



## TECHNICAL NOTE #3

### Establishing Native Riparian Shrubs Using Live Stakes

Planting large numbers of woody plants is typically done using bareroot or container seedlings. Another low-cost alternative for certain species, particularly for riparian plantings, is 'live stakes', which are unrooted stem cuttings that are inserted into moist soil in the dormant season before leaf-out. The stakes develop roots, and will become new plants. Live stakes are easy to handle and plant, and are well suited for volunteer efforts.

#### What is a Live Stake?

Live stakes are often described in discussions of "bioengineering", or the use of plant materials to stabilize restored, or vulnerable streambanks and shorelines. Live stakes are also useful, economical propagules for plantings in stable riparian areas that simply need more native woody plants.

A live stake is a woody stem cutting, typically 3/8- to 1-in diameter and 1- to 3-ft long, which will develop roots and become a new plant when placed in the soil. This is a horticultural implementation of a natural occurrence referred to as 'layering' - when a plant stem in contact with the soil takes root. You may have observed this with species such as black raspberry, multiflora rose, or silky dogwood. This effect is limited to particular species that are able to generate roots from stem tissue. These new roots arise from clusters of specialized cells known as root primordia ('root buds'). Some species develop root buds in their stems as they grow, and some species form root buds in response to sustained inundation. Root buds respond to hormonal cues resulting from conditions such as reduced oxygen due to flooding or burial, or the cutting of the stem, causing them to initiate new roots.

The plant propagation literature describes woody stem cuttings as 'hardwood' or 'softwood'. Hardwood describes when the stem's cells are fully expanded and have the fibrous character we would describe as 'wood'. Hardwood cuttings would be what you collect from a plant during the dormant season. Softwood cuttings are from stems that are still elongating and expanding, and are less fibrous and more like a non-woody stem in character. Softwood cuttings can be used to propagate some species. However, for our purposes, a 'live stake' specifically refers to a dormant, hardwood cutting, planted between late fall and early spring.

#### Using Live Stakes for Riparian Plantings

Live stakes have advantages and disadvantages. On the plus side, they are easy to obtain, handle, and plant. You can collect them yourself from local plant material, or purchase them. They are comparatively inexpensive, as they are literally cut sticks. They have been handled less, and are less vulnerable to inattention than seedlings. Keeping them cool and moist in the winter and early spring is not difficult - you can store them outside in most any manner that will keep them moist. Covering them with mulch or wood chips would be a simple solution. You can plant them on any site where you can get them into the ground, and where soil moisture will be high to moderate and constant in the spring. They are a convenient, low-impact means to revegetate vulnerable stream banks.

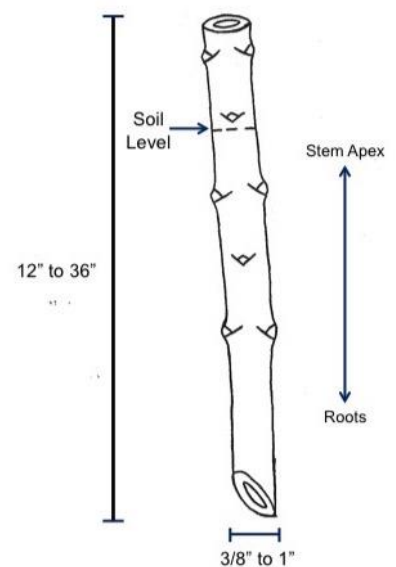
A drawback to live stakes is that they are slow to establish compared to rooted plants. You can view the planting year of a live stake as the year that a rooted seedling has already spent in the nursery, so they will take at least one year longer to provide the growth equivalent to a planted seedling.

#### Collecting and Planting Live Stakes

Live stakes can be collected any time during the dormant season - from leaf drop in the fall to bud break in the spring. If you can keep them cool and moist (refrigerated), you can plant them well after they were collected.

A longer stake has more stored energy and more surface area to generate

Figure 1. Guidelines for live stake sizing and planting. Place the majority of the stake in the soil to optimize production or roots instead of shoots.



NOT TO SCALE

roots. However, a longer stake may be difficult to properly plant in soils that are shallow or stony. Also, using longer cuttings means fewer plants for the same amount of stake. If you are harvesting your own stakes, using 1.5-ft stakes provides a good balance between getting more stakes from your source plants, and increasing chances of survival.

When cutting the stakes, make angled cuts at the bottom of the stake. Most importantly, this ensures that those planting the stakes will know the shoot end from the root end, as live stakes retain their root end/shoot end polarity. If you plant the stake upside down, it will not survive. A second consideration is that this 'point' may improve ease of penetration into the soil.

The key idea for planting is "roots before shoots". Therefore, most of the live stake should be below ground. When the stake is inserted, you only need one viable node above ground, and no more than 4- to 6-inches of stem above ground. Getting the stake into the ground can be challenging. The best method is to create a pilot hole with a metal rod or even a drill. A gas-engine or heavy-duty cordless drill with a 15-in long, 1/2-in diameter wood boring bit makes really short work of pilot holes. Many publications discuss hammering live stakes into the soil. If the soil is soft and deep, this will result in little damage to the stakes. However, pounding a live stake into stony soil is going to result in smashed tops and scraped sides. The root buds are close to the surface of the stem, so scraping the stake as you install it may be removing potential roots. If your planting is intended for streambank stabilization, spacing is typically 2- by 2-ft or 2- by 3-ft. If your objective is not bioengineering, you can space the stakes based on eventual plant size and preferred density, as well as stake availability.

For best results, suppress existing vegetation before planting live stakes. The best time would be in the fall prior to a spring planting. Failing that, treating any green vegetation immediately prior to spring planting will reduce the competition to the young stake. In the first season of growth, you can wait until late fall, after the stake's leaves have fallen, and spot treat problem vegetation such as exotic 'pasture' grasses. You can use the herbicide glyphosate for all of these treatments, but minimize contact with the stakes, even when dormant.

Live stake plantings are typically unprotected, but protecting them with tree shelters would be beneficial. Not only does it prevent the new growth from being browsed, it also makes it very easy to suppress surrounding vegetation with an herbicide treatment without contacting the live stake.

Figure 2. An 18-inch silky dogwood live stake one year after planting, showing root development.



Table 1. A partial listing of species suitable for live stakes. This listing is based on local or commercial availability, and a rooting assessment of "fair to good or better" in "Streambank and Shoreline Protection" in the USDA-NRCS Engineering Field Handbook<sup>1</sup>

Common Name	Scientific Name
buttonbush	<i>Cephalanthus occidentalis</i>
silky dogwood	<i>Cornus amomum</i>
gray dogwood	<i>Cornus racemosa</i>
red-osier dogwood	<i>Cornus sericea</i>
common ninebark	<i>Physocarpus opulifolius</i>
pussy willow	<i>Salix discolor</i>
sandbar willow	<i>Salix exigua</i>
black willow	<i>Salix nigra</i>
silky willow	<i>Salix sericea</i>
black elderberry	<i>Sambucus canadensis</i>
red elderberry	<i>Sambucus racemosa</i>
arrowwood viburnum	<i>Viburnum dentatum</i>
nannyberry viburnum	<i>Viburnum lentago</i>

1/ United States Department of Agriculture, Natural Resource Conservation Service. 1996. Streambank and Shoreline Protection. Chapter 16 in Part 650, Field Engineering Handbook. <http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17553.wba>. Accessed May 2, 2016.

Compiled by Art Gover and Grace Gover, 2015; revised 2019. The contents of this work reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the PA DCNR or The Pennsylvania State University at the time of publication.

**Penn State is committed to affirmative action, equal opportunity, and the diversity of its workforce. Where trade names appear, no discrimination is intended, and no endorsement by Penn State College of Agricultural Sciences is implied.**