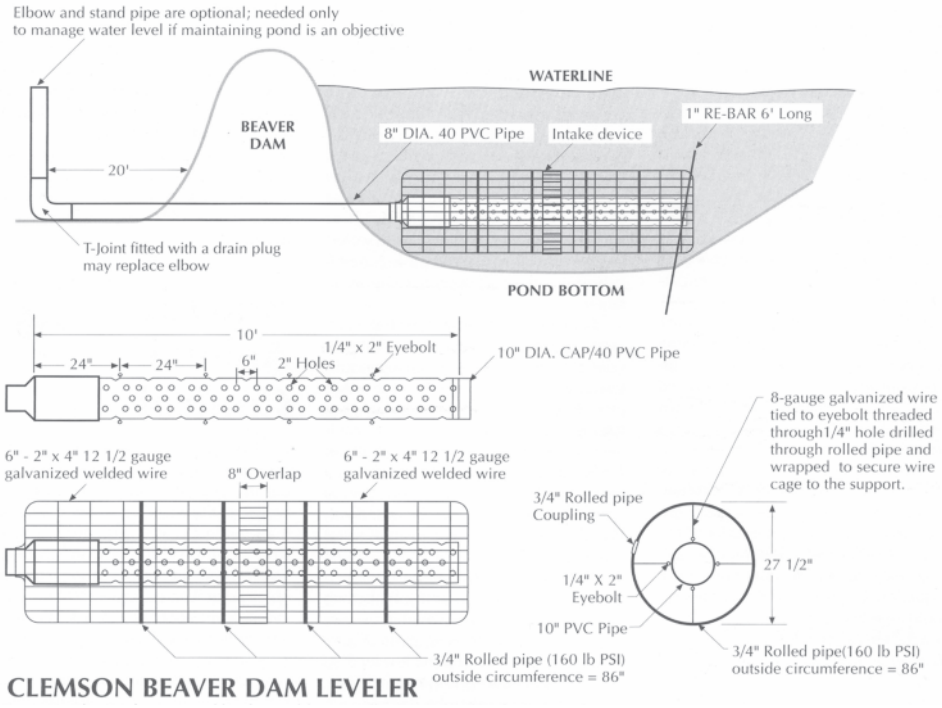

Figure 10. Clemson beaver pond leveler used for controlling water levels in beaver ponds.

Beaver ponds can be managed for wood duck habitat with proper water control.

Nuisance Plant and Animal Management

Aquatic Rodent Control

Aquatic rodent control is often a necessary part of waterfowl habitat management to reduce damage to levees and lessen maintenance to water control structures.

Beavers can dam almost any water system, including road culverts, bridges, and spillways. Beaver dens may be in river and stream banks, pond banks, and levees. When constructing dens, beavers also dig tunnels. This weakens levees and eventually causes levees to collapse.

The most effective tools for controlling beavers are body gripping traps and snares. Body gripping traps such as a No. 330 Conibear® quickly dispatch animals. You can buy these at farm supply stores or trapping supply companies. You can also use foothold traps set as a live capture or a drowning set. Snares are generally handmade, lightweight, and can be set in various wetland sites. When using any trap or snare, be aware of nontarget animals such as cats and dogs. To avoid most nontarget animals, put traps underwater.

Night shooting is another effective way to control beavers. Before trying this, check with your local conservation officer or county sheriff to make sure this method is legal. Be aware of safety, since many types of ammunition can ricochet off the water surface. A 12-guage shotgun with a slug or buckshot is probably all you need when night-shooting beaver in a pond setting. Again, be aware of nontarget species, such as otter. Check with your state conservation agency for proper permitting when removing otters. Taking otters may require a permit outside of trapping season, and it does require a trapping permit/license during the open trapping season.

Two other aquatic rodents cause similar problems: nutria and muskrat. Nutria and muskrat can burrow into levees and will eat lots of plants intended for waterfowl if population levels get too high. You can trap for both these animals with body gripping traps or snares. Because these animals are smaller than beaver, a No. 220 or No. 110 Conibear® is preferred, especially for muskrat.

For more information on state trapping laws and nuisance wildlife control laws, contact the Mississippi Department of Wildlife, Fisheries and Parks (MDWFP). The Mississippi Extension Service and USDA Animal Plant Health Inspection Service (APHIS) Wildlife Services can provide help and information on use of traps, snares, and other options to control aquatic rodents.

Weed Management in Waterfowl Management Areas

Managing weeds in waterfowl management areas requires an integrated approach for success. Relying on one technique does not work well enough. Techniques may include burning vegetation, disking, mowing, and using herbicides. Herbicides can offer a cost-effective alternative for management of problematic plants. **When using herbicides, always read labels and apply only prescribed label rates.** Another important factor is presence or absence of water. If there is water or if you are applying in a drained wetland, you are required to use herbicides with aquatic labels. An aquatic label means you can use the product in standing water at the recommended label rates. Still another concern with use of herbicides is the possible effect on desirable vegetation and nontarget plants and animals through spray drift or volatilization of the herbicide. Clearly, if you have any doubts regarding spraying herbicides, contact the herbicide company representative or your Extension office.

Application Methods and Calibration

Proper calibration and spray equipment are musts for effective weed management using herbicides. Commonly used spray equipment may include pump-up, handheld, and backpack sprayers; ATV and tractor-mounted tank and boom systems; and airplane- and helicopter-mounted spray systems. The last tools are typically used by professional applicators for large-scale treatments.

One of the most important aspects of using herbicides is proper calibration of spray equipment. Improper calibration can cause serious problems, such as killing nontarget vegetation and increasing cost of application by applying too much chemical. Calibration is equipment-specific, so do it before applying herbicides. Formulas are available to make calibration easier. It is also important to be able to change values from one unit of measure to another (as in changing acres to square feet).

COMMON FORMULAS USED IN CALIBRATING SPRAY EQUIPMENT

Description	Formula
Determining how many gallons per minute (GPM) your spray apparatus puts out	$GPM = \frac{(GPA)(MPH)(NSI)}{(5940)}$
Determining how many gallons per acre (GPA) your spray apparatus puts out	$GPA = \frac{(GPM)(5940)}{(MPH)(NSI)}$
Determining the correct speed (MPH) of your spray apparatus	$MPH = \frac{(GPM)(5940)}{(GPA)(NSI)}$
Determining the proper width of your nozzle spacing in inches (NSI)	$NSI = \frac{(GPM)(5940)}{(GPA)(MPH)}$

*5940 is a constant used to eliminate units within the above equations.
**Review Extension Publication 1532 for more information about calibrating spray equipment.

COMMON CONVERSION FACTORS FOR CALIBRATION AND HERBICIDE USE				
Area	**Acre to square feet** 1 ac = 43,560 ft^2	**Acre to hectare** 1 ac = 0.405 ha	**Hectare to square meter** 1 ha = 10,000 m^2	**Hectare to acre** 1 ha = 2.47 ac
Distance	**Inches to centimeters** 1 in = 2.54 cm	**Meter to feet** 1 m = 3.28 ft	**Meter to inches** 1 m = 39.37 in	**Miles to feet** 1 mi = 5280 ft
Speed	**MPH to feet/minute** 1 MPH = 88 ft/min			
Volume	**Gallon to fluid ounce** 1 gal = 128 fl oz	**Gallon to pint** 1 gal = 8 pt	**Gallon to quart** 1 gal = 4 qt	**Gallon to liter** 1 gal = 3.785 L
	Gallon to milliliter 1 gal = 3785 mL	**Pint to fluid ounce** 1 pt = 16 fl oz	**Pint to fluid ounce** 1 qt = 32 fl oz	**Fluid ounce to milliliter** 1 fl oz = 29.57 mL
Weight	**Pounds to grams** 1 lb = 453.6 g	**Pounds to ounce** 1 lb = 16 oz	**Pounds to kilograms** 1 lb = 0.45 kg	**Kilograms to pounds** 1 kg = 2.2 lbs

Herbicide Recommendations

Herbicide recommendations for problem plants are provided below. If you have questions regarding plant identification, contact your local resource management agency or organization (such as, NRCS, MSU Extension, or Ducks Unlimited). Following are recommendations to maximize effectiveness of common herbicides and restrictions for their use. For more information regarding each herbicide, consult the label and/or your Extension agent. ***Read each label carefully, and follow instructions explicitly.***

HERBICIDE RECOMMENDATIONS FOR COMMON PROBLEMATIC PLANTS IN WATERFOWL MANAGEMENT AREAS IN THE MISSISSIPPI ALLUVIAL VALLEY		
Troublesome Weeds	**Herbicide**	**Rate (fl oz/acre)**
Alligatorweed *(Alternanthera philoxeroides)*	2,4-D Carfentrazone Glyphosate Imazapyr Triclopyr	64 6.7 - 16.5 96 16 - 64 64 - 256
Beakrush *(Rhynchospora corniculata)*	Glyphosate Imazapyr	48 - 64 32 - 48
Buttonbrush *(Cephalanthus occidentalis)*	Glyphosate Imazapyr	48 - 64 32 - 48
Cattail *(Typha spp.)*	Glyphosate Imazapyr	72 - 96 32 - 64
Coffee Senna *(Cassia occidentalis)*	2,4-D Dicamba Glyphosate Triclopyr	32 - 128 8 - 24 16 - 32 42 - 192
Common Cocklebur *(Xanthium strumarium)*	2,4-D Aciflurofen Bentazon Bromoxynil Carfentrazone Dicamba Glyphosate Flumetsulam* Imazapyr Triclopyr	32 - 128 8 - 24 24 - 32 16 - 32 0.67 8 - 24 11 - 32 0.8 - 1.33 48 - 64 42 - 192
Duckweed *(Lemna spp.)*	Carfentrazone Diquat Flouridone** Imazapyr	6.7-13.5 128 4 32 - 48
Eurasian Watermilfoil *(Myriophyllum spicatum)*	2,4-D Diquat Endothall Triclopyr	364 128 - 256 256 - 320 90 - 294
Hemp Sesbania *(Sesbania exaltata)*	2,4-D Aciflurofen Carfentrazone Dicamba Glyphosate Triclopyr	32 - 128 16 6.7 - 13.5 8 - 24 16 - 32 42 - 192

HERBICIDE RECOMMENDATIONS FOR COMMON PROBLEMATIC PLANTS IN WATERFOWL MANAGEMENT AREAS IN THE MISSISSIPPI ALLUVIAL VALLEY

Troublesome Weeds	Herbicide	Rate (fl oz/acre)
Lotus, American *(Nelumbo lutea)*	Carfentrazone Glyphosate Imazapyr Triclopyr	6.7 - 13.5 64 32 - 48 64 - 256
Morninglories *(Ipomoea* spp.*)*	2,4-D Aciflurofen Bromoxynil Carfentrazone Dicamba Glyphosate Flumetsulam* Imazapyr Triclopyr	32 - 128 16 16 - 32 0.33 - 0.67 8 - 24 16 - 32 0.8 - 1.33 48 - 64 42 - 192
Prickly Sida "Teaweed" *(Sida spinosa)*	Glyphosate	32
Purple Loosestrife *(Lythrum salicaria)*	2,4-D Glyphosate Imazapyr Triclopyr	32 - 64 64 - 96 16 192 - 256
Redvine *(Brunnichia ovata)*	Aciflurofen Dicamba Glyphosate Imazapyr Triclopyr	8 - 24 16 - 64 16 - 48 48 - 64 42 - 192
Sicklepod *(Cassia obtusifolius)*	2,4-D Dicamba Glyphosate Flumetsulam* Triclopyr	64 - 128 8 - 24 16 - 32 0.8 - 1.33 42 - 192
Smartweed *(Polygonum* spp.*)*	2,4-D Aciflurofen Bentazon Bromoxynil Carfentrazone Dicamba Glyphosate Imazapyr Triclopyr	32 - 128 8 - 24 24 - 32 16 - 32 0.5 8 - 24 72 - 120 32 42 - 192
Trumpet Creeper *(Campsis radicans)*	Aciflurofen Dicamba Glyphosate Imazapyr Triclopyr	8 - 24 16 - 64 48 - 68 64 - 96 42 - 192
Waterhyacinth *(Eichhornia crassipes)*	2,4-D Diquat Glyphosate Imazapyr Triclopyr	64 - 128 64 - 96 80 - 96 16 64 - 256
Water Pod *(Hydrolea quadrivalvis)*	2,4-D Glyphosate	32 - 64 72 - 96
Water Primrose *(Ludwigia uruguayensis)*	2,4-D Carfentrazone Glyphosate Imazapyr Triclopyr	32 - 128 13.5 72 64 - 96 32 - 256
Willow *(Salix* spp.*)*	Dicamba Glyphosate Imazapyr Triclopyr	16 - 64 72 32 - 48 32 - 256

* Rate expressed as dry weight (oz/acre) ** Rate expressed as fl oz/acre foot

Recommendations and Restrictions for Commonly Used Herbicides in Waterfowl Habitat Management

2,4-D

Complete coverage of foliage is essential for maximum effectiveness. Apply when plants are small and actively growing before the bud and rosette stages and before flower stalks appear. Do not spray in winds higher than 10 mph. Do not apply during a low temperature inversion*, because drift potential is very high. Increase droplet size in low humidity periods to reduce the chance of drift. Adding 1 qt of nonionic surfactant per 100 gallons of spray solution may increase herbicide effectiveness. You can apply in water by spraying on exposed vegetation or subsurface injections. Carefully read and follow aquatic application recommendations from herbicide label. When using in water, do not treat more than one half of the area at time of application to avoid oxygen depletion and fish kill.

Aciflurofen

This product is not currently labeled for aquatic use. Do not apply more than a total of 3 pints per acre per season. Allow at least of 15 days between sequential treatments with aciflurofen. Do not use treated plants for feed or forage. Allow 4 hours or more to ensure rain fastness.

Bentazon

This product is not currently labeled for aquatic use. Uptake into the plant is primarily through the leaves. Thorough coverage of foliage is important for control. Failure to penetrate crop or weed leaf canopies with the spray will result in incomplete control of small weeds growing underneath. Cool weather conditions (such as < 50 °F) or drought will delay herbicidal activity and if prolonged, may result in poor weed control. Apply when broadleaf weeds are small and actively growing and before the weeds reach maximum size.

Bromoxynil

This product is not currently labeled for aquatic use, so do not apply to vegetation in standing water or if you plan to flood the sprayed area within one month after product application. Thorough coverage of foliage is essential for best results. Apply when the potential for drift to adjacent sensitive areas (such as residential areas, bodies of water, and known habitats for threatened or endangered species, non-target crops) is minimal (such as when wind is blowing away from the sensitive areas). Use a standard herbicide boom sprayer that provides uniform and accurate application. Sprayer should be equipped with screens no finer than #50 mesh in the nozzle tips and in-line strainers. Select a spray volume and delivery system that will ensure thorough and uniform spray coverage. For optimum spray distribution and thorough coverage, use flat fan nozzles (maximum tip size 8008) with a spray pressure of 40 to 60 psi. Other nozzle types and lower spray pressures that produce coarse spray droplets may not provide adequate coverage. In general, a spray volume of 10 to 20 gallons per acre (GPA) is recommended. Applications using less than 10 gallons per acre may result in reduced weed control. When weed infestations are heavy, you may have to use more spray volumes and spray pressure. When using in water, do not apply when winds are gusty, to minimize off-target spray movement.

Carefully read and follow aquatic and terrestrial application recommendations from herbicide label.

Carfentrazone

Thorough coverage of foliage is essential for best results. Do not spray in winds greater than 10 mph. Add 2 pints of nonionic surfactant per 100 gallons of spray solution. Make aquatic applications as subsurface or as a surface application with a suitable weighting agent (see label for recommended weighting agents) to submerse the spray. Total concentration of carfentrazone-ethyl must not exceed 200 ppb in the treated water area. Apply in spring or early summer when plants are actively growing. When using in water, do not treat more than one half the area at one time to avoid oxygen depletion and fish kill.

Dicamba

This product is not currently labeled for aquatic use. Apply when air temperatures are between 50 and 77 °F. Do not apply when there is a risk of severe drop in temperatures. Do not contaminate domestic or irrigation water. Thoroughly clean application equipment. Do not treat areas where movement of the chemical into the soil or surface washing may bring dicamba into contact with roots of desirable plants. Treat when wind is less than 9 MPH. Do not apply when weather conditions may cause drift from target areas to adjacent sensitive crops. Leave an adequate buffer zone between treatment areas and sensitive plants. Use coarse sprays, because they are less likely to drift than fine sprays. Do not spray when the temperatures are higher than 86 °F. Avoid spraying in high humidity or fog.

Diquat

Apply as a subsurface injection to non-flowing water. Apply evenly over plant-infested area and may apply directly to emergent or floating leaves. Do not apply in muddy/turbid water. Do not treat more

than one half the area at one time to avoid oxygen depletion and fish kill.

Endothall

Spray or inject liquids under water. Apply granules evenly with cyclone seeder. Apply as soon as possible after weeds begin to grow and water temperature is above 65 °F. When treating in sections, treat on 5- to 7-day interval. Use higher rates (as stated in label) when spot treating. Do not treat more than one half the area at one time to avoid oxygen depletion and fish kill.

Flumetsulam

This product is not currently labeled for aquatic use, so do not apply to vegetation in standing water or if you plan to flood the sprayed area within three months after product application. May not be mixed or loaded within 50 feet of any wells (including abandoned wells and drainage wells), sinkholes, perennial or intermittent streams and rivers, and natural or impounded lakes and reservoirs. Do not apply through any type of irrigation system.

Glyphosate

Thorough coverage of foliage is essential for best results. Add 1 to 2 qt nonionic surfactant per 100 gallons of spray solution. Aquatic applications require aquatic-labeled glyphosate as well as approved nonionic surfactants.

Imazapyr

Add 1 quart of an aquatic approved nonionic surfactant per 100 gallons of spray solution. Well established weed infestations may require greater rates (see product label for recommendations). Spray when wind speeds are between 3 and 10 MPH. Higher wind speeds increase chances for drift. Do not apply during temperature inversions (see footnote) because of high risk for drift. Note: imazapyr is not recommended for tank mixing; tank mixing may reduce efficacy and require higher rates of imazapyr. Adsorption of imazapyr to soil increases with decreased pH (less than 6.5) and is influenced by soil moisture. It is important to check the soil pH and moisture before using imazapyr.

Triclopyr

Complete coverage of foliage is essential for best results. Use higher rates within the labeled rate range when plants are mature, when the weed mass is dense, or for difficult-to-control species. Do not spray in winds greater than 10 mph. Do not apply during a low temperature inversion*, because drift potential is great. Adjust droplet size in low humidity periods to reduce chance of drift. Adding 1 qt nonionic surfactant per 100 gallons of spray solution may increase herbicide efficacy on the target plant(s).

*In a temperature inversion, the air at the soil surface is cooler than the air above. The cool air mass stays at the soil surface and does not vertically mix with the air above it. Small spray particles can be trapped within the cool air and may travel horizontally at low elevations for several miles, contacting off-target plants and crops.

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Appendix

Desirable Plants

Beggarticks (*Bidens* spp.)
Enhancement:
Late-season drawdowns.

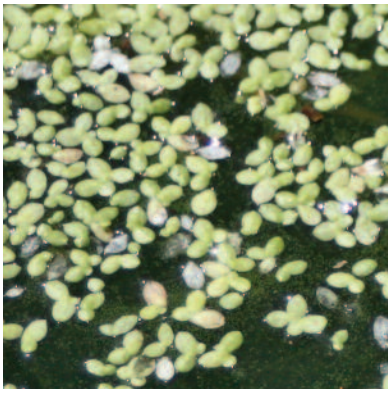
Broadleaf signalgrass
(*Urochloa platyphylla*)
Enhancement: Shallow disk
and late-season drawdown.

Chufa, Yellow nutsedge
(*Cyperaus esculentus*)
Enhancement: Shallow disk
and mid-season drawdown.

Crabgrass (*Digitaria* spp.)
Enhancement: Late-season
drawdowns.

Docks (*Rumex* spp.)
Enhancement: Early-season
drawdowns.

Duck potatoes (*Sagittaria* spp.)
Enhancement: Maintain shallow flood
and expose mudflats in August
through September.



Duckweeds (*Lemna* spp.)
No enhancement recommendation.

Flatsedges (*Cyperus* spp.)
Enhancement: Shallow disk and
mid- to late-season drawdown.

Foxtails (*Setaria* spp.)
Enhancement: Shallow disk
with slow drawdowns.

Millets, Wild (*Echinochloa* spp.)
Enhancement: Shallow disk and slow drawdowns.

Panic grasses (*Panicum* spp.)
Enhancement: Shallow disk and mid- to late-season drawdown.

Rice cutgrass *(Leersia oryzoides)*
Enhancement: Slow late-season drawdown.

Sedges *(Carex* spp.)
No enhancement recommendation.

Smartweeds, Annual
(Polygonum spp.)
Enhancement: Slow early-season drawdowns.

Spikerushes *(Eleocharis* spp.)
Enhancement: Maintain shallow flood.

Sprangletops *(Leptochloa* spp.)
Enhancement: Shallow disk and mid- to late-season drawdowns.

Teal Lovegrass
(Eragrostis hypnoides)
No enhancement recommendation.

Toothcup *(Ammania coccinea)*
Enhancement: Shallow disk and late-season drawdowns.

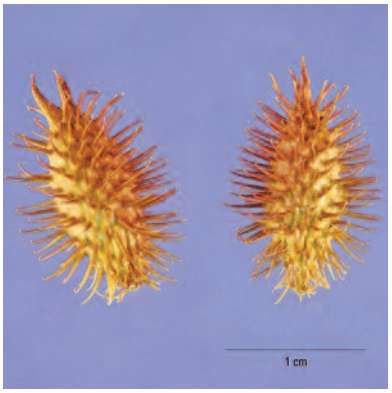
Water plantain
(Alisma subcordatum)
No enhancement recommendation.

Alligatorweed
(Alteranthera philoxeroides)
Control: See Herbicide Table on pages 19-20.

Lotus, American
(Nelumbo lutea)
Control: See Herbicide Table on pages 19-20.

Balloon vine
(Cardiospermum halicacabum)
Control: Late-season disking.

Cattails *(Typha spp.)*
Control: See Herbicide Table on pages 19-20.



Cocklebur *(Xanthium strumarium)*
Control: See Herbicide Table on pages 19-20.

Coffeeweed *(Sesbania spp.)*
Control: See Herbicide Table on pages 19-20.

Eurasian watermilfoil
(Myriophyllum spicatum)
Control: See Herbicide Table on pages 19-20.

Redvine *(Brunnichia ovata)*
Control: Control: See Herbicide Table on pages 19-20.

Rose mallow *(Hibiscus spp.)*
Control: Late-season disking.

Sicklepod *(Cassia obtusifolius)*
Control: See Herbicide Table on pages 19-20.

Teaweed *(Sida spinosa)*
Control: Late-season disking followed by slow drawdown.

Trumpet creeper
(Campsis radicans)
Control: See Herbicide Table on pages 19-20.

Waterpod *(Hydrolea quadrivalvis)*
Control: See Herbicide Table on pages 19-20.

Marginal Value Plants

These plants provide some waterfowl food and/or cover but may need control depending on management objectives. Consider control when these plants have 20 percent or greater coverage of impoundment.

Asters (*Symphyotrichum spp.*)
Control: Late-season disking followed by slow drawdown.

Beakrush, Horned
(*Rhynchospora corniculata*)
Control: See Herbicide Table on pages 19-20.

Broomsedge
(*Andropogon virginicus*)
Control: Late-season disking followed by slow drawdown.

Marginal Value Plants

These plants provide some waterfowl food and/or cover but may need control, depending on management objectives. Consider control when these plants have 20 percent or greater coverage of impoundment.

Burreed (*Sparganium* spp.)
Control: Late-season disking followed by slow drawdown

Buttercups (*Ranunculus* spp.)
Enhancement: early-season drawdowns

Buttonbush
(*Cephalanthus occidentalis*)
Control: See Herbicide Table on pages 19-20

Goldenrod (*Solidago* spp.)
Control: Late-season disking followed by slow drawdown

Johnsongrass (*Sorghum halepense*)
Control: Strip disking to discourage monoculture

Morning glories (*Ipomoea* spp.)
Control: Late-season disking followed by slow drawdown

Pigweeds (*Amaranthus* spp.)
Control: Late-season disking followed by slow drawdown

Ragweeds (*Ambrosia* spp.)
Control: Late-season disking followed by slow drawdown

Rushes (*Juncus* spp.)
Control: Late-season disking followed by slow drawdown

Marginal Value Plants

These plants provide some waterfowl food and/or cover but may need control, depending on management objectives. Consider control when these plants have 20 percent or greater coverage of impoundment.

Smartweeds, Perennial
(*Polygonum* spp.)
Control: See Herbicide Table on pages 19-20.

Sumpweed (*Iva annua*)
Control: Late-season disking followed by slow drawdown.

Swamp milkweed
(Asclepias incarnata)
Control: Late-season disking followed by slow drawdown.

Water primrose (*Ludwigia* spp.)
Control: See Herbicide Table on pages 19-20.

Willows (*Salix* spp.)
Control: See Herbicide Table on pages 19-20.

Food-producing Trees

Acorn/nut-producing Trees - Mast from these trees are used by wood ducks and mallards as rich sources of energy and fatty acids.

Bitter Pecan (*Carya lecontei*)

Cherrybark Oak (*Quercus pagoda*)

Overcup Oak (*Quercus lyrata*)

Food-producing Trees

Acorn/nut-producing Trees - Mast from these trees is a rich source of energy and fatty acids for wood ducks and mallards.

Pin/Nuttall Oak
(*Quercus palustris/nuttallii*)

Shumard Oak (*Quercus shumardii*)

Water Oak (*Quercus nigra*)

Willow Oak (*Quercus phellos*)

Samara-producing Trees

Samaras from these trees are a highly digestible source of carbohydrates in spring for wood ducks.

Red Maple (*Acer rubra*)

Silver Maple (*Acer saccharinum*)

Green Ash (*Fraxinus pennsylvanica*)

American Beech (*Fagus grandifolia*)

American Elm (*Ulmus americana*)

Bald Cypress (*Taxodium distichum*)

Black Willow (*Salix nigra*)

Red Maple (*Acer rubra*)

Silver Maple (*Acer saccharinum*)

Sugarberry (*Celtis laevigata*)

Sycamore (*Platanus occidentalis*)

Tupelogum (*Nyssa aquatica*)

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Mississippi Trees by Hodges, J.D., et al 2008, Mississippi Forestry Commission

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USDA Natural Resources Conservation Service

USDA NRCS PLANTS database

We thank the following for funding support:

Publication 1864 (rep-09-18)
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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. GARY B. JACKSON, Director