

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

TREE/SHRUB ESTABLISHMENT

(Acre)

CODE 612

DEFINITION

Establishing woody plants by planting seedlings or cuttings, direct seeding, or natural regeneration.

PURPOSE

To establish woody plants for forest products, wildlife habitat, long-term erosion control and improvement of water quality, treatment of waste, reduction of air pollution, sequestration of carbon, energy conservation, and enhance aesthetics.

CONDITIONS WHERE PRACTICE APPLIES

On any area where woody plants can be grown.

CRITERIA

General Criteria Applicable to All Purposes

Species will be adapted to soil and site conditions and suitable for the planned purpose.

Planting or seeding rates will be adequate to accomplish the planned purpose.

Planting dates, and care in handling and planting of the seed, cuttings, or seedlings will ensure that planted materials have an acceptable rate of survival.

Seedlings will be properly protected and stored from nursery through planting.

Only viable, high quality, and adapted planting stock or seed will be used.

Residual chemical carryover should be evaluated prior to planting.

Species considered locally invasive or noxious should not be used.

Site preparation shall be sufficient for establishment and growth of selected

species. See standard for Forest Site Preparation (Code 490).

Adequate seed or advanced reproduction needs to be present or provided for when using natural regeneration to establish a stand.

The acceptability and timing of coppice (i.e. sprouting) regeneration shall be based on species, age, and diameter.

Timing and use of planting equipment will be appropriate for the site and soil conditions.

The planting will be protected from unacceptable adverse impacts from pests, wildlife, livestock damage, or fire.

Each site will be evaluated to determine if mulching, supplemental water or other cultural treatments will be needed to assure adequate survival and growth.

Comply with applicable federal, state, and local laws and regulations during the installation, operation and maintenance of this practice.

Planting Adapted Species

Suggested species to plant are shown in Tables 1 and 2.

Other trees to plant and manage are listed in soil survey interpretations - Section II of the Technical Guide.

Trees and shrubs to plant for recreational use and beautification are listed in the standard for Recreation Area Improvement (Code 562).

Conservation practice standards are reviewed periodically and updated if needed.
To obtain the current version of this standard, contact the Natural Resources Conservation Service.

Site Preparation

Site preparation will vary according to the species to be planted, type of ground cover, soil type, slope, degree of erosion and other site factors. The objective is to reduce competition without removing or destroying topsoil and organic matter. See the standard for Forest Site Preparation (Code 490).

When conducting any practices that disturb the soil, an undisturbed strip will be planned along streambanks (streamside management zone-SMZ) to filter out sediment and remove nutrients from groundwater. Recommended minimum width is 50 feet with additional width for steeper slopes, trout waters, and public water supplies. See Forestry Best Management Practices Manual, North Carolina Division of Forest Resources (Forestry Technical Reference File). Also see the standard for Filter Strip (Code 393).

Site Improvement

Growth on wet and other low quality sites often can be improved by water control.

1. Water control should be designed to maintain optimum water table. In the flatwoods, pines grow best when the water table is at least 18 inches but less than 36 inches below the surface.
2. Bedding may be needed to improve drainage, make planting easier and improve survival and initial growth of loblolly pine. Pines planted on beds in wet areas benefit from improved nutrition and soil aeration.
3. Fertilization is generally considered an operational practice only in the poorly drained flatwoods and other soils of the Coastal Plains generally deficient in phosphorus.

Size of Openings

Openings within established stands of trees should not be planted unless they are wide enough to permit direct sunlight to reach the ground for several hours each day. The

openings should be at least twice as wide as the height of the surrounding trees.

Spacing

Trees should be spaced so that they will make normal growth until the time of the first cutting, which is usually a commercial thinning.

Open Fields: From 400 to 500 well distributed trees per acre is an adequate stand for trees of minimum pulpwood size (5 to 6 inches diameter breast high). From 1,000 to 1,200 trees per acre is an adequate stand for 5-foot to 8-foot high Christmas trees.

Plant interplanted seedlings no closer than 8 feet from established seedlings.

Spacing for special purpose plantings, such as wildlife or beautification, will be done in consultation with an appropriate specialist.

Interplanting

Interplanting will usually be done with hand tools such as dibbles, mattocks, or spades. Ordinarily, machine planting will not be practical, as (1) areas to be interplanted may be too small and scattered and (2) plantations or natural stands already established may be damaged by the heavy equipment. Interplanting should be done within the first year following failure of the original planting.

Remove or control trees and shrubs of unwanted species which overtop or compete with interplanted seedlings and trees already established, using the best-suited method described in the standard for Forest Stand Improvement (Code 666). Release work should be accomplished in the spring of the seedlings' first growing season to assure better survival and faster initial growth.

The objective of interplanting young stands is to attain an average stocking of at least 300 well distributed trees per acre (an average distance of 10 to 12 feet apart) by the time the trees are 5 to 6 inches in diameter at breast height.

Table 1
CONIFERS
Recommended Species and Spacing for Reforestation*

Species & Spacing	Coastal Plain	Sandhills	Lower Piedmont	Upper Piedmont	Mountains
Loblolly Pine ¹ minimum/Ac. 12'x12' maximum/Ac. 6'x10'	X	X	X	X	X ²
Longleaf Pine ³ minimum/Ac. 8'x10' maximum/Ac. 6'x10'	X	X	X		
Shortleaf Pine ⁴ minimum/Ac. 8'x12' maximum/Ac. 6'x10'			X	X	X ⁵
Virginia Pine ^{6,9} (Improved) minimum/Ac. 8'x 10' maximum/Ac. 6'x9'				X	X ⁷
Eastern Redcedar 5'x10'	X	X	X	X	
Eastern White Pine minimum/Ac. 12'x12' maximum/Ac. 7'x10'				X	X
Fraser Fir ⁹ 5'x5'					X ⁸

- ¹ Not recommended on sands over 30" in depth.
² Cherokee, Clay, and Macon only up to 1,500 elevation.
³ Best species for sands over 30" in depth.
⁴ Do not plant on severely eroded soil. Adapted to dry, infertile soils.
⁵ Recommended up to 2,500 ft. elevation.
⁶ Adapted to severely eroded soil. For erosion control.
⁷ Recommended to 2,500 ft. elevation.
⁸ Above 2,000 ft. elevation.
⁹ For Christmas tree production.

X = recommended

- Spacing can be varied to meet landowner objectives, level of management, and potential for commercial or precommercial thinning.

Number of Trees Required Per Acre at Various Spacings

5'x 5' = 1,742	6'x 9' = 807	8'x 8' = 681	10'x 10' = 435
6'x 6' = 1,210	6'x 10' = 726	8'x 10' = 545	12'x 12' = 302
6'x 8' = 908	7'x 10' = 622	8'x 12' = 454	

Planting Conifer Seedlings

1. **Seedling Quality** - A quality seedling is disease-free, root collar diameter no less than one-eighth inch, stiff and woody, with secondary needles present, maximum top length 14 inches and a root system no less than five inches nor more than 9 inches long.
2. **Care of Seedlings** - Seedling roots must be kept moist at all times. Seedlings (especially the roots) should not be exposed to the sun, wind, heating, drying, or freezing at any time from lifting at the nursery plantbeds until planted. No roots should be exposed to the sun or wind for more than 10 minutes. If cold storage is not available, keep seedlings packed in bales after delivery. They should not be stored in bales longer than 2 weeks.

Successful plantations depend so much on the care of planting stock that every effort should be made to keep it in good condition. Experience has shown that stock can be kept in better condition in bales/bags - as it comes from the nursery - than in field heel-in beds. This is particularly true where the stock will be planted in two to three weeks. The following additional precautions should be taken in storing bales/bags:

- a. Keep in a cool place. Avoid heated rooms.
- b. Protect bales/bags from freezing.
- c. Water at least once each week to keep roots and packing moss moist.
- d. Stack bales/bags on sloping racks to insure air circulation, easy watering, and drainage of excess water.

Stock must be kept cool (34 - 38 degrees F) and protected from "heating". Stock which is well watered, protected from direct sunlight, and properly aerated usually will not heat. Seedlings which have been subjected to heating should not be planted.

It should be remembered that the sooner seedlings are planted after being lifted from nursery beds, the better the chances for survival and normal growth. Loose

seedlings should be "heeled in" immediately upon arrival. Steps to follow are:

- a. Select a well-drained and slightly sloping spot with some shade.
- b. Dig the trench 2 to 4 inches deeper than the seedlings' roots are long. One side of the trench should be smooth and slightly sloping.
- c. Place a shallow layer (less-than 3 inches) of seedlings against the sloping side of the trench and cover the roots and 1 or 2 inches of the stem with soil.
- d. Water the soil thoroughly and repeat as necessary in order to keep the soil moist at all times.
- e. Keep seedlings covered while hauling and protect them from the sun and wind and prior to planting.

While planting, take the following precautions:

- a. Water, wet moss, or wet burlap should be kept around the seedling roots.
- b. When hand planting, one seedling should be selected at a time and immediately planted.
- c. At the end of each day, "heel in" the loose seedlings or repack them in wet moss and wrap tightly with waterproof paper.

Planting Hardwood Seedlings

Care of hardwood seedlings is similar to conifer seedlings with the following additions:

1. Seedlings must be large (at least 3/8" root collar diameter) and healthy. Small or weak seedlings invite planting failures.
2. Seedlings must be of correct geographic source.
3. The trees must be adapted to the site.
4. Site preparation and logging must be such that the soil is not abused, which causes erosion or puddling from working the soils when they are too wet. As a general guide, the site should have a pine site index of 90 feet or more at 50

years if hardwood plantations are to be considered as a satisfactory crop.

5. The newly planted seedlings need to grow without severe competition. This requires intensive site preparation and proper aftercare to control competing vegetation.
6. Plantations must be carefully protected. Hardwoods are killed or injured by light fires; they can be destroyed by grazing cattle and deer, and they are sensitive to herbicides.

Time to Plant - Plant during the dormant season. (The season can be extended from two to four weeks by placing dormant seedlings in cold storage.) Avoid planting when ground is frozen or dry - or excessively wet and sticky. Planting when soil is in poor condition results in low survival, poor planting production, misplanted seedlings and poor growth.

Planting Methods - Seedlings may be planted by hand or with a machine transplanter. Machine transplanters are effective where logging debris or steepness of slope does not prohibit their operation.

Planting bars or dibbles used for hand planting are effective on most soils. Mattocks are usually required on areas with severe gully or sheet erosion or in stony soils. Slits, holes or furrows should be free of plant stems, leaves or other litter. The dibble or planting bar must be 10 inches long or planting will be too shallow. On rocky or heavy soils, the KBC planting bar or equivalent is recommended.

Table 2
Suggested Major Hardwood Species for Plantations by Region and Soil Characteristics

		Coastal Plain Soil Characteristics				
Species	Planting Spacing	Well drained Deep, Rich (River Terrace)	Heavy, Somewhat Wet Soils (Mineral Soils)	Very Poorly Drained Permanently Wet Soils w/ Clay Base-Muck or Peat	Deep Sands	Shallow, Sandy Loamy Soils Over Clay Base (> 6" Topsoil)
Cottonwood	10' x 10'	X				
Green Ash	10' x 10'	X	X			X
Red Maple			X	X		
Red Oaks (Cherrybark)	10' x 10'	X	X			
Swamp Chestnut Oak	10' x 10'	X	X			
Sweetgum	10' x 10'	X	X			X
Sycamore	10' x 10'	X				X
Tupelo Gum			X	X		
Water-Willow Oak	10' x 10'	X	X			X
Yellow-Poplar	10' x 10'	X	X			
		Piedmont Soil Characteristics				
Species	Planting Spacing	Loamy, Clayey, Red, Droughty (Eroded)	Upland Slopes & Ridges; Deep, Loamy Soil (Little Erosion)	Small Stream Bottom (Variable)	Major River Bottoms (River Terraces)	
Green Ash	10' x 10'			X	X	X
Red Oaks	10' x 10'		X			X
Sweetgum	10' x 10'		X	X		X
Sycamore	10' x 10'		X	X		X
Water-Willow Oak	10' x 10'			X		X
White Ash	10' x 10'			X		X
Yellow Poplar	10' x 10'		X	X		
		High Piedmont & Lower Mountains Soil Characteristics				
Species	Planting Spacing	Upland Ridges Rocky, Eroded (Less than 3" Topsoil)	Upland Ridges, Deep Soil (less than 50 % Rocks)	Coves, Valleys	High Plateau	
Black Walnut	20' x 20'			X		
Cherry	10' x 10'		X	X		
Northern Red Oak	10' x 10'		X	X		
White Ash	10' x 10'			X		
Yellow-Poplar	10' x 10'		X	X		

- Depth of Planting - Plant seedlings slightly deeper (1" to 2") than they grew in the nursery in all soils except deep sands where they should be planted 2 to 4 inches deeper than they grew in the nursery, exercising due care not to cover the terminal bud. An exception is longleaf pine which should be planted with the terminal bud at ground level after the soil has settled.
- Condition of Roots - Roots must be planted straight down, not twisted, balled or U-shaped. The opening (slit, hole, or furrow) should be large and deep

enough to accommodate the root system in its normal position.

3. Firmness - Soil must be packed firmly around the planted seedlings with no air pockets around roots. For pines, test firmness by grasping 4 or 5 needle tips and pull. If seedling comes out of the ground, the trees have not been packed firmly. If the needles come loose, it is packed firmly.

Cottonwood cuttings are easily and quickly planted. A pointed steel rod, approximately 3/4" in diameter and of convenient length (36"-42"), may be used. The rod is inserted vertically in the soil to a depth of approximately 12". The rod is withdrawn, a cottonwood cutting 20" long is placed in a hole to a depth of 15", and the soil is then firmed around the cutting. Cottonwood cuttings of various lengths up to 40" may be planted. In such cases the cuttings are planted to depths which will permit 4 to 5 inches to extend above the surface of the ground.

4. Inspecting Machine Planting: Check for proper depth of the trench, correct tracking of packing wheels and proper closure of trench by the packing wheels. Check root placement by opening one side of the trench with a shovel to expose the seedling in place.

Direct Seeding

1. Seed Quality - Seed should be ordered from a reliable commercial seed dealer. Lots should contain no more than 10% empties by number and moisture content should be 10% or less. Impurities should be 2% or less by weight.
2. Seed Treatment - Seed stratification and repellent coating are essential for all pines except longleaf. Stratification will hasten germination after sowing, which in turn will reduce the period of exposure to predators and the elements. After stratification, the seed must be coated with a chemical repellent.

This coating is the same for all Southern pine species. It usually consists of one

chemical to repel birds and another to repel rodents and many insects. It also includes a substance that sticks the repellent to the seed, plus an aluminum powder to lubricate the seed so they flow through a seeding machine.

3. Timing and Rates - Seed should be sown about the time of the last killing frost. However, if longleaf seed are used, November or February are preferred seeding times.

For broadcasting, the rate for all species should be 10,000 to 15,000 seed per acre. In terms of weight, the following pounds per acre are recommended:

Longleaf	3.0
Loblolly	1.0
Shortleaf	0.4
Virginia	0.3
White	0.6

Leaf litter must be burned if it is deep enough to prevent seed from reaching mineral soil. If the tract cannot be burned, use the spot sowing method as follows:

Using a hoe, rake leaves from a spot about one foot square and drop six seeds on the exposed soil. Press them lightly into the soil. The leaves should be scattered, rather than piled, around the edge so they won't blow back over the bare spot and smother seedlings. Seeding 1,000 spots per acre, one man can cover 2 to 4 acres daily.

4. Release Seedlings - One advantage of direct seeding is that overtopping hardwoods do not hamper the operation; they offer shade to the seed during germination time and while the seedlings are getting established. The hardwoods should be killed by the middle of the following summer. Otherwise, they will compete for vital moisture and growing space.

Direct seeding should not be used on slopes which are steep and eroded because seed can easily be washed away. Also deep, sandy soils should be avoided because they dry out too fast for good seed germination.

For direct seeding to work on such sites, the seed have to be covered with 1/2 inch of soil -- a very time-consuming operation.

CONSIDERATIONS

The owner's choice of species to plant will be determined by the products desired and the existing soil and site conditions, or by the desirable species in existing understocked stands. Selection of indigenous species may improve or restore natural diversity.

When underplanting, trees should be planted sufficiently in advance of overstory removal to ensure full establishment.

Prescribed burning may be required for natural regeneration of serotinous cone species and for site preparation for other species.

Because seeding is less expensive than planting, it has much to offer the profit-conscious landowner. The money saved comes at the beginning of the forest rotation, which means less money to capitalize. This will lead to a larger financial rate of return on the investment, if timber growth and survival on direct-seeded stands is equal to that of plantations.

Use locally adapted seed, seedlings or cuttings. Priority will be given to plant materials that have been selected and tested in tree/shrub improvement programs. All plant materials should comply with a minimum standard such as the American Nursery and Landscape Association, Forest Service, or state-approved nursery.

Plans for landscape and beautification plantings should consider foliage color, season and color of flowering, and mature plant height.

Where multiple species are available to accomplish the establishment objective, consideration should be given to selecting species which best meet wildlife needs.

Tree/shrub arrangement and spacing should allow for and anticipate the need for future access lanes for purposes of stand management.

Species used to treat waste should have fast growth characteristics, extensive root

systems, be capable of high nutrient uptake, and produce wood/fiber products in short rotations.

For optimal carbon storage, select plant species that are adapted to the site to assure strong health and vigor and plant the full stocking rate for the site.

A planting bag is more efficient than a pail. A suitable bag has an adjustable shoulder strap, plus a strap to secure the bag to the planter's waist.

The "one-man planting unit" is most efficient with each person carrying his/her own seedlings in a bag.

For direct seeding with the hand-operated cyclone seeder, about 15 acres can be sown per man-day. This machine is efficient on tracts of up to several hundred acres.

Considerations for Insects and Disease

- a. Pales weevil is the most serious insect pest for pine seedlings on recently cutover pine lands. In susceptible areas, purchase treated seedlings if available. Another preventive measure is to delay for one season following harvest cutting. The greater the volume of slash and number of stumps, the higher the population of pales weevil will be.
- b. Fusiform rust is the most important disease of loblolly pines. In localities where fusiform rust incidence is high, consider planting rust resistant stock or species less susceptible to rust (longleaf, shortleaf, and white pine.)
- c. Brown spot on planted longleaf pine may be controlled or prevented by prescribed burning. Application of this practice will ensure better survival and increase early height growth at a reasonable cost. Detailed specifications may be found in the standard for Prescribed Burning, Code 338.

Considerations for Planting Christmas Trees

- a. Christmas tree production requires land of suitable quality, and adequate area.

Some species of Christmas trees that can be grown in North Carolina follow:

Coastal Plains

Redcedar
Virginia Pine
Eastern White Pine

Piedmont

Redcedar¹
Eastern White Pine
Virginia Pine

Mountains

Fraser Fir
Eastern White Pine
Virginia Pine²

¹ Local sales.

² Not generally used in commercial operations.

- b. Fraser fir grows slowly at first but it also brings the highest price of any Christmas tree grown in North Carolina. On a well-drained suitable site, 4 or 5 year old 8" to 12" transplants will require 7 to 12 years to grow into 7 to 8 foot trees.

Douglas fir is susceptible to drought and late frost damage in North Carolina. To grow 8 foot trees requires at least 12 to 15 years.

Eastern white pine is susceptible to root diseases, so avoid soils of the Piedmont underlain by plastic clay within a foot of the surface. It takes 7 to 10 years to grow a 2-year old seedling to a 7 to 8 foot merchantable Christmas tree.

Virginia pine is being genetically improved and selected for good Christmas tree characteristics. Growth is rapid so rotations of 4 to 6 years are possible.

Redcedar for many years has been the traditional natural Christmas tree in North Carolina. It has declined in popularity because of prickly foliage, poor form, and color.

Spruce species all grow slowly and except for Norway Spruce require 10 to 15 years to grow to Christmas tree size and are susceptible to several pests and needle cast diseases. They serve better

as a yard ornamental.

Consideration for Safety

1. Wear protective gloves and use care when handling seedlings treated with chemicals. Wash hands thoroughly and change clothes if they become soiled with chemicals.
2. Provide first aid kit and see that tree planters wear proper work clothing.

PLANS AND SPECIFICATIONS

Specifications for applying this practice shall be prepared for each site and recorded using approved specifications sheets, job sheets, technical notes, narrative statements in the conservation plan, references to enclosed plans from other agencies, or other acceptable documentation.

Minimum documentation for this includes:

- Species to be planted
- Plant spacing
- Site preparation and planting methods
- Equipment to be used
- Season of the year to be performed
- Soil amendments, if applicable
- Cultural practices
- Statement requiring compliance with all federal, state, and local laws
- Operation and maintenance requirements

Reference may be made to planting specifications prepared or approved by the N.C. Division of Forest Resources that covers each needed component listed above.

OPERATION AND MAINTENANCE

Planting Follow-Up - Seedling stocking and survival can be determined a year after planting by taking 1/100 acre randomly sampled plots in the plantation. The radius of a 1/100 acre plot is 11.75'. Sufficient plots are needed to give a good representation of area. As a rule, if 300 or more well established seedlings survive per acre, it will not pay to replant. Replacement plantings should be made within 2 years after the original planting.

Release and Cultural Practices

- Ordinarily, pine plantations do not require cultivation. If cultivation is needed, a light disking to reduce grass competition during the first year usually will suffice.
- Cultivation of cottonwood plantations is essential to survival and may be accomplished by disking, cross-plowing, or hoeing. Field plantations of other hardwood species such as sycamore and yellow-poplar will also benefit from these cultural measures.
- Planted seedlings or cuttings should be released from any overtopping vegetation not later than 2 years after planting. Consult the standard for "Forest Stand Improvement," (Code 666), for applicable methods of treating overtopping vegetation. "Foliage Spraying" methods should not be used on areas planted to hardwood species.
- If needed, competing vegetation will be controlled until the woody plants are established. Noxious weeds will be controlled.
- Replanting will be required when survival is inadequate.
- Supplemental watering will be provided as needed to ensure adequate survival.
- Damaging pests (insects and disease) will be monitored and controlled.
- Periodic applications of nutrients may be needed to maintain plant vigor.

Protection of Planted Seedlings

- **Livestock Exclusion**
All plantations should be protected from grazing by livestock until the trees are at least 8 to 10 feet high. Domestic livestock should be completely excluded from all hardwood and Christmas tree plantations throughout the life of the stands. Hogs must be completely excluded from plantations of all species. For further details, consult the standard for "Fence," (Code 382).
- **Protection From Fire**
Interplanted stands and young plantations of all species must be protected from fires. See the standard for "Firebreak," (Code 394).

REFERENCES:

- Zobel, B. J. and C. B. Davey, "A Simplified Guide to Hardwood Management in the Southeast", College of Forest Resources, North Carolina State University, Raleigh, NC.
- Pocket Guide to Seedling Care and Planting Standards. 1998. North Carolina Division of Forest Resources.