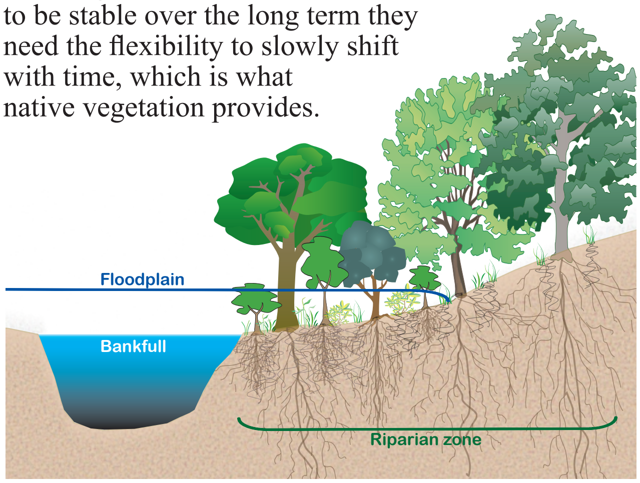
Stream Habitat Program

Resource Sheet 2: The Value and Use of Vegetation

Why is vegetation so important?

Naturally vegetated stream banks, riparian zones, and floodplains are crucial to streambank and channel stability, stream condition and function, water quality, and overall ecosystem health. Healthy streams provide, among many things, clean drinking water and a diversity of fish. The loss and degradation of native riparian vegetation through human activities is a common cause of streambank erosion and failure. These activities include cultivation, deforestation, watershed development, livestock overgrazing, herbicide application, and streambank armoring.

The most simple, inexpensive, and valuable form of streambank stabilization is the preservation and restoration of native riparian and floodplain vegetation. Vegetation, in addition to natural materials and structures, are rudiments of the natural channel design approach that naturally stabilize and protect streambanks. Larger materials such as logs and root wads provide strength and structure and gradually decompose giving streambanks time to re-vegetate and stabilize. For channels to be stable over the long term they need the flexibility to slowly shift with time, which is what native vegetation provides.



The benefits of streambank vegetation

Riparian zones, or buffers, along the banks naturally consist of deep-rooting, flood-tolerant plants and trees that provide multiple benefits:

Streambank stabilization

- Native riparian vegetation has dense, deep, intertwined root systems that physically strengthen soils.
- Riparian root systems remove excess moisture from the soil, making banks more resistant to erosion or slumping.
- Exposed root systems provide roughness that dissipates the water's erosive energy along the banks while the plant stems and leaves provide roughness during flood flows.

Water quality protection

- Vegetated buffers intercept and filter out much of the overland flow of water, nutrients, sediment, and pollutants; accordingly, wider corridors are more effective at protecting water quality and promoting ground-water recharge.

Riparian habitat benefits

- Diverse riparian vegetation provides shade, shelter, leafy or woody debris, and other nutrients needed by fish and other aquatic organisms.
- Wide, continuous, vegetated floodplains help dissipate flood flows, provide storage for floodwaters, retain sediment and nutrients, and provide shelter, forage, and migration corridors for wildlife.

Natural channel design fundamentals

Restoring and conserving native vegetation in the riparian zone and throughout the floodplain and meander belt is fundamental to bank stability and stream health because of the many benefits provided (see text box above). In situations where erosion is not severe and the grade is not too steep, restoring vegetation may be the only step required. In cases where erosion is more severe (e.g. cutbanks, incised channel), re-vegetation remains an essential component of a restoration involving more complex methods and structures, which are explained in following resource sheets.

Disadvantages of hard armoring

Hard armoring banks with rock (riprap), timber walls, sheet piling, or waste concrete (which is not allowed) is a common bank protection approach; however, there are many disadvantages and undesirable impacts.

- Hard armored banks transfer the problem downstream by strengthening and redirecting stream flows downstream of the armor and into the next bend or meander resulting in bank erosion and failure, particularly along downstream bend(s).
- From an ecological standpoint, armoring does not provide aquatic or terrestrial habitat (shade, shelter, food) and has no ability to filter or process nutrients and sediments, which negatively impacts stream health.
- Armored banks can negatively affect long-term stability because they lock the channel into place preventing it from adjusting to changes in the watershed.
- Lastly, riprap is expensive to install and looks unnatural.

Prior to planting native vegetation, non-native and nuisance species must be completely removed and the bank may need to be re-graded if the bank slope is too steep or unstable. Re-vegetation techniques include planting seeds, seedlings/saplings, live cuttings, and shrubs and hydroseeding. Live cuttings are branches cut from readily sprouting tree species, such as black willow or dogwood, preferably from nearby vegetation that is adapted to the site. These species will grow and root quickly, thereby providing immediate soil strength and erosion protection. The seeds, plants, disturbed soil, and bank toe should be protected from runoff and stream flow during the rooting process. Such erosion control products and methods are described next.

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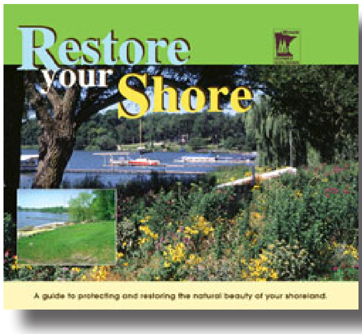
In choosing suitable native plant species, consider local habitat type (e.g. forest, prairie, wetland) and habitat components such as shade, soil type, moisture, and climate. Resources available to identify plant species suitable for various habitat types and desired purposes, such as erosion control, aesthetics, and wildlife habitat include: local nurseries, extension offices, soil and water conservation districts, the "Restore Your Shore" CD-ROM (info at http://mndnr.gov/restoreyourshore) and MN DNR website http://mndnr.gov/gardens/nativeplants. Vegetative stabilization has all the benefits of restoring native vegetation (strengthen and stabilize stream banks, runoff buffer, provide habitat, aesthetic value) in addition to low cost, low maintenance, lack of structural complexity, and endurance. Below is a list of plant species native to Minnesota that are recommended for streambank restorations.




Canada anemone


Swamp milkweed


Golden alexanders

Common name	Scientific name	Life form	Habitat
Blue vervain	*Verbena hastata*	F	W, UM
Canada anemone	*Anemone canadensis*	F	W, UM
Golden alexanders	*Zizia aurea*	F	W, UM
Grass-leaved goldenrod	*Euthamia graminifolia*	F	W, UM
Monkey flower	*Mimulus ringens*	F	W
Obedient plant	*Physostegia virginiana*	F	W, UM
Swamp milkweed	*Asclepias incarnata*	F	W, UM
Fowl manna grass	*Glyceria striata*	G	W
Fox sedge	*Carex vulpinoidea*	G	W, UM
Hardstem bulrush	*Scirpus acutus*	G	A, W
Porcupine sedge	*Carex hystericina*	G	W
River bulrush	*Scirpus fluviatilis*	G	A, W
Softstem bulrush	*Scirpus validus*	G	A, W
Tall manna grass	*Glyceria grandis*	G	W
Virginia wild-rye	*Elymus virginicus*	G	W
Basswood	*Tilia americana*	T	UM, UD
Black willow	*Salix nigra*	T	W
Red-osier dogwood	*Cornus sericea (stolonifera)*	T	W, UM, UD
Silver maple	*Acer saccharinum*	T	W, UM

Native Minnesota plant species recommended for stream bank restorations throughout the state (sorted by Life form then Common name).
***F**: forb (flower)* ***G**: grass or grass-like* ***T**: woody vegetation*
***A**: aquatic* ***W**: wet/transitional* ***UM**: upland moist* ***UD**: upland dry*


Fox sedge


Porcupine sedge


Red-osier dogwood

Natural materials and structures

Natural materials and structures can be used in addition to native vegetation to:

☆ protect seed & plantings from overland and stream flows,
☆ protect the toe of the streambank,
☆ prevent erosion on slopes,
☆ promote trapping of sediment,
☆ quickly develop dense roots and sprouts, & provide habitat.

The following six techniques are effective on small to medium streams. They are of moderate cost and can be installed by most landowners with a bit of direction. Landowners should consult an area hydrologist as project approval or a permit is required by the DNR and other agencies.

Biodegradable erosion control blankets (ECBs)

» Biodegradable ECBs are made of: jute (a vegetable fiber) mesh (*in photo*), coconut/coir fiber, straw, or excelsior (fine wood fiber) that are woven into a fiber matrix. ECBs are designed to temporarily provide erosion protection and assist with vegetation establishment as they degrade over 1-3 years leaving a vegetated bank. Products with polypropylene materials are not recommended because they do not degrade and can entangle wildlife in the rigid knitting.

× ECBs are placed over re-graded and re-seeded streambanks (use more durable netting for steeper banks). Wood stakes or live cuttings are used to secure the fabric in place (instead of metal anchor pins). Blankets should be installed promptly after the restoration to provide immediate erosion protection.

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Broadcast seeding and hydroseeding

» Broadcast seeding is the scattering of native seed mixes by hand or mechanically over prepared soil. Good seed to soil contact, protection (ECBs, mulch, oats or rye as a cover crop), and watering are important.

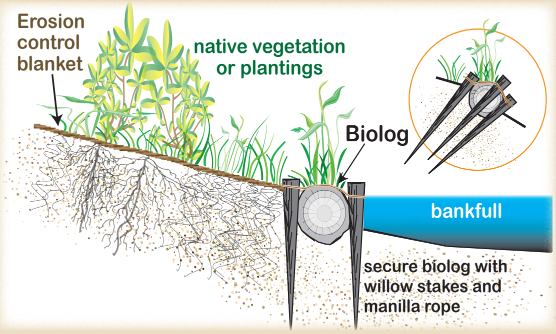
» Hydroseeding is a planting process that uses a mixture of water, seed, fertilizer, mulch, and tackifiers that is sprayed over renovated banks or slopes. Native seeds that are suitable to the habitat should be used in the mix. This mixture can be applied to the upper slopes, even on steeper slopes. The mixture should not be applied too close to the channel to avoid fertilizer from polluting the stream or seed from being washed away.

Staking and live cuttings

» Stakes and live cuttings from readily sprouting, local, healthy tree species such as black willow, dogwood, and alder are used to quickly vegetate restored streambanks. Staking can be applied on all types of banks and in addition to other techniques.

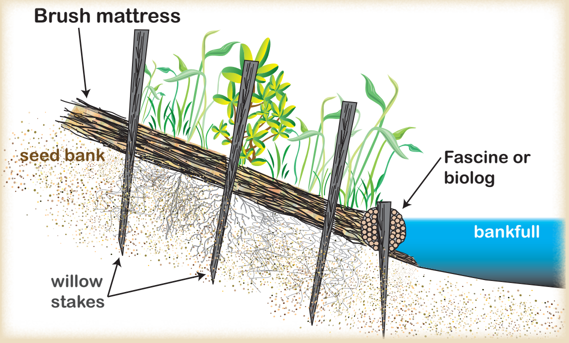
× The cuttings or stakes (branch sections without twigs or leaves) are cut and planted while dormant, late fall through early spring. Stakes are 2'+ in length and ½ - 3" in diameter with one end cut at a 45° angle. Stakes are planted 1 - 2' deep in soft soils or into a pilot hole in harder soils ensuring the stake is deep enough to reach permanently wet soils. Stakes are planted 1 - 2' apart depending on the size of the stakes to ensure successful survival and sufficient cover.

Biologs, coir fiber rolls, wattles, fascines



» Biologs and coir fiber rolls are made of coconut fiber, straw, or excelsior fiber. Wattles and fascines are cylindrical bundles of wheat or rice straw or cuttings. They are strong, flexible rolls (8-10' long, 8-12" diameter) of biodegradable material used to protect the toe of banks and to stabilize slopes . These structures work best where scour is not too severe and where flows will infrequently flow over the toe protection.

× The logs, rolls, or bundles are staked and tied into a shallow trench along the toe of the streambank to deflect flows and wave energy, retain sediment, and provide a stable structure for plant growth (substrate). Native vegetation is planted on and around the structures, then as the vegetation or cuttings becomes established, the natural materials will degrade in 2 to 6 years leaving a vegetated bank.



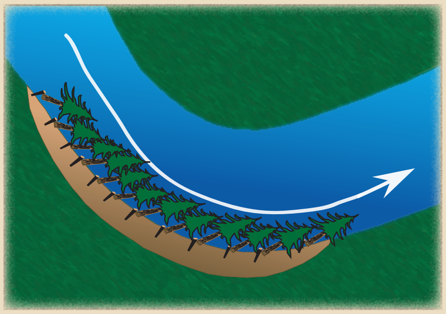
× Additional rows can be installed (placed in shallow trenches secured by wood stakes) upslope parallel to the toe of the bank for additional bank stabilization.

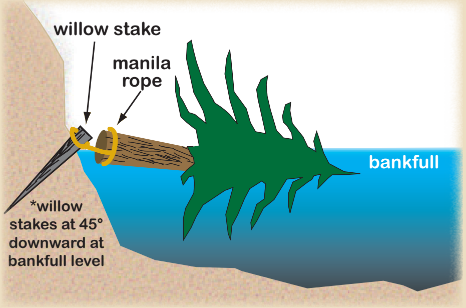
Brush mattresses

» Brush mattresses consist of a layer of interlaced dormant cuttings (e.g. willow, dogwood, alder) that are laid perpendicular to the toe and staked over a gently sloped streambank, often with a fascine or biolog at the base as toe protection.

× These structures work on most banks. They require good soil contact to support brush growth; base flows to keep the basal ends of the cuttings moist; and installation during the non-growing season, preferably early spring.

Tree revetments





» Tree revetments involve anchoring coniferous (such as Christmas trees) or hardwood trees along an outside bend where erosion is excessive.

× The trees are tied by the trunks with natural filament rope to wooden stakes placed at the bankfull level with the treetops pointing downstream. Tree revetments dissipate outside meander flows and collect sediment, thereby reducing erosion and promoting deposition.

× Tree revetments work best in small to medium streams with high sand or gravel loads because sediment deposition is important to the long-range goal of rebuilding and protecting the bank.

⇨ These structures provide habitat and as they degrade and accumulate sediment they become a natural, structural part of the bank.

Root wad revetments

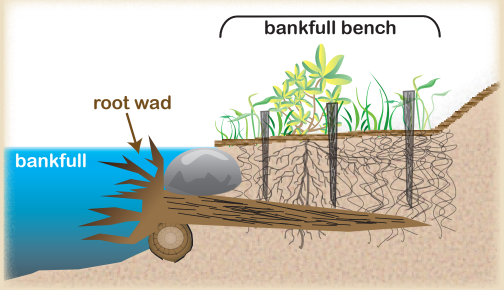
» Root wad revetments are more complex structures built into exposed cutbanks where erosion is actively cutting away the bank. These revetments commonly involve the construction of a bankfull bench to help accommodate and dissipate flood flows. This design is especially useful where there is infrastructure on the bank that needs to be protected from bank loss or slumping. These revetments can be scaled to the size of the stream (e.g., root wads can be stacked in large streams). They are not recommended in sandy soils where it is difficult to drive the trunks into the bank and the sand is more erodible.

✖ Large tree trunks with root wads are driven into a renovated cutbank so that the trunks angle upstream and the root wads are positioned below bankfull level directed into the flow. The trunks are secured with large boulders and a matrix of logs. Live cuttings are staked, natural vegetation planted or seeded, and erosion control fabric is staked on the bankfull bench and restored bank.

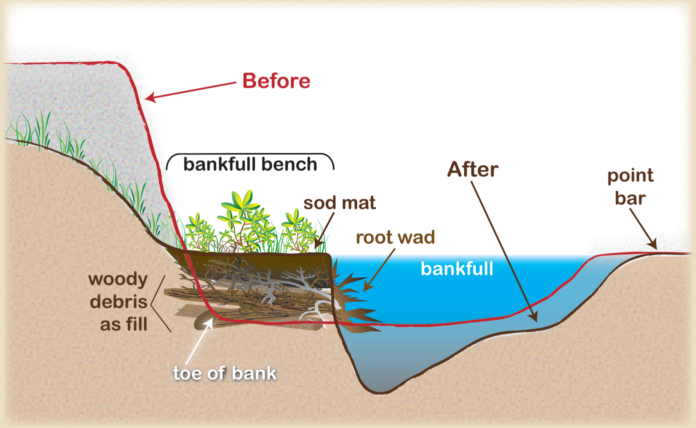
⇨These revetments protect the banks over a range of flows, provide substrate for invertebrates and refuge for fish, and will slowly degrade while becoming a natural part of the streambank.

Installation of root wads using an excavator to drive tree trunks into the bankfull bench (looking upstream).

*Variations of this design have been used through the years. For more specific design details see Applied River Morphology by Dave Rosgen, 1996.



Root wad revetment and a revegetated bankfull bench built to stabilize a cutbank encroaching on Interstate 94, two years after construction (looking downstream).



Toe wood-sod mats *(see fact sheet for more details)*

» Toe wood-sod mats involve similar design elements to the root wad revetments. This approach can be scaled to all stream sizes.

✖ Cutbanks are renovated with a bankfull bench consisting of layers of logs, branches, brush, roots, and fill. Root wads can be incorporated to provide additional roughness and habitat. These layers are then covered with sod mats, willow cuttings, and transplants set at bankfull stage.

⇨ This structure design restores the connection to the floodplain with a bankfull shelf, restores channel dimensions, protects a once vulnerable and unstable cutbank, provides habitat (both aquatic and terrestrial), and is relatively inexpensive.

*Variations of this design have been used through the years. General design details are credited to Dave Rosgen of Wildland Hydrology.

Review and advanced restoration designs

Bank restorations utilizing vegetation, erosion-control blankets, biologs, wattles, revetments, and mats or combinations thereof, can effectively protect and rebuild banks if properly placed and established. These approaches utilize all natural materials that do not artificially confine the channel, they are relatively inexpensive, and can be applied to all stream varieties (forested, prairie, steep, gentle, rocky, sandy). As explained in Resource Sheet #1, the cause(s) of stream instability and future watershed conditions should be considered. Most projects will need permits and professional assistance.

In some cases in-channel structures can also be used to protect restored or unstable banks. These include rock structures such as rock vanes, J-hooks, and riffles that are effective at properly slowing and deflecting flows from the streambanks. Installation of these structures requires professional assistance because proper placement is absolutely essential for successful streambank protection and restoration. This requires stream and watershed monitoring and assessments. These in-channel structures are explained in more detail in the following resource sheets.

Contact Information

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DNR Waters:
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DNR website:
http://mndnr.gov