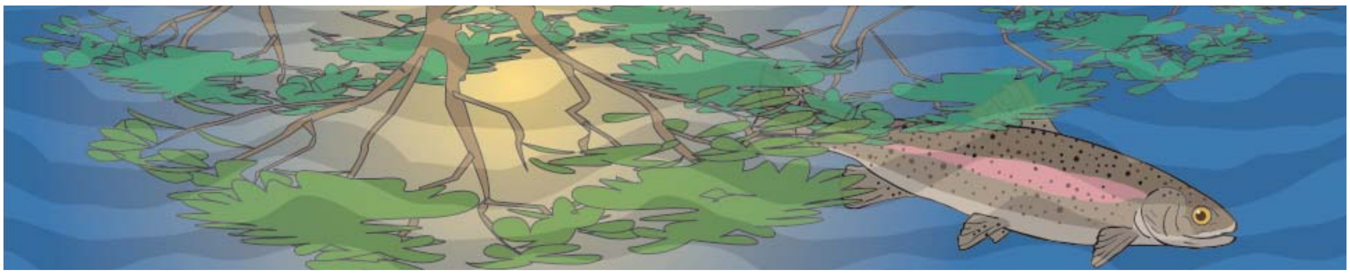
Riparian forest buffers for trout habitat improvement

Benefits of riparian forest buffers

Phyllis Bongard and Gary Wyatt[1]



What is a riparian forest buffer?

A riparian forest buffer is a planned combination of trees, shrubs, grasses and forbs planted along a stream or river. It can include many different species and perform several different functions. The most common design includes three zones: an unmanaged woody zone nearest the stream which is followed by a woody zone that can be managed for income and is bordered by a zone of grasses that may include forbs (Figure 1). A well-designed riparian forest buffer protects water quality, enhances aquatic and wildlife habitats and can provide income opportunities for landowners.

Riparian forest buffers improve trout and wildlife habitats

Minnesota is home to more than 450 miles of Department of Natural Resources designated trout streams. As a cold water species, trout are sensitive to warm stream temperatures. Trees in the riparian buffer improve trout habitat by limiting how much solar radiation can reach the stream surface. As a result, stream water temperatures are lower and they fluctuate less during the day compared to non-shaded portions of the small stream. Trees also provide woody debris for the stream, an important component of trout habitat.

Riparian forest buffers (RFBs) can be designed to enhance wildlife habitat. Depending on a landowner's objectives, plant materials for the buffer can be selected to provide food, shelter or nesting areas for various wildlife species. As a rule, wider buffers are needed to enhance wildlife habitat. While narrow buffers may provide a travel corridor, wide RFBs are more likely to support a greater diversity of wildlife (Table 1).

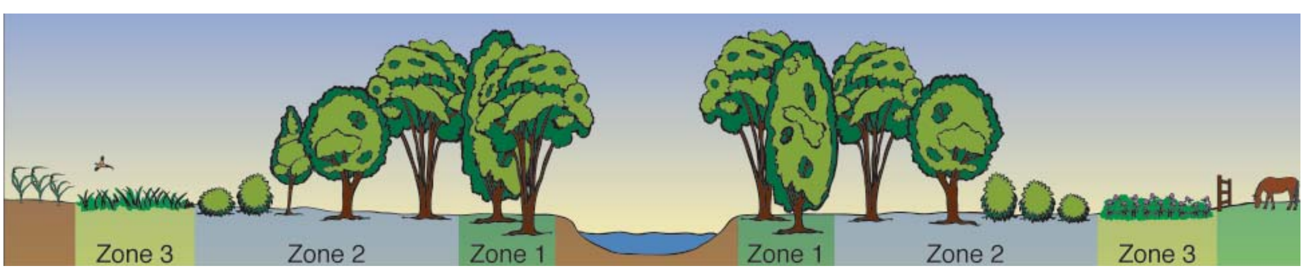


Figure 1. Example of a three-zone riparian forest buffer that is bordering cropland on the left side of the stream and pasture on the right. A strip of alfalfa may be substituted for the warm-season grasses in Zone III when the buffer borders pasture.

[1] Phyllis Bongard is an Extension educator, agriculture production/water quality, for University of Minnesota Extension, Dakota County. Gary Wyatt is an Extension educator, agroforestry, for University of Minnesota Extension.

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	

Riparian forest buffers improve water quality

Riparian forest buffers play a significant role in improving water quality by filtering sediment, nutrients and pesticides. Sediment entering a stream through soil erosion or field runoff negatively affects both the numbers and types of fish that can be found. An RFB protects the aquatic environment by significantly reducing the amount of sediment that can reach the stream. In a three-zone buffer, most of the sediment is trapped in the grass zone where dense stems slow and diffuse runoff. Tree roots also play a significant role in stabilizing stream banks and reducing erosion.

In agricultural areas, runoff of excess nutrients and pesticides into streams can be a significant concern. While narrow buffers are effective at trapping sediment, wider buffers (66 feet) are much better at transforming nutrients and pesticides. Nitrate-nitrogen and phosphorus (P) are frequently the agricultural nutrients of most concern. Riparian forest buffers have been shown to significantly reduce nitrate concentrations, largely through denitrification and vegetative uptake. RFBs are also very effective in reducing phosphorus concentrations. Since P is primarily attached to soil particles, reducing sediment loss through an RFB is the most effective way to reduce nonpoint source P pollution.

RFBs are also effective in both filtering and degrading pesticides. Pesticides are degraded more quickly in an RFB than in the field, largely due to enhanced soil characteristics in the buffer. Higher organic matter contents, greater infiltration capacity and higher microbial populations help bind and degrade pesticides more quickly.

Riparian forest buffers provide income opportunities

Multi-species, multi-use RFBs offer landowners an opportunity to not only improve stream habitat and water quality, but to explore income producing options from the buffer itself. When markets are identified, the buffer can be designed to produce income on both short- and long-term bases. High value hardwoods, such as walnut, oak or maple, may be planted in the managed woody zone (Zone II) and become a sustainable source of long-term income. Hybrid poplars are another option for Zone II and may be harvested for pulpwood, sawlogs or biomass. Shorter-term income may come from specialty forest products, such as fruits and nuts and decorative woody florals. In Zone III, the warm season grasses may be harvested annually for hay or biomass. (Note: Harvest may not be allowed depending on financial assistance programs used; check policies as part of the planning process.)

An example of how this might work comes from the Chesapeake Bay region. Based on a Mayan multi-layered, multi-species tropical forest practice, the model produces several sustainable forest products that can be marketed locally. In the Chesapeake Bay region, the adapted model included five species of fruit, four species of edible nuts and three woody ornamentals. The economic forest model provides both income production and environmental protection.

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* in this series for more detailed information about the types of programs available for establishing and maintaining riparian forest buffers.

For more information

Other publications in this series:

- Design 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 additional resources at the University of Minnesota Extension website, **extension.umn.edu/buffers.**

Reviewers: Brian Nerbonne, Minnesota Department of Natural Resources and Ken Brooks, Department of Forest Resources, University of Minnesota.

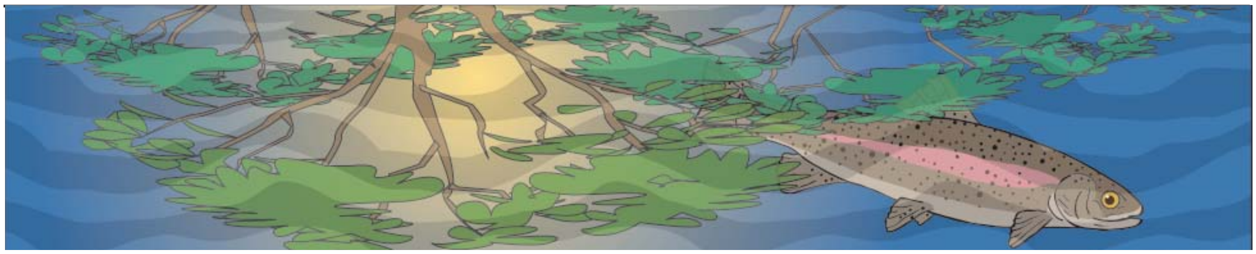
Illustrations by Robin Freese.

UNIVERSITY OF MINNESOTA | EXTENSION

Riparian forest buffers for trout habitat improvement

Design of riparian forest buffers

Phyllis Bongard and Gary Wyatt[1]



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.

[1] Phyllis Bongard is an Extension educator, agriculture production/water quality, for University of Minnesota Extension, Dakota County. Gary Wyatt is an Extension educator, agroforestry, for University of Minnesota Extension.

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

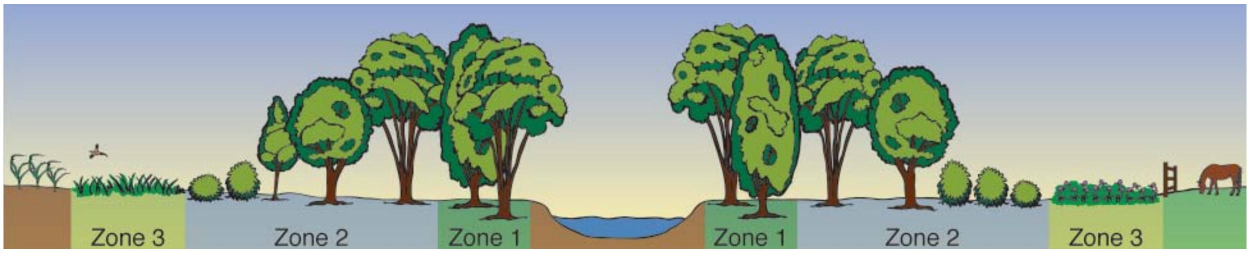


Figure 1. Example of a three-zone riparian forest buffer that is bordering cropland on the left side of the stream and pasture on the right. A strip of alfalfa may be substituted for the warm-season grasses in Zone III when the buffer borders pasture.

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.

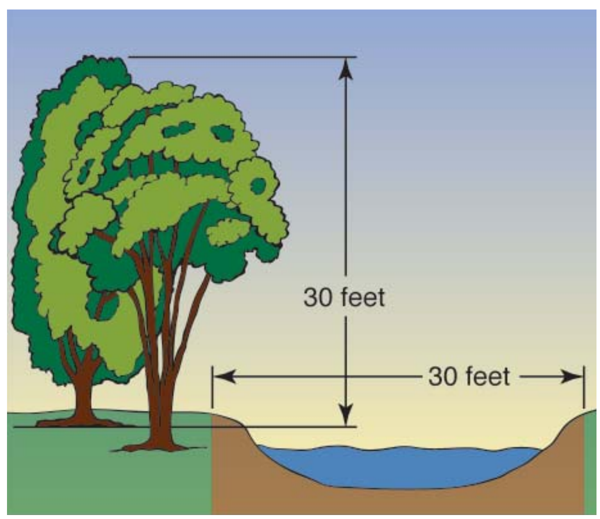


Figure 2. For optimal stream shading, the canopy height of Zone I trees should be equal to or greater than the width of the stream.

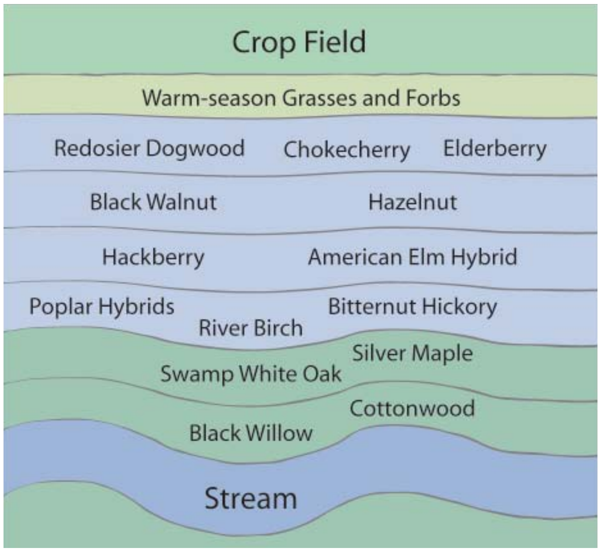


Figure 3. An example of a multi-species, three-zone riparian forest buffer that includes potential income producing trees and shrubs.

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.

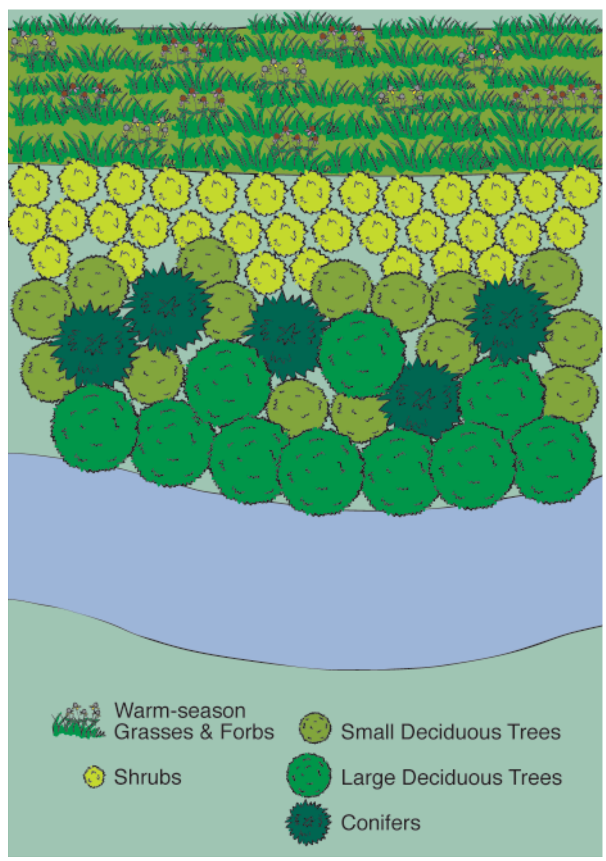


Figure 4. A mixed and randomly planted design for wildlife diversity.

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.

Reviewers: Brian Nerbonne, Minnesota Department of Natural Resources and Ken Brooks, Department of Forest Resources, University of Minnesota.

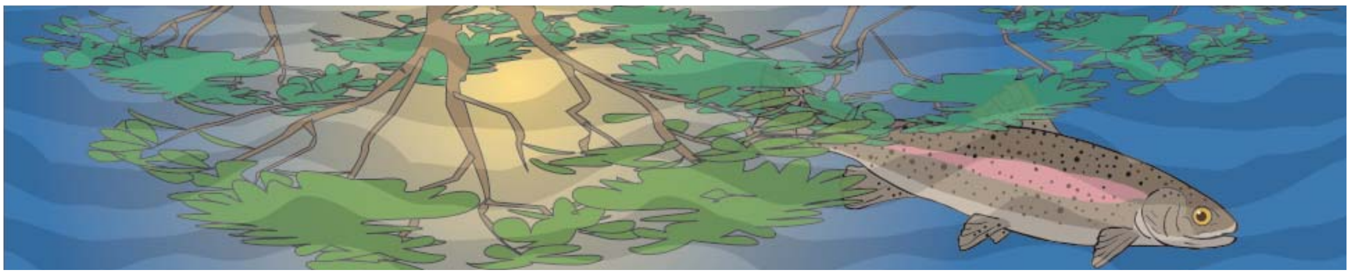
Illustrations by Robin Freese.

University of Minnesota | Extension

Riparian forest buffers for trout habitat improvement

Establishment of riparian forest buffers

Phyllis Bongard and Gary Wyatt[1]



Introduction

Minnesota is home to more than 450 miles of Department of Natural Resources 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.

Multi-species, multi-use RFBs offer landowners an opportunity to not only improve stream habitat and water quality, but to explore income producing options from the buffer itself. Currently, the most accepted design includes three zones: an unmanaged woody zone nearest the stream, a second zone of trees and shrubs that can be managed for income, and finally, a warm-season grass zone adjacent to cropland.

Site preparation

Once the buffer has been designed and any problem areas repaired, the site can be prepared for planting. Control of competing vegetation is essential for good seedling establishment and will vary somewhat depending on the zone being prepared and its land use.

When the land being prepared is pasture, burndown of the vegetation with glyphosate (e.g. Roundup®, many others) is recommended in the fall before planting. This may be followed by tillage, if desired. However, a recent Wisconsin study suggests that a single fall application of glyphosate with no follow-up tillage is a good option since it requires relatively little labor or equipment. For site preparation in the tree zones (Zones I and II), glyphosate should be applied in three to four foot strips or circles where the trees will be planted. A second spring burndown may be recommended if perennial weed populations are strong or if problem weeds are emerging. When a pasture area will be planted to Zone III grasses, the fall glyphosate application should be followed with a spring treatment and the desired grasses seeded with a prairie seed drill.

When cropland is being prepared for Zones I and II, light tillage, such as disking, is recommended to control the early spring weed flush. Planting this area with a mixture of perennial ryegrass and timothy (five and seven pounds per acre, respectively) will provide soil protection without competing with the young trees. Spring disking is also

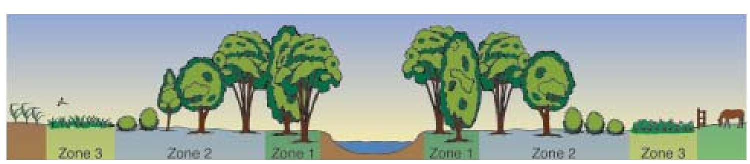


Figure 1. Example of a three-zone riparian forest buffer that is bordering cropland on the left side of the stream and pasture on the right. A strip of alfalfa may be substituted for the warm-season grasses in Zone III when the buffer borders pasture.

[1] Phyllis Bongard is an Extension educator, agriculture production/water quality, for University of Minnesota Extension, Dakota County. Gary Wyatt is an Extension educator, agroforestry, for University of Minnesota Extension.

recommended if cropland will be planted to Zone III grasses. In addition, the area should be cultipacked to prepare a good seedbed for switchgrass or other native grasses.

Planting trees and shrubs

Potential plant materials for the woody zones include both seeds and seedlings. Tree seeds can be collected in the fall and planted by hand or specialized machine. Direct seeding of hardwood nut trees (with nuts) is generally done in the fall. Planting depth should not exceed two to three times the seed diameter. Large seeds, such as acorns and walnuts, can also be broadcast with a fertilizer spreader and disked in to a depth of one to two inches. Lighter seeds, such as maple, can be broadcast and dragged in lightly. For more details about direct seeding, visit *www.dnr.state.mn.us/treecare/maintenance/collectingseed.html*.

Trees can be purchased as unrooted cuttings (sticks) and bareroot or container seedlings, but the most common is the bareroot seedling. Bareroot seedlings are generally less expensive than container trees and studies have found no differences in their survival rates. Bareroot seedlings need to be kept moist until planting. In addition, the seedling roots should be submerged in water for two to four hours before planting.

Bareroot seedlings are available mainly in the early spring. Both bareroot and unrooted cuttings (sticks) should be planted in the early spring after the last frost date. Container stock can be planted almost any time if watered correctly; however, the spring and fall are best.

The planting hole for both bareroot and container seedlings should be large enough to contain the entire root system without turning any roots up. Roots need to be covered and packed with soil and watered after planting.

Unrooted cuttings (sticks) should be placed in the ground with one bud (poplar) and two to three buds (shrubs) above the soil surface and watered immediately. In general, tree cuttings are difficult to establish with the possible exception of willow.

Minimizing wildlife damage

Protecting tree seedlings from animal damage in the first few years of establishment is important for their long-term survival. Significant damage from browsing deer, rabbits, voles and gophers can be minimized with an integrated pest management (IPM) approach. It can include exclusion, habitat modification, repellents and population management.

Solid, translucent tubes that surround the seedling are among the most common exclusion tools. These tree tubes provide protection from wind damage, animal browsing and girdling. Tree shelters also provide a greenhouse-like environment that promotes rapid growth and long-term seedling survival. Fences can also be used to exclude animals from tree and shrub seedlings but this can be expensive.

Managing vegetation to minimize herbivore habitat can be included in the integrated pest management approach. Late fall mowing is recommended in the buffer rows to reduce habitat for rodents. Other IPM options include using repellents and controlling the herbivore populations through hunting or trapping. Wildlife damage management is truly a diverse and complex topic. To learn more about the wildlife that can damage your property and ways to manage the wildlife-human conflict for the betterment of both, see the *Prevention and Control of Wildlife Handbook* at *icwdm.org/handbook/index.asp.*

Watering trees and shrubs

Providing adequate water the first year or two is essential for establishment. Seedlings should have adequate water each week. Newly planted seedlings should be watered one or two times per week depending on rainfall. If no rain occurs, watering two to five gallons per plant per watering is recommended.

For more information

Other publications in this series:

- Benefits of riparian forest buffers
- Design 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). 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.

Reviewers: Brian Nerbonne, Minnesota Department of Natural Resources and Ken Brooks, Department of Forest Resources, University of Minnesota.

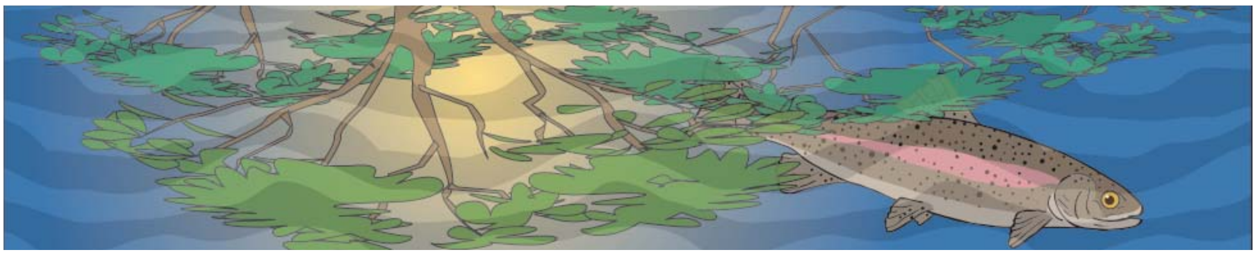
Illustrations by Robin Freese.

Printed on FSC-certified recycled and recyclable paper with at least 30 percent postconsumer material.

Riparian forest buffers for trout habitat improvement

Maintenance of riparian forest buffers

Phyllis Bongard and Gary Wyatt[1]



Introduction

Minnesota is home to more than 450 miles of Department of Natural Resources 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.

Multi-species, multi-use RFBs offer landowners an opportunity to not only improve stream habitat and water quality, but to explore income producing options from the buffer itself. Currently, the most accepted design includes three zones: an unmanaged woody zone nearest the stream, a second zone of trees and shrubs that can be managed for income, and finally, a warm-season grass zone adjacent to cropland.

Weed control

Until tree seedlings can compete with surrounding vegetation, weed control is the primary maintenance activity in the critical zone around the seedlings. Recommendations in neighboring states include mulching, mowing and shielded herbicide applications as options for weed control in the tree zones. Organic mulch, such as wood chips or shredded hardwood, can be applied to a four to six inch depth around the seedling to suppress weed competition. However, mulching alone may not be adequate if weed control during site preparation was poor. Mulching may also draw voles or mice that may chew on the bark in the winter, which could damage or kill the tree or shrub. A similar caution applies to both the use of weed mats and mowing. While mowing is

[1] Phyllis Bongard is an Extension educator, agriculture production/water quality, for University of Minnesota Extension, Dakota County. Gary Wyatt is an Extension educator, agroforestry, for University of Minnesota Extension.

useful to mark rows and reduce rodent habitat, it will not provide adequate weed control if the preplanting control in previous pastures was poor.

Herbicide applications are the most effective weed control method for the tree zones in the buffer. Glyphosate (Roundup® and others), a non-selective systemic herbicide, can seriously damage tree and shrub seedlings, so applications need to be shielded. Herbicide applications may be needed annually until the tree and shrub seedlings can compete with the surrounding vegetation.

While glyphosate is the most commonly recommended herbicide, applications of sethoxydim may be an option. Sethoxydim (ex. Poast®) is a systemic annual and perennial grass herbicide. In recent studies, a single early summer application was effective in reducing reed canarygrass biomass and seedhead density for that growing season. However, the herbicide effects didn't carry over into the following season, so multiple year applications would likely be required.

In large plantings, preemergence herbicides can also be used for weed control. These herbicides target weed seedlings before they emerge from the soil. Examples of herbicides used in forestry plantings include Goal® (oxyfluorfen), Oust® (sulfometuron methyl) and Surflan® (oryzalin). Always carefully read and follow label directions.

Weed control recommendations for the grass zone are quite different than for the tree zones. During the first year of warm-season grass establishment, the area should be mowed at a height of six inches when the weeds are a foot tall and again in mid- to late-September to help prevent annual weeds from going to seed. Appropriate herbicides may be used, if needed. When possible, early spring burns during the first few years of establishment help reduce competition from non-native cool-season grasses, weeds and woody plants.

Figure 1. Shredded hardwood mulch suppressing weed growth around tree seedling one year after planting at Vermillion River demonstration.

Long-term maintenance

Long-term maintenance activities promote strong plants that can survive environmental stress and optimize nutrient uptake and storage. In Zones I and II, harvesting or cutting back shrubs and pruning trees will stimulate vigorous growth. Pruning for plant health and growth is important in the first 10 years of growth. Pruning is also recommended for high value species managed for sawlog production. After eight to 12 years, thinning or selectively harvesting fast growing trees (ex. willows, cottonwoods, silver maple) will remove captured nutrients and chemicals from the riparian zone and continue to promote growth. A continual annual harvest where a portion of the tree zone (1/8 to 1/12) is taken is an option. Harvesting in the winter also has some advantages. The root systems of the harvested trees will be retained and continue to stabilize the soil while allowing trees to regenerate from stump sprouts in the spring.

To provide coarse woody debris for the stream, avoid disturbing existing large downed logs and stumps. If a snag must be dropped, leave it where it falls whenever possible. To create coarse woody debris, cut two to five bark-on logs greater than 12 inches in diameter per acre. Preferably select hollow butt or other defective log sections of at least six feet in length. Cut sound logs only if there is not enough defective material available.

After the first five years, the grass zone should be harvested or burned. To improve native grass and forbs plantings, it is recommended to conduct a prescribed burn every three or four years. Naturally, a fire break or buffer needs to be established to protect the desirable woody plantings. This will promote both root and dense upper plant growth and prevent a build-up of dead material on the soil surface.

Replanting or reseeding may be required during the life of the buffer. If three to four consecutive trees or shrubs die in Zones I or II, they should be replaced. Likewise, trees should be replanted after harvest if they are not regenerating on their own. In Zone III, if the grass establishment is poor, the area should be treated with glyphosate and redrilled. If there has been some establishment but it is less than optimal, new seed can be drilled directly into the existing stand. Small areas can be hand seeded and raked.

Buffers should be inspected regularly for eroded areas and repaired immediately. Sediment may also build up, particularly along the field edge of the grass zone. If this occurs, the sediment can be re-spread onto the field and the area replanted, as necessary.

Other maintenance activities might include insect and disease management, particularly if fruit and nut trees are included in the managed woody zone (Zone II). If the buffer is established during a drought, additional watering may be required. Finally, the tree zones (I and II) should be protected from livestock. Careful grazing of the grass zone (only) may be an option, although this has not been thoroughly tested. Grazing may not be allowed if this planting is enrolled in a government program.

Wildlife damage

These plantings must be monitored for all wildlife which could cause damage to the buffer planting. Significant damage from browsing deer, rabbits, voles, gophers and beavers can be minimized with an integrated pest management approach. Late fall mowing is recommended in the buffers to reduce habitat for rodents. Other options include using repellents and controlling populations through hunting or trapping. Beavers, attracted to riparian plantings where they can cause significant damage, are an example of a species that may legally be trapped.

Contact the Minnesota Department of Natural Resources for more information and regulations. To learn more about wildlife and ways to prevent and control damage, a handbook from a consortium of universities is available: *Prevention and Control of Wildlife Handbook*, *icwdm.org/handbook/index.asp*.

For more information

Other publications in this series:

- Benefits of riparian forest buffers
- Design of riparian forest buffers
- Establishment 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). 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.

Bedker, P.J., O'Brien, J.G. & Mielke, M.M. 1995. How to Prune Trees. USDA Forest Service. Available at *na.fs.fed.us/spfo/pubs/howtos/ht_prune/prun001.htm.*

Reviewers: Brian Nerbonne, Minnesota Department of Natural Resources and Ken Brooks, Department of Forest Resources, University of Minnesota.

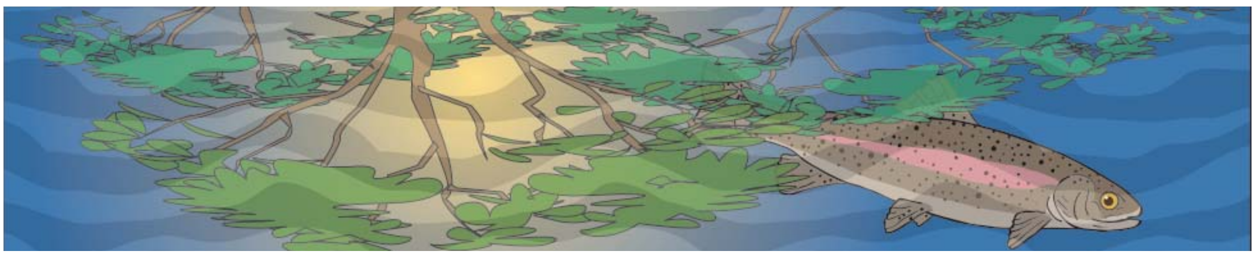
Illustrations by Robin Freese.

UNIVERSITY OF MINNESOTA | EXTENSION

Riparian forest buffers for trout habitat improvement

Financial assistance opportunities for riparian forest buffers

Gary Wyatt and Phyllis Bongard[1]



Introduction

Financial assistance for landowners adopting conservation practices is very important. Without financial incentives and cost share programs, many conservation practices would not be implemented. The main sources of financial and cost share assistance for riparian forest buffers come from state and federal government agencies.

The federal agencies offering assistance include the United States Department of Agriculture (USDA): Natural Resources Conservation Service (NRCS) and the Farm Service Agency (FSA). The Minnesota state agencies which offer assistance include mainly the Board of Water and Soil Resources (BWSR) working through the local or county offices of the Soil and Water Conservation Districts (SWCD). The Minnesota Department of Agriculture has an excellent website which reviews many possible funding programs for riparian forest buffers.

[1] Gary Wyatt is an Extension educator, agroforestry, for University of Minnesota Extension. Phyllis Bongard is an Extension educator, agriculture production/water quality, for University of Minnesota Extension, Dakota County.

Federal agencies

Farm Service Agency

Conservation Reserve Program

Forested Riparian Buffers (CP22) are one of the conservation reserve programs (CRP) offered by USDA through FSA offices. The payment consists of several parts: A land rental payment plus an additional 20% rental rate incentive payment is received annually for the 10-15 year life of the contract. (In 2008, CRP rental rates for this practice in Minnesota ranged from $45.48 to $187.06 per acre.) A one-time cost-share payment covers 50% of the cost of eligible products and services necessary to establish and maintain the practice, such as seeding/plant purchase and site preparation. Two one-time special incentive payments are received up front: a Signup Incentive Payment of $10 per acre per year enrolled (up to 10 years) and a Practice Incentive Payment equal to 40% of the total eligible cost of establishing the practice. A mid-contract maintenance payment defrays the cost of required management activities. Contact your local USDA Farm Service Agency office for further details.

Natural Resources Conservation Service

Conservation Stewardship Program (CSP2)

CSP2 encourages land stewards to improve their conservation performance by installing and adopting additional activities, and improving, maintaining and managing existing activities on agricultural land and nonindustrial private forest land. CSP is a voluntary program available nationwide on a continuous application basis. This is a whole farm comprehensive program that requires a five-year commitment. Payments are based on the amount of conservation performance for the types of practices or enhancements chosen and acres under contract. Riparian forest buffers are a cost-shareable practice under this program.

Environmental Quality Incentives Program (EQIP)

The Environmental Quality Incentives Program (EQIP) is a voluntary program and is the premier environmental conservation program that supports production agriculture and environmental quality as compatible goals. Through EQIP, landowners may receive financial and technical help with structural and management conservation practices on agricultural land. Riparian forest buffer is a water resource protection practice and is cost-shared according to the current payment schedule.

Wildlife Habitat Incentives Program (WHIP)

WHIP is a program designed to develop and improve wildlife habitat on private land. Under WHIP, the landowner and USDA/NRCS enter into a 5- to 10-year agreement that pays the landowner up to 75% of the cost to establish wildlife habitat practices. WHIP provides financial incentives to develop, enhance or restore habitat for fish and wildlife on private lands.

Stewardship Incentive Program (SIP)

The Stewardship Incentive Program (SIP) provides technical and financial assistance to encourage non-industrial private forest landowners to keep their lands and natural resources productive and healthy. Qualifying land includes rural lands with existing tree cover or land suitable for growing trees and which is owned by a private individual, group, association, corporation, Indian tribe or other legal private entity. Eligible landowners must have an approved Forest Stewardship Plan and own 1,000 or fewer acres of qualifying land.

Contact your local USDA Natural Resources Conservation Service office for more information on any of these programs.

State agencies

Board of Soil and Water Resources

Many conservation cost share programs are administered through BWSR which is offered through the Soil and Water Conservation Districts (SWCD) in each county in Minnesota.

Forested Riparian Buffer Payment: A one-time **cost share payment** covering up to 75% of the eligible costs for establishing a riparian buffer as a component of forestry conservation. Local SWCDs may set a payment rate lower than the statewide maximum of 75%. Higher cost share percentages may be targeted at areas identified with high priority erosion and water quality problems. Contact your local Soil and Water Conservation District office for details.

Local organizations

Special financial incentives are sometimes offered to landowners in a particular county or watershed for selected conservation practices for a limited time—usually as part of a special initiative funded by a federal or state grant. To find out if any special conservation incentives are offered in your area at this time, contact your local Soil and Water Conservation District, watershed organization, county, NRCS – Resource Conservation and Development office or other local contacts.

Many local conservation or wildlife organizations may also have funds available to help landowners cost share with plantings, or help with establishment or even maintenance of the conservation practice which improves wildlife habitat.

Ecosystem services

The USDA is developing policies and a structure through which landowners can receive payments for conservation methods and practices which preserve and protect our natural resources, including soil, water, air and wildlife.

Healthy ecosystems are ecological life-support systems that provide a full suite of goods and services that are vital to human health and livelihood, natural assets we call ecosystem services.

Many of these goods and services are traditionally viewed as free benefits to society, or "public goods"—wildlife habitat and diversity, watershed services, carbon storage and scenic landscapes, for example. Lacking a formal market, these natural assets are traditionally absent from society's balance sheet; their critical contributions are often overlooked in public, corporate and individual decision-making.

USDA – Ecosystem Services is exploring national opportunities to advance markets and payments for ecosystem services. With help from partners and others, broader thinking and collaboration that stimulates market-based conservation and stewardship.

Carbon credit markets are being developed. Most forest riparian buffers are eligible for forestry offset carbon credits from the Farmers Union Carbon Credit Program. Payments fluctuate based on the market price of carbon dioxide; see the Chicago Climate Exchange for the current price.

For more information

Other publications in this series:

- Benefits of riparian forest buffers
- Design of riparian forest buffers
- Establishment of riparian forest buffers
- Maintenance of riparian forest buffers

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

National Agroforestry Center
unl.edu/nac

Riparian Forest Buffer publications
unl.edu/nac/riparianforestbuffers.htm

USDA – Ecosystem Services and Marketing
www.fs.fed.us/ecosystemservices/

Carbon credit markets

Farmers Union Carbon Credit Program
carboncredit.ndfu.org

Chicago Climate Exchange
chicagoclimatex.com

Federal

USDA – Farm Service Agency – United States and Minnesota
fsa.usda.gov

Minnesota Farm Service Agency
fsa.usda.gov/FSA/stateoffapp?mystate=mn&area=home&subject=landing&topic=landing

USDA – Natural Resources Conservation Service – United States and Minnesota
nrcs.usda.gov

Minnesota Natural Resources Conservation Service
www.mn.nrcs.usda.gov

Conservation Stewardship Program (CSP2)
www.mn.nrcs.usda.gov/programs/csp2

Environmental Quality Incentives Program (EQIP)
www.mn.nrcs.usda.gov/programs/eqip/eqip2010.html

State and local

Minnesota Board of Water and Soil Resources
www.bwsr.state.mn.us

Easements, grants, resource management and planning, conservation implementation, wetlands

Minnesota Department of Agriculture–Conservation Funding Guide List of Contacts:
www.mda.state.mn.us/protecting/conservation/contacts.aspx#SWCD

This is not a comprehensive or complete directory of conservation organizations but provides info on many conservation organizations. Local or county organizations are not listed but can be contacted for possible cost-sharing opportunities.

Reviewers: Ginger Kopp, Natural Resources Conservation Service and Brian Nerbonne, Minnesota Department of Natural Resources.

Illustrations by Robin Freese.