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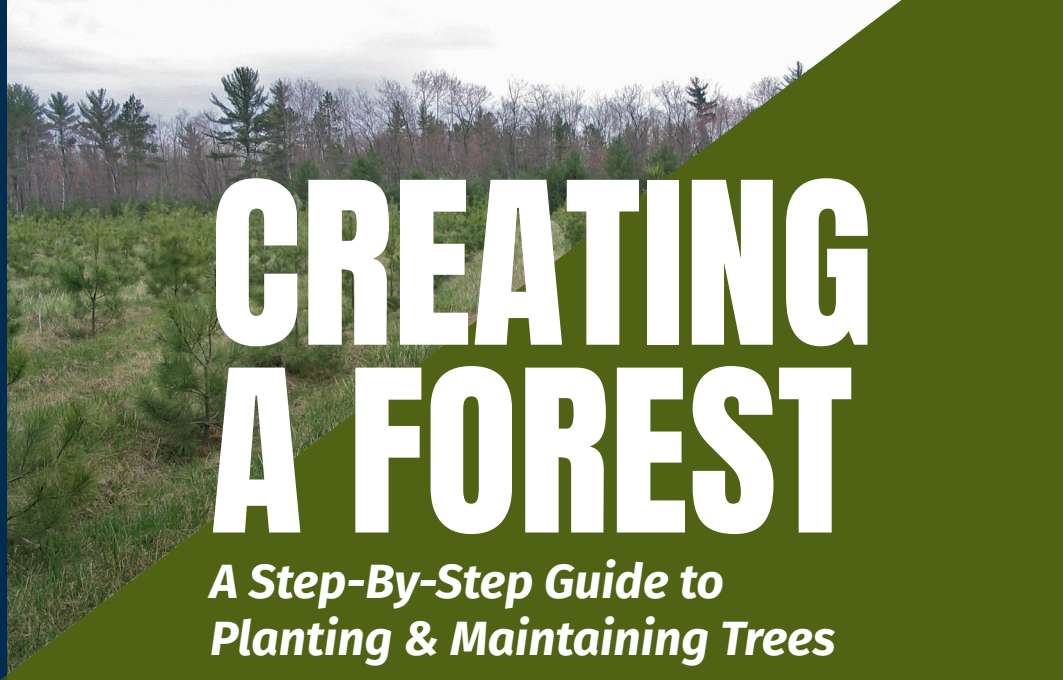

CREATING A FOREST

A Step-By-Step Guide to Planting & Maintaining Trees

This publication will take you through the steps needed for the successful establishment of a woodlot, starting with developing a plan for the site through tree planting and maintenance of the stand.

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A Step-By-Step Guide to
Planting & Maintaining Trees

CREATING A FOREST

Creating a forest begins long before and continues long after you plant your trees. This comprehensive guide to tree planting in Wisconsin covers these major areas: planning and designing your new forest, pre-planting seedling care, planting methods, and post-planting care and maintenance of your trees.

Although this publication covers the main issues you need to address when planting a forest, it is important to **consult with your local forester to assist with the details of a planting plan.**

https://dnr.wi.gov/fal/

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STEP 1:

PLANNING & DESIGN

Matching Uses and Goals to Tree Types

How and what to plant will depend, in part, on what the property will be used for. Therefore, it is important to develop a vision for your land and set goals to meet your particular interests and needs. For example, if you are a bird watcher, you could attract songbirds by planting fruit-bearing trees or species that provide attractive nesting habitat.
If you want privacy, you may want to plant a fast-growing species that will quickly become a natural screen. If you are counting on income from your land now or in the future, you may wish to choose a species valued for its timber.

Please refer to the species selection table (Refer to Table 2 – Tree and Shrub Species) for more ideas.

TABLE 1: GOALS AND DESIGN CONSIDERATIONS

From Wisconsin Forest Management Guidelines

I. TIMBER MANAGEMENT

- Match species with area market demands and opportunities
- Provide equipment access for thinning, pruning, and harvesting
- Include harvest roads and firebreaks
- Add species that will create natural regeneration opportunities
- Leave space around power lines, underground cables, and gas lines
- Avoid steep slopes and wet areas
- Provide closer spacing to improve saw timber quality

II. AESTHETICS

- Use a variety of species, including wildlife shrubs
- Use non-row plantings, curved rows, and irregular edges for a more natural effect
- Plant species with desirable fall color
- Leave openings or islands of various sizes and aged trees
- Retain landmarks and distinct features
- Create or retain scenic views
- Locate trails or roads to take advantage of scenic quality

III. WILDLIFE MANAGEMENT

- Enhance biological diversity and complement the habitat in the surrounding landscape
- Offer habitats that are locally short in supply
- Choose species that provide preferred food for desired wildlife
- Establish or expand travel corridors so they connect habitats
- Create irregular boundaries for more habitat options
- Enhance interior forest habitat by planting artificial openings, such as isolated fields
- Plant around existing “wolf” trees
- Leave frost pockets and odd corners unplanted to improve habitat variety
- Leave wildlife openings

IV. EROSION CONTROL

- Leave grass buffer zones near streams to help prevent erosion
- Plant trees along contours to help control runoff
- Leave drainage pathways covered in grass
- Concentrate trees in “problem” areas
- Plant tree species in riparian zones that have a long life expectancy
- Plant highly erodible upland fields to decrease runoff

Site Evaluation

After you have decided what you want your land to be, the next step in planning your forest is to evaluate the site. Every location will be different, and the chosen plants, planting methods, stand layout, and maintenance will all depend on a thorough assessment of the climate, soil type, existing vegetation, topography, location in the landscape, and conditions in surrounding forests.

Climate

Wisconsin's wide range of climatic conditions influences the distribution of tree species throughout the state. For example, the range of northern white cedar in Wisconsin is north and coastal east. Black walnut grows in the far southern part of the state. Species range maps can be found in tree identification books. The main factors influencing climate ranges include minimum winter temperatures, timing and amounts of precipitation, and timing of seasonal frosts.

Soils

Soil type will determine the amount of water and nutrients available to the trees. Soil types span a range from sand to loam to clay, and every combination in between. Sandy soils drain easily, and so tend to be dry and low in nutrients. Clay soils tend to be higher in nutrients but wet because they drain poorly. Loam soils are a combination of sand, silt, and clay. Their nutrient and water holding capacity varies, depending on the degree of clay, sand, and organic matter present. Most tree species are adapted to grow in specific soil conditions, so some will grow best in sandy soils while others prefer clay soils. County soil surveys and maps can give you an idea of what soils your land has, but can be fairly general. Detailed information on soil type and available nutrients can be obtained by having soil tested through UW–Madison's Division of Extension. Visit your local county office for more information on soil tests and to obtain bags for soil sampling.

Competing Vegetation

In any given area, there is a set amount of moisture, nutrients, and light available for plant growth. Existing vegetation can compete with your new plantings for these essentials. It can also harbor insects and diseases that may spread to the new trees. Look carefully both at the vegetation that is already present on the site and at what may grow as your trees establish themselves. Eliminating problem vegetation or seed sources early can avoid larger problems once trees are planted. If you are planting in an open area, you may need to mow between the trees to control the competing vegetation for the first few years. For example, alfalfa is common in old agricultural fields and will re-sprout for several seasons. If you are planting in an established forest, the seedlings may face competition for light from larger trees. If you do not wish to remove any existing trees, you will need to plant shade-tolerant species.

Topography

Topographic factors that may influence where and what to plant include elevation, slope, aspect (which direction the slope is facing), and drainage. In addition to actual elevation, spot changes in the landscape such as frost pockets must also be considered. Frost pockets are low-lying areas, hollows, and drainage bottoms where cold air can pool. Some species, like black walnut, are vulnerable to frosts that occur in these areas.

Site direction, or aspect, affects temperature, sunlight, and moisture levels. For example, a north-facing slope tends to get less direct sunlight, and so has cooler temperatures and less evaporation. This means that there will also be more moisture in the soil available to support growth. Slope and drainage affect whether the water moves off the site or pools. Pooling water can slow tree growth in many species. Topography can also restrict the types of equipment used when preparing a site, and may limit you to hand planting only.

Location in the Landscape

Take a look at the landscape around your planting site. What is growing near your site might be an indicator of what grows best in the area. For example, if the site is bordered by tamarack and black spruce, which do well in wet areas, jack pine probably isn't the best choice for your stand because it prefers well-drained soil. You can also use the neighboring landscape to encourage trees that may be declining. For example, if you have old, large oaks, but most of the smaller trees are maples, you may want to plant oaks to keep them as part of your woods. If you live in an area with smaller parcels of disconnected woodlands, you may want to plant an old field to connect two smaller parcels. This will act as a corridor for wildlife to travel between these smaller woodlots.

Forest Pests

Pests such as insects, diseases, and animals may negatively impact the success of your planting. Be aware of what insect and disease problems are present in your area. You will probably want to avoid planting large quantities of the species preferred by those particular pests. For example, if oak wilt is a concern in your area, you would do best to avoid planting oaks in the red oak group (black, northern red, northern pin, and others with pointed leaf edges). These are more susceptible than white oaks to the disease.

Deer and rodents are the biggest culprits in the animal pest category. Deer may damage new tree plantings, mainly by feeding on buds and leaves. Erecting physical barriers such as fencing and tree shelters is one way to deter deer. Rodents will also damage trees, but controlling competing vegetation can reduce their impact by removing potential nesting sites. **Refer to page 20 for more information on this topic.**

Selecting the Right Trees for Your Planting Plan

Selecting the right trees for your site will give your forest the best chance for growth and survival. **Table 2** provides some information on shrubs and trees commonly planted in Wisconsin. It lists species characteristics and can help narrow your choices based on your planting goals, climate change considerations, and site characteristics. The table is not a comprehensive tree reference, and landowners should consult a local forester for specific information and recommendations about establishing plantations in their particular areas.

Planting Design

Now, with your site evaluation in hand, you are ready to develop a planting design that meets your goals and is appropriate for the conditions found on your planting site. A local forester (**https://dnr.wi.gov/fal/**) can help with the specific details for the creation and management of your planting (see Table 1 for goal and design considerations).

Size, Shape, Location

A number of factors will determine the size and scale of your reforestation project. Acreage, existing land cover, available time, costs, and incentive programs will all factor in. Reforestation projects are often of a size that can be completed in a single planting season. However, in some cases, it may be beneficial to stagger a large reforestation project over time. In the short term, staggering the planting over several years can spread out up-front costs, labor, and risk (i.e., weather extremes such as drought). In the long term, staggered planting can spread out potential income (commonly done by Christmas tree growers) or create age diversity in the landscape.

The best-designed plantings are those that take existing natural landscape features into account. In most cases, a site visit and review of maps/aerial photos is essential in determining the optimum location and shape of your planting site. It can be as important to consider where not to plant trees as it is to consider where to plant them. Creative consideration of size, shape, and location can often meet multiple objectives in a single planting. An example of this is a planting designed for timber production that links two natural habitats together, creating an important travel corridor for wildlife.

Arrangement

Arrangement, or layout, refers to the pattern or distribution of species across a planting site (**see Figure 1** for example). The arrangement of species may be varied to suit the different soil and landscape conditions you may have found during your site evaluation. For example, black walnut could be planted on the rich soils of a lower slope, while oak could be planted near a ridge top. Consider planting species with similar growth rates next to each other or grouped so one species doesn't dominate another.

Spacing

Tree spacing will depend on the species you select, the product desired, the need for intermediate stand treatments, and cost. For example, common spacing for a red pine plantation for timber production in an open

TABLE 2
Trees and Shrubs Commonly Planted in Wisconsin

TREE SPECIES

TABLE 2 CONTINUED ON NEXT PAGE ➡

Red Oak

Where to Plant

Statewide; full sun

Soil Preference

Variety of types, but best on fertile, well-drained soils

Growth Rate & Size

Medium; 60–80 feet

Wildlife Value

Good cover and nesting sites; leaves and stems browsed and acorns eaten by various species

Economic Value

Wood used for construction and finish of houses, furniture including veneers, and fuel

Considerations

Prone to heavy deer browse when young; may require exclusionary fencing; susceptible to oak wilt

White Oak

Where to Plant

Southern half of state; prefers full sun, but tolerates some shade

Soil Preference

Variety of types, but best on fertile, well-drained soils

Growth Rate & Size

Medium; 60–80 feet

Wildlife Value

Good cover and nesting sites; leaves and stems browsed and acorns eaten by various species

Economic Value

Wood used for construction and finish of houses, furniture including veneers, and fuel

Considerations

Prone to deer browse when young

Swamp White Oak

Where to Plant

Southern half of state; full sun

Soil Preference

Variety of types, but best on fertile, well-drained soils

Growth Rate & Size

Medium; 60–80 feet

Wildlife Value

Good cover and nesting sites; leaves and stems browsed and acorns eaten by various species

Economic Value

Wood used for construction and finish of houses, furniture including veneers, and fuel

Considerations

Prone to deer browse when young

Bur Oak

Where to Plant

Statewide; full sun

Soil Preference

Moist, well-drained soils

Growth Rate & Size

Slow; 50–70 feet

Wildlife Value

Good cover and nesting sites; leaves and stems browsed and acorns eaten by various species

Economic Value

Wood used for heavy construction, railroad ties, finish of houses, furniture, and fuel

Considerations

Will survive on drought-prone sites

Black Walnut

Where to Plant

Southern third of state; full sun; susceptible to frost so avoid low, frost-prone areas

Soil Preference

Fertile, well-drained loams and silt loams

Growth Rate & Size

Medium; 60–100 feet

Wildlife Value

Nut meats preferred by squirrels and many birds

Economic Value

Wood highly valued for furniture and gun-stocks

Considerations

Grows well in pure stands, as roots emit chemical that can inhibit under-story plants and other trees

Sugar Maple

Where to Plant

Statewide; full sun to deep shade

Soil Preference

Fertile, moist, well-drained soils

Growth Rate & Size

Slow; 80–100 feet

Wildlife Value

Good cover and nesting cover; variety of birds eat seeds

Economic Value

Wood used for flooring, furniture, and fuel

Considerations

Susceptible to sun scalding when planted in open fields

Silver Maple

Where to Plant

Southern two-thirds of state; full sun

Soil Preference

Moist soils

Growth Rate & Size

Fast; 60–100 feet

Wildlife Value

Good cavity and nesting cover; variety of wildlife eat seeds, bark, and twigs

Economic Value

Wood occasionally used for flooring, furniture, and fuel

Considerations

Lowland species

TREE SPECIES, CONTINUED

White Birch

Where to Plant

Statewide; full sun

Soil Preference

Variety of types, but best on cool, well-drained soils

Growth Rate & Size

Fast; 50–70 feet

Wildlife Value

Good cover and food source for game birds, songbirds, and browse for deer

Economic Value

Wood used for pulp and paper; important for landscaping as ornamentals

Considerations

Important cultural species to many Native American tribes

Quaking & Bigtooth Aspen

Where to Plant

Statewide; full sun

Soil Preference

Variety of types, but best on fertile, well-drained soils

Growth Rate & Size

Fast; 40–80 feet

Wildlife Value

Good cover, especially when young; preferred browse for deer, buds for grouse

Economic Value

Wood used for pulp and paper, and some construction and finish of houses, furniture including veneers, and fuel

Black Cherry

Where to Plant

Southern half of state; prefers full sun, but tolerates some shade

Soil Preference

Variety of types, but best on fertile, well-drained soils

Growth Rate & Size

Medium; 40–70 feet

Wildlife Value

Fruit eaten by a variety of wildlife

Economic Value

Wood used for tool handles, furniture, and interior furnishing

Considerations

Susceptible to black knot fungus that causes gnarled, black cankers on tree; rarely causes mortality but will impact growth and development

Red Pine

Where to Plant

Statewide; full sun; susceptible to frost so avoid low, frost-prone areas

Soil Preference

Well-drained sandy to loamy sites

Growth Rate & Size

Medium; 80–90 feet

Wildlife Value

Young plantations provide good cover

Economic Value

Wood used for paper pulp, construction lumber, and poles

Considerations

Good for wind breaks and timber production

Northern White Cedar

Where to Plant

Statewide; full sun to partial shade

Soil Preference

Organic soils

Growth Rate & size

Medium; 50–60 feet

Wildlife Value

Cover and nesting sites

Economic Value

Wood especially important for rot-resistant lumber, posts, poles, and shingles

Considerations

Good stabilizer for stream banks, good for hedges and wind breaks; deer browsing can have a significant effect on plantation success

Jack Pine

Where to Plant

Southern two-thirds of state; full sun

Soil Preference

Sandy, dry soils

Growth Rate & size

Medium; 50–70 feet

Wildlife Value

Excellent cover for sandy sites; will tolerate moderate browsing

Economic Value

Wood primarily used for paper pulp

Considerations

Good frost tolerance; will stabilize sandy and wind-blown areas; will survive on drought-prone sites; good wildlife habitat species

White Spruce

Where to Plant

Statewide; full sun

Soil Preference

Moist, moderate to well-drained loams

Growth Rate & size

Medium; 60–80 feet

Wildlife Value

Nesting sites; seeds eaten by some songbirds

Economic Value

Wood primarily used for paper pulp, but also for lumber and general construction

Considerations

Optimal for screening and windbreaks

Black Spruce

Where to Plant

Northern half of state; full sun

Soil Preference

Wet, poorly drained soils

Growth Rate & size

Slow; 30–60 feet

Wildlife Value

Cover

Economic Value

Wood primarily used for paper pulp

Considerations

Lowland species

SHRUB SPECIES

White Pine

Where to Plant

Statewide; full sun to partial shade

Soil Preference

Variety of types, but best on well-drained sandy loams

Growth Rate & Size

Medium; 70–100 feet

Wildlife Value

Ideal winter cover and nesting for some birds

Economic Value

Wood used for matches, lumber, laths, and interior finishing

Considerations

Good for wind breaks, mixed species planting, and timber production

Redosier Dogwood

Where to Plant

Statewide; tolerates shade but best in full sun

Soil Preference

Wet to well-drained soils, but not dry soils

Growth Rate & Size

Fast; 8–10 feet

Wildlife Value

Fruit is preferred by a variety of species; stems are browsed by deer

Pollinator Value

Small white flowers; white berries

Considerations

Extremely winter-hardy; lowland species

Silky Dogwood

Where to Plant

Statewide; tolerates shade, but best in full sun

Soil Preference

Moist to well-drained soils

Growth Rate & Size

Fast; 8–10 feet

Wildlife Value

Fruit is preferred by a variety of species

Pollinator Value

Small white flowers; blue berries

Considerations

Extremely winter-hardy

Ninebark

Where to Plant

Statewide; full sun to shade

Soil Preference

Variety of types, does well on very dry soils

Growth Rate & Size

Medium; 6–10 feet

Wildlife Value

Excellent cover; grouse eat buds and songbirds eat seeds

Pollinator Value

Small white flowers; red fruit turns brown in fall

Considerations

Green cluster of seed capsules turn brown and open in fall

Tamarack

Where to Plant

Statewide; full sun

Soil Preference

Moist, organic soils and well-drained uplands

Growth Rate & size

Medium; 30–60 feet

Wildlife Value

Variety of birds eat seeds

Economic Value

Wood used for paper pulp, posts, poles, ties, and locally for lumber

Considerations

Good stabilizer for stream banks; lowland species

Wild Plum

Where to Plant

Southern part of state;

full sun

Soil Preference

Well-drained silt loam

Growth Rate & size

Fast; 12–18 feet

Wildlife Value

Excellent cover; stems and foliage browsed by deer

Pollinator Value

Dense clusters of aromatic white flowers; one-inch red-orange to blue fruit in August

Considerations

Spine-tipped twigs

American Hazelnut

Where to Plant

Statewide; full sun

Soil Preference

Variety of types; best on well drained loams

Growth Rate & size

Medium; 6–8 feet

Wildlife Value

Nuts are an excellent food source; catkins eaten by grouse

Pollinator Value

Tiny red flowers; edible nuts mature in late summer

Considerations

Optimal for screening and windbreaks

American Highbush Cranberry

Where to Plant

Statewide;
full sun to partial shade

Soil Preference

Well-drained to moist soils

Growth Rate & size

Medium; 10–12 feet

Wildlife Value

Fruit may not be palatable to most wildlife

Pollinator Value

Clusters of white flowers; bright orange-red fruit in September

Considerations

Fruits persist until spring

field would be 800–900 trees per acre. To grow high-quality hardwood trees, you would use close spacing to encourage straight trees with small lower branches that self-prune easily. In comparison, if the goal of your planting is to attract wildlife, you would space hardwoods farther apart to promote crown development and seed production. **Refer to Table 3** to determine number of trees to plant per acre based on spacing. Remember to include space for mowing and other maintenance.

Interplanting

Interplanting is the practice of planting seedlings by hand into an existing forest or planting. This practice supplements natural regeneration in plantations with areas of mortality or poor natural seedling growth following a harvest. Plant larger seedlings that will become established quickly and use weed control to help combat existing unwanted vegetation.

TABLE 3

Number of Trees per Acre by Spacing Between Rows and Between Trees (in feet)

	4'	5'	6'	7'	8'	9'	10'
4'	2,722						
5'	2,178	1,742					
6'	1,815	1,452	1,210				
7'	1,556	1,244	1,037	889			
8'	1,361	1,089	908	778	681		
9'	1,210	968	807	691	605	538	
10'	1,089	871	726	622	545	484	436
11'	907	726	605	518	454	403	363
12'	726	581	484	415	363	323	290

Figure 1
Planting Maps

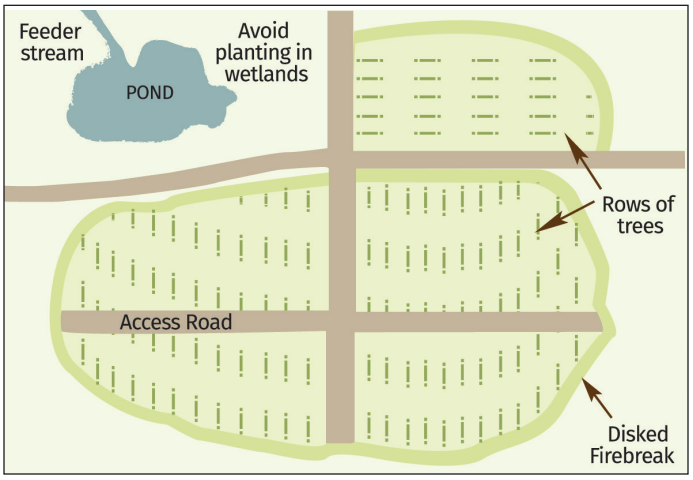

Figure 1a: Planting Map for Timber

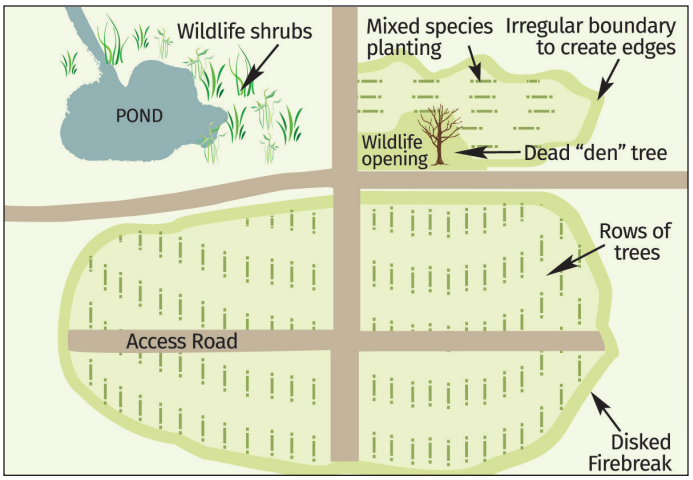

Figure 1b: Planting Map for Wildlife and Timber

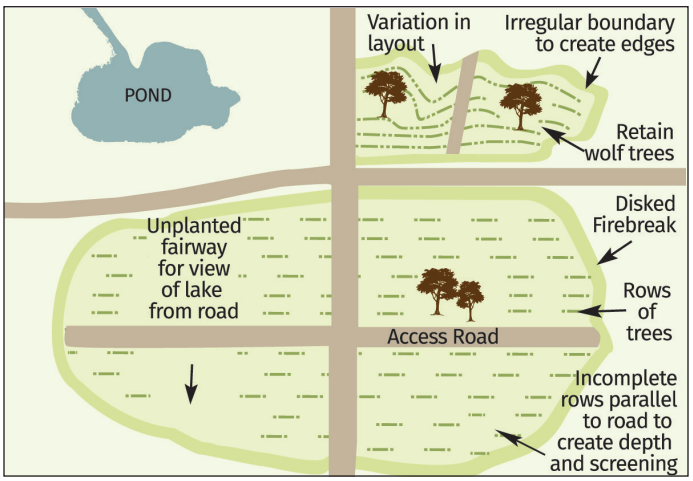

Figure 1c: Planting Map for Aesthetics and Timber

Reforestation Plan and Map

A written plan and map will clarify the details of your plantation and make any necessary modifications before planting. The plan will outline such details as the size of your planting area, number of trees, species, spacing, arrangement, site preparation and planting method, layout of roads and firebreaks, post-planting maintenance, and harvest procedures. A map will help you and others visualize how the plantation will look when complete.

Choosing Nursery Stock

Seed Source

Selecting nursery stock (i.e., the seedlings a nursery has in its inventory for sale) that was grown from a good seed source is a key consideration when ordering trees. Ideally, select stock grown from seed collected within the same region of the country that you are planting in. Local seed sources (e.g., Wisconsin) are the most appropriate. Seedlings grown from seed collected in the same region will be adapted to the weather conditions found in that area. These trees may also have developed some natural resistance to certain insect and disease problems.

Stock Type

While reviewing nursery catalogs, you will find code numbers for nursery stock types. Stock is identified with a two-number code indicating its age and growth history in the nursery. The first number indicates the time the seedling was grown in its original seedbed, and the second number indicates the time (if any) the seedling grew in a transplant bed. Therefore, a designation of 2-0 means a two-year-old seedling that has never been transplanted or moved within the nursery fields. A 2-1 seedling is three years old, grew in the original seedbed for two years and was then moved to another bed for one year. Transplanting a seedling in the nursery provides the tree more room to grow and will result in a larger plant. Since transplants are larger, they are well-suited for planting on harsh, difficult-to-establish sites. Transplants are generally more expensive than smaller 2-0 or 3-0 seedlings.

Many nurseries now offer “plug plus” seedlings (they are identified as “plug+1”). These seedlings were started in a greenhouse and then transplanted into the nursery fields for one or more growing seasons.

Direct Seeding

Another possible planting option to consider is direct seeding on your land. This is a relatively new concept that in certain situations has resulted in successful establishment of trees. Instead of planting trees, you are planting the tree seed directly into the field. Additional information on this practice can be obtained from your local DNR forester.

Bare Root vs. Container Stock

Seedlings packed and shipped bare root are the most common in Wisconsin. These seedlings are lifted from the nursery fields and packed without any soil around the roots. Bare root seedlings need to be moved from the nursery to the planting site while still dormant in order to minimize transplant shock. In Wisconsin, the optimum time to move bare root plants is from early April to mid-May.

Container, or potted, seedlings are raised in greenhouses. They are shipped in containers (to be removed before planting) with soil surrounding the root system like any potted plant. This allows the trees to be planted later in the growing season with less transplant shock. These seedlings are usually more expensive than bare root stock and are usually planted by hand.

Ordering Stock

Ordering trees well in advance (four to six months before the planting season) will provide the best chance of obtaining the species and quantities desired. In Wisconsin, you can either order from the state nurseries operated by the Department of Natural Resources or from a private nursery. The state nurseries begin accepting orders on the first Monday in October each year. Private nurseries offer variable ordering dates and should be contacted for details. The Wisconsin DNR Reforestation Program website provides a list of private nurseries in Wisconsin that offer reforestation stock.

https://dnr.wisconsin.gov/topic/treeplanting/nurseries

CHECKLIST
Planning and Design

GOALS FOR THE PLANTATION

- ☐ Identified long-term goals (i.e., what I want from mature trees)
- ☐ Identified short-term goals (i.e., how I will use the land while trees grow)

SITE CHARACTERISTICS

- ☐ Identified soil type
- ☐ Identified more appropriate tree species to plant
- ☐ Identified diseases and insects of concern
- ☐ Identified climate considerations

SPECIES SELECTION AND GOALS

- ☐ Identified species that are suited to the site and meet my goals

PLANTATION LAYOUT

- ☐ Created a plantation map
- ☐ Included access points, trails, and appropriate spacing
- ☐ Created wildlife openings (Note: only if this is part of your goals)

ORDERING STOCK

- ☐ Identified appropriate stock for my site
- ☐ Identified seed from the same region or growing zone

STEP 2:

PLANTING

Site Preparation

Preparing a site for planting is an often overlooked, yet important, part of establishing a successful plantation. A few simple steps can make the difference between a healthy planting and one where trees struggle to survive. The main objective in site preparation is weed control. Controlling weeds allows trees to become established without competition for water, sunlight, and nutrients.

To determine the most effective and cost-efficient method of site preparation, the landowner should consider soil type, existing vegetation type and density, and time and financial constraints. There are two main site preparation methods used prior to tree planting: mechanical and chemical. These methods can be used separately or together. Also, mechanical site preparation uses various types of machinery and tools to prepare the planting site. Chemical site preparation uses commercially produced herbicides. Contact your local forester for a recommendation on appropriate site preparation method for your land.

Mechanical

Mechanical site preparation uses plowing, disking, chopping, crushing, furrowing, or other approaches to reduce vegetation. It can be used to disturb the planting rows or the entire planting area. Mechanical preparation is preferred on "light" soils with few weeds. You can reduce the height of competing plants (mow or crush), scrape away the vegetation on the surface (scarification), or simply plow the vegetation to destroy the roots.

There are some downsides to using mechanical control. Heavy machinery will compact the soil, which makes it difficult for tree roots to grow. Also, mechanical preparation exposes more soil to the air, which increases the chance of erosion. Finally, mechanical techniques usually provide only short-term relief from competing vegetation, which means more treatments over time.

Chemical

Chemical treatments are more thorough and use less labor than most mechanical techniques. This site preparation method uses herbicides to reduce current weed populations and can impede future weed growth. However, chemical site preparation also has drawbacks. Environmental impacts can occur from improper storage, application, and disposal of herbicides. Chemical treatments are dramatically affected

Good site preparation will enhance seedling survival.

by weather conditions, soil texture, and the stage of weed development. Proper application requires specific equipment and knowledge of application rates, and all herbicides must be applied in accordance with label recommendations and their registered use. This can be challenging, especially for the inexperienced, and may require professional assistance.

Other Methods

Additional site preparation techniques include prescribed burning and use of cover crops. Both are best used in combination with chemical and mechanical methods, as neither is as effective alone.

With prescribed, or controlled, burning the competing vegetation is only slightly affected for a short time. The resulting regrowth is usually heavier than the original vegetative cover, so use of a chemical following a burn is recommended. Prescribed burning appeals to many landowners, but it can be dangerous. It must be carefully planned, weather conditions must be right, and it requires the appropriate equipment and training.

Cover crops can provide erosion control, suppress weed growth, and help retain soil moisture. It is important to select a cover crop that will inhibit weeds but not compete with seedling growth. Common choices are winter wheat, winter rye, oats, and white clover. Cover crops are most easily planted in former agricultural fields due to the equipment used to seed the crop and the flat nature of the terrain. However, if a planting area is small, rocky, or has rough topography, cover crops can be planted by broadcast seeding or with smaller, specialized equipment. It is strongly recommended to band spray (i.e., apply the spray in bands centered on the row) the seedling rows with an herbicide if planting a cover crop or the cover crop itself will compete with the seedlings.

Some cover crops may attract deer, which can increase seedling losses through browsing. They may also provide cover and nesting areas for small rodents, so limit the use of cover crops if mice and voles are a concern. Your local forester can help you determine which techniques work well in your area and how best to prepare your site for trees.

Caring for Seedlings Before Planting

Careful handling of tree seedlings from the nursery to the planting site is a critical component of a successful reforestation effort. Seedlings are living organisms and they require certain conditions in order to maintain good health and vigor. Proper care and handling can protect your investment and ensure that your forest plantation has the best start possible.

Three key points to remember when caring for your tree seedlings:

1. Keep trees cool with an ideal storage temperature of 34–36° F
2. Keep trees at humidity levels between 90% and 95%
3. Keep trees free from physical damage

If you maintain the trees under these conditions, you have taken a major step toward planting success.

Transporting

The ideal method of transporting seedlings is under refrigeration, between 34° and 36° F. If refrigerated trucking is not available, there are other ways to minimize overheating of the seedlings. If you are using a pickup truck for transporting your trees, place a layer of foam insulation on the bed of the truck to prevent heat from the exhaust system from reaching the packaged stock. Covering the load with a solar reflective tarp can greatly reduce solar heat. If possible, pick up your trees early or late in the day when temperatures are most likely to be cooler. If you need to stop for any length of time with the load of trees, park in a shaded location. Also, leave air gaps between the packages to allow air movement and reduce heat buildup.

Storage and Handling of Seedlings

It is best to plant seedlings within a day or two of when you receive them. When storing the seedlings either short-term (< 3 days) or long-term (4–7 days), keep the seedlings as cool as possible, but not frozen. Refrigerated storage is ideal. If refrigerated storage isn't available, a good alternative is a root cellar. If nighttime temperatures are cool, a barn or shed floor will keep the trees at acceptable temperatures. Metal pole sheds can heat significantly on sunny days and may not be a good storage area.

Bare root nursery stock will often require sorting prior to planting. This is the case in ungraded orders, where weak and damaged seedlings should be removed. Sorting should be done in a sheltered location out of the sun and wind. Keep the trees moist throughout the sorting process. If the root system of the seedlings is too large to plant properly, some root pruning may be needed. Prune the roots using a sharp implement such as large scissors, pruning shears, or a machete, and be sure to sanitize tools between seedlings to avoid spreading root diseases. Leave at least eight inches of root after pruning, as measured from the root collar (**see Figure 2**). Once the seedlings are sorted and pruned, dip them in water and repack them in the original container. Do not let roots stand submerged in water, as this can drown the fine root hairs. Moisture enhancers or root gels have become popular recently. Root gels are intended to help tree roots retain moisture. If you are planting on a windy day or on a very dry site, root gels may help prevent tree roots from drying out. Consult your local forester for advice and ordering information.




The Planting Process

The best time to plant is on a cool, overcast day with low wind to minimize seedling exposure to drying conditions. If your planting site is located away from your storage site, then take only as many trees as can be planted in one day out to the site. If you are storing trees at the planting site and there is no building nearby, put the trees in heavy shade or under a solar reflective tarp. Do not use canvas tarps to cover the packaged trees. The less time your seedlings spend out of ideal storage conditions, the more vigorous they will be. Proper care and handling of seedlings before and during the planting process is essential for seedling survival.

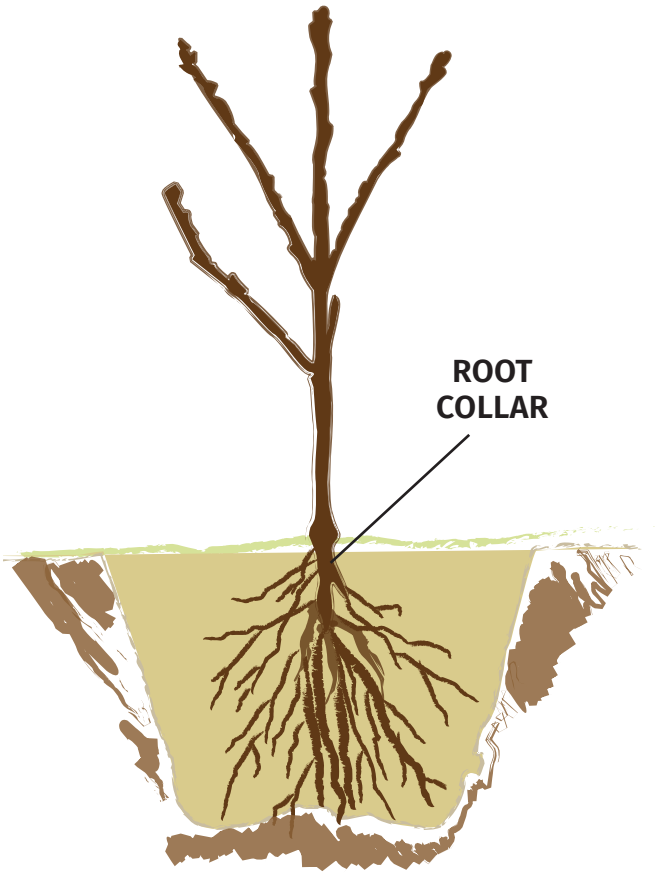

Figure 2. Illustration of Proper Planting Depth

Correct Placement and Depth

It is critical to place the seedling in the planting hole or slit properly. Whether machine planting or hand planting, four basic planting steps are necessary for seedling survival.

1. Create a planting hole, slit, or furrow large enough to accommodate a seedling's root system.
2. Place the roots straight and hanging freely within the hole and not twisted or bent.
3. Plant the seedling with the root collar at or no more than half an inch below the soil. Note: You can recognize the root collar by a change in color and slight swelling on the stem (see **Figure 2**).
4. Pack the soil firmly around the seedling to anchor it and eliminate air pockets.

Hand Planting

Hand planting is necessary when the terrain is rough, the seedlings are too large for a machine planter, or when planting within an existing forest. Various tools can be used for hand planting seedlings.

These include a shovel, planting bar (dibble), hoe-dad tool, or power auger. Depending on the field conditions and the size of the seedlings, one person can plant between 500 and 1,000 trees per day by hand. When carrying the seedlings to the planting site, avoid exposing the roots to the air. Carry seedlings in a planting bag or bucket along with wet burlap to keep the roots moist. Handle the roots as little as possible and do not immerse the seedlings in water. Follow the correct placement and depth guidelines mentioned above and shown in

Figure 2 to insure good seedling survival. A properly planted seedling should remain in the ground when gently tugged upward by the terminal tip. If you intend to plant by hand and would like assistance, your local forester may be able to provide you with names of planting crews that work in your area. You may need to book a planting crew several months ahead, so ask your forester about availability well in advance of the spring planting season.

Machine Planting

Machine planting is better suited for large sites and level terrain. While quick and efficient, machine planters should not be used if a site is rocky, steep, contains logging slash or stumps, or has heavy clay soil. A planting machine plows a slit about 10 inches deep in the soil. As the machine moves forward, a person on the machine inserts a seedling into the slit and holds it at the appropriate planting depth until the rear packing wheels close the slit and compress the soil into place around the roots. Make sure the machine you are using can plow to the proper depth for the stock you are planting. Hardwoods, with their large roots, need deeper and wider planting slits than do conifers. Planting machines generally require a 30–50 horsepower tractor and a crew of four people–one person to drive the tractor,

Hand Planting

Machine Planting

another to ride the planting machine and do the planting, a third to provide seedlings to the planter and check for proper planting depth, and a fourth person to follow behind the planter to fill in gaps and make sure trees are planted correctly and packed in firmly. The average number of trees planted with a machine planter is about 5,000 per day.

The same seedling care and handling techniques used for hand planting apply to machine planting. Do not load too many seedlings in the machine's storage bins at one time. Instead, supply stock in small amounts to keep seedlings moist and cool. To prevent drying out, protect the seedlings that are on the planting machine with moist burlap or a reflective tarp. Planting machines are often available from various public agencies or private firms. Consult your local forester for more information.

STEP 3:

MAINTAINING A FOREST PLANTATION

The success of a new tree planting will often be determined by the follow-up care it receives. Caring for new tree plantings includes monitoring survival, continuing control of competing vegetation, providing protection from animal damage such as deer or rodents, and monitoring for disease and insects. Weather will also play a role in the success of your new tree planting. You cannot control the weather, but by following through on the factors you can control, you can help reduce many of the impacts from the weather, especially with intensified weather events due to climate change. This section will help you develop skills to assess tree survival and stocking levels, identify and contend with pest and disease problems, and keep ahead of competing vegetation. These steps are often overlooked, but are just as important to the success of your plantation as are proper planning, site preparation, and planting.

Evaluating Survival

The primary reason for evaluating seedling survival is to determine whether you will need to replant seedlings in order to meet your management goals. Survival checks are usually done in late summer after planting and again at year three. If the situation warrants, and you have the time, annual inspections for the first three years can be very beneficial. This will allow you to identify any potential problems early, during the planting's critical establishment period. Refer back to your goals and desired planting density to determine if the survival rate is acceptable. If stocking levels are not adequate, you still have time for a successful replant. Your local forester can help you assess whether additional planting may be needed.

Rather than count all the trees within your plantation, it is easier to count the trees in a portion of the plantation and use that to estimate the numbers for the rest of the site.

CHECKLIST
Preparing for and Planting Your Trees

SITE PREPARATION

- ☐ Addressed competing vegetation

RECEIVING SEEDLINGS

- ☐ Identified appropriate seedling transportation method
- ☐ Identified appropriate timing for seedling planting
- ☐ Identified appropriate number of seedlings to transport to site at one time
- ☐ Have tools and helpers ready when seedlings arrive at site

This is called taking sample plots, with the circular and row methods being the common ones used for checking seedling survival. The row method is quicker, but the circular plot method is generally more accurate. At least 10 sample plots should be taken across the entire site and an average taken to determine survival.

The Circular Method

The best size for a circular plot is 1/100th of an acre. To estimate survival using this method, you will need a stake and an 11.8-foot-long rope. This will measure the radius of a 1/100th acre circle (**see Figure 3**). Choose a random spot within your plantation and put the stake in the ground there. Stretch the rope out and walk in a circle around the stake, marking the perimeter as you go. Count all live trees and the total number of trees planted within the resulting circle. Repeat this process for each of your circular plots, making sure none overlap. The sidebar on this page contains the circular plot method. An average of this number from the 10 sampling circles will tell you the survival rate for the whole plantation.

The Row Method

The row method is a very quick way to determine survival. Simply choose a row in the planting and count the number of live trees and the total number of trees planted. Do this for several of the rows. If the rows are particularly long, just do a portion of each row. To calculate stocking level you will need to know the total number of trees planted and the total acreage planted. The formula in the sidebar on this page will help you determine percent survival using the row method.

Calculations for 100th acre circular plot method

Seedling survival rate:
Live trees/total trees x 100
= percent of survival

Stocking level:
Live trees x 100 = trees/acre

Calculations for row method

Seedling survival rate:
Live trees/total trees x 100
= percent of survival

Stocking level:
Live trees planted/total acreage x percent survival = live trees per acre

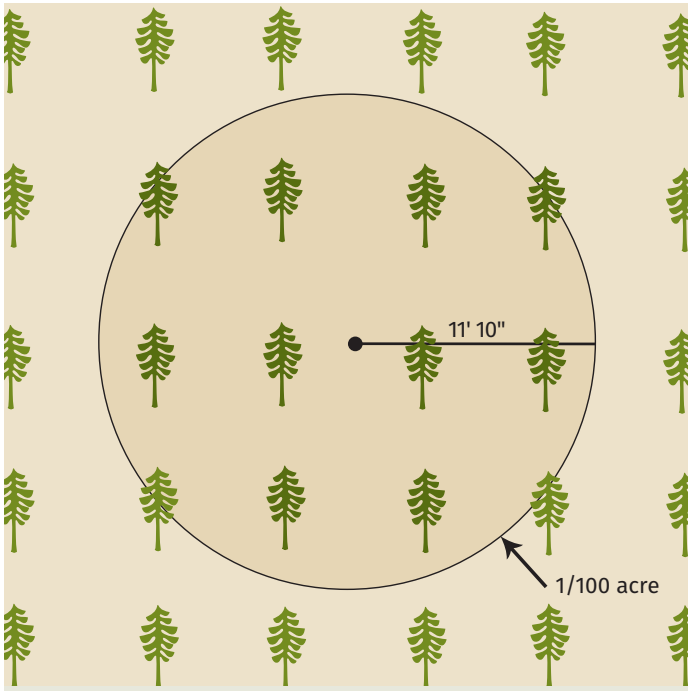

Figure 3
Example of sample plot

Controlling Competing Vegetation

All vegetation growing in the same soil and air space competes for sunlight, water and nutrients. In plantings where weeds and tree seedlings grow together, the "losing competitor" will be the tree, since weeds and grasses grow faster. Good site preparation will get the seedlings off to a fast start, but weeds may need to be controlled for at least three growing seasons or until trees are well-established. Methods to control weeds include herbicides and mechanical means, with both often being used together.

Herbicides

Though not the only alternative, herbicides are the most commonly used weed control measure. This is because herbicides kill the entire plant, root and stem, and their application is not very labor intensive. The proper choice of herbicide, timing, and method of application are critical to ensure that planted trees are not damaged. Your local forester or the Wisconsin DNR Forest Health website are good sources for this information.

https://dnr.wisconsin.gov/topic/ForestHealth

Mechanical Control

Mechanical weed control may be suitable for some situations. Shallow disking or rototilling between rows is effective if care is taken to avoid damaging the trees and their root systems. Mowing can reduce weed maturation and seed production, and minimize rodent habitat. Be aware that good weed control using mechanical methods requires extra attention and time since it may not entirely eliminate the roots, and weeds may regrow.

Bud caps protecting young trees from deer browse

Chemical treatment of weeds in planted rows

Unprotected rows of planted hardwood trees between rows of conifers

Limiting Animal Damage

Anything that attracts wildlife to your land will increase the potential for wildlife damage to your seedlings. Most tree plantings will experience some animal damage such as browsing, rubbing, or bark feeding. To control damage, you may need to keep wildlife at bay for the first few years while seedlings establish themselves. Many different techniques can be used to discourage wildlife or protect the trees from damage. You will first need to determine the type and source of the tree damage. For instance, a branch or bud torn off may indicate deer browsing. Rabbits leave a clean edge much like a knife cut. Rodents chew the bark just above or below soil level.

Deer

Deer are capable of serious damage to a tree planting. Browsing damage typically occurs on hardwoods during the growing season and on conifers throughout the year, although most frequently during the winter. Discouraging the presence of deer in and around the tree planting during the first few years is the best way to avoid damage. This may mean aggressively reducing the deer herd through hunting. The following are some other ways to reduce deer damage:

Polypropylene mesh fencing

- provides a barrier for the entire planting
- labor intensive
- must be installed immediately after planting

Tree shelters

- provide a barrier for individual trees
- labor intensive
- must be installed immediately after planting
- must be raised in the winter

Bud caps or nets

- an approach usually used only on conifers
- need to be removed prior to each growing season
- provide a barrier for the main buds of individual trees in winter

Repellents

- are sprayed on individual trees
- rely on unpleasant smell or taste to discourage browsing
- may need to be reapplied during the growing season

Fencing protects a planting from deer browse

Rodents feed on the root collar of trees

An example of a raptor perch

Small Mammals

Mice, voles, gophers, porcupines, rabbits, and other small mammals are often responsible for serious damage to tree plantings. Mowing, removing brush and brush piles, and maintaining one-foot-wide vegetation-free zones around the trees are helpful ways to control these animals. Encouraging fox, coyotes, owls, and hawks will help control rodent populations. Constructing raptor perches will give aerial predators spots from which to hunt. Sometimes controlling a pest before planting is the best bet. While trapping can be effective, rodenticides and repellents should only be used as a last resort when other techniques have failed.

Insects and Diseases

Insects and diseases are present in all tree plantings. Whether or not their presence is considered harmful depends on the specific pest as well as how you intend to use the trees. It can be very difficult to diagnose insects and diseases, since they may be underground, inside the tree, or microscopic. Sometimes multiple factors or a combination of insects and diseases may be causing the problems.

Insect Pests

Three main types of harmful insects are stem and root feeders, shoot or branch pests, and defoliators. Weevils and white grubs feeding on stems and roots are typically the most destructive insects in a tree planting. Ask your local forester about site sanitation and other preparations to reduce their populations before planting. Usually, by the time you recognize stem or root feeding symptoms, the seedling is dead or dying. Most seedlings can overcome some shoot and branch feeding or defoliation, so control is not always necessary, but the situation should still be monitored.

Diseases

Disease problems fall into three categories: root rots, cankers and rusts, and foliar diseases. Root rots tend to cause slow twig and leader growth and an overall yellowing of the crown. Root rots often form in pockets rather than randomly across the planting. Controlling root rots is usually not practical. Swelling, lesions, and/or weeping sap on the stems and branches

Gall rust on jack pine

Red-headed pine sawyer beetle larvae

Die back and epicormic branching from EAB

could be signs of cankers and rusts. Cutting and removing infected parts of the tree is your best option for control. Foliar diseases affect the needles or leaves. Controlling foliar diseases is generally not necessary or practical.

Maintaining good tree health and vigor are the best prevention measures for fighting off the insects and diseases that will attack your trees. This means selecting the appropriate species for the site, obtaining healthy stock, storing and handling seedlings properly, maintaining good soil fertility, controlling competing vegetation, and preventing animal damage.

Fire Protection

It is a good idea to maintain firebreaks and access roads in and around your tree planting. You can never predict when and where a wildfire may get started, but you can help to prevent its spread. The best firebreaks are 15 to 20 feet wide and disked annually or mowed. In areas with high erosion, your local forester may suggest planting a legume crop on the firebreak instead of disking.

Down the Road

In 5–10 years, your plantation will be well established and you will need to begin thinking about the next phase in the management of your stand. This will most likely involve harvesting some of the trees. Having a plan established will ensure you meet the goals you outlined for the stand.

CHECKLIST

Caring for Your New Trees

MONITORING THE HEALTH OF THE TREES

- ☐ The success rate of my planting is:
- ☐ Maintained a space around my trees that is free of competing vegetation
- ☐ Monitored for animal, insect, and disease damage

PROTECTING TREES IN THEIR EARLY YEARS

- ☐ Controlled competing vegetation
- ☐ Understand options when I find animal damage

To find names and contact information for your local foresters, refer to the Wisconsin DNR Forestry list of consulting and DNR private land foresters at: **https://dnr.wi.gov/fal/**

Information about forest health, pests, and diseases can be found on the Wisconsin DNR Forest Health web page: **https://dnr.wisconsin.gov/topic/ForestHealth**

Additional information on tree planting care can be found at the Wisconsin DNR Reforestation Program webpage:

https://dnr.wisconsin.gov/topic/TreePlanting

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