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Forestry Leaflet 34

Management of Bottomland Hardwood Forests in South Carolina for Wildlife Using Green Tree Reservoirs

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Introduction

Bottomland hardwood forests occupy the floodplains of many large and small rivers of the southeastern United States. These forests are productive systems and contain a variety of wildlife habitats. Many of these areas have been leveed and are flooded to make food, such as acorns and benthic organisms, available to waterfowl. The forested areas within the levees are called greentree reservoirs (GTRs). Flooding normally occurs during the winter dormant season and drainage when foliage begins to develop.

Greentree management originally developed in Arkansas during the 1930s to create more dependable waterfowl habitat in the fall. The majority of the sites were developed for hunting and used to attract waterfowl before natural flooding occurred. In areas where extensive drainage or conversion of forests to agricultural fields had occurred, GTRs often provide the only habitat consistently available for migrating and wintering waterfowl. By the 1950s GTRs were found in Arkansas and other states as refuges and public hunting grounds. Greentree reservoirs were common through the lower Mississippi and Atlantic flyways by 1963. While still used chiefly in the southern states, they can be found as far north as Illinois and Maryland.

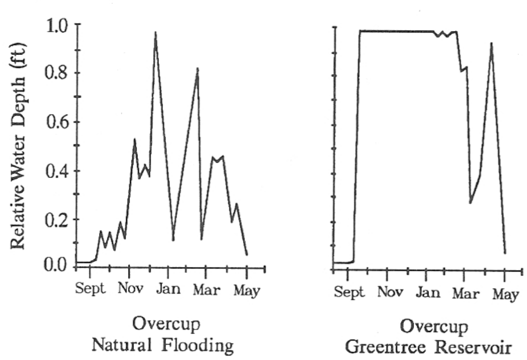

Figure 1. Comparison of water depth between a naturally flooded southern forest and a GTR (source: Fredrickson and Batema 1993).

Greentree reservoir flooding differs from natural flooding regimes (Figure 1). These forests are generally flooded earlier and at depths greater than normally occur. These changes in flooding patterns impact the structure and function of bottomland forests, causing changes in the flora and fauna that are adapted to normal seasonal and long-term fluctuating water regimes.

Early studies in GTRs indicated that water management was not harmful to bottomland trees, but more recent studies indicate that shifts in species composition from less flood tolerant to more flood tolerant species may occur. Changes in species composition are generally subtle and slow. Long-term tree declines in growth generally occur as a result of modifications in flooding regime. Early and prolonged flooding to greater depths during the dormant season and flooding into the growing season cause changes to the stand, including reduced regeneration, decreased acorn production, and tree mortality and disease. To maintain tree growth and vigor in GTRs and provide hunting opportunities requires that natural water regimes be mimicked. In recent years, the body of knowledge on these bottomland systems has increased, but much of it is scattered and in forms not readily available for the general public. Thus, the purpose of this brochure is to provide a synopsis of current information for landowners and managers interested in this management technique.

Wildlife Use

Waterfowl use is a primary reason for establishing a GTR. In the Atlantic Flyway, mallards, wood ducks, and black ducks are the major waterfowl species that are attracted to GTRs, with wood ducks being the primary reservoir users at the southern end of the flyway. Ducks are attracted to GTRs for mast, cover, or both. In natural areas, food may be of primary importance, while in heavily farmed areas with alternate food sources such as soybeans or grains, resting areas are of more importance.

Drawdowns attract a diversity of foraging birds by concentrating foods in smaller areas and at water depths within the foraging range of target wildlife. A general pattern commonly associated with drawdowns is an initial use by species adapted to exploiting resources in deeper water. As dewatering continues, these “deep water” species are gradually replaced by those adapted to exploit foods in shallower water (Figure 2).

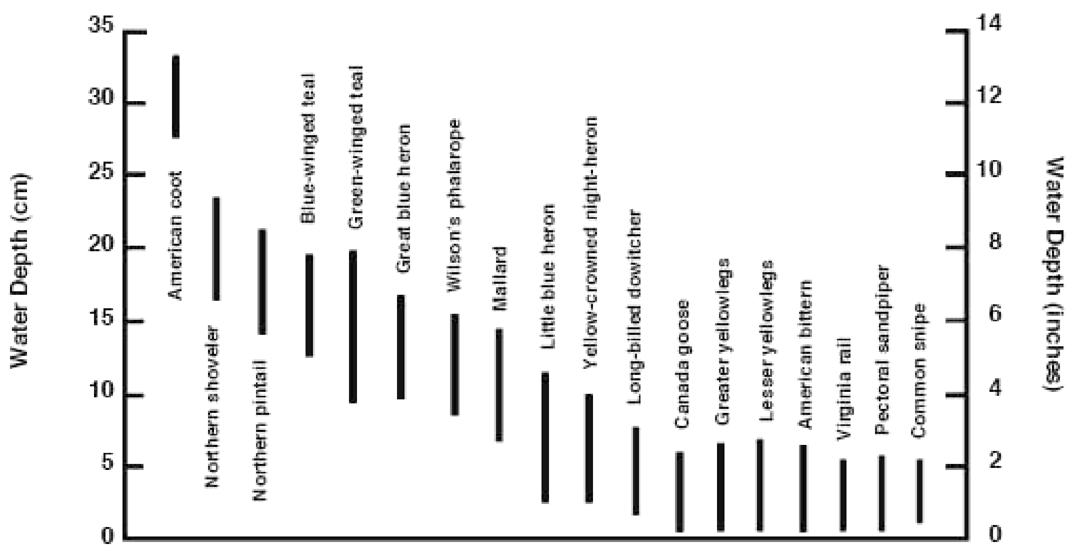

Figure 2. Preferred water depths for wetland birds commonly associated with moist-soil habitats (source: Fredrickson 1991).

In addition to waterfowl, many species of mammals, birds, reptiles, and amphibians occur in GTRs. In gradually flooded or shallow reservoirs where some dry ground remains, mast is accessible to wild turkey, northern bobwhite, eastern gray squirrel, and fox squirrel. Raccoon, mink, muskrat, and beaver are also commonly found in greentree impoundments.

Deciding on a GTR

The decision to create a GTR should never be taken lightly. Site selection, design, management, personnel, and operational budget all need to be considered to eliminate financial and ecological mistakes. An evaluation of site hydrology is critical in determining site suitability. Drainage patterns need to be understood before the GTR is constructed in order to prevent poor decisions on site selection and design that can lead to irreversible impacts to the forest. In bottomland forests where hydrology has already been altered due to drainage ditches, channelization, dams, or levees, GTR management cold provide benefits to numerous plant and animal species. Sites that normally flood on a frequent basis already provide foraging opportunities to waterfowl. Additional flooding on these sites could increase tree mortality and degrade waterfowl habitat. Thus, if a site already provides the functions and values that GTRs are supposed to provide, then protect the site from development and changes in hydrology.

Sites suitable for GTR establishment are generally flat or have less than 1% slope. Soils should have a low permeability to inhibit subsurface drainage. Soils that are predominantly clay are ideal.

A dependable and adequate water supply is also necessary for proper management. Rainfall, storage reservoirs, streams, rivers, lakes, and wells all represent potential sources of water. Rainfall is the most economical means of flooding a GTR, but is the least dependable because rainfall is so variable from year to year. An advantage of using rainfall is that it results in a more natural flooding pattern. Storage reservoirs from which water can be released through gravity flow also is a cost effective manner of flooding GTRs. Streams, rivers, and lakes represent a dependable source of water, but the costs of water control structures, pumps, and/or diversion ditches are high.

Vegetation for the potential impoundment site should be evaluated to ensure that the tree community capable of meeting the objectives of the landowner (Table 1). If the objective is to enhance waterfowl habitat by providing foraging opportunities, then the impoundment should have a strong component of oaks. If the objective is to restore functions typical of natural bottomland forests, then other species can be considered. The timing, depth, and duration of flooding are important variables to be considered. If the site contains many species that are intolerant of flooding, the site should never be considered for a GTR.

Design, Development, and Construction

The most effective management is possible on GTRs of 100 to 500 acres in size. Units of greater than 500 acres are difficult to manage and have greater potential for compromising the productivity of forests. In general, most GTRs are 20-100 acres in size. Some small impoundments of 1-2 acres can provide adequate resources for breeding wood ducks. Smaller units provide more options and are more easily managed than single larger units. With multiple units, one can vary the timing and depth of flooding, vary the timing of drawdown, or allow some units to remain dry while others are flooded to promote regeneration of desirable tree species.

The height and width of levees depends on topography, depth of flooding, and size of the impoundment. In most cases a levee height of 2-3 feet is sufficient. Usually the maximum height of the levee should be 12-18 inches above maximum water depth. Levees should be large enough (crown width of 10 feet) to accommodate maintenance equipment and have side slopes at least 3:1; although 4:1 or 5:1 is better (Figure 3).

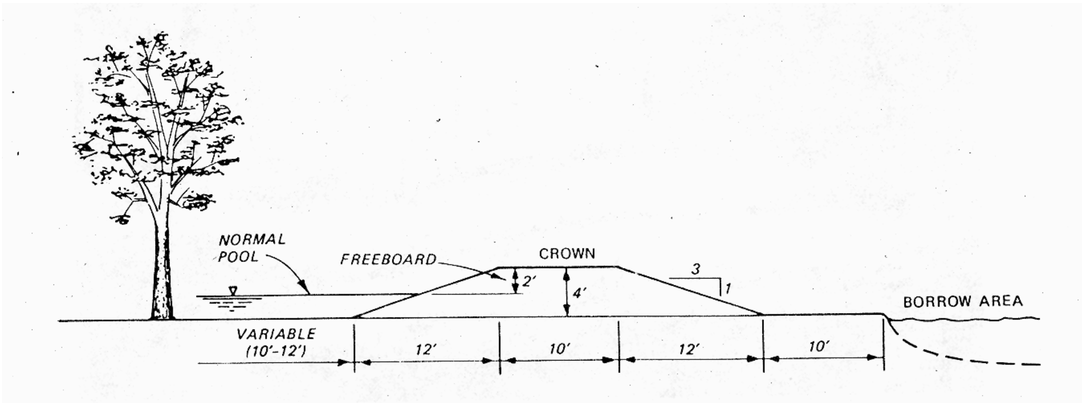

Figure 3. Cross-section of an impoundment levee with a 3:1 slope (source: Mitchell and Newling 1986).

Borrow areas can be either inside or outside of the GTR, but where hunting is a major objective, location may influence hunter access. Where the primary purpose is a refuge, excavation from inside the GTR provides some deep water habitat for diving waterfowl and other wildlife.

A water control structure such as a flashboard riser is used to hold water in the fall and winter, and the boards are removed to drain the area during the spring and summer. Types of water control structures are illustrated in Figure 4. The impoundment should be flooded only after the leaves on the trees have changed color in the fall, which normally happens about late October or November. Once the leaves change color, the trees have gone dormant for the winter, and they will not be damaged by flooding. The impoundment should be flooded to a depth of no more than

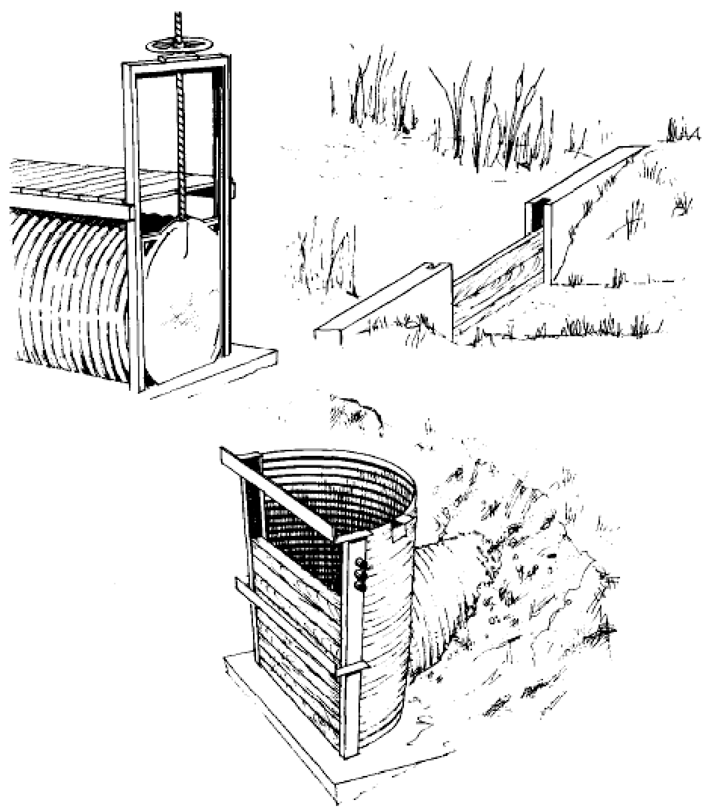
Figure 4. Screw-gate (top left), drop-log (top right) and flash-board riser water control structures (source: Ortego et al., Texas Parks and Wildlife).

18 inches. The primary food source in a greentree reservoir is acorns, and the waterfowl that benefit the most include mallards, wood ducks, and black ducks. The local NRCS office can offer engineering assistance.

In the spring, drain the impoundment when the buds on the trees begin to swell, which normally happens in late February or early March. If the impoundment remains flooded too long in the spring, the trees could be killed. Flooding a greentree reservoir every year will slowly weaken the trees, and some eventually will die. Flooding the impoundment every other year is one way to extend the life of the trees. Another option is to flood the impoundment for three years in a row, and then let it remain dry for two years in a row. This rotation will allow use of the impoundment 3 out of every 5 years.

Sources for Further Information

1. Green-Tree Reservoir Management. Brent Ortego, Carl Frentress, Hayden Haucke, and Julie Hogan Rose. Texas Parks and Wildlife Department. Available at: http://lighthouse.tpwd.state.tx.us/publications/pwdpubs/media/pwd_bk_w7000_0157.pdf

2. Bottomland Hardwood Guidebook. Sammy King and Leigh Fredrickson. 1998. The Environmental Protection Agency, Dallas, TX. Available at: http://fwf.ag.utk.edu/mgray/wfs340/PDF/Bottomland_Hardwood_Guidebook.pdf

3. Greentree Reservoir Management Handbook. Leigh Fredrickson and Donald Batema. 1993. Gaylord Memorial Laboratory, Wetland Management Series No.1. University of Missouri-Columbia, Puxico, MO. Available at: http://fwf.ag.utk.edu/mgray/wfs340/PDF/GTR_Management_Handbook.pdf

4. Greentree Reservoirs: Section 5.5.3, U.S. Army Corps of Engineers Wildlife Resources Management Manual. Wilma Mitchell and Charles Newling. 1986. Environmental Impact Research Program, Technical Report EL-86-9. Waterways Experiment Station, Vicksburg, MS.

5. Strategies for Water Level Manipulations in Moist-soil Systems. Leigh Fredrickson. 1991. Wildlife Management Handbook. Fish and Wildlife Leaflet 13.4.6. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.

Table 1. Shade and flood tolerance ratings for various tree and shrub species commonly found in or near bottomland hardwood forest sites in South Carolina.

Scientific name	**Common name**	**Flood Tolerance**	**Shade Tolerance**	**Wildlife Value**
Cephalanthus occidentalis	Buttonbush	Most tolerant	Moderately tolerant	High seed usage by waterfowl
Forestiera acuminata	Swamp-privet	Most tolerant	Tolerant	
Fraxinus caroliniana	Carolina ash	Most tolerant	Moderately tolerant	
Fraxinus profunda	Pumpkin ash	Most tolerant	Moderately tolerant	
Nyssa aquatica	Water tupelo	Most tolerant	Intolerant	
Nyssa biflora	Swamp blackgum	Most tolerant		
Planera aquatica	Water-elm	Most tolerant	Tolerant	
Salix nigra	Black willow	Most tolerant	Very intolerant	
Taxodium distichum	Baldcypress	Most tolerant	Moderately tolerant	
Carya aquatica	Water hickory	Highly tolerant	Moderately tolerant	
Gleditsia aquatica	Water locust	Highly tolerant	Intolerant	
Quercus lyrata	Overcup oak	Highly tolerant	Moderately intolerant	Acorns of low waterfowl value
Acer negundo	Boxelder	Moderately tolerant	Moderately tolerant	
Acer rubrum	Red maple	Moderately tolerant	Tolerant	Samaras provide food for ducks
Betula nigra	River birch	Moderately tolerant	Intolerant	
Celtis laevigata	Sugarberry	Moderately tolerant	Very tolerant	Seeds consumed by doves, quail, & turkey
Crataegus spp.	Hawthorn	Moderately tolerant	Moderately intolerant	
Diospyros virginiana	Persimmon	Moderately tolerant	Very tolerant	
Fraxinus pennsylvanica	Green ash	Moderately tolerant	Moderately tolerant	Samaras eaten by waterfowl, esp. wood ducks
Gleditsia triacanthos	Honey locust	Moderately tolerant	Intolerant	
Liquidambar styraciflua	Sweetgum	Moderately tolerant	Intolerant	Low value as food source
Magnolia virginiana	Sweetbay	Moderately tolerant		
Plantanus occidentalis	American sycamore	Moderately tolerant	Intolerant	
Populus deltoides	Eastern cottonwood	Moderately tolerant	Very intolerant	Low wildlife value
Quercus phellos	Willow oak	Moderately tolerant	Intolerant	Acorns important food of waterfowl
Quercus palustris	Pin oak	Moderately tolerant	Intolerant	Acorns used by mallards & wood ducks
Ulmus americana	American elm	Moderately tolerant	Moderately tolerant	Samaras consumed by waterfowl esp. wood ducks
Carya illinoensis	Pecan	Weakly tolerant	Moderately intolerant	
Morus rubra	Red mulberry	Weakly tolerant	Very tolerant	
Quercus laurifolia	Laurel oak	Weakly tolerant	Moderately intolerant	
Quercus michauxii	Swamp chestnut oak	Weakly tolerant	Moderately intolerant	
Quercus nigra	Water oak	Weakly tolerant	Intolerant	Acorns used by mallards, pintails, & wood ducks
Quercus pagoda	Cherrybark oak	Weakly tolerant	Intolerant	
Cornus florida	Flowering dogwood	Intolerant		
Fagus grandifolia	American beech	Intolerant	Very tolerant	
Liriodendron tulipifera	Yellow-poplar	Intolerant	Very intolerant	
Quercus alba	White oak	Least tolerant	Moderately intolerant	

APPENDIX

Department of the Army
Charleston District, Corps of Engineers
Post Office Box 919, Charleston, SC 29402
334 Meeting Street, Charleston, SC 29403
Voice: 843-727-4330 or 800-208-2054

**Interagency Guidance Concerning
Authorization, Siting, Construction and Management of
Greentree Reservoirs**

October, 1997

Site Suitability Criteria

- Avoid areas where GTRs would adversely affect threatened or endangered species, bird rookeries, trout streams, and or waters designated as outstanding resource waters.
- Choose a site that requires a minimum of embankment construction to accomplish water control. Favored sites contain natural grade controls or other existing embankments (e.g. roads, railroad grades, rice field dikes, etc.)
- Site topography should be near flat with slope not to exceed 1% (one foot rise per hundred foot length).
- Soils should have low permeability to allow proper water level maintenance.
- The site should be dominated (50% or more) by a hard mast producing hardwood component (i.e., oaks) and should include trees currently producing adequate mast to provide forage for ducks and other species of wildlife.
- Areas subject to tidal influence and/or long periods of inundation, such as cypress/tupelo forests, are generally not suitable sites.
- Sites that require impoundment of perennial streams and primary river floodplains are not suitable.
- The site should be adequately sized to accomplish the project purpose and should facilitate a low ratio of dike fill to reservoir size (e.g., 1:50, not 1:5).
- Areas of heavy beaver activity are generally not recommended sites.

Construction Criteria

- Soil material for dike construction should be non-contaminated and come from an appropriate upland source outside of the reservoir area. Material should be clean earthen fill suitable for maintaining a steep slope.
- Dikes should not exceed a bottom width of 20 feet; however, smaller dikes are encouraged.
- Dike height should be limited to a design that allows a maximum of one foot of free-board with an average depth of flooding of 6-18 inches.
- Dikes should be located to minimize impacts to mature trees and should take advantage of existing high ground such as roads, river berms, railroad tracks, old dikes and/or other disturbance corridors.
- Water control structures should be flush with the base level of the reservoir (the base level of the streambed when present) to allow for unimpeded passage of aquatic organisms and complete drawdown during the non-flooded seasons.
- Where appropriate, project design should include emergency spillways to prevent dike

failure due to heavy rain or other flooding events.

- In areas subject to beaver activity, measures such as the installation of beaver pond levelers and/or emergency drainage systems are necessary to maintain control of water levels.
- Dike construction should occur during dry periods.
- Construction access impacts should be limited to the footprint of the dike.
- The following best management practices should be followed during construction.
    - (1) Prior to the beginning of any construction activities, appropriate erosion control measures, such as silt fences, silt barriers or other suitable devices, will be placed between the construction area and affected waterways (wetlands); and maintained in a functioning capacity until the area is permanently stabilized upon project completion.
    - (2) In areas where silt barriers cannot be effectively employed, mulching, burlap or other suitable materials will be applied and maintained on all disturbed land surfaces to control erosion until the area can be permanently stabilized.
    - (3) All steps necessary will be taken to prevent oil, tar, trash, debris and other pollutants from entering adjacent wetlands and/or waterways.
    - (4) Once initiated, the project will be carried to completion in an expeditious manner in order to minimize the period of disturbance to the environment.
    - (5) Upon completion, all disturbed areas will be promptly and permanently stabilized with vegetative cover.
    - (6) Construction activities will avoid to the greatest extent practicable, encroachment into any wetland areas not designated as fill for dike construction.

Management Criteria

- Flooding shall not commence until November 1.
- To ensure that foods are available to dabbling ducks, GTRs should be gradually flooded to a depth of six to eighteen inches, with a maximum of twenty-four inches (excluding channels).
- Gradual drawdown shall begin early enough in February to ensure that the majority of the impoundment is totally dried to bed level by March 1 unless precluded by natural flooding.
- Water control structures shall remain open during time of drawdown to facilitate water, nutrient and/or organism exchanges.
- The reservoir shall not be flooded more than three consecutive years followed by at least one dry year with control structures completely open. This will result in reducing water stress that could be responsible for declines in growth and mast production, poor natural regeneration and/or mortality often associated with hydrological changes of the soil.
- Snags will be allowed to remain standing to provide habitat for cavity nesting species.
- No timbering or significant modification to existing wetland vegetation shall occur within the impoundment. Any forest manipulation within the impoundment shall be conducted in accordance with a management plan approved by the regulatory and review agencies through the permitting process and shall be restricted to those activities that promote the growth of mast producing trees.