SARE Project ANC93-17

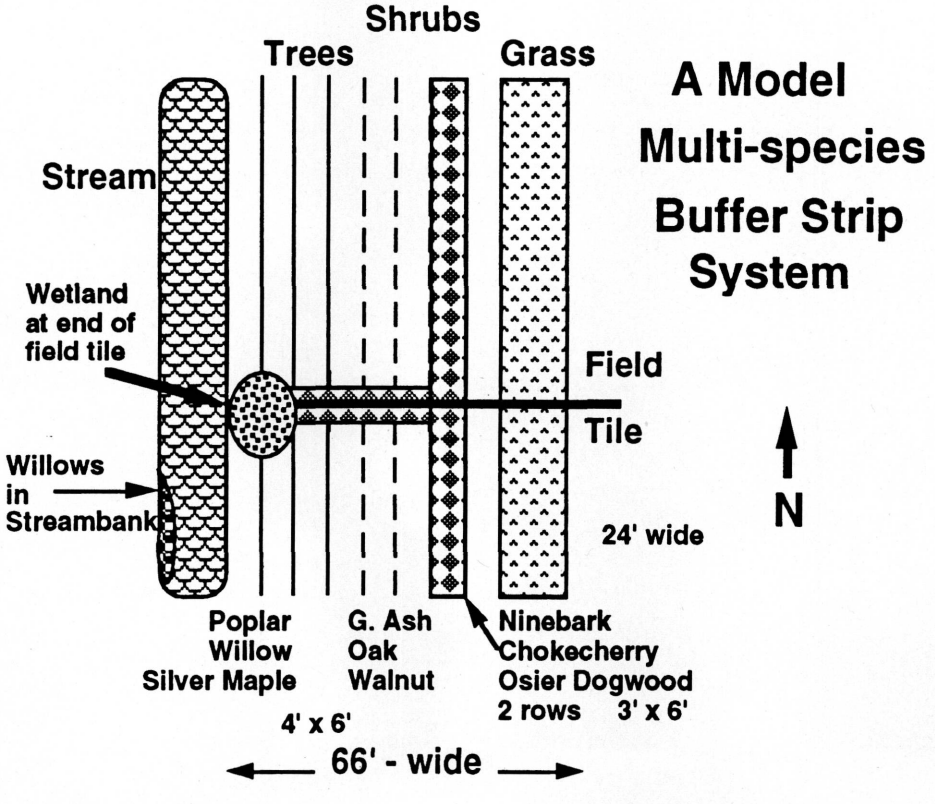
# DESIGN AND ESTABLISHMENT OF A MULTI-SPECIES RIPARIAN BUFFER STRIP

LEOPOLD CENTER

These recommendations for a multi-species riparian buffer strip (RBS) are based on research conducted by the Iowa State University Agroforestry Research Team (IStART).

## GENERAL DESIGN

- The general layout consists of three zones, starting at the creek or stream bank edge, the first zone, includes a 30 ft wide strip of trees (4-5 rows), the second zone, a 12 ft wide strip of shrubs (1-2 rows), and the third zone, a 24 ft wide strip of native warm-season grass.
- This zonation design is important because the trees and shrubs provide perennial root systems and long-term nutrient storage close to the stream and the grass provides the highest density of stems to dissipate the energy of surface runoff from the adjacent cropland.
- Design can be modified by replacing the shrubs with more trees or replacing some or all of the trees with shrubs. More grass could replace the shrub rows.
- The width of the grass zone should be not be less than 20 ft wide.



A photograph of the multi-species buffer strip. Starting at the stream (left side of the picture) there are five rows of trees (Zone 1) followed by 2 rows of shrubs (Zone 2) and a strip of switchgrass (Zone 3).

## SPECIES COMBINATIONS

### Trees

- Fast growing trees are needed to develop a functioning RBS in the shortest possible time.

- Rows 1-3 (row 1 is the closest to the streambank edge) in the tree zone (zone 1) should include fast-growing, riparian species such as: willow, cottonwood, silver maple, hybrid poplars, green ash, and box elder. Other moderate-growth species include: black ash, river birch, hackberry, shellbark hickory, swamp white oak, pin oak, Ohio buckeye, and sycamore. The key to tree species selection is to observe native species growing along existing natural riparian zones and select the faster growth species.

- If height from the top of the bank to the water level at normal flow (summer non-flood stage) is more than 4 ft and soils are well drained species such as: black walnut, red oak, white oak, or white ash could be planted in rows 4 and 5. Again, other species could be selected based on species growing in neighboring uplands.

### Shrubs

- Shrubs are included in the design because of their permanent roots and because they add biodiversity and wildlife habitat. Their multiple stems also function to slow flood flows.

- The mixture of species that have been used by IStART include: ninebark, red-osier and gray dogwood, chokecherry, Nanking cherry, and Nannyberry. Again, select shrubs based on native species and desired wildlife/aesthetic objectives.

- Other species include: speckled alder, serviceberry, silky dogwood, roundleaf dogwood, hawthorns, Eastern wahoo, wild plum, pin cherry, peachleaf willow, Bebb willow, sandbar willow, buffalo berry, Nannyberry, viburnum, blackhaw, and rusty blackhaw.

- Species should be for their ability to select specific wildlife and their adaptability to the specific site.

## Grass

- The grass functions to intercept and dissipate the energy of surface runoff, trap sediment and ag chemicals in the surface runoff, and provide a source of soil organic matter for microbes (those little organisms so important for decomposition and plant growth), and improved soil quality.

- Switchgrass is recommended because it produces a uniform cover and has dense, stiff stems which provide a high frictional surface to intercept surface runoff.

- Other permanent warm season grasses, such as Indian grass, big bluestem and little bluestem can be included as long as switchgrass is the dominant species.

- Native perennial forbs may also be part of the mix, especially if they are seeded in clumps.

- Switchgrass is a very aggressive competitor and may, in time, out compete other plants in the grass strip.

## Other Species Combinations

The CMRBS system that is presented here prescribes a zone of trees, a zone of shrubs, and a zone of prairie grass. Within the tree zone, riparian species such as willow, silver maple, and cottonwood are recommended for the two or three rows nearest the stream and other species could be planted in the other one or two rows. A wide variety of shrub species can be used depending on the wildlife use. The grass strip should contain a native grass that is very dense and able to slow down surface runoff rather than flatten under the runoff, actually accelerating the water moving toward the creek. Although these species combinations provide a very effective plant community they are not the only combinations that can be effective. Site conditions, major buffer strip biological and physical function(s), owner objectives, and cost-share program requirements should be considered in specifying species combinations.

The following are given as examples of other possibilities. Although these have not been field tested throughout Iowa, they are believed to be effective.

- Shrub rows replaced by trees or tree rows replaced by shrubs (timber vs wildlife habitat considerations - in any case a mixture of trees or shrubs species should be used)

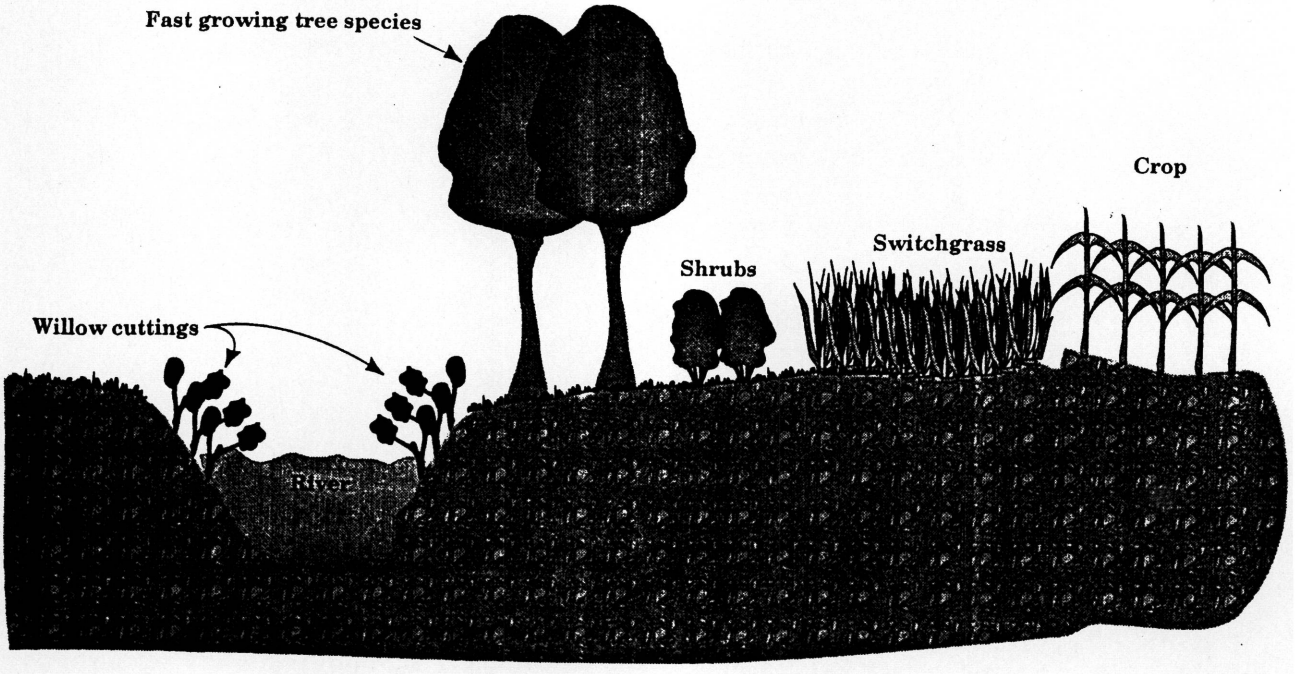
- Trees composed of slower growing high-value species (this buffer strip will not begin to function as quickly, but its longevity might be greater).

- All zones planted to prairie grass instead of the shrubs and trees (a dense zone of prairie grass should be planted adjacent to a crop field, but the zone closest to the stream could include a mixture of grasses and forbs). In this example willow cuttings or other shrub species could be used in the streambank to provide long term streambank stability.

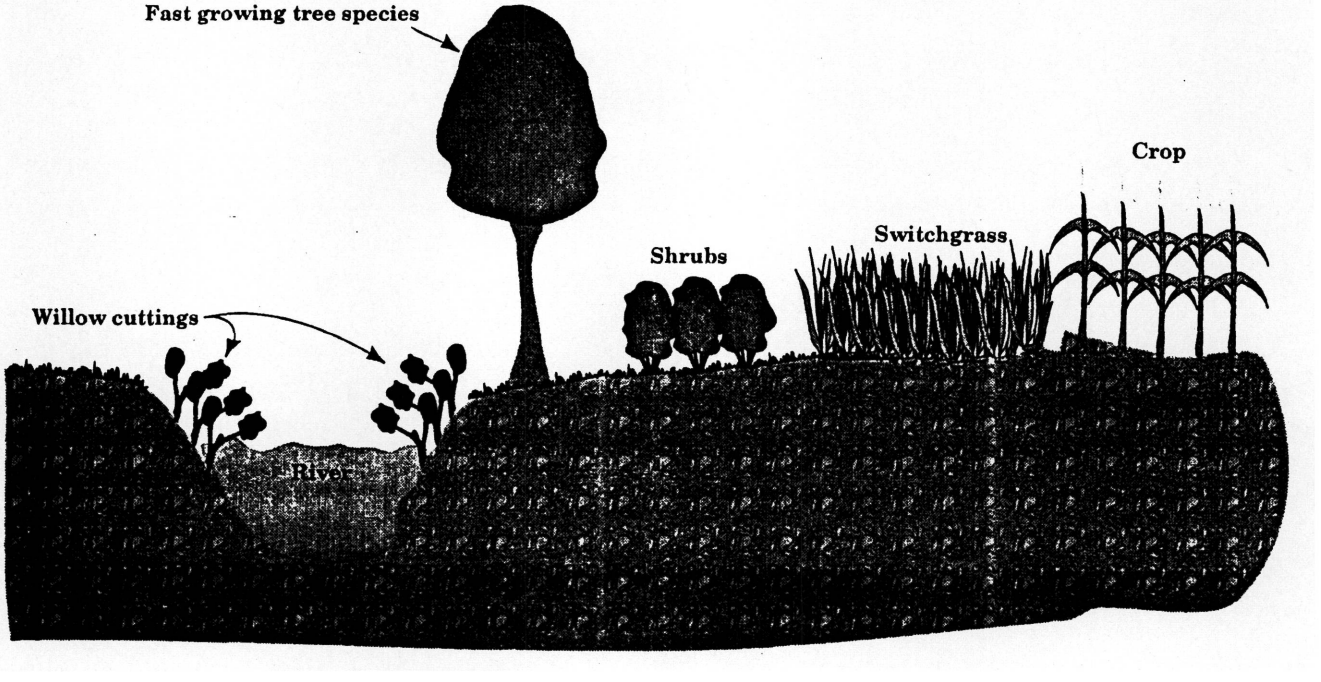
- Prairie grass replaced by a dense, strong, cool-season grass such as fescue that might be more palatable forage (especially if surface runoff is not a major problem). Harvesting or controlled grazing and using fence to keep livestock out of the stream could be used to remove the biomass from the site.

- Direct broadcast seeding of a mixture of trees and shrubs in the tree-shrub zone to naturalize the planting by avoiding rows and by reducing the cost of planting seedlings.

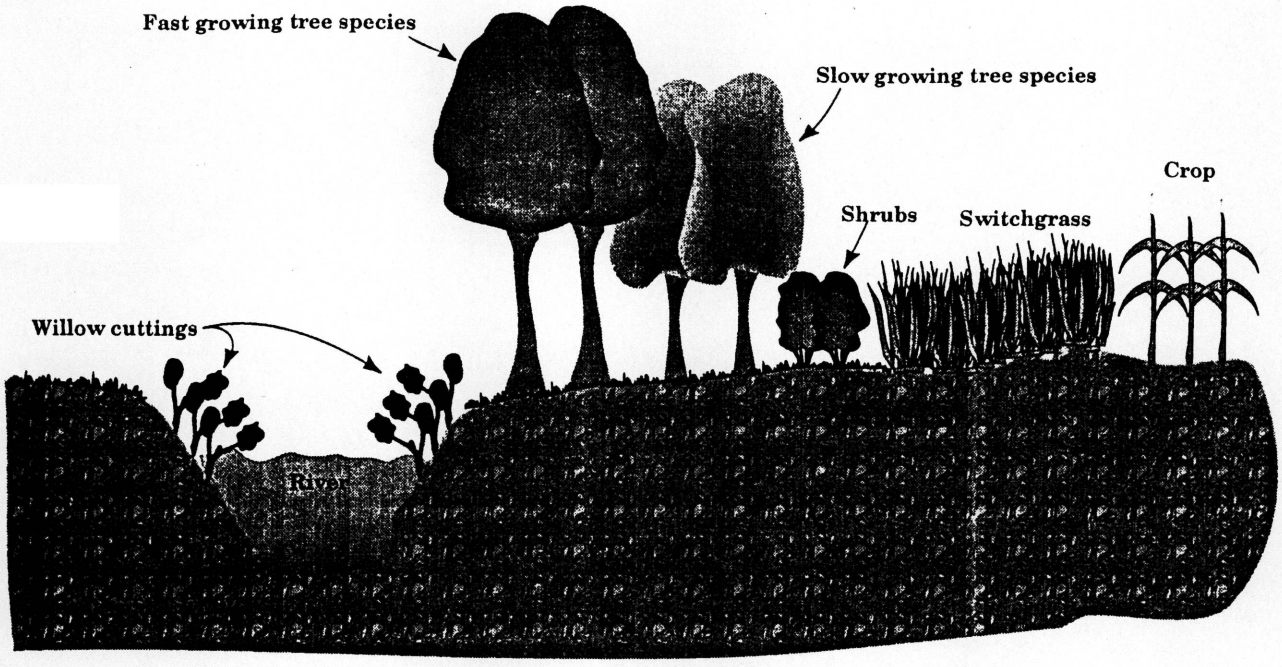
Buffer Strip Width - 50 ft.




Buffer Strip Width - 50 ft.



Buffer Strip Width - 66 ft.

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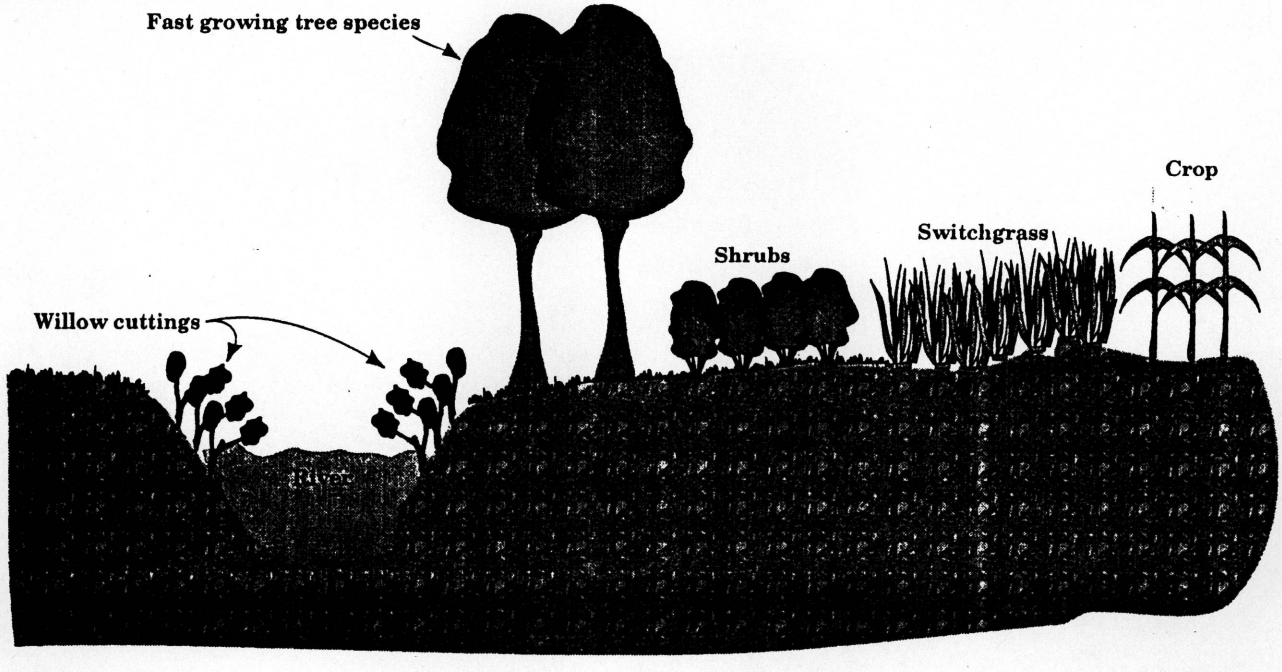
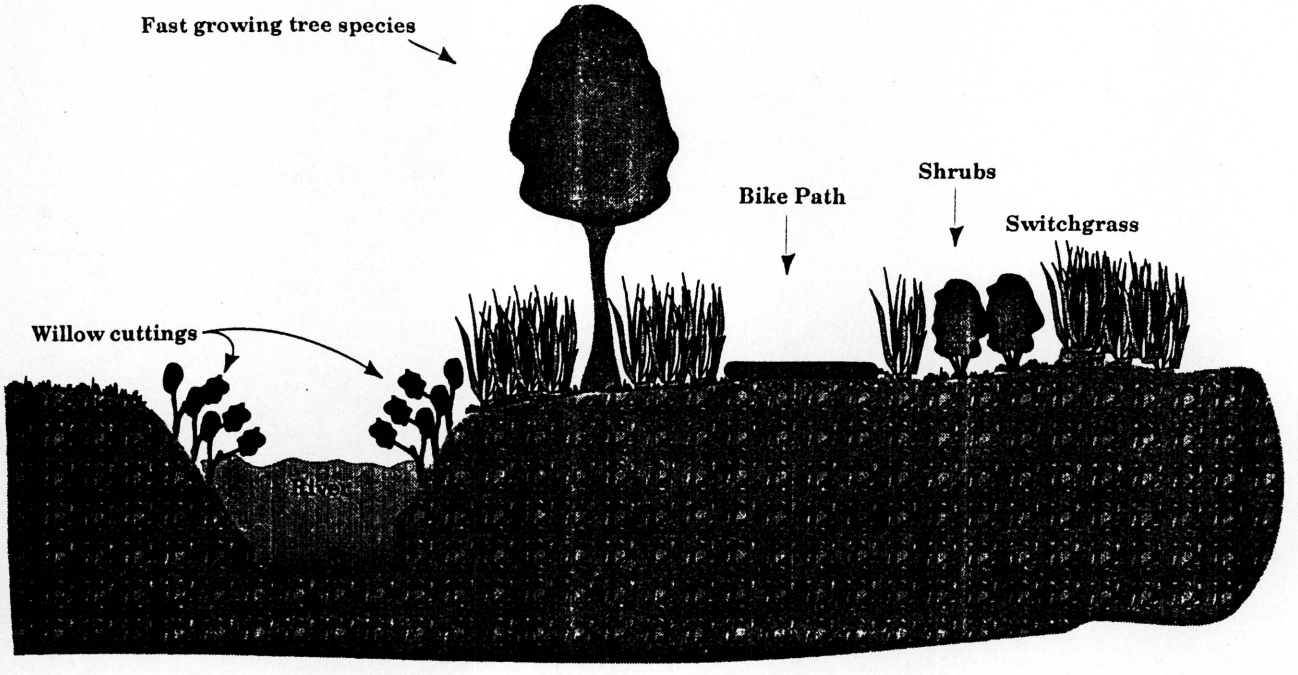
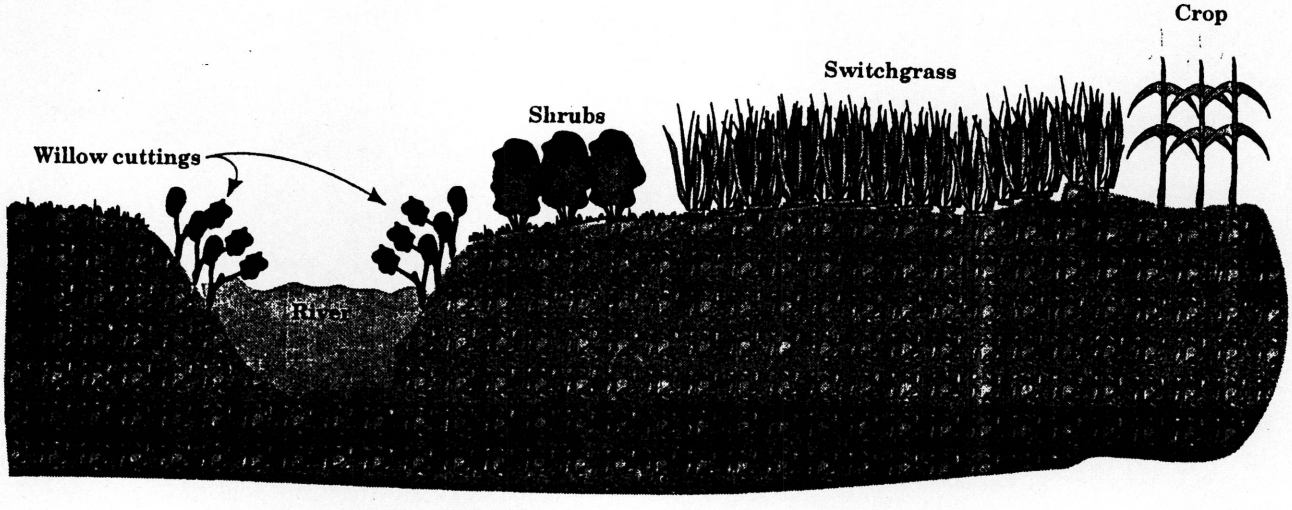


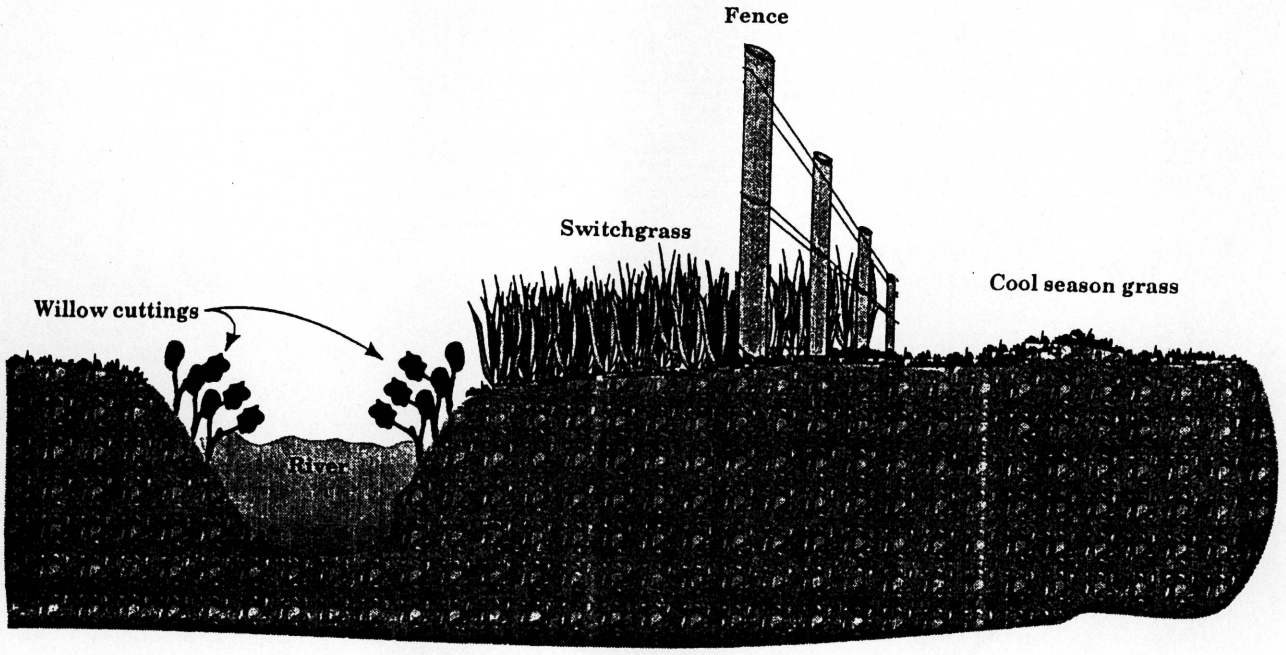
**Urban Area**



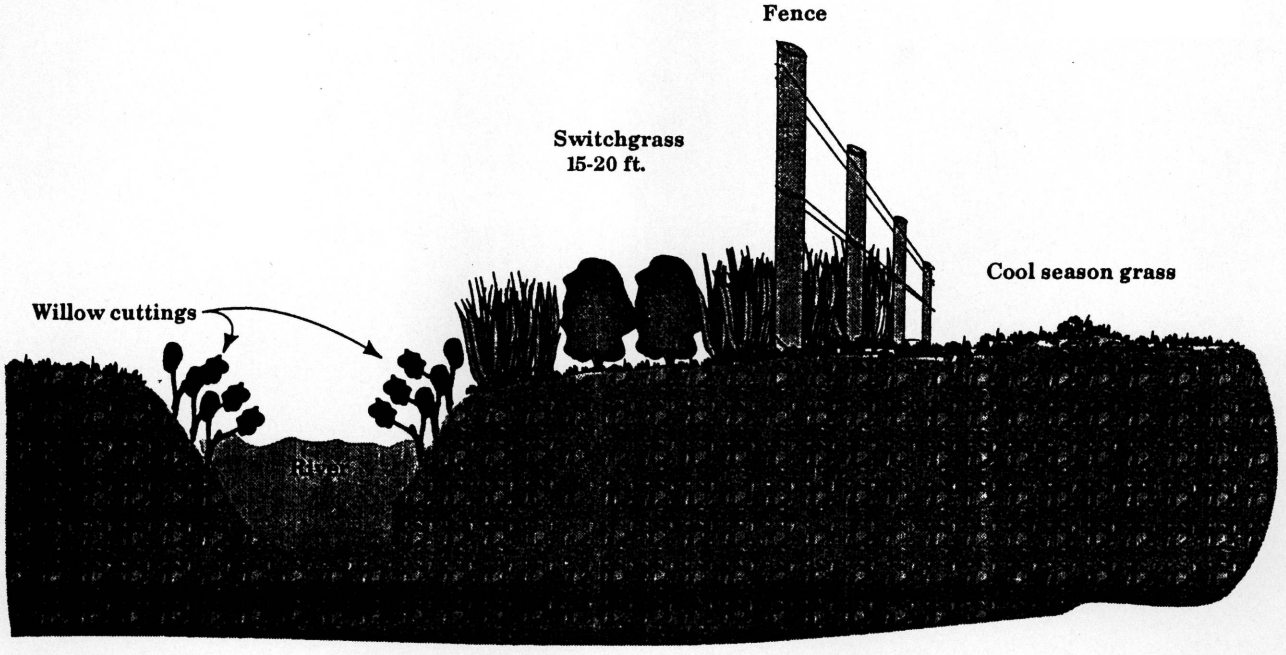

**Buffer Strip Width - 66 ft.**



Grazing Buffer Strip




Grazing Buffer Strip
15-20 ft.



- Planting 15-20 ft of grass along the streambank, then trees widely spaced (14 ft between rows) and planting row crops in those 14 ft wide alleys until tree crowns touch. This would provide some annual monetary return during the establishment phase of the buffer strip.

- In urban settings plant warm season grasses over the whole zone and plant small groups of shrubs and/or trees to provide a diverse, naturalized look. This might provide a good setting for installing a well designed bike or walking path within the buffer strip. The dense zone of grasses at the interface with the upland may not be as important in many urban settings.

There are numerous other possible combinations. The keys to remember is that the plant community should be matched to the owners objectives, the major function(s) of the buffer strip, and cost-share program requirements.

## WIDTH

The model that IStART has developed has a width of 66 feet wide on each side of the creek, stream, or river. However, the CMRBS system presented in this brochure has many possible variations and should be adapted to fit each site and land ownership. The total width of the buffer strip depends in large part on the major functions of the buffer strip and the slope and use of the adjacent land.

- If the major purpose of the buffer strip is sediment removal from surface runoff, a width of 50 ft may be sufficient on slopes of 0-5%.

- If excess nutrient N removal also is an important function a width of 66 to as wide as 100 ft would be necessary depending on the kind and quantity of agricultural chemicals applied and the soil and cultivation system which is used.

- If row-crops presently are found adjacent to the buffer strip, both the sediment and chemical removal functions would be important.

- In an urban setting where surface runoff is the major concern, a 50 ft wide buffer strip should be effective.

- If wildlife habitat is an important component of the buffer strip, widths of 100 - 300 ft would provide a more suitable wildlife corridor or transition zone between the upland agricultural land or urban/suburban areas and the aquatic ecosystem.

- USDA Forest Service and USDA Soil Conservation Service recommend a width of at least 95 feet.

- As the slope, intensity of land use, or total area of the land producing NPS pollutants increases or as soil permeability decreases, a wider RBS is required. Some recommendations in the literature suggest:

  - 20% of the total NPS pollutant area should be in RBS.

  - Land capability classes I, II, V = 95 ft; III & IV = 120 ft; VI & VII = 170 ft

Before and after picture looking upstream toward the bridge. The before picture was taken in March, 1990 before planting the buffer strip and the second picture (right) was taken in early June, 1994, during the beginning of the fifth growing season.

## ESTABLISHMENT

### SITE PREPARATION

- If the site was a grazed pasture - treat 4 ft wide strips in Zones 1& 2, where trees and shrubs are to be planted, with Roundup. Treat all of Zone 3, the grass zone, with Roundup. Treatment should be done the fall before spring planting.

- If the site was in row crops, disk the area, plant a mixture of 5 lbs/ac of perennial rye and 7 lobs/ac timothy where the trees and shrubs will be planted. Disk and pack the area where switchgrass will be planted.

- If perforated tile lines run through the proposed RBS they should be replaced with solid lines or a 30 ft wide strip of grass or shallow-rooted shrubs should be planted across the RBS.

### LAYOUT

- Plant tree rows 6-8 ft apart. Within rows trees should be planted 4-8 ft apart depending on product. For short-rotation biomass products 4 ft spacing is good, for timber products use 8 ft spacing.

- Plant shrub rows 6 ft apart. Within rows shrubs should be planted 3-6 ft apart depending on the mature size of the shrubs.

- Make sure the rows are laid out properly to facilitate access by maintenance equipment after planting.

- A prairie seed drill should be used to plant switchgrass at 5-8 lbs/ac. Seed can be drilled into killed sod or into a disked and packed soil.

## PLANT CARE PRIOR TO PLANTING

- Trees and shrubs seedlings and/or unrooted cuttings should be planted as soon as possible after receiving them from the nursery. Keep plants cool and moist until actually planted.
- Cull seedlings that do not meet minimum standards for the species (ex., a minimum of 4-5 lateral roots).
- Soak seedlings for 2-6 hours before they are field planted.

## PLANTING

- Machine, auger, or shovel planting can be used for the trees and shrubs. Use a hardwood planting machine or an 8 in diameter two-person or tractor-mounted auger. These may be available from your local County Conservation Board or District Forester.
- Plant seedlings with root collars slightly below the soil surface, make sure the planting holes are closed, but do not pack them tightly.
- Immediately after planting apply a pre-emergent herbicide in a 4 ft wide band (ex. Goal & Surflan, Oust)
- Use a prairie seed drill for the warm season grass and forbs. The drill may be available from your local County Conservation Board.

## MAINTENANCE

- Weed control is of paramount importance during the first 2-3 years of establishment.
- Inspect the planting frequently and use appropriate herbicides or mowing if needed.
- Mow the tree and shrub rows once or twice during the season to help identify the planting rows and to discourage rodent problems.
- Inspect the planting after every major storm event and repair areas where surface runoff or flood flows have washed out plant material.

## OBTAINING GRASS SEED AND TREE SEEDLINGS

- Tree and shrub seedlings can be obtained from the Department of Natural Resources Forest Nursery or other private vendors.
- Visit you local County Conservation Board to find grass and forbs seed vendors in your area

## ESTIMATED COSTS

- $350-$400 per acre to install RBS. This includes plant purchases, site preparation, planting, and maintenance costs in the first year.
- $20 per acre for annual maintenance for the first 3-4 years.

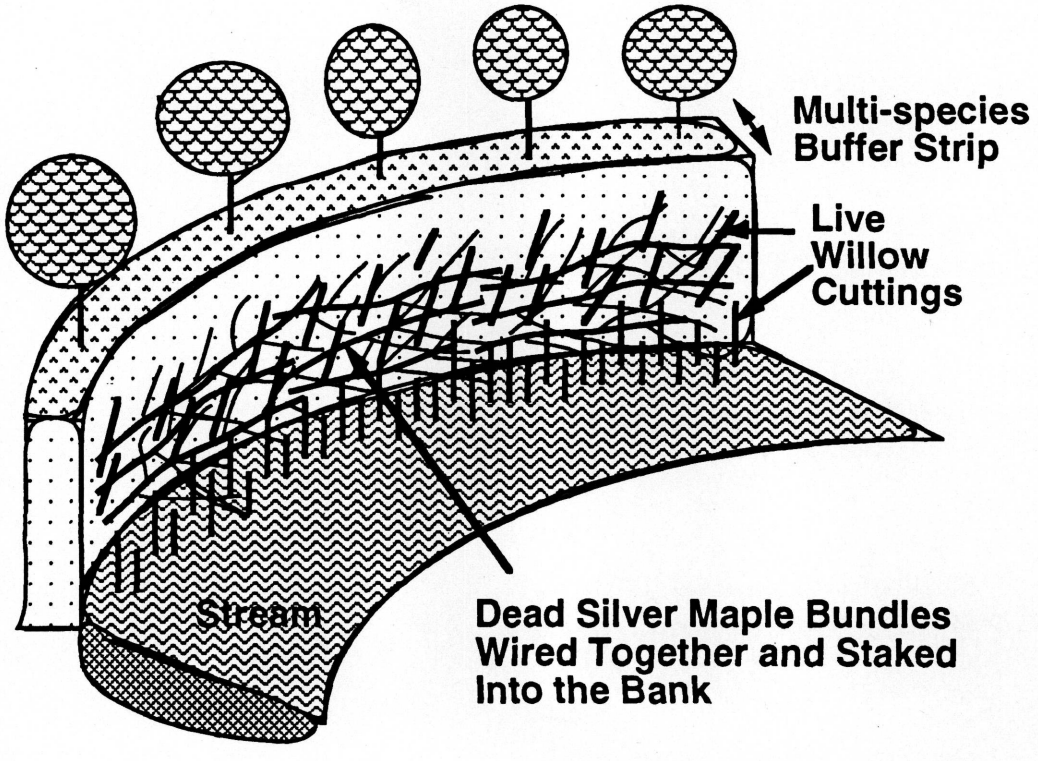
Before and after picture looking downstream toward the bridge. The before picture was taken in March, 1990 before planting the buffer strip and the second picture (right) was taken in September, 1994, near the end of the fourth growing season.

## STREAMBANK BIOENGINEERING OPTIONS

### GENERAL LAYOUT

- On vertical or actively cutting streambanks use combinations of willow 'posts' and/or anchored dead tree revetments.
- Materials provide frictional surface for absorbing stream energy and trapping sediment.
- Goal is to change streambank angle from vertical to about 50° so other vegetation can become established.

**STREAMBANK BIOENGINEERING USING WILLOWS AND DEAD TREE BUNDLES**



## PLANT MATERIAL CONSIDERATIONS

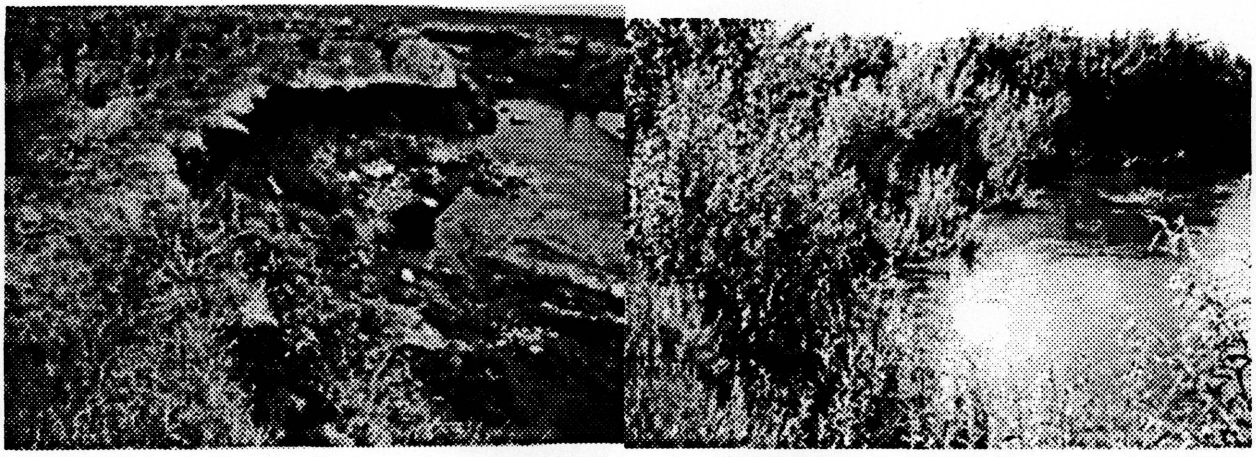
- Willow cuttings are collected during the dormant season, cut into 1-4 ft sections, and stored in a cooler until planting.
- Cuttings for hand installation should have diameters between 1/4 - 3 inches.
- Cuttings to be installed hydraulically with a backhoe can be up to 5-6 inches.
- Willow cutting can be obtained from vigorously growing native willows or from established cutting orchards.
- Cutting orchards can easily be established by the land owner.

## INSTALLATION

- Largest cutting should be pounded into the stream bed at the base of the streambank at spacing of 1-2 ft between posts.
- Use a rubber mallet to install the posts to minimize damage to the plant material.
- Small wing dams of willow posts can be extended into the stream by placing double rows of 3 - 4 posts at right angles or pointed slightly downstream.
- Cuttings should be pounded or pushed into the streambank on a 1 ft x 2 ft or 2 ft x 2 ft grid.
- Larger diameter cutting should be used at the base of the streambank and smaller ones toward the top.

## PLANT MATERIAL REVETMENTS

- Bundles of eastern redcedar or small hardwoods (5-6 year old) silver maples, willows, etc. can be tied together into 2-4 tree bundles.
- Bundles can are laid against the bank with the bottoms pointing upstream.
- They are anchored to the bank using various anchoring devises.
- Willow cuttings are pounded between the bundles to provide a living anchor.

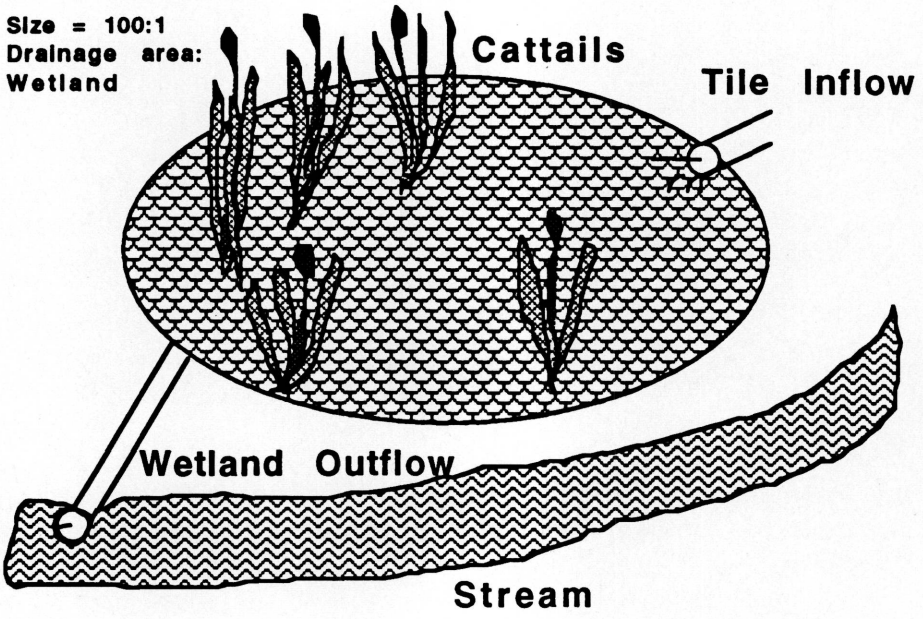


Before and after picture looking downstream from the bridge. The before picture was taken in June 1991 and the second picture (right) was taken in early June, 1994, during the beginning of the fifth growing season. Note the loss of two rows of trees that were planted (left picture). This bank collapse resulted from two 100 year floods in 1990 and 1991. Willow posts and cuttings were used to stabilize this bank.

## TILE WETLAND CONSTRUCTION

- Small wetlands can be constructed at the end of field tiles if a small depression can be developed with a berm to keep the stream water out.
- Determine size of the field area that the tile line is draining.
- Construct a depression at the ratio of 1:100 (1 acre of wetland for 100 acre drainage).
- Construct a berm between the stream and the wetland; stabilize the berm on the stream side with willow cuttings and seed the rest to a mix of prairie grasses and forbs.
- Seal the bottom of the wetland with clay if soil texture is sandy.
- Install a gated control structure for controlling water level.
- Collect cattail rhizomes during early spring when shoots have just begun to elongate.
- Rhizomes can be stored in the cooler for up to 1 month.
- Plant rhizomes in the wetland at a spacing of 2 ft x 2 ft.

## RIPARIAN FIELD TILE WETLAND




## OTHER CONSIDERATIONS

### RIPARIAN BUFFERS FOR GRAZING SITUATIONS

Livestock walking directly above streambanks, climbing on streambanks, and spending time in the stream itself introduce major pollutants into the water and physical damage to the land. Streambank collapse along grazed streams is the major source of stream sediment. Removing livestock from the whole riparian zone is not necessary if rotational or deferred grazing is practiced. Fencing livestock away from the streambanks and out of the streams is necessary if water quality and stream habitat is to be improved. The following are design considerations for riparian zone grazing. Although these have not been fully tested research from many states suggest that they will work.

- Install electric or permanent high-tensile fence 15-20 ft away from the top of the streambank.
- Maintain the grasses that are presently in this zone or establish warm season grasses, such as switchgrass and Indian grass, which typically have deeper root systems than the Iowa cool season grasses.
- Establish willow cuttings or other woody plants in the bank (soil bioengineering) to help stabilize the banks.
- Provide access to water with 50 ft wide accesses to the channel along reaches of the stream where banks are gently sloped and can be stabilized with crushed rock and gravel.
- Provide watering systems away from the stream by using solar pumps or livestock operated 'Wisconsin' pumps.

## BEAVER

Planting trees, especially cottonwoods and willows along the streambank can attract beaver. These mammals can effectively pool water behind their dams. These pools trap sediment and organic matter providing conditions for denitrification and chemical adsorption, slowing water movement through the stream system during flood flows, providing base flow longer throughout the season, and providing habitat for waterfowl and other animals.

However, these same biological and physical benefits may sometimes pose problems for agriculture by flooding some additional lands and backing up tile water keeping fields wetter. Beaver dams can be removed, beaver can be lived-trapped, or by-pass pipes can be put into the dams that allow water to move rapidly through the dams.

## WOODY PLANT ROOTS AND FIELD TILE

Clay tile and perforated plastic tile can become plugged by tree and shrub roots in the buffer strips. Two possible solutions to this problem exist:

- Replace the tile passing through the buffer strip with solid tile @ $300 per 100 ft. Cost-sharing may be available for this activity.

- Plant a strip of warm season or cool season grass above the tile line at a width of 60-100 ft wide depending on the woody plants that are planted

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