Conservation Landscaping Series

SP 781-B

Improving Stream Channels, Ditches and Lakeshores With Live Staking

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What is live staking?

Live stakes are cuttings from dormant woody vegetation that can be driven into wet soils of streambanks or shorelines for an easy and cost-effective way to revegetate a bare bank. Just as rebar strengthens concrete by reducing cracking and keeping it together, plant roots can do the same for soil. Trees and shrubs native to Tennessee that are adapted to growing at water's edge have extensive root systems that work to hold streambank soils in place. This allows the bank to resist erosive storm flows that come with the fast-moving high water that occurs as a result of heavy rains. Live stakes are a cost-effective way to establish trees or shrubs. Over time, they grow into full trees and shrubs, holding soil in place and providing shade to the stream. Live staking also promotes healthy streams by providing wildlife habitat, protecting, and improving water quality.

Figure 1. Eroded streambank with exposed soils, invasive species and sloughing bank failure.

Figure 2. Just three years after installation, a large netting of roots from this black willow protect the soil on this bank.

Where do I use live stakes?

Live stakes can improve any channel that holds water during most of the year or lake shorelines that have relatively stable water levels. Areas of active erosion with exposed bare soils would benefit the most from live staking. In order to root, live stakes must be in contact with saturated soils, so a stake must be installed deep enough to intersect the water table. Streambanks that are taller than 4-5 feet will present a challenge for establishing live stakes at the top of the bank because the soil is not saturated. This also affects lakeshores that have highly fluctuating water levels. In this case, consider live staking the bottom 2-3 feet and then planting bare root seedlings at the top of the bank and in the buffer (i.e., the area beyond the top of the bank adjacent to the stream). These seedlings already have roots and don't require contact with saturated soils in order to grow. This combination of stakes and rooted seedlings will provide the greatest plant survival and coverage of the entire bank.

How do I implement live staking?

Materials List:

- Gloves, hand clippers
- Ladder
- Plastic buckets or bags
- Newspaper
- Colored flags
- Tape measure
- Colored yarn or paint
- Twine
- Rubber mallet
- 2-foot section of rebar
- Dead blow hammer

Live staking is best completed in late fall to early spring, when plants are dormant. Harvest or purchase and install stakes within this time period when soils are not frozen. It is important that stakes are harvested, stored and installed in a certain manner to get the best survival rate possible.

1. Evaluate the site and select species.

Go to the site where revegetation is needed and evaluate the site conditions affecting plant placement and survival: 1) sunlight availability, 2) depth to saturated soils, and 3) desired height and spread (or thickness) of mature vegetation. Also consider site conditions that might affect installation, such as where access locations appear along the bank and whether the soil is highly compacted. Draw a map of the site noting these characteristics, and match species characteristics with planting locations.

2. Harvest or purchase stakes.

Stakes should be harvested or purchased as close to the time of installation as possible. If you do not have a place to harvest stakes, many native plant or conservation nurseries and seed companies sell stakes and smaller cuttings called whips (generally less than ½ inch in diameter). Be careful to discuss the site in detail with the supplier to ensure you are buying native species that are adapted to the conditions of the intended location.

Live stakes can be harvested from plants you may already have on your property. Many riparian woody plants native to Tennessee have the capability of propagation with cuttings. Look for plants growing in wet areas of your property. Refer to the identification table at the end of this document to help determine staking species (most easily accomplished when leaves are present) and flag plants for harvesting the following winter. If you are unsure about a plant, you may take a whip and test for rooting ability by putting it in a jar of water in a warm sunny spot like a windowsill. If the cutting has produced roots within two to three weeks, then the plant would be ideal for harvesting stakes. You may also ask around your community for other location options that might be available for harvesting (with permission).

To harvest stakes, you will need clippers that can cut through a half- to 2-inch diameter branch and potentially a ladder to reach into taller trees. Go to the harvest site, taking tools along with buckets or plastic bags and newspaper. Make clean cuts of straight branches of 2-3 feet. Cut at an angle just below a leaf node. This is the rooting end of the stake. Remove lateral branches and make a clean straight cut at the top end of the stake. This is the end that will be pounded with a mallet during installation, so a flat surface makes the installation easier. One branch can be cut into multiple stakes as long as there are at least three to four nodes along the stake. Be sure not to remove more than 25 percent of the biomass of the parent plant, so as to not cause harm to the plant.

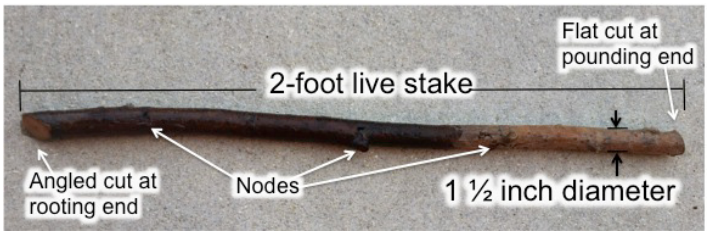

Figure 3. Live stake with important features and dimensions highlighted.

You may consider dipping the top end in hot beeswax to help prevent dryout. If you are harvesting different types of species, use colored tape or yarn to differentiate between species. Place live stakes in buckets of water or wrapped in wet newspaper and plastic bags, keeping the rooting end wet at all times. Use twine to wrap bundles of similar species and for easy storage.

3. Store stakes.

Store stakes in a cool, damp, shaded place in buckets of water with the rooting end down. Do not allow the rooting ends to dry out. Soaking the entire length of the stakes before installation increases plant survival. If more than three days pass between stake harvest and planting, add fresh water to the bucket in which the stakes are soaking. You may also wrap the top of the bundles in burlap or paper, store in loosely sealed plastic bags (not in tightly sealed bags), and keep them moist.

Figure 4. Live stakes of various lengths and species soaking in buckets of water and bundled during staking.

4. Lay out planting plan.

Live stakes should be installed in a triangular pattern with 2-6 feet between stakes, depending on the plant species' growth habits. Use a tape measure or visually estimate to divide the streambank into horizontal slices about 2-3 feet apart (lines parallel to the streambank). Mark locations for stake installation with flags along these slices about 3-4 feet apart, alternating the flags to make triangles up and down the bank. Decrease the spacing to between 6 inches and 1 foot in areas of severe erosion.

Figure 5. (Left) Volunteers install stakes along an eroded stream channel in a park. (Right) Live stakes hand-driven into saturated clay soils at the toe of the streambank, at a slight angle pointing downstream and at a 90-degree angle to the face of the bank.

5. Dig pilot holes.

Ideal soil conditions will allow stakes to be simply pushed into the bank without the use of tools. But, if soils are dry or compacted, pilot holes may be necessary to get the needed stake length into the soil. Use a dead blow hammer to drive a piece of rebar into the bank to create a pilot hole. The rebar should be driven at a 90-degree angle to the slope of the bank (or perpendicular) and as deep as possible up to 2 feet. Test your capabilities in removing the rebar from the soil before you drive it too deep. Try not to make holes larger in diameter than the stakes to be used, so saturated soils can contact the stake.

6. Install the stakes.

Immediately prior to planting, make a new angled cut at the rooting end of the stake. If needed, use a rubber mallet to strike the pounding end of the stake, driving stakes into the bank at a 90-degree angle until about two-thirds of the stake is in the soil and at least two to three nodes are buried (at least 1 foot). Try not to damage the stakes' end as much as possible. Tamp down the soil around the stake to ensure that the soil contacts the stake. If the top end is damaged by the mallet, prune off the damaged portion.

7. Observe and evaluate planting success.

Depending on the species selection, time of year and site conditions, stakes will begin to send out roots with branches and foliage developing within the next growing season. Under ideal conditions, some species will take root within a couple of weeks. Others may take several weeks to months to show signs of growth. Take note of which species of stakes are establishing well and which are not. If needed, fill in areas with unsuccessful stakes with stakes of successful species. This may be done early in the spring, but the success rate of stakes installed after plants come out of dormancy decreases during that time of year.

8. Maintain over time.

Remove invasive and/or undesirable species in your project area in order to minimize the amount of competition felt by the stakes and other desirable plants.

How do I restore a heavily eroded bank?

Live staking can be a part of a larger streambank restoration project if the channel is heavily eroded. If you are changing the slope of a bank or making any alterations to the stream channel itself along a reach that is 35 feet long or greater, you should seek the guidance of a professional engineer, landscape architect or restoration specialist. You will also need a permit from the state. If you are simply revegetating (including live staking), then a permit is not required. Three easy steps to streambank and ditch stabilization include:

1. **Protect the toe:** The toe (or bottom) of a streambank is vulnerable to scour and erosion during high water events, especially if the channel is incised (or downcut). Large rocks or woody debris lining the toe can resist erosive flows and minimize the risk of bank failure.

2. **Cover the face:** The face of a streambank is ideally at a slight slope consisting of native soils. Establish a stand of native hardwood trees or shrubs to hold the bank in place with extensive root systems. If a lower view line is desired, use native grasses, perennial herbs and sedges to keep vegetation low but still benefit from deep roots.

3. **Buffer the bench:** Create a no-mow and pesticide-free zone of at least 35 feet from the top of the streambank. This riparian buffer will ensure long-term stabilization as well as provide for wildlife. If planted in trees and shrubs, this buffer will shade the creek from sunlight, eliminating nuisance algal blooms and providing cool temperature waters that fish prefer.

While these three easy steps will make improvements in many scenarios, there is no quick fix for heavily incised channels, channelized systems or other severe symptoms of hydrologic modification. If a stream has been altered in such a way as to take out its natural sinuosity through channelization, then there are likely to be erosive forces acting on the stream bed and banks that would require a bioengineering design to restore a stable channel shape.

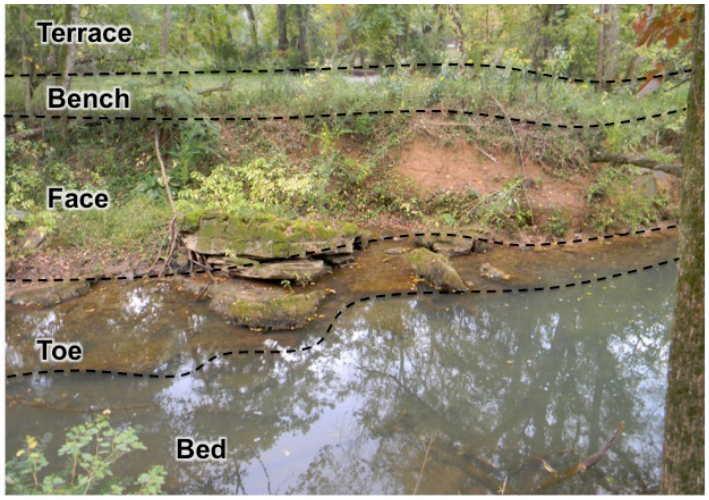

Figure 6. Unstable streambank labeled with components.

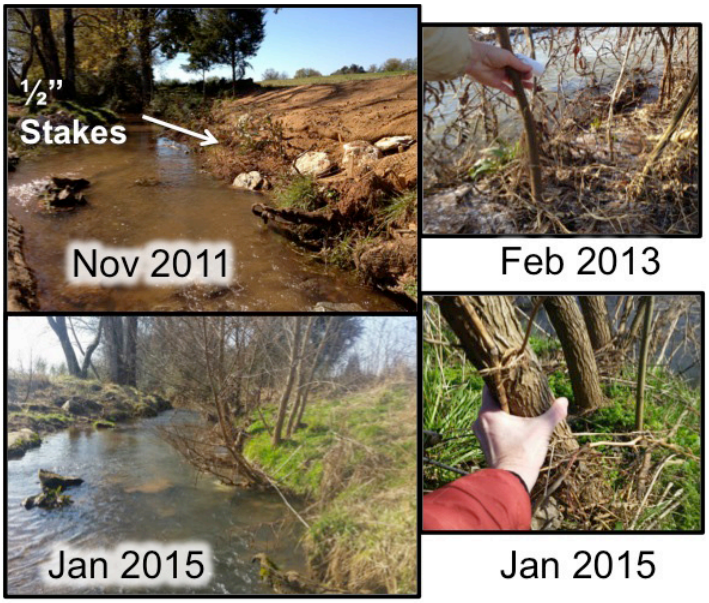

Figure 7. Streambank restoration project using bioengineering. Live stakes and whips were used at waters edge to stabilize soils over time. This work required a state permit called an Aquatic Resource Alteration Permit (ARAP) due to the level of grading and in-channel work performed.

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Table 1. Plant identification guide for native Tennessee staking species. Photos courtesy of the Tennessee Valley Authority and Mary Ellen Harte and Ruchard Webb (via www.forestryimpages.org).

Common Name	Scientific Name	Height	Photograph
Silky Dogwood	*Cornus amomum*	3-8’	
Virginia Sweetspire	*Itea virginica*	3-8’	
Streamco Willow	*Salix purpurea*	6-10’	
Black Willow	*Salix nigra*	20-50’	
Arrow Wood	*Viburnum dentatum*	8-20’	

Hazel Alder	*Alnus serrulata*	8-20’	
Elderberry	*Sambucus canadensis*	3-8’	
Redosier Dog-wood	*Cornus sericea*	4-8’	
Ninebark	*Physocarpus opulifolius*	8-20’	
Buttonbush	*Cephalanthus occidentalis*	3-8’