Riparian Forest Buffer - 391
DESIGN AND INSTALLATION GUIDE

Riparian Forest Buffer shall be planned and applied in accordance with the Standard detailed in the Field Office Technical Guide- Section IV. This document provides additional parameters, procedures, and requirements for developing site-specific plans for this practice. Where appropriate, specific references are noted and hot linked to provide detailed information needed for a successful design.

Generally Riparian Forest Buffers are designed for different purposes than are windbreaks or wildlife plantings. As with most forestry practices, however, slight modifications of design will permit Riparian Forest Buffers to serve additional purposes while addressing the main purpose.

RIPARIAN FOREST BUFFER PARTS AND FUNCTION

Riparian forest buffers are positioned on the landscape adjacent to permanent and intermittent streams and water bodies. They are strongly influenced by the additional water that is present within riparian areas. See Figure 1. This additional moisture, beyond normal precipitation for the locality, impacts the type and vigor of vegetation that can be sustained in a riparian area. Riparian areas are generally the most biologically diverse and productive landform. Riparian forests can vary in width from a narrow band near the stream edge to a fully stocked forest that encompasses the entire flood plain.

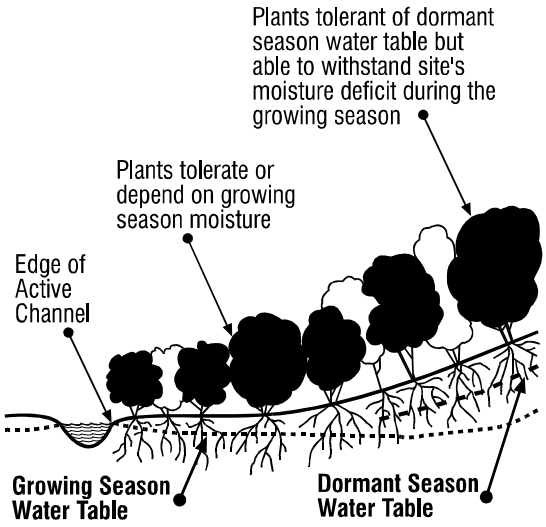

Figure 1. Plant adaptation to soil moisture.

Riparian Forest Buffer Parts

All buffers will consist of a zone 1 that begins at the normal water line (bank-full elevation) or at the top of the bank and extends a minimum distance of 15 feet, measured horizontally on a line perpendicular to the water body. See Figure 2. Generally, only the minimum management to maintain required forest cover is permitted in Zone 1.

All buffers will also consist of a zone 2 that begins at the upper end of zone 1 and extends outward for a minimum of 20 feet. See Figure 2. Most normal forestry management and harvest activities are permitted in zone 2 as long as riparian functions are maintained.

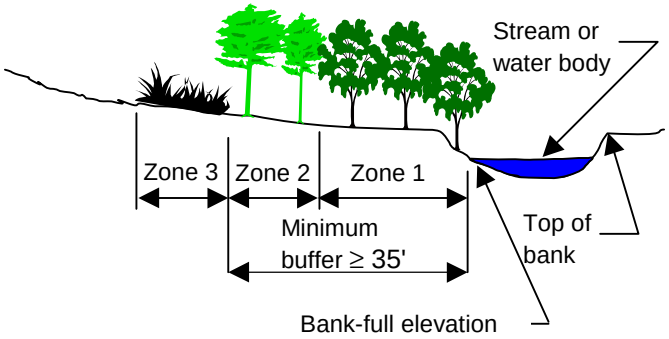

Figure 2: Parts of a Riparian Forest Buffer

Bank-full elevation is the lowest point in the stream channel where permanent vegetation begins to take hold on sand and gravel bars. Often this elevation is equivalent to the top of the water on a 2-year frequency storm event. Local experiences or on-site observations are necessary to determine bank-full elevation.

Where riparian forest buffers are located

downstream of a potential sediment source, they should also include a zone 3, consisting of stiff, upright grasses. See ND FOTG practice "Filter Strip" for design considerations. The minimum design for a zone 3 will be the minimum filter strip design required for sediment entrapment.

Riparian Forest Buffer Functions

To design better riparian forest buffers, knowledge of how they function is necessary. A short summary of riparian forest buffer functions follow.

Riparian Forest Buffers reduce sediment, organic matter, nutrients and pesticides in surface water by:

Retarding runoff and increasing infiltration. RFB's can absorb rainfall that carries soil and pollutants at 10-15 times the rate of grass turf and 40 times that of a plowed field. (*Maryland Dept. of Natural Resources)*

Reducing excess nutrients and other chemicals in shallow ground water by: absorbing nutrients and chemicals and storing them in the roots and stems of the RFB plants. Some generalized averages for annual nitrogen uptake by trees include about 60 pounds per acre per year for deciduous species. (*Cole and Rapp, 1980.)* Wooded riparian buffers in the Maryland coastal region were found to remove as much as 80 percent of excess phosphorous and 89 percent of excess nitrogen with most effect occurring within the first 62 feet. (*Shisler et al, 1987*)

Denitrification. Estimates for denitrification in natural riparian forests in the U.S. are in the range of 25 to 35 pounds N per acre per year. Several studies indicate that denitrification [anaerobic microbial conversion of nitrate to N gases] is concentrated in surface soil down to about 6 to 12 inches. (*Hendrickson, 1981*)

Retarding flood flows to encourage trapping of debris and deposition of sediment along with the contaminants attached to the sediment. Missouri studies after the 1993 floods showed that healthy contiguous RFB's effectively kept debris and sediment off crop fields behind the RFB while depositing debris and sediment within the RFB. (*Conversation with NRCS Forester, Missouri*)

Riparian Forest Buffers reduce scour erosion by:

Anchoring flood plain soils with extensive and deep root systems, reducing flood velocities across the flood plain and the corresponding erosive energy. They act as a physical barrier between floodwaters and landforms behind the RFB, protecting these more distant sites from erosion. (*Value of Woody River Corridors in Levee Protection along the Missouri River in 1993, Journal of the American Water Resources Association*)

Riparian Forest Buffers provide harvestable products.

Almost one-fifth (80,000 acres) of the timberland of North Dakota is within 200 feet of a stream or lake. In 1992 North Dakota's 44 lumber and wood product establishments… shipped products valued at almost $73 million. (*North Dakota's Forest Resources, 1994*)

Riparian Forest Buffers reduce stream temperatures

Through direct shading of the stream and by shading the soil over which and through which stream recharge waters flow. Small streams flowing through exposed reaches can experience increases in temperature of up to 1.5 degrees Fahrenheit for every 100 feet of sun exposure. Maximum daily temperatures can be as much as 12 to 15 degrees higher in exposed streams, rendering them unfit for many species of fish. (*Maryland Dept. of Natural Resources*)

Riparian Forest Buffers are a source of large, woody debris for streams.

In one Oregon study, large woody debris was looked at to determine pool creation potential. The large woody debris created an additional 43 percent pool volume in one stream and 71 percent in the other. Local trout species were attracted to the new pool location, particularly during low flows in summer. (*Montana State University, 1997*)

Riparian Forest Buffers are important wildlife habitat.

Hundreds of bird species use riparian forests. In western Montana, 59 percent of all land birds use riparian forests for breeding. Of that, almost half are totally dependent on riparian areas and are unable to reproduce in other habitats. The number of species of neotropical migrant birds (birds that fly south of the U. S. border each winter] in Montana total 144, which is over half of the breeding land birds in the state. (*Montana State University, 1997*)

Riparian Forest Buffers sequester carbon by:

Actively growing in size, both above and below ground. About half the wood in a tree is made of carbon. Temperate deciduous tree species produce about 180 pounds of biomass per one pound of nitrogen uptake. (*Cole and Rapp*) Research in the Pacific Northwest shows that 10-year old forest plantations removed 180-330 metric tons of CO2 per acre. (*Working Trees for Carbon Balance, 2001*)

RIPARIAN BUFFER DESIGN FOR ALL PURPOSES

Riparian Forest Buffers shall be located no closer than 16 feet to any property line unless a signed agreement between both owners exists that would permit a closer planting.

According to North Dakota Century Code, no trees or shrubs may be placed within 33 feet of a section line unless written permission has first been secured from the county commissioners or township supervisors.

No trees shall be placed within the easement area of overhead transmission lines unless permission has been secured from the appropriate utility company.

As per international treaty, no trees or shrubs shall be planted in a location where the foliage, at maturity, will encroach upon the 20' wide (10' each side) line-of-site vista along the Canadian-US border.

Trees or shrubs that are adjacent to, or cross, legal and private drainage ways should be setback at least 100' to prevent snow and ice buildup that will restrict spring drainage.

Riparian Forest Buffers will not be located where they will cause snow drifts to impact roadways. See "Windbreak Shelterbelt Establishment" in the ND FOTG for set back distances.

Avoid establishing buffers where snowdrifts created by the planting will impact transportation corridors.

Consider the type of human use (rural, suburban, and urban) and the aesthetic, social and safety aspects of the area to determine the vegetation selection, arrangement and management. For example, avoiding shrubs that block views and pruning lower tree branches near recreation trails allows for ease of patrolling. Refer to "Tree and Shrub Characteristics" for specific plant characteristics.

Caution: Several of the riparian forest buffer establishment methods involve substantial soil disturbances to depths below typical agricultural tillage. This depth of disturbance may require notification of various utility companies via the North Dakota One Call System at 1-800-795-0555.

Certain riparian forest buffers will require compliance with Federal Historic Preservation Law.

In all cases, if local units of government have established more restrictive setback distances, then the more restrictive regulations will apply.

Minimum Design Width (All Riparian Forest Buffers)

1. 30 percent of the width of the geomorphic flood plain or 100 feet, whichever is smaller
2. No matter the flood plain width, the minimum width for a riparian forest buffer is 35 feet. (For flood plains wider than 115 feet, the minimum riparian forest buffer width will be wider than 35 feet and calculated using condition 1 above.)
3. Figure 4 illustrates examples of minimum widths for zone 1 and 2 along watercourses and water bodies formed under different hydrologic conditions.

Minimum Design Widths by Specific Function (each side of stream)

Listed below are generalized riparian forest buffer minimum widths necessary for adequate performance of several specific buffer functions.

- ❑ 60-100 feet for water temperature moderation
- ❑ 35-200 feet for sediment removal
- ❑ 35-300 feet for nutrient removal
- ❑ 35-600 feet for species diversity (habitat)

Minimum Design Widths for Selected Species of Wildlife (Total of both sides of stream)

- 600 feet for bald eagles, cavity-nesting ducks, heron rookeries, sandhill cranes
- 450 feet for common loons, pileated woodpeckers
- 300 feet for beaver, dabbling ducks, mink, salmonids
- 200 feet for deer
- 165 feet for lesser scaup, harlequin ducks
- 100 feet for salamanders, frogs

The initial goal of a riparian forest buffer is to fully "capture" the site with a fully stocked forest planting that will quickly develop a duff layer, detritus, and rapidly growing trees with extensive root systems that will begin riparian functions as soon as possible. High initial stocking rates will minimize establishment delays and lead to a riparian planting with greater management options in the future.

Initial plant-to-plant densities for trees and shrubs will depend on their potential height at 20 years of age. Heights may be estimated based on: 1) performance of the individual species (or comparable species) in nearby areas on similar sites, or 2) predetermined and documented heights, using Expected 20-Year Tree Heights found in Section II of the Field Office Technical Guide.

Plant Density Specification Are:

Plant Types/Heights	Plant to Plant Spacings (feet)
Shrubs less than 10 feet tall	3 to 6
Shrubs/trees 10-25 feet tall	5 to 8
Trees greater than 25 feet tall	8 to 14

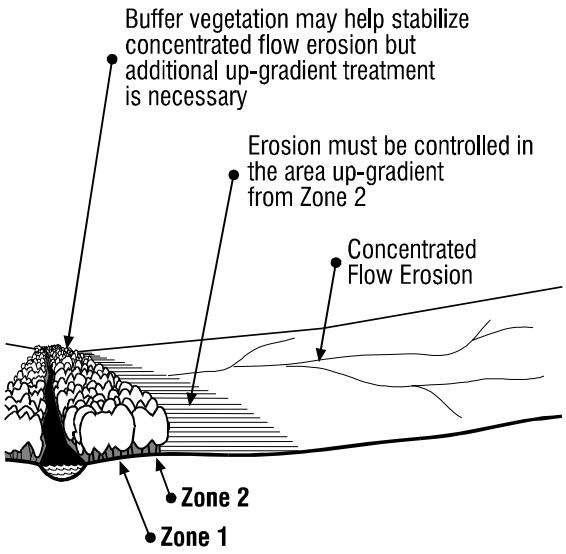

Figure 3: Control of Concentrated Flow Erosion

Concentrated flow erosion upgradient of the buffer (zone 3) must be controlled to assure successful function of the riparian forest buffer in filtering sediment and pollutants from adjacent land uses. See Figure 3. At a minimum, the addition of a grassed filter strip will usually be necessary. Refer to FOTG practice standard "Filter Strip"

Where filter strips are not expected to control the concentrated flow, structural measures may be needed. Refer to the appropriate structural practice standard in Sec IV ND FOTG. For maximum water quality improvement, water moving across the RFB must be as sheet flow, or near-surface groundwater flow.

For watercourses or waterbodies with streambank or shoreline erosion, the establishment of riparian forest buffers must be done at the same time or following the installation of streambank and shoreline protection. Refer to FOTG practice standard "Streambank and Shoreline Protection"

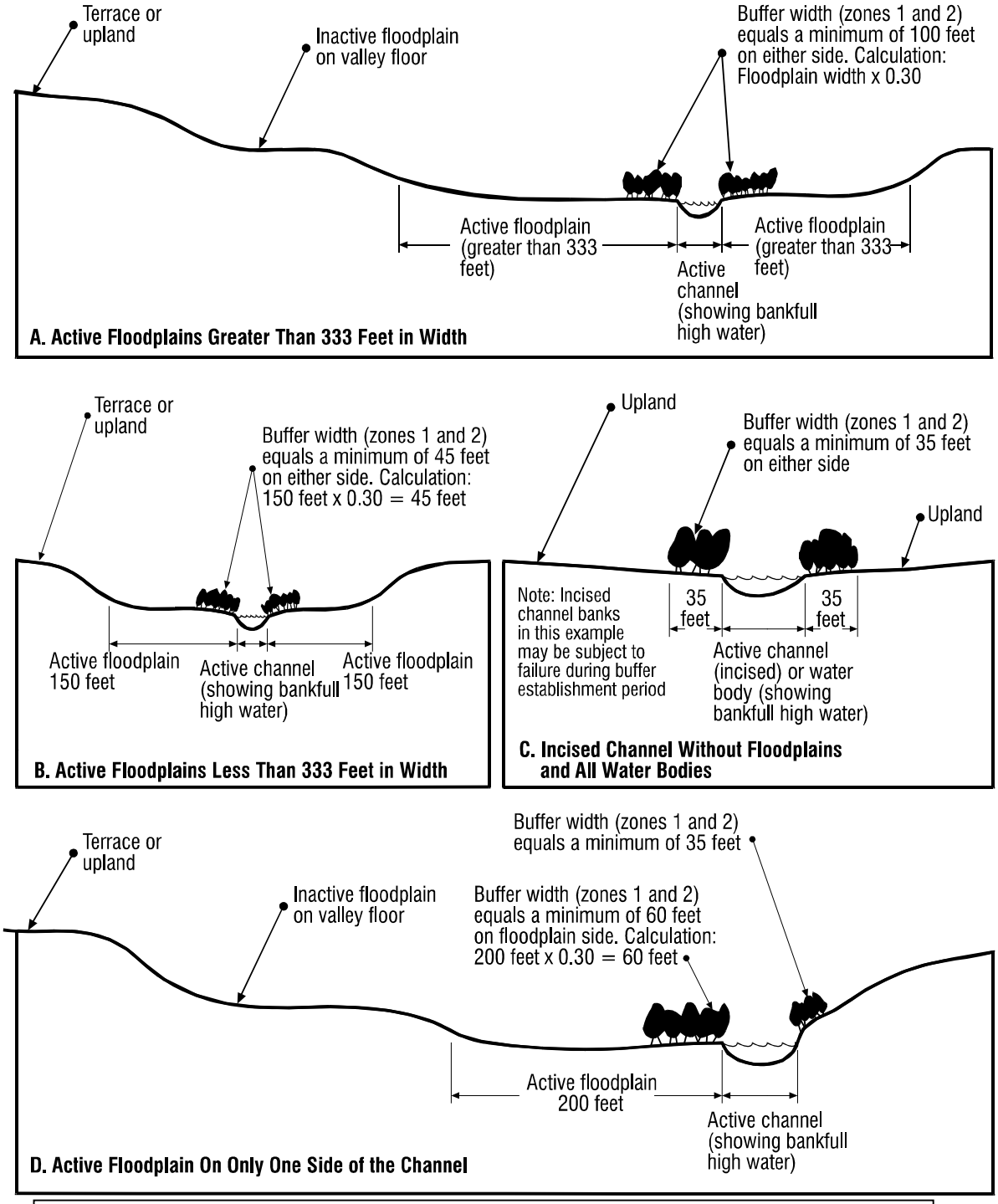

Figure 4. Examples of riparian forest buffer widths for watercourses and water bodies.

Riparian Forest Buffer - Tree/Soil Compatibility

Selection of local native species will be a priority where feasible. Plantings will consist of two or more species with individual plants suited to the seasonal variation of soil moisture at the site. To determine which trees will grow satisfactorily on which soils and to determine the expected heights after 20 years, refer to the Expected 20-Year Tree Heights and Windbreak Suitability Groups by County found in Section II, Field Office Technical Guide. Species that resprout will be used when establishing new rows nearest to streams or waterbodies subject to flooding or ice damage.

Woody Plant Stock

Plant types and species shall be selected based on the their compatibility in growth characteristics and applicability to specific riparian functions and locations within the riparian zone. Species to meet a specific riparian function shall be selected from "Tree and Shrub Characteristics". Tree planting stock may vary depending upon the site and purpose of the planting. Once stock type has been determined refer to "Tree Care and Management" page 2 for quality of planting stock to use. Use of native species is strongly encouraged. State-listed noxious weeds will be controlled and will not be part of the planting design.

Species diversity should be considered to avoid loss of function due to species-specific pests.

Woody phreatophytes (plants that obtain water by the penetration of their roots into the water table) and hydrophytes that deplete ground water should be used with caution in water-deficit areas

An adequate upstream or adjacent seed source must be present when using natural regeneration to establish a buffer. Follow the guidelines found on pages 6 and 10 of "Tree Care and Management," when determining the practicality or methodology of using natural regeneration as an establishment method.

Stock Storage, Handling, and Care Requirements

To determine proper stock storage, handling and care requirements, refer to "Tree Care and Management" page 3-4.

Site Preparation

To determine an appropriate method of site preparation, refer to "Tree Care and Management" pages 4-8.

Planting

To determine an appropriate planting technique for a particular stock used in a riparian forest buffer, refer to "Tree Care and Management", page 8-11.

DESIGNS BY PURPOSE

Designs to Reduce Sediment, Excess Nutrients, Pesticides and Organic Material

Select species that are rapid growing and have an ability to absorb large amounts of nutrients from the ground water. Generally, species like cottonwood, hybrid poplars and willows grow fast in riparian areas. See Plant Density Specifications, page 4 of this document for plant to plant spacings. See "Tree and Shrub Characteristics" to determine which species are appropriate for this purpose.

Weed control should be sufficient to ensure rapid establishment of the woody plants. Be alert to erosion potential if using tillage, especially in areas prone to flooding.

For best results the woody plants should be harvested (utilized) and removed from the site to ensure long-term water quality improvement.

Designs for Erosion Control

Where ephemeral, concentrated flow or sheet and rill erosion and sedimentation is a concern in the area up-gradient of zone 2, consider the application of a vegetated strip consisting of grasses and forbs. Stiff-stemmed grasses established at the up-gradient edge of zone 2 will accelerate deposition of sediment. See figure 5. Refer to "Filter Strip" in the ND-NRCS FOTG for guidance in establishing filter strips up-gradient from zone 2. When concentrated flow or excessive sheet and rill erosion and sedimentation cannot be controlled vegetatively, consider structural or mechanical treatments.

Consider species that resprout when establishing new rows nearest to watercourses or water bodies.

Avoid layouts and locations that would concentrate flood flows or return flows. Low, flexible-stemmed shrubs will minimize obstruction of local flood flows.

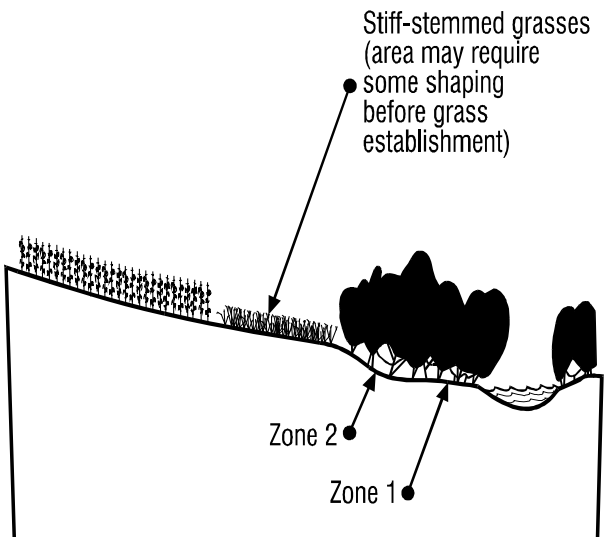

Figure 5: Sediment trapping above zone 2

Designs to Restore Riparian Plant Communities

Joining of existing and new buffers increases the continuity of cover and will further moderate water temperatures. A mix of species with growth forms that are tall and wide-crowned or drooping will increase moderation effects. For watercourses, buffers established on both sides will enhance multiple values.

Use recommendations from regional or other large-scale evaluations and plans when designing, locating and connecting buffers for indicator and/or target species of wildlife, fish and other aquatic organisms. The Buffer Width Guide for Selected Wildlife Species in General Specifications contains guide widths for key species.

The location, layout and density of the buffer should complement natural features.

Designs for Forest Products

Favor tree and shrub species that are native and have multiple values such as those suited for timber, biomass, nuts, fruit, syrup, and exhibit a tolerance to locally used herbicides. Select stocking rates within the range of those given on page 4 of this document. For most situations, subsequent thinning or pruning operations will be needed to maximize the value of the forest products produced. For pruning guidance refer to "Tree and Shrub Pruning". For guidance on thinning, refer to "Forest Stand Improvement",
For a variety of designs specific to individual forest products refer to pages 4 and 5 of "Tree Shrub Establishment"

Designs to Lower Stream Temperatures

A buffer for lowering warm-season water temperatures shall consist of at least zone 1 for watercourse reaches or water bodies less than or equal to 30 feet in width or water bodies greater than 30 feet wide but less than 1 acre. (Note: Buffers for wider water courses or larger water bodies may be valuable but will have only site-specific impacts on lowering water temperatures.)

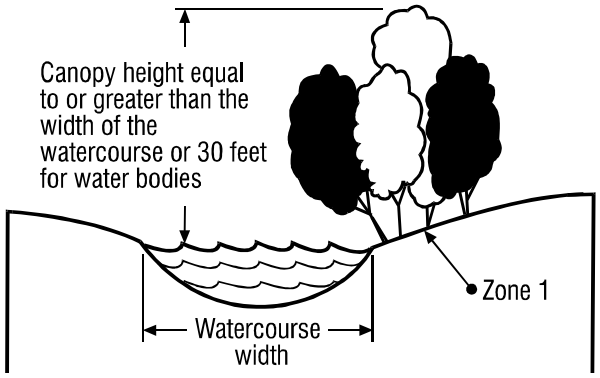

Figure 4. Canopy height for water temperature control.

Buffers shall be established or maintained on south and west sides of watercourses and bodies insofar as practical. The buffer canopy shall be established to achieve at least 50 percent crown cover with average canopy heights equal to or greater than the width of the water course or 30 feet which ever is less. See Figure 4.

Designs for Aquatic Organisms

Within zone 1 generally favor species that attain a large size to provide an eventual source of large woody debris for in-stream habitat for fish and other aquatic organisms. To determine which species are effective sources of detritus, refer to "Tree and Shrub Characteristics". Where zone 1 plants can be damaged by ice and flood flows, utilize species that sucker freely. If needed, these suckering plants may be interspersed with larger-growing species that are detritus sources.

Designs For Wildlife

When the primary purpose of a riparian forest buffer is to improve conditions for wildlife, it is best to refer to the "Wildlife Upland Habitat Management" and "Wetland Wildlife Habitat Management" of the ND NRCS FOTG for specific details appropriate for the wildlife specie(s) of interest. However, the designs of riparian forest buffers for other purposes can be modified to make the practice more beneficial to wildlife while still addressing the original purpose of the planting. Considerations for improving the wildlife value of riparian forest buffers include, but are not limited to:

1. Provide dense areas (thickets) of suckering shrubs for winter thermal protection. For this purpose suckering shrubs shall be planted at a 4x4 or 5x5 foot spacing.
2. Choose a variety of plants that will provide food throughout the growing season, especially during mid and late winter. Refer to "Tree and Shrub Characteristics "for the value of individual species as a food source. Plantings shall consist of at least one food source that provides food from mid through late winter.
3. Retain 1-2 dead trees per acre as den trees and roost sites.
4. Connect isolated plantings together and provide travel corridors by extending riparian forest buffers along more of the stream reach or water body.
5. Consider the positive and negative impacts beaver, muskrat, deer, rabbits and other local species may have on the successful management of the riparian and stream system. Temporary and local population control methods of these kinds of local species should be used cautiously and within state and local regulations.

Designs for Carbon Storage

For maximum carbon storage, select species that live long; grow large, both above and below ground; and have the potential to develop usable material. Use a variety of species to minimize catastrophic losses. Maximum carbon storage is realized when the trees that capture the carbon are utilized in place of carbon-based fuels or are stored in a manner where the carbon will not be released through decomposition or combustion.

PLANS, AND SPECIFIC SPECIFICATIONS

Site-specific design specifications shall be prepared for each site and include, at a minimum, the following information to assist with installation and maintenance of the riparian forest buffer.

- Landowner name, address, email or phone number
- Legal description to nearest quarter section
- Aerial photo, arc view image or scaled sketch of the planting area showing location of key components
- Extent of practice(s)
- Soils and windbreak suitability groups of the tree and shrub planting area
- Recommended site preparation methods
- Planting technique(s)
- Plant stock - Type of stock, species, number of each species,
- Planting design - plants per acre, location of each species on site
- Time of year to be planted
- Maintenance requirements

OPERATION AND MAINTENANCE

A riparian forest buffer planting shall be considered successfully established if during the third growing season, 75 percent of the trees and shrubs planted are growing vigorously. For riparian forest buffers established from seeds, a successful planting shall consist of 15,000 seedlings per acre measured during the first growing season.

Competitive vegetation will be controlled for at least 3 years after planting. To minimize erosion risks and to maximize riparian benefits, do not remove herbaceous vegetation from the entire area of the riparian planting. Utilize patch or strip weed control methods to maintain a 3-foot wide, weed-free zone (1½ feet either side of the plant) around each plant while leaving herbaceous vegetation on the rest of the site to prevent erosion.

Utilize mowing, herbicides, or tillage to prevent invasion of aggressive sod-forming grasses and weeds until the tree canopies have closed.

Where overland water flow may create a scour erosion hazard, orient the weed free zones at an angle to the water flow. Perpendicular is most effective.

Felling and skidding of trees shall be directed away from the water course or water body. Skidding will be done in a manner that prevents creation of ephemeral channels perpendicular to the stream.

Successful establishment of a Riparian Forest Buffer may be hindered or threatened by activities of beaver, moose, muskrat, mice, deer, rabbits or etc. Temporary and local population control or behavioral control may be necessary until the plants of the riparian forest buffer are large enough to withstand the wildlife pressure. For wildlife control procedures refer to "Prevention and Control of Wildlife Damage" http://wildlifedamage.unl.edu/

Water course crossings and livestock watering shall be located and sized to minimize impact to buffer vegetation and function. On established buffers included within grazed areas, set utilization rates of key woody browse to allow woody vegetation to re-grow sufficiently for its intended function. Impairment of buffer function by livestock overuse (soil compaction, trampling, or over-utilization of woody plants) shall require immediate removal of livestock from the riparian area.