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Riparian forest buffers for trout habitat improvement

Design of riparian forest buffers

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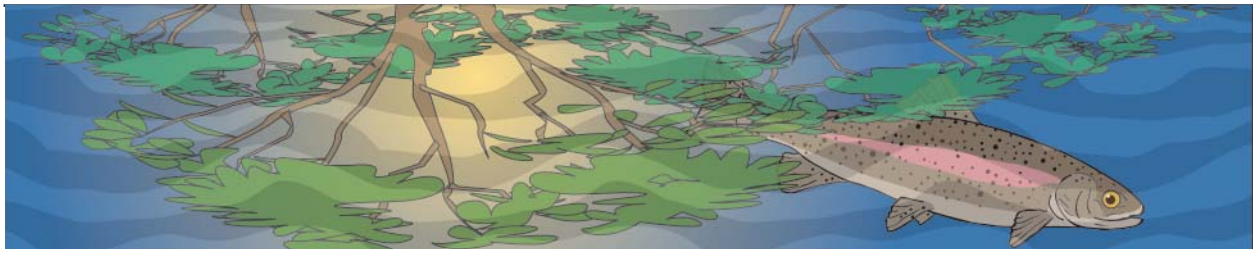

Introduction

Minnesota is home to more than 450 miles of Department of Natural Resource designated trout streams. As a cold water species, trout are sensitive to warm stream temperatures. Establishing trees in riparian buffers is widely recognized as a significant tool for stabilizing stream temperatures and improving trout habitat. Riparian forest buffers (RFBs) provide other benefits, as well. They filter sediment, nutrients and pesticides, thus preventing movement of these nonpoint pollution sources downstream. Trees in the buffer zone provide woody debris for the stream, an important component of trout habitat. The woody roots also help stabilize stream banks and help with flood control.

Identifying objectives for the riparian forest buffer (RFB)

Landowner objectives should be identified before the riparian forest buffer is designed. In addition to improving water quality and stream habitat, a landowner may wish to generate income from the buffer or enhance wildlife habitat.

Considerations for income generation

Multi-species, multi-use RFBs offer landowners an opportunity to explore both short- and long-term sources of income from the buffer itself. High value hardwoods, such as walnut, oak or maple, may become a sustainable source of long-term income. Hybrid poplars might be harvested for pulpwood, sawlogs or biomass. On a shorter-term basis, decorative woody florals may be ready to harvest in two years, while income from edible berries and nuts may take 2 to 15 years to produce. In all cases, markets for the specialty forest products should be explored and identified before the RFB plan is finalized. (See Table 5 for a list of possible plantings.)

Government and other agency programs that provide technical and financial assistance to conserve and enhance soil and water resources may also be a source of income. Refer to *Financial assistance opportunities for riparian forest buffers* for more detailed information about the types of programs available and their requirements for establishing and maintaining riparian forest buffers.

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In the longer term, United States Department of Agriculture Ecosystem Services is exploring opportunities to advance markets and payments for practices such as wildlife habitat and diversity, carbon storage and watershed services. While these practices have traditionally been viewed as free benefits to the society, Ecosystem Services is developing policies to stimulate market-based conservation and stewardship.

Considerations for enhancing wildlife habitat

Plant materials can be selected to provide food, shelter or nesting areas for various wildlife species. For example, deer and wild turkeys prefer acorns when they are available and both use woody edges for food and cover. Trees and shrubs with high wildlife merit rankings can be selected for the buffer from Tables 3 and 4. If runoff is not a major concern, a wide variety of native grasses and forbs can be selected for Zone III to provide greater habitat diversity and attract more wildlife species. If creating winter habitat for wildlife is a goal for the buffer, see the recommended conifers listed in Table 4.

Buffer widths need to be increased when a landowner wishes to support wildlife. In general, width guidelines of 100 to 300 feet are considered a minimum for enhancing wildlife habitat and providing a travel corridor (Table 1).

Table 1. Minimum buffer widths for wildlife (not site specific)

Wildlife species	Buffer width (ft.)
Bald eagle, cavity nesting ducks, heron rookery, sandhill crane	600
Common loon, pileated woodpecker	450
Beaver, dabbling ducks, mink, and to maximize bird species diversity	300
Deer	200
Lesser scaup, harlequin duck, muskrat	165
Frog, salamander	100

NRCS – Conservation Practice Standard for Riparian Forest Buffer, Code 391

Vegetation selection

The purpose or goal of the riparian buffer planting will have a direct relationship with the design and vegetation selected for the planting. Trees, shrubs and grasses vary in the kinds of benefits they provide to the buffer. Table 2 shows the relative effectiveness of these different vegetation types in providing a variety of benefits.

Table 2. Relative effectiveness of different vegetation types for providing specific benefits

	Vegetation type		
Benefits	Grass	Shrub	Tree
Stabilize bank erosion	Low	High	High
Filter sediment	High	Low	Low
Filter nutrients, pesticides, microbes			
Sediment-bound	High	Low	Low
Soluble	Medium	Low	Medium
Aquatic habitat	Low	Medium	High
Wildlife habitat			
Range/pasture/prairie wildlife	High	Medium	Low
Forest wildlife	Low	Medium	High
Economic products	Low	Medium	High
Flood protection	Low	Medium	High

Iowa State University

Three-zone buffer design

A three-zone riparian forest buffer is widely recognized as the best approach for mitigating agricultural impacts (Figure 1).

Zone I is the unmanaged woody zone nearest the stream. Trees in this zone are selected for rapid root development and tolerance of wet conditions. Tables 3 and 4 include information on growth rates and flooding tolerance for trees and shrubs that are appropriate for riparian areas in Minnesota. Zone I trees provide perennial root systems to stabilize stream banks, woody debris for aquatic habitat and shade for

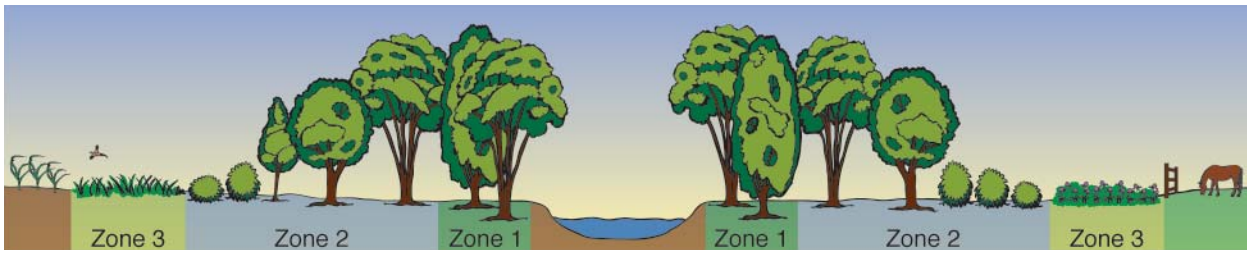

Figure 1. Example of a three-zone riparian forest buffer that is bordering cropland on the left side of the stream and pasture on the right. A strip of alfalfa may be substituted for the warm-season grasses in Zone III when the buffer borders pasture.

stream temperature moderation. For shading streams and rivers, the canopy at maturity should have at least 50 percent crown cover with average canopy heights at least equal to the width of the water body (Figure 2). A minimum width of 35 feet is required by Natural Resources Conservation Service programs.

Zone II is the wider managed woody zone. Trees and shrubs in this zone should be fast-growers that can tolerate periodic flooding (Tables 3 and 4). The primary role of this zone is to absorb and store nutrients, degrade pesticides and slow floodwaters. It can also add diversity for wildlife habitat and be managed for additional income. See Table 5 for a list of riparian trees and shrubs that can produce a marketable crop. Four to five rows of trees and one to two rows of shrubs are recommended for this zone. Recommended widths within and between rows for Zones I and II can be seen in Table 6.

Zone III consists of at least a 20 to 24 foot width of warm-season grasses and forbs and is essential in an agricultural setting. Nutrient uptake and sediment filtering are the major roles of this high infiltration zone. Where runoff is an issue, switchgrass is the preferred warm season species due to its dense, stiff stems that slow water flow. In areas where runoff is not a concern, other warm season native grasses, such as indiangrass and big and little bluestem can be used (Table 7). Non-native cool season grasses like smooth bromegrass and reed canarygrass are not appropriate for this zone, since they have less root mass for stabilizing soil than warm season grasses. They tend to lay down under water flow and can be invasive. However, native cool season grasses should be included as part of the seed mixture, since they establish more quickly and provide cover earlier than warm season grasses. As the warm season natives become well established, the cool season grasses will naturally diminish. An example of a design that includes switchgrass, other warm-season grasses and potential income-producing trees and shrubs can be seen in Figure 3.

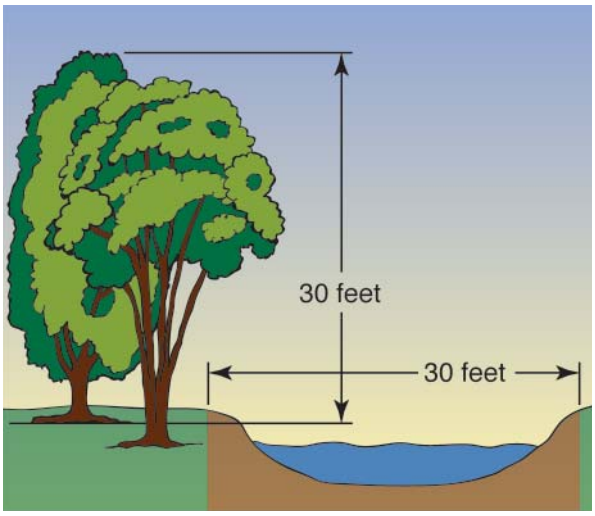

Figure 2. For optimal stream shading, the canopy height of Zone I trees should be equal to or greater than the width of the stream.

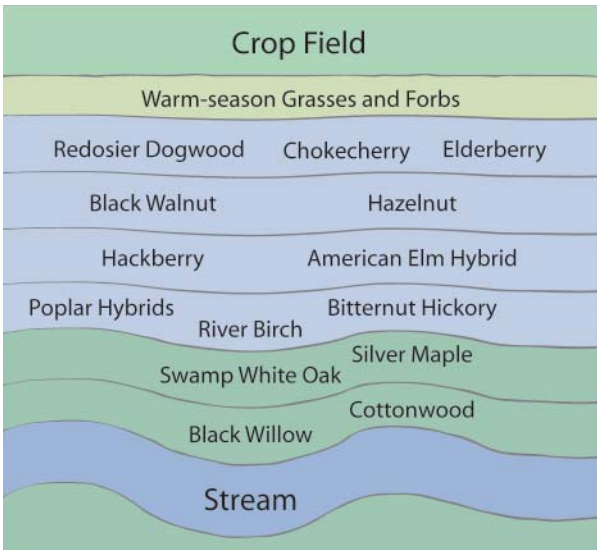

Figure 3. An example of a multi-species, three-zone riparian forest buffer that includes potential income producing trees and shrubs.

Buffer width

Narrow buffers are effective at trapping sediment, but extensive buffers are better at transforming nutrients and pesticides. Buffers narrower than 66 feet generally do not hold water long enough for chemicals to be removed. As stated above, wider buffers are also needed to enhance wildlife habitat.

To design a wider buffer, any of the three zones can be increased. Widths may also vary to address runoff hotspots or to more easily accommodate machinery and straighten the outer buffer edge on a meandering stream. While wider buffers are generally better, the landowner must be sure to follow the minimum and maximum width requirements when the buffer is enrolled in a government program. Landowners may be able to create buffers wider than government program requirements but incentives and cost share would not be allowed on those acres. Other sources of cost share funds may be available through other organizations.

"Naturalized" planting as an option

Although establishment and maintenance of a buffer is more convenient when it is arranged in rows, a mixed planting of trees and shrubs that mimics native woodlands is particularly beneficial for wildlife and may be more aesthetically pleasing (Figure 4).

An economic forest model developed for the Chesapeake Bay region uses a multi-layer, block approach. A cross between planting in rows and a more naturalized approach, the plants are grouped in blocks with understory forest crops in the same area as taller trees. Modeled after a Mayan tropical forest practice, this model produces several non-timber forest products, including fruits, nuts and woody ornamentals.

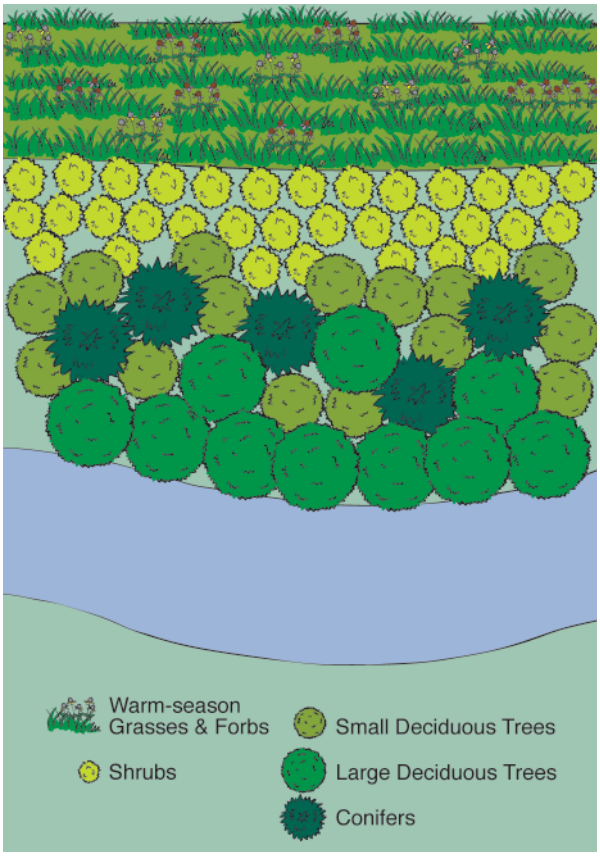

Figure 4. A mixed and randomly planted design for wildlife diversity.

Repairing problem areas

Riparian forest buffers can have little effect on filtering dissolved nutrients and pesticides if subsurface tiles discharge directly into the stream. If this is the case, creating a small wetland to intercept field drainage tiles will help protect the stream. In addition, tree roots can clog clay or perforated tiles, so these should be replaced with solid PVC tile. If problem tiles cannot be replaced, a 30 to 40 foot strip of cool season grasses should be planted above the drainage line.

Other problem areas, such as gullies and eroded stream banks, should be identified and addressed before the riparian buffer is installed. Additional management practices may be required to repair eroded areas, reduce undercutting of the stream bank or slow water movement. Many different types of stabilization practices are used and help is available from the Minnesota Department of Natural Resources or your local Soil and Water Conservation District.

For more information

Other publications in this series:

- Benefits of riparian forest buffers
- Establishment of riparian forest buffers
- Maintenance of riparian forest buffers
- Financial assistance opportunities for riparian forest buffers

Find the full series as well as these additional resources at the University of Minnesota Extension website, extension.umn.edu/buffers.

Center for Agroforestry. 2005. Establishing and managing riparian forest buffers. University of Missouri Center for Agroforestry, Columbia, Mo. AF1009.

Fox, A., Franti, T., & Kucera, M. (2005). Planning your riparian buffer: Design and plant selection. Lincoln, Nebraska: University of Nebraska-Lincoln Extension G1557.

Fox, A., Franti, T., & Kucera, M. (2005). Installing your riparian buffer: Tree and grass planting, postplanting care and maintenance. Lincoln, Nebraska: University of Nebraska-Lincoln Extension G1558.

Schultz, R.C., Wray, P.H., Colletti, J.P. et al. 1997. Stewards of our streams: Buffer Strip Design, Establishment and Maintenance. Ames, Iowa: Iowa State University Extension PM-1626b.

Table 3. Deciduous woody species recommended for riparian forest buffers in Minnesota[1]

Common name	Scientific name	Growth	Flooding tolerance	Large woody debris	Shade value	Wildlife merit
Shrubs						
American cranberry	Viburnum trilobum	Slow	H-M	L	L	H
Arrowwood	Viburnum dentatum	Moderate	H	L	L	H
Black chokeberry	Aronia melanocarpa		M	L	L	H
Black elderberry	Sambucus nigra	Mod/fast	H	L	L	H
Dogwood, red osier	Cornus sericea	Fast	H	L	L	M
, silky	C. amomum		H	L	L	M
, gray	C. racemosa	Moderate	M	L	L	M
Nannyberry	Viburnum lentago	Slow	M	L	L	H
Ninebark, common	Physocarpus opulifolius	Moderate	L	L	L	H-M
Willow, sandbar	Salix exigua	Fast	H	L	L	H
Winterberry	Ilex verticillata	Moderate	H	L	L	H
Small deciduous						
American plum	Prunus americana	Fast	L-M	L	L	H
Chokecherry	Prunus virginiana	Fast	L-M	L	L	H
Crabapple	Malus spp.	Moderate				H
False indigo	Amorpha fruiticosa		H	L	L	L
Hawthorne, cockspur	Crataegus crusgalli	Slow/Mod	M	L	L	H
Hazelnut, American	Corylus americana	Moderate	M	L	L	H
Serviceberry (Juneberry)	Amelanchhier alnifolia	Moderate	M-L	L	L	H
Willow, peachleaf	Salix verticillata	Fast	H	L	L	H
Tall deciduous						
Ash, green[2]	Fraxinus, pennsylvanica	Fast	M	M	M	M
, white	F. americana		M	M	M	M
, black	F. nigra	Moderate	H-M	M	M	M
Aspen, quaking	Populus tremuloides	Fast	L	M	M	H
Birch, white	Betula papyrifera	Fast	M-H	M	M	H
, river	B. nigra	Fast	M-H	M	M	M
, yellow	B. alleganiensis	Fast	M-H	H	M	H
Basswood	Tilia americana	Moderate	L-M	H	H	L
Cherry, black	Prunus serotina	Fast				M
Cottonwood, eastern	Populous deltoids	V. fast	H-VH	H	H-VH	M
Hackberry, common	Celtis occidentalis	Fast	M	M-H	H	H
Maple, silver	Acer saccharinum	Fast	H	H	H	M
, red	A. rubrum	Fast	H	H	H	M-H
, sugar	A. saccharum	Slow				
Oak, bur	Quercus macrocarpa	Slow/mod	H-M	H	H	H
, northern pin	Q. ellipsoidalis		M-L	H	H	H
, red	Q. rubrum	Mod/fast	L	H	H	H
, swamp white	Q. bicolor	Fast	H	M	H	H
Poplar, hybrid	Populus	Fast				H
Walnut, black	Juglans nigra	Fast	H	M	H	M
, white (Butternut)	J. cinerea	Fast	L	M	M	H
Willow, black	Salix nigra	Fast	H	M	H	M

Relative ranking values: VH=Very high; H=High; M=Medium; L=Low

[1]Tree list compiled from NRCS Conservation Practice Standard, Riparian Forest Buffer, Code 391; 2009 Minnesota State Forest Nursery Order; Forest Management Guidelines.

[2]Planting ash species should be highly scrutinized due to the possible infestation of the invasive species emerald ash borer.

Table 4. Woody conifer species recommended for riparian forest buffers in Minnesota[1]

Common name	Scientific name	Growth	Flooding tolerance	Large woody debris	Shade value	Wildlife merit
Small conifers						
Cedar, red	Juniperus virginiana	Slow/mod	M	M	H	H
, white (arborvitae)	Thuja occidentalis	Slow/mod	H-M	M	H	H
Tall conifers						
Balsam fir	Abies balsamea	Slow/mod	M-H	M	M	H
Pine, jack	Pinus banksiana	Fast	L	L	M	L
, red	P. resinosa	Mod/fast	M	H	M	M
, white	P. strobes	Fast	M	H	H	H
Spruce, black	Picea mariana	Moderate	H-VH	M	M	M-H
, white	P. abies	Moderate	M-L	H	M-H	H
Tamarack (Larch)	Larix laricina	Fast	H-M	H	M	M

Relative ranking values: VH=Very high; H=High; M=Medium; L=Low

[1]Tree list compiled from NRCS Conservation Practice Standard, Riparian Forest Buffer, Code 391; 2009 Minnesota State Forest Nursery Order; Forest Management Guidelines.

Table 5. Woody plant materials for the riparian buffer that can produce marketable crops[1]

Common name	Product	Minnesota regions
Shrubs		
American cranberry	Fruit preserves, wine	all
Elderberry	Fruit preserves, wine	all
Dogwood, red-osier	Woody ornamentals	all, but not as well in southwest
Nannyberry	Fruit preserves	all
Small deciduous		
American plum	Fruit preserves, wine	all
Chokecherry	Fruit preserves, wine	all
Crabapple	Fruit preserves	all
Hawthorne	Fruit preserves	all
Hazelnut, hybrid	Biofuels (oil), biomass, nuts	all
Serviceberry (Juneberry)	Fruit preserves	all
Tall deciduous		
Birch, white	Woody ornamentals (branches, birch cones)	all but Red River valley
, river	Woody ornamentals (branches, birch cones)	better in south
Maple, sugar	Maple syrup	all
Poplar, hybrid	Fuel biomass, pulp and paper	all
Walnut, black	Nuts, shells, lumber	southeast (best), southwest

[1]Tree list compiled from Producing Marketable Products from Living Snow Fences, University of Minnesota Center for Integrated Natural Resources and Agricultural Management.

Table 6. Recommended spacing within and between rows of trees and shrubs in the riparian buffer[1]

	Spacing
Spacing within rows	**(feet)**
Shrubs	3-8
Small trees	6-10
Tall trees	10-16
Spacing between rows	
Shrubs	10
Shrubs and small trees	12
Small trees	12
Small trees and tall trees	16
Tall trees	16
Fast growing trees/conifers and conifers	20

[1]G. Kopp, personal communication, 2009.

Table 7. Native grasses (not inclusive) for Zone III of the riparian buffer and their tolerance to drought and flooding[1]

Common name	Scientific name	Cool/Warm season	Drought	Flooding	Wet soil
Canada wild rye	Elymus canadensis	Cool	Fair	Good	No
Slender wheatgrass*	Elymus trachycaulus	Cool	Good	Good	No
Big bluestem*	Andropogon gerardii	Warm	Fair	Poor	No
Little bluestem*	Schizarium scoparium	Warm	Good-Excellent	Poor	No
Indiangrass*	Sorghastrum nutans	Warm	Fair	Poor	No
Sideoats grama*	Bouteloua curtipendula	Warm	Good-Excellent	None	No
Prairie cordgrass	Spartina pectinata	Warm	Poor	Excellent	Yes
Switchgrass*	Panicum virgatum	Warm	Good	Good	Yes

*Varieties adapted for different areas of Minnesota. See NRCS Conservation Practices Standard: Filter Strip.

[1]Native grass list compiled from NRCS Conservation Practices Standard: Filter Strip; Producing Marketable Products from Living Snow Fences, University of Minnesota Center for Integrated Natural Resources and Agricultural Management; MN/DOT Seeding Manual: 2007 Edition.

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