Guidelines for Coastal Georgia Riparian Buffer Restoration

Photo Credit: James Holland

Prepared by:

Keren Giovengo
University of Georgia Marine Extension Service
Coastal Sustainable Communities and CoastScapes Conservation Landscaping Program

Prepared for:

Georgia Department of Natural Resources Environmental Protection Division
Coastal Nonpoint Source Program and
GADNR Coastal Management Program

Acknowledgements

The University of Georgia Marine Extension Service wants to thank the Georgia Department of Natural Resources (GADNR) Environmental Protection Division's Coastal Nonpoint Source Program and the GADNR Coastal Management Program for their support throughout the duration of this project. Special thanks to Jeannie Lewis who provided constant support throughout the project.

This guidance document draws from various programs and resources prepared by several federal and state government and academic institutional sources. Some of the material in this document was adapted and modified for coastal Georgia from the following documents:

A Soil Engineering Guide for Streambank and Lakeshore Stabilization. Eubanks, E.C. and D. Meadows. USDA Forest Service Technology and Development Programs. 187 pgs.

Forest Buffer Toolkit. Pennsylvania Stream Releaf Alliance for the Chesapeake Bay and Pennsylvania Department of Environmental Protection, Bureau of Watershed Conservation. September 1998. 40 pgs.

Riparian Buffers for Wildlife. Pennsylvania Wildlife No. 16. 2004. Jenifer A. DeCecco and Margaret C. Brittingham. The Pennsylvania State University, College of Agricultural Sciences, Cooperative Extension. 8 pgs.

This document was prepared by the University of Georgia Marine Extension Service under grant award #NA08NOS4190461 from the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. The statements, findings, conclusions, and recommendations are those of the author and do not necessarily reflect the views of OCRM or NOAA. The Coastal Management Program of the Georgia Department of Natural Resources and the U.S. Department of Commerce, National Oceanic and Atmospheric Administration grant award #NA08NOS4190461 served as a partial funding source for the development of this product.

Guidelines for Coastal Georgia Riparian Buffer Restoration

Table of Contents

Guidelines for Coastal Georgia Riparian Buffer Restoration

Introduction

Defining Coastal Georgia's Riparian Resources and Challenges

In 2006, a study conducted by the Georgia Institute of Technology Center for Quality Growth and Regional Development projected that over 840,000 people would live in the ten-county area within Georgia's coastal region by 2030, representing a 50% increase in population from the roughly 558,000 people living in the coastal area in 2000. These future predictions are worth noting: this region has already seen a large population increase of 17.5% growth between 1990 and 2000.

Such urban growth has contributed to the loss of coastal forests, making the management and protection of the remaining coastal riparian habitat critical to the overall health and resiliency of Georgia's coastal ecosystems. As a result of this growth, the coast's forested and riparian ecosystems are not evenly distributed in the watersheds resulting in fragmentation and isolated and degraded habitats due to deforestation from rapidly developing communities along the coast. Silviculture and agricultural practices are also impacting these resources. Coastal Georgia population increases, such as the numbers projected, will add increased pressure to the already fragile coastal ecosystems that are critical to the human environment, including commercial and recreational seafood industries, coastal tourism industry, water quality, aesthetic beauty, and the overall quality of life on Georgia's coast.

For Georgia's coast, these changes have major ramifications. Acre for acres, forests contribute less sediment and nutrient runoff pollution than any other land use. Riparian buffers have the ability to filter water that is often comparable to wetlands. The loss of forests and their riparian buffers is therefore correlated with declining water quality in both the coast's marine and estuarine environments as well as the rivers and streams that supply it with freshwater. In recent years, studies have suggested that streamside forests can serve as highly effective filters that control both surface runoff and, in many landscapes, groundwater flow in streams. In addition, they provide shade, temperature control, and food required by many aquatic species.

Streamside forests with their riparian buffers, as a result, are being viewed as a way to partially mitigate the loss of forest over much of the remaining landscape. This recognition has come after many streamside forests were cleared for other uses. Thus,

riparian areas have an extremely important role in maintaining the health of Georgia's coast in its entirety.

The State of Georgia has long recognized the important benefits of both the human **and** natural resource components that our coastal waterbodies provide to our communities. The Coastal Marshlands Protection Act's preamble (CMPA, O.C.G.A. § 12-5-280 *et seq.*) states the following:

> *The coastal marshlands of Georgia comprise a vital natural resource system. The estuarine area of Georgia is the habitat of many species of marine life and wildlife that cannot survive without the food supplied by marshlands. The estuarine marshlands of coastal Georgia are among the richest providers of nutrients in the world. Such marshlands provide a nursery for commercially and recreationally valued species of shellfish and other wildlife, provide an important buffer against flooding and erosion, and help control and disseminate pollutants. The coastal marshlands provide a natural recreation resource which has become vitally linked to the economy of Georgia's coastal zone and to that of the entire state.*
>
> *This coastal marshlands resource system is costly, if not impossible, to reconstruct or rehabilitate once adversely affected by man. It is important to conserve this system for the present and future use and enjoyment of all citizens and visitors to our state. Activities and structures in the coastal marshlands must be regulated to ensure that the values and functions of the coastal marshlands are not impaired and to fulfill the responsibilities of each generation as public trustees of the coastal marshlands for succeeding generations*

In 2007, rules were adopted to the Coastal Marshlands Protection Act which double the riparian buffer for the upland component of a project permitted in Georgia's estuarine wetlands. The rules establish a 50-foot marshlands buffer applicable to the upland component of the project, define how to measure that buffer, and require that the buffer remain in an undisturbed, naturally vegetated condition. Exceptions are provided for temporary construction and maintenance, permanent structures essential for the function or permanent access to the marsh component of the project, landscaping to enhance stormwater management, and pedestrian access for passive recreation. Existing impervious surfaces may be maintained in their current condition provided replacement or modifications do not encroach further into the buffer. Following temporary or permanent land disturbance, marshlands buffer vegetation must be restored and maintained so as to protect water quality. The marshlands buffer must be designed, installed and maintained to achieve stormwater treatment consistent with the standards of the most recent edition of the Georgia Stormwater Management Manual, and once amended, any future standards specific to the coast.

Riparian buffers directly adjacent to our coastal marshlands are not only affected by land use changes in the immediate area, but are also greatly affected and impacted by human activities that are affecting riparian buffers upstream. For this reason, this document will address the coast's marshland and upstream riparian buffers.

Purpose and Intent of Guidelines

Rehabilitating riparian buffers is key to restoring natural stream functions and aquatic habitats. There are many economic benefits derived from increased riparian habitat including channel stabilization, improved water quality, improved wildlife and fish populations, improved aesthetics, and other associated values. In addition, as stated above, riparian buffers have been identified as a valuable tool for water quality protection when properly designed and established in the appropriate landscape setting.

For these reasons, the goal of the document is to provide guidance on implementing projects to restore coastal riparian buffers in order to reduce pollutants in our coastal waters as well as provide important aquatic and wildlife habitat. In addition, the purpose of these guidelines is to provide private landowners, private consultants, and local organizations and government agencies with the technical information and/or resources necessary to successfully plan, design, establish, and maintain coastal streamside riparian buffers.

The intent of the document, however, is not to provide bioengineering techniques which may be necessary in the stabilization and restoration of coastal riparian buffers. If these techniques are deemed necessary, numerous comprehensive bioengineering technique guidance resource documents are provided for references purposes in Chapter 10.

Why Restore Coastal Georgia's Riparian Buffers?

Although coastal Georgia is still covered by some forest, today's existing mature woods are scarce and are not evenly distributed. Most of the forests have vanished in rapidly developing urban centers and suburbs, or in agricultural areas.

Trees, shrubs and other native vegetation that once hugged the shores of rivers, streams, wetlands and marshes in coastal Georgia are no longer present to filter surface runoff and, in many landscapes, groundwater flow. Riparian buffers have the ability to filter water that is often comparable to wetlands. They provide shade, temperature control and food for many aquatic and terrestrial species of wildlife. As a result, riparian

buffers are heralded as a way to partially mitigate the loss of forest over much of the remaining landscape. Riparian buffers are the link between land and water, and trees and other natural vegetation are a vital component of a healthy stream ecosystem.

In addition, many of coastal Georgia's streams, rivers, and marsh channels have had their riparian areas converted or degraded.

We who live in coastal Georgia value the aesthetic beauty that is provided in our region. However, in order to keep our precious natural resources, we must conserve existing riparian buffers and restore degraded buffers within our coastal region's waterways.

Chapter 1. The Riparian Ecosystem

Water is the most critical resource issue of our lifetime and our children's lifetime. The health of our waters is the principal measure of how we live on the land."
Luna Leopold

Introduction

Riparian ecosystems are the most sought-after forested areas by both humans and other animals. Any plant communities associated with water, whether they are in coastal areas, deserts, foothills, or mountains, are considered riparian. They offer major creature comforts such as food, water, and shelter. Yet they are often misused, misunderstood, and abused portions of the landscape.

Riparian ecosystems are the canaries of the coal mine. They give warnings of erosion and pollution problems that threaten streams, rivers, wetlands, lakes, marshes, and oceanfronts across the Nation. They further warn that when water quality is impacted, the fundamental ecology is deeply disturbed.

Source: Alabama State Water Program

All across the country, this Nation's riparian areas flourish with bountiful populations of wildlife and diverse plant communities. They serve as a classroom for complex ecology

and show how interrelated and interdependent ecosystems are. However, even the most innocent or invincible acts impact the riparian ecosystem and, ultimately, the water we drink. Examples of these disruptive acts include fertilizing lawns and farm lands; mowing beside rivers, streams, lakes and marshes; removing trees, shrubs and other vegetation; constructing access roads and trails for recreation and logging; fishing from streambanks; camping at the water's edge; and other recreational activities.

At the same time, we truly value riparian ecosystems more than any other type of forested environment. They offer recreational opportunities that are parallel to none. They are important for: flood mitigation; water quality control; and regulating the movement of water, sediment, minerals, and woody debris between terrestrial and aquatic ecosystems. They offer critical habitat and food sources to a diverse population of wildlife, including fish and aquatic insects, birds, mammals, amphibians and reptiles, plant species, as well as to humans.

Riparian Integrity

The structural and functional characteristics of the riparian ecosystem are the key links to maintaining ecological integrity. Quite often riparian buffers are described as land and vegetated areas associated with streams, rivers, lakes, and wetlands that have complex ecosystems and provide food, lodging, and travel corridors for both aquatic and terrestrial species.

The influences on the riparian ecosystem should be viewed topographically from upstream to downstream, from upslope to downslope, from subsurface through the vegetated canopy, and over time. This is better expressed as longitudinal, lateral, vertical, and temporal influences.

- The longitudinal influence extends the length of the stream;
- The lateral influence begins in the water body and extends through the riparian vegetation, through the transitional ecotones, into the upland forest or dry land vegetation, to the point where overland flow (runoff) is initiated;
- The vertical influence extends below the dry season water table and up through the canopy of mature vegetation;
- Temporal influences are changes to the ecology over time.

Riparian areas are not tied to a set number of meters/feet from the stream, but rather to changes in vegetation types, soil moisture, and other ecological characteristics. If the structure or function is compromised, the consequences may become apparent in habitat degradation.

Structure and Function

Riparian ecosystems are the most important link between the upland forest and the aquatic habitat with a unique array of functions in the natural environment. The structure and function of the riparian buffer are complex and diverse (see Table 1).

Canopies of large trees mesh to create a microclimate that functions to cool the riparian ecosystem, maintain the water temperature, and shelter wet areas. In the absence of trees, low-growing plants and grasses provide shade as do undercut banks. Canopies of riparian buffers produce particulate matter, primarily leaf litter. This is an important energy base for aquatic food webs.

Leaf litter and standing biomass are also necessary for soil regeneration. Without the cycle of litter and biodegrading, flooding, and plant growth, the soil would not be replenished. Without soil, plants cannot grow; without plants, the soil is washed away. When soil is impaired or topsoil is threatened, plants are less plentiful, have smaller basal areas, and have more space between them. Such poor vegetation cover leaves the soil even more exposed to sheet runoff and erosion. As little or no moisture is held in the ground, the water table becomes lower, water quality suffers, and fewer plants survive. Stream surface flow may cease.

The plant structure (standing and down), leaf litter, and uneven ground capture sediment and slow runoff by additional friction to de-energize overland flows. For example, plants with flexible stems and rhizomatous root systems lie flat against the ground as floodwaters wash over them, shielding the bank from erosion. Such plants and upright shrubs trap sediment. Tree species slow water flow, and their roots hold the soil together. Root systems create an interwoven structure that holds soils together, stabilizing streambanks. They catch and hold pollutants, use phosphates adhering to the soil and sediment particles deposited by runoff or floodwater, and hold harmful or toxic substances in place by minimizing soil movement.

Large woody debris affects the configuration of a stream by diverting water flow and forming pools. The debris helps regulate storage of sediment, particulate, and organic matter, and provides aquatic habitat. Large woody debris also affects ponds and lakeshores by providing aquatic habitat and by forming natural environments that shelter the shore, causing beaches to form.

Large woody debris is generated from several sources. Generally, the main source is from large trees falling into a stream when soil has been eroded away from the roots by stream flow.

Riparian ecosystems regulate not only the movement of water between terrestrial and aquatic ecosystems, but also the movement of nutrients, sediments, and particulate organic matter. Floodplains, another important part of the riparian buffer, trap

sediment and particulate organic matter outside the active channel during overbank flows. Without this access, riparian function declines, as does streambank stability.

Table 1-1. Riparian Ecosystem Structure and Function. (Source: Pages 22-23 *in A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization*, USDA Forest Service, 2002)

Structure and Function Chart

STRUCTURAL COMPONENTS	FUNCTION	EXAMPLES
Roots– Interwoven infrastructure	Capture overland flow and nutrients. Remove nitrogen from soil. Stabilize banks by holding the soil together. Trap and retain pollutants. Use phosphates adhering to soil and sediments.	 USDA Forest Service
Soil	Holds moisture. Offers a growing medium for plants. Promotes good water quality by acting as a filter.	 USDA Forest Service
Canopy– Trees, shrubs, grasses	Provides food. Creates microclimates Shade ■ provides cool forest. ■ provides cool water. ■ shelters wet areas. Creates migration corridors. Provides shelter and protection.	 USDA Forest Service
Floodplain	Traps sediment and particulate matter during floods. Slows velocity of flood waters. Holds nutrients and sediments deposited during floods to enrich soil.	 USDA Forest Service

Structure and Function Chart

STRUCTURAL COMPONENTS	FUNCTION	EXAMPLES
Standing and downed vegetation, foliage, branches, leaf litter, uneven ground, and stream substrate	Aids water infiltration by slowing flow. Provides bank protection–plants lay against banks during high flows. Provides habitat. Reduces near bank velocity and redirects flow. Traps sediment by slowing down and stopping runoff and floodwaters (the sediment drops out).	 USDA Forest Service
Large Woody Debris (LWD)–large trees, tree branches, shrubs caught in streams, and log jams	Aids in floodplain development. Affects: ■ formation of pools and riffles ■ formation of beaches and seedbeds on lakes. Provides habitat. Provides resting and hiding cover for fish. Stores sediment and organic matter.	 USDA Forest Service
Litter–leaves, twigs, needles, blossoms, seeds, snags, rotting logs, and tree cavities	Provides food and habitat: Benthic and macroinvertebrates feed on litter. Provides food for fish and other aquatic species. Insects incubate on plants, then drop into water as food. Biodegrades into new topsoil.	 USDA Forest Service
Stream, river, lake basin, wetland, vernal pool, and ground water level	Carries away or impounds excess water. Provides food and water for animals. Water percolates into streams during low flow periods. Affects the microclimate.	 USDA Forest Service

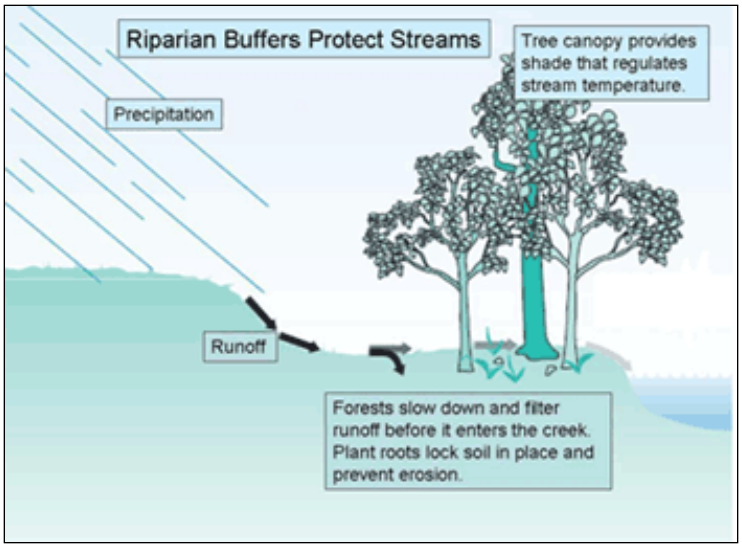
Chapter 2. Riparian Buffers: Their Roles And Values

What is a Riparian Buffer?

The Georgia Erosion and Sedimentation Control Act defines a buffer as the "area of land immediately adjacent to the banks of State waters in its natural state of vegetation, which facilitates the protection of water quality and aquatic habitat". In the coastal context, a riparian buffer consists of land along the edge of a stream, river, wetland, tidal and non-tidal marshland, shoreline, pond, or impoundment that protect these waterways by providing a transition zone between upland activities and development and adjoining surface waters. They are often narrow corridors containing native grasses, flowers, shrubs and trees that line the water's bank. They are also called "vegetated buffer zones". A healthy riparian area is evidence of wise land use management.

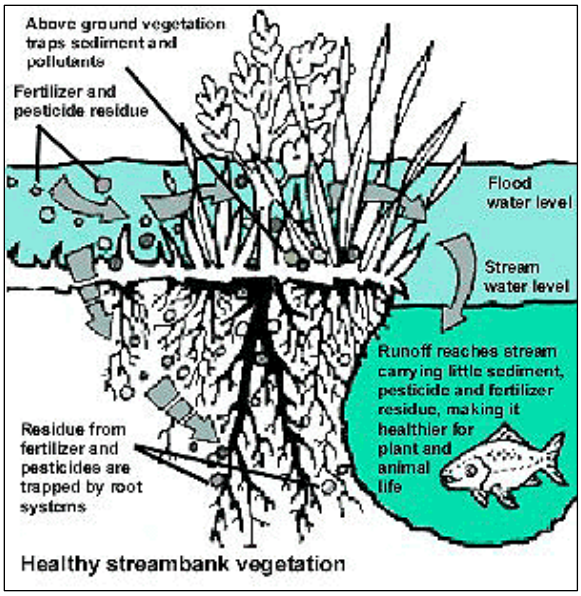
What Are Riparian Buffer Roles and Values?

Preserving and restoring connectivity of riparian buffers is essential in protecting the water and habitat quality of our coastal streams, rivers, wetlands, and marshes. Riparian buffers are the first and last defense a waterbody has against overland flow of pollutants contained in stormwater. The tree and plant stems slow water velocity allowing pollutants to settle out and soils in riparian areas are active in transforming pollutants to less harmful forms. Riparian vegetation roots hold streambanks in place, minimizing erosion and streambank failure. The shade provided by vegetation keeps small streams cooler and provides input of large woody debris (limbs, leaves) that is important in the stream food web. These vegetated buffer strips play an important role in water quality, particularly in urban and agricultural settings where runoff of sediment, nutrients, and other pollutants are a concern.



Riparian buffers perform a wide range of ecological functions and provide services having high environmental, economic, and social value. Scientific research increasingly shows that riparian buffers play a crucial role in protecting our waters from the effects of nonpoint source pollution by acting as filters and removing pollutants before they enter our waterways. Riparian and coastal riparian vegetative buffer zones provide substantial benefits, including:

- Minimize activities that degrade, destroy, or otherwise negatively impact the value and function of our coast's waterways, including coastal marshlands;
- Maintains the watershed's hydrology (baseflow);
- Maintains stream and river water quality;
- Filters and traps sediment and other pollutants, such as pesticides and fertilizers, found in surface runoff;
- Transforms and removes nutrients, such as nitrogen and phosphorus;
- Promotes bank stabilization and reduces erosion;
- Provides a major source of energy and nutrients for stream communities through the riparian vegetation. They are especially important in small, headwater streams where up to 99% of the energy input may be from woody debris and leaf litter;
- Protects and maintains valuable terrestrial habitat for wildlife, including nesting, feeding, and sheltering habitat, as well as providing important corridors or travel ways for a variety of wildlife;
- Provides a critical interface for species that use both water and land (diamondback terrapins, wood storks, wading birds;
- Riparian vegetation increases temporary floodwater storage and filtration areas, slows floodwaters, thereby helping to maintain stable streambanks and protects downstream property. By slowing down floodwaters and rainwater runoff, the riparian vegetation allows water to soak into the ground and recharge groundwater. Slowing floodwaters allow the riparian zone to function as a site of sediment deposition, trapping sediments that would otherwise degrade our streams and rivers while overall reducing the impacts of flooding;
- Enhances the marshlands' scenic value and recreational opportunities;
- Protects property values of individual landowners by reducing property damage from floods, high tides and storm surges;
- Protects and restores greenspace and the natural character of the region;
- Protects aquatic habitat including important nursery grounds for fisheries, which provide food and habitat to numerous species of fish and shellfish, including commercially important species;
- Additionally maintains aquatic habitat through:



Source: National Sustainable Agriculture Information Service

    - Moderation of water temperature; and
    - Contribution of leaves and woody debris (provide food source and habitat);
- Protects the coastal region's visual character and unique natural resources;
- Provides scenic and aesthetic benefits which provide enhancement of property = increased property values;
- Reduces maintenance costs and time compared to turfgrass;
- Protects coastal fishing, recreation and tourism industries; and
- Provides recreational and educational opportunities.

Riparian buffers are most effective at improving water quality when they include a three-zoned native grass or native herbaceous filter strip along with deep rooted native trees and shrubs. The three-zoned riparian buffer concept is provided in the following chapters.

Loss of Riparian Areas

Degraded riparian buffers reduce water quality values, reduce wildlife and fish populations, cause serious property damage (bank erosion) and loss of valuable lands. Removal of riparian vegetation results in increased water temperatures and decreased dissolved oxygen. The loss of shade exposes soils to drying by wind and sunlight and reduces the water storage capacity of the riparian area. Loss of riparian vegetation causes streambank erosion. Eroding banks contribute to sedimentation and lead to a wide shallow stream with little habitat value. These factors result in significant reductions in aquatic stream life.

Chapter 3. Riparian Buffers for Water Quality and Wildlife

Some of the material in this chapter was adopted and modified for Georgia from the following document: Riparian Buffers for Wildlife. Pennsylvania Wildlife No. 16. 2004. Jennifer A. DeCecco and Margaret C. Brittingham. The Pennsylvania State University, College of Agricultural Sciences, Cooperative Extension.

Introduction

Riparian buffers protect water quality by intercepting sediment and pollution from residential lawns, roadways, agricultural fields, and other sources. This improves habitat for aquatic wildlife while providing food, cover, water, and breeding areas for many kinds of wildlife.

Riparian forests have been severely damaged or removed for many human uses, including development, timber harvesting, agriculture, and recreation. Losing these buffers has negatively affected wildlife habitat and water quality throughout coastal Georgia.

If your backyard is located adjacent to marsh, or you own cabin near a river, or your agricultural fields border a stream, you can improve water quality and wildlife habitat by creating a riparian buffer. Restoring and maintaining riparian buffers may take time, money, and effort, but assistance is available to help you through the process. This guidance document provides the basic information you need to create an effective riparian buffer for wildlife while protecting water quality for everyone.

Benefits of Riparian Buffers for Water Quality and Wildlife

Riparian buffers offer many benefits for wildlife; but they also improve water quality for humans. In general, the wider and more diversely planted the buffer, the more likely it is to yield positive benefits. A riparian buffer:

- ✓ **Traps sediment.** Runoff from lawns, roads, and agricultural fields is deposited in the buffer rather than being allowed to enter the water. Trees and shrubs along a stream bank help to keep moving water from eroding the bank, further reducing sedimentation rates.

- ✓ **Traps nutrients and pollutants.** Excessive amounts of pesticides, fertilizers, and animal wastes from lawns, roadways, and farms can seriously disrupt an aquatic system. Fertilizers that make a lawn lush and green and that make corn grow also encourage high levels of plants and algae in a stream, which depletes oxygen levels. A good riparian buffer can remove up to 80 percent of excessive nutrient inputs.

- ✓ **Recharges groundwater.** A riparian buffer prevents surface runoff from moving too quickly over the land before it can filter into the soil and recharge

groundwater supplies. This also helps to control flooding as well as maintain adequate flow during dry times.

- ✓ **Provides better habitat for fish.** Fish depend on good aquatic habitat, and a stream without a riparian buffer is not likely to support good fish populations. Resident fish as well as migratory fish depend on the quality of each "link" in the stream system. A poor or nonexistent riparian buffer can affect fish both directly and indirectly. Too much fine sediment caused by erosion and runoff can be especially damaging to fish by clogging their gills and smothering spawning sites for both fish and aquatic insects. A lack of trees along the riparian zone can cause higher water temperatures, which may ultimately deplete oxygen levels in the water.

  A riparian buffer helps to supply organic materials (leaves and woody debris), which provide food for aquatic invertebrates (and these, in turn, provide food for wildlife). A buffer serves as the basis for a more diverse structural habitat for all aquatic life. As a stream system's quality declines, fish like catfish and carp, more tolerant of poor conditions, begin increasing, and those less tolerant begin to decline.

  An important food source for fish include macroinvertebrates, such as aquatic insects. The presence or absence of riparian trees may be the single most important factor altered by humans that affects the structure and functions of stream macroinvertebrates (Table 2). The removal of forested riparian buffers results in several changes in the watershed. Watercourses become much narrower, resulting in less benthic area. When trees are removed, grasses take over, sod forms, and the stream narrows rapidly. Tree removal results in loss of tree root systems, an important component of fish habitat.

Table 3-1. Benefits of Riparian Buffer Vegetation on Aquatic Ecology

VEGETATION	BENEFITS
Trees and shrubs overhanging the stream	• Shade lowers the water temperature, which improves the conditions for fish • Source of large and fine plant debris • Source of terrestrial insects that fish eat
Leaves, branches, and other debris in the stream	• Helps create pools and cover • Provides food source and stable base for many stream aquatic organisms
Roots in the stream bank	• Increases bank stability • Creates overhanging bank cover
Stems and low-growing vegetation next To the watercourse.	• Restarts movement of sediment, water, and debris floating in flood waters

- ✓ **Improves habitat for other wildlife.** A good riparian buffer provides food, shelter, water, and breeding sites for birds, mammals, amphibians, and reptiles. Which species will be found in riparian habitats largely depends on the type and size of the water source (wetland, river, stream, lake, or pond) as well as the habitat within the riparian buffer (diversity of tree species, availability of nest and perch sites, frequency of flooding, etc.). For example, some smaller mammals may be found in a riparian buffer as long as some cover is available. Other mammals look for expanses of riparian forest with scattered down trees, which provide shelter near streams and ponds.
- ✓ **Provides travel corridors.** Riparian buffers along intermittent and permanent streams and rivers provide travel routes for wildlife. These may serve as forested connectors between wooded habitats. Wildlife may use such habitat for cover to travel through otherwise unforested urban or agricultural areas.
- ✓ **Provides transition zone between land and water for species.** Numerous wildlife species, such as diamondback terrapins and wading birds, depend greatly on this transition zone for their primary food source.

Chapter 4. Riparian Buffer Design and the Three-Zone Riparian Buffer System

Maintaining a forested riparian buffer along creeks, streams, rivers, wetlands, and marshes provides more than just a beautiful landscape. The combination of trees, shrubs, and native grasses and forbs (broad-leaved herbaceous plants and wildflowers) can improve water quality by removing sediment and chemicals before they reach the waterway. A properly cared for buffer area can moderate flooding, help recharge groundwater, prevent soil erosion, and preserve or improve certain types of wildlife habitat.

A well-designed buffer system may include not only a multi-species buffer area established on land next to the stream, but also plantings that stabilize the streambank and wetlands constructed to absorb storm runoff. This chapter discusses how to design a riparian buffer in relation to the three-zone concept, which serves as an important part of the riparian ecosystem.

The Three-Zone Concept

The "Three-zone Concept" provides a framework for planning, grouping types of plantings, as well as establishment and maintenance of a long-term riparian buffer. Combining fast- and slow-growing trees, shrubs, grasses, and forbs helps protect the waterway and provide a diverse habitat for wildlife. Trees and shrubs provide perennial, deep-reaching root systems to hold the soil and absorb nutrients into the woody biomass for long-term storage. Forbs and grasses provide a high density of stems to slow surface runoff, trap sediment, and absorb nutrients. The riparian buffer stabilizes the soil, removes nutrients from both surface and sub-surface water flow, slows rainwater runoff velocity, and traps sediment. This reduces the amount of nonpoint source pollutants entering our coastal rivers, streams, lakes, wetlands, and marshes.

Each zone's basic design and function, along with its water quality and ecological functions, are shown in the diagram and narrative below. Zone 1 begins at the water's edge, and Zones 2 and 3 move inland. Each zone has a different mixture of trees, shrubs, or grasses; the composition and the width of each depends on the size of the water body, the intensity of upstream land use, the wildlife and water quality benefits desired, and other factors.

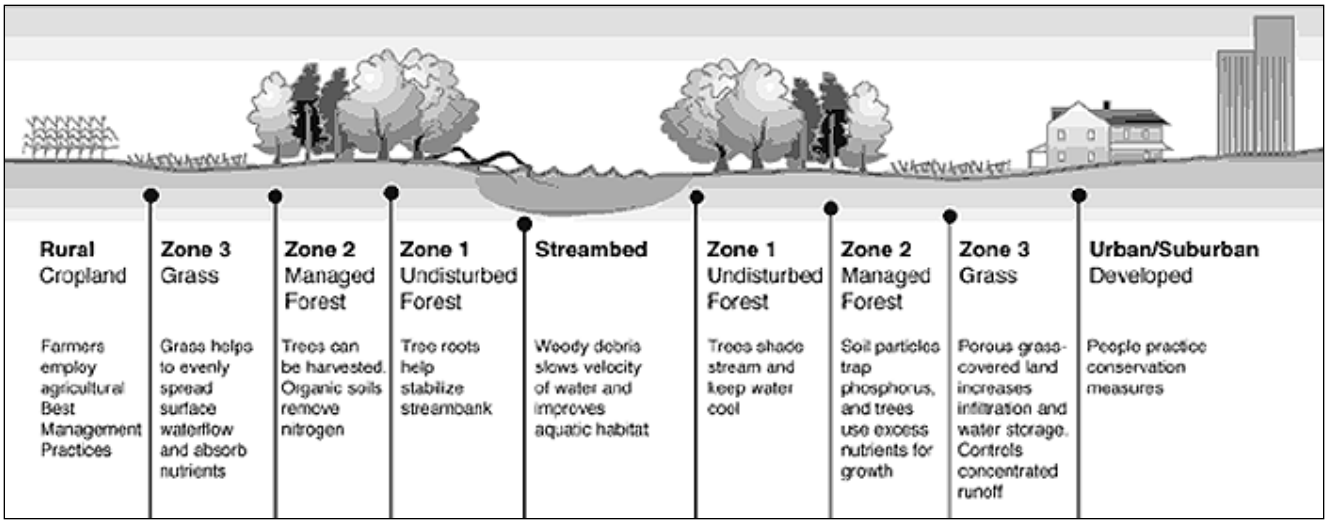


Figure 1. The three-zone riparian buffer system.

(Figure courtesy B. Tjaden and G.M. Weber, University of Maryland Cooperative Extension, 1998)

Function of Three-Zoned Forested Riparian Buffer

Zone1. The trees in this zone help provide streambed and streambank stability. Deadwood and leaf litter falling into the stream help regenerate the streambed, which is constantly changing and eroding. This regeneration is very important to the health of the stream and to all life in the stream. The tree species nearest the water's edge also provide shade and are selected for their ability to quickly develop deep roots that can increase bank stability. Native riparian tree species are preferable because they evolved with the stream's inhabitants. Bottomland species are best suited for Zone 1 in coastal Georgia. These species tolerate wet conditions, grow quickly, and, while the main trunks are flexible and sturdy, the branches are brittle. This fast growth rate and brittleness help these species withstand the periodic trauma of heavy flooding. Instead of washing away and exposing unstabilized banks to erosion, these trees will "shed" branches, which causes little damage to the main trunk stem.

In the drier portions of Zone 1, hardwoods can be planted. If the water table is at least 3 feet below ground for most of the growing season, plant hardwood species that require good drainage. If the site has poor drainage, select hardwood species that are more tolerant of wet conditions.

The large hardwood tree species provide a canopy as they mature. Understory trees and shrubs should be interplanted among these canopy species to provide stability for the streambank and shading next to the water. Select native shrub species that are tolerant of flooding and wet soils. On sunny banks, shade-tolerant species will thrive

until overshadowed by the canopy. On wide streams, south- and west-facing banks receive more sun. North-facing streambanks receive less solar exposure. Fewer species thrive in these shadier conditions, so plant selection is more limited.

Zone 1 is an undisturbed forested area where activities are extremely restricted. Livestock should be excluded from this zone. Stream crossing, watering sites, and any streambank stabilization work must be carefully planned to minimize negative impact on water quality.

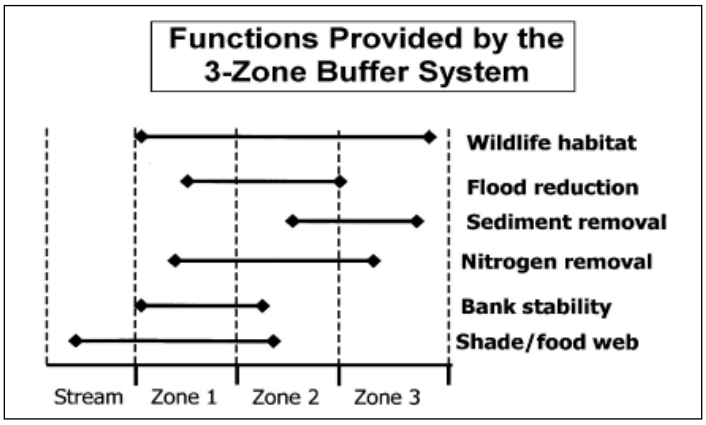
Zone 2. This zone allows the water to infiltrate or percolate into the soil so that waterborne nutrients/pollutants are absorbed and cleansed through vegetation and other natural ecological systems. Zone 2 also provides long-term storage of nutrients in the woody biomass of trees and shrubs. Large trees dominate Zone 2, which has an understory of smaller trees and shrubs. This zone can tolerate some disturbance. A wide range of forest management options can be used in Zone 2. Other nontraditional agricultural products can be grown in this area including shade-loving wildflowers, and some nut crops.

Select species adapted to the specific site and soil conditions. Look at adjoining areas for the types of native species that grow in that locale. Shade-tolerant shrub species such as winterberry and Virginia sweetspire generally do well in this zone. Planting a variety of tree and shrub species increases diversity and improves wildlife habitat. Also, planting a mix of species prevents loss of all benefits if one species does not thrive or fails to grown completely.

Zone 3. Zone 3 is the transition zone between the forested areas in Zones 1 an 2 and adjacent land. When carefully designed, this zone filters sediments, increases water absorption capacity, converts nutrients into green biomass, takes in nutrients, and prevents erosion by spreading the concentrated surface water flow to a uniform sheet flow. Zone 3 also provides valuable food and cover for certain wildlife species. A dense, herbaceous cover with no trees or shrubs works best to slow and filter runoff. Native grasses are recommended in this zone. Switchgrass is a good selection because its dense, stiff stems remain upright throughout the seasons. This slows the overland flow of water, allowing the water to infiltrate the buffer, and also allows sediment carried by the water to be deposited in the buffer area. In addition, switchgrass produces an extensive and deep root system, much of which is replace annually, providing large amounts of organic matter to the soil. Organic matter improves soil quality by increasing infiltration rates and microbial activity. Switchgrass takes approximately 3 years to become fully established. Switchgrass can be grown as a cash crop and also is particularly efficient at removing nitrogen.

Where surface runoff is not a major problem, other permanent grasses such as Indiangrass, big bluestem, and little bluestem can be used. Black-eyed Susan and purple coneflower also can be planted with grass to intercept surface runoff. Other grasses

may be combined with the switchgrass to promote wildlife diversity within this zone. Other native forbs also may be part of the mix, especially if they are seeded in clumps with other native grasses.



Each zone of the riparian forest buffer provides various functions and values to the landowner.

Other Planting Strategies

The combination of plantings already described provides the most effective buffer system, but the three zones are not the only approach to improving water quality, wildlife habitat, and flood control. Site conditions, surrounding land use, owner objectives, and cost-share program requirements should be considered in determining combinations of species for a buffer.

The following strategies also provide some reduction of nonpoint source pollution:

- Plant the entire buffer area to warm season grasses and forbs. Some soil stabilization may be needed, such as growing willow stakes along the streambank. This system does not provide as many benefits as multispecies design (three zones) and is best suited where streambanks are not very high or steep.
- In urban areas, plant warm season grasses over the entire area and small groups of shrubs and/or trees to provide a diverse, natural look. Recreational facilities such as hiking or biking trails can be incorporated into the system. Careful design will help avoid erosion problems often associated with runoff from trails.
- Accelerate succession by overplanting with seedlings of fast-growing, shade-intolerant species at a high enough density to provide canopy closure relatively rapidly. Tulip poplars and red maples are among the fastest growing trees appropriate for the riparian zone. Seedlings of shade-tolerant canopy species interplanted among these pioneer species can be selectively released after canopy closure to become the eventual dominants. That is, once the species

intended to be the dominant trees are well-established, the protective, fast-growing, shade-intolerant species are removed. Canopy overplanting will also reduce deer browsing on the future dominant species. This strategy also provides more wildlife habitat and deadwood in the riparian zone. The decision to use this strategy is largely determined by the existing vegetation in the riparian zone. Where many indigenous seedlings exist, the planting approach should attempt to capitalize on this.

Three-Zone Riparian Buffer Guidelines

The following narrative provides specific components of each Zone. Utilize this list when you consider goals and design for the riparian buffer restoration.

Zone 1: Undisturbed Forest

Purpose: To provide bank stabilization as well as shade and organic inputs for the stream system.

What to plant: Larger trees and shrubs typically are planted in this zone to increase stability; they should be species that tolerate wet conditions.

Water Quality Functions:

- **Sediment Control –** The roots of trees in Zone 1 hold together the soil to resist the erosive force of flowing water. This keeps sediment, and any nutrients bound to it, out of the stream.

Ecological Functions:

- **Habitat Biodiversity-** Roots and fallen logs slow stream flow and create pools that form unique microenvironments. Pools support species of macroinvertebrates different from those in riffles only a few feet away. Fallen debris also traps leaves, twigs, fruit seeds and other material in the stream, allowing it to decay and be used by stream-dwelling organisms.
- **Food –** The two primary sources of food energy input to streams are litterfall (leaves, twigs, fruit seeds, and other organic debris) from streamside vegetation and algal production. Recent studies have shown that in a healthy stream leaf litter is trapped and consumed in a relatively small area, rarely moving more than 100 yards; therefore, an upstream forest does little to “subsidize” an unforested area downstream.
- **Temperature Control -** The leaf canopy of the trees provides shade that helps to control water temperature. Maximum summer temperatures in a deforested stream may be 10-20 degrees warmer than in a forested stream. Temperature

changes of only 4-10 degrees usually alter the life-history characteristics of macroinvertebrates that form an important part of the food web.

In addition, shaded streams support algal communities dominated by diatoms – a type of algae favored by many species – throughout the year while areas getting more direct sunlight are dominated by filamentous algae. While crayfish and a few insects will consume filamentous algae, most macroinvertebrate species cannot because they have evolved as specialists for scraping diatoms from the bottom.

Where the tree canopy completely covers the water surface, Zone 1 will have the greatest impact on improving habitat along the stream, providing maximum control over light and temperature conditions.

Potential wildlife benefits:

- Shades water to keep temperatures cooler for fish.
- Organic inputs from trees provide food for aquatic insects, which in turn provide food for fish, amphibians, and birds.
- Branches falling into stream can provide structure as well as hiding places for small fish and insects.
- Bats forage for insects near water.
- The belted kingfisher uses overhanging branches to forage for fish.
- Wood ducks use cavities or nest boxes along larger streams for nesting.
- Trees like the river birch are hosts for butterflies like the tiger swallowtail.

Zone 2: Undisturbed and/or Managed Forest

Purpose: This zone is usually a managed forest or mixed forest-shrubland. The vegetation here helps to absorb excess nutrients such as nitrogen and phosphorus, preventing them from entering the water. This zone also helps slow runoff and allows it to recharge the groundwater supply.

What to Plant: A diverse array of native trees and shrubs.

Water Quality Functions:

- **Nutrient and Sediment Control –** Where shallow groundwater flows through the root zones of trees, large amounts of nitrate can be removed before the water enters the stream – on the order of 90 percent. In areas where groundwater flows deeper, much of this benefit will be lost as most of the water bypasses the root zone.

  Debris from trees slows and traps sediments in the runoff, giving the nutrients they carry time to infiltrate into the ground where they may be stored or

removed through natural processes. Studies have shown that Zone 2 can remove 50-80 percent of the sediment in runoff from upland fields.

Two processes are at work: 1) trees convert available nutrients to biomass in leaves, stems, trunks, and roots; and 2) bacteria that thrive in organic, carbon-rich forest floors covert harmful nitrates to nitrogen gas that is released into the atmosphere, a process called denitrification.

Potential Wildlife Benefits:

- Travel corridor for wildlife.
- Migrating birds find insects and fruits on shrubs and trees during stopover.
- Deer, birds, and other wildlife use evergreen shrubs and trees as winter cover.
- Native shrubs and small trees like American holly, inkberry, persimmon, and dogwood provide fruit for many wildlife species throughout the year. Larger trees like oak supply acorns for mammals and waterfowl during the fall.
- Amphibians use seasonal pools of water within low spots for breeding. Some salamander species place their eggs on wet logs or rocks.
- Fallen trees can provide dens or shelter for some mammals.
- Bats roost in large standing cavities.

Zone 3: Transition Zone Between Forested Area and Adjacent Land

Purpose: Planted as native grassland or a mix of native grasses and wildflowers. In residential areas, gardens or compost piles can be established here. In agricultural areas, this zone can be important for slowing runoff and trapping sediment.

What to Plant: Native grasses, wildflowers or gardens if being used near agricultural or residential areas. Can also be planted in shrubs or trees where there is not high sediment runoff.

Water Quality Functions:

- **Nutrient and Sediment Control -** A native grass and/or wildflower filter strip or other control measure upslope from Zone2 helps to slow runoff, filter sediment and its associated chemicals, and allows water to infiltrate into the ground. Native grass filter strips protect the wooded areas by spreading the flow from adjacent land uses which might otherwise cut channels into the forest buffer. Zone 3 can range from suburban lawns to stormwater management measures to pasture.

  Native grass filter strips can reduce sediment runoff at rates of 50 percent or more. They can be effective at removing sediment-bound phosphorus, but less effective at removing dissolved nutrients. Over time, the removal efficiency decreases as grass is smothered by deposited sediment; therefore, grass filter

strips require periodic maintenance. **Generally, the narrower the filter strip, the shorter its effective life.**

Potential Wildlife Benefits:

- Hummingbirds use certain wildflower species for nectar.
- Butterflies, moths and other pollinators use certain wildflower species for nectar and as host breeding plants.
- Large areas of grassy habitat can attract breeding grassland birds.
- Nest boxes can be used to attract bluebirds and tree swallows.

Chapter 5. The Nine Steps to a Forested Riparian Buffer Site Plan

Disclaimer: Any project that proposes to work within 25 feet of State waters may require a buffer variance, issued by the Director of EPD, GA Department of Natural Resources (GADNR). Contact the GADNR Environmental Protection Division for further information.

Criteria for Priority Riparian Buffer Restoration Projects

A number of factors determine the success of particular riparian buffer restoration projects. In addition to the physical characteristics of the site, issues such as land costs, land ownership, and logistical constraints must be taken into consideration. The following physical characteristics are intended to provide general guidance for identifying potential restoration sites and are not intended to exclude sites that may have merit based on other criteria.

- Woody vegetation absent or sparse (less than 100 stems per acre that are ≥ 5 inches diameter at breast height) measured within 50 feet of intermittent and perennial streams, lakes, ponds, and shorelines;
- Adjacent to headwater streams or those streams defined as first, second, or third order;
- Ditches, gullies, or evidence of concentrated flow within 50 feet of intermittent and perennial streams, lakes, ponds, and estuaries;
- Adjacent nitrogen sources including residential development, golf course, cropland, pasture, ball field, etc;
- Water table depth within three to four feet of surface as determined by characteristics of soil cores;
- Adjacent to protected or high priority plant and/or animal habitat; and
- Restoration would provide invaluable linkage to other adjacent natural habitats and/or wildlife corridors.

A Different Planning Approach

Planning will go a long way to making your riparian buffer project a success in the end. It is critical that you know your site conditions, understand the objectives of the landowner(s) and/or project, and match your project goals and site conditions with the correct native plants.

When completed, a site plan should include the following:

1. a map of the site with appropriate marked planting zones;
2. a native plant species list;
3. planting directions;

4. equipment/tool list;
5. site preparation directions; and
6. a maintenance schedule.

The Nine Step Process

Below is a nine step process that will help you arrive at a final site plan. You may want to form a buffer planning committee to share the tasks so that all of the planning does not fall on the shoulders of only one or two participants. In Appendix D, a checklist for success can be photocopied for use by all those involved in your project.

The nine steps to a streamside forest site plan include the following:

1. Obtain landowner permission and support;
2. Make sure your project site is suitable for restoration;
3. Obtain landowner permission and support;
4. Analyze your site's physical conditions;
5. Analyze your site's vegetative features;
6. Draw a map of the site;
7. Create a design that meets multiple objectives;
8. Draw a planting plan;
9. Prepare your site ahead of time; and
10. Determine maintenance needs.

Chapter 6. Riparian Buffer Restoration
Site Selection and Assessment

The Virtues of a Streamwalk

A simple walk along the stream targeted for restoration is an excellent diagnostic technique. A field visit will aid you in analyzing the physical and vegetative features of your site as described below.

When you walk your stream segment, the following tools will help with your investigation:

- ✓ Field guide to identify native trees and shrubs
- ✓ Clipboard with pad of paper and pencil to sketch a map of the site
- ✓ A USGS topographic map that includes your streamwalk area
- ✓ Tape measure
- ✓ Camera and film
- ✓ Waterproof boots
- ✓ Thorn-proof clothing
- ✓ Work gloves

No matter what the scale of your project, a site map of some type is necessary for proper planning and sharing information about your project with others. A map showing how your project fits into the larger geographic area may be required in order to obtain funding from existing grant programs. A good map to start with are the 7.5 minute USGS topographic maps, which are available from county planning offices, sporting good stores, or engineering/survey supply stores.

Step 1. Obtain Landowner Permission and Support

If your site is part of a subdivision, contact the homeowner association president (HOA) and/or landowner and enlist his/her approval and support of the project. Walk along the stream with the landowner/HOA and discuss his/her goals and wishes. The HOA and/or landowner's commitment is essential for the project's success.

Step 2. Make Sure Your Project is Suitable for Restoration

Consider areas where streamsides lack shrubs or trees, or where bare soil is exposed to erosion along the shore. If streambanks are extensively eroded, you should obtain professional help in evaluating the need for streambank restoration before buffers are planted. Look for evidence of instability, such as vertical, eroded banks, excessive sediment deposition, and signs of frequent flooding. Rapidly eroding streambanks can

undermine seedlings before they become established. Extensive streambank restoration will require additional time, professional advice and funding.

Step 3. Analyze Your Site's Physical Conditions

A. Evaluate the Soil – Soil moisture, seasonable high water table, flooding potential, topography, soil pH, and soil texture (proportion of sand, clay, and silt) are all important physical characteristics of a site's soil that affect plant viability. For instance, most streamside plants tolerate a wide variety of soil textures, although certain species do not tolerate excessively sandy or clayey soils.

A soil survey will give you basic, background information about these characteristics, which you can then match with specific species of trees and shrubs. Soil surveys may be available at your local UGA Cooperative Extension offices conservation district or regional USDA Natural Resources Conservation Service offices. Professionals at these offices can help you understand the soil survey symbols and how they apply to your specific site.

To obtain accurate information on the soil's organic content, pH levels, and nutrient composition, test the soil at various locations within the streamside area. Soil test kits are available from your local Cooperative Extension Service office, private nurseries, and private laboratories. An extension agent can tell you how many samples are needed for your project's area.

B. Give Your Site the "Shovel Test" – With shovel in tow, dig up a small area to see how compacted the soil is and how easy it will be to dig. If possible, take a soils specialist with you to help identify any special soil characteristics, such as the presence of a hardpan, shallow soil, or high water table that can interfere with the function of tree roots. Keep in mind that volunteers will come back if the work is made as pleasant as possible.

C. Identify the Hardiness Zone – Tree species are designated to particular hardiness zones based on their tolerance to winter cold. In coastal Georgia, the hardiness zone range is 8 (8a or 8b depending on location). All the plant species listed in Appendices B and C are classified as hardy in these zones. However, caution must be exercised when specifying plants near the northern limit of their hardiness zones. Streamside areas typically lie in frost pockets that effectively reduce the regional zone by at least one increment. Microclimate is also affected by solar exposure.

Step 4. Analyze Your Site's Vegetative Features

While physical features control plant selection, existing vegetation in a streamside area will dictate the choice of strategy for buffer establishment. Depending on whether the site is presently an overgrown abandoned field, marsh front property or a mid-

succession forest (halfway between field and forest), different approaches are needed to properly establish the desired vegetation. An area's present condition affects conditions such as competition for light, water, and nutrients. Different plant species will respond differently to these conditions.

In addition, the upper soil layers will also determine the plant community likely to emerge during buffer establishment. This area includes not only the seeds of the plants in the immediate vicinity but also the substantial extent of the root biomass from which new vegetation can sprout.

The first step is to look around at what is already growing in the vicinity. If you are in an area where native vegetation is available, getting a sense of the natural landscape in the immediate and adjacent vicinity will provide you a natural plant community template for your restoration.

Identify Desirable Native Species

Retaining native tree and shrub species that thrive in riparian areas will provide substantial benefits for the stream ecosystem. Appendix A lists native species appropriate for riparian buffer restoration in the coastal plain physiographic region of Georgia area. Carefully examine the site to locate the seedlings of these species. While certain species may be inappropriate as part of the final stand (for example, black locust where nitrate reduction is a goal – this species takes nitrogen from the air and fixes in the soil), they should be retained during buffer establishment to provide shade for tolerant species and to protect the stream environment.

In addition to those listed, there are several pioneer tree species that can be found colonizing a streamside area. Although they are short-lived, shade intolerant, upland species, these plants provide shade and structural diversity in a young riparian forest and their presence will benefit the establishment of a buffer. Pioneer riparian species include river birch, cherry (high wildlife value), sumac, black locust (a nitrogen fixer, useful for canopy establishment), and sassafras.

Several native shrub and vine species also thrive in the transitional disturbed conditions found in streamside areas. Common species include blackberry, greenbrier, poison ivy, wild grape, Virginia creeper, and spicebush. While less desirable as components of a riparian forest, these native species can provide effective ground cover during establishment of the buffer and also provide many wildlife benefits. It is important to note that some of these species can and will grow up and over newly planted trees. Therefore, they should be selectively controlled if this occurs. Eventually, forest canopy species will shade out the intolerant species.

Identify Undesirable Invasive Species

Since the introduction of exotic plants for landscape and reclamation purposes over the last century, many exotic species have aggressively invaded streamside areas in coastal Georgia. In many areas, these plants have completely taken over the riparian areas to the exclusion of desired native species, effectively stalling the natural progression of native plant communities. Most invasive species reproduce heavily from ground root systems, as well as by seeds. These plants are so aggressive when established that it is preferable to control them as much as possible before the buffer planting. If present in adjacent upland areas, these plants should be controlled to reduce the seed source in the streamside zone. Appendix B provides the Georgia Exotic Pest Plant Council's Invasive Plant List.

Identify Sensitive Species or Habitats to Protect

The Georgia Department of Natural Resources (GADNR) provides a collection of data that describes the state's rarest and most significant ecological features, including plant and animal species of special concern, and rare and exemplary natural communities. Since riparian zones in particular are rich in wildlife habitat and wetland plant species, it is important to consult with both the GADNR and local U.S. Fish and Wildlife Service (USFWS) Ecological Services Office to be aware of any rare, threatened or endangered species of plants or animals in the vicinity of your project. Much of the information can be accessed through the USFWS Georgia Ecological Services Division and GADNR Wildlife Resources Division websites.

Step 5. Draw A Map of the Site

As you collect the information noted above, sketch a map of the site that shows the stream width and length, streambank condition, existing streamside vegetation, width of desired buffer, and adjacent land uses. Other conditions may also be worthwhile to note, such as stream activities (recreational access sites or livestock), discharge pipes or other obstructions to digging, or conditions of the stream such as evidence of algae or scum floating or covering substrate. These important collected stream components can be recorded in the Georgia Adopt-A-Stream Visual Survey Forms (see reference in Chapter

Category 1, Category 1 Alert, and Category 2 Georgia Invasive Plants

(Source: Georgia Exotic Pest Plant Council)

- *tree of heaven*
- *mimosa*
- *alligatorweed*
- *water hyacinth*
- *autumn olive*
- *English ivy*
- *hydrilla*
- *shrubby lespedeza*
- *sericea lespedeza*
- *Chinese privet*
- *Japanese honeysuckle*
- *Japanese climbing fern*
- *Chinaberry*
- *Nepalese browntop*
- *marsh dewflower*
- *princesstree*
- *kudzu*
- *mutliflora rose*
- *Chinese tallowtree*
- *Chinese wisteria*
- *Japanese chaff flower*
- *garlic mustard*
- *small carpgrass*
- *oriental bittersweet*
- *congongrass*
- *skunk vine*
- *Japanese knotweed*
- *giant salvinia*
- *coral ardisia*
- *camphortree*
- *bermudagrass*
- *Chinese yam*
- *thorny olive*
- *oxeye daisy*
- *Japanese privet*
- *amur honeysuckle*
- *Chinese silvergrass*
- *parrotfeather watermilfoil*
- *sacred bamboo*
- *watercress*
- *bahiagrass golden bamboo*
- *bigpod sesbania*
- *rattlebox*
- *Japanese spiraea*
- *French tamarisk*
- *bigleaf periwinkle*
- *common periwinkle*

10 document provides “hands on” guidance on how to conduct and document the stream visual survey. In addition, a chart regarding the evaluation of stream conditions is also provided.

Also, note any access areas near the site where plants and animals can be delivered and volunteers can park. Telephone or restroom access should be noted. These minor amenities will ease planting day in little but important ways.

Chapter 7. Site Design

Some of the material in this chapter was adopted and modified for Georgia from the following document: Riparian Buffers for Wildlife. Pennsylvania Wildlife No. 16. 2004. Jennifer A. DeCecco and Margaret C. Brittingham. The Pennsylvania State University, College of Agricultural Sciences, Cooperative Extension.

Step 6. Create a Design That Meets Multiple Objectives

The three-zone system explained in Chapter 4 was developed to help plan riparian forest buffers. This three-zone concept is intended to be flexible in order to achieve water quality, wildlife habitat, and landowner objectives.

Consider Landowner Objectives

Designing a streamside buffer involves more than applying scientific criteria. Constraints imposed by land use do not always allow for an "ideal" three-zone buffer design; in these cases, modifications must be made to meet as many objectives as possible. Determining the landowner's goals and wishes is critical to the success of your project. Answers to questions like those listed below will guide your determination of how wide a buffer to plant and what species to include.

Questions to Ask….

- What is the landowner's current use of the riparian zone?
- What is the landowner's need for an economic return from the riparian area?
- What is the owner's interest in conserving the site in perpetuity (if not yet been implemented)?
- What is the owner's ability to carry out management responsibilities?
- What is the owner's interest in wildlife enhancement?
- What is the owner's interest in recreational pursuits?
- What is the owner's interest in maintaining a view of the stream from his/her private residence?
- Is the landowner in a position to consider linking his/her riparian site to a planned greenway or recreational trail?
- Would the landowner be interested in participating in any government or privately funded conservation programs to help restore or conserve his/her streamside property? Is the land currently enrolled in any existing conservation program?
- Are there any legal limitations currently placed on the riparian site by existing federal or state regulations, deed restrictions, and or municipal zoning?

- Does the landowner have any objections to volunteers maintaining the site once it is planted?
- Is the landowner able and willing to maintain the plantings to ensure that they become established?

As you discuss options with the landowner, specific objectives will evolve and need to be considered in choosing the appropriate width and native plant species for the buffer.

Tree Tip!

Forests provide as much as forty (40) times the water storage of a cropped field and fifteen (15) times that of grass turf.

In agricultural settings, many farmers have conservation plans developed in cooperation with the USDA Natural Resources Conservation Service and county conservation districts. A conservation plan usually addresses the total resource concerns of the landowner, so it is important to integrate plans for a riparian buffer into the overall farm conservation plan.

Match Your Buffer Width to Scientific Objectives

There is no ideal buffer width for all applications in all areas. Buffer width is site specific and dependent on both scientific criteria and landowner objectives. When a scientifically-derived buffer width is reduced because of land use constraints, it is important to recognize that compromises are being made to the long term ecological function of the buffer. For example, when a decision is made to choose warm-season grasses over forest as the target buffer vegetation, reductions in stream stability, flood mitigation, groundwater nutrient removal, and aquatic/terrestrial habitat should be recognized.

The most commonly prescribed ***minimum*** buffer widths for use in water quality and habitat maintenance are approximately 35 to 100 feet. Buffers of less than 35 feet cannot sustain long-term protection of aquatic resources because they do not contain a "critical mass" or sustainable width that is essential for long term sediment and nutrient reductions. Larger buffers, such as 150 -300+ feet, serve as important wildlife habitat and corridors.

From a scientific standpoint, you should consider the facts about your stream with regard to:

(1) its resource value;
(2) its soil and hydrogeologic characteristics;
(3) the intensity of adjacent land use; and

4) the desired buffer functions.

The function(s) of the buffer, that is, the reason for installing a riparian buffer, should be the overriding criterion in determining buffer width with other factors influencing the final decision to a greater or lesser degree.
Some situations that might influence the decision to design a smaller buffer include:

- A lower order stream (headwater) where a smaller buffer may be adequate to maintain the desired level of protection;
- A stream system where it is a high priority to achieve contiguous buffers where wildlife habitat goals are important;
- A stream where there's a low potential yield of nutrients, sediment, chemicals and runoff from adjacent land use.

Conversely, other situations may warrant the decision to go with a wider width, such as:

- A stream within a watershed providing municipal water supply;
- An area where steep slopes add a greater risk of runoff pollution;
- A site where buffer width is expanded to incorporate sensitive landscape features such as floodplains and wetlands;
- A site where buffer width is expanded to incorporate sensitive habitat features for high priority habitats and/or species.

Of all the scientific criteria that can be applied to making buffer width determinations, the most important are the specific functions that a buffer needs to provide under site-specific conditions. Some judgment and setting of priorities is nearly always necessary to attain a desired minimum buffer width for a desired set of functions.

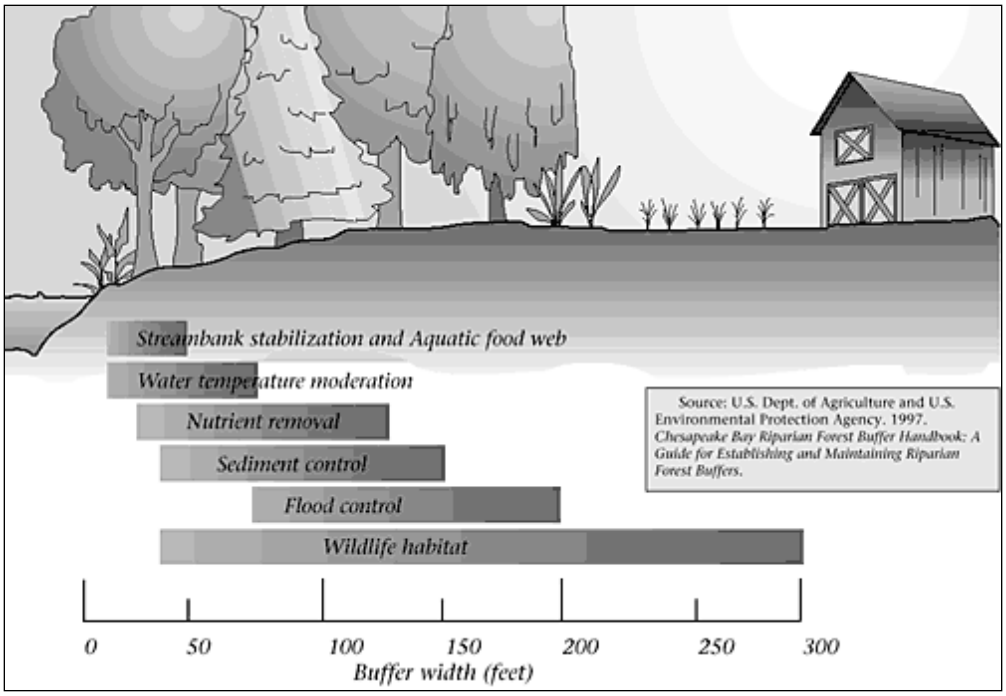


Figure. Buffer widths (in feet) for specific objectives.

Again, to provide an array of functions, buffers should be a minimum of 35 to 100 feet in width under most circumstances. **Ideally, the width should be a minimum of 75 feet in order to serve a variety of objectives.** Buffer widths toward the lower end of the range provide some physical and biological benefits, while buffer widths at the upper end of the range are likely to provide protection of physical, chemical, and biological characteristics of the aquatic resource. Streamside buffers narrower than 35 feet can provide some limited benefits but may require long term maintenance since their ability to trap sediments is reduced and the lack of shading invites more invasive species.

- ✓ While wildlife use may be you primary consideration, hydrology, prior land use, slope of the land, and desired water quality benefits are a few of the many considerations in determining zone and total buffer width. For example, a small stream with minimal inputs from adjacent land use may require only a small Zone 1 to improve aquatic habitat, while a larger water body with intense adjacent land use (e.g., residential development, golf course, etc.) might require larger areas of each of Zones 1-3 to provide water protection and wildlife habitat. If you live near a lake or pond you may simply be able to leave the area adjacent to the water unmowed or planed with native plants, especially if fertilizers or pesticides are not used (preferred). In areas with excess sedimentation and erosion problems, you may want to consider planting a larger Zone 3 buffer in grasses, which help to hold the soil.

A minimum total width of 50 feet from the stream's edge is usually the minimum suggested as an effective buffer for bank stabilization and water quality control, but most wildlife require wider buffer widths. **As the size of the buffer increases, the benefits for both wildlife and water quality increase.** Providing a very small buffer (less than 50 feet) may not be very useful for wildlife, but it would still have some water quality benefits. Small mammals generally require 30 feet of buffer, while amphibians can require up to 300 feet. Birds that prefer edge habitat use almost any size of buffer, but many more area-sensitive species need at least a 100 to 300 foot riparian buffer. If you have only a small area of land to put into a riparian buffer, consider planting fruit-bearing native shrubs and trees that will afford the most benefits for wildlife.

- ✓ **Current Adjacent Land Uses.** The recommended minimum buffer width (75 minimum) depends on the adjacent land use. For example, is the land adjacent to the water a residence, commercial use, or in agriculture? If it is agriculture, does the farmer use best management practices (BMPs), or are there heavy inflows of excess fertilizer, animal waste, or pesticides into the water? Agricultural land that contributes heavy loads of sediment and other pollutants requires a larger buffer than a single residence where no chemical pesticides or fertilizers are used.

- ✓ **Creating Corridors.** A riparian buffer is more valuable to wildlife if it is connected to similar habitat areas. A small patch of riparian forest will not attract the same diversity of wildlife as one made larger by being connected to additional habitat of the same (or more optimal) type. Connectivity is especially important for some amphibians, which move to upland habitats after the breeding season and avoid crossing dry, open areas.

- ✓ **Current Condition of the Stream and Stream Bank**

Completion of a Visual Stream Survey (Appendix D) can help you determine the overall condition of your stream. If the stream bank is very eroded or the stream has been channelized, additional work may be needed before riparian areas can be replanted. This will likely incur additional costs, and professional assistance may be necessary.

- ✓ **Existing Soil Conditions**

The pH of the soil in your riparian buffer and its composition will determine what types of plants to use. In addition, well-drained soils absorb runoff more quickly, requiring a small buffer width, while poorly drained soils require a wider buffer.

- ✓ **Slope of the Land**

Where the riparian area has a very steep slope leading to the water, a wider buffer is necessary to slow runoff traveling over the land to the water. Planint more of the total buffer in grasses rather than trees and shrubs can help to spread and slow runoff, allowing it greater infiltration into soil.

- ✓ **Technical and Financial Assistance**

  Many programs for farmers and residential landowners can provide monetary assistance, technical advice, and labor for a riparian buffer project. In addition, many local organizations can furnish volunteers to help replant riparian areas. Before starting any project, check with these sources and with your county extension office and county conservation district office to make sure that the project is appropriate for existing zoning regulations.

Enhancing Wildlife Habitat and Water Quality

Once you have assessed current conditions on your land, it is time to figure out your goals for the wildlife that may be using your buffer. While it may be hard to create a buffer with a particular species in mind, there are many things you can do to improve the overall quality of your riparian buffer. There are only general guidelines as to which species will use a buffer of a certain width, and much variation can exist within a particular group of animals. For example, the pileated woodpecker and scarlet tanager are likely to be found only in large expanses of forested riparian habitat (greater than 500 feet total width), whereas the hairy woodpecker and red-eyed vireo may be found in somewhat smaller forested buffers (150 feet total width). The northern cardinal, brown thrasher, and northern mockingbird will use even the smallest areas of shrubby riparian habitat since they prefer transitional zones. As a general rule, the wider the buffer, the more species it supports. The same holds true for mammals, amphibians, and reptiles.

No matter how large a riparian buffer you can provide, keep in mind the following to improve the design of your buffer so that you attract the greatest diversity of wildlife:

Control excess sediment in water. An increase in fine sediment owing to a poor or nonexistent buffer can be extremely detrimental for fish and aquatic insect populations. As you increase the size of your riparian buffer, the more opportunities there are for runoff to be intercepted by trees, shrubs, and grasses, and the benefits generally increase as the total size of the buffer increases (up to around 100 feet). Where sedimentation is a problem, a greater portion of the total buffer may need to be planted in grass (zone furthest away from stream), which will more effectively slow and trap sediment.

Keep water temperatures cool. Large, flood-tolerant trees like willow or river birch if planted along your stream bank help to shade the water, keeping water temperatures cool. Cooler water temperatures also help to discourage filamentous algal growth, which can deplete oxygen levels and encourage the growth of parasitic bacteria.

Source: Captain Scott Owens

Provide food for aquatic insects. As leaves and branches from a riparian buffer fall into a stream, they eventually become food for aquatic invertebrates (insects). These are, in turn, an important food source for fish and other wildlife. Some evidence suggests that providing such insects with native vegetation (rather than invasive and/or exotic plants) helps to create a more abundant and diverse aquatic community.

Add structure to water. The branches and other woody debris that fall into a stream from a riparian zone afford structure as well as refuge and hunting spots for fish. Some aquatic turtles use logs and other woody debris as "sunning" spots.

Increase structural diversity on land. A riparian buffer that has a mix of native vegetation is more likely to attract a greater diversity of wildlife. Therefore, a buffer planted only with pine trees will benefit a few species, but one that combines native tree and shrub species with a border of native grasses or wildflowers will attract a greater assortment of wildlife. See "Planting Your Riparian Buffer" (below) for more details.

Source: James Holland

Retain large, standing, dead trees (snags). Primary cavity-nesting birds (those making their own nest cavities), such as the downy, hairy, and red-bellied woodpeckers, use snags as nesting sites. Secondary cavity-nesting birds (those using cavities already created), like the bluebird, tufted titmouse, and great-crested flycatcher, may eventually use these sites. Also, many bats prefer to feed on insects in riparian areas on or near rivers, ponds, and lakes and roost underneath the peeling bark of larger, dying trees.

Provide food for wildlife. Providing a natural food source is one of the best ways to attract wildlife to your riparian buffer. Squirrels, turkeys, ducks, and deer take advantage of the acorns from oak trees. Both birds and mammals find shrubs that produce berries, such as the holly, dogwood, and viburnum (there are many varieties). A good riparian buffer also serves as a stopover site for migratory birds, which use even small patches of riparian habitat to find food (insects on trees and fruit produced by shrubs) and water during migration.

Provide winter cover. Resident mammals and birds use small areas of dense, coniferous trees such as cypress and pine for shelter from winds and harsh weather in winter.

Install nesting or roost boxes. Many species use artificial nest boxes because they mimic natural cavities. Boxes placed near grassy areas and open fields (they can be near a forested edge) attract both bluebirds and tree swallows. If placed within or near a forested setting, boxes are more likely to attract birds such as the tufted titmouse. Larger next boxes situated within more mature wooded areas can attract the great-

crested flycatcher. Wood ducks, typically found along rivers at least 600 feet wide, nest in large cavities along the river's edge. Installing appropriately placed cavity boxes in large trees along a river or lake encourages use by this waterfowl species.

Bats are one of the best wildlife species to have near your home or farm because they help control insect pests. To attract roosting bats to your riparian buffer, place bat boxes in sunny locations near the water. There are fairly specific requirements for the construction and placement of bat houses, and organizations such as Bat Conservation International, Inc. (see below) and/or the Georgia Department of Natural Resources, have more information on this and other topics related to bats.

Use native plant species. Native wildlife and native plants belong together. In particular, many butterflies and moths use certain native tree species as host plants. Other insects, such as pollinators, use wildflowers planted in a riparian buffer as a nectar source. Beneficial insects, such as dragonflies, are also attracted to buffers.

Leave hollow logs or brush piles. Many small mammals use downed hollow logs or brush piles for cover or nesting sites. Amphibians also use these structures as cover. Snakes use large rocks as den sites and take cover under large brush piles or logs.

Source: Eagle Wing Tour

Maintain stream bank integrity. Mink and otter use burrows within a streambank as den sites, and rough-winged swallows and belted kingfishers excavate nest tunnels within stream banks. Trampling by livestock and lack of vegetation along a stream bank increases erosion and limits the availability of this type of habitat.

Remove any existing invasive plants within the riparian buffer corridor. Non-native invasive plants can alter the community composition of natural habitats, reducing food and shelter resources available for species of wildlife. In addition, invasive species cause a reduction in the populations of animal pollinators needed to maintain stable ecosystems. See Appendix 4 for a list of Georgia's invasive plants.

Consider the Costs

Establishment and maintenance costs should be considered up front in the plan design. Although every project is site-specific, the following estimates provide realistic per acre costs on which to base your own budget figures.

One tool that can be used for establishment planning is the riparian forest buffer specification developed in 1990 by the USDA Forest Service. That specification, as described in this guidance document, outlines three distinct zones.

Zone 1 is nearest the streambank, has a recommended minimum fixed 15-foot width, and is a no harvest zone to achieve streambank stabilization.

Zone 2 is recommended to be a minimum 60-feet width; if allowed and desired, harvested trees promote nutrient removal as newly planted trees take up more nitrogen fro early growth.

Zone 3 is recommended to be a minimum 20-feet width and consists of dense grasses and forbs to convert concentrated water flow to uniform sheet flow.

Below are associated costs.

Tree Tip!

In establishing a new riparian forest buffer, it is usually both economical and practical to select a group of no more than 6 to 12 species. Zone 1 is likely to be flooded and should therefore be dominated by good tolerant species. Hardy shrub species can also be planted along the streambank to provide stabilization. Zone 2 contains a managed forest and may include hardwoods and evergreens that have more intermediate flood tolerances. Zone 3, if needed, may contain grasses or other features helpful in slowing and infiltrating water. Shrubs and small trees may also be desirable in Zone 3 to provide a diversity of habitat for birds and other wildlife.

Costs Per Acre Estimated Costs

Establishment

Preparation	Light site preparation - Mow, disking	$ 12.00
Planting	Tree Seedlings 8 x 8 spacing, 430 trees/acre (Hardwoods - $1.15/seedling) 12-18” seedlings with labor included	$ 495.00
Subtotal		$ 507.00

Maintenance

Reinforcement Planting	Seedlings 50/acre Year Two after establishment	$ 58.00
TOTAL COST	**Planting and Establishment**	**$ 565.00**

Optional Costs

Establishment	Shelters ($5,000/tree installed)	$2,150.00
	Fencing (One acre = 282 feet)	564.00
Maintenance	Competition control	
	- Herbicide treatment	$ 54.00
	- Mowing	$ 12.00

Costs include labor estimates.

Pick the Right Plants

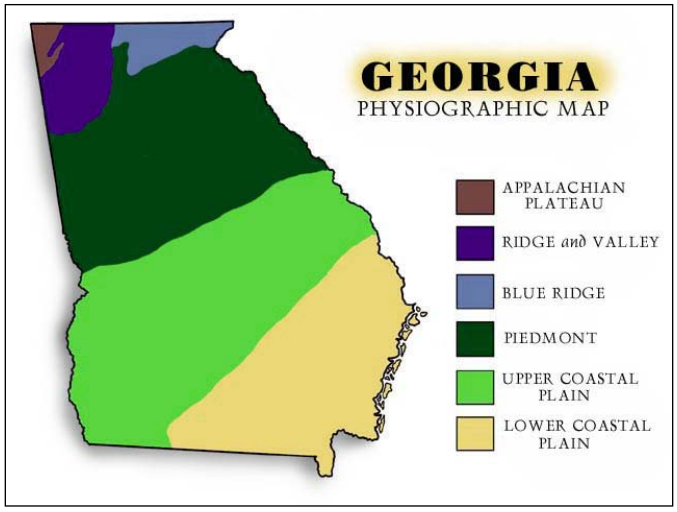
An important step in planning and establishment is the Plant Schedule, which lists the plant species, quantity, size and type. Planting specifications should detail the installation procedures, protection measures, and maintenance practices to be followed.

Which Species?

Designing the planting plan starts with selecting the best plants for each particular combination of hardiness, moisture, flooding, and soil pH. Your streamwalk and up front research will give you this basic information.

Species Range

If species native to the area in which you are working are planted, they are more likely to establish and grow with less need for maintenance and water. The physiographic region of the coastal plain of Georgia is includes hardiness zone 8. The upper coastal plain contains hardiness zone 8a. The lower coastal plain contains both 8a and 8b, depending on the location.



Flood Tolerance

Although all of the shrubs and trees in Appendices A and B are commonly found in the Georgia's coastal plain riparian areas, some species are not able to survive frequent or prolonged flooding. Trees that are planted closest to the waterway are more likely to be flooded and should be able to withstand a high water table. More flood-tolerant trees should be planted in any site that tends to be very wet as well. Appendix B provides some tree and shrub species that fit into the typical moisture conditions of a

streamside area. Species not suited for reasons of pH, moisture, or flooding will be excluded from certain areas of the riparian zone. The remaining species can be selected according to wildlife value, price, economic value, availability, and other landowner objectives

What Size Plants?

Your choice of planting stock, which ranges from seeds to large caliber nursery stock, depends to a large extent on available funding resources. Larger plant material, such as balled and burlapped (B&B) trees or large container stock (>2 gallons), will cost more, although they will attain the desired goals more rapidly. Alternatives include bare root seedlings and seeds and plugs.

Where funding is limited, least expensive material can be widely used, while the most expensive materials can be used sparingly in high visibility locations or in other high priority areas where, for instance, you may want faster results or ease of maintenance over the first few years. Where cost differential is not a factor, plants remaining on the list should be used in roughly equal proportions within each combination of physical conditions to provide the greatest diversity and resistance to plant diseases.

Also, consider the planting rate that it will take for a three-person crew to install a buffer. The following chart is a conservative estimate of planting rates for a trained three-person crew with adequate soil conditions. It includes digging holes, fertilizing (if necessary), planting, back filling, and flagging the site.

Trees and Shrubs	Quantity Per Hour
Bare Root Stock	100
Containerized Seedling	50
1 Quart Pot	45
1 Gallon Pot	40
2-3 Gallon Pot	20

Source: Pennsylvania Stream ReLeaf Forest Buffer Toolkit
Herbaceous material in bare root, plugs, or peat pots can be installed considerably faster but, as for woody vegetation, factors like soil conditions, spacing, terrain of the site, weather and age of the volunteers can influence planting rates.

Balled and Burlapped and/or Container Stock

The most expensive approach is to plant the canopy, midstory and understory in the final locations, using B&B and large container stock. In mature riparian forests, canopy

tree stem density is roughly 150 stems per acre, indicating a tree spacing of 16 to 18 feet. B&B material will attain a higher canopy height in the shortest time. Large material is most appropriate in riparian forests where intensive multiple uses are anticipated, as in urban development or part of an urban park system.

The typical cost for B&B material with roughly 1.5 inch diameter stems is about $35 and up. Five-foot tall B&B material costs from $8 to $20, depending upon source and species (1998 prices). Installation costs are about $10 to $30 per plant, depending upon method, size of plant, and source. The installed cost ranges from $18 to $50 (or higher), or $2700 to $7500 per acre. Since it is relatively expensive, this approach is inappropriate for use in most riparian sites.

Bare Root Stock

A more cost-effective approach is to use bare root material. Planting density should be higher than the final stem density desired, to allow for losses due to competition, stress and deer. At a survival rate of 75 percent, roughly 200 plants are needed per acre. A spacing of 14 to 16 feet is appropriate for larger material at least several feet high and around ¾" in diameter. Bare root material can grow relatively rapidly after the root system is established, reaching canopy closure soon after similar size B&B material. Bare root plantings are best in situations where visible plantings are desired after riparian forest buffer planting.

Bare root material ranges in price from $2 to $6 per plant (1998 prices) for five-foot plants, less than half the price of B&B for the same height. Hand planting with mattocks is the least expensive, but root spread may be compromised. Using power augers to dig the planting holes, installation costs should run from $0.40 to $0.50 per plant, or an installed cost from $2.40 to $6.50 per plant (1998 prices). At 240 stems per acre, installed costs would run from $575 to $1500 per acre (1998 prices).

Seedlings

Seedlings can be purchased as container grown seedlings or bare root seedlings. Container grown seedlings are often grown in paper pots that disintegrate and allow for both seedling and pot to be planted. This increases survival rate because the plant never loses contact with the soil and suffers less stress. Plastic containers work well for producing plugs that are pulled out of the container before planting.

In situations where a longer time to attain canopy closure is acceptable, smaller bare root seedlings are used. They are the least expensive type of plants. Seedling stock is either lifted directly from the nursery bed and shipped or is shipped as transplants (two years in the nursery and one year in a transplant bed.)

Depending upon plant condition, species and site stresses, the survival rates range from less than 30 percent to over 90 percent. At an average survival rate around 50 percent, the plant spacing should be 6 feet by 6 feet, or 1,210 stems per acre. Assuming a 50 percent survival rate, the site will have over 600 seedlings per acre.

Seedlings and two-year transplants are considerably less expensive than larger stock, varying from $0.30 to $1.50 per plant according to source and type of plant. With experienced personnel, at least 60 to 80 plants can be planted per hour. At $10 per hour (1998 prices) this results in installation costs for $0.10 to $0.15 per plant, or an installed cost of $0.40 to $1.65 per plant. Given a planting density of 300 trees per acre, the installed cost ranges from $120 to $495 per acre (1998 prices). Herbaceous control is more extensive, though, requiring at least several years of control.

Tree Tip!

Rules of Thumb:

Spacing and Density Recommendations:

Seedling: 6-10 feet spacing or roughly 700 seedlings/acre

Bare Root Stock: 14 to 16 feet spacing or roughly 200 plants/acre

Balled and Burlapped and Large Container Stock: 16 to 18 feet spacing or roughly 150 plants per acre

Tree shelters accelerate growth and increase the survivability of seedlings but add to the installation costs (approximate $3-$4 per plant). Where shelters are used, the density can be decreased and the results improved. See page x for more information on tree shelters.

Seeds and Plugs

For certain riparian species with large seeds, such as walnut and oak, planting of the seed is a viable alternative. While the planting material may be the least expensive, tree shelters are required to obtain acceptable survivability. Given the absence of transplant shock and the favorable conditions inside a shelter, growth rates from seed can be surprisingly fast. Walnut seedlings in shelters have grown up to 4 feet within the first growing season. For grasses and forbs, seed is the material of choice.

Step 7. Drawing A Planting Plan

Given the planting density and a conceptual plant mix, drawing up the planting plan is straightforward. The plan can be a simple line drawing of the site with areas denoted for tree and shrub species with appropriate notes on spacing and buffer width.

Many native riparian plant species have a wide degree of tolerance in soil moisture, pH and shade. Therefore, these species can be used effectively in many locations through the streamside area.

Where site conditions permit a wide choice of material, the individual species selection is not as important as the overall mix in a particular area. Overall, the planting plan should appear random; the crucial issue being that all plants are native and are located where they will thrive.

Please note that many riparian plant species have a wide degree of tolerance in soil moisture, pH, and shade. Therefore, these species can be used effectively in many locations through the stream-side area. Where site conditions permit a wide choice of material, the individual native species selection is not as important as the overall mix in a particular area. Overall, the planting plan should appear random; the crucial issue being that all plants are native and are located where they will thrive.

Canopy plantings are delineated with graphic symbols of a diameter representing the spacing and random arrangement throughout the streamside area. (If mowing is not used for herbaceous control, an artificial grid patterns is not necessary.) Understory plants are similarly arranged, using symbols of smaller diameter. Typically, there should be at least three or four understory trees for every canopy tree. This will provide structural diversity similar to mature forests. Shrub species are most intensively arranged at the margins of streamside forest buffers, where edge effects are the greatest. To avoid clutter and provide more graphic clarity in the dense plantings of the buffer, complete names can be omitted from the plan. Instead, species can be listed by initials generally representing the genus and species, with the key listed on the planting plan.

Tool and Equipment List for Site Preparation:

- Brush ax
- Bush hog
- Weed wacker
- Backpack sprayer
- Lopping shears
- Pick axe or mattock
- Mower
- Tractor with disk and seeder
- Herbicide

Step 8. Prepare Your Site Ahead of Time

Often, a streamside buffer area to be reforested will have a mixture of undesirable species, pasture, overgrown fields and a line of pioneer species of trees along the stream requiring a combination of site preparation techniques. ***Wetlands, streams, and the initial 25 feet of any buffer should not be***

***exposed to herbicides*.** In stubborn situations, a variety of physical and herbicidal methods will be effective in manipulating the plant composition to control undesired species.

The Nature Conservancy (Wildland Invasive Species Team, 2001) developed a guidance document entitled *Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas* which may provide valuable information prior to making any decisions that may involve chemical use for site preparation. In addition, it is best to acquire the help of a professional in determining whether chemical controls are absolutely necessary to prepare a site for planting. Site-specific hydrology and soil conditions will dictate what types of herbicidal applications can be done without detriment to surface water quality. Even though aquatic insects and fishes may seem to be unaffected by the "Most Preferred" herbicides, diatoms (a type of single-celled algae) are likely to be affected. Notwithstanding the apparently low toxicity of such herbicides to aquatic organisms, timing application after peak diatom activity sometime in the spring should result in lesser effects upon stream ecosystems. Where invasive species are a problem, consult a professional. ***Important reminder: Before using an herbicide, read the label and follow instructions carefully. Do not use a "restricted use" pesticide unless you are a formally trained, certified pesticide applicator.*** **"**Highly mobile or toxic" herbicides usually fall under the "restricted use" category.

In some situations, site preparation can require up to a year of vegetative control prior to planting. Any necessary streambank stabilization needs to be included in the planting plan so work can proceed in a logical order.

Abandoned fields of varying ages already have saplings, shrubs and vines. In this situation, site preparation focuses on releasing the desired saplings and other plants from competition by undesired species. Release methods vary according to the target species and extent of infestation by invasives. Techniques include spraying basal bark herbicides (spraying the base of plant) during the dormant season, cutting large shrubs and vines then treating the stumps to prevent resprouting and mowing everything around the "keepers" after they have leafed out in the spring. Larger cut stumps may also require an application of an herbicide to control.

Undesirable invasive plant species will still need to be controlled by cutting, pulling, and/or herbicides.

Step 9. Determine Maintenance Needs

Before the actual establishment of the streamside buffer, serious consideration must be made as to maintenance needs and long-term monitoring of the site. Often times this issue is overlooked in the planning process but is an important key in the longevity and sustainability of the forest. It is advisable to develop a schedule that identifies the commitments of each party in maintaining the site. Make this schedule a part of the

site plan so that everyone is familiar with the assigned responsibilities. Groups that may be able to assist with maintenance include service corps, high school and college students, and scout clubs. A detailed overview of maintenance and monitoring considerations is provided below under the section titled “Buffer Maintenance and Monitoring”.

Chapter 8. Buffer Establishment: Planting Your Riparian Buffer

What does he plant who plants a tree?
He plants, in sap and leaf and wood
In love of home and loyalty
And far-cast thought of civic good-
His blessing on the neighborhood
Who in the hollow of His hand
Holds all the growth of all our land.
A nation's growth from sea to sea
Stirs in the heart who plants a tree.

-Author unknown

Purchasing Plants

It is important to purchasing plants native to the area. This is due to the fact that locally evolved species have better vigor and hardiness and are better able to compete. These native plants also provide food to aquatic insects, some of which have mouths adapted to feed only on these local species of plant materials. For more information on Georgia's coastal plain native plants and/or appropriate native plants for riparian buffer restoration, go to www.coastscapes.org/

In recognition of the merits of native material, many nurseries now stock native plants. Where available, this stock should be used, although much of the plant material may have to come from more distant genetic sources. Nursery stock from large or distant suppliers often comes from a biotype far removed from the site of installation. Where stock from remote sources differ substantially in hardiness, it is a less desirable option, even though its cost may be slightly more competitive. Local sources may be a little more expensive, but the better quality control and reduced shipping and handling costs can offset initial price disadvantages. For more information on native plant selection and purchasing, go to www.coastscapes.org/. When purchasing plants from a nursery, ask the source of the plant and/or if is propagated onsite.

It is important to note that plant species should not be dug and transplanted from the wild. In many cases the species are site specific to the growing conditions and some have a deep taproot which if severed will kill the plant. It is, however, possible to "rescue" individual plant specimens from the wild if the site is officially slated for developed. Always request approval from the landowner prior to removing any plants.

During formulation of the plan, likely sources of plant materials will have to be identified, contacted and visited to check on the condition of the stock. The size, condition, and health of the plants should be examined before ordering. Specimen material can be tagged at this time, and arrangements for delivery, payment, and guarantee conditions are drawn up. When ordering plants, it is important to provide as much lead time as possible to ensure the best selection. Prior to early spring is the best time to place orders, as the best trees are shipped first. Consider ordering 10 to 15 percent more trees and shrubs than what you think you will need. The additional plants can be planted in a nearby "holding" area and used for replacement plantings. Reputable nurseries will often guarantee their stock for up to one year, provided proper care is given to the plants.

In most cases, plants should not be paid for until delivery and unloading. This ensures that delivered material meets the specifications stipulated, and that the plants arrive in good condition. Plants that do not meet specifications should not be accepted and sent back to the supplier with arrangements for replacement or refund. The material should be examined for the following criteria at delivery:

> ***Vigor*** – The plants should have well developed branches and adequate buds. Gently bend tree seedlings to check for pliability; if the seedling snaps, then it is too dry and should not be planted. Bark should be pliable and green when scratched, without shriveling or discoloring. Leaves should not be discolored or dessicated, or show spotting indicative of potential disease or nutrient stress.
>
> ***Roots*** – Balled and burlapped (B&B) plants should have the specified root ball size. The root ball should be securely wrapped without any signs of looseness, or the roots are likely to be damaged and/or desiccated. The ball should be moist. Container plants should be upright and firmly rooted. Inspect for circling, kinked, or "J" roots that may girdle the tree. Rootbound plants often have roots protruding above the surface or through the drain holes, a leggy appearance, and/or they are unusually large for the container. Bare root material should be wrapped in burlap and packing. The roots should be damp, fresh, and flexible.
>
> ***Wounds and Diseases*** – The trunk should be free of abrasions, cuts, scars, knots, and/or sunscald injury. There should be no insect egg masses or fungi on the branches or trunks.

Be sure to store delivered plants in a cool spot, out of direct sunlight, and water them adequately.

Planting Layout: Marking the Site

Prior to planting, the site may be marked so the volunteers can put the right plant in the right place. A specific marker is used to delineate each plant at each location. This approach may be helpful for inexperienced volunteers.

Where precise detail is not essential, zones can be marked for a particular mix of plant species. Volunteers can then be instructed as to which species they can randomly plant within a zone and what spacing to maintain. Crew leaders must provide necessary guidance along the way.

A variety of markers can be used. On mowed sites, lime can be rapidly applied to the ground and vegetation, but this method has minimal ability to convey species selection. Various colors of spray paint can be used to differentiate species, as well as color-coded flagged wires. Survey flagging can be used in a similar manner if enough vegetation is present onto which the flagging can be tied.

To mark the site, it is not necessary to conform rigidly to geometry set forth in the planting plan. If mowing is essential to control weeds, trees should be spaced evenly in rows across the planting area to prevent tree loss from lawnmower damage. Trees can be planted randomly or in clusters in mowed areas, but trees may be lost due to lawnmower damage. In random, mow-free plantings, trees are placed irregularly throughout the planting area, which is converted to a "natural forest" by not mowing. Weeds should be periodically removed around individual seedlings until trees become established (generally three years after planting).

Planting Tip

When planting seedlings, it is helpful to mark the plants with colored ribbons or flagging to make them easier to locate during maintenance tasks. Young plants can easily become "lost" in areas where weeds and other pioneer species are left to grow. You can also color-code the ribbons to mark plants that have died within the first year for replacement at a later date.

Plants should not be placed where roots, stumps, hummocks, depressions, and gullies will interfere or create less than optimal conditions. Plants should not be placed next to existing trees or shrubs. Knowing the average plant spacing, relative plant location is easily paced off, starting from the streambank and proceeding upslope. Landmarks from the mapping are used to ensure that spacing errors are not compounded as the planter proceeds along the stream.

In smaller sites where the buffer is not too wide, an experienced professional should be able to mark the plantings without even drawing up a detailed planting plan. Each plant or mix of species is placed as he/she proceeds through the streamside area, based upon judgment of site conditions and a knowledge of plant availability. The planting are then counted, and the plant list is drawn up

according to the actual layout. This is a more accurate method as to total number, and the total effort involved is reduced. A conceptual plan is still necessary to assist volunteers in staging.

For large sites, you may want to predrill the planting holes prior to planting day. You can rent soil augers or ask for an in-kind contribution from a landscaping company to do the job. Predrilled holes speed planting tremendously and help the volunteers focus their energies on planting the trees and shrubs correctly.

Planting Practices

Planting Tip

Keep seedling roots moist and do not allow them to be exposed for extended periods of time. When planting, you can either dip the roots into water and cover them with a bag or you can stand the seedlings in a bucket of water filled to the root collar. Volunteers can carry the bags or buckets to each hole to be planted.

Planting Seasons

Trees and shrubs can be planted during the spring or fall, with the preference in early spring between February and April. Deciduous species are best planted in the early spring before bud break in March/April. This ensure the longest season for root growth and gives the plant a chance to establish feeder roots prior to the moisture demands of the growing season. While less than optimal, planting can extend further in moist conditions found in streamside areas. Evergreens can be planted with good results before the new growth is fully extended in the spring. Planting later in the growing season will subject plants to moisture stress, unless proper care is taken to ensure adequate moisture in the root zone.

In the fall, evergreens can be planted after the heat of summer has passed. Most deciduous trees and shrubs can be planted later in the fall after leaf drop, since their roots will continue to grow unless the soil temperature falls below 45 degrees. However, the ground must have adequate moisture, or a severe winter will kill the trees. Many oaks are listed as fall hazard plants, so they should be planted in the spring. Check with local certified arborists or native plant nursery specialists regarding individual species.

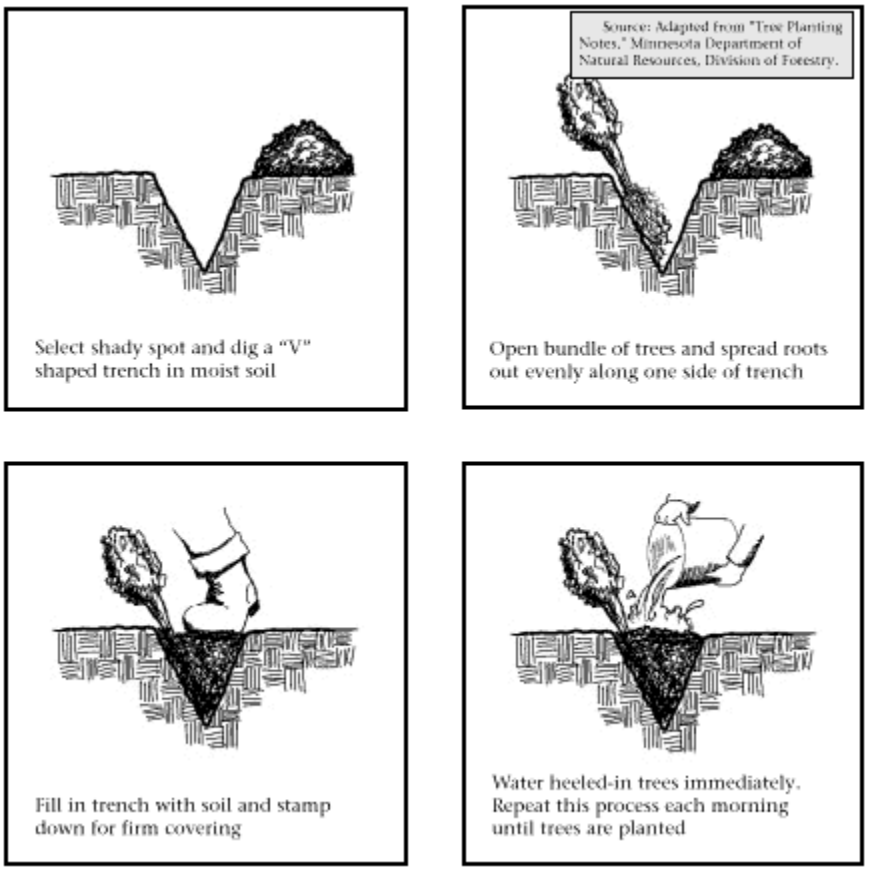
Winter transplanting is possible if the planting area is mulched enough to prevent freezing throughout the winter. Bare root material and seedlings should be planted in the winter to early spring while they are still dormant. Planting bare root material after leaf emergence is not recommended even if adequate shade and moisture are present.

Storage Before and During Planting

After delivery, plant material should be stored on site in a moist, shaded location prior to and during planting. The root balls of B&B stock and the packing of bare root stock should be thoroughly watered and kept moist with a covering of mulch, pine straw, or straw. Bare root stock can be stored for several weeks if "heeled in" by laying the plants in a trench of loose soil or mulch. The tops should face toward the south at an angle of 30 to 45 degrees.

Seedlings should be moist and cool upon receipt. Seedlings can be stored b stacking them in a circle with the roots facing inward in layers separated by packing material and kept moist at all times. Alternatively, they can be heeled in or refrigerated if facilities are available. Container material is least susceptible to moisture stress and will store will if properly watered.

If you transport seedlings in an open truck or trailer, cover the seedlings with a tarp to prevent excessive drying from high winds. So that air can circulate, do not lay the tarp directly on the seedlings.



Heeling in Seedlings to Protect Roots

Planting Methods

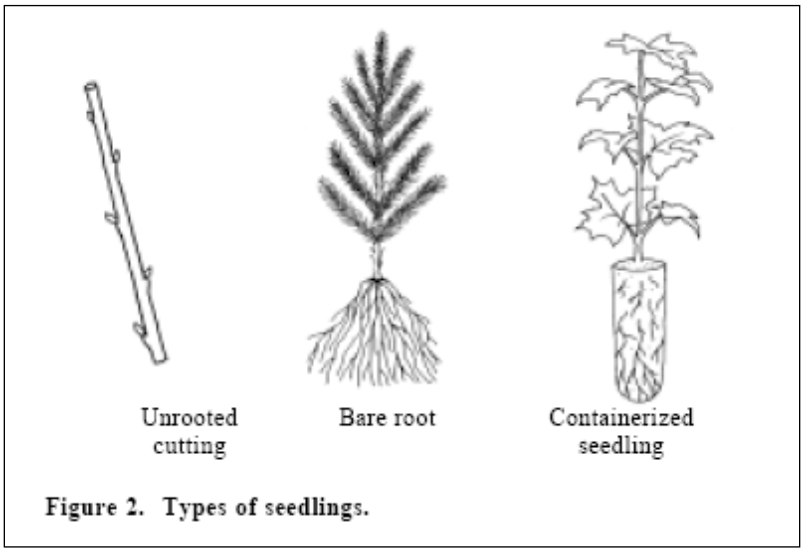


Figure 2. Types of seedlings.

B&B Trees

B&B stock should never be picked up by the trunk or dropped, as this will damage the root ball. To more B&B stock during planting, the root ball should be firmly cradled. The planting hole should be twice the width of the root ball, but no deeper. Soil amendments, such as the addition of organic matter, are not recommended since few roots will grow beyond the amended soils. All sod should be discarded. The root collar (the base of the plant stem) should be placed at the same level as the original soil; if the hole is overdug and backfill is necessary, the tree should be placed an inch or two higher to allow for settlement. After placement of the tree, completely remove any wire baskets and twine. Remove as much burlap as possible without damaging the root ball by cutting it down to where the root ball rests on the native soil. Work the backfill around the root ball, firmly compacting in place to avoid any air pockets. Fill up to original grade with the balance of the soil, compact, and water. Fill in any spots that settle, and place excess soil in a ring around the tree to retain water. A mulch of wood chips and/or geotextile fabric should be placed in a three-to-four-diameter circle around the tree to inhibit grass and herbaceous competition. Avoid placing organic mulch directly against the trunk, as this will harbor insects and rodents that may damage the tree. (For more information on mulching, see below).

Container Stock

For container material, the planting hole should be twice as wide and as deep as the soil in the container. Carefully cut the container away from the plant to expose the roots. After exposing the roots, look for circling roots. The small ones can be teased apart and

spread out in the planting hole. Plants with large and extensive circling roots should be rejected. Backfill, water, and mulch as in B&B plants.

Bare Root Seedlings and Year Transplants

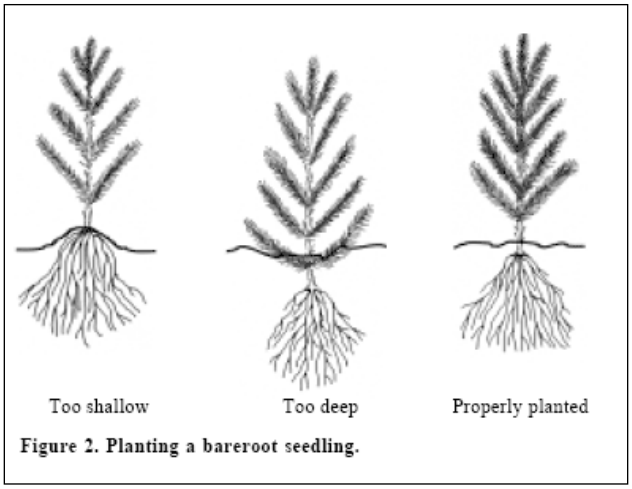
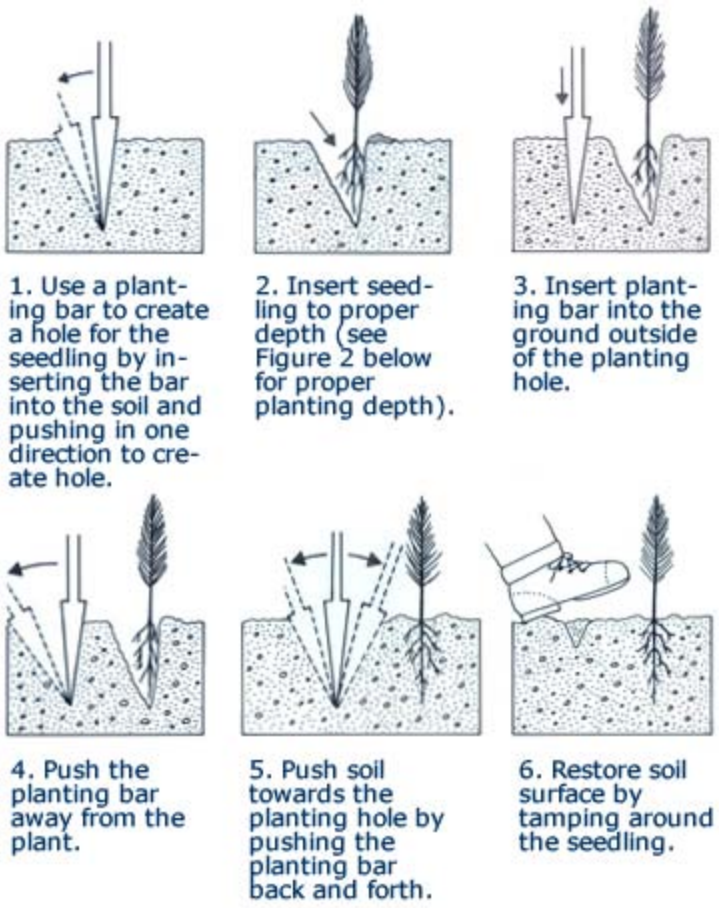


Figure 2. Planting a bareroot seedling.

Source: University of Nebraska – Lincoln

Trees can be planted by hand or by machine. A correctly planted tree should have the following general characteristics:

1) Planted at about the same depth, or not to exceed one-half inch deeper than it was in the nursery. Use the root collar for depth judgment.
2) Have the main roots nearly straight and spread out, not doubled, or sharply bent.
3) Have the soil firm around the roots. Leave no air pockets.
4) Have the tree in an upright position, and have it nearly even with the general ground level, not sunk in a hole or raised on a mound.



Silt Method of Planting (Source: U.S. Forest Service)

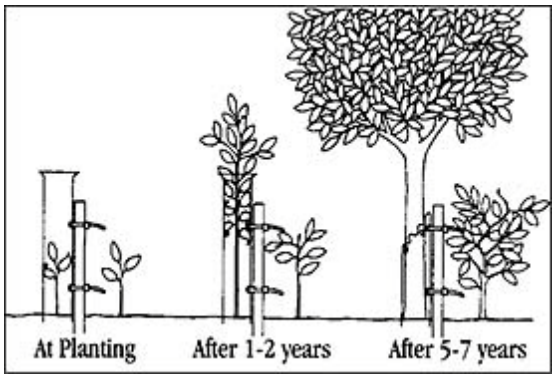
There are two methods of hand planting – slit method (using planting bar or dibble) and side-hole method (using mattock). Hand planting tools such as planting bars, dibble bars, mattocks, and hoe-dads are used for rapid planting of bare root stock and seedlings.

The slit method consists of making a slit with a planting bar or dibble bar for smaller seedlings. It is much more rapid than the side-hole method. After placement, the bar is reinserted several inches away, rocked away from the seedling to kick in the soil at the bottom of the roots, and then rocked toward the plant to compress the soil around the base of the plant. Where water is not available to settle the soil, it is important to firmly compress the soil around the plants.

The side-hole method consists of digging a hole deep enough with a mattock or grub hoe to hold the roots of the tree. Mattocks and hoe-dads are suitable for larger seedlings and most bare root stock.

Tree Shelters

In areas where deer browsing is a substantial problem or where you want rapid growth, tree shelters, plastic tubes that fit over the trees, have been used with considerable success. With shelters 4-feet high, seedlings are protected until the root system is well established. Five-foot shelters should be used where browsing is very heavy. Shelters also prevent rabbits and rodents from girdling the base of the tender trunks. Where deer browsing is light, shorter tree shelters (2 or 3 foot lengths) will provide protection at a lower cost. Over-planting other vigorous species is another method to sustain deer browsing without excessive pressure on the desired species.



Source: Octoraro Wholesale Nursery

Other benefits of tree shelters are:

1) Provide a favorable microclimate for seedlings. When shelters are properly installed, moisture transpired from the leaves condenses inside the tube, resulting in more humidity and moister root zone.
2) Increased carbon dioxide levels, resulting in favorable growth. Tree shelters generally increase initial growth rates by a factor of two to four times that of unsheltered seedlings.
3) Protect against wind and drought, shelters increase seedling survivability in adverse circumstances. Red oak is particularly responsive to the benefits tree shelters.
4) Management of competing vegetation after planting is much easier; mowing and weedwacker strikes are prevented, and herbicides (if used) are isolated from trunk contact.

There is some concern that shelters reduce rooting and trunk strength due to wind isolation during initial growth. However, once the sapling has emerged to the crown spreads, there is enough trunk movement to build stem and root strength. The tree then allocates resources toward stem growth. For this reason, tree shelters should be left on for two to three years after emergence. After this time, the tree shelter must be physically removed.

White tree shelters allow more light through them and are preferred in sites where shady conditions will occur over the four to five-year span that they are used. Brown shelters are less obtrusive in more open sites. Tree resistant stakes shelters should be staked with rot-resistant stakes such as white oak. The base of a tree shelter must be driven at least an inch into the soil to avoid a chimney effect, which increases moisture loss and to prevent rodents from girdling the tree. The shelters are then tied to a stake, located on the upwind side and protective mesh placed over the top to prevent entry of birds. Netting should be removed once the trees grow out of the top of the shelter. There are several types of shelters available.

The cost of installing tree shelters varies according to the product type and size used. As an example, a 1998 tree planting project in Pennsylvania paid $556 for 150 four-foot tree shelters (including stakes and delivery), which works out to $3.71 per plant.

Because of the cost involved, shelters would not be recommended for every seedling. They are most appropriate for the more expensive seedlings of species difficult to establish, such a red oak. However, reductions in maintenance costs and increased seedling vigor associated with tree shelters suggest that shelter plantings may be a more cost-effective approach than planting unprotected larger material.

Is It Necessary To Fertilize?

Generally, adding fertilizer at the time of planting is not necessary, especially if your native plant species match your site's soil conditions. A soil test will, however, help you determine the need for any soil amendments. When taking a soil test, it is important to dig deep to cover the depth of your average seedling root length (20 -30 inches). Your local University of Georgia Cooperative Extension Service agent can give you the proper guidance in testing your site before planting begins.

If the soil has been seriously disturbed, then fertilizer and other soil amendments may be needed to recondition the soil for planting.

Chapter 9. Buffer Maintenance and Monitoring

The critical question should be asked – can the site be maintained by the current caretaker? Does the caretaker understand what will it take to maintain the site? Has a maintenance plan been written for the specific site, gone over with the caretaker and agreed upon by all principal parties involved in the planning and planting process?

The most critical period during streamside forest buffer establishment is maintenance of the newly planted trees during canopy closure. Ongoing maintenance practices are necessary to ensure establishment of a thriving buffer, particularly where smaller seedling plant material has been used. Even where large plants are involved, deer browsing, invasion by exotic species, and competition by herbaceous forbs and grasses will be a continuing problem. Therefore, maintenance practices are necessary to ensure the long-term effectiveness of the buffer.

In many cases, existing grasses and forbs are mowed once or twice per year to control their height. **Avoid mowing from March through July when birds may be nesting there.** This method maintains a vigorous herbaceous layer, even though the species mixture may shift away from warm season grasses to other perennial forbs. Mowing also requires that the plants be spaced in a grid patterns, resulting in an artificial aspect to the buffer. The requirement for mowing also inhibits the establishment of understory species and shrubs until canopy closure. Mower strikes on the trunks are often unavoidable if no protective measures such as mulches or tree shelters are used.

During the first year, control annual weeds in zone 3 by mowing to 6 inches. Do not let weeds get higher than 12-14 inches before mowing. Cutting down tall weeds can smother the small seedlings below. During the second year mow to 12 to 18 inches in early summer if weeds are a problem. Mowing lower (and earlier) could harm plants and nesting animals.

Maintenance & Monitoring Tools:

- Watering
- Fertilizing
- Fence maintenance (usually agriculture sites)
- Habitat structures (brush piles, tree swags, bird boxes)
- Signage
- Periodic photos of buffer

An alternative to mowing is the use of biodegradable mulches to control weed and forb growth (see more under “Mulching” section below). Because annuals and perennials easily root within such organic mulches as they decompose, an option is to lay plain newsprint or cardboard beneath the mulch for added protection against herbaceous competition. The newsprint or cardboard will eventually decompose.

Tree mats also reduce the rooting ability under organic mulches. A tree mat is a geotextile

fabric (roughly 3' x 3') with a slit in the middle to allow it to be placed over the seedling, and four large staples to secure the corners. Mats are used in areas of light deer browsing and a turf grass setting or an area that is heavily maintained to ensure that vines and grasses do not over grow the seedlings. The down-side is that tree mats are highly labor intensive to install and must be removed once the trees have developed a canopy that will naturally shade out competitive weed growth.

Non-chemical weed control techniques are preferred because chemicals can quickly enter the water system in streamside forest areas. If herbicides are needed, use wisely and sparingly. Weed control should be continued until woody plants occupy the area, normally within two to three years.

Long-term Management and Monitoring

Buffer strips must be monitored and managed to maintain their maximum water quality and wildlife habitat improvement. They should be inspected at least once a year, and always within a few days of severe storms (if possible) for evidence of sediment deposit, erosion, or concentrated flow channels. Repairs should be made as soon as possible.

Grasses should be harvested, burned, or in some cases, may be control grazed. The use of fast growing tree species ensures rapid growth and effective removal of nutrients and other excess chemicals that could pollute waterways. Harvesting fast-growing trees as early as possible removes the nutrients and chemicals stored in their woody stems. Periodic harvesting also promotes continued vigorous growth. If harvested in winter, these species will regenerate from stump sprouts, thereby maintaining root system integrity and continued protection of the streambank.

Finally, if possible, avoid working in the streamside forest area between March 15 and August 15. During this time period, disturbance can be detrimental to a variety of wildlife.

Depending on the objectives of the buffer project, baseline monitoring of the stream's physical, chemical, and biological characteristics may be warranted to evaluate the success of the buffer over the long run. Periodic Visual Stream Surveys (see Chapter 10 for website) as well as consideration in participating in the volunteer water quality monitoring program entitled "Georgia Adopt-A-Stream" is strongly encouraged. For more information, contact the Program at www.GeorgiaAdoptAStream.org.

Watering

During the first growing season, newly planted trees and shrubs need water at least once a week until they become established. However, watering at many reforestation sites is difficult. Typically, water is not readily available from a public water supply or it may be difficult to haul from the stream's banks. Frequently, plants rely on rain events

for watering. For this to be successful, plantings must be timed to coincide with seasonal rains. Rainfall must be monitored well in advance of the planting date to ensure that the surface soil has received adequate moisture and that there is time for additional rainfall in the post-planting period. Newly planted vegetation should also be inspected after heavy rains to make sure that they are not damaged.

Although this method seems somewhat precarious, the success rates are higher than might be expected. This is one reason why the timing of plantings discussed earlier is critical. Success is contingent on having plant root-balls (container grown or B&B plants) or root mats (for seedlings) sufficiently moist at the time of planting. Coordinate with the plant supplier to ensure that plants will be watered a day or so before delivery. As an added assurance, on-site during the planting, store the plants in a 5 gallon bucket with water.

Occasionally, local sources may be helpful in providing initial or post installation watering. Deep water regularly throughout the first growing season.

Mulching

Mulch the soil surface around the plants with two or three inches of a course slow-decomposing media, such as shredded bark, compost, leaf mulch, or wood chips. Organic mulches retain moisture, retard evaporation, moderate soil temperatures, control weeds, and improve appearance. Uncomposted mulches, such as pine straw, grass clippings and sawdust, decompose rapidly and require more frequent applications resulting in reduced benefits. They are not recommended. Do not place mulches directly against the tree trunk as this creates a moist area that can provide a favorable environment for boring insects or fungus growth.

Mulch is considered by many to be a cosmetic top dressing. However, the proper type of mulch can have many benefits. Research results suggest that height growth and trunk diameter increase significantly if the ground near the tree base is kept free of grass. Besides the clear advantage of preventing turf competition to young trees, expect fewer tree injuries caused by mowing equipment.

In general, shredded hardwood mulch has good moisture retention and weed control benefits and is relatively unaffected by wind and rain. Shredded mulch is marketed in coarse, medium, and fine grinds. The more course the grind, the greater the moisture retention and weed control benefits. Coarse ground mulch is also susceptible to dispersment by wind and rain. Whichever mulch type is selected for use, make sure that it has been properly composted before use to minimize the ensuing leachate. Uncomposted yard waste, such as grass clipping, twigs, branches, and leaves can be harmful to plants when used as mulch, because they compete with the plant for soil nitrogen to continue decomposition. Improperly composted wood chips can be harmful to plants because the decomposing microorganisms haven't been neutralized. When

the chips are stored in large piles, sufficient amounts of alcohol and/or acetic acid can accumulate and kill plants when the chips are later used as mulch. Another concern of using this freshly chipped waste is that the composition is unknown. If the material being chipped was dead, diseased, or insect infested, and not properly sterilized, these problems can be spread by using this material as mulch.

Not surprisingly, the mulches used most frequently on reforestation sites are a combination of wood chips/leaves/twigs because it is readily available and may require a nominal delivery fee. If possible, try to stockpile this type of mulch for six months to a year before use or reserve monies in the budget for obtaining composted mulch.

Conclusion

While many different wildlife species will "find" your riparian buffer immediately after it has been planted, others will not use your buffer until it has a chance to mature, which may take several years to several decades. As your riparian buffer ages, the plant communities and habitat within it change as well and become attractive to different wildlife. Whatever type of riparian buffer you create, you have contributed a valuable resource for both people and wildlife.

Chapter 10. Source of Assistance and Additional Information

Stream Stabilization and Restoration Resources

Green Growth Guidelines
http://crd.dnr.state.gas.us/Assets/Documents/green%20growth%20cover.pdf

Specifically written for coastal Georgia, this document provides invaluable guidance on sustainable land use for construction projects. Very resources and includes, but is not limited to, site planning, site design, and green infrastructure stormwater BMPs are provided.

Hydromodification Best Management Practices Manual for Coastal Georgia. 2009.

Provide tools for better, less invasive methods for implementing and maintaining hydromodification projects and activities.

Federal Interagency Stream Corridor Restoration Working Group
***Stream Corridor Restoration: Principles, Processes, and Practices* (USDA NRCS), 1988**
www.nrcs.usda.gov/Technical/stream_restoration/ or
http://www.usda.gov/stream_restoration

Developed as a cooperative effort between numerous agencies, this document provides a comprehensive discussion of the processes and procedures of setting up a restoration or revegetation plan. If there is a lot of riparian work to do, this is a must have publication. It is a large Adobe Acrobat file that can be downloaded and viewed on any computer, but will take some time to load. A hard copy or CD-ROM can also be ordered.

***A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization* (USDA Forest Service Technology and Development Programs)**
http://fsweb.sdtdc.wo.fs.fed.us

This guide provides information on how to successfully plan and implement a soil bioengineering project, including the application of soil bioengineering techniques. Basic principles and background information on ecology and the stream dynamics needed before attempting a restoration project are also presented.

This guide is designed for those who plan restoration projects and for those engaged in the day-to-day construction and maintenance of water-related recreation facilities, including dispersed areas, forest roads, and trails. It is also for persons interested in learning more about soil bioengineering stabilization techniques and how to apply them.

Stream Restoration: A Natural Channel Design Handbook **(NC Stream Restoration Institute and North Carolina Sea Grant)**
www.bae.ncsu.edu/programs/extension/wqg/sri/stream_rest_guidebook/guidebook.html

Visual Stream Survey**. Georgia Adopt-A-Stream Program, Georgia Department of Natural Resources, Environmental Protection Division, August 2008.**
www.GeorgiaAdoptAStream.com

Stream Restoration Handbook **(USDA NRCS)**
www.wsi.nrcs.usda/gov/products/w2q/strm_rst/stream.html

U.S. EPA River Corridor and Wetland Restoration
www.epa.gov/OWOW/wetlands/restore/

Guidelines for Streambank Restoration. **Georgia Soil and Water Conservation Commission. 1994.**

USDA Stream Systems Technology Center
www.streams.fs.fed.us/

USACE Stream Mitigation Guidelines
www.saw.uszce.army.mil/wetlands/Mitigation/stream_mitigation.html

Books

Verry, E.S., J.W. Hornbeck, and C.A. Dolloff. ***Riparian Management in Forests of the Continental Eastern United States.*** 2001. Gives detailed information on the specific habitat needs and uses of wildlife along riparian zones in the eastern United States. Although geared towards forest managers, it still provides useful information for all landowners.

Other Related Web Sites

Natural Resources Conservation Service
Stream Visual Assessment Protocol
This protocol helps landowners to assess visually the condition of their stream.
www.wcc.nrcs.usda.gov

Bat Conservation International, Inc.

Provides help on constructing bat houses and information on how to attract bats to your property.
www.batcon.org/

Financial Assistance, Technical Advice, and Volunteer Help

U.S. Fish and Wildlife Service
Partners for Fish and Wildlife Program
Provides financial and technical assistance for habitat restoration on private lands.
Eligible land must be set aside for at least 10 years.
www.partners.fws.gov

U.S. Department of Agriculture/NRCS/Farm Service Agency
Web site (www.fsa.usda.gov/dafp/cepd/default.htm) has information on all the programs listed below. Or contact your local USDA service center office for more information.

Conservation Reserve Program (CRP)
Offers annual rental, incentive, and maintenance payments for certain activities, including establishing riparian buffers on croplands or marginal pasturelands.

Conservation Reserve Enhancement Program (CREP)
An offspring of the CRP, the CREP is a voluntary program for agricultural landowners. The program involves state-federal partnerships that focus on high priority environmental concerns.

Environmental Quality Improvement Program
Farmers can receive financial and technical help to implement structural or management conservation practices on suitable lands.

Sources on Native Plants of Georgia

CoastScapes Conservation Landscaping Program, University of Georgia Marine Extension Service
www.coastscapes.org
Georgia coastal plain native plant search engine, coastal plain native plant conservation landscaping lists, native plant nursery suppliers, and other resources.

Georgia Native Plant Society

Web site lists native plant sources in the state
www.ganps.org

APPENDIX A.

University of Georgia Marine Extension Service CoastScapes Conservation Landscaping Program

Georgia Coastal Plain Native Plants For Riparian Buffers

UNIVERSITY OF GEORGIA MARINE EXTENSION SERVICE

CoastScapes

Georgia Coastal Plain Native Plants For Riparian Buffer Restorations

Water is the most critical resource issue of our lifetime and our children's lifetime. The health of our waters is the principal measure of how we live on the land." Luna Leopold

What Are Riparian Buffers and What Are Their Values?

Riparian buffers are vegetated lands adjacent to streams, rivers, wetlands, lakes, and freshwater and tidal marshes that protect these waterbodies from activities in upland areas. They are often the vegetated corridors containing trees, shrubs, non-woody plants, and native grasses that line the water's bank.

A healthy riparian area is evidence of wise land use management. Thus, preserving and restoring connectivity of riparian buffers is essential in protecting the water and habitat quality of our coastal streams, rivers, wetlands, and marshes. These coastal riparian buffers perform a wide range of ecological functions and services that have high environmental, economic, and social value.

Riparian buffer zones provide substantial benefits, including:

- Minimize activities that degrade, destroy, or otherwise negatively impact the value and function of our coast's waterways, including coastal marshlands;
- Maintains the watershed's hydrology (baseflow);
- Maintains stream and river water quality;
- Filters and traps sediment and other pollutants, such as pesticides and fertilizers, found in surface runoff;
- Transforms and removes nutrients, such as nitrogen and phosphorus;
- Promotes bank stabilization and reduces erosion;

- Provides a major source of energy and nutrients for stream communities through the riparian vegetation. They are especially important in small, headwater streams where up to 99% of the energy input may be from woody debris and leaf litter;
- Protects and maintains valuable terrestrial habitat for wildlife, including nesting, feeding, and sheltering habitat, as well as providing important corridors or travel ways for a variety of wildlife;
- Protects aquatic habitat including important nursery grounds for fisheries, which provide food and habitat to numerous species of fish and shellfish, including commercially important species;
- Additionally maintain aquatic habitat through:
    - moderation of water temperature, and
    - contribution of leaves and woody debris (provide food source and habitat);
- Riparian vegetation increases temporary floodwater storage and filtration areas, slows floodwaters, thereby helping to maintain stable streambanks and protect downstream property. By slowing down floodwaters and rainwater runoff, the riparian vegetation allows water to soak into the ground and recharge groundwater. Slowing floodwaters allows the riparian zone to function as a site of sediment deposition, trapping sediments that would otherwise degrade our streams and rivers while overall reducing the impacts of flooding;
- Enhances the marshlands' scenic value and recreational opportunities;
- Protects property values of individual landowners by reducing property damage from floods, high tides and storm surges;
- Protects and restores greenspace and the natural character of the region;
- Protects the coastal region's visual character and unique natural resources;
- Provides scenic and aesthetic benefits which provide enhancement of property = increased property values
- Reduces maintenance costs and time compared to turfgrass;
- Protects coastal fishing, recreation and tourism industries; and
- Provides recreational and educational opportunities.

Loss of Riparian Area

Degraded riparian buffers reduce water quality, reduce wildlife and fish populations, cause serious property damage (e.g., bank erosion) and loss of valuable lands. Removal of riparian vegetation results in increased water temperatures and decreased dissolved oxygen. The loss of shade exposes soils to drying by wind and sunlight and reduces the water storage capacity of the riparian area. Loss of riparian vegetation causes streambank erosion.

Eroding banks contribute to sedimentation and lead to a wide shallow stream with little habitat value. These factors result in significant reductions in aquatic stream life.

What Can We Do?

Riparian buffers are the invaluable link between land and water, and the trees and other native vegetation that make up the riparian buffers are vital components of a healthy stream ecosystem. We who live in coastal Georgia value the aesthetic beauty that is provided in our region. In order to keep our precious natural resources, we must conserve existing riparian buffers and restore degraded buffers within our coastal region's waterways.

A Georgia coastal plain native plant list is provided below for use as a tool when planning a coastal riparian buffer restoration effort. In addition, there are several other coastal Georgia riparian buffer tools available:

Coastal Georgia Riparian Buffer Restoration Guidelines. UGA MAREX CoastScapes Conservation Landscaping Program: www.coastscapes.org

Protecting Riparian Buffers in Coastal Georgia: Management Options. UGA River Basin Center and UGA School of Law. Includes Model Coastal Riparian Buffer Ordinance:
http://www.rivercenter.uga.edu/research/coastal.htm

Coastal Riparian Buffer Guidance Manual: A Companion to the Model Coastal Buffer Ordinance. UGA River Basin Center:
http://www.rivercenter.uga.edu/research/coastal.htm

Plant Choice Considerations

This Georgia coastal plain native plant riparian buffer list consists of native plants that have been reported by various sources to provide valuable riparian buffer native plant vegetation. Although these plants provide numerous benefits of being native plants (e.g., reduced water needs, reduced fertilizer and pesticide use, etc.), new plantings will require regular irrigation for six weeks to six months or more before they become established. Trees larger than two inches caliper width will take longer to establish. Although native plants have evolved to local conditions, plants of any species must be allowed time to become fully established in a landscape before all of its native plant features will be evident. All plants need water while establishing their root system and during periods of extended drought. Root establishment can take from months to one to several years, depending on the original size of the plant. Larger plants will take longer to establish.

Although the plants provided in the list below may be native to the coastal plain region of Georgia, individual plants may not grow everywhere in the region. In addition, the characteristics of any site will typically vary from place to place and some plants may do better than others at various places within a site. Putting plants in the right places is the key to ensuring they survive and remain healthy in your landscape. When selecting plants from this list, remember that many factors determine the suitability of a plant for a particular location. Consider light requirements, local climate, soil type, moisture, adaptability, hardiness, heat tolerance, and other factors. All plants listed are suited to the USDA Hardiness Zone 8. Please check to see if your zone falls within the 8a or 8b hardiness zone and then choose plants accordingly. Choose native plants that match and thrive under the conditions in your landscape and you will have a CoastScapes riparian buffer landscape! You will reduce the need for water, fertilizers, pesticides, and pruning while providing valuable wildlife habitat. Properly fit the plant to your site and local climate and you will have a beautiful riparian buffer landscape!

For more information regarding Georgia's coastal plain native plants, to utilize the University of Georgia Marine Extension Service/Bugwood CoastScapes Coastal Plains Native Plant search engine, or how to further protect water quality and wildlife habitat, go to the CoastScapes website: www.coastscapes.org.

UNIVERSITY OF GEORGIA MARINE EXTENSION SERVICE

CoastScapes

Georgia Coastal Plain Native Plants For Riparian Buffer Restoration

Trees

Acer barbatum	southern sugar maple
Acer rubrum	red maple
Aesculus pavia	red buckeye
Betula nigra	river birch
Carya alba	mockernut hickory
Carya aquatica	water hickory
Carya cordiformis	bitternut hickory
Carya glabra	pignut hickory
Carya ovata	shagbark hickory
Castanea pumila	chinkapin
Catalpa bignonioides	southern catalpa
Celtis laevigata	sugarberry
Celtis occidentalis	common hackberry
Chamaecyparis thyoides	Atlantic white cedar
Diospyros virginiana	common persimmon
Fagus grandifolia	American beech
Gleditsia triacanthos	honeylocust
Ilex opaca	American holly
Juglans nigra	black walnut
Liquidambar styraciflua	sweetgum
Liriodendron tulipifera	tuliptree
Magnolia grandiflora	southern magnolia
Nyssa aquatica	water tupelo
Nyssa biflora	swamp tupelo
Nyssa ogeche	Ogeechee tupelo

Nyssa sylvatica	blackgum
Oxydendron arboreum	sourwood
Pinus clausa	sand pine
Pinus echinata	shortleaf pine
Pinus elliottii	slash pine
Pinus glabra	spruce pine
Pinus serotina	pond pine
Pinus taeda	loblolly pine
Platanus occidentalis	American sycamore
Populus deltoides	eastern cottonwood
Populus heterophylla	swamp cottonwood
Prunus americana	American plum
Quercus alba	white oak
Quercus falcata	southern red oak
Quercus incana	bluejack oak
Quercus laevis	turkey oak
Quercus laurifolia	laurel oak
Quercus lyrata	overcup oak
Quercus margarettae	runner oak
Quercus marilandica	blackjack oak
Quercus michauxii	swamp chestnut oak
Quercus nigra	water oak
Quercus pagoda	cherrybark oak
Quercus phellos	willow oak
Quercus shumardii	Shumard's oak
Quercus stellata	post oak
Quercus velutina	blackoak
Quercus virginiana	live oak
Robinia pseudoacacia	black locust
Sabal palmetto	cabbage palm
Taxodium ascendens	pond cypress
Taxodium distichum	bald cypress
Tilia americana	American basswood
Ulmus alata	winged elm
Ulmus americana	American elm

Small Trees

Amelanchier arborea	common serviceberry
Amelanchier canadensis	Canadian serviceberry
Asimina triloba	pawpaw
Carpinus caroliniana	American hornbeam
Cercis canadensis	eastern redbud
Chionanthus virginicus	white fringetree
Cornus amomum	silky dogwood
Cornus florida	flowering dogwood
Cornus foemina	stiff dogwood
Crataegus crus-galli	cockspur hawthorn
Crataegus flava	yellow hawthorn
Cyrilla racemiflora	swamp titi
Fraxinus americana	white ash
Fraxinus caroliniana	Carolina ash
Fraxinus pennsylvanica	green ash
Fraxinus profunda	pumkin ash
Gordonia lasianthus	loblolly bay
Halesia carolina	Carolina silverbell
Ilex coriacea	large gallberry
Ilex decidua	possumhaw
Ilex verticillata	common winterberry
Ilex vomitoria	yaupon holly
Juniperus virginiana	eastern redcedar
Magnolia virginiana	sweetbay
Morus rubra	red mulberry
Ostrya virginiana	hophornbeam
Persea borbonia	redbay
Persea palustris	swamp bay
Prunus angustifolia	Chickasaw plum
Prunus caroliniana	Carolina laurelcherry
Prunus serotina	black cherry
Salix caroliniana	coastal plain willow
Salix nigra	black willow
Sassafras albidum	sassafras
Ulmus rubra	red elm

Shrubs

Alnus serrulata	hazel alder
Amorpha fruticosa	desert false indigo
Baccharis halimifolia	eastern baccharis
Callicarpa americana	American beautyberry
Ceonothus americanus	New Jersey tea
Cephalanthus occidentalis	common buttonbush
Clethra alnifolia	coastal sweetpepperbush
Cornus amomum	silky dogwood
Cyrilla racemiflora	swamp titi
Erythrina herbacea	redcardinal
Eubotrys racemosa	swamp doghobble
Eunonymus americanus	bursting-heart
*Fothergilla gardenii***	dwarf witch alder**
Gaylussacia frondosa	blue huckleberry
Hamamelis virginiana	America witchhazel
Ilex cassine	dahoon holly
Ilex glabra	inkberry
Ilex vomitoria	yaupon holly
*Illicium floridanum***	Florida anisetree**
Itea virginica	Virginia sweetspire
Iva frutescens	Jesuit's bark
Leucothoe axillaris	coastal doghobble
Lindera benzoin	northern spicebush
Lyonia ferruginea	rusty staggerbush
Lyonia ligustrina	maleberry
Lyonia lucida	fetterbush lyonia
Morella caroliniensis	southern bayberry
Morella cerifera	wax myrtle
Osmanthus americanus	devilwood
Photinia pyrifolia	red chokeberry

** PLEASE NOTE!! *Fothergillia gardenii* and *Illicium floridanum* are protected plants in Georgia. Before choosing either of these shrubs for planting, please take great care to assure that your conditions are appropriate for the necessary requirements and needs of these rare and protected plants.

Rhododendron atlanticum	dwarf azalea
Rhododendron canescens	mountain azalea
Rhododendron periclymenoides	pink azalea
Rhododendron viscosum	swamp azalea
Rhus copallinum	winged sumac
Rosa carolina	Carolina rose
Rosa palustris	swamp rose (subshrub)
Rubus cuneifolius	sand blackberry (subshrub)
Sabal minor	dwarf palmetto
Sambucus nigra ssp. canadensis	American black elderberry
Serenoa repens	saw palmetto
*Stewartia malachodendron***	silky camellia**

** PLEASE NOTE!! *Stewartia malachodendron* is a protected plant in Georgia. Before choosing this shrub for planting, please take great care to assure that your conditions are appropriate for the necessary requirements and needs of this rare and protected plant.

Styrax grandifolius	bigleaf snowbell
Symplocos tinctoria	common sweetleaf
Vaccinium arboreum	farkleberry
Vaccinium corymbosum	highbush blueberry
Vaccinium crassifolium	creeping blueberry
Vaccinium elliottii	Elliott's blueberry
Vaccinium stamineum	deerberry
Viburnum dentatum	southern arrowwood
Viburnum nudum	possumhaw
Viburnum prunifolium	blackhaw
Viburnum rufidulum	rusty blackhaw
Xanthorhiza simplicissima	yellowroot

Cactus and Succulents

Yucca aloifolia	aloe yucca
Yucca filamentosa	Adam's needle

Perennials

Asclepias tuberosa	butterfly milkweed
Coreopsis gladiata	coastal plain tickseed
Coreopsis lanceolata	lanceleaf tickseed
Glandularia canadensis	rose mock vervain
Helianthus angustifolius	swamp sunflower
Hibiscus moscheutos	crimsoneyed rosemallow
Iris virginica	Virginia iris
Kosteletzkya virginica	Virginia saltmarsh mallow
Liatris spicata	dense blazing star
Oenothera drummondii	beach evening primrose
Oenothera speciosa	pinkladies
Phlox carolina	thickleaf phlox
Rudbeckia hirta	blackeyed Susan
Rudbeckia fulgida	orange coneflower
Salvia coccinea	blood sage
Salvia lyrata	lyreleaf sage
Solidago sempervirens	seaside goldenrod

Grasses and Sedges

Andropogon gerardii	big bluestem
Andropogon glomeratus	bushy bluestem
Andropogon virginicus	broomsedge bluestem
Arundinaria gigantea	giant cane
Chasmanthium latifolium	Indian woodoats
Chasmanthium laxum	slender woodoats
Chasmanthium sessiliflorum	longleaf woodoats
Eragrostis spectabilis	purple lovegrass
Muhlenbergia filipes	gulfhairawn muhly
Panicum amarum	bitter panicgrass
Panicum anceps	beaked panicgrass
Panicum virgatum	switchgrass
Rhynchospora colorata	starrush whitetop
Rhynchospora latifolia	sandswamp whitetop

Schizachyrium scoparium	little bluestem
Sorghastrum nutans	Indiangrass
Tridens flavus	purpletop tridens
Tripsacum dactyloides	eastern gamagrass
*Uniola paniculata***	seaoats**

**PLEASE NOTE!! *Uniola paniculata* is a protected plant in Georgia for its important role in beach ecosystems and shoreline stabilization. It is against Georgia law to collect the plant or its seeds from the wild.

Vines

Bignonia capreolata	crossvine
Gelsemium sempervirens	evening trumpetflower
Parthenocissus quinquefolia	Virginia creeper

Ground Covers

Mitchella repens	partridgeberry

Appendix B. Georgia Exotic Pest Plant Council

List of Non-native Invasive Plants in Georgia

Georgia EPPC Invasive Plant List Purpose

The purpose of the Georgia EPPC Invasive Plant List is to identify and categorize plants that pose threats to natural areas in Georgia. Natural areas are those areas that are managed to conserve or restore the native plant communities. For this list, invasive plants do not include plants that are only problems in agricultural or pastoral systems. The list does not have regulatory authority; it is intended to aid in land management decisions and increase public awareness of invasive species.

Invasive Plant Definition

Invasive species is defined as any species, including its seeds, spores or other biological material capable of propagating that species, that is not native to that ecosystem and whose introduction does or is likely to cause environmental harm. Political boundaries are not used when determining a species nativity. Instead, a species is defined as being exotic when it is not native to a particular ecosystem, making it possible to have a species that is native to parts of Georgia, but considered invasive in others.

List Description

The invasive plant list is separated into 4 categories with one subcategory (see category definitions below). Species were ranked by EPPC members with input from other professionals and land managers. Detailed distribution information does not exist for many of these species, making it difficult to use demonstrable distribution data as a criterion for ranking a species. Efforts are underway to collect this distribution data, and future revisions of the Georgia EPPC Invasive Species List will incorporate the data.

Category 1 - Exotic plant that is a serious problem in Georgia natural areas by extensively invading native plant communities and displacing native species.

Scientific Name	Common Name
Ailanthus altissima (P. Mill.) Swingle	tree of heaven
Albizia julibrissin Durazz.	mimosa
Alternanthera philoxeroides (Mart.) Griseb.	alligatorweed
Eichhornia crassipes (Mart.) Solms	Water hyacinth
Elaeagnus umbellata Thunb.	autumn olive
Hedera helix L.	English ivy
Hydrilla verticillata (L. f.) Royle	hydrilla

Lespedeza bicolor Turcz.	shrubby lespedeza
Lespedeza cuneata (Dum.-Cours.) G. Don	sericea lespedeza
Ligustrum sinense Lour.	Chinese privet
Lonicera japonica Thunb.	Japanese honeysuckle
Lygodium japonicum (Thunb. ex Murr.) Sw.	Japanese climbing fern
Melia azedarach L.	chinaberry
Microstegium vimineum (Trin.) A. Camus	Nepalese browntop
Murdannia keisak (Hassk.) Hand.-Maz.	marsh dewflower
Paulownia tomentosa (Thunb.) Sieb. & Zucc. ex Steud.	princesstree
Pueraria montana (Lour.) Merr.	kudzu
Rosa multiflora Thunb. ex Murr.	multiflora rose
Triadica sebifera (L.) Small	Chinese tallowtree
Wisteria sinensis (Sims) DC.	Chinese wisteria

Category 1 Alert - Exotic plant that is not yet a serious problem in Georgia natural areas, but that has significant potential to become a serious problem.

Scientific Name	Common Name
Achyranthes japonica (Miq.) Nakai	Japanese chaff flower
Alliaria petiolata (Bieb.) Cavara & Grande	garlic mustard
Arthraxon hispidus (Thunb.) Makino	small carpgrass
Celastrus orbiculatus Thunb.	Oriental bittersweet
Imperata cylindrica (L.) Beauv.	cogongrass
Paederia foetida L.	skunk vine
Polygonum cuspidatum Sieb. & Zucc.	Japanese knotweed
Salvinia molesta D. S. Mitchell	giant salvinia

Category 2 - Exotic plant that is a moderate problem in Georgia natural areas through invading native plant communities and displacing native species, but to a lesser degree than category 1 species.

Scientific Name	Common Name
Ardisia crenata Sims	coral ardisia
Cinnamomum camphora (L.) J. Presl	camphortree
Cynodon dactylon (L.) Pers	bermudagrass
Dioscorea oppositifolia L.	Chinese yam
Egeria densa Planch.	Brazilian egeria
Elaeagnus pungens Thunb.	thorny olive
Leucanthemum vulgare Lam.	oxeye daisy
Ligustrum japonicum Thunb.	Japanese privet
Lonicera maackii (Rupr.) Herder	Amur honeysuckle
Miscanthus sinensis Anderss.	Chinese silvergrass
Myriophyllum aquaticum (Vell.) Verdc.	parrotfeather watermilfoil
Nandina domestica Thunb.	sacred bamboo
Nasturtium officinale Ait. f.	Watercress
Paspalum notatum Flueggé	Bahiagrass
Phyllostachys aurea Carr. ex A.& C. Rivière	golden bamboo
Sesbania herbacea (P. Mill.) McVaugh	bigpod sesbania
Sesbania punicea (Cav.) Benth.	Rattlebox
Spiraea japonica L. f.	Japanese spiraea
Tamarix gallica L.	French tamarisk
Vinca major L.	bigleaf periwinkle
Vinca minor L.	common periwinkle

Category 3 - Exotic plant that is a minor problem in Georgia natural areas, or is not yet known to be a problem in Georgia but is known to be a problem in adjacent states.

Scientific Name	Common Name
Alternanthera sessilis (L.) R. Br. ex DC.	sessile joyweed
Ampelopsis brevipedunculata (Maxim.) Trautv.	Amur peppervine
Anthoxanthum odoratum L.	sweet vernalgrass
Arundo donax L.	giant reed
Berberis thunbergii DC.	Japanese barberry
Broussonetia papyrifera (L.) L'Hér. ex Vent.	paper mulberry
Carduus nutans L.	musk thistle
Centaurea cyanus L.	garden cornflower
Clematis terniflora DC	sweet autumn virginsbower
Colocasia esculenta (L.) Schott	coco yam, wild taro
Daucus carota L.	Queen Anne's lace, wild carrot
Dioscorea alata L.	winged yam
Dioscorea bulbifera L.	air potato
Eragrostis curvula (Schrad.) Nees	weeping lovegrass
Euonymus fortunei (Turcz.) Hand.-Maz.	winter creeper
Hemerocallis fulva (L.) L.	orange daylily
Hibiscus syriacus L.	rose of Sharon
Lantana camara L.	Lantana
Lespedeza thunbergii (DC.) Nakai	Thunberg's lespedeza
Ligustrum lucidum W.T. Aiton	glossy privet
Limnophila sessiliflora (Vahl) Blume	Asian marshweed
Liriope muscari (Dcne.) Bailey	Monkeygrass
Lonicera fragrantissima Lindl. & Paxton	sweet breath of spring
Mahonia bealei (Fortune) Carr.	leatherleaf mahonia
Marsilea minuta L.	dwarf waterclover
Melilotus alba Medikus	
Melinis repens (Willd.) Zizka	rose natal grass

Mentha x piperita L. (pro sp.)	Peppermint
Morus alba L.	white mulberry
Mosla dianthera (Buch.-Ham. ex Roxb.) Maxim.	miniature beefsteakplant
Myriophyllum spicatum L.	Eurasian watermilfoil
Panicum repens L.	Torpedograss
Paspalum urvillei Steud.	Vasey's grass
Phragmites australis (Cav.) Trin. ex Steud.	common reed
Poa annua L.	annual bluegrass
Polygonum persicaria L.	spotted ladysthumb
Poncirus trifoliata (L.) Raf.	trifoliate orange
Potamogeton crispus L.	curlyleaf pondweed
Pyrus calleryana Dcne.	Callery pear (Bradford pear)
Rottboellia cochinchinensis (Lour.) W.D. Clayton	Itchgrass
Rubus armeniacus Focke	Himalayan blackberry
Schedonorus phoenix (Scop.) Holub	tall fescue
Securigera varia (L.) Lassen	Crownvetch
Sesbania vesicaria (Jacq.) Ell.	Bagpod
Solanum viarum Dunal	tropical soda apple
Sorghum halepense (L.) Pers.	Johnsongrass
Stachys floridana Shuttlw. ex Benth.	Florida hedgenettle
Vernicia fordii (Hemsl.) Airy-Shaw	tungoil tree

Category 4 - Exotic plant that is naturalized in Georgia but generally does not pose a problem in Georgia natural areas or a potentially invasive plant in need of additional information to determine its true status.

Scientific Name	Common Name
Akebia quinata (Houtt.) Dcne.	chocolate vine
Allium vineale L.	wild garlic
Alysicarpus vaginalis (L.) DC.	white moneywort
Artemisia vulgaris L.	common wormwood
Bidens bipinnata L.	Spanish needles
Bidens pilosa L	hairy beggarticks
Bromus secalinus L.	rye brome
Bromus tectorum L.	Cheatgrass
Cirsium vulgare (Savi) Ten.	bull thistle
Commelina benghalensis L.	Benghal dayflower
Cytisus scoparius (L.) Link	Scotch broom
Euonymus alatus (Thunb.) Sieb.	winged burning bush
Fatoua villosa (Thunb.) Nakai	mulberryweed
Firmiana simplex (L.) W. Wight	Chinese parasoltree
Ilex cornuta Lindl. & Paxton	Chinese holly
Ilex crenata Thunb.	Japanese holly
Ipomoea coccinea L.	Redstar
Ipomoea cordatotriloba cordatotriloba Dennst.	Tievine
Ipomoea purpurea (L.) Roth	tall morningglory
Jacquemontia tamnifolia (L.) Griseb.	smallflower morning-glory
Kummerowia stipulacea (Maxim.) Makino	Korean clover
Kummerowia striata (Thunb.) Schindl.	Japanese clover
Liriope spicatum Lour.	creeping liriope
Najas minor All.	brittleleaf naiad
Orobanche minor Smith	small broomrape
Paspalum quadrifarium Lam.	tussock paspalum
Polygonum caespitosum Blume	oriental ladysthumb
Polygonum sachalinense F. Schmidt ex Maxim.	giant knotweed

Pyracantha coccinea M. Roemer	scarlet firethorn
Quercus acutissima Carruthers	sawtooth oak
Rosa laevigata Michx.	Cherokee rose
Rubus phoenicolasius Maxim.	wine raspberry
Setaria faberi Herrm.	giant foxtail
Setaria pumila (Poir.) Roemer & J.A. Schultes	yellow foxtail
Setaria viridis viridis (L.) Beauv.	green bristlegrass
Sonchus asper (L.) Hill	spiny sowthistle
Sonchus oleraceus L.	common sowthistle
Torilis arvensis (Huds.) Link	spreading hedgeparsley
Verbascum thapsus L.	common mullein
Verbena bonariensis L.	purpletop vervain
Verbena brasiliensis Vell.	Brazilian vervain
Wisteria floribunda (Willd.) DC.	Japanese wisteria

Appendix C.

☑ Riparian Buffer Checklist for Success

Site Selection

- ☐ Site is suitable for restoration.
- ☐ Landowners permission is granted.

Site Analysis

- ☐ Evaluated site's physical conditions (soil attributes, geology, terrain)
- ☐ Evaluated site's vegetative features (desirable and undesirable species, native species, invasive species, sensitive habitats)
- ☐ Sketch or map of site obtained.

Buffer Design

- ☐ Consider landowner objectives in creating buffer design
- ☐ Determine desired functions of buffer in determining buffer width.
- ☐ Plant species selection matches site conditions (hardiness zone, moisture, pH)
- ☐ Plant species selection meets objectives of buffer functions (water quality, wildlife, recreation, etc.)
- ☐ Plant sizes meet budget limitations.
- ☐ Sketch of planting plan developed.

Site Preparation

- ☐ Undesirable invasive species are eliminated well ahead of planting date (may require combination of physical and herbicidal techniques).
- ☐ Planting layout is marked for volunteers at the site.
- ☐ Plants and planting materials (mulch, tree shelters) are purchased well in advance.

Site Plan Includes the Following Information:

- ☐ Map of the site with appropriately marked planting zones.
- ☐ Native plant species list
- ☐ Planting directions (spacing, pattern of planting)
- ☐ Equipment/tool list
- ☐ Site preparation directions
- ☐ Maintenance schedule

Planting Day

- ☐ Plants are kept moist and shaded.
- ☐ Adequate number of tools are on hand.
- ☐ If utilizing volunteers, they are adequately trained and have signed waiver forms.
- ☐ Photos are taken of site planting.
- ☐ Refreshments are on hand.

Site Maintenance

- ☐ Responsibilities are assigned for watering, weeding, mowing, and maintenance of tree shelters or mats.
- ☐ Site is monitored regularly for growth and potential problems.

APPENDIX D.

How Can I Help Restore and Protect Georgia's Coastal Riparian Buffers?

If you are a landowner:

- Plant native species of trees and shrubs.
- Stop mowing to the stream's edge.
- Join your local watershed organization.
- Protect buffers through conservation easements.

If you are a farmer:

- Fence streams.
- Enroll buffers in set aside programs.
- Partner with local watershed and sporting organizations.
- Consider alternatives to cropping that also provide economic returns while preserving buffers (e.g., pollinator plantings)

If you are a developer:

- Avoid removing streamside trees and shrubs.
- Incorporate conservation into your subdivision designs.

If you help run a business or industry:

- Plant native species of trees and shrubs.
- Consider sponsoring a school or community organization that wants to plant trees.
- Consider options for limiting business activities that impact buffers.

If you belong to a conservation or volunteer organization:

- Plant native species of trees along streams.
- Partner with agricultural landowners and municipalities.
- Organize volunteers and work parties to help maintain buffers.

If you are a municipal official:

- Adopt the Coastal Georgia Riparian Buffer model ordinance that protects and improves stream corridors.
- Support landowners who protect their buffers.
- Establish incentives for participation.

- Partner with neighboring municipalities to promote consistent ordinances.
- Create recreational greenways.

If you are a student or teacher:

- (Colleges/universities) – Conduct research to help futher define buffer values and maintenance techniques.
- Incorporate buffer protection activities into lesson plans.
- Establish a buffer on school premises if you have a stream or pond.

If you work for a governmental agency:

- Develop new information and act as a clearinghouse for existing information.
- Support existing coastal Georgia riparian buffer guidelines for establishing and maintaining buffers, and provide technical assistance.
- Establish incentives for participation.