Management of

South Atlantic Coastal Wetlands

for Waterfowl and Other Wildlife

Atlantic Coast Joint Venture

North American Waterfowl Management Plan

Ducks Unlimited
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MANAGEMENT OF SOUTH ATLANTIC COASTAL WETLANDS FOR WATERFOWL AND OTHER WILDLIFE

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FOREWORD

The South Atlantic Coastal region is steeped in natural and cultural heritage. Nowhere is this as evident as with migratory birds. Ducks, shorebirds, and warblers alike frequent the South Atlantic Coast as an important home and highway. Each fall and winter hundreds of thousands of ducks and geese fill the estuaries, marshes, and flooded bottomlands of this region. In spring, magnificent flocks of dowitchers, yellowlegs, and sandpipers grace its coastal mudflats. And in summer, the cypress swamps are filled with music of prothonotary warblers, egrets, and herons. Simply put, the wetland habitats of the South Atlantic region are an extraordinary bird resource.

Along with the birds come sportsmen, bird watchers, tourists, and others who appreciate the beauty of birds on the water. It is therefore no coincidence that the people of the South Atlantic embrace a rich conservation ethic as stewards of the natural diversity that surrounds them. Much of the wetland habitat that exists today is a direct result of the care and management provided by numerous private citizens and public and private organizations. These people and organizations are the core of the conservation partnerships that have flourished in recent years, and the Atlantic Coast Joint Venture (ACJV) is the rallying point and catalyst for mobilizing partner activities in a coordinated fashion.

From the earliest land protection work in the ACE Basin Initiative and the expanded Low Country Initiative, Ducks Unlimited has sought to make a positive contribution to the conservation of these landscapes. Today, our efforts throughout the South Atlantic continue to include protection as an essential tool for conserving valuable wild landscapes. However, we are now working with our partners more than ever to restore, enhance, and manage degraded wetland habitats throughout the region.

Ducks Unlimited is proud to be a partner in conservation in the South Atlantic. We, along with ACJV partners, recognize that accurate and practical information is essential for proper management of wetland resources. We are pleased to make available this revised management manual for use by landowners and mangers of coastal marshes along the South Atlantic Coast.

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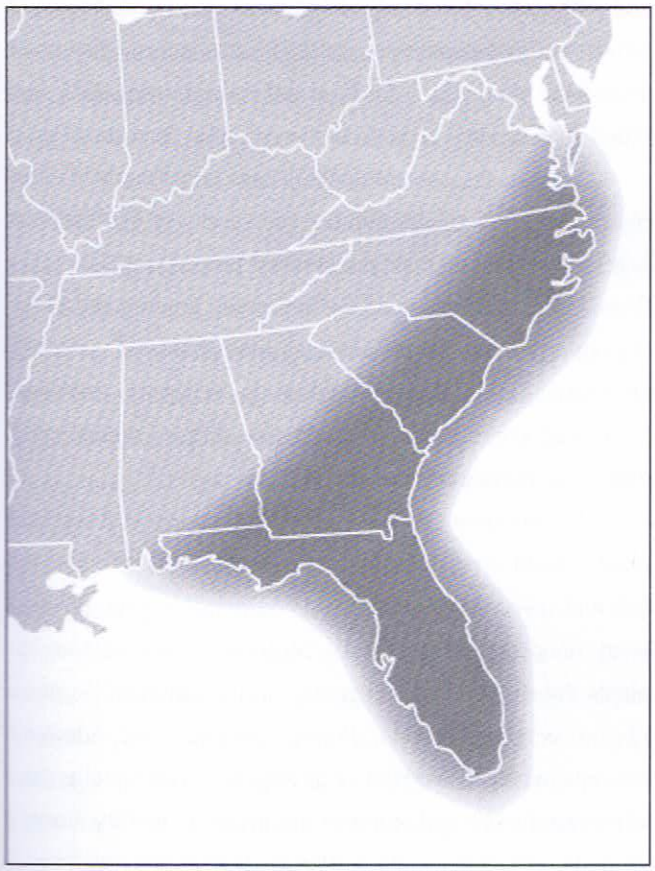
Approximately 40% of the wetland acreage existing in the South Atlantic during the late 1700s has been either lost or significantly altered. These changes have impacted water quality, flood frequency and magnitude, and populations of culturally and economically important fish and wildlife species. Wetland destruction and alteration can affect quality of human life as well as sustainability of water quality, diversity, and fish and wildlife populations.

Because large acreages of remaining wetlands are controlled by private interests, landowners play a crucial role in wetland conservation and management. Private landowners can increase functional values of wetlands by restoring hydrology and water chemistry, which positively influences plant growth and builds the food and cover habitat base that supports a diverse fish and wildlife community. Wetland management also can contribute to improved local and regional water quality because wetland plants and soils are effective filters of nutrients and contaminants. Wetlands also function to store and slowly release flood waters minimizing economic impacts on local and regional infrastructure.



While traditional wetland management has focused on waterfowl, landowners are becoming more aware that other wildlife, economic, ethical and aesthetic values are impacted by wetland loss and degradation. Depending on a landowner's interests and objectives, management plans can be tailored to benefit waterfowl as well as a variety of other wildlife species. Trade-offs often exist in targeting wetland management for a particular group of species, such as waterfowl, but managers are realizing that by maintaining diversity and adaptability in their approaches, a variety of wildlife species can be sustained and enjoyed throughout each year.

This handbook primarily is written to assist landowners in managing coastal wetlands for waterfowl. Attention also is given to other wetland-dependent fish and wildlife species as well as other wetland functions. Because each wetland type presents a unique collection of plant species and management issues, techniques are presented according to the prevailing hydrology (water depth and flooding frequency) and water chemistry (salinity).

LANDOWNER BENEFITS

Landowners are becoming increasingly aware that wise management of natural resources on their property results in the greatest economical, recreational, and aesthetic values. In particular, restoration and management of wetlands in the South Atlantic can:

1) Decrease flooding and improve water quality.
2) Improve aesthetic values.
3) Improve hunting and recreational opportunities.
4) Provide opportunities for ecotourism.
5) Increase property values.

By storing runoff during intense rain events, wetlands buffer property damage. The filtering effect of wetland plants and soils also reduces stormwater erosion and enhances water quality. Many landowners consider well-managed wetlands aesthetically pleasing and deem wise management an ethical responsibility to future generations.

Landowners also can benefit from quality wetland management by selling hunting and fishing rights. In many regions of the country, leasing hunting rights is more economically beneficial than traditional ranching and agriculture.

Ecotourism is a rapidly growing industry in the South Atlantic region. Landowners have capitalized on the growing numbers of non-consumptive users by selling recreational and educational opportunities such as bird watching, natural trails, and small-scale overnight accommodations (e.g., bed and breakfast). Many South Atlantic properties also have historical significance further enhancing tourism value. Because wetlands attract concentrations of large, visible wildlife they are particularly marketable in ecotourism.

ENVIRONMENTAL BENEFITS

Quality wetland management not only improves local water quality and flood control, but also enhances these values on a regional scale. Nutrients, heavy metals, and other chemicals in stormwater runoff are absorbed by wetland plants and soils, protecting human, wildlife, and fisheries populations from exposure and deleterious effects. Circulation of tidewater through managed wetlands further can improve water quality by increasing dissolved oxygen.

Water quality and flood control functions provided by wetlands not only benefit wetland-dependent wildlife populations, but also local economies. Wetlands perform flood control and water purification at a fraction of the costs (often <10%) required for comparable engineered systems.

WILDLIFE & FISHERIES BENEFITS

In many areas, including the South Atlantic, the bulk of the remaining wetlands exist on private lands. When a complex of well-managed private wetlands exist in conjunction with state and federal management areas, waterfowl and other wetland-dependent wildlife are more dispersed decreasing competition for food and cover, nesting sites, and brood-rearing sites as well as the potential for catastrophic events such as disease outbreaks. These larger wetland complexes support a greater number and variety of wildlife than is often possible on a single, isolated property, which benefits all adjacent landowners by improving hunting and viewing opportunities. When increased food resources are available to wildlife, body condition is generally improved increasing survival and reproductive output, which carry over to sustaining future generations.

By managing for moist-soil and submergent wetland plants, landowners contribute to a greater food base for area fish and invertebrates than would be possible from unvegetated or perennial wetlands. Moist-soil and submergent plants are digested and degraded easily compared to more fibrous perennial plants. Proper circulation of tidewater through managed wetlands can improve water quality and allow marine fish and invertebrates access to quality nursery grounds within managed wetlands. Increased survival and reproduction of fish and invertebrates not only enhances landowner recreational opportunities, but also helps support regional commercial and recreational fisheries.

SETTING OBJECTIVES

Objectives of wetland management typically focus on improving carrying capacity for target species or species groups by increasing food and cover plants, invertebrates, and open water areas. Target species may include migrating and wintering waterfowl and shorebirds; breeding wood ducks, egrets, and herons; as well as other wildlife and fish. A clear understanding of management objectives is crucial to consistent, successful management. First however, managers should examine the potential of habitats on the property to support various wildlife species. Identifying wetland types, water quality, and dominant plant species are the first steps toward identifying realistic objectives (Table 1). Finally, with the end product in mind, management activities can be focused on providing the necessary biological and physical factors.

Evaluations of water sources, embankments (dikes), elevations, water control structures, and overall objectives are also essential. Managers should identify opportunities for the following improvements: (1) new or additional water control structures for improved water level and salinity management; (2) cross-diking to compartmentalize areas with elevational differences; (3) internal ditching to improve drainage for prescribed burning, mowing, disking, rotavating, planting, and water circulation; and (4) diversion ditches to discharge excess rainwater during the growing season. No two management areas are exactly alike. Subtle differences in soil composition, soil chemistry, hydrology, acreage, juxtaposition, local and regional wildlife populations, hunting, disturbance, and management history may affect success of management programs.

THE BIOLOGY OF MANAGEMENT

Distributions of wetland plant species are determined by numerous physical and chemical factors including tidal influence, water depth, water quality, soil texture, soil pH, soil moisture, and soil organic matter. Competition, disturbance, tidal influence, water depth, and water quality are the principal factors responsible for plant community composition. The most important techniques in coastal habitat management for wildlife involve: (1) manipulation of water levels to control soil moisture and flooding depth, and (2) manipulation of water quality, primarily salinity. Water levels and salinity are manipulated to retard growth of undesirable, competing vegetation and promote establishment and growth of preferred plant species (i.e., food and cover plants attractive to waterfowl and other wetland wildlife). Plant succession is an ongoing natural process in wetlands, favoring dominant plant species in the absence of disturbance. Many management scenarios are designed to mimic natural disturbance, which interrupts plant succession, creating conditions favorable to early successional plant species. Early successional habitats produce plants with abundant seed resources and a diverse group of invertebrates.

Manipulation of the physical and chemical factors affecting plant community composition is required to succeed in managing coastal habitats for waterfowl and other wildlife. While all physical and chemical factors affecting plant succession are important, manipulation of water levels and salinity are most effective in improving habitats on managed properties.

Well-designed dikes and water control structures are fundamental to management programs. Management plans should consider all physical and chemical factors affecting each habitat and be adaptable to seasonal and annual climatic variations. Managers should follow typical scenarios when conditions are favorable, but adjust objectives and techniques during adverse conditions in an annual cycle.

Some freshwater wetlands offer little potential for water level manipulation. Ponds and lakes designed for warmwater fisheries or stock watering often do not have structures for manipulating water levels. These habitats may have little shallow water and are difficult to manage for waterfowl. However, some lakes and ponds may provide excellent food and cover resources in the form of naturally-occurring floating or submergent plants and/or flooded timber. Water control structures can be installed in these deep-water habitats for water level manipulation to improve wildlife habitat.

Management Note

Universality of Management Principles

Although much of the interest in wetland management in this region traditionally has been along the coast, the principles and techniques outlined in this manual are applicable to freshwater wetlands throughout the South Atlantic states.

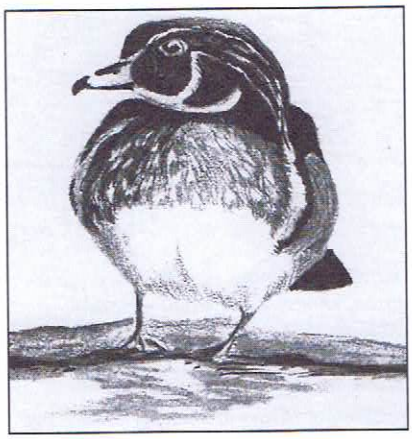
CEREAL GRAINS IN MANAGEMENT

Landowners often are persuaded to plant freshwater wetlands with cereal grains such as millets, grain sorghum, corn, rice, or other planted species such as chufa in lieu of moist-soil or other natural wetland plants. Declining or limited waterfowl use of managed wetlands is the typical rationale for turning to high energy cereal grains, because these food sources indeed are attractive to wintering waterfowl, particularly during prolonged cold periods. Research and management experience has shown that habitat use by waterfowl is complex and varies depending on behavioral and nutritional requirements during various stages of the annual cycle. The most successful management programs contain a complex of wetland habitats that provides diverse food sources, a variety of vegetative cover and open water, and controlled levels of human disturbance. Thus, management for naturally-occurring plant communities is the best approach to meet the overall nutritional and behavioral requirements of wintering and migrating waterfowl. Cereal grains are suitable only as a partial food source for waterfowl because they lack essential proteins. Natural foods also buffer the effects of lead poisoning in areas where residual shot is available. Costs of managing wetlands for naturally-occurring foods are low (~1/3) compared to cereal crops. Naturally-occurring plants are almost always productive whereas crop failures are common with cereal grains. Additionally, diverse populations of invertebrates, amphibians, reptiles, and mammals usually are present in natural plant communities.

If a manager decides to incorporate cereal grains into management plans, then trade-offs should be understood and success evaluated. Planted crop production often requires specialized and expensive farm machinery as well as extensive ditching, drainage networks, and mechanical pumps. Pesticides and herbicides are also necessary for successful crop production. Adverse weather and flooding from extreme tides or intense rainfall make row crop production more difficult. However, if cereal grains are included in the overall management plan, rice is the recommended crop. Because rice strains were developed from natural wetland plants, they often produce excellent and attractive yields. Naturally-occurring, moist-soil food plants often grow in or adjacent to areas cultivated for rice, offering nutritional supplements. Finally, invertebrate populations usually thrive in flooded rice, augmenting the benefits to waterfowl and other wetland birds by providing additional protein.

Table 1. Wetland types, salinity, dominant plants, and target plants for South Atlantic coastal wetlands.

Wetland type	Salinity	Dominant plant species	Target plant species
Wooded Swamps (greentree reservoirs, beaver ponds)	fresh	bottomland oaks, gums, tupelos	same
		buttonbush, willow, primroses, smartweeds, white waterlily, watershield	Asiatic dayflower, rice cutgrass, panic-grass, smartweeds, white waterlily, watershield
Ponds and Lakes	fresh	white waterlily, watershield, pond-weeds, coontail, cowlily, lotus, alligatorweed	white waterlily, watershield, pond-weeds, coontail
Tidal Coastal Marshes			
1. Semi-permanently Flooded Freshwater Marsh (Reserves)	< 1 ppt	giant cutgrass, white waterlily, cowlily, lotus, alligatorweed, black willow	white waterlily, watershield, pond-weeds, coontail
2. Freshwater Marsh	<1 ppt	giant cutgrass, pickerel-weed, arrow-heads, arrow arum, smartweeds, alliga-torweed, gums, baldcypress	smartweeds, panic-grasses, flatsedges, Asiatic dayflower, arrow arum, redroot (organic soils); planted crops-corn, rice, Japmillet, grain sorghum
3. Intermediate Marsh	1-5 ppt	giant cutgrass, giant cordgrass, narrowleaf cattail, bulrushes	fall panicgrass, wild millet, saltmarsh bulrush, giant foxtail, dotted smartweed, flatsedges
4. Brackish Marsh	5-20 ppt	giant cordgrass, narrow-leaf cattail, smooth cordgrass, bulrushes, saltgrass	saltmarsh bulrush, dwarf spikerush, wid-geongrass, sprangletop
5. Brackish/Salt Marsh	20-30 ppt	smooth cordgrass, giant cordgrass, black needlerush, saltgrass	widgeongrass, dwarf spikerush, sea purslane
6. Salt Marsh	30-35 ppt	smooth cordgrass, black needlerush	widgeongrass, sea purslane, Gulf Coast muskgrass



GREENTREE RESERVOIRS

Greentree reservoirs (GTRs) are a relatively new technique for wetland and waterfowl management. In many areas of the United States, over 80% of forested wetlands have been drained and cleared for development and agricultural activities. To offset impacts of these losses, greentree reservoir techniques were developed and employed on a wide-spread basis in the 1960s. Although pioneering GTRs provided immediate and excellent waterfowl habitat, flooding regimes differed from historic patterns and after several successive years (usually > 10, but sometimes < 3) of artificial winter flooding, the long-term habitat quality of GTRs declined due to flood stress and/or death of mature trees, lack of seedling regeneration, and reduced mast production. Before constructing a GTR landowners need to closely evaluate potential sites. If the natural hydrology remains intact such that stands of oaks, gums, maples and tupelos are naturally-flooded in winter during periods of average or above-average rainfall and are dry during summers and periods of below-average rainfall then GTR construction is probably not necessary and may even cause habitat degradation. Periodic dry winters are natural for forested wetlands and necessary to ensure regeneration and tree vigor.

However, for sites with mast-producing trees such as oaks, gums, and tupelos where the hydrology has been altered due to ditching, draining, and dike construction, GTRs are appropriate and offer important waterfowl, songbird, and wading bird habitat. Ideal sites are flat, wooded swamps containing braided, intermittent streams and/or drainage ditches. GTRs generally are developed by construction of a low dike and installation of a flashboard riser in the channel of the intermittent stream or drainage ditch. However, in some instances dikes may not be necessary and the installation of a water control structure in a small drain may provide quality waterfowl habitat without the necessary maintenance of dikes and the potential flooding problems caused by large or misplaced dikes. Dike construction and riser installation require permits from state and federal regulatory agencies (e.g., U.S. Army Corps of Engineers). Flashboard risers should be large enough not to impede streamflow when opened during the growing season (Table 2). Management goals include providing mast, such as acorns, and invertebrates to migrating and wintering waterfowl by flooding these areas in late fall (when trees are dormant). Flooding during the dormant season and de-watering during the onset of spring should not harm hardwoods in GTRs, provided that it does not occur every year.

Many GTRs also contain lower elevational areas adjacent to stream channels which contain trees such as cypress and black gums. These areas are important nesting habitat for wood ducks, songbirds, and wading birds. Research shows that these species have greater nesting success when cypress trees remain shallowly flooded (< 6 inches) during summer. Managers can adjust riser boards to maintain shallow flooding of low-lying cypress areas during summer while also removing water from higher elevation oaks. Installing a riser large enough to remove stormwater from the oaks during summer is essential to this management option.

Management Note

Maintaining GTR Vigor

GTRs should not be flooded every year as this retards growth of mature trees, inhibits regeneration, and reduces mast production. There are two options to maintain GTR vigor and productivity: 1) allow GTRs to remain un-flooded for 2 successive years every 5 years (i.e., winter flood for 3 successive years and then drain for 2 complete years), or 2) flood GTRs during winter, incrementally on a 5-year cycle (i.e., 0% of area 1st year, 25% 2nd year, 50% 3rd year, 75% 4th year, 100% 5th year, repeat 0% 6th year, etc.). The latter option provides some winter waterfowl habitat while also reducing flooding stress and allowing regeneration.

Annuals such as Asiatic dayflower, and shade tolerant grasses and smartweeds may dominate the understory of GTRs providing additional waterfowl food resources. Water depths in areas of GTRs that are flooded should average 8-12 inches. The number of boards required to reach this depth is determined by trial and error on individual sites. Managers should be diligent in removing all surface water as soon as buds begin to swell in the spring (usually around February 15) to avoid tree mortality.

Table 2. Specifications for straight-pipe water control structures equipped with flashboard risers. Reprinted from the USDA Soil Conservation Service Grade Stabilization, Structure Design Data Sheet, MS-Eng-410AA (Delta).

	Drainage areas (0.5 foot head)		Riser specifications	
Round pipe diameter	**4 inches/24 hr**	**6 inches/24 hr**	**Half-round riser diameter**	**Box riser L x W**
inches	(acres)	(acres)	(inches)	(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

BEAVER PONDS

Beavers have recolonized many habitats along the South Atlantic Coast after previous extirpation by fur traders. Beavers inhabit rivers, streams, ditches, ponds, and lakes throughout the region. Where beavers construct a dam and impound areas, habitat is created and waterfowl use may be considerable. With some management, waterfowl habitat in beaver ponds can be enhanced. There generally are two stages of beaver ponds: (1) shallow ponds with few emergent plants (newer ponds), and (2) shallow ponds with many emergent plants (older ponds).

Many older ponds contain food and cover plants attractive to wintering waterfowl as well as nesting and brood-rearing habitat for wood ducks, songbirds and wading birds. Older ponds may become less attractive to waterfowl over time as undesirable vegetation (e.g. common cattail, woolgrass bulrush, giant cutgrass/southern wildrice, black willow, buttonbush, water willow, maidencane) increases. These ponds require management to increase food and cover plants and reduce competing plants.

Various devices can be installed in beaver ponds for water level management. Beaver dams also can be breached by shovels, backhoes, or explosives to provide drainage.

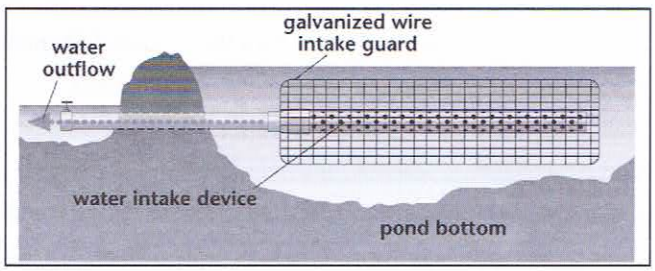


Fig. 1. Clemson beaver pond leveler used for controlling water levels in beaver ponds.

However, beavers tend to repair the breaks almost immediately. The most effective method of lowering water levels is installation of a drainage device in the dam (Figure 1). Several devices exist including; 3-log drains, box drains, perforated PVC drains and the Clemson beaver pond leveler. Drainage structures are installed in dams at a level to expose most of the pond bottom. Although beavers will repair dams, they tend to rebuild on top of drainage structures, burying them in the dam without impeding water flow. Once ponds have been drained and mechanically manipulated, devices can be removed or adjusted to re-flood ponds.

Typical Management Scenarios For Beaver Ponds

New Beaver Ponds-Few Emergent Plants

1. Drain ponds mid-July to mid-August to expose pond bottom.

2. Allow seeds of moist-soil plants to germinate and grow from the natural soil seedbank. Typically, seeds of desirable plants exist in the top few inches of soil in most natural wetlands. This accumulation of seeds is known as the soil seedbank. If the seedbank is limited, resulting in poor germination and plant establishment, seed unvegetated areas of the exposed bottom with annuals such as Japanese millet which germinate and mature in 90 days. Fertilizer applications are usually not necessary for millet plantings. Do not mow or disturb planted crops once they mature as this would be a violation of baiting regulations.

3. Flood ponds to an average of 8-10 inches in mid-October to provide food and cover resources for waterfowl.

Old Beaver Ponds - Dense Emergent Plants

Older ponds may have thick organic matter accumulations on the pond bottoms and/or dense stands of undesirable vegetation (due to advanced plant succession). These habitat changes are not attractive to waterfowl and most other wetland birds, and require management to restore early successional plant communities.

Shaping Up Old Beaver Ponds

1. Drain ponds completely during late winter (January) for thorough drying and winter kill of emergent vegetation.

2. Conduct a hot burn of all emergent vegetation when conditions are optimal.

3. Mechanically disturb (disk or rotavate) as much of the exposed pond bottom as is accessible prior to onset of spring growth (early April).

4. Monitor germination and growth of desirable moist-soil vegetation during the growing season.

5. Control dense stands of cattails, woolgrass bulrush, and other undesirable vegetation with spot spraying of approved herbicides (e.g., Rodeo)

6. Re-flood during October in ponds with few emergent plants. Delay flooding until 1-2 "killing" frosts in ponds with an abundance of emergent plants. Flooding green vegetation may cause "souring" and reduce attractiveness.

Once early successional plant communities with a good mix of food and cover have been restored, ponds can be managed as described for new beaver ponds.

FRESHWATER RESERVES

Many historic rice plantations created freshwater reserves by constructing dikes at the lower ends of swamps or at the upper reaches of tidal streams. These reserves were used during drought periods when rivers and streams normally used to flood ricefields became brackish. Most reserves had water control structures which allowed gravity flow of freshwater into lower elevational ricefields. Due to upland runoff, reserves often had tannin-stained, acidic waters leading to the term blackwater reserve.

Semi-permanently flooded freshwater reserves offer an alternative to moist-soil management in freshwater wetlands. These wetlands provide year-round habitat for breeding wood ducks, wading birds, and wetland songbirds. Flooded reserves also provide foraging habitat for ospreys, bald eagles, river otters, and alligators. Populations of warmwater fishes and amphibians (e.g., bullfrogs) may also increase providing recreational opportunities. However, sustained flooding may cause increased growth of undesirable emergent plants and woody shrubs as well as increased organic matter accumulations on pond bottoms. Organic accumulations can be reduced periodically through draining, drying, and/or burning.

Typical Management Scenario for Semi-permanently Flooded Freshwater Reserves

The following treatment is recommended before managing a freshwater reserve as a semi-permanently flooded system:

1. Completely drain the reserve by late January to mid-February for drying and winter kill of emergent vegetation.

2. Conduct a hot, prescribed burn of the drained reserve when conditions are optimal (dry bed, dry vegetation, favorable winds, low humidity; and, trunks, bulkheads, blinds, and bridges secured).

3. Mow woody shrubs and emergent vegetation that were not reduced to stubble during prescribed burns. Small islands and patches of woody shrubs can be left in the reserve to provide nest sites for songbirds and wading birds and cover for wood duck broods. Do not allow shrub patches to spread throughout the reserve as this would result in decreased habitat value to waterbirds.

4. After mowing, immediately re-flood the reserve with stream runoff, tidal inflow, or pumping. Flood the mowed reserve as deeply as possible given the existing dikes and risers (ideally, 30" or more).

> *Management Note*
> **Wood Duck Boxes**
> If wood duck nest boxes are to be installed, this is the time for installation.

5. Monitor risers to maintain deep flooding which will retard growth of woody shrubs and perennials such as giant southern wildrice or common cattail.

Semi-permanently flooded reserves will provide several years of quality habitat for many wildlife species. However, as the wetland begins to show signs of habitat change (woody shrubs, cattails, giant southern wildrice, floating islands, fish kills, etc.), the above procedure should be repeated.

FRESHWATER TIDAL WETLANDS

Freshwater tidal wetlands occur where salinity averages less than 1 ppt (parts per thousand) throughout the year, and are found along the South Atlantic Coast from southeastern North Carolina to northern Florida. Most managed tidal wetlands are former ricefields that were diked and cleared during the late 1700s and early 1800s. Water control structures installed in dikes, locally known as "ricefield trunks", were used to drain or flood ricefields with twice-daily tides. Old ricefields are located in zones of tidal rivers and streams that were primarily freshwater during the rice culture era. Some former ricefields have become brackish or transitional due to changes in river salinity caused by upstream damming, industrial and municipal water use, and construction of the Atlantic Intracoastal Waterway. More recently, managed tidal wetlands have been established in brackish and saline zones more seaward of historic rice plantations.

Abandoned ricefields have left a diverse collection of coastal marshes, unique to the South Atlantic Coast, with varying salinity, tidal ranges, and accompanying management potential. Also unique to the South Atlantic Coast are wooden ricefield trunks with 2 flapgates and a flashboard riser constructed as a single structure (Figure 2). Trunks are used to drain, flood, mix, and circulate tidewater of varying salinity to promote establishment and growth of food and cover resources for waterfowl and other wetland wildlife. The circulation of water through the flapgates also enhances ingress and egress of marine and freshwater fish and invertebrates as well as improving water quality (e.g., dissolved oxygen).

Repair of broken dikes and installation of water control structures in abandoned tidal ricefields that are not currently managed requires permits from state (South Carolina

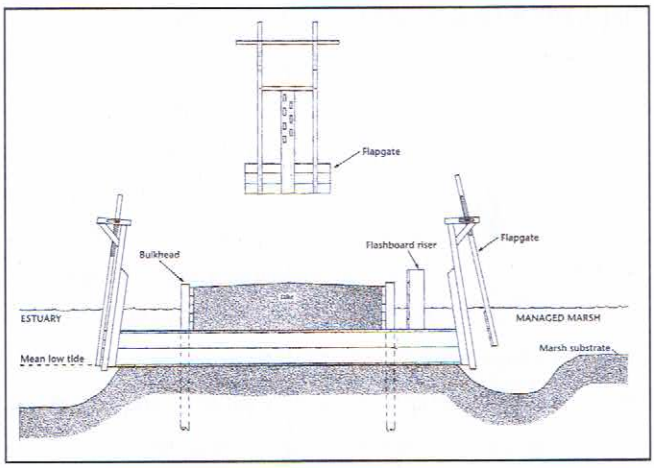


Fig. 2. Cross-sectional and frontal views of a rice trunk in a dike.

From "South Atlantic Coastal Wetlands" by David H. Gordon, Brian T. Gray, Robert D. Perry, Michael B. Prevost, Thomas H. Strange, and R. Kenneth Williams in Habitat Management for Migrating and Wintering Waterfowl in North America edited by Loren M. Smith, Roger L. Pederson, and Richard M. Kaminski, Texas Tech University Press, copyright (c) 1989. Reprinted with permission of the publisher.

Office of Coastal Resource Management) and federal (U.S. Army Corps of Engineers) regulatory agencies. In recent years, permits to restore management capability of abandoned tidal ricefields have been difficult to obtain due to concerns on ingress and egress of marine fishes and invertebrates. Additional scientific data are needed to determine the effects of tidal wetlands management and infrastructure on populations of marine fishes and invertebrates.

Freshwater tidal wetlands are typically managed by moist-soil techniques which include a drawdown during the growing season followed by shallow flooding during fall and winter. Wetlands managed as moist-soil habitats not only offer excellent wintering waterfowl habitat, but also are attractive to white-tailed deer, marsh rabbits, shorebirds, wading birds, and many other breeding bird species. Due to summer drawdowns, moist-soil wetlands also provide increased storage capacity for runoff due to heavy rainfall and tropical storms protecting landowner infrastructure. Productivity of moist-soil plants is not adversely affected by runoff inundation during the growing season as long as water does not cover the marsh bed for more than 1-2 days.

Shaping Up Freshwater Tidal Wetlands

During the initial year, the following procedure is recommended to prepare the wetland for subsequent management activities:

1. Completely drain the managed wetlands by mid-February for drying and winter kill of emergent vegetation.

2. Burn each wetland with a hot fire when conditions are optimal (dry bed, dry vegetation, favorable winds, low humidity; and, trunks, bulkheads, blinds and bridges secured).

3. Mechanically disturb (disk or rotavate) as much of the exposed bed as is accessible with tractors. Areas that did not burn to stubble should be mowed prior to disking and rotavating. Concentrate tractor work on previously unproductive areas first, then work remaining marsh as time and conditions allow. Ideally, all mowing, disking and rotavating should be completed by the end of April. Disk rough areas, then rotavate for a mulching and leveling effect.

SAFETY NOTE!
Never work alone in wetlands with tractors or other heavy equipment.

4. Circulate tidewater into and out of managed wetlands through properly adjusted trunks from April through mid-September. Adjust trunk doors and flashboard risers (spillways) to maintain water levels at or slightly below the marsh bed through the growing season. Soil moisture is critical for growth of desirable waterfowl food plants. The marsh bed should not be saturated or covered with water.

Management Note

Japanese Millet & Other Planted Crops

If Japanese or browntop millet is to be planted near blinds (or other sites) for additional food resources, lower water levels in perimeter and internal ditches by early July for tractor access and mechanical disturbance prior to planting. Fertilize and adjust pH according to soil test results. Japanese millet plantings should be completed by the end of July. After millet stands have grown to 8-10 inches, circulate tidewater through perimeter and internal ditches through mid-October to encourage moist-soils annuals in unplanted zones.

5. After mid-October, gradually lower water levels in ditches to remove sheet water and hasten plant senescence prior to spot burning in November.

6. In late October, check conditions for burning. Optimum burning occurs when the weather has been dry or after a series of early frosts. Spot burns are conducted by alternately setting fire and leaving unburned strips. Ideally, a mosaic of burned and unburned emergent vegetation will result. Consider using a backfire if the fire is burning too hot with the wind.

Management Note

Hunting & Baiting Regulations

If hunting is to occur on the management area, do not burn or otherwise mechanically disturb planted crops as this would be a violation of baiting regulations.

7. Flood managed wetlands in mid-November to an average depth of 9 inches. Postpone flooding if there is an abundance of green, emergent vegetation. Flooding green vegetation can produce a souring effect and promote algal growth. When fall burning cannot be accomplished or does not create the desired interspersion of food plants, cover and open water; raise the water level to 18 in., then gradually lower the level to an average of 9 inches. Deep flooding followed by gradual lowering of water levels causes vegetation to weaken and fall, increasing food availability and open water. This technique is known as "nursing" or "weathering down" standing vegetation.

8. Monitor water levels throughout fall and winter to maintain the optimum waterfowl feeding depth of 9 inches until drawdown in late winter.

Typical Moist-soil Management Scenario For Freshwater Tidal Wetlands

A typical moist-soil scenario can be used for many years once competing vegetation has been eliminated through mowing, burning, mechanical disturbance, and water level manipulation and a diverse community of natural waterfowl food plants and invertebrates has been established.

1. Slowly drawdown managed wetlands during late February to early March to expose and dry marsh soils. Drawdowns should be gradual to concentrate invertebrates for waterfowl and shorebirds, and forage fish for wading birds.

2. Maintain water levels at marsh elevation through March and April for germination of target plant species. No standing water should cover the marsh bed during this period.

3. In late April to early May, circulate tidewater through perimeter and internal ditches. As before, the marsh bed should not be covered with water. Maintain water levels in the ditches at or slightly below the marsh elevation.

Management Note

Fall Shorebirds and Wading Birds

For managers desiring to provide habitat for fall migrating shorebirds and fledgling wading birds, vegetation in freshwater tidal wetlands can be manipulated in late summer to improve habitat for these species. Water levels should be lowered in perimeter and internal ditches in late July for tractor access and mechanical disturbance. Mowing, mashing, and rolling should be concentrated on the lowest elevation portions of the field. Once the desired proportion of open areas are created, water levels should be raised to cover disturbed areas with 1-2 inches by the first of August. This level will allow moist-soil plants in higher elevations to continue to flourish. In mid-October, water levels can be lowered again to conduct spot burns and prepare the marsh for the upcoming waterfowl migration.

4. Continue circulation of tidewater until mid-October, then gradually lower water levels in ditches to 10 inches below the marsh bed.

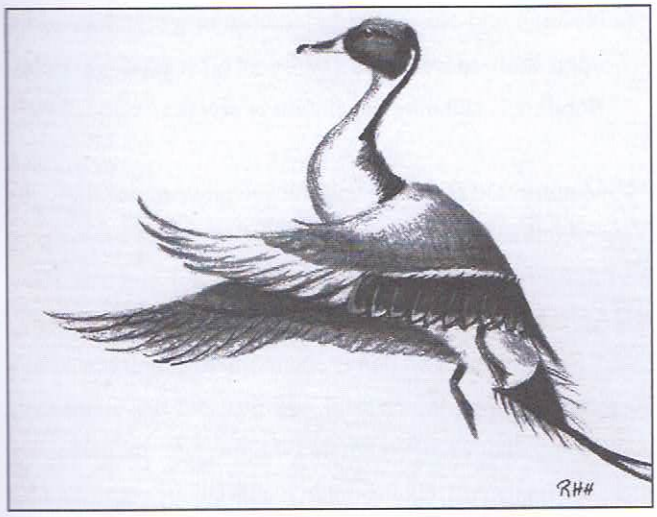
Management Note
Japanese Millet
If Japanese millet is to be planted, repeat the procedure outlined in step #4 under "Shaping Up Tidal Freshwater Wetlands".

5. Conduct spot burns in late October-early November when conditions are optimal.

6. Flood the managed wetland during mid-November to an average depth of 9 inches or more, depending upon success of the partial burn and condition of standing vegetation. Delay flooding if standing vegetation is green.

7. Closely monitor water levels throughout fall and winter to maintain an average depth of 9 inches over the bed.

Management Note
Redroot Management
Freshwater wetlands with organic, acid soils can be managed for redroot by following the same procedures outlined for typical moist-soil management of managed tidal freshwater wetlands. Redroot tubers can be transplanted in March or April in freshly disturbed organic soils. Redroot is spread in successive growing seasons by annual rotavation in March. Redroot stands lose vigor in the absence of annual soil disturbance.



INTERMEDIATE TIDAL WETLANDS

Intermediate tidal wetlands occur where salinity averages 1-5 ppt. Management is similar to freshwater tidal wetlands. However, certain undesirable plants as well as certain target plants tend to thrive at low soil salinity.

Shaping Up Intermediate Tidal Wetlands

Managers should reduce or eliminate competing stands of giant cordgrass and saltgrass before initiating management. Procedures to reduce undesirable plants may have to be repeated for several years to achieve desired results.

1. Drain wetlands completely in late January for drying and winter kill of emergent vegetation.

2. Conduct a hot cover burn from February to March to reduce emergent vegetation to stubble.

3. Flood as deeply as possible after burning (outside trunk doors completely open, riser boards to top of riser).

> *Management Note*
> **High Spring Tides**
> Managers should take advantage of high spring tides to add additional water to the burned wetlands. A minimum depth of 24 inches will reduce germination of giant cordgrass.

4. Maintain deep flooding until mid-July or longer for best results. If giant cordgrass coverage is extensive, it may be necessary to sacrifice an entire growing season by maintaining deep flooding.

5. Drain in mid-July if deep flooding has reduced giant cordgrass stands and created open water.

6. Saltmarsh bulrush should germinate first on the exposed bed followed by other target plant species as the growing season progresses.

7. Adjust trunks to circulate tidewater through managed wetlands until mid-October. Maintain water levels at or slightly below the marsh bed during this period. Marsh soils should not be covered with water for longer than 1-2 days.

8. In late October, gradually lower water levels to 10 inches below the marsh bed to remove sheet water and hasten plant senescence prior to burning.

9. Conduct spot burns when conditions are favorable. Optimum burning occurs when the weather has been dry or after a series of early frosts. Spot burns are conducted by alternately setting fire and leaving unburned strips. Ideally, a mosaic of burned and unburned emergent vegetation will result. Consider using a backfire if the fire is burning too hot with the wind.

10. Flood in mid-November to an average depth of 9 inches. Delay flooding if there is an abundance of green emergent vegetation. Flooding green vegetation can produce a souring effect and promote algal growth. When fall burning does not accomplish the desirable mix of plants and open water, raise water levels to 18 inches, then gradually lower to 9 inches. This procedure will cause vegetation to weaken and fall, increasing food availability and open water.

11. Maintain water levels at an average depth of 9 inches throughout fall and winter.

Typical Moist-soil Scenario For Intermediate Tidal Wetlands

A typical moist-soil scenario can be used for many years once competing vegetation has been eliminated through mowing, burning, and water level manipulation; and a diverse community of natural waterfowl food plants has been established.

1. Drawdown during late February-early March to expose marsh soils. Drawdowns should be gradual to concentrate invertebrates for waterfowl and shorebirds, and to concentrate forage fish for wading birds.

2. Maintain drawdown through April for germination of target plant species. Standing water should not cover the marsh during this period.

3. In late April to early May, flood ditches by circulating tidewaters through trunks. The marsh should not be covered with water; maintain water levels slightly below the marsh bed.

4. Continue circulating tidewaters through ditches until late September.

Management Note

Fall Shorebirds and Wading Birds

For managers desiring to provide habitat for fall migrating shorebirds and fledgling wading birds, vegetation in freshwater tidal wetlands can be manipulated in late summer to improve habitat for these species. Water levels should be lowered in perimeter and internal ditches in late July for tractor access and mechanical disturbance. Mowing, mashing, and rolling should be concentrated on the lowest elevation portions of the field. Once the desired proportion of open areas are created, water levels should be raised to cover disturbed areas with 1-2 inches by the first of August. This level will allow moist-soil plants in higher elevations to continue to flourish. In mid-October, water levels can be lowered again to conduct spot burns and prepare the marsh for the upcoming waterfowl migration.

5. In early October, gradually lower water levels to 10 inches below the marsh bed. Conduct spot burns from October to November when conditions are optimal.

6. Flood in mid-November to 9 inches or more, depending upon burn success and condition of vegetation. Delay flooding if standing vegetation is green.

7. Monitor and maintain water levels at 9 inches throughout fall and winter.

BRACKISH TIDAL WETLANDS

Brackish tidal wetlands occur where salinity averages between 5-20 ppt. Water level, salinity, and dissolved oxygen manipulations are extremely important in managing these wetlands. Most undesirable plants can be controlled by water level and salinity manipulations.

Shaping Up Brackish Tidal Wetlands

Reduce competing stands of giant cordgrass, smooth cordgrass, cattails, and saltgrass by the following procedures prior to intensive management:

1. Drain managed wetlands completely in late January.

2. Conduct a hot cover burn to reduce emergent vegetation to stubble (mid-February to mid-March).

3. Flood as deeply as possible with spring tides (outside trunk doors completely open, riser boards to top of riser) immediately after burning.

4. Maintain deep flooding at least through May. Deep flooding through August may be necessary to reduce dense stands of competing plants.

5. Drain in late May to early June (depending upon effects of deep flooding) to 10-18 inches below marsh elevation.

6. Allow emergent vegetation to germinate and grow to 6 inches (approximately 2 weeks). Saltmarsh bulrush will invade higher elevations during this period.

7. Begin flooding to stimulate widgeongrass growth in late June to early July. Flood marsh 6-8 inches using 10-15 ppt tidewater.

8. Continue flooding by adding 4-6 inches of tidewater twice monthly until mid-October. Highest tides occur on new and full moons. Maintain water levels slightly above widgeongrass and salinities at 5-15 ppt during the growing season.

Management Note

Circulating Tidewater

Vigorous circulation of tidewaters should occur throughout the growing season. While raising water levels inside the wetland 8-12 inches per month, allow excess tidal and rain water to flow over flashboard risers for circulation. Circulation will lower water temperature reducing infestation of widgeongrass beds by filamentous algae. Circulation also will increase dissolved oxygen reducing potential for fish kills. In addition to waterfowl, shorebirds and wading birds, brackish tidal wetlands offer quality nursery habitat for crabs, shrimp, and saltwater fish. Adult shrimp and saltwater fish typically move up tidal rivers and creeks during May and June to reproduce. These adults are allowed access to managed wetlands through open trunks. Water circulation improves the habitat quality of managed wetlands to marine fish and invertebrates by allowing access, lowering water temperatures, and increasing dissolved oxygen in the water.

Salinity should be monitored carefully during the growing season. Tidewater salinity may increase during dry summer periods and low river flows. Salinity also may increase inside managed wetlands due to evaporation and plant transpiration. When salinity inside wetlands approaches 15 ppt, retain rainfall or pump freshwater reserves to lower salinity by dilution. If water in reserves in tannin-stained, reduced light transmission through this water source may reduce growth of desired submergents, so managers should use these sources only when salinities are above 15 ppt and rainfall probability is low.

9. Drawdown beginning in early November by removing one riser board weekly to achieve an average depth 10-15 inches by early December. This will allow waterfowl access to food plants.

Typical Management Scenario For Brackish Tidal Wetlands

Once brackish wetlands have been managed to reduce undesirable plants for at least 1 year, implement the following procedure for production of desirable food plants:

1. Gradually lower water levels during late February to early March by removing one riser board each week. This allows germination of saltmarsh bulrush at higher elevations and dwarf spikerush at lower elevations and also concentrates fish and invertebrates for shorebirds and wading birds. Water levels should be below bed level by late March.

2. Circulate tidewater through the wetland while maintaining water levels at 4-6 inches below the marsh bed through May to allow marsh sediments to consolidate. Excessive drying during this period may cause acid soils also known as cat clays. Use caution to not excessively dry brackish soils.

Management Note

Shorebirds, Wading Birds, & Fish

For managers also desiring to improve habitat for shorebirds, wading birds, and marine fish and invertebrates, partial drawdowns of brackish marshes are often more effective than complete drawdowns. Partial drawdowns are accomplished by lowering water levels to 2-4 inches during late February and maintaining this level through May. March to May is the peak shorebird migration period as well as the beginning of the wading bird nesting season. The sheetwater across the wetland also will provide quality habitat for juvenile shrimp, crabs, and marine fishes. Saltmarsh bulrush and dwarf spikerush will germinate at the exposed higher elevations while widgeongrass will germinate in the sheetwater. Circulate tidewater during partial drawdowns and do not allow bed to dry or widgeongrass production will be reduced. Beginning in June, add 4-6 inches of tidewater twice monthly until mid-October and then gradually lower water levels to 10-15 inches by December. After 3-5 years of partial drawdowns in brackish marshes, a complete drawdown may be necessary to consolidate sediments.

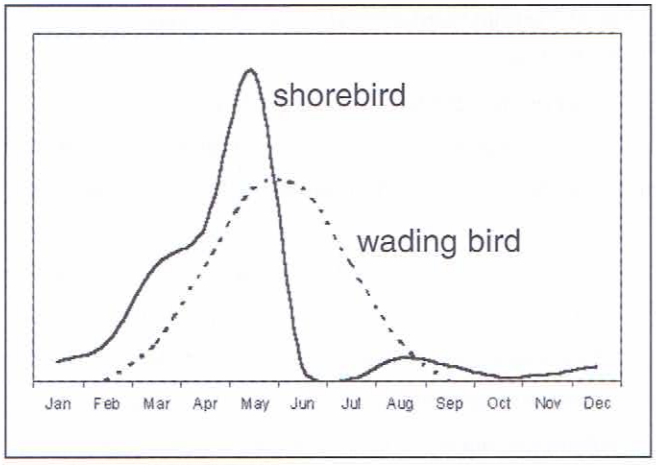


Fig. 3. Chronology of shorebird populations and wading bird breeding season in the South Atlantic region.

3. Flood during June with 6-8 inches of tidewater to promote growth of widgeongrass and dwarf spikerush.

4. Continue adding 4-6 inches of tidewater twice monthly until mid-October. Water control structures must be carefully monitored during the growing season. Salinities over 15 ppt will retard growth and seed production of saltmarsh bulrush.

5. In early November, drawdown by removing one riser board each week for an average depth of 10-15 inches by early December. Lowering water levels to 10-15 inches will allow waterfowl access to plant foliage and seeds. Various riser board widths should be available at each trunk to effectively lower water levels to the desired depth.

Management Note

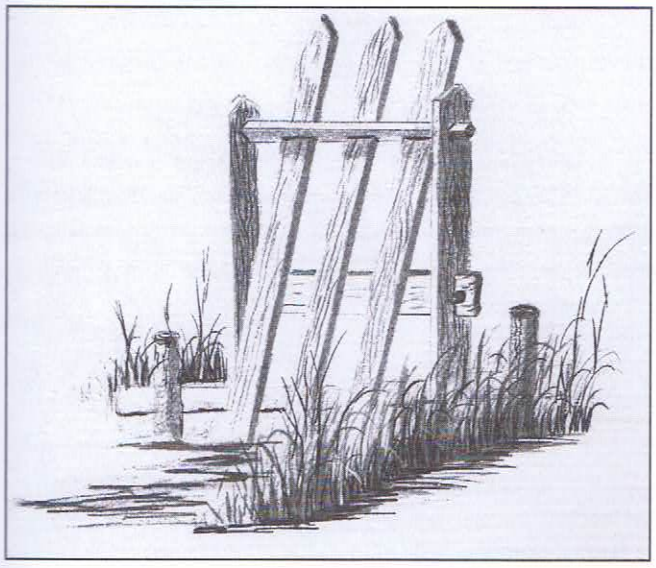
Salinity Management

Management of small brackish wetlands (<100 acres) can result in extensive, dense stands of saltmarsh bulrush. Dense stands of any type vegetation, even target plants, usually are not attractive to waterfowl. Flooding to 18-24 inches through a growing season can reduce saltmarsh bulrush density, create openings, and promote growth of widgeongrass and dwarf spikerush which will enhance waterfowl use. In order to retard competing vegetation, maintain salinity at 10-20 ppt. Once open water patches are created, management should target growth of widgeongrass and dwarf spikerush.

Besides adjusting water levels, salinity manipulations will also enhance habitat conditions. Narrowleaf and tropical cattail are controlled at salinities from 15 to 20 ppt. However, saltmarsh bulrush growth is greatest at 3-7 ppt with growth restricted at salinities >15 ppt. Thus, trade-offs exist between controlling undesirable vegetation and promoting food plants. Heavy rainfall reduces salinity. Flashboard risers can be used to remove excess rainwater during ebb tides. Conversely, retention of rainwater following drought, can offset high salinity. During normal weather, salinity should be monitored every 2-4 weeks. During periods of heavy rainfall or drought, salinity should be monitored weekly. A hand-held refractometer provides fast and accurate estimates in the field. Water samples should be taken from the bottom of inlet and outlet canals at high tide to accurately measure the salinity affecting plant growth.

Prolonged drought can interfere with typical brackish marsh management. Summer flooding may be delayed for extended periods because of high tidewater salinity. Soil salinity also can increase due to evaporative concentration. Saltmarsh bulrush can become stressed resulting in poor seed production. During droughts, sea purslane may flourish in higher elevations normally dominated by saltmarsh bulrush. Managers can adjust procedures to take advantage of sea purslane production.

Repeated flooding and drawdown can elevate soil pH to levels supporting waterfowl food plants in brackish wetlands that have been dried excessively. A pH >4.0 is necessary for dwarf spikerush and a pH >5.0 is required for widgeongrass. However, a rapid increase in pH may result in red or orange iron compounds in the water. Numerous field observations suggest a gradual exchange of water is most effective for encouraging dwarf spikerush and widgeongrass in marshes previously drained for extended periods. In marshes with iron compounds, a series of drawdowns followed by rapid re-flooding and continuous circulation are most effective for improving water quality (e.g., raising pH).



BRACKISH/SALINE AND SALINE TIDAL WETLANDS

Brackish/saline wetlands occur where salinity averages 20-30 ppt while saline wetlands occur where salinity averages 30-35 ppt. Water level and salinity manipulations of these 2 habitat types are similar. Higher salinities in these marshes preclude growth of competing species such as cattail and giant cordgrass as well as desirable saltmarsh bulrush. Small stands of saltmarsh bulrush that persist may increase temporarily during seasons of abundant rainfall and accompanying lower salinity. However, the primary foods encouraged are widgeongrass and dwarf spikerush.

Typical Management Scenario For Brackish/Saline and Saline Tidal Wetlands

1. Gradually lower water levels during late February to early March by removing one riser board each week. Water levels should be below bed level by late March.

2. Circulate tidewater into and out of the wetland while maintaining water levels at 4-6 inches below the marsh bed through April to allow marsh sediments to consolidate.

Management Note

Shorebirds, Wading Birds, & Fish

For managers also desiring to improve habitat for shorebirds, wading birds, and marine fish and invertebrates (i.e., crabs and shrimp), partial drawdowns of saline marshes are often more effective than complete drawdowns. Partial drawdowns are accomplished by lowering water levels to 2-4 inches during late February and maintaining this level through May. March to May is the peak shorebird migration period as well as the beginning of the wading bird nesting season. The sheet water across the wetland also will provide quality habitat for shrimp, crabs, and juvenile fish. Saltmarsh bulrush and dwarf spikerush will germinate at the exposed higher elevations while widgeongrass will germinate in the sheetwater. Circulate tidewater during partial drawdowns and do not allow bed to dry or widgeongrass production will be reduced. Beginning in June, add 4-6 inches of tidewater twice monthly until mid-October and then gradually lower water levels to 10-15 inches by December. After 3-5 years of partial drawdowns in saline marshes, a complete drawdown may be necessary to consolidate sediments.

3. Flood during May with 6-8 inches of tidewater to promote growth of widgeongrass, dwarf spikerush, and muskgrass.

4. Continue adding 4-6 inches of tidewater twice monthly until mid-October.

5. In early November, drawdown by removing one riser board each week for an average depth of 10-15 inches by early December. Lowering water levels to 10-15 inches will allow waterfowl access to food plants' foliage and seeds. Various riser board widths should be available at each trunk to effectively lower water levels to the desired depth.

Management Note

Sea Purslane

Extended spring drawdowns of high salinity marshes can encourage extensive stands of sea purslane on mud flats. In such instances, saturated soils should be maintained until sea purslane has matured before flooding for widgeongrass and dwarf spikerush. Flooding as late as August or September can produce good crops of widgeongrass and dwarf spikerush while maintaining sea purslane production.

Although sea purslane can sometimes be grown in brackish marshes, its greatest management potential is in saline marshes. Sea purslane is the only seed-producing plant stimulated by drawdown of saline marshes. Optimum growth has occurred on organic soils, whereas attempts to establish sea purslane on heavy clay soils have been unsuccessful due to acid soil or cat clay conditions. Management for sea purslane during successive growing seasons may result in increased growth of competing species such as saltmarsh asters, glassworts, saltmarsh fleabane, saltgrass, giant cordgrass, and smooth cordgrass. Management experience suggests that delaying drawdown until late spring (May to early June) retards growth of competing plants while allowing excellent sea purslane production. After several years of drawdowns for sea purslane, flood the wetland through a growing season to control competing vegetation and to promote growth of widgeongrass. Another option involves early spring drawdown for sea purslane growth, followed by late summer or fall flooding for widgeongrass production. Techniques involving rotational and multispecies management will maintain productivity and diversity in saline marshes.

Widgeongrass

Salt marshes with salinity greater than 30 ppt are managed for widgeongrass through techniques similar to those employed in brackish marshes. Although widgeongrass will tolerate sea water salinities (>35 ppt), growth and seed production are often reduced. The best growth of widgeongrass usually occurs within a salinity range of 10-20 ppt. Successful widgeongrass production requires flooding in early spring, when tidewater salinity is lower and adjusting trunks to hold rainfall to lower salinity.

In addition to limitations of high salinity, other factors including unstable soils and turbidity make saline marshes difficult to manage for widgeongrass. Properly timed drawdowns are important to consolidate soils to reduce both turbidity and uprooting of widgeongrass stands by wave action.

Gulf Coast Muskgrass

Gulf Coast muskgrass grows well in saline marshes with soft, organic sediments. Compared to widgeongrass, muskgrass has increased ability to tolerate high salinity, ability to withstand wave action and turbidity, and ability to compete with filamentous algae. Large scale management of Gulf Coast muskgrass is limited by a lack of information concerning growth requirements.

Banana Waterlily

A specialized situation in some semi-permanently flooded brackish wetlands (salinity <5 ppt) is management for banana waterlily. During periods of low salinity, banana waterlily temporarily occurs in brackish marshes managed for other species; however, it is most successfully managed for in saltmarsh creek channels and sloughs with soft mud soils and alkaline waters. Desirable submersed aquatics commonly growing in association with banana waterlily include sago pondweed, bushy pondweed, and muskgrass. As banana waterlily rootstocks can survive occasional inundation with saline water, competing vegetation such as tropical cattail and bullwhip bulrush may be controlled by periodic flooding with high salinity water.

Control of Undesirable Vegetation

Major species of competing vegetation in higher salinity marshes are black needlerush and smooth cordgrass. Black needlerush can be controlled by continuous flooding (12-24 inches) for several growing seasons, with reduction determined by depth of flooding. However, with elevated water levels smooth cordgrass can increase at higher elevations. Complete drawdown for an entire growing season can control smooth cordgrass. Prolonged drawdown may temporarily decrease soil pH limiting desirable plant growth.

WILDLIFE USE OF MANAGED WETLANDS

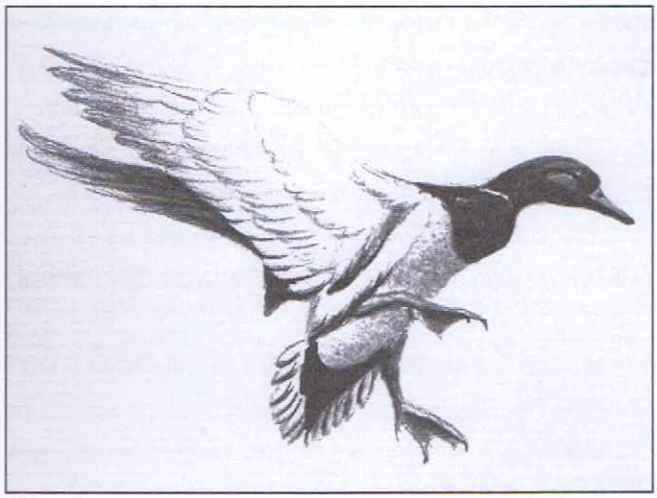
Food resources, plant structure and water depth influence wildlife use of wetland habitats. Diversity within and/or among wetlands provides a variety of foods and cover utilized by dabbling and diving ducks as well as shorebirds, wading birds and songbirds. Seeds, tubers, and foliage of plants produced in managed coastal wetlands contain important nutrients. Standing emergent vegetation and woody shrubs provide nesting and cover sites for waterfowl and other wetland birds. A diverse diet of natural plant foods together with associated invertebrates provides energy, protein, and minerals required by waterfowl.

Water depth, plant density, and plant height influence wildlife selection of specific habitat types. Forested wetlands attract wood ducks, mallards, and black ducks as well as breeding songbirds (e.g., warblers, vireos, flycatchers) and wading birds. In South Atlantic GTRs, waterfowl primarily feed on acorns and seeds of gums and associated moist-soil plants. Freshwater reserves and semi-permanently flooded freshwater marshes with abundant pad and submergent plants attract wood ducks, ring-necked ducks, American wigeon, and gadwall as well as breeding osprey, bald eagles, bitterns, egrets, and herons. Freshwater reserves also provide quality habitat for alligators, otters, amphibians, and fishes. Seeds of white waterlily, watershield, and banana waterlily; as well as seeds and foilage of pondweeds are preferred foods of waterfowl in freshwater reserves.

Tidal freshwater wetlands with a good mix of seeds and tubers are used by a wide variety of dabbling ducks including wood ducks, green- and blue-winged teal, mallards, black ducks, northern pintails, American wigeon and northern shovelers. Seeds of smartweeds, panicgrasses, flatsedges, Asiatic dayflower, planted crops, and tubers of redroot are preferred foods of waterfowl in moist-soil wetlands. Moist-soil wetlands also are used extensively by white-tailed deer and many songbird species. In intermediate and brackish wetlands, seeds of fall panicgrass, wild millet, saltmarsh bulrush, giant foxtail, dotted smartweed, and flatsedges attract mallards, northern pintail, black ducks, green- and blue-winged teal and northern shovelers. Open water ponds, supporting dwarf spikerush, and widgeongrass can attract American wigeon and gadwall as well as egrets and herons. Saline managed wetlands containing sea purslane and widgeongrass typically have sparse emergent cover and can attract teal and northern pintails. Late winter and spring drawdowns which concentrate invertebrates and small finfishes attract large numbers of wading and shorebirds.

In addition to quality of food, cover and water, other factors affect wildlife use of managed wetlands; these include:

1) Weather - inclement weather usually increases waterfowl use. Windy weather can cause bird movements to increase. Warm weather reduces energy demand and waterfowl movements and use of some habitats. Managers should limit hunting during periods of mild weather to allow resource utilization. Hunting stress without environmental stress will cause waterfowl to leave high quality habitat,
2) Hunt Management - limit the number of guns per area. Limit the number of shells to 3-5 per bird in the legal bag limit so that hunters are forced to be careful and accurate. One recommended formula is 2 guns per every 50 acres and 3 shells per bird. Shooting should cease by 9:00 a.m. and all hunters vacate hunt sites by 9:30 a.m.,
3) Disturbance - excessive disturbance of migrating and wintering waterfowl limits use of managed wetlands, especially during balmy weather. Shooting is the primary disturbance, both within and around managed areas. Managers should keep disturbance to a minimum. Limit vehicle driving on dikes to inspections of water levels and trunks, scheduled observations of bird use, and trespass investigations, and
4) Water Levels - water level maintenance is critical to wildlife use. Do not allow leaking water control structures or excess rainfall to flood managed wetland systems too deeply. Waterfowl will move to other areas quickly when conditions are not favorable for feeding and/or loafing. Favorable feeding depths for dabbling ducks are equal to body length from breast to tail. More energy is required for waterfowl to dive than to dabble. During severe weather, more energy is lost to heat regulation which may cause waterfowl to conserve energy by feeding on lower quality food sources at shallower depths.



To assist in restoring and protecting the nation's declining wetlands and waterfowl populations, many public and private conservation agencies have developed private lands programs. In the South Atlantic Coastal region, Ducks Unlimited, Inc. (843-745-9110), U.S. Fish & Wildlife Service (803-727-4707), USDA Natural Resources Conservation Service (formerly SCS) (803-253-3894), Cooperative Extension Services (e.g., Clemson University, 864-656-3117), South Carolina Department of Natural Resources (803-734-3888), North Carolina Wildlife Resources Commission (919-733-3391), Georgia Department of Natural Resources (404-656-3510), and Florida Game and Freshwater Fish Commission (904-488-1960) offer technical assistance for wetland and waterfowl management and conservation on private lands. Financial incentives to landowners may be available in some cases where unique wetland habitats exist and/or where wetlands are particularly valuable to waterfowl and other wildlife.

For lands considered to be agricultural, landowners may receive financial assistance through the Conservation Reserve Program (CRP) and/or the Wetland Reserve Program (WRP) administered through the Natural Resources Conservation Service for restoring and/or protecting wetland habitat and managing their lands for waterfowl and other wetland birds. Funds to restore and enhance wetlands may also be available through the U.S. Fish & Wildlife Service's Partners for Wildlife program and federal grants administered through state forestry agents for forested wetland enhancement and restoration.

Management Note

Shallow Water Areas for Wildlife

United States Department of Agriculture (USDA)
Conservation Reserve Program (CRP)

Shallow water areas for wildlife are restored, enhanced or created open water areas which average 6-18 inches in depth. These areas provide habitat for water dependent wildlife such as migratory shorebirds, waterfowl, reptiles, amphibians and aquatic mammals. Proper management can increase and maintain desirable foods for waterfowl and other species of wildlife. The shallow water area must provide a water source for wildlife during the majority of the year.

To be eligible for cost-share and technical assistance under CRP, the practice must be included in a conservation plan approved by USDA-Natural Resources Conservation Service (NRCS). In addition, the land must have a cropping history (two out of the last five years) and the landowner must have owned the land for at least 12 months prior to submission of the application.

Protection of water quality is critical in shallow water areas. The practice must include an adequate buffer area of perennial vegetation. Soil type, slope, and conservation practices applied on the field determine the width of the buffer. However, the buffer width shall not be less than 20 feet or exceed average maximum width of 120 feet. The practice, including the buffer area, shall not exceed 10 acres per tract.

Cost-share is authorized for:

- Earthmoving
- Plantings for permanent habitat cover and to serve as the buffer
- Seedbed preparation
- Structures, such as pipes, chutes, and outlets to regulate flow
- Seeding temporary cover for erosion control
- Herbicides, pesticides, and insecticides to facilitate cover establishment
- Mineral or nutrients (lime and fertilizers)

Requirements:

- The practice must provide a source of water for wildlife for the majority of the year
- The water area shall be an average of 6-18 inches in depth
- The seeded area shall not be harvested nor grazed by domestic livestock
- The practice, including the buffer area, shall not exceed 10 acres per tract
- The practice must be established and maintained according to the NRCS practice standards

• Planting or sowing of approved cover shall be completed within 12 months of effective date of contract

NRCS has the technical responsibility for planning, design, and management guidelines of the practice according to technical standards. The technical standard for the practice is Shallow Water Management for Wildlife (646). This standard provides guidelines for open water areas (sheet water) and moist-soil areas on agricultural lands for waterfowl resting and feeding, as well as reptiles and amphibians. Natural vegetation management is recommended, however some plantings of annual wildlife foods may be permitted. Specific recommendations are based on state specifications, which may vary, somewhat, from state to state. The requirements for the practice are basically low permeable soils, adequate water supply, and use of a water control structure to allow 6-18 inches of water level management.

CRP sign-up is continuous. Eligible applicants will receive 50 percent cost-share on installation, plus 40 percent practice bonus on installation, totaling 90 percent cost-share. Rental rates are based on local (county) soil rental rates. The contract period is ten years.

For more information on shallow water areas for wildlife (CR9) or to apply, visit or call your local USDA Service Center or to see more information on CRP and other USDA programs, visit their website at http://www.nrcs.usda.gov/NRCSProg.html#Anchor-CRPConservation.

Management Note

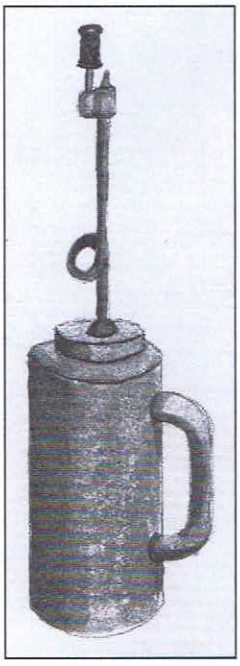
Wetland Reserve Program (WRP)

United States Department of Agriculture (USDA)
Wetland Reserve Program (WRP)

The focus of WRP is to provide landowners with a voluntary mechanism to restore wetlands that were cleared and/or drained for farming, pasture or timber production. Nationwide, over 1 million acres have been enrolled in WRP. As with most voluntary USDA conservation programs, there are more landowners wishing to sign up for WRP than there are funds available.

WRP has many benefits that have made this program popular with landowners. First, WRP pays landowners per acre based on the agriculture value of the land and can pay up to 100% of the restoration cost, depending on the length of time the landowner enters into WRP. The landowner in many cases is taking out of production marginal farmland that stays wet a majority of time and is not economical to farm. Landowners retain access and the ability to control access onto their property. The right to ownership of the land under a WRP easement remains with the landowner, as does the right to sell or will the land to someone else. The landowner has the right to hunt, fish, trap and pursue other appropriate recreational uses and may sell or lease land enrolled in WRP. The landowner has the option to choose between a 10-year cooperative agreement, a 30-year or a permanent conservation easement. For the permanent conservation easement NRCS can pay 100% of the restoration and legal costs. Additionally, NRCS will provide the landowner with a one-time easement payment based on either the appraised agriculture value of the land, the geographical area rate cap, or an amount offered by the landowner. In contrast, for a 30-year conservation easement, NRCS pays 75% of what would be paid for a permanent easement. For the 10-year restoration agreement, NRCS will only pay 75% of the restoration costs and no easement payment. Over three quarters of the nation's one million acres signed into WRP are in the permanent easement option – forever protecting these restored lands for wildlife, water quality, flood control and aesthetics.

To enroll into WRP, landowners need to visit their local NRCS office to review eligibility and easement requirements as well as submit a signed application form. The application form is not a commitment by the landowner. Once a landowner submits an application into WRP then NRCS will visit the site and evaluate the land's eligibility as well as develop a preliminary restoration plan. WRP allows up to 30% of each enrollment to be "enhanced", which in many cases means putting semi-permanent and permanent water back on the land. These permanent and semi-permanent water areas can be in the form of moist-soil and shallow-water management areas. The remaining 70% of the tract must be restored back into an original vegetation community. Once the preliminary restoration plan is complete, applications will be ranked according to environmental and economical benefits.



The following items are needed for effective management of most coastal habitats:

1. **Tractor** - Preferably 4-wheel drive to facilitate mowing, disking and rotavating managed wetlands, particularly freshwater systems.

2. **Tractor implements** - Disk harrow, rotary mower, rotavator and sprayer.

3. **Drip torch** - For prescribed burning.

4. **Refractometer** - Salinity testing device essential for use in management of brackish and saline wetlands.

5. **Bottom sampler** - Bottle with stopper on long pole for sampling tidewater from bottom of inlet canal at structures during high tide.

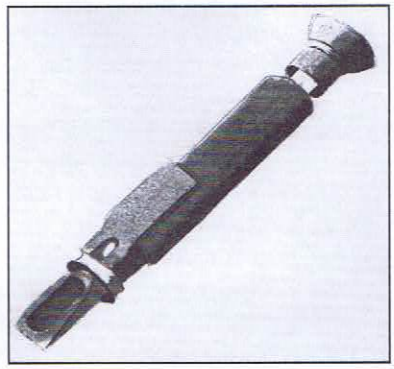
6. **Rain gauge** - To record rainfall.

7. **Staff gauge** - Graduated in 1 in. and 1 ft. increments and installed at strategic locations inside managed wetlands adjacent to water control structures. Staff gauges should be installed after recording and averaging marsh elevations across a managed wetland.

8. **Field Notebooks** - For recording dates, salinity readings, water levels, observations of plant growth and observations of wildlife populations to evaluate annual success of management programs and determine if goals or being reached.

Herbicide applications are normally not recommended for control of undesirable vegetation in coastal wetlands due to expense and short-term results. Successful management of coastal wetlands can usually be achieved through water level and salinity manipulations, and prescribed fire or mechanical techniques. Therefore, herbicides should be applied only to dense areas of difficult to control species such as common reed (phragmites), cattails and giant southern wildrice.

Dikes and water control structures require annual maintenance. Bulkheads should be carefully inspected for erosion, washouts and undermining. Water control structures must be in good working order prior to critical management periods and irrespective of habitat types or management objectives.



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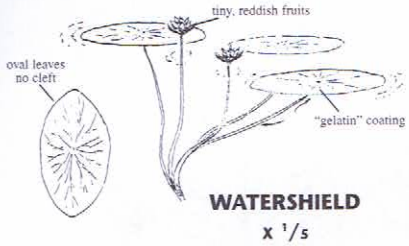
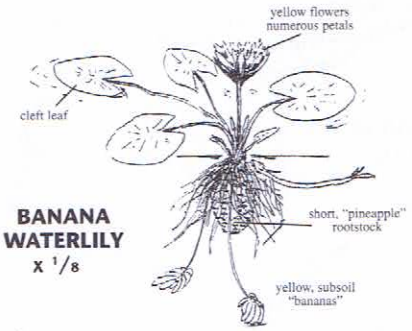
Appendix I. Common South Atlantic Wetland Plants. Modified from W.P. Baldwin, 1956, Food Supply Key to Attracting Ducks, South Carolina Wildlife.

FRESHWATER TARGET SPECIES

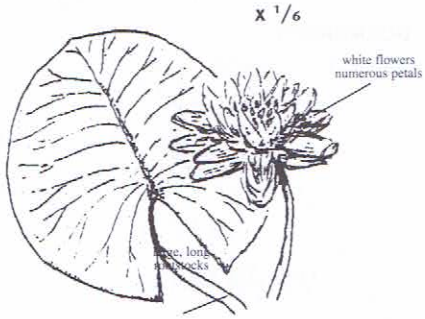


WATERSHIELD
x 1/5



BANANA WATERLILY
x 1/8

WHITE WATERLILY
x 1/6

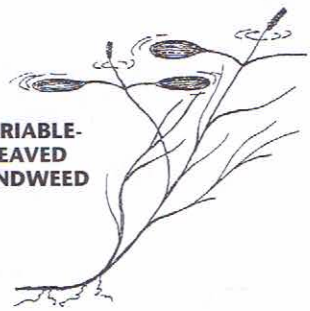


BUSHY PONDWEED

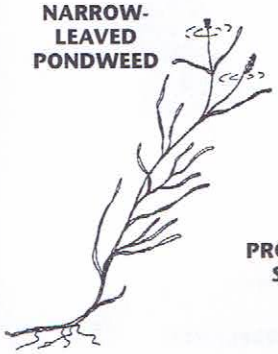
SAGO PONDWEED

COONTAIL

VARIABLE-LEAVED PONDWEED



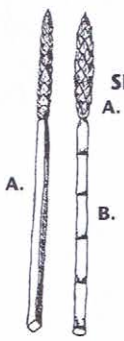
NARROW-LEAVED PONDWEED



PROLIFERATING SPIKERUSH

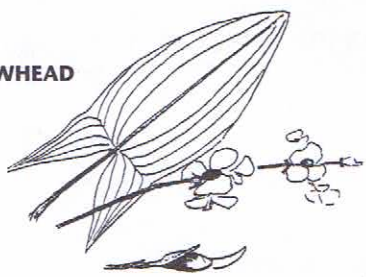
WILD RICE

SPIKERUSHES
A. SQUARE STEM
B. JOINTED

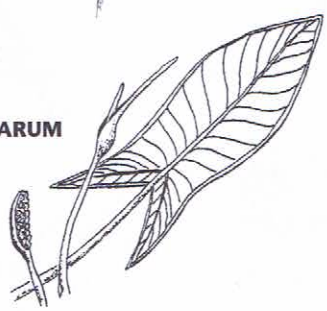


SOUTHERN SMARTWEED

ARROWHEAD



ARROWARUM



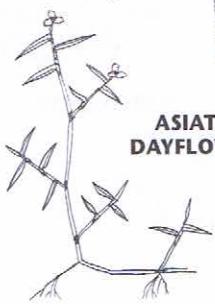
SWAMP SMARTWEED

LARGESEED SMARTWEED

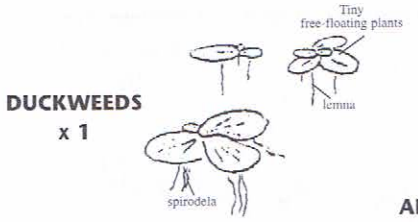
WILD MILLET

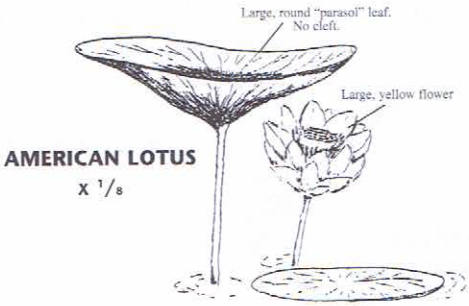
REDROOT

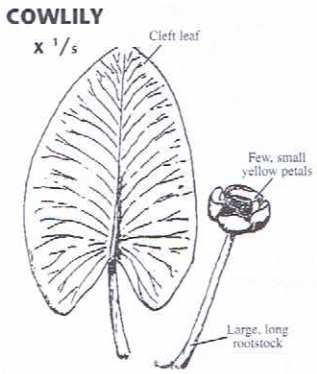
ASIATIC DAYFLOWER

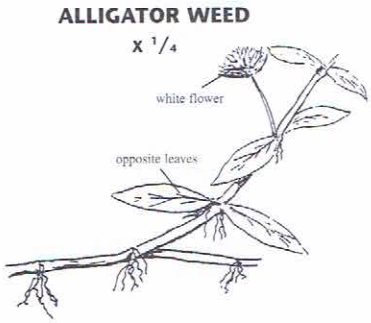


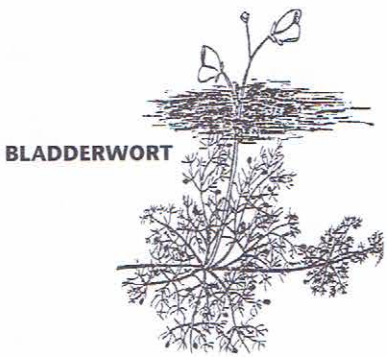
FRESHWATER DOMINANT SPECIES

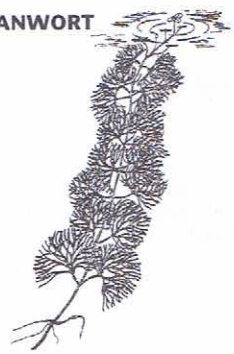


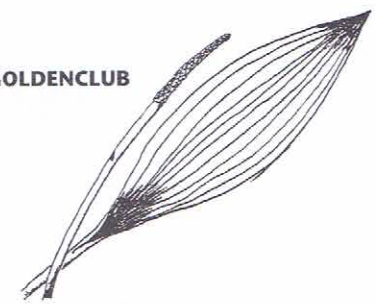


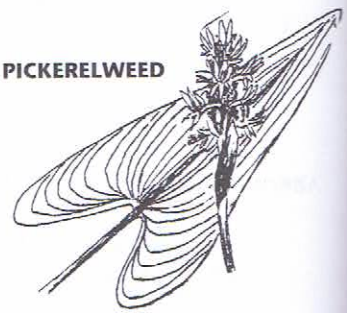


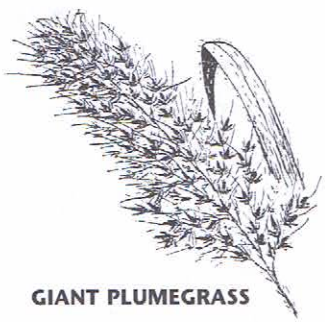


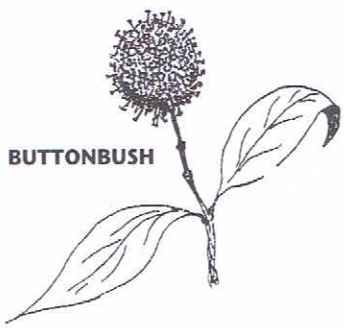




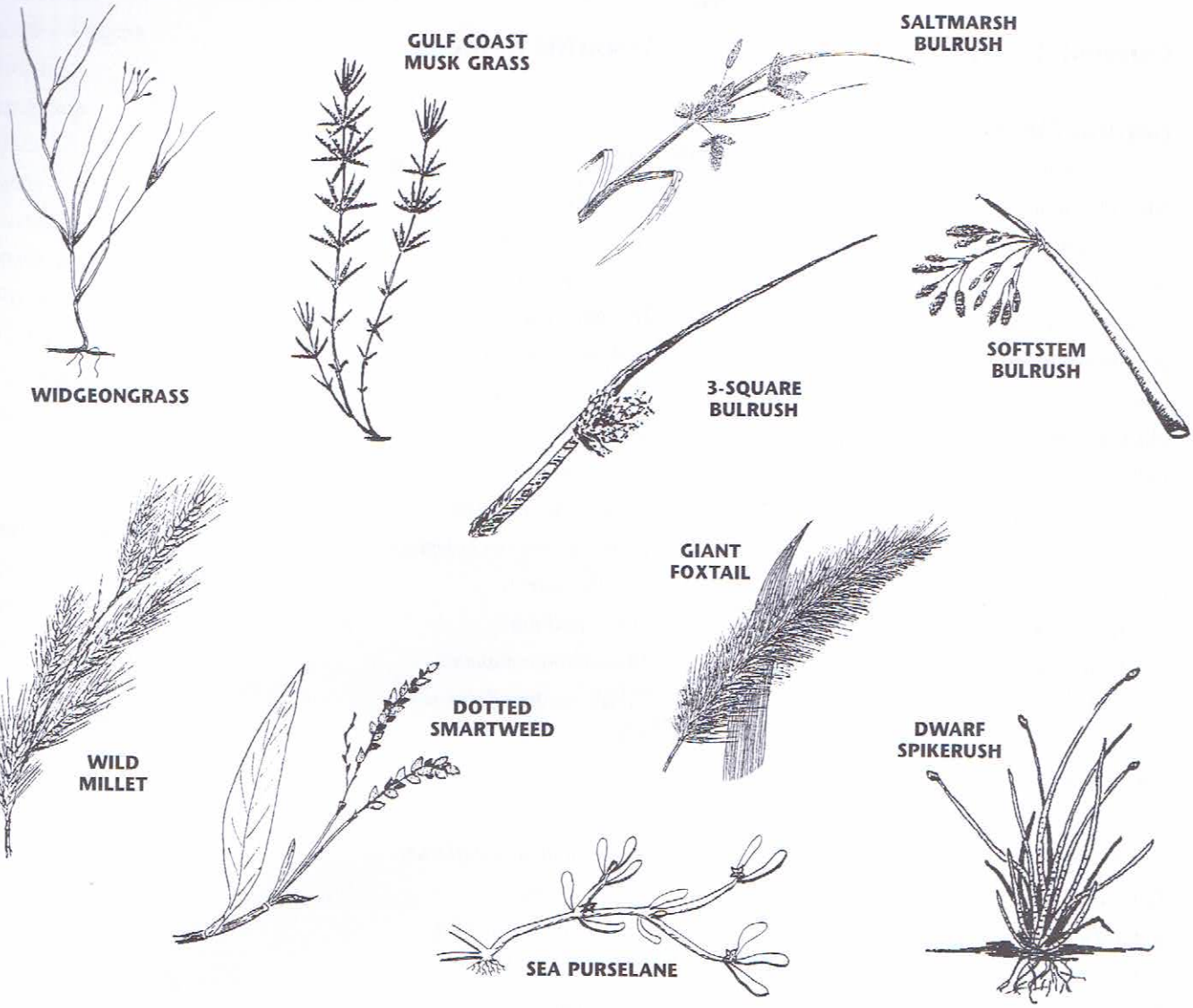




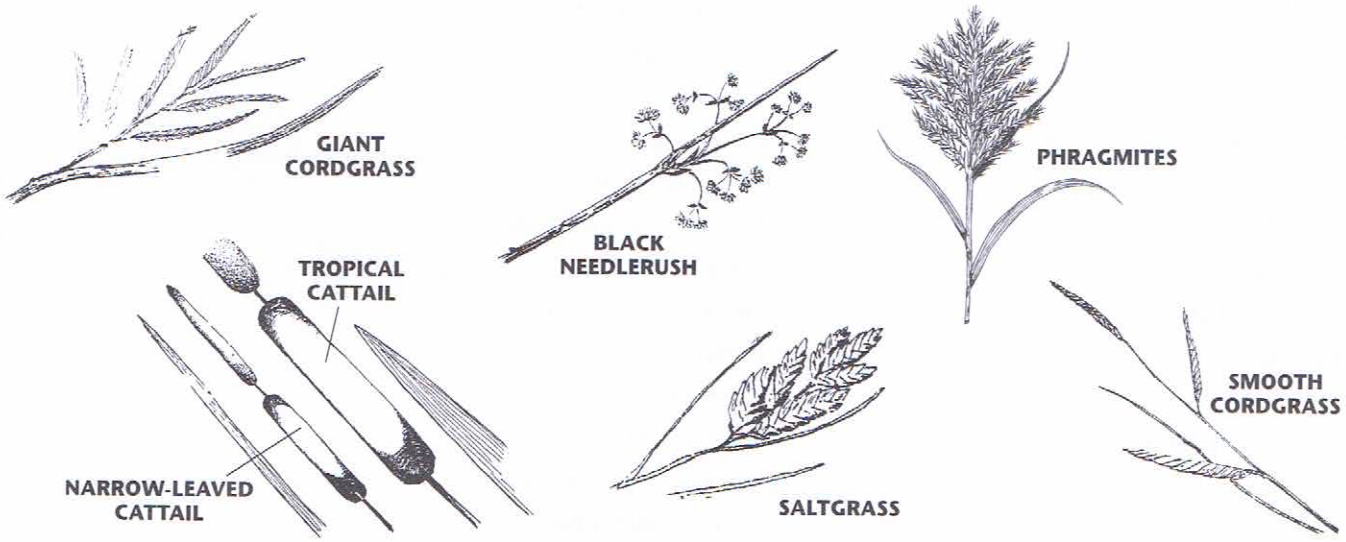




SALTWATER TARGET SPECIES



SALTWATER DOMINANT SPECIES



Appendix II. Common and scientific names of plants mentioned in this manuscript.

Common Name	Scientific Name
Natural Plants	
alligatorweed	*Alternarthera philoxeroides*
American lotus	*Nelumbo lutea*
arrow arum	*Peltandra virginica*
arrowheads	*Sagittaria spp.*
Asiatic dayflower	*Murdannia keisak*
banana waterlilly	*Nymphaea mexicana*
black needlerush	*Juncus roemerianus*
black willow	*Salix niger*
bullwhip bulrush	*Scirpus californicus*
bushy pondweed	*Najas guadalupensis*
buttonbush	*Cephalanthus occindentalis*
clump cordgrass	*Spartina bakeri*
common cattail	*Typha latifolia*
common reed	*Phragmites communis*
coontail	*Ceratophyllum demersum*
cowlily	*Nuphar luteum*
dotted smartweed	*Polygonum punctatum*
dwarf spikerush	*Eleocharis parvula*
fall panicgrass	*Panicum dichotomiflorum*
flatsedges	*Cyperus spp.*
giant cordgrass	*Spartina cynosuroides*
giant southern wildrice	*Zizaniopsis miliacea*
giant foxtail	*Setaria magna*
glassworts	*Salicornia spp.*
Gulf Coast muskgrass	*Chara hornemannii*
maidencane	*Panicum hemitomon*
narrowleaf cattail	*Typha angustifolia*
oaks (bottomland)	*Quercus spp.*
panicgrasses	*Panicum spp.*
pondweeds	*Potamogeton spp.*
redroot	*Lachnanthes caroliniana*
rice cutgrass	*Leersia oryzoides*
sago pondweed	*Potamogeton pectinatus*
saltgrass	*Distichlis spicata*
saltmarsh aster	*Aster subulatus*
saltmarsh bullrush	*Scirpus robustus*
saltmarsh fleabane	*Pluchea purpurascens*
sea purslane	*Sesuvium maritimum*

Natural Plants

smartweeds	*Polygonum spp.*
smooth cordgrass	*Spartina alterniflora*
softrush	*Juncus effusus*
sprangletop	*Leptochloa fascicularis*
tropical cattail	*Typha domingensis*
tupelos	*Nyssa spp.*
watershield	*Brasenia schreberi*
water willow	*Decodon verticillatus*
white waterlily	*Nymphaea odorata*
wild millet	*Echinochloa walteri, E. crusgalli*
widgeongrass	*Ruppia maritime*
woolgrass bulrush	*Scirpus cyperinus*

Planted Foods

browntop millet	*Panicum ramosum*
chufa	*Cyperus esculentus*
corn	*Zea mays*
grain sorghum	*Sorghum vulgare*
Japanese millet	*Echinochloa crusgalli var. frumentacea*
rice	*Oryza sativa*

Appendix III. Common and Scientific Names of Mammals, Amphibians and Reptiles Found in South Atlantic Wetlands.

Common Name	Scientific Name
Mammals	
big brown bat	*Eptesicus fuscus fuscus*
bobcat	*Lynx rufus*
eastern cottontail rabbit	*Sylvilagus floridanus*
gray fox	*Urocyon cinereoargenteus*
gray squirrel	*Sciurus carolinensis*
marsh rabbit	*Sylvilagus palustris*
mink	*Mustela vison*
opossum	*Didelphis marsupialis*
raccoon	*Procyon lotor*
Rafinesque's big-eared bat	*Plecotus rafinesquii macrotis*
red fox	*Vulpes fulva*
river otter	*Lutra canadensis*
white-tailed deer	*Odocoileus virginianus*
beaver	*Castor canadensis*
fox squirrel	*Sciurus niger*
marsh rice rat	*Oryzomys palustris*
cotton rat	*Sigmodon hispidus*
cotton mouse	*Peromyscus gossypinus*
Amphibians	
bronze frog	*Rana clamitans*
green treefrog	*Hyla cinerea*
little grass frog	*Hyla ocularis*
ornate chorus frog	*Pseudacris ornata*
pig frog	*Rana grylio*
Pine woods treefrog	*Hyla femoratis*
southern chorus frog	*Pseudacris nigrita*
southern cricket frog	*Acris gryllus*
southern leopard frog	*Rana pipiens sphenocephala*
southern toad	*Bufo terrestris*
spring peeper	*Hyla crucifer*
squirrel treefrog	*Hyla squirella*
bullfrog	*Rana catesbiana*
lesser siren	*Siren intermedia*
marbled salamander	*Ambystoma opacum*
mole salamander	*Ambystoma talpoideum*
slimy salamander	*Plethodon glutinosus*

Common Name	Scientific Name
Reptiles	
American alligator	*Alligator mississippiensis*
banded water snake	*Natrix sipedon fasciata*
black racer	*Coluber constrictor*
black rat snake	*Elaphe obsoleta*
canebrake rattlesnake	*Crotalus horridus*
copperhead	*Agkistrodon contortrix*
corn snake	*Elaphe guttata*
cottonmouth	*Agkistrodon piscivorus*
eastern diamondback rattlesnake	*Crotalus adamanteus*
eastern garter snake	*Thamnophis sirtalis*
eastern hognose snake	*Heterodon platyhrinos*
eastern kingsnake	*Lampropeltis getula*
ringneck snake	*Diadophis punctatus*
rough earth snake	*Haldea striatula*
rough green snake	*Opheodrys aestivus*
southeastern crowned snake	*Tantilla coronata*
common snapper	*Chelydra serpentina*
eastern box turtle	*Terrapene carolina*
eastern mud turtle	*Kinosternon subrubrum*
eastern musk turtle	*Sternothaerus odoratus*
yellowbelly turtle	*Pseudemys scripta*
broadhead skink	*Eumeces laticeps*
Carolina anole	*Anolis carolinensis*
eastern fence lizard	*Sceloporus undulatus*
eastern glass lizard	*Ophisaurus ventralis*
five-lined skink	*Eumeces fasciatus*
ground skink	*Lygosoma laterale*
southeastern five-lined skink	*Eumeces inexpectatus*
Florida cooter	*Pseudemys floridana*
river cooter	*Pseudemys concinna*

North American Waterfowl Management Plan

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