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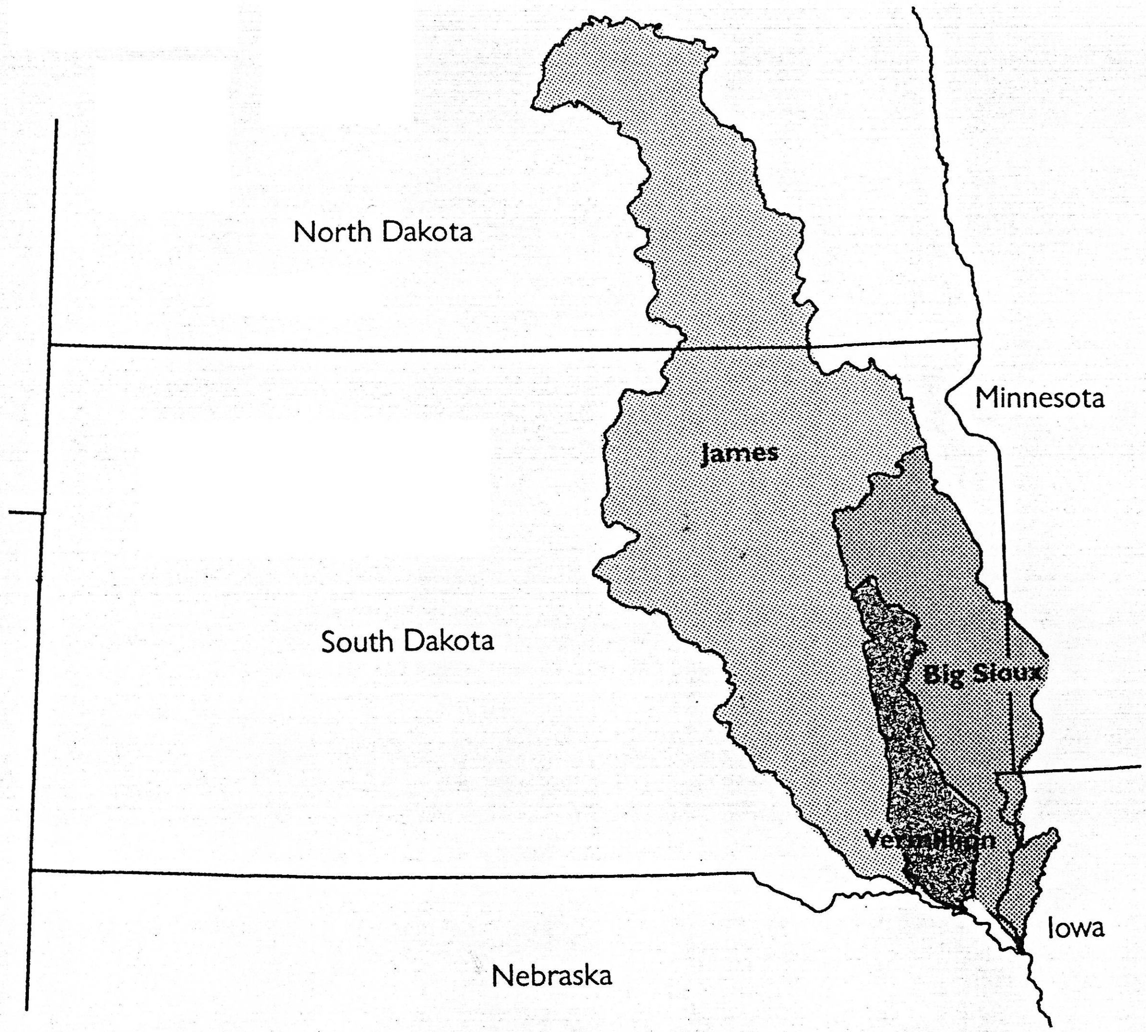


# WATERSHED MANAGEMENT WORKSHOP FOR THE JAMES, VERMILLION, AND BIG SIOUX RIVERS

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# Design, Function, and Management of Multi-Species Riparian Buffer Strip Systems

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The highly productive agricultural landscape of the midwestern United States yields substantial quantities of non-point source (NPS) pollutants which find their way into surface and ground waters. While upland conservation practices can reduce NPS pollution, it is the riparian zone immediately along the stream edge which may contribute the most to NPS pollution. If this zone is exploited by row crop agriculture or overgrazing, NPS pollutants can be generated immediately adjacent to the stream. If riparian zone best management practices (BMP) are employed, this source of NPS pollution is eliminated and the riparian zone becomes a living filter of NPS pollutants generated in the upland. Increased use of such buffer zones has the potential to greatly improve the environmental performance of the agricultural landscape.

The Agroecology Issue Team of the Leopold Center for Sustainable Agriculture and the Iowa State Agroforestry Research Team (ISTART) are conducting research on the design and establishment of multi-species riparian buffer strip systems (MSRBS). The plan is that the buffers will intercept eroding soil and agricultural chemicals from adjacent crop fields, slow flood waters, stabilize streambanks and reduce channel movement, and improve in-stream environments, while also providing wildlife habitat and biomass for energy and high quality timber. The MSRBS system is an integrated management system which also includes willow-post soil bioengineering features to stabilize streambanks and constructed wetlands placed at the outlet of field drainage tiles to process agrichemicals contained in tile flow before they enter the stream.

The interdisciplinary teams began the research on a private farm located along Bear Creek in a highly developed agricultural region of central Iowa in 1990. The restored MSRBS systems have reduced sediment and chemicals moving with surface runoff by trapping over 90% of the material in the buffer zone where the plants and soil microbes can immobilize and metabolize them. NPS pollutants moving through the soil solution of the rooting zone or in the shallow ground water also are reduced by over 90% to levels well below the maximum contaminant levels allowed by the U.S. Environmental Protection Agency. Similar improvements in water quality are seen in water passing through the tile wetland, and streambanks are stabilized by living willow stems and associated grasses and forbs.

Beginning at the streambank edge, the first zone of the MSRBS is 10 m wide and contains four or five rows of rapidly growing trees, the second zone is 4 m wide and contains one or two rows of shrubs, and the third zone is 7 m wide and contains native, warm-season grasses. This zonation is important because the trees and shrubs provide perennial root systems and long-term nutrient storage close to the stream, while the shrubs add more woody stems near the ground to slow flood flows and provide a more diversified wildlife habitat. The native grasses provide the high density of stems needed to dissipate the energy of surface runoff and the deep and dense annual root systems needed to increase soil infiltration capacities and provide organic matter for large microbial populations.

Fast-growing trees are needed to develop a functioning MSRBS in the shortest possible time. It is especially important that rows 1-3 (the first row is the closest to the streambank edge) in the tree zone (zone 1) include fast-growing, riparian species such as willows (*Salix* spp) and cottonwoods (*Populus* spp). If, throughout the year, the rooting zone along the streambank is more than 1.2 m above normal stream flow and soils are well drained, then upland deciduous and coniferous trees and shrub species can be planted in rows 4 and 5. Although these slower growing species will not begin to function as nutrient sinks as quickly as faster growing species, they will provide a higher quality product to the landowner. Shrubs are included in the design because their permanent roots help maintain soil stability, their multiple stems help slow flood flows, and their presence adds biodiversity and wildlife habitat. Many native shrubs can be used and are often selected because of their desirable wildlife and aesthetic values.

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The three-zone MSRBS model of trees, shrubs, and prairie grasses is well suited to agroecosystems of the Midwest and eastern Great Plains. Although these species combinations provide a very effective riparian buffer strip plant community, there are other combinations that can be effective. Site conditions, major buffer strip biological and physical functions, owner objectives, and cost-share program requirements should be considered in specifying species combinations.

It costs about $875 per ha to install the three-zone MSRBS. This includes plant purchases, site preparation, planting, labor, and maintenance costs in the first year. About $50 per ha should be figured for annual maintenance for the first 3 to 4 years.

Streambanks that have been heavily grazed or that have had row crops planted to the edge of the bank are often very unstable and need extra protection beyond that provided by the vegetated buffer strip. In these situations soil bioengineering techniques, such as the willow post method, can be employed. On vertical or actively cutting streambanks, combinations of dormant willow 'posts' are planted along with anchored dead tree revetments to protect streambanks. These plant materials provide a frictional surface for absorbing stream energy and trapping sediment and also provide shade and organic matter for instream biota. Where there is a concern for active undercutting of the bank, bundles of eastern red cedar or small hardwoods (3-4.5-m-long silver maples, willows, etc.) can be tied together into two- to four-tree bundles. A row of these bundles is laid along the bottom-most row of willow posts with the lower trunks pointed upstream and the bundles anchored to the willow posts or streambank.

In areas of artificial drainage, small wetlands can be constructed at the end of field tiles to interrupt and process NPS pollutants before they enter water bodies. A 0.5-1 m deep depression is constructed at the ratio of 1:100 (1 ha of wetland for 100 ha drainage). A berm should be built along the stream, stabilized on the stream side with willow cuttings, and seeded with a mixture of prairie grasses and forbs. If a coarse textured soil is encountered, the bottom of the wetland can be sealed with clay and topped with original soil. A gated control structure for controlling water level should be installed at the outflow into the stream.

In designing the wetland it is important to remember that most of the chemical transformation and retention occurs at or near substrates (sediments or plant litter). Wetlands containing large amounts of vegetation and decaying plant litter will thus have a much greater capacity for pollutant removal. Any management technique which accelerates vegetation establishment (active regeneration) or litter buildup (addition of organic substrate) will improve chemical retention.

The above recommendations will provide a MSRBS system that effectively intercepts and treats NPS pollution from the uplands. However, a MSRBS system cannot replace upland conservation practices. In a properly functioning agricultural landscape both upland conservation practices and a MSRBS system should be in place.