

Bareroot Hardwood Seedling Lifting, Packing, and Storage at the Missouri Department of Conservation George O. White State Forest Nursery

G.A. Hoss

*Gregory A. Hoss, retired as Forest Nursery Supervisor,
George O. White State Forest Nursery, Missouri Department of Conservation*

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Outline

Introduction

- Nursery Location
- Labor Source
- Outplanting Schedule

Lifting Operations

- Timing of Lifting
- Seedling Preparation
- Equipment Preparation

Packing

- Location, Procedures, and Materials
- Seedling Grading
- Packaging and Shipping

Storage

- Storage Facilities
- Storage Problems
- Maximum Recommended Storage Times

Facing Page: *Seedling bundles being manifested for shipment in Missouri. (Photo courtesy of Greg Hoss, Missouri Department of Conservation, 2011.)*

Introduction

Nursery Location

The George O. White State Forest Nursery is located in Texas County in south central Missouri. The seedbeds are located along a narrow creek valley with no more than a 1- or 2-percent slope. Average yearly rainfall is about 45 well-distributed inches per year. The nursery typically grows about 4 million hardwood seedlings each year, consisting of about 60 species of native hardwood trees and shrubs, which is around 80 percent of the total nursery production. Because it is centrally located, Missouri grows both what is considered “southern” and “northern” species. Nearly all the hardwoods are grown as a 1-0 seedling, with the exception of a few species grown to a 2-0 seedling.

Labor Source

The nursery uses local labor, and some of the lifting crew have worked at the nursery for many years. No prison labor or contract crews are used. The lifting crew is hired in the fall and employed until the following April. Typically, 16 to 18 seasonal hourly workers are hired for lifting. About 15 to 20 seedling graders are employed soon after the lifting starts each November. They work until grading is finished, usually through the middle to the end of April.

Outplanting Schedule

Most tree and shrub planting in Missouri occurs from February to May, with the majority of seedling demand occurring in March. Every species grown at the nursery should be lifted, graded and ready for shipment by mid-February. Some seedlings are readied for customers for December and January planting, particularly in the Missouri and Mississippi River bottoms as these areas are prone to spring flooding. Often these areas can be planted in the winter months and if not then, it may be June or even July before they can be planted.

Lifting Operations

Timing of Lifting

Seedling lifting begins after November 20 in most years. At least 2 or 3 nights of temperatures below 25 °F (-4 °C) helps ensure that seedlings have hardened off before the lifting operation begins. In some years, it is late November before these temperatures are reached. Experience indicates that some species can be lifted in November and December and other species need to be kept in the seedbeds until needed in the spring. During November and December, lifting

operations concentrate on those species that will store well until spring shipping begins. Lifting will continue to mid-April, except during periods of extreme cold, usually in late December into January. During those periods of extreme cold, the lifting crew processes cuttings that are taken from cottonwood (*Populus deltoides* Bartr.) and sandbar willow (*Salix interior* Rowlee) stool beds established in the nursery. The lifting crew cuts down the 1-year old stump sprouts and transports the whips to a cool building. Once inside, the whips are trimmed of all limbs and cut to lengths of 18 inches (in) (46 centimetres [cm]) for cottonwood cuttings and 12 in (30 cm) for willow cuttings, then graded into bundles of 25 cuttings.

It is not uncommon in a Missouri winter to be able to lift nearly every day. Lifting is stopped when the ground is frozen or when morning temperatures fall below 28 °F (-2 °C). Below this temperature, it is simply too cold for field crews to work effectively. Once the temperature rises above 28 °F, the lifting process can begin. At those times when the lifting crew is unable to go out and lift trees, the crew stays inside and assists the grading crew in grading seedlings.

Moisture is the other weather issue affecting lifting operations. Because the nursery is in a creek bottom and the soil is mostly clay (sometimes heavy clay and little sand or gravel), winter rains can keep the soil too wet for operations. The soil is slow to dry out, quick to freeze, and slow to thaw. Lifting after heavy winter rains can become just about impossible, even without freezing temperatures, as equipment cannot get through the seedbeds. Similarly, when there is little rain, the clay soil becomes very dry and blocky, causing the lifter to bring up seedlings and large chunks of soil. It is difficult to remove the seedlings from these large chunks of soil without damaging the roots. In this situation, the irrigation system must be reinstalled to wet those beds to be lifted.

Seedling Preparation

Seedlings are not undercut prior to lifting. Some undercutting was tried in the past, particularly in the heavy-rooted species such as pecan (*Carya illinoensis* Wangenh. K. Koch) and hickory (*Carya* spp.). However, attempting to undercut in the nursery's heavy clay soils tended to pull the seedlings underground instead of cutting them clean. The equipment could not function properly in these heavy soils, and on more than one occasion, the undercutter tool was pulled apart.

The nursery sells a number of hardwood species as an extra-large seedling, and this is a very popular item with customers. These are seedlings that are over 30 or 36 in tall (76 or 91 cm) (depending on species), and the price



Figure 11b.1—An “extra-large” seedling is a popular item with customers. This is a bundle of 25. (Photo courtesy of Greg Hoss, Missouri Department of Conservation, 2011.)

is double that of a regular seedling. Each year nearly all extra-large seedlings are sold.

Top clipping is generally avoided, but must be done under certain circumstances. Currently, the nursery ships about 75 percent of the seedling harvest via United Parcel Service (UPS) or the United States Postal Service (USPS). This can result in getting oversize charges for the tall trees as well as occasional breakage to the tall seedlings. Top clipping is therefore sometimes done to reduce the number of tall trees shipped (but only those species not offered as extra-large). In addition, the nursery ships four or five species with thorns. The UPS and USPS drivers do not like to handle seedling bundles where thorny branches are protruding.

When necessary, seedlings are top clipped to about 22 in (56 cm) tall as this is the maximum cutting height of the mower. It is preferable, but not feasible, to let them grow to 30 in (76 cm). When the trees grow to about 25 in (64 cm) tall, they are clipped back to 22 in (56 cm). This means

there may be more than one clipping on a species during the growing season, but every effort is made to cut only new and actively growing wood so that damage to the seedling is minimal. Top clipping is typically done in late July or August, when the trees are actively growing. If field clipping is not feasible for one reason or another, and the seedlings grow to over 30 in tall when mechanical clipping could cause noticeable damage on the stem, seedlings are top clipped by hand during the grading process.

Equipment Preparation

Lundeby tree lifters made in North Dakota by Lundeby Manufacturing are used for lifting. This machine withstands lifting deep-rooted hardwood seedlings in wet clay soil, but not without some modification to the lifters, which are reinforced with additional metal braces to resist heavy soils. Two lifters are kept ready to use throughout the lifting season, usually having both on tractors. The lifter in use is greased daily, and a spare lifting blade is always kept on the nursery during the winter. Tractors with about 90 horsepower, four-wheel drive, and a creeper gear are used for the best lifting operation. Three of the nursery tractors can be used for lifting, so if there are any breakdowns or if two lifters are needed, the equipment to keep lifting is available. If one machine breaks down, little time is lost in getting a second tractor and lifter to the field. This is especially important so that 15 or 20 employees are not standing around waiting for equipment to be fixed. During the off-season, each lifter is thoroughly inspected for any needed repairs or parts replacement.

Prior to the operator entering a seedbed, the depth of the lifter is set by adjusting the four wheels on the Lundeby lifter. The depth is usually set to at least 10 in (25 cm) for hardwoods. The operator enters the bed, lifts several feet of seedlings, gets out and pulls trees to check root length. If the tap root is being severed on the seedlings, the machine is adjusted to dig deeper. It is preferable to cut as little tap root as possible, so often, especially with deep rooted species such as hickory or pecan, the lifter may run as deep as 15 in (38 cm). This does leave a long root system for the customer, but a customer can always prune the root shorter if desired.

Packing

Location, Procedures, and Materials

As seedlings are being lifted from seedbeds, a lifting crew of 15 to 20 employees pick up the seedlings, shake off excess dirt, and put the seedlings into Lewis Bins nested

tubs. The lifting crew lifts and tubs every seedling. They are instructed to do no field grading and to get every seedling out of the seedbeds and into the tubs regardless of size. (This is done to eliminate seedlings being left in the seedbeds and resprouting later in the spring.) A tractor and trailer makes continuous runs from the lifting area to the cold storage facility, picking up the tubs of trees and delivering them to cold storage. On cold, wet days, the trailer is filled before it comes back to cold storage, but on windy or warm days, the trailer is constantly delivering trees to cold storage, whether full or not. Every effort is made to have seedlings into cold storage as quickly as possible. Likewise, lifted seedlings are left in the seedbeds when the crew comes in for a break or lunch while lifting on a cold or wet day, but no lifted seedlings should be left on the seedbeds on a windy or warm day.

Once the trailer backs up to the cold storage loading dock, all the tubs are unloaded onto wheeled carts and taken into the cooler. Two workers are in the cooler at all times and with the help of the tractor operator to unload the seedlings and reload the trailer with empty tubs; the turn around time from dock back to field is minimal. The tubs

are then dumped onto seedling storage racks and thoroughly watered. Each rack is labeled with species, source (i.e., "north MO" or "south MO") and lifting date. The full racks of seedlings are then stacked in the cooler. Jarke storage racks that can be stacked onto each other are used for stacking. Trees are stored loose on the Jarke racks until they are graded.

Seedling Grading

Every seedling that leaves the nursery has been graded at a seedling grading table by workers inside the packing house. The typical daily goal is to grade about 40,000 trees for a crew of 15 to 20 employees. Care is taken when grading to always rotate seedlings from the cooler to grade from oldest lifted to newest lifted. Trees are graded by height, caliper, and root mass. A height of 12 in (30.5 cm) has been the required minimum for all hardwood seedlings, although flexibility in this minimum criteria is often needed. Some species might fall below this minimum height criteria yet possess good caliper (i.e., greater than 1/2 in or 13 mm) and root development indicating a quality seedling. In these cases, the minimum height requirement is lowered.



Figure 11b.2—All seedlings processed at the George O. White State Forest Nursery are graded and counted in the packing shed. (Photo courtesy of Greg Hoss, Missouri Department of Conservation, 2011.)

Similarly, some species or a seedling lot grown at high density may produce seedlings that are well over the minimum height. In this case the minimum height criteria may be raised to ensure that a suitable caliper is obtained. In addition, “special projects” may require a seedling grade different from the standard 12 in (30.5 cm) minimum height. Or, if the sales for a particular species are slow, the minimum standards may be increased so that only the very best seedlings are going out the gate. Proper supervision, observation, and training is the key to make sure the grading process meets the criteria established.

A seedling either makes that grade and goes down the conveyor belt, or it is placed into the cull tub and taken to the compost pile. If there are extra-large seedlings needing to be separated, the grader pulls out the large seedlings and sets these aside to be graded later. The large seedlings are collected, wet down, and either bundled when the regular grade is done, or returned to the cooler to be bundled later. Occasionally seedlings not making the grade are saved to be used for special projects or special requests. Normally seedlings are never regraded for customers. Each seedling makes the selected grade or it does not. This method of grading, while labor-intensive, ensures that if a customer orders 500 trees, the customer gets exactly 500 trees that have been counted, not bulk packaged in the field. There is no guess work to the number of trees a customer is getting. There is also a consistency in size and quality that a customer can count on from year to year.

Each grader looks at every seedling and counts out 5 seedlings that meet the grade and places this bundle of 5 seedlings on the conveyor belt. Another employee picks up 5 bundles of 5 seedlings to make up a standard bundle of 25 seedlings. These bundles are tied together and tagged with a species tag. The tying is done both by hand and with mechanical tying machines. Bundles are placed back onto a Jarke rack and the roots wet down with water mixed with TerraSorb gel, then moved back into the cooler. Seedlings are returned to the cooler after grading as unpackaged bundles of seedlings on Jarke racks. Since these bundles are unpackaged and the roots exposed, they are watered daily until packaging takes place. Unless the seedlings are being sold as extra-large, any seedling top sticking out beyond the edge of the rack is trimmed using an electric hedge trimmer. This gives a clean cut to any long seedling top. The racks of graded trees are labeled by species, source, and date graded.

Packaging and Shipping.

Shipping typically begins the second week of February. Shipping tags are printed weekly for all seedlings to be

shipped, delivered, or picked up the following week. A four-person baling crew then packages the seedlings. The bundles of seedlings are now packaged using nursery wrap baling paper, wet sphagnum moss and then banded and labeled. Since all trees come in bundles of 25 and customers can order as few as 25 of each species, often the packages may have 2, 3, 4, or even more species. Contracts with the USPS and UPS allow shipment in open-ended bundles, with trees sticking out the top of the package without paying any excess fees for the open packages. When baling, each method of delivery is kept separate. UPS packages will be processed, manifested, and stacked on racks, then the same will be done with packages being picked up by USPS. Pick-up orders and orders to be delivered will be packed and placed on separate racks according to the customer. All of the packages are then moved back into the coolers, regardless of distribution.

UPS leaves a trailer at the nursery which is filled once or twice a week. When a trailer is picked up, an empty one is left in its place. For USPS orders, carts provided by USPS are used. USPS also comes twice a week with a large trailer truck to pick up filled carts and leave empties. We have been using both carriers for many years and have developed excellent working relations with each. Both UPS and USPS guarantee second-day delivery and rarely is this guarantee not met. USPS is very efficient on small orders going to rural addresses. UPS works best for large orders. Another advantage of having two carriers is that if an issue with one carriers develops, we have another to fill in and ensure seedlings are delivered. The nursery does not currently charge for shipping. The cost to the customer is the same for picking up, shipping, or delivery by a nursery truck.

Many orders are picked up at the nursery. Some customers want to avoid the possibility of damage or delay from UPS- and USPS-shipped seedlings. Some just want their trees in hand and see the nursery operation. Most contractors also prefer to pick up their orders rather than having them shipped to the landowners.

Some orders are delivered by nursery staff. These orders are usually large or multiple orders in the same general location that will fill a big truck or trailer. Delivery is at the discretion of the nursery, not the landowner. Based on the number of packages, delivery location and availability of staff, the nursery decides if it would be more economical to ship or deliver. Customers are allowed to request delivery on a specific date, and the nursery makes every effort to accommodate the request.



Figure 11b.3—Seedling roots are watered, wrapped with baling paper, and banded in preparation for shipping. Bundles are then returned to the cooler and shipped within a day or two of packaging. (Photo courtesy of Greg Hoss.)

Storage

Storage Facilities

The primary cold storage building for the George O. White State Forest Nursery is 50 by 250 ft (15 by 76 m). This long, narrow building is divided into 5 bays, each 50 by 50 ft (15 by 15 m). Each bay has its own compressor and temperature control. Additional bays can be turned on when needed as the lifting season progresses. Unused bays can be turned off and shut to save cooling costs as seedlings are shipped in the spring. Each bay will hold 120 Jarke stackable racks. Each row is five double-stacked racks. Space is left between each row for employees to water and find trees.

Every rack is tagged on the upper front right so that each species can be easily identified and located. The cooler manager keeps lists of where every graded and ungraded rack of seedlings is located and this is kept on the forklift, so that any employee can look at this list and find out where a particular species is located within the five bays. Racks are constantly moved around to always keep the oldest graded or ungraded seedlings accessible first.

Coolers are kept at about 34 °F (1 °C) and all trees are wet down each morning. Cooler watering is done by two

employees using water hoses. They move in and around all the rows of Jarke racks and thoroughly wet the seedlings. Coolers are watered on late Friday and are not typically watered over the weekend. There is some overhead mist watering, but this does not thoroughly wet the seedlings like hand watering does. Employees not only wet the seedlings, but also wet floors and walls to maintain high humidity.

Storage Problems

There are several potential problems with seedling storage. When seedlings are lifted and brought into the cooler, they are unloaded onto racks, watered, and placed into cold storage. If the seedlings are lifted on a warm day and then stacked tightly on a rack, there can be molding and heating if the seedlings are not soon graded. Seedlings lifted and stacked on warm days are usually graded within a few weeks. This stirs the seedlings and as they are graded, banded, and put back into the coolers, seedlings that had not cooled properly after lifting now get proper cooling for long-term storage.

A lot of bundles are stacked on a rack during grading. These bundles are watered with a terra-sorb gel mixture as

stacked, but as time in cold storage lengthens, bundles in the middle of the rack can dry out, no matter how much surface watering is provided. Again, making sure to ship the oldest graded seedlings first helps keep racks stirred.

Lifting any hardwood seedlings with leaves attached creates many problems. The leaves take up a lot of space on the racks. As they fall off, constant sweeping is required to keep the cooler floors from getting slick. Over time, the wet leaves mold and this creates a slimy mess to deal with and can cause some top dieback in the seedling. Seedlings should only be lifted with leaves still attached if they are going to be shipped out in a very short time after lifting.

Various species get root molds, but this is usually on root tips that were severed during the lifting process. Both aromatic (*Rhus aromatica* L.) and smooth (*Rhus glabra* L.) sumac tend to develop considerable mold on the roots. A thorough wetting eliminates the mold.

Maximum Recommended Storage Times

Over the years, it has been found that some hardwood species can be stored for many months and the customer can still have success in planting and survival. This is not true, however, of all species. Flowering dogwood (*Cornus florida* L.), persimmon (*Diospyros virginiana* L.), Washington hawthorn (*Crataegus phaenopyrum* Ehrh.), sweetgum (*Liquidambar styraciflua* L.) and deciduous holly (*Ilex decidua* Walt.) DO NOT store well and outplanting survival may be affected. These species are lifted only as needed. This can cause issues when customers request a particular species that is still in the ground and weather or other factors will not permit lifting operations. Lifting way ahead of shipping, however, is not good for some hardwood species. Lower survival with long-term storage has been observed with the red oak group. Red oaks may be kept in storage for only a few months, but white oak species, particularly swamp white (*Quercus bicolor* Willd.) and bur oak (*Quercus macrocarpa* Michx.), may be cold stored for over six months with still nearly 100% survival. Species such as silver maple (*Acer saccharinum* L.), black walnut (*Juglans nigra* L.), black cherry (*Prunus serotina* Ehrh.), wild plum (*Prunus* spp.), roughleaf (*Cornus drummondii* Meyer) and silky (*Cornus oblique* Raf.) dogwood, Kentucky coffeetree (*Gymnocladus dioica*, L., K. Koch), bald cypress (*Taxodium distichum* L., Rich.), hackberry (*Celtis occidentalis* L.), serviceberry (*Amelanchier arborea* Michx. f.), hazelnut (*Corylus Americana* Walter), ninebark (*Physocarpus opulifolius* L. Maxim), and others store very well for many months, and these species are the first lifted during December and into January. Pecan, hickories, gray dog-

wood (*Cornus racemosa* Lam.), tulip poplar (*Liriodendron tulipifera* L.), sycamore (*Platanus occidentalis* L.), river birch (*Betula nigra* L.), and others that store fairly well, along with the red oaks, are lifted as needed or after the species listed above are lifted. Willow oak (*Quercus phellos* L.) and sometimes black oak (*Quercus velutina* Lam.) seem to never lose their leaves, and these species are not lifted until needed to avoid rotting problems with the leaves. Several species seem to have a problem with hardening off in the seedbeds, particularly tulip poplar and redbud (*Cercis Canadensis* L.). If these species are lifted too early in the lifting season, the tops tend to mold and dieback during storage.

At some point all trees are stored for a long time, sometimes longer than they should be stored. There are customers who do not want their seedlings until late May or even early June. The last of the seedlings are lifted by the first part of April, so every seedling would have 2 or more months of storage before some late orders are shipped.

But, bareroot hardwood seedlings are amazing sometimes. It is usually July before the coolers are shut down and excess seedlings disposed of. It may have been weeks since the last watering, the seedlings have been lifted and stored for months, laying on their sides, stored at 34 °F (1 °C) and yet, even species that do not seem to store well, will be leafing out—without light, without water, and without heat. Some have leafed out and grown several inches, at right angles to the stem, in this environment! It is not clear how well these seedlings would do if outplanted in the summer, but in spite of their final abuses, they are still trying to grow.

