

# A GUIDE FOR HARVESTING, STORING, AND PLANTING DORMANT WILLOW CUTTINGS

*Prepared By:*

**Ann Lezberg, Technical Advisor**  
Wildlands Restoration Volunteers

*and*

**John Giordanengo, Projects Director**  
Wildlands Restoration Volunteers  
633 Remington St.  
Fort Collins, CO 80524  
www.wlrv.org  
303-543-1411

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**REVIEWERS:** **GREG AUBLE**, RESEARCH SCIENTIST, USGS, FORT COLLINS, CO  
**ALAN CARPENTER**, WETLAND ECOLOGIST, BOULDER, CO  
**CHRIS HOAG**, WETLAND PLANT ECOLOGIST, NRCS, PLANT MATERIALS CENTER,  
ABERDEEN, ID  
**DEREK TILLEY**, RANGE CONSERVATIONIST, NRCS, PLANT MATERIALS CENTER,  
ABERDEEN, ID

**WILDLANDS RESTORATION VOLUNTEERS** is a non-profit organization whose mission is

*“to foster a community spirit of shared responsibility for the stewardship  
and restoration of public lands in Northern Colorado, and beyond.”*

As of May 2008, WRV has completed **144 stewardship projects**, contributing over 97,000 volunteer hours, valued at over \$1,700,000, toward the stewardship of Colorado public lands.

**We restore streams and wetlands**, build trails, obliterate old roads, remove invasive weeds, collect native seeds, **and much more** from the prairie up to high alpine country.

If you would like to volunteer, are looking for training opportunities, or would like to propose a stewardship project to us, **please contact us** at 303-543-1411 or info@wlrv.org.

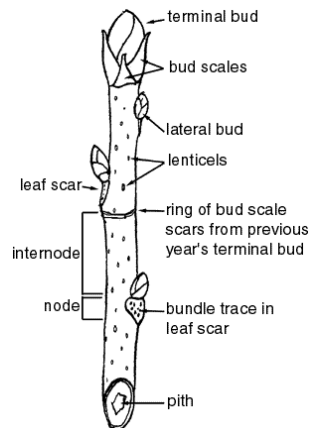


**WHERE THERE’S A WILLOW THERE’S A WAY**

Willows provide important wildlife habitat, as cover for nesting birds, and forage for elk, moose, and other herbivores. Under the right conditions, willows can grow rapidly and provide effective soil stabilization along stream banks or in other highly erodible areas. This guide conveys basic willow biology and fundamental techniques for selecting, harvesting, and installing willow cuttings. These skills are essential to the success of nearly every willow restoration technique, from willow stakes to advanced bioengineering structures. This guide does not cover the details of all advanced willow restoration techniques, but a few common techniques are presented on page 4 to *wet* your appetite. Exact specifications on stem diameter, planting depth, length of cutting, etc. will vary by project depending on site conditions, species of willow being used, time of year, and logistical and funding constraints. Always defer to the agency staff or technical advisor for ultimate specifications.

**WILLOW BIOLOGY**

Willows are deciduous woody plants in the Willow Family (Salicaceae) that commonly grow in moist soils of riparian areas and wetlands. All willows are classified in the genus *Salix*. Willows have a number of characteristics that make them resilient to high-velocity flood waters, burial by sediments, long-periods of water inundation, high winds, and heavy browsing by wildlife. Willows can sprout new shoots from roots and root crowns readily and their stems possess abundant **adventitious buds** (i.e., buds that develop in an “atypical” place rather than at the branch tip or in leaf axils) that have the flexibility to form roots when in contact with saturated soils.



**WHY ARE MOST WILLOWS SHRUBBY? WHY IS THIS INFORMATION USEFUL?**

Most vascular plants produce auxins, a group of plant hormones that play an essential role in coordination of growth and behavioral processes. In willows, auxins are produced in terminal buds and transported to lateral buds and adventitious buds (i.e., along the stem below the terminal bud) to convey a message to “stay dormant”. If the terminal bud, also called the apical bud, is removed by a browsing animal, or cut by a willow harvester, that chemical signal is interrupted. In response, the lateral buds and adventitious buds will be stimulated to grow, no longer suppressed by the auxins. In heavily browsed areas, it is the removal of the terminal buds that causes a bushy appearance in willow shrubs. Removing the terminal buds of harvested willows can stimulate growth of lateral stems in planted cuttings. Under some conditions, however, and for certain species (i.e., sandbar willow, *Salix exigua*), removal of the terminal bud may not be necessary or desirable to achieve project goals. If you want a tree-like willow to develop, removing the terminal bud may not be recommended.



**REVEGETATING WITH WILLOW CUTTINGS—THE BASICS**

Restoration techniques exploit the ability of willows to reproduce from adventitious and dormant buds. **Willow cuttings** (also referred to as poles or stakes) are commonly used in a variety of restoration practices. Using willow cuttings in restoration activities involves strategic harvesting of dormant willow stems from vigorous healthy willows. Dormant cuttings can be driven into the ground, where they will sprout shoots and roots during the growing season. Once established, willow cuttings form a web of fibrous roots that can provide highly effectively soil stabilization.

Survival of willow cuttings through the first growing season can be greater than 90%. However, survival through the second growing season is highly variable. Lack of adequate soil moisture and poor selection of willow stems are two important factors associated with poor second year survival of cuttings. Careful attention to stem size, site hydrology, depth of willow stake installation, and good soil to stem contact can contribute to successful restoration projects.

Roots sprouting from adventitious buds after 13 days of soaking. USDA-NRCS, Aberdeen Plant Materials Center

### SELECTING THE RIGHT WILLOWS AND WILLOW STEMS

1. **Locate a collection site** near the project site with similar willow species, comparable site conditions (e.g., hydrology, landscape position, elevation), and abundant, vigorous willow stands.
2. **Obtain landowner permission** to collect from the site.
3. **Choose healthy stems** (i.e., “green” wood in cross section) that are: relatively straight, covered in smooth bark (i.e., not furrowed or damaged), and free of insect/pathogen damage.
4. **Follow ethical harvest guidelines** to conserve health of the donor stand:
  - Remove no more than 1/3<sup>rd</sup> of the branches from any single willow.
  - Never remove more than 40% of the overall willow canopy cover.
  - Harvest stems evenly through the stand (e.g., not from one side of the willow only).

### HARVESTING AND PREPARATION OF WILLOW CUTTINGS

**Tools:** Lopping shears, hand pruning shears, small wood saws or brush cutters, twine, labels, buckets.

1. **Harvest willow cuttings** during the dormant season (between leaf fall and bud break):
  - **Select stems ½ to 1¼ inches in diameter** for most willow cutting projects. However, some projects may require stems that are 1 to 3 inch in diameter or even 3 to 6 inches in diameter (i.e., *posts*) where longer or stronger poles are needed. In general, smaller diameter cuttings are appropriate for shrub willows (i.e., *Salix exigua*, sandbar willow) while larger diameter cuttings are more appropriate for tree willows (i.e., *Salix amygdaloides*, peachleaf willow).
  - **Cut stems to length**, as determined by specific project needs (e.g., depth to late-summer water table, severity of erosion and flood damage). Cuttings can range from 18 inches to 5 feet long depending on depth to groundwater. Remove the cutting with a clean diagonal cut at the base of the stem. The diagonal cut is used to differentiate the rooting-end from the above ground end, and to aid installation.
  - **Prepare cuttings** by clipping the terminal bud (unless a tree-like form is desired) with a horizontal cut and removing all lateral (i.e., side) branches along the stem, as close to the stem as possible. Use caution and avoid damaging the stem while clipping the lateral branches. Removing lateral branches helps maintain an appropriate root-to-shoot ratio, reduces transpiration, and creates a cutting that is easier to install. Cut the top end of the stem horizontally to create a flat pounding surface if necessary.
2. **Bundle and tag cuttings** by species, size, date, and site. Keep bundles cool, moist, and shaded during transportation and on-site storage.
3. **Prior to planting, soak willows** in water for 5-14 days to increase speed of adventitious root formation. Willows can be soaked in buckets, a stream, or a lake with well-oxygenated water. Roughly 50 to 80% of the length of the cutting should be in contact with water while soaking. For disturbance-adapted willows (i.e., sandbar willow, *Salix exigua*), and under hydrologic conditions that are highly favorable to the establishment of willow cuttings, pre-soaking may not be necessary.



Pre-soaking willow cuttings. USDA-NRCS, Aberdeen Plant Materials Center.

### LONG-TERM STORAGE OF WILLOW CUTTINGS

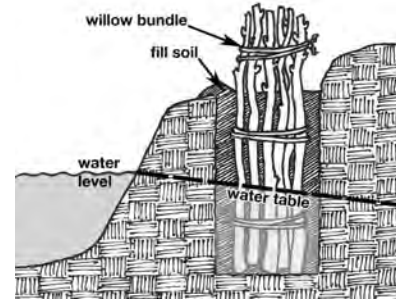
If willows need to be stored for more than three weeks, follow these guidelines to ensure that willows don't sprout or rot before they are installed. There are many different methods of long-term storage.

1. **Dip the top ends** into a 50:50 mix of latex paint and water prior to storage. Painted tips can prevent drying and cracking, aid in identifying species, and increase visibility of cuttings in the field.
2. **Store willow cuttings** for up to 6 months in dark, cool (33-36° F), and moist (60-70% humidity) locations protected from wind and sun. Remove moldy, dried, or sprouted cuttings prior to planting.

### **PLANTING WILLOW CUTTINGS**

**Tools:** planting bars (dibbles), rebar, rubber or wooden mallet, post-hole diggers, electric hammer-drills, soil augers, pick mattocks, power stingers, shovels, buckets, lopping shears.

1. **Locate and flag planting sites, and determine planting densities** based on knowledge of hydrology, location of existing willow populations, and specific site objectives. Areas where the water table drops more than 3 ft during the growing season or with large fluctuations in water-table depths are problematic for survival of willow cuttings. In areas with low erosion potential, space cuttings 1-3 feet apart for creeping rhizomatous willows (e.g., sandbar willow) and 3-8 ft for “clumpy” willows (e.g., Drummond’s willow) apply generally on mild slopes. On steeper slopes, or where there is a greater threat of soil erosion, denser plantings may be appropriate.
2. **Optimal time of willow planting** varies by region. Typically, willow cuttings are installed after spring thaw but before bud break, or in fall after leaves change color and/or fall. If planting in fall, be sure to install cuttings deep enough (at least 2 feet deep) to avoid them from being lodged out of the ground by winter freeze-thaw cycles.
3. **Prepare pilot holes**, if necessary, for willow cuttings by pounding in rebar, using a pick mattock or other appropriate tools. Mechanical devices (i.e., stingers or augers) can also be used to prepare deeper holes in difficult soils. Pilot holes allow for easier installation without damaging the cuttings. In soft soils, pilot holes may not be necessary.
4. **Plant willow stakes** into prepared “pilot” holes or directly into substrates by hand-pressure or tapping with a rubber mallet. The bottom 6-8 inches of the cutting should be installed below the expected dry-season water table. Generally, 50-80% of the cutting is buried and at least 4 to 6 inches should remain above ground, or enough to overtop competing herbaceous vegetation. At least 2 lateral stem buds (and preferably 3 or 4) should be present on the above-ground portion of the stem. Be sure that pointy tips on lateral buds point sky-ward and that the diagonally cut end, usually the thicker end of the cutting, is inserted into the ground. Multiple stakes may be placed in a single hole. If the tops of the cuttings were damaged (cut or mangled) during installation, trim the top cleanly with a horizontal cut at least one inch below the longest split.
  - Cracked or heavily damaged tops can hasten drying of the stem and increase susceptibility to pest damage, decreasing survival rates. If tops are damaged from installation, cut them cleanly to remove the cracked portion without greatly reducing the amount of stem that remains above ground.
  - If the stems dry out during transportation, remove the bottom 2 to 3 inches of the cutting to recreate a “fresh” end just before installation.
5. **Backfill around cuttings**, when necessary, and tamp soil around cuttings to insure good soil to stem contact (i.e., without air pockets). Alternatively, pour a syrup-like slurry of soil and water into the hole, allowing sediment to displace any air pockets as water leaches into underlying soil. **NOTE: Poor soil-to-stem contact is a leading cause of willow stake death!**

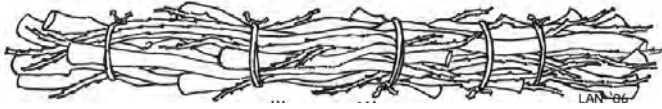


### **SITE PROTECTION AND MONITORING**

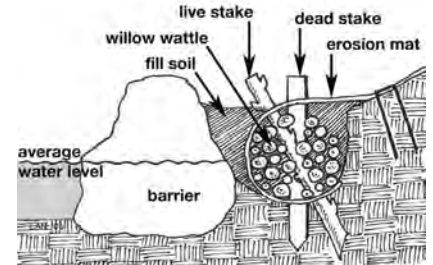
1. **Prevent livestock or wildlife browsing** with tree guards or fencing as needed.
2. If site lacks adequate soil moisture, **water during the first six weeks.**
3. **Monitor for causes of success/failure**, and replant as necessary.

**A FEW ADVANCED WILLOW TECHNIQUES**

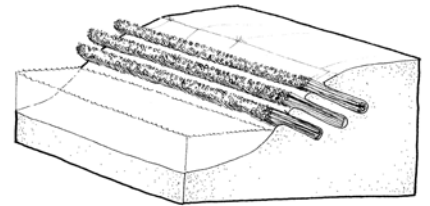
The following techniques are but a few of the dozens of willow restoration techniques used by agencies across the United States. None of these techniques can be used successfully without adequate knowledge of proper harvesting, preparation, storage, and planting techniques. All of these techniques rely on the ability of willow cuttings to sprout when placed in moist or saturated soils.



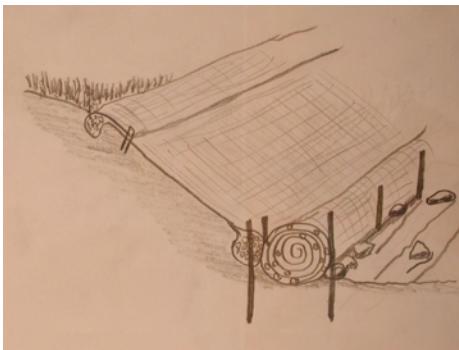
**Willow wattles & fascines:** Bundles of willow poles bound or woven and installed in shallow trenches along stream banks or other appropriate erosion-prone areas to increase bank stability. Drawings by Larry Nygaard.



**Brush Layering:** Vertical bundles of willow poles installed in 2-3 foot deep layers (back and down into bank), along stream banks to increase bank stability. USDA-NRCS, Aberdeen Plant Materials Center. Drawing by Gary Bentrup.



**Biologs (AKA Sushi Rolls):** Constructed from Coir fabric or other erosion matting, dirt, and willow poles. Used to stabilize stream banks. Drawing by David Hirt, Boulder County Parks and Open Space. Photos of Biologs used at Left Hand Creek by Wildlands Restoration Volunteers, Boulder, CO.



2 Months



18 Months Later

## **GLOSSARY**

Most of the following definitions are provided by the USDA-NRCS, Plant Materials Center, Aberdeen, ID. This is not a comprehensive list of willow or riparian-related terms, but are common terms found in the literature related to willows, riparian restoration, stream ecology, etc.

**Aggradation:** To fill and raise the level of the bed of a stream by deposition of sediment.

**Alluvial:** Deposited by running water.

**Bankfull Discharge:** The discharge corresponding to the stage at which the natural channel is full. This flow typically has a recurrence interval of 1.5 to 2 years.

**Best Management Practices:** A practice used to reduce the impacts from a particular land use.

**Bioengineering:** The integration of living woody and herbaceous materials along with organic and inorganic materials to increase the strength and structure of soil.

**Buffer:** A vegetated area of grass, shrubs, or trees designed to capture and filter runoff from surrounding land uses.

**Canopy:** The overhead branches and leaves of vegetation.

**Capillary Fringe:** The distance water is wicked upwards above the water table by capillary action in the soil.

**Coir:** A woven mat of coconut fibers used for various soil erosion control applications; Biodegrades after a period of a few years.

**Degradation:** The process of by which stream beds lower in elevation; opposite of aggradation.

**Deposition:** The settlement of material out of water.

**Geomorphology:** The geologic study of the evolution and configuration of land forms.

**Habitat:** The area or environment in which an organism lives.

**Incised Channel:** A stream that has cut its channel into the bed of a valley.

**Reach:** A short length of stream that has similar physical and biological characteristics.

**Riparian Area:** A riparian area is an ecosystem situated between aquatic and upland environments and is characterized by greater soil moisture than adjacent upland areas. Riparian areas are periodically influenced by flooding.

**Root to Shoot Ratio:** the dry weight of root biomass divided by the dry weight of shoot biomass. A plant that has a greater biomass of leaves and stems, compared to the biomass of its roots, would have a low root to shoot ratio. A low root to shoot ratio is considered an unhealthy condition for many plants.

**Scour:** Erosive action of flowing water in a stream.

**Substrate:** The mineral and organic material that from the bed of a stream.

**Thalweg:** A longitudinal line that follows the deepest part of the channel of a stream.

**Watershed:** An area of land that drains into a particular river or stream, usually divided by topography.

**Wattle:** A sausage-like bundle of plant cuttings used to stabilize stream banks and other slopes.

**SUGGESTED READING & REFERENCES**

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~ **ABOUT WILDLANDS RESTORATION VOLUNTEERS** ~

WRV is a 501(c)(3) tax exempt organization whose **mission** is “to foster a community spirit of shared responsibility for the stewardship and restoration of public lands in Northern Colorado, and beyond.”

**Our work began in 1999**, when about 20 volunteers planted willows to improve wetland habitat around a pond in Boulder County. As of May 2008, WRV has completed **144 stewardship projects**, contributing over 97,000 volunteer hours, valued at over \$1,700,000 toward the care and restoration of Colorado public lands.

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**The greatest impact** of our work reaches beyond the thousands of hours of volunteer labor on the ground. **WRV provides** skills, education, tools, and a vision of hope that catalyzes people to fall in love with wild places and realize that they can work together to restore those places and make a real difference in the world.