NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

RIPARIAN FOREST BUFFER

(Ac.)

CODE 391

DEFINITION

An area, predominantly trees and/or shrubs, located adjacent to and up-gradient from watercourses or water bodies.

PURPOSE

- Create shade to lower or maintain water temperatures to improve habitat for aquatic organisms.
- Create or improve riparian habitat and provide a source of detritus and large woody debris.
- Reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow ground water flow.
- Reduce pesticide drift entering the water body.
- Restore riparian plant communities.
- Increase carbon storage in plant biomass and soils.
- Mitigate flooding damage by trapping large debris and water-borne sediments, and slowing flood waters.

CONDITIONS WHERE PRACTICE APPLIES

Riparian forest buffers are applied on areas adjacent to permanent or intermittent streams, lakes, ponds, and wetlands. They are not applied to stabilize stream banks or shorelines.

CRITERIA

General Criteria Applicable to All Purposes

The riparian forest buffer shall be positioned appropriately and designed to achieve sufficient width, length, vertical structure/density and connectivity to accomplish the intended purpose(s).

Excessive sheet-rill and concentrated-flow erosion will be controlled in the areas immediately adjacent and up-gradient of the buffer site.

Dominant vegetation will consist of existing, naturally regenerated, or seeded/planted trees and shrubs suited to the soil and hydrology of the site and the intended purpose(s).

Necessary site preparation and planting shall be done at a time and manner to insure survival and growth of selected species for achieving the intended purpose(s). Refer to TREE/SHRUB SITE PREPARATION (490) and TREE/SHRUB ESTABLISHMENT (612).

Harmful plant and animal pests present on the site will be controlled or eliminated as necessary to achieve and maintain the intended purpose. If pesticides are used, refer to the standard INTEGRATED PEST MANAGEMENT (595).

The vegetation will extend a minimum width to achieve the purpose(s). Measurement shall begin at and perpendicular to the normal water line, bank-full elevation, or the top of the bank as determined locally.

The buffer will consist of two zones. Zone 1 will begin at the normal water line or at the upper edge of the active channel or shore and extend 25 feet (measured horizontally on a line

perpendicular from the watercourse). Zone 2 will begin immediately from Zone 1 and extend a minimum distance listed in the Minimum Zone Widths table below. Zone 1 and 2 additive distances equal the minimum required riparian forest buffer width.

Minimum Zone Widths

Stream Order	Zone 1	Zone 2	Total
1, 2	25 feet	25 feet	50 feet
3 and larger	25 feet	75 feet	100 feet
(3 exception*)	25 feet	25 feet	50 feet

** Third order streams that have surface flow for less than 6 months out of the year.*

Stream order is a description of a drainage pattern. It is a measure of the position of a stream in the hierarchy of tributaries. First order streams are those which have no tributaries. Stream order increases when two streams of equal order join. For example it takes two second order streams joining to make a third order stream.

Use tree and shrub species that are native and non-invasive. Substitution with improved and locally accepted cultivars or purpose-specific species is allowed. For plantings and seeding, only viable, high-quality and adapted plant materials will be used. No single species will make up more than 50% of the total number of species planted.

Favor tree and shrub species that have multiple values such as those suited for timber, biomass, nuts, fruit, browse, nesting, aesthetics and tolerance to locally used herbicides.

Periodic removal of some forest products such as high value trees, medicinal herbs, nuts, and fruits is permitted provided the intended purpose is not compromised by the loss of vegetation or harvesting disturbance.

Livestock shall be controlled or excluded as necessary from Zones 1 and 2 to achieve and maintain the intended purpose. Refer to the standards PRESCRIBED GRAZING (528), and/or ACCESS CONTROL (472), as applicable.

Livestock control must include a grazing prescription that addresses duration, intensity, season/frequency of use, and alternative water sources. Impairment of planned riparian buffer function by livestock overuse (trampling, compaction, over utilization of woody cover, etc.) shall require immediate removal of livestock from the riparian area. Reduce or eliminate livestock access to keep the riparian area fully functional.

Additional Criteria to Create Shade to Lower or Maintain Water Temperatures to Improve Habitat for Aquatic Organisms.

Buffer species shall be capable of achieving desired height and crown density required for shade production. The buffer canopy shall be established to achieve at least 50 percent crown cover with an average projected (for the critical shading time and month) canopy shade (shadow) length equal to or greater than the width of the water course or the area in need of shading. Refer to Practice Specifications for calculating shadow lengths.

Place drooping or wide-crowned trees and shrubs nearest the water course or body. Shoreline or channel relief (e.g., deeply incised channels) and topographic shading should be taken into account in selecting species and determining shadow lengths.

Additional Criteria to Create or Improve Riparian Habitat and Provide a Source of Detritus and Large Woody Debris.

The width will be extended to meet the minimum habitat requirements of the wildlife or aquatic species of concern.

Existing functional underground drains shall be replaced with non-perforated pipe under the buffer area to alleviate root intrusion and to sustain the drains functionality. Alternatively, a regulating valve or structure may be installed on the drain to control drain outflow.

Establish plant communities that address the target aquatic and terrestrial wildlife needs and have multiple values such as habitat, nutrient uptake and shading. The establishment of diverse native woody and herbaceous species will enhance wildlife and pollinator values.

For riparian wildlife buffer width guidelines refer to Practice Specifications.

Additional Criteria to Reduce Excess Amounts of Sediment, Organic Material, Nutrients and Pesticides in Surface Runoff and Reduce Excess Nutrients and Other Chemicals in Shallow Ground Water Flow

The minimum width shall be at least *50 feet* measured horizontally on a line perpendicular to the water body beginning at the normal water line, bank-full elevation, or the top of the bank as determined locally.

The width will be extended in high nutrient, sediment, and animal waste application areas, where the contributing area is not adequately treated or where an additional level of protection is needed.

Existing, functional underground drains through the riparian area will pass pollutants directly to the outlet. To filter such pollutants, drains can be plugged, removed or replaced with perforated pipe/end plugs to allow passage and filtration of drain water through the riparian forest root zone. Caution is advised that saturated conditions in the riparian and adjacent areas may limit existing land use and management.

A herbaceous Zone 3, immediately adjacent to Zone 2, shall be established and designed in accordance with criteria in FILTER STRIP (393). The use of native species is highly recommended.

Livestock will be excluded from all Zones, except for needed maintenance activities.

Additional Criteria for Increasing Carbon Storage in Biomass and Soils

Maximize width and length of the riparian forest buffer.

Select plants that have higher rates of carbon sequestration in soils and plant biomass and are adapted to the site to assure strong health and vigor. Plant the appropriate stocking rate for the site.

Additional Criteria to Mitigate Flooding Damage by Trapping Large Debris and Water-borne Sediments, and Slowing Flood Waters.

Zone 2, for any stream order classification, shall be widened, to include areas of overland out-of-bank flow that show evidence of scour erosion, debris deposits, or sediment deposition.

Select species that have good survival success from anticipated periods of extended flooding. Refer to Table 1 in Practice Specifications for survival ratings.

For the Missouri and Mississippi Rivers, Zone 2 will be widened to a minimum width of 275 feet. The total width for Zones 1 and 2 will equal a minimum of 300 feet.

CONSIDERATIONS

Tree and shrub species, which may be alternate hosts to undesirable pests, should be avoided. Species diversity should be considered to avoid loss of function due to species-specific pests.

Allelopathic impacts of plants should be considered.

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

For sites where continued function of drains is desired, woody root penetration may eventually plug the underground structure. In these cases, a setback of woody vegetation planted over the drain maintained in herbaceous cover or using rigid, non-perforated pipe will minimize woody root penetration.

Maximize widths, lengths, and connectivity of riparian forest buffers. Zone 2, for any stream order classification, may be widened to include areas of overland out-of-bank flow that show evidence of scour erosion, debris deposits, or sediment deposition.

The species and plant communities that attain biomass more quickly will sequester carbon faster. The rate of carbon sequestration is enhanced as riparian plants mature and soil organic matter increases.

Favor tree and shrub species that are native and have multiple values such as those suited for timber, biomass, nuts, fruit, browse, nesting, aesthetics and tolerance to locally used herbicides. Consider species that resprout when establishing new rows nearest to water courses or bodies.

Where feasible, consider alternative water sources, such as tanks, ponds, wells, solar pumps, and ram pumps, for livestock water supply needs.

A riparian forest buffer will be most effective when used as a component of a sound resource management system that includes integrated crop management and sediment and erosion control practices.

Adding a herbaceous Zone 3, immediately adjacent to Zone 2, can increase habitat diversity and improve the overall function of the buffer.

For sites that have a history of being wet or flooded consider using plants produced by a containerized air-root pruning method.

Air root-pruned material tend to be larger plants, with thick, fibrous roots and capable of beginning seed production within 4 to 5 years.

PLANS AND SPECIFICATIONS

Specifications for applying this practice shall be prepared for each site and recorded using approved specification sheets, job sheets, technical notes, and narrative statements in the conservation plan, or other acceptable documentation.

OPERATION AND MAINTENANCE

The riparian forest buffer will be inspected periodically and protected from adverse impacts such as excessive vehicular and pedestrian traffic, pest infestations, concentrated flows, pesticides, livestock or wildlife damage and fire.

Replacement of dead trees or shrubs and control of undesirable vegetative competition will be continued until the buffer is, or will progress to, a fully functional condition.

Conduct maintenance activities (periodic harvests or thinning) to keep the riparian zones in a healthy, vigorously growing condition. Any manipulation of species composition, stand structure and stocking by cutting or killing selected trees and understory vegetation shall maintain the intended purpose(s). Refer to FOREST STAND IMPROVEMENT (666).

Control or exclusion of livestock and harmful wildlife shall continue. Refer PRESCRIBED GRAZING (528), and/or ACCESS CONTROL (472) as applicable.

Fertilizers, pesticides and other chemicals used to maintain buffer function shall not impact water quality or non-target species.

PRACTICE SPECIFICATIONS

Plant List

Table 1 lists trees and shrubs commonly associated with and suited to riparian areas. Key attributes are listed for each plant to assist with the design process for establishing new buffers.

Species are arranged alphabetically. Heights and attributes represent expected performance of individual plants on medium-textured, non-saline, neutral pH soils. Species in the Table represent trees and shrubs commonly associated in Missouri riparian ecosystems. This list is meant to be a guide and is not inclusive.

Planting Rates

Initial plant densities for trees and shrubs should be based on their potential height, crown characteristics and growth form, in addition to planting objectives. Refer to TREE/SHRUB ESTABLISHMENT (612), Planting Rates – General, for guidelines on planting densities.

Residual Tree Guide for Trapping Large Debris and Slowing Flood Waters

Minimal stocking levels and size classes should be maintained to achieve the intended purpose of the riparian buffer.

The following chart can be used as a guide in determining residual stand goals.

Average tree DBH (inches)	Number of trees per acre	Average spacing (feet)
2-6	222	14
8-12	90	22
14+	38	34

Source: "Best Management Practices for upland and wetland forests." Hans Riekerk, 1991.

Summer Sun Shadow Lengths

Listed below is a shadow length table for design tree heights in Missouri.

Shadow Length (ft) Tables

10 AM and 2 PM

Tree Height (ft)	June	July	August
40	23	25	32
50	29	31	40
60	35	38	48
70	41	44	56
80	47	50	64
90	52	57	72

11 AM and 1 PM

Tree Height (ft)	June	July	August
40	15	17	24
50	19	22	30
60	23	26	36
70	27	30	42
80	30	35	48
90	34	39	53

12 Noon

Tree Height (ft)	June	July	August
40	12	14	21
50	15	18	26
60	18	21	32
70	21	25	37
80	24	28	42
90	27	32	47

(Shadow lengths based on sun angles for solar time, 40 degrees north latitude. Source: ASHRAE Handbook, 1972.)

To use this data, first select the critical shading month and solar time. Then choose the shadow length that equals the water body dimensions that need shading. The tree height value on the left will be the needed projected mature height for the design shading lengths. Account for effective tree heights when determining shading lengths. Adjustments should be made for incised streams and topographic features that would add to the effective height of woody vegetation. For example, a tree 50 feet tall along an incised stream with normal flow elevation 10 feet below stream bank would have an effective tree height of 60 feet.

Riparian Wildlife Width Guidelines

The following guidelines represent the suggested minimum riparian forest buffer widths for selected species:

Species	Minimum Width
Cavity nesting ducks, bald eagle, heron rookery, pileated woodpecker, turkey	600 feet
Beaver, dabbling ducks, song birds, squirrels, mink	300 feet
Deer, frogs, salamanders	200 feet

REFERENCES

Burckhardt, J. C. and B. L. Todd. 1998. Riparian forest effect on lateral stream channel migration in the glacial till plains. Journal of the American Water Resources Association. 34:179-184.

Dwyer, J.P., D.C. Wallace, and D.R. Larsen. 1997. "Implications of Woody River Corridors in Levee Protection Along the Missouri River in 1993". Journal of American Water Resources Association: Vol. 33, No. 2.

Schultz, R.C., J.P. Colletti, T.M. Isenhart, W.W. Simpkings, C.W. Mize, and M.L. Thompson. 1995. Design and Placement of a Multi-species Riparian Buffer Strip. Agroforestry Systems 29:201-225.

Table 1. Plant List for Riparian Forest Buffers (see CTSG for additional species)

Species Common/(Scientific)	Flooding Tolerance	Large Debris	Shade Value	Wildlife Merit	Height (feet)	Growth Rate	CTSG Group
~~ash, green (*Fraxinus pennsylvanica)**~~	~~M~~	~~M~~	~~H~~	~~M~~	~~60~~	~~H~~	~~1,2~~
~~white (*Fraxinus Americana)**~~	~~M~~	~~M~~	~~H~~	~~M~~	~~70~~	~~M~~	~~1~~
baldcypress (*Taxodium distichum)*	VH	M	M	M	80	M	1,2
birch, river (*Betula nigra)*	M	H	M	M	50	M	1,2
buttonbush (*Cephalanthus occidnetalis)*	VH	L	L	L	10	M-H	2
cane, giant (*Arundinaria gigantea)*	H	L	L	H	12	M-H	1,2
cottonwood (*Populus deltoides)*	H	H	M	H	90	H	1.2
dogwood, silky (*Cornus obliqua)*	H	L	L	H	12	M-H	1,2
red-osier (*Cornus stolonifera)*	H	L	L	H	12	M-H	1,2
hackberry (*Celtis occidentalis)*	M-L	M	M	M	60	M	1
hawthorn, green (*Crataegus virdis)*	M	L	L	H	20	M	1,2
hickory, shellbark (*Carya laciniosa)*	M	M	H	H	70	M	1
holly, deciduous (*Ilex opaca)*	VH	L	L	M	16	M	1,2
maple, boxelder (*Acer negundo)*	M	H	M	M	40	H	1
silver (*Acer saccharinum)*	M-H	H	H	M	80	H	1,2
red (*Acer rubrum)*	M	M	H	M	70	M	1
oak, bur (*Quercus macrocarpa)*	H	M	H	H	80	L	1,2
pin (*Quercus palustris)*	M-L	H	M	H	75	M-H	1,2
Nuttall (*Quercus nuttallii)*	VH	M	H	H	70	M	2
willow (*Quercus phellos)*	M	M	H	H	70	M	1
overcup (*Quercus lyrata)*	VH	M	H	H	70	M	2
swamp white (*Quercus bicolor)*	M-H	M	H	H	70	M	1,2
cherrybark (*Quercus pagodafolia)*	M	M	H	H	75	M	1
shumard (*Quercus shumardii)*	M	M	H	H	80	M	1
native pecan (*Carya illinoensis)*	M-H	M	H	H	80	L-M	1,2
persimmon (*Diospyros virginiana)*	M	M	M	H	50	L	1
privet, swamp (*Forestiera acuminata)*	VH	L	L	L	14	M	1,2
sugarberry (*Celtis laevigata)*	M-L	H	M	M	60	M	1
sycamore (*Platanus occidentalis)*	H	H	M	H	90	H	1,2
wahoo (*Euonymus atropurpureus)*	M-L	L	L	M	12	M	1
walnut, black (*Juglans nigra)*	M-L	M	M	H	80	M	1
willow, black (*Salix nigra)*	VH-H	H	L	M	60	H	1,2
sandbar (*Salix exigua (interior)*	VH	L	L	L	6	H	1,2
peachleaf (*Salix amygdaloides*)	H	L	L	L	30	H	1,2

VH = very high; H = high; M = medium; L = low

~~**** Use these species with caution due to potential European ash borer concerns.***~~

Notes:

Flooding Tolerance. General capacity of the plant to withstand standing water. VH = able to survive deep, prolonged flooding for more than one year; H = able to survive deep flooding for one growing season, with mortality occurring if flooding is repeated the following year; M = able to survive flooding or saturated soils for 30 consecutive days during the growing season; L = unable to survive more than a few days of flooding during the growing season without mortality.

Large Debris. Potential for the plant to produce debris larger than ten inches in diameter before secensence. H = large debris likely within life span of the plant; M = large debris possible within life span of the plant; L = large debris unlikely within life span of the plant.

Shade Value. The density or fullness of shade provided by an individual plant's crown in full leaf-out condition. H = large crown providing full shade; M = paritally open or medium sized crown that provides patchy or incomplete shade; L = very open or small crown that provides minimal shade.

Wildlife Merit. The potential for the plant to provide useful cavity sites and/or quality fruit production for wildlife. H = excellent large cavity potential and/or high quality fleshy fruit or nut production; M = moderate cavity potential or fruit production; L = low cavity potential and dry, non-nut fruit production.

Height. Typical potential height at physical maturity.

Growth Rate. The rate at which the plant grows in height during its development period (after seedling stage and before final maturity stage). H = Rapid growth of 3 or more feet per year; M = Medium growth of 1 to 3 feet per year. L = Low growth rates of generally less than 1 feet per year.

CTSG Group. Trees and shrubs to plant based on soil Conservation Tree and Shrub Groups. Group 1 = somewhat poorly drained soils with a water table at 1 to 3 feet in the spring or subject to flooding. Permeability is moderately slow to rapid. Group 2 = poorly drained soils with slow to rapid permeability or somewhat poorly drained soils with slow permeability. Subject to ponding and/or frequent flooding.