Reforestation & Afforestation Guidance for New York

Created by The Nature Conservancy in partnership with the New York State Department of Environmental Conservation

NEW YORK STATE | Department of Environmental Conservation

The Nature Conservancy

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Introduction

Climate change is impacting the globe, with thousands of documented cases of altered air and water temperature, rising sea levels, shrinking glaciers and sea ice, and other changes. Climate change is already affecting New York through increased average temperatures, annual precipitation, and frequency and intensity of extreme weather events—and impacts are projected to continue into the future.

To reduce future impacts, it is vital to take steps to minimize net greenhouse gas emissions and maximize carbon sequestration and storage. Through photosynthesis, trees and forests sequester carbon dioxide from the atmosphere and can store this carbon for long periods of time—which helps mitigate climate change. In addition, forests promote community resilience to climate impacts like flooding and extreme heat, among other benefits, in communities disproportionately impacted by climate change and other environmental challenges. Reforestation and afforestation encourage the establishment of forests through practices like tree planting, invasive species control, and protection from deer. Protecting and increasing New York's forested area is one of the most cost-effective natural climate solutions available—and it includes planting trees via afforestation, reforestation projects, and implementing practices that enhance natural regeneration.

New York's Climate Act Scoping Plan has directed state agencies, authorities, partners and organizations to broadly encourage and support statewide tree planting, tree regeneration and tree maintenance programs to establish and maintain 1.7 million acres (approximately 680 million trees) by 2040, which would result in more than 4.9 MMT CO2e of additional annual sequestration by 2050 (Cook-Patton et al 2020). To jump-start this effort, Governor Kathy Hochul announced a statewide initiative to plant 25 million trees by 2033 as part of her state-of-the-state address in January 2024.

Purpose of This Guide

This guide serves as a starting point for landowners, municipalities, organizations and others who are planning a reforestation or afforestation project. For simplicity, this guide uses the singular term reforestation, defined here as the act of planting ecologically appropriate tree species on non-forest lands that were once under natural forest cover (sometimes called afforestation). Since this guide focuses on planting trees, it does not cover the planting of woody shrubs and herbaceous plants—several of the planning tools and references mentioned do provide information about other types of restoration.

While this guide is a starting point, it includes many reference documents with additional information to assist you in your reforestation and afforestation efforts. Thank you for helping to reduce the impacts of climate change by following this simple guide and planting trees.

Planning for Reforestation

Site Planning
(Year 1)

- Establish goals
- Conduct site assessment
- Create initial site plan
- Select tree species to plant

Implementation
(Years 2-3)

- Source/purchase trees
- Prepare site
- Plant trees

Maintenance & Monitoring
(Begin years 2-4)

- Maintain site and plants
- Monitor progress
- Evaluate success

Timeline

Successful reforestation typically requires multiple years of planning and implementation followed by maintenance and monitoring. Before any work begins, a plan needs to be developed to help guide the project. Start the planning process with a local natural resource professional—such as a forester, County Soil and Water Conservation District staff or local extension office—as soon as possible. The natural resource professional will have technical expertise for creating a plan, and depending on the funding source will be able to offer guidance throughout the entire project. If you are not working with a natural resource professional, the following guidelines are many of the key considerations for creating a project plan.

Site Planning

Planning Step 1: Establish Goals and Identify Funding Source(s)

Your reforestation plan should reflect your goals for the property. Identify what you would like the reforestation project to accomplish at the very beginning of the planning stage. Some common goals including the following forest benefits:

- Carbon sequestration
- Erosion control
- Water quality
- Timber production
- Wildlife habitat
- Recreation
- Aesthetics

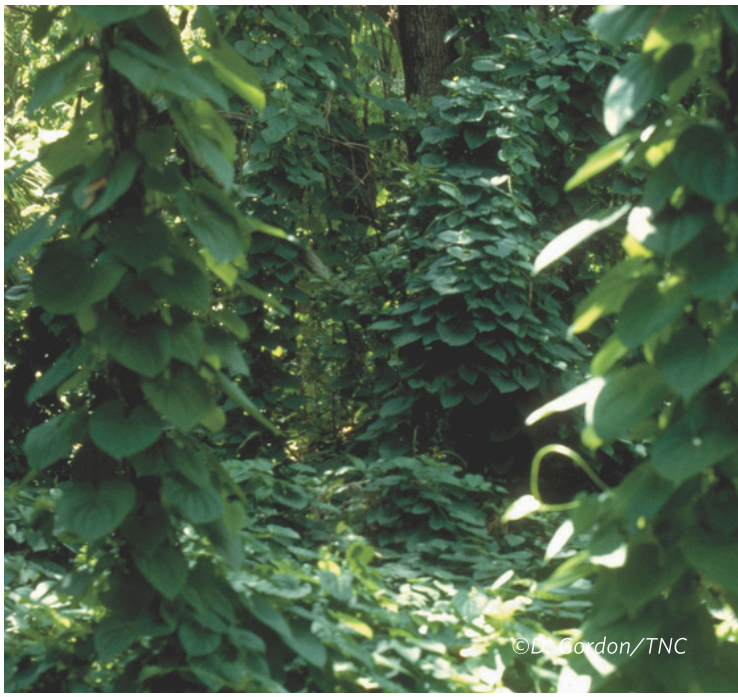
Depending on the size and goals of the project, funding may be available to assist with your tree planting project, and funders often have specific goals and/or requirements. Identifying funding sources early in the process will enable you to include any specific funding requirements into your goals.

Planning Step 2: Assess the Site

Assessing the physical attributes of the reforestation site will provide essential information to ensure the success of your tree planting project. Conditions such as soil type, existing vegetation, climate and availability of water will inform what you plant and when.

A. Existing Vegetation

In most cases, there will already be some vegetation at a site. One of the first steps in assessing existing plants is to determine if plants are native or invasive. Once identified, plant names can be searched in the New York Flora Atlas to determine if they are native to New York. When possible, and when it meets your project goals, existing native plants should be left in place. Avoid walking, operating vehicles, removing or compacting soil, or otherwise disturbing the area around existing native plants you wish to retain.



Invasive plants are non-native plants that were introduced to an area and that cause harm to the environment, the economy and/or human health. Many invasive plants, such as kudzu which is pictured above, can impede the growth of forest regeneration or planted seedlings and thereby reduce the site's carbon sequestration potential. Take inventory of the invasive species present at the site and follow the steps in Implementation Step 2 for managing these species during planting. Plan to monitor the site to make sure the invasive plants do not return and/or do not further invade the site.

There may be natural regeneration of native trees at your site already. Work with a forester or other natural resource professional to evaluate if there are existing tree seedlings and saplings at the site, or if there is a viable and nearby seed source. Depending on the density of seedlings and saplings, additional tree planting may not be needed to establish forest cover at the site. If plants are expected to grow back naturally, the site should be monitored for at least five years to determine if the establishment of native seedlings from the nearby seed source is successful. If it is not successful, a tree planting project should be considered to establish a forested condition.

B. Climate

Climate limits where different types of plants can grow. The United States Department of Agriculture (USDA) USDA plant hardiness zones map shows areas where plants are limited, and is based on the average low temperatures reached each winter. Climate effects are further impacted by elevation and the amount of sunlight that hits a slope as indicated in the following examples:

- Higher elevations have cooler temperatures
- North and northeast-facing slopes having colder and wetter climates
- South and southwest-facing slopes having hotter and dryer climates

C. Sunlight

Different trees have different sunlight requirements to grow (ex: full shade, partial sun, full sun) and the amount of sunlight within a site can limit the types of trees that will thrive. Prior to selecting the species you will plant, the amount of sunlight should be evaluated by observing the site throughout the day. A site is considered full sun if it receives at least 6 hours of direct sunlight and is considered full shade if it gets less than 3 hours of sunlight.

D. Soil

Soil texture (whether a soil is clayey, loamy, silty or sandy) determines how long water will remain in the soil and be available to plants. Clays, loams and silts tend to hold more water, longer. Soil texture may also indicate how susceptible a site is to erosion, as clays and silts are the most susceptible to erosion by water. Some trees require moist soils, while others prefer dryer soils—and soil texture should be considered alongside the site's hydrology to determine if the area is suitable for certain species. The soil texture can be determined by following the USDA Natural Resource Conservation Service's (NRCS) soil texture guide. USDA also has web-based soil survey maps for a large portion of the country at its Web Soil Survey website.

Soil pH measures the acidity of the soil. Many trees survive well in neutral soil conditions (pH 6 to 7), however there are trees that require more acidic or more basic soils to grow. A site's soil pH can be measured using a pH meter or pH paper. Soil pH can vary across a site, so multiple locations throughout the site should be tested. Soil testing is not required for tree planting projects, but this level of information can assist in planning for success.

Soil compaction is when soil particles are pressed closely together. This typically occurs after

heavy equipment is used on a site. Soil compaction can reduce the amount of water that the soil can absorb, the amount of water the soil can hold, and the ability of plant roots to grow through the soil. In addition, soil compaction can increase erosion. To assess soil compaction, a penetrometer can be used or you can push a survey flag wire (15.5ga steel) into the ground and compare the amount of wire deformation with a reference site (defined on page 10). If the wire can easily be pushed in 6 to 12 inches during moist conditions above freezing without deformity, the site has high soil porosity and the soil is not compacted. If some deformity occurs in the wire while being pushed into the ground at the project site, but no deformity occurs at a reference site, the soil may be compacted. See the New Jersey Department of Agriculture's Division of Agriculture and Natural Resources' guide to soil de-compaction for additional information and protocols.

Bedrock is solid rock that is typically beneath soil and looser materials. Bedrock depth impacts the depth of rooting from plants and pooling of water. Sites where the bedrock is shallow (less than 6 feet below the soil's surface) are limited to trees with shallow root systems.

Soil erosion is the removal of soil by water and wind. It is often more difficult to grow trees in areas with high levels of erosion since the soil is less stable and has fewer nutrients. Erosion is typically higher in clay soil, silt soil, and areas with steep slopes. In these areas, erosion may need to be addressed before planting, which may require the assistance of an engineer. For more information, see the USDA NRCS Guide to Conservation Plantings on Critical Areas for the Northeast.

Salt is another factor to assess. Many trees do not tolerate high levels of salt within the soil. Some locations naturally have high salt levels, while others—such as along highly salted roadways and near salt plants—may have unnaturally high levels of salts within the soils. In either of these conditions, it is best to select salt-resistant species that will survive at the site. Soil salinity can be measured using a salinity meter in a mixture of soil and water.

E. Water Resources

Water availability can impact which trees can grow at a site and how successful planting efforts will be if seedlings need to be watered. Potential water sources in and around the site should be noted, including lakes, rivers, streams, groundwater and road drainage. As you evaluate the water sources, also consider whether the site could be subject to flooding.

Underground water availability can be tested by digging 18 to 24-inch-deep test holes in various locations across the site, filling them with water, and watching how fast water drains from them after it is filled a second time.

For more information, see Bartlett Tree Expert's soil drainage report.

- If water drains faster than 1 inch per hour from the test holes, use species that are suited for well-drained sites.
- If water drains between 0.5 inches to 1 inch per hour, use species that are suited for moderately well-drained sites.

- If the hole drains less than 0.5 inches per hour, use species that are tolerant of wet conditions and/or flooding.
    - If water remains within the hole overnight, only use shallow-rooted plants.
    - If water remains within 12 inches from the surface of the hole after 1 week, it will be challenging to have trees grow.

For wetlands, shorelines and other sites with more complicated hydrology, a professional hydrologist can evaluate the site to determine if the natural hydrology needs to be restored and to provide more guidance where replanting should occur.

Frost heaving is when water pushes soil apart by freezing in between the pores of the soil, which can kill plants by pushing them out of the soil during the fall and spring. Frost heaving is most common in silty and compacted soils. A site can be assessed to see if frost heaving will be an issue during the spring or fall during cold temperatures when soil moisture levels are high. A site is susceptible to frost heaving if there is a loose crust on the soil that collapses when walked over. To help prevent frost heaving, till compacted soils during site preparation, mulch around plants, avoid planting in the wet parts of the site, maintain existing native shrubs and trees on the site, and/or plant species that are adapted to ice scour conditions.

Soil moisture can be impacted by steep slopes, south or southwest-facing aspects, high elevations, and windy areas. Existing plants can also contribute to water loss at a site. Select more drought-tolerant species for these conditions. In addition, leave undisturbed native plants and natural barriers like logs, rocks, stumps, soil ridges and furrows to help preserve the site's moisture. Shelter belts (linear rows of trees or other tall plants) and tree shelters can help further improve planting survival in these areas.

F. Deer Pressure

Deer browse pressure will limit the ability of tree seedlings to survive, and is a significant threat to their establishment. Even minor browse of the the tree's foliage, buds and branches can set it's growth back permanently or even cause death. Tree protection should be used on all hardwood tree plantings, especially if there are signs of deer use in an area. You can also plant species deer do not prefer and/or plan to protect seedlings with fencing, tree tubes or other protection devices. Common tree protection methods include 8-feet high polymesh fencing around the planting site, properly constructed slash wall, or the installation of individual 5-feet plastic tree tubes.

Signs of deer pressure include browsed plants, frequent and recent deer droppings and other visual observations. In a low-impact area, natural regeneration of species preferred by deer, herbaceous plants, and spring wildflowers are common. In a heavily-impacted area, natural regeneration of species preferred by deer is rare to absent, spring wildflowers are absent or stunted, and a "browse line" may be readily evident. For photo-descriptions of deer impact, see Cornell University's "Assessing Vegetation Impacts from Deer" manual.

G. Forest Pests

Knowledge of whether the area is infested with invasive forest pests or pathogens will influence your planting plans. For example, presence of emerald ash borer (EAB) in your area would mean you should avoid planting ash species or try to source EAB-resistant ash when such trees eventually become commercially available. If you plant species such as eastern hemlock, where forest pests like hemlock woolly adelgid can be controlled with pesticides, your long-term maintenance plan should include monitoring for and managing the forest pest. New York's iMapInvasives, the statewide invasive species database, has great information about the location of forest pests and other invasive species. Your local Partnership for Regional Invasive Species Management is also a good source of information.

Planning Step 3: Choose Which Species to Plant

Your choice of tree species for planting in the northeastern hardwood region is extensive. Each species has their own characteristics and preferred growing conditions, and a forester or natural resource professional should inform your selections to maximize project success.

A. Selecting Species

Reforestation efforts should encourage the establishment of a diversity of native tree species that are adapted to the site, help build resilience and provide greater ecosystem benefits. Since tree planting is a long-term commitment, your choices should be deliberate and carefully planned. Combine your goals, site characteristics, and other factors that may impede tree growth (such as deer pressure, presence of invasive plants and forest pests, and exposure to extreme climate conditions) to determine which trees will grow best at your site.

One approach to selecting the species you want to plant is to mimic species at a reference site. A reference site is an area within the same general location as your project site that has similar conditions (climate, sunlight, soils, water availability) that your project site would be expected to have in its natural condition (if it didn't need planting). Because your project site has similar conditions to the reference site, creating a list of trees that are present at a reference site can help select trees that will do well at your project site. It is important to also include early successional tree species that grow quickly and establish the site to provide habitat for mid- and later-successional tree species, such as trees that prefer shade and grow in the understory.

Studies have shown that native trees have co-evolved with native wildlife and better provide the food and shelter required for their survival—and native trees that are adapted to the local climate and soil conditions typically require less water, fertilizer and pruning. Native species should be prioritized for reforestation. Depending on your project goals and funding source, non-native, non-invasive species are considered for projects on a case-by-case basis with assistance from a forester or natural resource professional. Examples include sites where there is a need to replace ecosystem functionality where existing species are declining (ex: hemlock), and projects

considering novel disease- and pest-resistant genotypes of species that have been impacted by forest health issues (ex: American chestnut, ash). Unfortunately, some non-native species can become invasive—such as tree-of-heaven which rapidly invades native forests, crowds out natural vegetation and wildlife, and serves as preferred habitat for the spotted lanternfly. Non-native species can also carry forest pests and pathogens that can harm native tree species. If you are considering planting non-native species, make sure they are not listed on the New York State prohibited and regulated plants list.

Some planting projects may have a goal of expanding the range of a species or increasing its population within its range for future climate resilience purposes. This is an emerging and developing strategy and consultation with an expert is advised before choosing this approach. There are some species with information available for you to consider their current and future potential habitat under a warming climate and changing conditions. Tools you can use to inform purchasing trees with these considerations include:

- The USDA Forest Service Climate Change Tree Atlas web tool Eastern Seed Zone Data Viewer
- Seedlot Selection Tool
- Assisted Migration as a Climate Change Adaptation Strategy for Conservation, a report by The Nature Conservancy – January, 2024.

There are many useful guides to help you in your selection of tree species for your site, including:

- Collaborative Reforestation Species List for New York State
- Northeastern Tree Planting & Reforestation, Cornell Cooperative Extension, 2009. *This guide has an easy-to-use Tree Selection Chart (page 34) that identifies species by site conditions and landowner goals.*
- NY Flora Atlas
- Ecoregions of NY
- USDA PLANTS Database
- Tree Atlas
- A national list of native plant nurseries can be found online in the National Nursery and Seed Directory. Your local Partnership in Regional Invasive Species Management (PRISM) may also have a list of local native plant sources. Nurseries will also have recommendations.

B. Spacing

How many trees to plant will vary based on the species you choose, your project goals, the type of plant material used (see the Plant Material Type Chart on page 14), the density of existing trees on

the site, and any planting density requirements specified by the funding source. One strategy is to mimic the spacing of trees on a reference site. If your goals are for a more park-like or savannah-style, your spacing will be much wider to allow for space underneath the trees at maturity, up to 20 feet x 20 feet or even 40 feet x 40 feet spacing. Riparian projects are typically 12 feet x 15 feet spacing, or approximately 250 trees.

Reforestation projects should seek to create canopy closure at tree maturity, or create a forest ecosystem. This requires much denser spacing, especially when planting bareroot or container trees less than 3-feet tall. To ensure maintenance can occur during the establishment period (three years after planting), a density of 500 trees per acre, or approximately 9 feet x 9 feet spacing, is recommended. This is to achieve a specific density after establishment, assuming survivorship is approximately 65% to 70% of the original planting density. The objective for reforestation projects is to achieve a fully stocked stand, with a minimum of 365 trees per acres to occupy available growing space, achieve crown closure, and have an approximate mean diameter of 3 to 4 inches within 20 to 30 years. The target objective is generally based on 'C-level' stocking from the Silvicultural Guide for Northern Hardwoods in NE.

Planning Step 4: Establish Your Maintenance and Monitoring Schedule

The tree is in the ground—now what? Planting trees is the fun part, and proper maintenance will ensure your project has a high rate of success. A maintenance and monitoring schedule (see Maintenance and Monitoring section below for more information) should be included in your planting plan to help account for the capacity needed and costs associated with the project after the planting is complete. One resource to consult when developing your maintenance plans is Northeastern Tree Planting & Reforestation, Cornell Cooperative Extension, 2009. You can also find information in Section 3 of this guide that will help inform the maintenance and monitoring section of your plan.

Implementation

Implementation Step 1: What To Look for at a Nursery

Selecting the species to plant is an important part of the planning phase. Sourcing trees is the first step in implementing your project. Typically, a propagation cycle at a nursery requires 18 months to 4 years to grow a seedling. For larger projects, especially if requiring less common species, it is recommended to reserve trees 18 months or more in advance of planting. Below are some factors to consider when purchasing your trees.

A. Locally-Adapted Plants

Ask the nursery for the seed source or parent source (provenance) of the trees you are interested in buying to help determine if they will be suitable for the project location. When possible, use trees that are sourced from locations that are close to the project site and/or areas with similar conditions as the project site. For some additional guidance on seed sourcing, see Seed Sourcing for Reforestation in an Era of Climate Change. Seed zones can also be viewed online on the Ecoregional Revegetation Application.

Avoid using plant cultivars for the project. Cultivars are plants that have been bred for certain characteristics. The way that cultivars are bred and produced typically makes them less genetically diverse and less able to tolerate local conditions than locally-sourced plants. When possible, avoid using plants that are all clones of one another. This can lower the plants' resistance to issues like pests and disease.

B. Plant Health

Before purchasing plants from a nursery, ask the nursery what practices it uses to control the spread of insects and disease. When possible, carefully inspect the plants' health before purchasing or accepting delivery of your trees. Some things to check for include:

- Plants should have healthy leaves and stems without obvious signs of disease
  - Leaves should only be present on trees with soil around the roots (bareroot should be leafless and dormant)
- Typically, the plant's top should not be pruned immediately prior to sale
- Plants in containers should maintain a firm ball of soil when they are removed from the container
  - Roots should be throughout the container—not only at the top, bottom or one side
  - Roots should not be compacted or woody
  - Roots should have white tips
  - Ideally, roots are not coming out of the drainage holes in the bottom of the container
- Roots should not circle (if they do, these will need correcting before planting using pruners)
- Roots should not be swept to one side and growing in a "J" shape
- Conifer trees should have dormant buds and secondary needles

Also look for signs of invasive pests, including the following:

- Obvious signs of insect infestations such as insects on stems or rotten/missing buds
- Presence of woolly masses on conifer trees
- Worm castings or other evidence of jumping worms in soil or mulch
- Signs of cankers, peeling bark or other indications of insects or disease

Additional things to look for can be found within the American Standard for Nursery Stock by the American Nursery and Landscape Association. A good guide to nursery sanitation practices can be found in this Oregon State University Extension Service publication, "Preventing Phytophthora Infestations In Restoration Nurseries: A Key to Protecting Wildland Plant Communities." (While the publication focuses on the control of phytophthora, the basic sanitation practices are applicable to all nurseries.)

C. Plant Material Options

Depending on what trees are on your planting list, there may be many different options for purchasing trees. Some things to consider when selecting which type to use are shown in the chart below (adapted from Dorner 2002).

Plant Material Type	Advantages	Disadvantages
Bare-Root A plant without any soil around the roots. Wide range of heights (6 inches to over 5 feet). Common reforestation plant material type.	• Inexpensive • Easy to transport to and at the site • Roots have not been restricted by containers	• Requires proper storage and care so roots do not dry out before planting • Can have lower survival rate than containerized plants • Can have a low survival rate in warm, dry, and/or sunny sites • Planting limited to fall/early spring
Container Plants and soil are held in a container with drainage holes. Containers vary in size and shape and may be used for a wide variety of plants.	• High survival rates, even in excessively dry or wet soils and areas with disturbance, flooding, or weedy plants • Plants establish quickly • Can be used for larger plants • Can purchase and plant year-round	• More expensive than bareroot, especially for large projects with many plants • Requires more logistics to transport to and at site • Larger plants and trees may experience some shock after planting
Liners/Plugs Small plants (<18 inches tall) with some roots and soil. Liners and plugs are often used for herbaceous plants and grasses.	• Less expensive than plants in containers • Fairly high survival rate • Easy to plant	• Will take time to establish • Plants will require more initial maintenance (ex: watering) than those planted from a container
Cuttings/Livestakes A piece of branch or root from a tree or shrub. This method is limited to certain species such as willows, cottonwood, and dogwoods.	• Inexpensive • Easy to transport to and at the site • Easy to plant	• Lower survival rate (no roots) • Takes time for tree to establish • Requires proper storage and care to ensure cuttings do not dry out before planting • Planting limited to fall/early spring • Only specific species can be planted by cuttings/livestakes
Balled & Burlap A tree that has the roots and soil wrapped in a protective material, such as burlap	• High survival rate • Can be used for large projects • Good for community park projects or screening	• Most expensive option • Difficult to transport to and at site • Require more involved planting protocols

Implementation Step 2: Site Preparation

Site preparation may be needed in some areas prior to planting, like in areas that have a high amount of soil erosion or runoff, compacted soils, invasive species or contaminated soils. Where possible, keep soil disturbance and site preparation to a minimum to avoid disturbing any native plants that are already in the area, prevent additional invasive species introductions, and maintain the site's natural conditions. This is especially necessary for areas at high elevations and areas that have highly-acidic or highly-basic soils. If site preparation is needed, plantings should begin soon after the site is disturbed—so make sure that site preparation timing aligns with planting season!

If site preparation is needed, the following are some general things to consider:

- In natural areas, leave rocks, logs, brush, stumps and other vegetative material where possible as these may provide benefits to wildlife.
- In general, avoid using fertilizers at the site, as they encourage plants to grow leaves rather than establish roots, which can reduce long-term survival. An exception may be planting in urban settings or in areas with extremely poor soil quality.
- Do not conduct activities that will alter the hydrology of a wetland or stream—or cause sedimentation to nearby areas. Follow all state and local erosion and sediment laws and obtain all required permits.
- If soils need to be moved, know where underground utilities are located, as they could be damaged or pose a hazard to you as you dig (call 8-1-1 or visit digsafelynewyork.com for more information). See more on soil movement below.
- Only operate heavy equipment at sites in dry conditions and use smaller equipment where possible to limit soil compaction. For safety and to limit erosion, do not operate equipment on steep slopes.
- Additional considerations are described in more detail below.
- Determine the type of tree protection to be used. If fencing is used, it is easier to install during the site preparation phase.

A. Removing or Avoiding Invasive Species

Remove or avoid any invasive species near or at the site to prevent spreading them into the project area—and to ensure they do not impede the growth of newly planted trees. It is best to remove or control any invasive plants at the site before planting efforts are conducted. Best management practices (BMP) for removal or treatment of many invasive plants can be obtained by contacting your local Partnership for Regional Invasive Species Management (PRISM). The Adirondack PRISM has an easy-to-follow BMP guide that covers most common invasive plants across New York. If you are not able to remove the plants, mark off and avoid the area to prevent accidental movement of seeds and other plant parts.

B. Soil Compaction

If soils at the site are compacted, the soil may need to be loosened before planting to allow water to be absorbed and roots to grow. Some methods that can be used to help loosen the soil include disking, tilling, raking, trenching, skidding, plowing and scarification.

C. Topsoil Replacement

If the top 8 to 10 inches of soil have been removed from the site by erosion or other means, additional topsoil may need to be added to the site. If new soils are being brought to a site, you should visit the location the soil is taken from to ensure it is free of invasive plants and/or competing species. Moving even small amounts of contaminated topsoil on equipment—such as in tire treads—can transport eggs, seeds or fragments of invasive species to a new area. Invasive species are difficult and costly to eradicate once introduced. It is especially important to inspect the replacement soil to make sure it is free of jumping worms and cocoons. If you cannot confirm the source is jumping worm-free, avoid using this source of soil. Once jumping worms are introduced to a site they cannot be eradicated. Follow these simple BMPs for the Movement of Topsoil and Fill created by the Adirondack PRISM when moving soil to or at your planning site.

The site the top soil originates from should have similar characteristics to your project site, when possible—and try to avoid talking soil from another undisturbed natural area.

D. Soil pH

If a site's soil pH has been altered from its natural levels, it may need to be addressed before planting if native plants cannot survive in the area and/or if the goal is for the site to return to its natural conditions. To help address soil pH, amendments may need to be added to change the soil's pH. If the soil pH does not allow natural planting due to contamination, lime can be added to make the soil less acidic or sulfur can be added to make the soil more acidic. However, if high amounts of sulfur or lime are needed to correct the pH, the soil may become too salty for native plants to survive. In this case, the site may need to be planted with a temporary cover plant such as rye or wheat grass to hold the soil in place until it is able to support native plants.

Implementation Step 3: When to Plant

Plant as soon as possible following any site preparations. The best time for planting is during the spring or fall while trees are dormant and there is still some moisture in the soil, but before or after there is a danger of frost. Planting during the spring and fall avoids the heat and direct sunlight of the summer, which can dry out young plants.

In general, you will have a higher success rate if you plant in the spring, particularly with bareroot stock. This is especially true for areas that have been disturbed or have excessively dry or wet soils, flooding, or weedy plants—and areas that have longer winters or early freezes. In addition, some species have been documented as having low survival rates following fall planting including the following species:

- Beech (Fagus)
- Birch (Betula)
- Dogwoods (Cornus)
- Fir (Abies)
- Hawthorn (Crataegus)
- Hemlock (Tsuga canadensis)
- Hop hornbeam (Ostrya virginiana)
- Hornbeam (Carpinus)
- Mountain ash (Sorbus)
- Some oak species (Quercus)
- Red maple (Acer rubrum)
- Sassafras (Sassafras albidium)
- Sweet Gum (Liquidambar)
- Tulip tree (Liriodendron tulipifera)
- Tupelo (Nyssa)
- Conifers

For planting in the fall, chose a time when soil temperatures should remain at or above approximately 42°F for one month after planting. More specific timing for plantings will depend on the site's temperatures and soil moisture levels, which will vary by location, elevation, aspect and snow accumulation. Choose a day with moderate temperatures, sunlight and other weather conditions to plant. Planting on a rainy day is beneficial to plants as it helps prevent them from drying out.

Implementation Step 4: Planting Practical Tips

Now that you have done the planning and site preparation work, follow these planting tips to help ensure the survival of the trees you plant.

A. Planting Labor

It is recommended to use a professional crew (contractor) for planting projects, particularly when they are larger projects (over an acre). It is a more expensive option, but funding typically covers the cost of hiring a professional crew, and it is the fastest and most effective method for planting. Utilizing professional crews often increases the overall success of plantings. A crew is typically made up of a project manager, a foreman and/or crew leader, and a crew. A crew member can plant up to 1,000 trees a day by hand, and the foreman are providing oversight to ensure proper planting.

Recruiting local volunteers is a great way to engage your community when planting trees—and it can be cost-effective. But it can be time consuming, and it is not recommended to coordinate volunteer plantings on projects over one acre in size. If utilizing volunteers, use containerized stock to increase survivorship of trees (it is easier for a volunteer to plant a container tree than a bareroot tree).

Individuals can plant trees on their own properties. This is the most cost-effective option and requires the least amount of oversight. However, it can take much longer to plant a project, depending on the size. Consulting with a local natural resource professional on proper techniques is recommended.

B. Plant Care

The following tips should be followed before and during planting:

- Keep plants cool and moist until they are planted.
  - Keep plants out of direct sunlight.
  - Cover plants with a blanket or tarp if they are being moved in the back of a truck.

    - Have the planting locations and equipment ready to go before bringing plants to the site.
    - Leave plants in bags, containers or other storage material until they are being planted.
- Remove any containers and wrappings before planting.
- Cut off any broken, dead or circling roots and spread the roots out.
- Make planting holes twice as wide and as deep as the plant's root for liners/plugs, containerized, and balled-in-burlap plants.
    - Planting holes for bareroot stock should be a minimum of 1 foot x 1 foot. If using larger bareroot stock, the hole should increase based on the size of the root mass (avoiding bending roots).
- Loosen the sides of the planting hole before putting the plant in.
- Be sure roots are in their natural shape in the planting hole and are not squished to fit in the hole (ex: bottom of roots should not form a "J" shape).
- Do not bury the plant's stem; maintain the original soil level of the stem. The soil line should be at the root flare, which is located below where the main stem typically changes color.
- Create a small berm of soil around the planting hole to help hold and direct water to the plant's roots.
- If containerized, water plants after planting when possible. If bareroot, and you are in a drought (ex. no rain event for 2+ weeks after planting), it is recommended to water after the trees begin leafing out. For bareroot, water with ~1 gallon of water. For containers, water with ~3 to 5 gallons of water (depending on tree size).
- If mulch is being used, mulch around the base of the plant. Do not put mulch in direct contact with the stem of the plant as this can lead to decay. See more below on mulch.
- If staking, tubing and/or netting will be used to help protect the plant against rodents, deer, wind or other factors, put these in place after planting.

Additional information and guidance for planting and maintenance of seedlings can be found in the New York State Department of Environmental Conservation's Planting and Caring for Your Seedlings guide.

C. Avoiding Inadvertent Movement of Invasive Species

Moving even small amounts of soil on equipment like shovels, boots and tire treads can transport invasive species to a new area. Make sure that any planting equipment brought to the site has been thoroughly cleaned before arriving at the planting location.

If there are already invasive species present on the site, clearly mark these areas. Start planting in the section of the property that is least invaded and work toward the more invaded location. Clean equipment when moving between invaded and non-invaded areas. Otherwise, you may hasten the spread of the invasive species and impede the survival rate of your planting. Ensure staff and equipment operators are informed about the importance of preventing the spread of invasive species before planting begins. See the Ontario Invasive Plant Council's guide for equipment inspection and cleaning for additional guidance and information about proper equipment practices.

D. Mulch

Mulch can help prevent soil erosion at the site, reduce weed growth, keep soils moist and reduce frost-heaving. If you're planning to use mulch at your site, purchase weed-free certified mulch or visit the area the mulch will be taken from to make sure there are no invasive plants or animals that could be introduced to your site. Mulch is best applied in the spring, so it can breakdown prior to winter (decreasing vole habitat).

One important consideration when moving mulch, compost or shredded leaves is to confirm that measures have been taken to reduce the spread of jumping worms. Inspect the mulch or compost to make sure it is free of jumping worms and cocoons. If you cannot confirm the source is jumping worm-free, only purchase mulch or compost that has been heated to appropriate temperatures and duration following protocols for reducing pathogens (104 to 130°F for three days is sufficient).

Do not use inorganic mulches like plastics for natural areas as these are difficult to remove and do not naturally decompose into the soil over time. If mulch is being placed around plants, it should not be piled up against the stems or trunks, as this can lead to tree stem decay. Some additional information on types of mulch and applications can be found in the table below (adapted from Salon and Miller, 2012).

Mulch Type	Notes
Wood chips or shavings	• Only use around larger plants • Do not incorporate into the soil • Resistant to being blown by wind
Gravel, crushed stone or slag	• Only use around large woody plants
Shredded leaves	• Inexpensive • Can prevent water penetration into the soil • Can easily transport invasive jumping worms
Pine needles	• Only use for plants that prefer a low pH • Inexpensive • Typically free of invasive species • Resistant to being blown by wind
Buckwheat or coconut fiber	• Designed to tolerate higher velocity waterflow • May be blown easily by wind if not held in place with netting
Sawdust	• Only use around larger plants that prefer a low pH • Do not incorporate into the soil • Does not need to be anchored to the soil

Grass hay or cereal grain straw	• Best and most common mulch for seeding • May need to anchor to the soil in windy areas unless kept moist • Straw is less likely than hay to have invasive species—unless you are sure your source of hay does not have invasive species, avoid using it
Wood excelsior	• Excellent for seed establishment • May need to anchor to the soil in windy areas unless kept moist
Cornstalks	• Do not need to anchor to the soil • Typically free of invasive species

Implementation Step 5: Track Your Trees

Governor Kathy Hochul launched the 25 Million Trees Initiative in 2024 to highlight the importance of trees and forests for climate resilience and community health. New York State aims to plant 25 million trees by 2033 to meet climate goals, support reforestation projects, track progress with technology, and engage future environmental stewards. As part of this initiative, an online tree tracker and public resource is available. Add your planted trees to the tracker and view where other trees are being planted. All New York planting projects should be reflected in this tracker to illustrate progress.

Maintenance and Monitoring

Maintenance and Monitoring Step 1: Care for Your Trees

Reforestation projects that involve planting require maintenance. Regular maintenance might include twice a year mowing, watering plants, weeding around plants, and adjusting staking, tubing and/or fencing. These maintenance protocols will ensure a higher survival rate for your project. While maintaining your trees, you should monitor for pest pressure, such as vole damage around the base of the tree, branches growing out of the sides of the tubes, deer browse and rub, and bird nests inside of tubes. There are maintenance methods for decreasing these pressures, and identifying them during maintenance and monitoring will be key to success. Check your new plants a few weeks after planting to see if there are any immediate problems you need to address.

The need to water your new trees will depend on your site conditions and availability of water sources. Keeping track of rainfall after planting and checking on your trees will help you determine if water is needed. Similarly, site conditions will dictate whether you need to weed around your new trees. Using mulch can help reduce the amount of watering and weeding that is needed throughout the year.

If your maintenance plan involves mowing, be sure to follow best management practices to avoid the spread of invasive species. This includes cleaning all equipment before and after working at the site—and, if invasive species are present, working from the least invaded portion of the property to the most invaded. Also, time your mowing before seeds set on invasive plants to help control future spread.

Continue to monitor plants for several years after planting and continue any maintenance. NYSDEC

has a helpful guide for inspecting and taking care of newly planted trees: see this tree care checklist. In addition, remove stakes after 1 year to prevent any harm to a tree's trunk. Remove tree tubing once a tree has a trunk diameter of 2 inches and when the tree is tall enough to be out of reach from deer. Northeastern Tree Planting & Reforestation, Cornell Cooperative Extension, 2009, is another great resource for practical tips for ensuring the survival of your newly planted trees.

Maintenance and Monitoring Step 2: Monitor Progress

After planting, begin monitoring tree survival. Monitoring for survival and health in natural areas typically is done for five years after planting. Some items that should be monitored include the following:

- Number of trees that have survived
- Composition of species that have survived
- Surviving tree health
- Potential causes of tree decline or death
- Presence of invasive species

It is important to collect your monitoring data in a systematic way. Design your monitoring protocols and data-collection forms during the planning phase of your project to be sure you have sufficient funds to monitor and track results. Plantings up to an acre can easily be monitored through a complete census count. For larger plantings of one acre or more, it can be effective to observe a representative sample of the trees planted. Potential sampling programs may include: sampling 10% to 20% of the trees planted across a range of soil types, or sampling a minimum of 50 trees of each species planted. For more information on sampling and data analysis methods, see the United States Department of Transportation Federal Highway Administration's Roadside Revegetation Tech Monitoring Protocols Guide. In addition to collecting monitoring data, taking before and after photos can also be an effective tool to document and communicate the results of a project.

Maintenance and Monitoring Step 3: Evaluate and Document Results

Once you have collected monitoring data for several years, it is time to evaluate your project's success. Some evaluation considerations can be found in the chart below. Document your findings and conclusions in a report to inform and improve future efforts. Include the goals of your project, site preparation and planting methods, maintenance activities, monitoring results, and evaluation of successes and failures. What you learn is incredibly important for future planting projects and for advancing future climate mitigation efforts across New York.

Monitoring Data	Evaluation: Project Successful	Evaluation: Project Not Successful Next Steps
Number of trees growing versus the number planted Collect data on the number, species, and distribution of trees growing at the site (you can also record information on trees that died)	• All species planted are present at the site • High percentage of plants survived planting (at least 70%) • Not many large bare patches on the site by year two or three (having some bare patches is good for wildlife)	• Species were not a good choice for the site conditions • Maintenance was inadequate • Plants are being eaten by insects or animals Reassess the conditions of the site and/or large bare patches and augment with another planting.
General plant health Note the color of plant leaves and the presence of any obvious signs of insects, disease, or other stressors	• Plant leaves are green in the growing season with no signs of damage or disease (note, plants may appear yellow if mulch depleted the soil's nutrients)	• Species were not a good choice for the site conditions • Forest pests or pathogens may have invaded the area • If yellow leaves, mulch may not have been a good choice and/or may need more time to decompose Reassess the site conditions and augment with another planting of trees more suited to the site. Consider adding fertilizer if you suspect that mulching has depleted the soil's nutrients.
Weed and invasive species type and abundance Collect data on the presence and density, of invasive species and problematic weeds each year	• No invasive plants • No jumping worms • A decrease in the presence and density of invasive species and problematic weeds over time	• Site preparation (ex: invasive species removal) may have been inadequate • Planting practices and/or equipment may have brought in invasive species or problematic weed seed or plant parts Remove weeds using best management practices, especially if they are invasive species.

Conclusion

You've finished reading this guide, and now it's time to get outside and start planting! Natural climate solutions play a powerful role in mitigating climate change, and planting trees is an impactful way that you can make a difference. As a planting project matures into a forest, it will provide many co-benefits, including improved wildlife habitat, cleaner air and water, and a healthier environment for future generations to enjoy.

Thank you for following these recommended steps and for your interest in reforestation. Remember, this guide is meant to serve as a starting point—and it includes many reference documents and supporting resources to assist you in your reforestation and afforestation efforts.

If you have questions or would like additional information, please contact: **ReforestNY@tnc.org**

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