SP-316
8/07

AgriLIFE EXTENSION
Texas A&M System

Techniques for Wetland Construction & Management

Trinity River Initiative

Techniques for Wetland Construction and Management

Shawn L. Locke, Ph.D., Texas Cooperative Extension, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Texas, USA

Carl Frentress, Advanced Ecology Ltd., Athens, Texas, USA

James C. Cathey, Ph.D., CWB, Texas Cooperative Extension, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Texas, USA

Corey D. Mason, CWB, Texas Parks and Wildlife Department, Austin, Texas, USA

Rick Hirsch, Texas Cooperative Extension, Athens, Texas, USA

Matthew W. Wagner, Ph.D., CWB, Texas Parks and Wildlife Department, Austin, Texas, USA

ACKNOWLEDGEMENTS

This document represents the second in a series of publications involving a partnership between Texas A&M University, Texas Cooperative Extension, Department of Wildlife and Fisheries Sciences, Institute of Renewable Natural Resources, and Texas Parks and Wildlife Department. We thank the Texas Parks and Wildlife Department for funding for this work. Additional funding was provided from the Renewable Resources Extension Act. We thank James and Jim Reed, owners of the Reed Family Ranch, for sharing their ideas of wildlife management and access to their property. The Trinity Basin Conservation Foundation was a catalyst for this work, and we appreciate the collaboration with its members. Photos were provided by James C. Cathey, Wes Littrell, Corey Mason, Michael Masser and Wesley Newman. We appreciate the efforts of Billy Higginbotham, Michael Masser, Cody W. White, and R. Montague Whiting Jr. for providing editorial review of this manuscript.

TABLE OF CONTENTS

INTRODUCTION

For many people, wetlands equate to swamps, which bring to mind images of dangerous alligators and snakes. However, wetlands are important systems that contain a vast array of plants and animals. They are as valuable ecologically as they are beautiful. Wetlands serve many functions that rarely are recognized by most people, yet they are vital to human existence. Wetlands help regulate the climate, as well as provide flood and erosion control, while at the same time storing and recycling nutrients. Furthermore, wetlands remove human, livestock, and wildlife waste and protect water quality. They provide habitat for numerous wildlife species and present cultural and recreational opportunities for humans. Collectively, these are called ecosystem services (Table 1).

In the previous publication in this series, "Linking Water Conservation and Natural Resource Stewardship in the Trinity River Basin," the potential water crisis in Texas was described, and the connection between ecosystem function and responsible land stewardship was explored. Here, our objective is to provide land stewards with the knowledge to perform actions on individual properties to create, restore, or enhance wetlands.

Land stewards throughout the Trinity River Basin and elsewhere have expressed interest in ways to improve ecosystem function and restore ecological services in addition to enhancing wildlife habitat. This interest may be stimulated by the demand for access to hunting lands, the increasing trend to use the land for recreational purposes, alternative economic land uses, or a strong sense of land stewardship among East Texas landowners. The desire for information regarding wetland management for ecological services is growing among landowners.

While basic wetland development concepts and techniques are relatively straightforward, managers should recognize that only site-specific assessments and subsequent management programs can achieve objectives successfully. Wetlands are dynamic

Table 1. Ecosystem services provided by watersheds (Costanza et al. 1997).

Ecosystem Service	Ecosystem Function
gas regulation	regulation of the atmosphere's chemical composition
climate regulation	regulation of temperature, precipitation, and other biologically controlled climatic processes
disturbance regulation	regulation of environmental fluctuations
water regulation	regulation of water flow
water supply	storage and retention of water
erosion control	soil retention
nutrient cycling	storage, cycling, and processing of nutrients
waste treatment	uptake, removal, and breakdown of nutrients
biological/pest control	regulation of populations due to food webs
wildlife habitat	habitat for resident and migratory wildlife
food production	production of plants, animals, etc.
raw materials	production of extractable raw materials
genetic resources	source for unique biological materials and products
recreation	opportunities for recreational activities
cultural aspects	opportunities for non-commercial use (i.e., aesthetic, artistic, educational, spiritual, and/or scientific values of ecosystems)

systems often having subtleties that may complicate the scope of management. Whenever possible, professionals should be consulted for recommendations and ultimate formulation of plans.

What are Wetland Ecosystems?
Although numerous scientific and legal definitions of wetlands exist, for the purpose of this publication a simple definition provided by the U.S. Environmental Protection Agency (EPA) will be used: "A wetland is an area that is regularly saturated by surface water or groundwater and is characterized by a prevalence of vegetation that is adapted for life in saturated soil conditions (e.g., swamps, bogs, fens, marshes and estuaries)." An ecosystem is defined as a functional unit consisting of plants, animals and all of the physical and chemical components involved in energy flow. Within the Trinity River Basin, both inland and coastal wetlands exist. Inland wetlands are found along the Trinity River and its tributaries and may consist of forested or non-forested wetlands. Coastal wetlands are found where the Trinity discharges into the Gulf of Mexico via the Trinity Bay near Houston, Texas.

Extensive losses of wetlands in the lower 48 states have occurred over the last two centuries. Approximately 52 percent of wetlands in Texas have been lost or degraded since the 1780s, primarily as a result of human actions (e.g., drainage, diking, damming, tilling for crop production, mining, construction, etc.). Not until the late 1960s did legislation in the U.S. begin to provide protection for wetlands. Although no specific law exists, wetlands are managed through numerous agencies under regulations pertaining to land use and water quality (e.g., Section 404 of the Clean Water Act).

Examples of the Economic Benefits of Wetlands
Richland Creek WMA — Richland Creek Wildlife Management Area (RCWMA) is in the Trinity River floodplain in Freestone and Navarro Counties. This nearly 14,000-acre property was deeded to the Texas Parks and Wildlife Department (TPWD) as mitigation for the loss of bottomland hardwood habitat resulting from the construction of Richland-Chambers Reservoir. In 1996, TPWD partnered with the Tarrant Regional Water District (TRWD) to develop up to 2,000 acres of water treatment wetlands on RCWMA. Objectives of the project were to produce high quality water, to produce wetland habitat for wildlife, and to apply the concept of natural wetland function in water reuse. The project operates by pumping water from the Trinity River and filtering it through native wetland plants living in a series of constructed wetland units. Then the treated water is pumped into Richland-Chambers Reservoir, where it is piped back to customers in the Dallas–Fort Worth Metroplex. This project serves as a model for meeting increasing water needs in an environment-friendly manner without the construction of additional reservoirs. Wetlands and bottomland hardwood forests provide habitat for deer, waterfowl and other game and nongame species that would be destroyed by reservoir construction. The RCWMA model serves as a win-win solution for water consumers and wildlife enthusiasts, and similar projects are underway in other parts of the state.

Reed Family Ranch — The RCWMA example is likely too expensive for most private landowners in Texas. The Reed Family Ranch offers a more feasible example of wetland management on private lands. The Reeds own approximately 1,780 acres of wildlife habitat, including both uplands and forested bottomland wetlands along the Trinity River in Navarro County. They made a decision to diversify ranch income from traditional farming and ranching to incorporate wildlife enterprises in their land management plan. Jim and his son James are quick to point out that cattle are not leaving the landscape, but are used as a tool to manipulate habitat to benefit wildlife and improve soil conditions. This is accomplished using cross fencing and rotational grazing. Maintaining excellent ecological conditions is the highest priority in decision-making.

Wetland management is another component within the long-range planning of the Reed family. In addition to the river frontage and forested bottomlands, three impoundments are managed for fish and/or waterfowl. Recently, the Reeds installed a flashboard riser (described on page 7) on an impoundment to manage moist soil plants. The flashboard riser allows water to be manipulated so that it mimics historical hydrology. Through wildlife enterprises (e.g., duck hunting leases), the Reeds have offset construction and equipment costs. Their aggressive land management and ethics have earned the Reeds the Leopold Conservation Award by the Sand County Foundation and TPWD.

The Value of Wetlands

Placing a monetary value on wetlands is difficult and, some may argue, unjustified. Wetlands are important to humans and the environment, but many landowners may inquire about the value of wetlands to their livelihood. In Texas, private landowners can benefit from positive land management through incentives to maintain open space (Wildlife Property Tax Valuation Program — http://www.tpwd.state.tx.us/landwater/land/private/agricultural_land/) and direct improvements like increased forage production, game abundance, and water quality. Today, most landowners are familiar with wildlife enterprises. Hunting leases offer landowners an opportunity to generate income from their wetland investment. For example, duck hunts can generate between $150 and $400 per hunter per day. Additionally, income through birding is becoming increasingly more popular and lucrative. In the future, we anticipate that markets for ecosystem services will gain momentum and diversity, thus providing landowners alternative land-based incomes (e.g., conservation credits, wetland banking or carbon credits).

WETLAND CONSTRUCTION AND MANAGEMENT

Any given wetland improvement project can be classified into one of three general categories: 1) creation, 2) restoration, or 3) enhancement.

Creation is the most dramatic of the three categories. Here, wetlands are made where none existed previously, although the soil characteristics may be favorable for holding water and some wetland components may be present (e.g., water-adapted plants and animals). Wetland creation techniques drastically and rapidly change surface conditions of the land.

Wetland restoration techniques seek to alter an existing site by returning it to a set of previous conditions. Usually, some idea of the characteristics of the earlier wetland conditions is desirable when applying restoration activities. Thus, the expected outcomes may be defined by a set of objectives prescribed by the history of the site. Wetland restoration builds on pre-existing wetland conditions.

Enhancement is the most common category of wetland management. This involves "making the good even better." Adjustments are made to balance factors that will cause more desirable conditions to prevail. The results of enhancement practices are the least dramatic in terms of landscape appearance.

In this publication, the term “development” is considered to encompass these three categories. Thus, any given habitat development project may include enhancement, restoration, creation or a combination of these approaches.

Site Selection

Evaluation of a wetland development project begins by assessing current land conditions. Soils, vegetation and water are the three critical factors that control the presence and quality of wetlands. Initial site evaluations include examinations of soil characteristics (available from the Natural Resource Conservation Service [NRCS]), the seasonal availability of water (i.e., hydroperiod), the abundance of wetland-adapted plant seeds in the soil (i.e., seedbank), and existing plant communities. The combination of water-holding (impermeable) soils, adequate surface water during fall and winter, and a community of annual wetland plants indicates the potential for wetland development. Otherwise, development by some type of construction activity may be warranted.

The Trinity River Information Management System (TRIMS — http://trims.tamu.edu/) can provide landowners with support for land conservation and habitat restoration decisions in the Trinity River Basin. Through a web-based geographic information system, TRIMS provides landowners with geospatial and baseline data that addresses water quality, hydrology, floodplain management, wetland restoration, bottomland hardwood establishment and wildlife habitat management.

Wetland Placement and Land Surveys

Evaluation of the topography is the first step if wetland construction is recommended. Large flat areas in the local terrain are preferable. In East Texas, few expansive areas of uniformly flat topography exist except in major river floodplains. When prospective development sites are identified, a topographic elevation survey is required. This may be done by the landowner, a private land surveyor or engineering personnel with the NRCS.

Topographic elevation surveys are necessary because existing U. S. Geological Survey (USGS) topographic maps do not provide the terrain detail needed for development of wetlands. Contours of one-foot accuracy must be revealed. Wetland plants attractive to wildlife require shallow water in which to prosper. The coverage of shallow water in any given unit must be evaluated in order to achieve the largest amount of habitat. Furthermore, elevations over a locale are required for the best placement of levees and water control structures.

After elevation data are obtained, a diagram of the various elevations should be prepared. This may be as simple as drawing lines to show areas that would be the same depth if the areas were flooded. By showing all the areas within the respective one-foot contour intervals, the best location for placement of levees can be determined. A potential area can be located for impounding the most acreage of shallow water. In East Texas, many terrain situations may be suitable for a series of levees in stair-step fashion. Compromises may be required to minimize construction costs. However, any given unit should be no more than three feet deep over natural ground near the levee.

Levee Construction Planning
Examinations of soil factors must be conducted to ensure that levees and the units they impound do not leak. Coring and compaction testing are vital during construction planning. Soil testing and engineering design can be obtained from contractors or personnel with the NRCS. County soil surveys contain useful information on the suitability of soils for construction and water-holding capacity.

The purpose of levees is to impound shallow water so it can be manipulated to stimulate wetland vegetation growth. Levees should never be >4–5 feet tall and must be constructed to withstand over-topping by floodwater. A freeboard (the distance from the water level to the top of the levee) of about 18 inches above the normal water level is desirable — 30 inches is better (Figure 1). Levee crown widths can be narrow unless vehicle traffic is expected. Many managers believe that levee side slopes should be as gradual as possible. The traditional side slope ratio of 3:1 can be extended to as much as 10:1 where situations permit. Levee crowns are constructed so that their elevations are uniform throughout the length of the levee. This will prevent excessive erosion at sections lower than the remainder of the crown when floodwaters overtop the levee. However, the levee should be at its highest point near the water control structure and pipe to prevent washouts at this important location.

Benefits of Levee Side Slopes and Spillways
Gradually sloping sides provides several important benefits. Levees are less vulnerable to erosion, and vegetation is more easily established. Levees with gradual side slopes allow additional area inside the conservation pool for growth of desirable wetland plants along the lower zone of the levee side slope. Side slopes serve to optimize the various zones of wetland vegetation types along levees. Another advantage of gradual slide slopes is the ability to maintain the grass cover by mowing/shredding. A disadvantage of steeper side slope ratios is that more fill material is required to construct levees of this type.

The value of a large and well-designed spillway cannot be over-emphasized. Most levee crowns are designed to be 18–30 inches above the normal water level. Spillways should be set about 0.1 to 0.5 feet above the normal water level (the "operating level"). In this way, incoming floodwater immediately passes through the unit rather than being temporarily impounded, causing unwanted stress on levees.

Borrow Areas and Deep Water Zones
Levees are built from excavated material (Figure 2). Levee material should be bor-

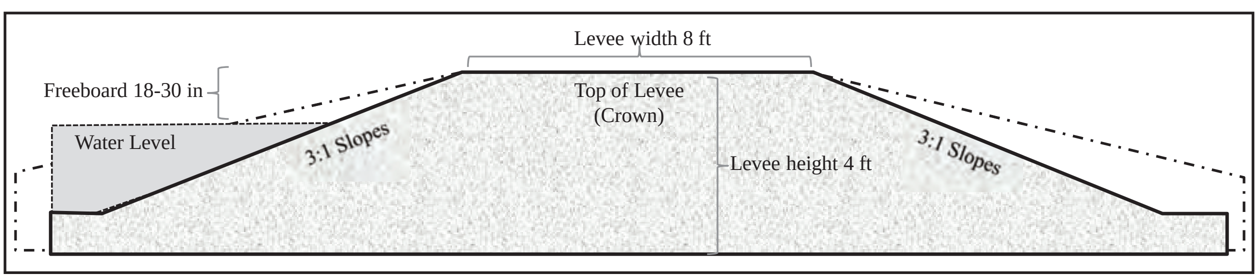


Figure 1. Cross section of a typical levee constructed for wetlands. Crown or top of levee should be wide enough to permit tractor or vehicle traffic to facilitate mowing/shredding. Dash-dot line represents a levee with 10:1 side slopes. Figure is not to scale.

(A)

(B)

Figure 2. In a large wetland creation project, GPS-guided bulldozers work to build levees using soil from inside the wetland compartment (A). The foreground shows deep water zones adjacent to the levee. Once vegetated, the newly constructed wetland will eventually look like the constructed wetland in frame (B), which was developed in 2001 on Richland Creek Wildlife Management Area. Note the levees and screwgate water control structure in the background.

rowed from within the unit being constructed, that is, the upstream side of the levee. This will result in a narrow channel adjacent to the levee. This channel occasionally may be more than three feet deep. This deeper zone can serve as a refuge for invertebrates and fish. During drawdowns (the gradual lowering of water level), invertebrates and fish may be trapped in small pools, offering an abundant food supply for wading birds. This deeper zone only applies to levee borrow ditches or deep zones in the vicinity of the levee.

These ditches do, however, have some disadvantages. They add to the volume of water required to fill the unit to conservation pool. They can pose a deep-water barrier to hunters attempting to reach hunting areas by entering from points along the levees. A good practice is to leave undisturbed sections (a walk way) along the inside of the levee and adjacent impoundment pool. Remember to mark these areas because hunters will be accessing the wetland when the unit is full of water and in the dark. Finally, borrow areas inside the unit reduce the area of shallow water.

Levee Management Considerations

Exposed soil of levees and borrow areas always should be vegetated immediately after construction. Often temporary vegetation such as ryegrass must be used until the next growing season will permit establishment of permanent native vegetation. A sod-forming grass is necessary in all cases. If native grass mixtures can thoroughly establish thick cover on the soil surface, then they are preferred. In some locales, buffalo grass may be useful for establishing sod on levees. Practically speaking, however, common Bermuda grass or coastal Bermuda grass offers the best situation for permanent sod-forming grasses for levee surface protection in East Texas.

Establishment of woody plants on the levee must be prevented. Roots from these plants can penetrate the interior of the embankment, creating macro-pores that often result in percolation and piping that can cause a washout. Woody plants can also shade out desirable sod-forming grasses, thus creating potential spots for erosion. Mechanical (i.e., shredding and/or dozing) or herbicide treatments are used to remove undesirable woody plants from levees and portions of the conservation pools of the wetland compartments. Professionals experienced in regulated aquatic herbicide selection and application can offer advice on the use of these chemicals. Mechanical brush control of woody plants is only temporary, requiring continual treatment on an annual or semi-annual basis, while herbicide treatment is more permanent.

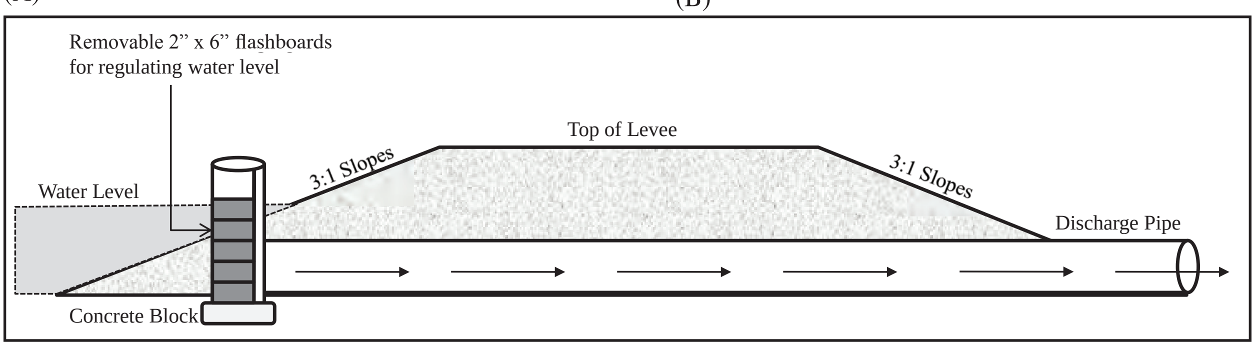
Water Sources and Control Devices

Water is a critical consideration. Rainfall run-off is the usual source of water for wetlands. Watershed acreage, patterns of surface water collection, and evidence of large, frequent, and damaging floods are among the issues to be considered at potential development sites. In the final analysis, project planners need assurance that development investments can produce reasonable results for improving wetland habitat. This means a reliable source of water must be expected. Other water supply options such as wells, pumping, upstream storage lakes or flow diversions may be used when the benefits justify the costs. These alternative water sources are considered when the reliability of supply must be improved.

Water control devices provide mechanisms to regulate water that is impounded by levees. These devices are not flood control fixtures, although some floodwater may be discharged through them. Many different types and sizes of water control devices are available for use in wetland projects, including flashboard risers (Figure 3), screw gate structures (Figure 4), flap gate structures (Figure 5), and drop pipes (Figure 6).

(A)

(B)



(C)

Figure 3. Flashboard risers are devices used to manipulate water levels for moist soil management within wetland units. Gradual drawdowns can be accomplished by removing one board at a time as seen in frame (A) above. In frame (B), one can see many installed flashboards keeping water at a desired level. Frame (C) shows a side view of flashboards riser installed within a levee. Side slopes in the diagram are depicted at 3:1; however, levees may have higher side slope ratios (e.g., 10:1).

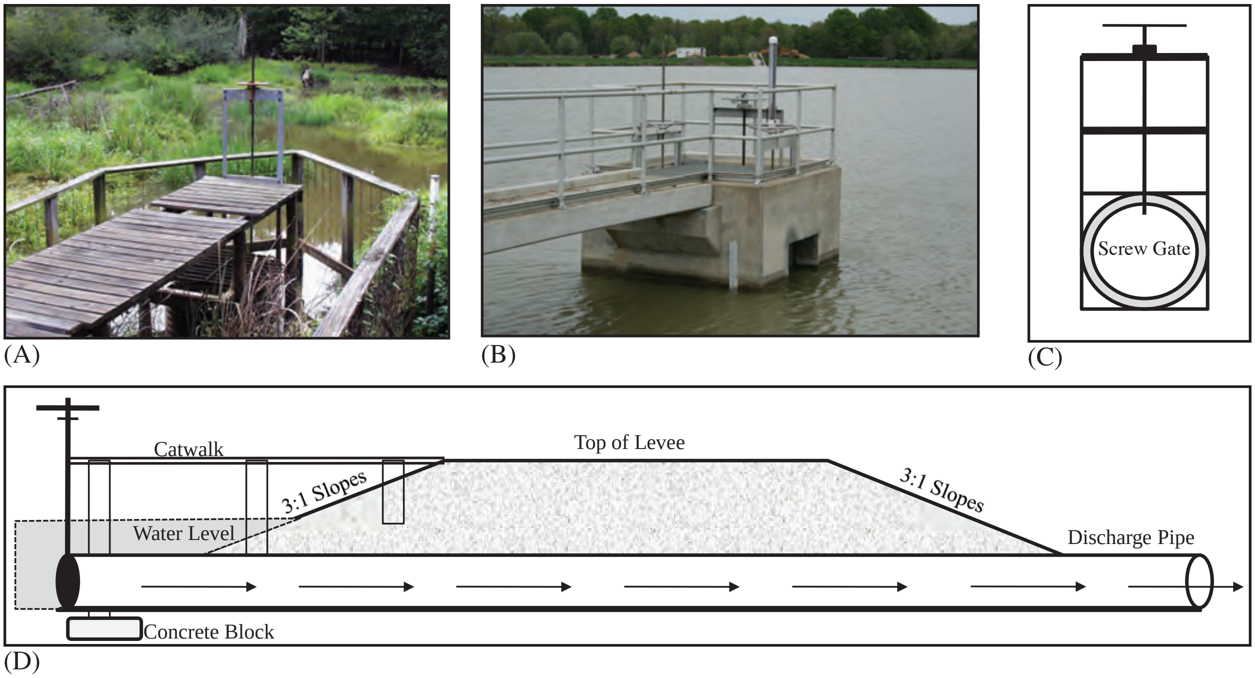


Figure 4. Screw gates are used to manipulate water levels for moist soil management within wetland units (A, B, and C). Gradual releasing of water can be done to stimulate germination of wetland plants. Gates come in different sizes depending on the size of the managed wetland. Note the fenced area in frame (A), which was installed to prevent beavers from plugging the water intake pipe with mud and debris. Side slopes in the diagram (D) are depicted at 3:1; however, levees may have higher side slope ratios (e.g., 10:1).

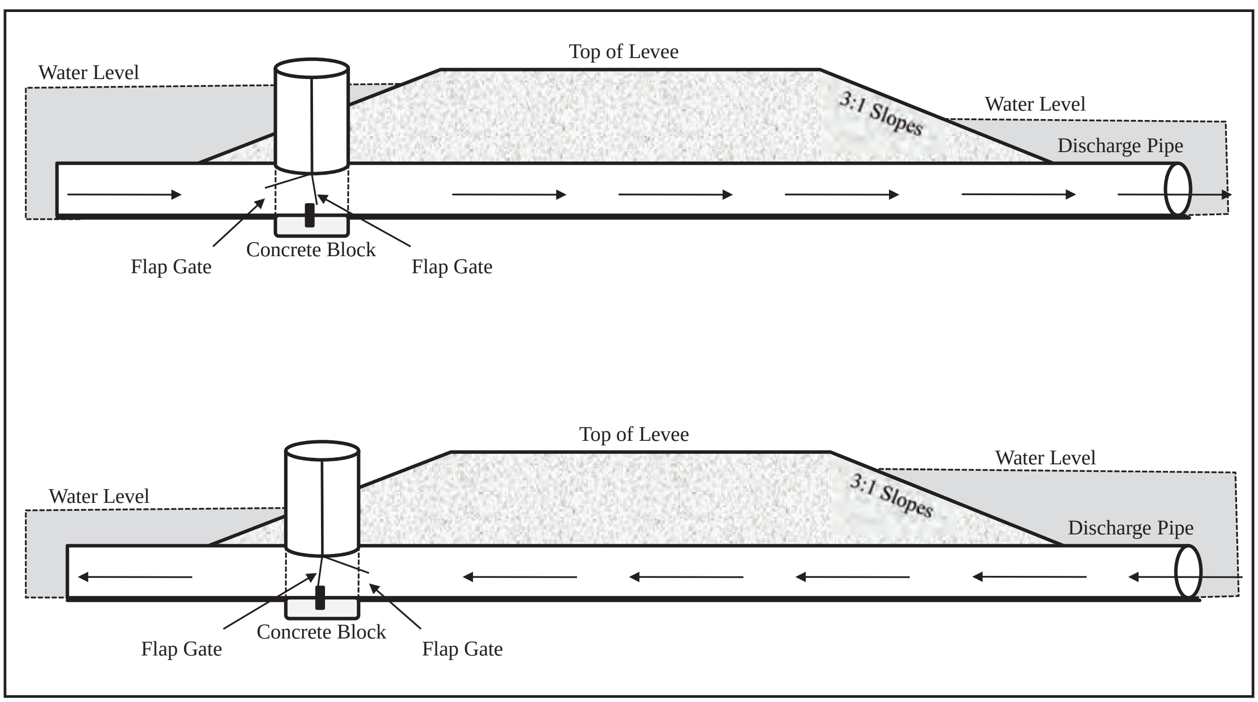


Figure 5. Flap gates are used as a passive system to capture water from canals, streams, rivers, and rainfall events. Water also can be moved from one wetland compartment to another. With dual flap gates (as shown), water flow exerts force on the flap gate pushing it open while the other flap gate prevents water from backdraining when rainfall events or flooding recedes. Side slopes in the diagram are depicted at 3:1; levees may have higher side slopes ratios (e.g., 10:1).

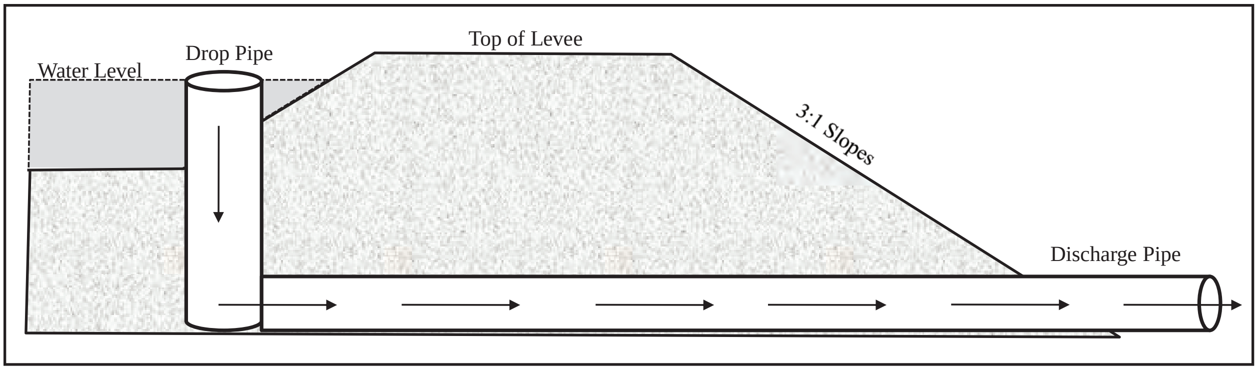


Figure 6. Drop pipes can be used in wetland management. However, a disadvantage is that they typically maintain water at a constant level, preventing the drawndown needed to stimulate seed germination for many wetland plants. Side slopes in the diagram are depicted at 3:1; however, levees may have higher side slope ratios (e.g., 10:1).

The most versatile and desirable type is the flashboard riser system. Flashboard risers function through the use of a series of "boards" fitted in slots in such a way as to form one side of the riser box (Figure 3). Aluminum and PVC flashboards are practical replacements for wooden flashboards. Boards are removed or added to regulate water levels in the wetland compartments. The capability to regulate water levels is necessary because several zones of desired vegetation can be produced by water level drawdowns. The rate of discharge can be slowed by the use of wedges placed between the top and second flashboard or by substituting top flashboards that are half the height of normal flashboards. More discussion on drawdowns is given in the section on vegetation management.

A flashboard riser box is coupled to a culvert pipe that passes through the levee. An anti-seep collar that is fitted to the culvert pipe midway along its length may be placed in the center of the levee. However, with thorough soil compaction during installation, the anti-seep collar is sometimes omitted from the pipe assembly.

Installation of flashboard riser systems requires attention to several details. Systems must be placed in such a way that the top of the riser box has adequate freeboard to impound water at the desired level. Make sure that the elevation of the desired water level (the water's edge when the compartment is filled at normal operating level) is the same as the top board in the riser box. Use of a survey level is recommended for determining these elevations. Flashboard riser systems are placed in levees at locations that allow for maximum drainage of water stored in the unit (e.g., lowest elevation point).

Large riser boxes must be anchored into the ground. All boxes have displacement when the boards are in place and the unit is filled with water. Displacement of water causes buoyancy that exerts force on the structure. If not anchored, the box would be forced to float in a fashion similar to a boat. On small systems, the weight of the materials and the secure fastening of the box to the culvert pipe overcome the buoyancy factor. However, on larger systems, the buoyancy force can be strong enough to bend or break the box-to-pipe attachment. In these situations, additional anchors are recommended. Anchors similar to those used for securing mobile homes can be used. Also, chains or cables attached to the boxes and encased in concrete footings provide sufficient anchors. Design personnel and/or vendors for water control systems can assess buoyancy factors.

WETLAND MANAGEMENT TECHNIQUES

Wetland management techniques are designed to enhance the natural processes of a wetland ecosystem. This is often accomplished through mimicking the natural hydrology of the area via the construction of impoundments and water control structures, and by manipulating water levels. The timing and rate of water release has a significant impact on the plant communities that become established. Wetlands have a tremendous impact on improving water quality, and they are also beneficial to wildlife, particularly waterfowl. Therefore, wetland management techniques often focus on the manipulation of wetland plant communities and the associated wildlife.

Water Manipulation and Wetland Vegetation

Annual Plant Communities — Moist soil management refers to the growing conditions needed to encourage desirable, annual seed-producing plants. These plants produce heavy crops of seed because they germinate, grow to maturity, and die in one growing season. Seeds lie dormant through the winter and germinate to produce new plants during the following growing season. Seeds of these annual plants are used as food by many wildlife species, especially waterfowl such as dabbling ducks.

In wetlands, annual plants respond positively to the gradual lowering of water levels. Drawdown occurs naturally because 1) rainfall gradually ceases through the summer months, 2) evaporation increases in proportion to spring and summer weather, and 3) live vegetation takes up and disperses water. Management techniques simply attempt to simulate the annual dynamics of water levels in natural wetlands. Timing of the onset and duration of the drawdown period strongly influences the kinds of plants that grow in wetlands.

Drawdowns are generally conducted in stages (early, mid, and late), and rates (slow, moderate, and rapid). This situation in natural wetlands has two characteristics that are important for managers. First, the process is variable and dynamic. Second, the process is continuous. Even when wetlands are completely dry or completely flooded, wetland vegetation is subject to the influences of temperature, oxygen availability and other factors. These situations must be kept in mind, although management is normally conducted in terms of stages and rates.

Water manipulation and soil disturbance are the practices that cause major changes in wetland plant communities. In East Texas, the most beneficial drawdowns begin in early to mid-season with gradual to moderate water discharge rates. Early season periods are regarded as beginning in late winter to early spring. This timing is associated with the onset of soil warming. As soil temperatures reach about 60º F, many early season seeds begin to germinate. Annual smartweeds, such as pink smartweed, are examples of plants that respond to early drawdowns. Midseason periods may be considered to be from mid-spring to early summer. By this time, soils usually warm considerably, thus stimulating germination of plants adapted to midseason conditions. Barnyardgrass is an example of a desirable moist soil plant that prospers with midseason drawdowns. Whether an early or midseason drawdown is preferred, drawdowns should be made slowly, often taking 1–2 months to completely drain the wetland.

Once dry, mowing and burning are techniques used to enhance the dynamics of wetland plant communities. Midseason to late season mowing of noxious plants such as cocklebur, sumpweed (marsh elder), or sesbania can reduce these undesirable stands and encourage more desirable food plants. Mowing and/or prescribed burning reduce heavy, extensive stands of one to a few low quality, undesirable species. Importantly, mowing and prescribed burning produce only short-term results.

Disking when sites are dry serves to reduce the relative abundance of perennial species while increasing annual species. Stirring of the soil brings annual seeds to the surface where they can germinate. Additionally, it exposes rootstocks of perennial species to drying or freezing, thus depleting the number of perennial plants. Stirring of surface soils is recommended at three to four-year intervals. At somewhat longer intervals (5–7 year intervals), deep soil disturbance can produce more favorable plant species. Hydraulic disks or moldboard plows are needed for this type of management treatment. Intense, short-term trampling by livestock can be used to re-invigorate wetland plant communities. This can be done by applying very high stocking density during a short period of time (from a few hours up to a day or two).

Perennial Emergent Plant Communities – Unlike annual plants, perennial plants do not completely die every year. While the top parts may die back, the rootstocks or small cool season forms (basal rosettes) remain viable. Each growing season, these viable parts (propagules) produce the top growth from buds or rosettes, as compared to annual plants that grow from seed. Many perennial plants do yield seed that produce new plants. However, parts such as tubers formed on the roots are more likely to be valuable as wildlife foods.

The term “emergent” signifies the “growth form” of the plant. The aboveground parts of these plants “emerge” from clear shallow water, where they are adapted to grow best. These emergents persist for several years during periods when large drawdowns do not occur. Therefore, while drawdowns are not used annually to manage perennial emergent plant communities, this practice may be required periodically.

Occasionally, managing for perennial emergent plant communities is the best approach. This may apply in 1) lakes and ponds where conflicts with fisheries management occur, or limited capabilities for water discharge prevent drawdowns on shallow portions, 2) combinations with moist soil management where water is retained across portions of units, 3) units managed for brood habitat for wood ducks, or 4) drawdowns are not used because of limited manpower to oversee discharging water.

Another viewpoint on this situation may apply when droughts lower otherwise stable water levels. These events may produce germination and growth of perennial emergent species. Management can capitalize on this unplanned event by restoration of generally stable water levels. Some important perennial emergent and submergent plants and their features are given in Figure 7. Appendix A contains a list of forbs, grasses, shrubs, trees and vines that are found in wetlands and are beneficial to wildlife.

Submergent Plant Communities — Management for submergent plant communities generally is not considered among mainstream wetland practices. However, this approach can be appropriate to some situations in East Texas. It can be compatible when management includes perennial plant communities, or when deeper water conditions are a factor.

Submergent plants prosper in water depths up to eight feet. Because they favor underwater conditions, little or no fluctuation of water levels is needed.

Management for submergent plant communities actually involves little more than introducing the desired native plant species and maintaining constant water levels. Plant material may be obtained from wetlands nearby or from commercial nurseries. When plant material is purchased from commercial vendors, sources should be as close to the transplanting sites as possible. Often plants obtained from locations far away from the transplanting site do not grow well.

A selection of desirable submergent plants species includes wild celery, pink smartweed, sago pondweed, Illinois pondweed, bushy pondweed, arrowhead, water stargrass and sedges (Figure 7). All these plants are used to some extent as foods by waterfowl. They also can be beneficial when fisheries management is integrated with waterfowl habitat needs. In deeper zones adjacent to perennial emergent plant communities, submergent beds offer good complements to overall habitat conditions. This situation often is encountered in small lakes and ponds throughout East Texas.

(A) wild celery

(B) pink smartweed

(C) sago pondweed

(D) bushy pondweed

(E) Illinois pondweed

(F) arrowhead

(G) water stargrass

(H) sedges

Figure 7. Desirable emergent and submergent wetland plants provide food for waterfowl and shorebirds in the form of seeds, leaves, roots, and tubers. Likewise these plant provide habitat for aquatic invertebrates, another important food source for these birds. Here, desirable plants include the following: (A) wild celery, (B) pink smartweed, (C) sago pondweed, (D) bushy pondweed, (E) Illinois pondweed, (F) arrowhead, (G) water stargrass, and (H) sedges.

Farm Practices and Wetland Management

Various crops such as corn, milo, soybeans and rice may have been suggested as food sources for waterfowl. Waterfowl obtain these foods by field-feeding or from shallow flooding of crops. When the opportunity to utilize waste grain to benefit waterfowl is easily accommodated, then "farming" practices are practical operations. However, specific development of farming for waterfowl on many wetland sites in East Texas can be an extremely expensive venture.

In most situations, only one planting practice is recommended for this category: production of Japanese millet (Figure 8). This plant has features useful to waterfowl management needs because 1) the plant has broad ecological tolerances, 2) it is available in two varieties (regular and Chiwapa), 3) seeds are cheap and readily available, 4) minimal equipment is needed, 5) seed yield is high, and 6) seeds are eaten readily by waterfowl.

Two methods can be employed to grow Japanese millet 1) farming, and 2) drawdown. Japanese millet can be farmed similar to other small grain crops. The first step in farming millet should be to obtain a soil analysis for the fields to be farmed. Local NRCS and Texas Cooperative Extension county offices can assist with submitting soil samples and interpreting analyses. Disking and harrowing are used to prepare a good seedbed. Broadcast seeding works fine, although seed may be drilled if desired. Good results are obtained by simply blending the seed with the fertilizer, then broadcasting with one pass over the field. Substantial stands are obtained with seeding rates of 20 pounds per acre.

In warm, moist weather, the seeds will germinate in four days and be 8–12 inches

(A) Japanese millet

(B) Japanese millet seed head

Figure 8. Japanese millet can be planted in wetlands to provide an additional seed source to those of native wetland plants. Frame (A) show the entire plant, while (B) shows the seed head.

tall in two weeks. This lush, fast growth prevents considerable weed competition. Planting dates should be considered carefully. Japanese millet can produce mature seed heads in 60 days in the long growing season of East and Central Texas. Furthermore, matured seed will sprout if the stems fall over and rainfall soon follows. For this reason, later planting dates are recommended in order to prevent seed loss. Planting dates from July 1 to August 15 are recommended so that the seeds mature as late as possible, prior to the first frost. However, this strategy can be complicated when soils are dry. Germination and early growth cannot occur without excellent soil moisture. An alternative to this predicament is to utilize the Chiwapa variety, which matures in 120 days. The longer maturity period hopefully will permit planting when soil moisture is adequate earlier in the summer. Seed maturity would occur about the same time as the 60-day variety planted later. The Chiwapa variety, however, grows much taller and produces more leaf and stem material.

Another strategy for producing Japanese millet crops is to employ the drawdown technique. This can apply to shallow-water compartments (e.g., moist soil units), small lakes and beaver ponds. Under this approach, water levels are maintained until mid- or late summer and then lowered approximately 18 inches below the normal water level. The water level should be reduced quickly so that a wet mudflat is exposed. This mudflat becomes the seedbed that may be broadcast-seeded with Japanese millet. Seeding and fertilization is the same as farming rates. When the crop has matured and ducks arrive, water may be raised to normal levels. It is important to know and understand the laws when hunting in and around agricultural fields. Baiting areas for the purpose of attracting and harvesting migratory waterfowl is illegal. Contact a local game officer or visit the U.S. Fish and Wildlife Service website (http://www.fws.gov/le/HuntFish/waterfowl_baiting.htm) for specific laws regarding waterfowl hunting.

Nuisance Vegetation

No wetland management project is free of pest plants (Figure 9), and direct reduction measures will be needed. However, some steps can be taken to minimize the effect of pest plants.

Cocklebur, sumpweed, and sesbania frequently respond to rapid drawdowns during summer. This is one reason the early to midseason drawdowns are recommended in moist soil management. Pest plants are capable of extensive stands even when management prescriptions seem in order. Mowing or treatment with broadleaf registered aquatic herbicides may be needed to reduce or eliminate these undesirable plants. These are annual plants, and shredding of mature plants will aid in seed dispersal, which may increase management problems in subsequent years. Because these species are fast growing, it is crucial for managers to treat these pest plants quickly. If stands of these species are detected, herbicide treatment is recommended prior to seed production. Managers must be aware of the tenacity of these plants and prevent or remediate their presence in managed wetlands. The Texas Cooperative Extension website AQUAPLANT (http://aquaplant.tamu.edu/) is a useful diagnostics tool for plant identification, and it gives potential management options for aquatic systems.

Black willow and cattail are plants that disperse windblown seed in late spring and early summer for immediate germination on bare moist soil. Their tiny seeds do not remain viable very long and cannot withstand


(A) cocklebur


(B) cattail


(C) sesbania


(D) black willow


(E) giant cutgass

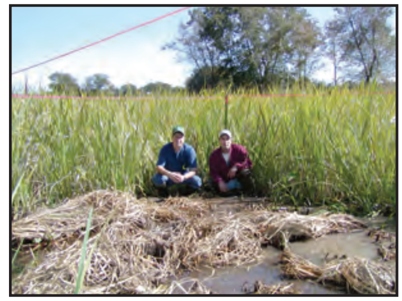

(F) giant cutgrass

Figure 9. When managing wetlands, one should plan strategies for reducing problematic (nuisance) plants like (A) cocklebur, (B) cattail, (C) sesbania, (D) black willow, and (E and F) giant cutgrass that provide little forage for waterfowl. Although each plant has its place in nature, manager strive for plant diversity through management actions to avoid monocultures of plants with lesser food value. Frames (E and F) show before and after pictures of heavy tarps used to create "duck holes" in a wetland dominated by giant cutgrass. Because this plant reproduces by seeds and rhizomes this hole was quickly taken over by giant cutgrass during the following growing season.

competition. Therefore, establishment of willow or cattail can be overcome by producing desirable plants on bare moist soil in late spring or early summer. Recently completed construction projects are vulnerable to cattail and willow establishment. Consequently, attention must be given to producing temporary or permanent sod or seeding beneficial plants, such as Japanese millet, to prevent willow or cattail establishment.

In East Texas, giant cutgrass may dominate wetlands that contain permanent water. This is a persistent plant that can spread by daughter plants produced at the nodes of creeping rhizomes. Registered aquatic herbicide treatment may be needed for control or eradication. Usually, cutgrass stands are on soils too wet to support equipment sufficient for meaningful mechanical control. Mechanical treatments are not effective unless the soil is dry enough to allow killing of the buds at the root crown. After initial control, monitoring and follow-up measures are essential to prevent re-invasion.

Nuisance Wildlife

Beaver are abundant throughout East Texas and can be expected in wetland projects. Their activities eventually result in damage or undesirable obstructions to management. Nuisance beaver may either plug water control devices and/or spillways, or burrow into levees. Wetland projects can be expensive and they must be protected from beaver damage.

The most common beaver nuisance in a managed wetland is obstruction of water control devices. Various mechanisms exist to prevent beaver from depositing woody material and mud in flashboard risers. Use of pens is the most effective means of excluding beaver from water control devices (Figure 10). Heavy wire sections (bull panels) are fastened to sturdy posts placed to form a pen extending from the levee and protecting the water control devices from access by beaver. A space of at least five or six feet is needed between the water control device and the sides of the fence. This discourages beaver from stacking material against the fence in an attempt to block the flow of water. Even if beaver do build dikes along the fence, these obstructions are easier to clear if a larger amount of space is left as a work area inside the pen. Installation of beaver exclusion pens prior to flooding can be accomplished with minimal effort, while clearing a plugged flashboard riser post-flooding is a difficult and unpleasant task. More importantly, management success can be affected when the water control structure cannot function properly.

Nutria are another nuisance species in aquatic environments. This exotic animal feeds on many kinds of aquatic vegetation and their populations grow quickly. Once established in lakes, wetlands or other aquatic environments, nutria can quickly become overpopulated and destroy local vegetation that is important for native wildlife species. Nutria, like beavers, are capable of clogging water control devices with debris and preventing water discharge. Nutria also tunnel into the sides of levees, thereby weakening the structure and causing potential points of failure. Eradication of established nutria populations can be difficult and expensive.

Figure 10. Use of fencing/cattle panels is the most effective means of excluding beaver from water control devices. Vegetation surrounding "pens" should be cleared periodically.

Feral hogs must also be controlled within constructed wetlands. Feral hogs often root along and on levees, potentially causing weak spots, erosion and loss of ground cover. Feral hog damage can be decreased through trapping and shooting.

SUMMARY

Wetlands are dynamic, productive ecosystems that are invaluable from a human and wildlife perspective and can be economically important to private landowners. Given that wetland soils are most often saturated with water, a unique suite of plants and animals is adapted to live in this environment. Although once drained primarily for agricultural fields and community development projects, now the importance of wetlands is recognized in energy and hydrological cycles.

Implementing some of the basic management techniques found in this paper can help create, restore or enhance wetlands on individual properties. Site selection for wetland development projects is a critical first step, and resource personnel within the NRCS can provide invaluable insight. Landowners in the Trinity River Basin can use the web-based TRIMS system to develop their own maps using GIS techniques. Moist soil management is most often aimed towards waterfowl management, and shallow impoundments are necessary. Therefore, quality information for topography, even at the 1-foot level, is needed. Careful planning and designing of levees is a must, and it is best that levee side slopes range from 3:1 to 10:1 to prevent overtopping of floodwaters from eroding the levee. Of course, well designed spillways provide added protection to levee stability, as well as sod-forming grasses to hold soil in place. Deepwater zones will be created adjacent to the levee during construction. These areas serve as refuges for invertebrates and fish during low water times. When impoundments are at full level, deepwater zones should be marked to indicate their location, thus reducing a potential hazard to hunters and other users.

A number of plans were provided for water control structures, but the one most often used is the flashboard riser. This system is easily managed to manipulate flooding or drawdown water to mimic the natural hydrological cycle. In wetland management, plant communities can be altered by the timing of flooding and drying by drawdowns. Likewise, different types of plants (e.g., seed producing annuals, perennial emergent or submergent plants) are adapted to live in various water depths. Although expensive, some managers may wish to farm some plants for waterfowl. The best option is probably seeding with Japanese millet, but one should understand the laws associated with baiting migratory birds.

All plants have value. However, some may become a nuisance, like cattail, or giant cutgrass, and prompt action needs to be taken to reduce these plants. A valuable resource to managers will be the AQUAPLANT website, used to identify plants and understand treatment options. Likewise, all animals have their place in nature. However, wetland managers will likely encounter beaver and exotic nutria plugging drain pipes and burrowing into levees. Their actions undermine the integrity of levees and reduce the manger's ability to control water levels. Therefore, managing beaver and nutria numbers will be an important strategy.

Wetland management has more benefit than attracting waterfowl for hunting purposes. The collective action of numerous land stewards can have a tremendous impact on water quality and quantity, in addition to improving wildlife habitat. Water quality and availability are quickly becoming significant issues throughout Texas, and although many solutions have been proposed to increase future water availability (e.g., reservoirs) many have failed to recognize the impact of private landowners and their contribution. Both corporations and individual landowners can implement win-win solutions that provide water for people and conserve wetlands.

It is sometimes difficult to understand the economic benefits of wetlands. Among the ecological services that wetlands provide, revenue generated from wildlife recreation, like waterfowl hunting or wildlife viewing, can be important to private landowners. In the future, additional markets will likely become established that deal in conservation credits, wetland banking and carbon markets. By providing land stewards with the knowledge and expertise to implement wetland management techniques, water quality and quantity can be greatly enhanced in other regions, just as it has been at the Richland Creek Wildlife Management Area.

RESOURCES

Baldassarre, G. A., and E. G. Bolen. 1994. Waterfowl ecology and management. John Wiley and Sons, Inc., New York, New York, USA.

Frentress, Carl. 2007. An improved device for managing water levels in beaver ponds. Available from http://www.tpwd.state.tx.us/publications/pwdpubs/media/pwd_br_w7000_0320.pdf. Accessed August 15, 2007.

Mitsch, W. J., and J. G. Gosselink. 2000. Wetlands. John Wiley and Sons, Inc., New York, New York, USA.

Natural Resource Conservation Service (NRCS), http://www.nrcs.usda.gov/. Washington, D.C., USA.

Payne, N. F. 1992. Techniques for wildlife habitat management of wetlands, McGraw-Hill, Inc., New York, New York, USA.

Texas Parks and Wildlife Department. 2000. Wetlands assistance guide for landowners. Available from http://www.tpwd.state.tx.us/publications/pwdpubs/media/ pwd_bk_r0400_0020_11_00.pdf . Accessed July 31, 2007.

Texas Parks and Wildlife Department. 2006. East Texas wetlands management calendar. Available from http://www.tpwd.state.tx.us/publications/pwdpubs/media/ pwd_pr_w7000_1179a.pdf . Accessed July 31, 2007.

Trinity River Information Management System http://trims.tamu.edu/, Institute of Renewable Natural Resources, Texas A&M University, College Station, TX, USA.

GLOSSARY

Abiotic – non-living chemical and physical factors in the environment. For example, light, temperature, water, atmospheric gases, wind and soil.

Annual plants – a plant that usually germinates, flowers and dies in one year.

Basal rosettes – When the leaves on a plant are arranged in a circular pattern at the base of the stem.

Biotic – the living components in the environment. For example, plants and animals.

Conservation pool – amount of water an area will hold within an impoundment.

Dabbling duck – ducks that feed mainly on vegetable matter by upending on the water surface or grazing. They rarely dive. Examples include: mallard, gadwall, wigeon, pintail and teal.

Displacement – the point at which the weight or the volume of water moves or shifts a submerged structure such as a water control structure.

Diving duck – ducks that feed mainly by diving to obtain plants and animals. Examples include: canvas back, redhead, ring-necked duck and scaup.

Drawdown – refers to the release of water from a wetland unit to dry the soil.

Emergent plants – a plant which grows in water and is rooted in the soil but rises above the surface so that it is partially standing erect in the air.

Evapotranspiration – loss of water from the soil both by evaporation and by transpiration from the plants growing thereon.

Levee – a natural or artificial slope or wall that holds water

Moldboard plow – a wedge formed by the curved part of a steel plow blade that turns the furrow.

Perennial plants – a plant that lives for more than two years.

Propagules – any plant material used for the purpose of increasing individual plants using cuttings, seeds, or other reproductive parts.

Seed bank – collection of dormant plant seeds that are stored within the soil. Seed banks can persist for many years and germinate given the appropriate environmental conditions.

Spillway – structure used to provide for the controlled release of flood water from a dam or levee.

Submergent plant – a plant that grows completely beneath the surface of the water and firmly rooted in the soil.

Tubers – modified plant structures that are enlarged to store nutrients. Example: potato tuber.

Appendix A[1]. Forbs, grasses, shrubs, trees, and vines that provide food and/or cover and are beneficial to wildlife in aquatic environments.

Common Name	**Scientific Name**	**Life Cycle**[2]
Forbs		
arrowhead	*Sagittaria* spp.	P
bushy knotweed	*Polygonum ramosissimum*	P
common poolmat	*Zannichellia palustris*	P
curltop smartweed (willow-weed)	*Polygonum lapthifolium*	A
duckweeds	Family *Lemnaceae*	P
Illinois pondweed	*Potamogeton illinoensis*	P
long-leaf pondweed	*Potamogeton nodosus*	P
Pennsylvania smartweed	*Polygonum pennsylvanicum*	A
red clover	*Trifolium pratense*	B
sago pondweed	*Potamogeton pedctinatus*	P
Schreber watershield	*Brasenia schreberi*	P
southern naiad	*Najas guadalupensis*	A
swamp smartweed	*Polygonum hydropiperoides*	A, P
trailing wildbean	*Strophostyles helvola*	A
water stargrass	*Heteranthera dubia*	A, P
white clover	*Trifolium repens*	P
wild celery	*Vallisneria americana*	P
yellow sweetclover	*Melilotus officinalis*	B
Grasses		
barnyard grass	*Echinochloa crusgalli* var. *crusgalli*	A
bearded sprangletop	*Leptochloa fascicularis*	A
buffalograss	*Buchloe dactyloides*	P
common reed	*Pragmites australis*	P
marshmillet (giant cutgrass)	*Zizaniopsis miliacea*	P
rice cutgrass	*Leersia oryzoides*	P
switchgrass	*Panicum virgatum*	P
Walter's millet	*Echinochloa walteri*	A
Sedges		
beakrush	*Rhynchospora* spp.	P
flatsledge	*Cyperus* spp.	A, P
hardstem bulrush	*Scirpus actutus*	P
sedges	*Carex* spp.	P

softstem bulrush	*Scirpus tabernaemontani (S. validus)*	P
spikerush	*Eleocharis* spp.	A, P
yellow nutgrass (chufa)	*Cyperus esculentus*	P
Shrubs		
common buttonbush	*Cephalanthus occidentalis*	P
indigobush (false indigo)	*Amorpha fruticosa*	P
swamp privet	*Forestiera acuminata*	P
American snowbell	*Styrax americana*	P
downy viburnum (rusty blackhaw)	*Viburnum rufidulum*	P
possum-haw viburnum	*Viburnum nudum*	P
water honey locust	*Gleditsia aquatica*	P
Trees		
baldcypress	*Taxodium distichum*	P
blackgum (black tupelo)	*Nyssa sylvatica*	P
bur oak	*Quercus macrocarpa*	P
cedar elm	*Ulmus crassifolia*	P
flowering dogwood	*Cornus florida*	P
laurel oak	*Quercus laurifolia*	P
live oak	*Quercus virginia*	P
pecan	*Carya illinoensis*	P
Shumard oak	*Quercus shumardii*	P
southern red oak	*Quercus falcata*	P
water elm (planer tree)	*Planera aquatica*	P
water hickory	*Carya aquatica*	P
water oak	*Quercus Nigra*	P
white ash	*Fraxinus americana*	P
white oak	*Quercus alba*	P
willow oak	*Quercus phellos*	P
Vines		
Alabama supplejack (rattan vine)	*Berchemia scandens*	P
common greenbriar	*Smilax rotundifolia*	P
riverbank grape	*Vitis riparia*	P

[1] Additional information on each plant can be found on Texas Parks and Wildlife Department's Texas Plant Information Database (http://tpid.tpwd.state.tx.us/index.asp).
[2] Life cycle of the plant is annual (A), biennial (B) or perennial (P).

Issued in furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914, in cooperation with the United States Department of Agriculture. Edward G. Smith, Director, Texas AgriLife Extension Service, Texas A&M System.