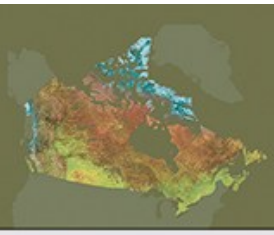

Review of Best Practices for Tree Planting on Marginal Agriculture Lands in Ontario

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Review of Best Practices for Tree Planting on Marginal Agriculture Lands in Ontario

by

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Natural Resources Canada
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February 2005

Cat. no. Fo124-3/2005E
ISBN 0-662-38353-2

Library and Archives Canada Cataloguing in Publication

White, Trevor J. R.

Review of best practices for tree planting on marginal agriculture lands in Ontario

Includes bibliographical references.

1. Tree planting – Ontario.

2. Planting (Plant culture) – Ontario.

I. Dominy, S. W. J.

II. Allen, Darren J.

III. Great Lakes Forestry Centre.

IV. Title.

SD146.05.W37 2005 634.9'56'09713 C2004-980329-8

Copies of this publication are available at no charge from:

Publication Services
Natural Resources Canada
Canadian Forest Service, Great Lakes Forestry Centre
1219 Queen Street East
Sault Ste. Marie, Ontario P6A 2E5

Cover photo by Mark Primavera

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ACKNOWLEDGEMENTS

We thank the following individuals for their valuable contributions: Barb Boysen, Laura Challen, Gilles Chantal, Gaëtan Daoust, Graeme Davis, Rudy Dyck, John Enright, Rick Grillmayer, Art Groot, Ed Iskra, Dan McKenney, John Oatway, Doug Pitt, Dave Pridham, Scott Reid, Robert Sajan, Rod Smith, Laurie Thompson, Upper Lakes Environment Research Network and Adam Zulinski.

We also extend thanks to Karen Jamieson for editing and Mark Primavera for graphic design and layout.

Disclaimer

INTRODUCTION

Afforestation, the planting of trees on abandoned or under-utilized agricultural lands, has occurred to varying degrees in Ontario since the turn of the 20th century. Knowledge of plantation establishment techniques has been gained through experience and experimentation, and has been relatively well documented. At the turn of the 21st century, the level of tree planting reached a several decade low, resulting in the loss of some on-the-ground expertise.

The forestry and related communities recognized this deficiency, and began to actively pursue the revitalization of afforestation efforts in the province. The Ontario Forestry Association, was in the forefront of these efforts. Subsequently in 2003, the Canadian Forest Service of Natural Resources Canada announced the Forest 2020 Plantation Demonstration and Assessment initiative, which has the objectives of establishing fast-growing plantations on agricultural lands to assess climate change mitigation, and private sector investment potential. (See Appendix I for Forest 2020 site and species eligibility)

With this renewed interest in afforestation came the recognition that both seasoned practitioners and those new to the endeavour would value a current compilation of knowledge on the subject.

Intended Audience and Scope

Methods for growing, planting and tending plantations are continually evolving, and the need was identified for an up-to-date reference guide that brings this knowledge under one cover. This guide has been written to assist forest practitioners, community-based organizations and landowners in undertaking afforestation in Ontario. In general, the guide will provide a set of 'best practices' for establishing and tending fast-growing tree species within an afforestation context in Ontario.

The information herein is not intended to be a comprehensive compendium, but rather an overview of the many considerations required to ensure successful plantation establishment. Readers are encouraged to consult the literature in the references and seek advice from local professionals before implementing site and silvicultural plans. Forest plantation establishment is costly; careful advance planning will help ensure it is done properly the first time, yielding a healthy forest and quickly returning the desired benefits to the landowner.

The guide emphasizes fast-growing native and non-native species and clones, but the techniques described apply generally to any species. Given the variety of species and site conditions found across Ontario, readers are encouraged to consult with local organizations having tree planting expertise before embarking on a plantation project.

SECTION ONE

Afforestation Practices

CROP PLANNING

A well-designed crop plan provides valuable information on the expected type and quality of wood or other products to be produced from a plantation. The critical elements of a crop plan include the silvics of the species selected for planting, the desired minimum initial spacing, the length of the optimum rotation age, and the optimum densities to maintain throughout the life of the plantation (Day 1996). For well-managed timber crops, the initial density should usually be set at the density of the first commercial thinning. For some species, increased initial densities are recommended to minimize branching (Day 1996); this approach may demand a pre-commercial thinning.

Where the objective is to produce as much woody biomass as quickly as possible, higher initial densities and shorter rotations may figure into crop plans. Density Management Diagrams (DMDs) have been developed for some species to help landowners and forest practitioners get the highest yield from plantations through regular thinnings. DMDs can be used to compare the results of different management levels and forecast future wood volumes based on the end product, site productivity, thinning intensity and frequency. Some Stewardship Councils offer self-contained workshops on conifer plantation management, teaching the use of DMDs (see http://www.ontariostewardship.org/cfyl/index.htm for details).

Although it is not considered in detail in this publication, thinning of the future crop should be considered as part of the crop plan. Thinning should be considered because it increases the diameter growth of crop trees, maintains vigorous growth and good health, and removes the poor quality trees, providing pulp and other niche market products in the first thinning and more valuable larger diameter timber in subsequent thinnings (Ontario Ministry of Natural Resources 1998). It can also create space for underplanting the next crop or for natural regeneration of the stand or neighbouring stands. The openings created from thinning provide access for recreation and reduce the visual impact of the rows of trees in plantations (Ontario Ministry of Natural Resources 1998). A pre-commercial thinning can be used to improve the stand at a young age. However, due to the high cost, it is seldom used in Ontario.

SITE REQUIREMENTS AND SELECTION CRITERIA

Allocating species to sites is a critical task in establishing plantations. Species that are well adapted to site conditions can demonstrate good growth and survival rates, increased vigour and resistance to insects and disease (Taylor and Jones 1986). It is important to assess the entire site because it may not be consistent in topography, soil texture and drainage. Even small changes in site characteristics can have a large impact on species suitability (Anonymous 2004). Figure 1 shows a key for identifying preferred species in relation to soil and site characteristics. A Guide to Tree Species Suitability for Site Regions 6e and 7e Using Field Recognizable Soil Properties (Taylor and Jones 1986) has been included as Appendix III. It is a good resource for identifying soil characteristics and matching tree species to Ontario sites. This appendix provides growth productivity rating tables by site region for a range of soil texture classes and moisture regimes based on height and diameter data collected from hundreds of forest stands in site regions 6e and 7e. In addition to these resources, some Stewardship Councils offer a series of self-contained workshops designed for landowners, forest practitioners, and the public.

Under the Forest 2020 (PDA) Initiative, a variety of additional site selection requirements must also be considered, including ease of access, landowner commitment, ease of plantation establishment, and potential to yield high growth rates with desired and available species.

Operational Factors To Consider

Access

Poor access can limit the timing and type of equipment used for site preparation, tending and harvesting. Ensuring good all-season access to the site will help reduce the costs of these treatments by reducing the need for major road upgrades throughout the rotation of the crop (Ontario Ministry of Natural Resources 1991a).

Plantation Shape

The ideal plantation shape is long and rectangular because the cost of planting, tending and harvesting operations is reduced by minimizing the number of turns and maneuvers required for mechanical tree planters, tractors and harvesters. The rectangular shape also allows more trees to be planted and less area is required to turn the machines at the end of the field (Ontario Ministry of Natural Resources 1991a). However, other operational considerations such as, available suitable lands, and landowner objectives may require alternate configurations. Hand planting operations are typically not constrained by the shape of the planting block.

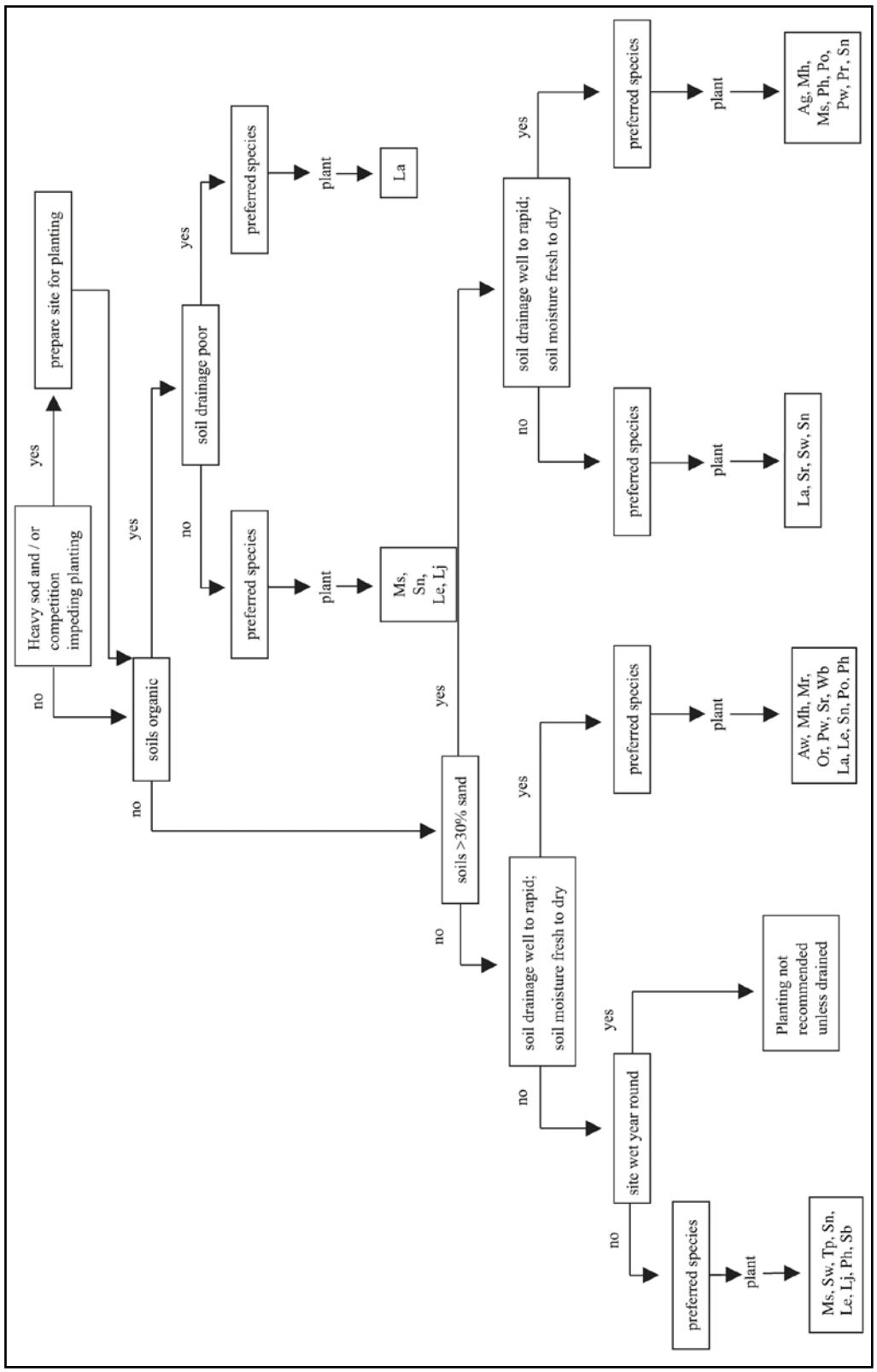

Figure 1. Silvicultural key for identifying preferred species in relation to soil and site characteristics. Adapted from the Species and Stock Selection Manual (Johnson et al. 1996) (See Apendix II for species names).

Soil Properties

The most important soil properties to evaluate when conducting a site survey include soil moisture and drainage, aeration, depth, depth to distinct mottles, pH, texture, and fertility (Ontario Ministry of Natural Resources 1991a). It is important to understand the interactions between these properties when evaluating the site, and not just their individual effects (Ontario Ministry of Natural Resources 1991a). Detailed measurements of these combined properties will give forest practitioners and landowners a good assessment of the potential site productivity, and enable them to allocate the appropriate species and plan the most cost effective tending activities required to maximize tree health and growth throughout the rotation of the crop (Ontario Ministry of Natural Resources 2000).

Site Limiting Factors

The following is a list of site limiting factors that affect growth and survival of seedlings, adapted from the Species and Stock Selection Manual (Johnson et al. 1996)

- Competition from vegetation or other trees;
- Mechanical damage such as heavy snow loads coupled with snow press from thick mats of vegetation that may cause smothering of seedlings;
- Flooding or drought;
- Shallow or rocky soils;
- Potential for frost damage in low depressions and frost heaving on heavy clay soils;
- Susceptibility of species to insect infestations and disease;
- Slope and aspect of the site: e.g., trees planted on the top of a long, south facing drumlin can have very poor success, while trees planted in the bottom slope of this landform can do quite well;
- Deer, rabbit and rodent damage on planted seedlings.

Location

When planning to establish a tree crop, it is important to identify the local markets that would purchase (make use of) the particular products that can be made from the trees selected for planting. Evaluating the distance to potential markets and forestry contractors can help reduce unnecessary costs associated with transportation, tending and monitoring the health of a plantation (Ontario Ministry of Natural Resources 1991a).

SITE PREPARATION

Conifer and hardwood species have different site preparation requirements. Hardwood trees are more demanding for soil nutrients and moisture than conifer seedlings and are highly susceptible to rodent damage. Successful hardwood establishment requires intensive site preparation and tending for at least three years to maintain a relatively weed free site, while conifer species require less intense management, usually for only one to two years (Ontario Ministry of Natural Resources 1995a). Hybrid poplar is the most site demanding species and requires the highest level of site preparation and tending activities. Site preparation and tending intensity for hybrid poplar also depends on stock type, clone type and available tending funds. These treatments may include ploughing, frequent discing, and intensive weed management for the first three to four years to ensure rapid growth and a healthy crop.

Careful site preparation can help establish planting density, improve planting quality, facilitate tending operations, and reduce competition and establishment costs (Ontario Ministry of Natural Resources 1998). For example, ploughing on compacted sites can increase soil aeration, allowing for greater rooting volume and increased soil drainage by breaking up a hardpan layer within the top 30 cm of the soil surface. Discing increases site productivity, and provides a good smooth soil surface for pre-emergent herbicide applications. Discing also reduces the number of chemical tending treatments required throughout the establishment phase (Ontario Ministry of Natural Resources 1991a).

Before a method of site preparation can be chosen, the site must be inspected to identify any limiting factors that may affect the timing and implementation of certain site preparation operations. Sites with higher establishment costs, i.e., more limiting factors, would be given lower priority in the Forest 2020 (PDA) initiative. The following descriptions of site limiting factors that can affect site preparation activities have been adapted from A Grower's Guide To Hybrid Poplar (Ontario Ministry of Natural Resources 1991a).

Limiting Factors That Can Affect Site Preparation

Heavy Rainfall

- Can limit access to the site.
- Rutting may become a problem if machinery is used on the site when the soil is wet.
- May affect waiting periods between site preparation activities (e.g., 14 to 30 days between applications of post emergent herbicide application and ploughing).

Steep Slopes

- May inhibit site preparation in some areas.
- May require a modification to site preparation activities (e.g., strip or spot site preparation).
- To prevent erosion the site preparation activities should be carried out perpendicular to the slope to follow the natural contours of the land.

Large Stones

- May limit operations to areas with smaller and less frequent stones. Machine operability is difficult when the stone size is greater than 20 cm and can cause damage to machine parts.

Heavy Clay Soils

- Can limit access even with light rainfall.
- Can cause compaction, reducing soil aeration and available nutrients.
- May require a fall ploughing to let the winter frost break up the large structures in the clay called 'clods'.
- Ploughing may pull very large clay clods to the surface. If they are left to bake in the sun, they create a rough site and poor planting conditions.
- May require the use of a chisel plough when the site is slightly moist to break up the soil clods.

Hardpans

- May require a ploughing operation, provided that the hardpan is within the plough layer (30 cm).
- If the hardpan is below the plough layer, choose a species that will perform well on shallow poorly drained soils.

Large Stumps

- Large stumps may restrict machine operability. Stumps greater than 10 cm in diameter may need to be removed, depending on the machines being used.
- Site prepare around larger stumps that would be difficult to remove and are slow to decay.

Existing Weeds

- The growing stage, type and amount of weeds growing should be assessed before any site preparation activity. Applying post-emergent herbicides to inactively growing weeds can significantly reduce the efficacy of the treatment.

Controlling Existing Vegetation

Woody vegetation (hardwoods and shrubs) is considered the primary source of competition causing poor survival and growth rates for young crop trees (Ontario Ministry of Natural Resources 2001). Woody vegetation has a high potential to use up site resources, e.g., light, water, nutrients, and space for long periods of time (Newton 1973). Herbaceous vegetation (grasses, forbs, and ferns) also affects seedling survival and performance, but usually for shorter periods of time. In some cases, particularly in old fields, herbaceous competition can dominate a site, limiting crop tree growth for many years. It is important to consider the species of competing woody and herbaceous vegetation when planning site preparation and tending activities (von Althen 1987). Appendix IV summarizes the most common herbicides available for use in forestry in an afforestation setting and describes them in terms of soil type limitations, target vegetation, mode of action, and application criteria. The following are some key points to consider when dealing with woody and herbaceous vegetation growing in unused fields.

Woody Vegetation

- Use a brush cutter to remove all of the woody vegetation.
- Leave large diameter trees and shrubs as islands to prevent potential damage to the equipment and to add to the diversity of the site. Be sure to account for the lost area within these islands when calculating the total productive area for the plantation.

Herbaceous Vegetation

- When the height of herbaceous weeds exceeds 40 cm, herbicide applications become difficult and ineffective. We recommend that the site be brush cut, to remove the tall vegetation, followed by an application of herbicide.
- With perennials, apply a post-emergent herbicide such as glyphosate followed by mechanical cultivation.
- Provided that annual vegetation has not gone to seed, it is possible to only use mechanical site preparation. In every case, a follow up survey is required to assess the results.
- For heavy sod layers, apply Simazine in strips or over the entire site during the fall prior to spring planting. This treatment may be followed by ploughing the strips to expose mineral soil for the seedlings to be planted. Note: exposing mineral soil on highly productive sites may increase new herbaceous growth in some cases. Post-planting applications of simazine are also an accepted method for controlling competition. However, species like ashes and larches do not tolerate high dosages of Simazine and can be damaged by such application rates.

Agricultural Crops

- When dealing with corn fields, the site may require testing for Atrazine herbicide residue to plough depth. Depending on the applied rate and soil type, Atrazine can be persistent for up to three years. Atrazine herbicide can negatively affect a variety of tree species.
- For perennial crops, use a post emergent herbicide before ploughing and cultivating.
- Annual crops may be ploughed under and cultivated.

Types of Mechanical Site Preparation

Adapted from A Grower's Guide to Hybrid Poplar (Ontario Ministry of Natural Resources 1991a).

Brush-cutting

Brush cutting is used to remove both herbaceous and woody vegetation from the site. If herbicides are not to be used, brush cutting should be completed early in the year after leaf flush to allow adequate time for ploughing and/or discing so that it will be ready for planting the following spring. The size of prime mover required to brush cut can vary depending on the type of vegetation. Generally, a light tractor (20-40 horsepower) outfitted with a Bush Hog Squealer or equivalent, is sufficient for controlling light woody and herbaceous vegetation, while a larger (90+ horsepower) tractor would be required to operate a Hydro Axe brush cutter for removing very heavy, larger diameter woody plants.

Ploughing

Ploughing is recommended but not essential for soil that has been in agriculture recently, but may be necessary to break up sod layers or previous crop residue such as corn stubs. Ploughing is not normally used when planting conifer species but has been used frequently to prepare sites for hybrid poplar and other site-demanding hardwoods. If ploughing is chosen, ensure the plough reaches a depth of at least 25 cm and that the furrows follow the contours of the land to reduce soil erosion. In the spring, the site should be sufficiently dry to allow machines to operate on it. Fall ploughing is usually done on heavy clay soils to allow the winter frost to break up large clods. If herbicides are used prior to ploughing, ensure sufficient waiting time, at least 14-21 days after an application of herbicide on herbaceous vegetation, and 21 days for woody vegetation to realize the full effect of the treatment. If surface drainage is a problem in some areas, the furrows can be directed towards secondary ditches, usually located on the perimeter of the site to alleviate pooling and poorly drained areas. Generally, a light tractor (20-40 horsepower) is sufficient to pull a 1-2 furrow, 10-12" mould board plough, see Figure 2, while a larger (90+ horsepower) tractor would be required to operate a 5-7 furrow, 16-18" mould board plough attachment.

Figure 2. Mould board plough attachment with 37 hp 4X4 tractor *(Photo: NRCan, AFC)*

Discing

Discing is necessary to produce a smooth soil surface for planting hybrid poplar cuttings and ensures good herbicide effects. It also provides good aeration for early root development and facilitates drying of the site. Discing operations should be carried out in two directions perpendicular to each other and to a minimum depth of 20 cm. Sufficient time between ploughing and discing allows the soil to dry out adequately, usually 5 days is enough depending on the moisture content and weather conditions. Wet soils should never be disced. Usually, a 45-60 horsepower tractor is required to use a 35 cm, and up to a 70 cm offset disc attachment, see Figure 3.

Figure 3. Offset discing attachment 30 cm deep disc *(Photo: NRCan, NoFC)*

Cultivating

Cultivation is an optional treatment for most species. It helps bring clods to the surface, especially in heavy clay soils or sites with a thick sod layer. For hybrid poplar cuttings, cultivation is required to ensure a smooth site, and provides an even surface for pre-emergent herbicides. It also facilitates quicker drying of the soil, and kills roots and rhizomes of existing vegetation. Cultivation can be done with various types of equipment including, spring tooth harrows (Figure 4), pulverizers, and rotovators. The best time to cultivate is between, or after discing, especially following heavy periods of rain, provided the site is not too wet to operate on. A light (20-40 horsepower) tractor to a heavy (90+ horsepower) unit can be used depending on the size and type of cultivator chosen.

Alternative methods

Cover Crops

Planting cover crops, such as rye grass or clover is an alternative option for controlling unwanted vegetation. Other benefits to cover cropping include, increased soil stabilization and fertilization, a reduction in the amount of herbicide required to control competing vegetation, and they are a good source of food for game birds, rabbits and deer (Ontario Ministry of Natural Resources 1994). Field trials conducted by the Ministry of Natural Resources suggest that rodent damage to young seedlings can be reduced when a cover crop is sown between crop trees (Ontario Ministry of Natural Resources 1994).

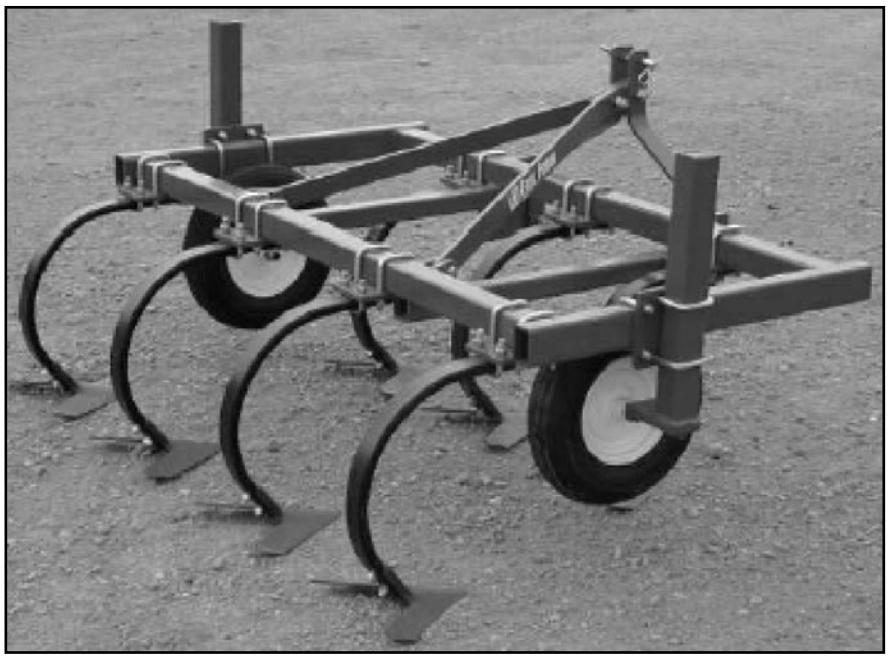

Figure 4. Cultivator attachment *(Photo: NRCan, NoFC)*

Types Of Chemical Site Preparation

Herbicides such as glyphosate and Simazine can be very effective in controlling competing herbaceous and woody vegetation. Herbicides alone can be used on some sites with light sandy soils and less competition. The timing, rate and method of application are very important and can greatly affect the results. Each site should be assessed individually prior to treating the area to adjust for variations in soil type, vegetation composition and abundance. When applying herbicides, always follow the directions and safety procedures printed on the container labels (See Appendix IV for details on commonly used herbicides in forestry).

One method of applying herbicides is boom spraying where the boom is attached to either a farm tractor or ATV that can spray the areas between the tree rows after planting or in strips with alternate unsprayed strips before planting (von Althen 1990). Strip spraying reduces the amount of chemical required by two-thirds. Spot spraying is also a viable option but costs more due to increased labor. The common method for spot spraying includes the use of a stove-pipe to cover the tree while the chemical is applied in the surrounding area to a minimum of 1m in diameter around each tree (Ontario Ministry of Natural Resources 1995b).

SEED COLLECTION AND STOCK PRODUCTION

Seed Collection

(Adapted from Ontario Ministry of Natural Resources 2001).

The best stock is grown from seed that has been collected from locally adapted superior trees. Superior stem form and fast growth are ideal traits for the production of high quality wood products. Other characteristics to consider when implementing a seed collection program are resistance to disease and insects, seed production potential, and good crown form. To maximize seed viability and genetic quality, seed should be collected from a stand of trees rather than isolated individuals. Single trees tend to self-pollinate and produce seed that is less viable and genetically inferior (Rudolf 1974). Table 1 shows the general criteria for selecting parent trees for seed collection.

Table 1. General criteria for selecting parent trees for seed collection (*Adapted from Ontario Ministry of Natural Resources 2001*).

Desirable parent tree traits	Undesirable parent tree traits
Good form	Poor form
Fast growth rate	Slow growth rate
Healthy appearance	Disease symptoms or insect damage
Dominant or co-dominant trees	Intermediate or suppressed trees
Good foliage color	Poor foliage color
Mature trees	Immature trees
Trees in stands of the same species	Isolated trees

When forecasting for seed collection, it is important to understand that productive seed crop years vary greatly between species. White pine for example, can have anywhere from three to nine years between good seed crops, and when it does, the amount of seed collected should be able to meet the demand until the next good seed crop. Seed collection for most species begins in late summer and lasts until early fall; however, forecasting should be started in late June. Crop forecasting information provides valuable information on seed development, maturity, and insect and disease damage. Five to ten cones, fruits or nuts should be sampled from different parts of the crown and several trees in the collection area (Creasey 1996). Some species, like silver maple and red maple, produce mature seed in early spring. The number of clean processed seeds per hectoliter (100L) depends on cone or fruit and seed size, and thus varies greatly between species. Careful and continuous monitoring of crop development over the summer will help to ensure that mature seeds are collected at the optimal time (Ontario Ministry of Natural Resources 2001).

The Ontario Tree Seed Plant in Angus and the Forest Gene Conservation Association (FGCA) co-host workshops for certified seed collectors. Participants learn the intricacies of seed crop forecasting, seed quality, and collection, handling, and storage techniques. The FGCA also holds volunteer Seed Collector Workshops as part of a Certified Seed Collector program.

Nursery Practices

There are many stages in the production of growing stock including, preparing the nursery site or greenhouse growing medium, sowing the seeds, tending, lifting, transplanting, and packaging for storage or transport. Each stock type has its own requirements, and whether it is bareroot, container or cuttings, special care must be taken at each stage to produce good quality stock that has high survival and growth rates after outplanting. Only healthy source-identified, vigorous planting stock should be accepted; poor quality and / or non-source-identified stock is never a good investment of time or capital.

Choice Of Planting Stock

Species and seed source are two important factors that must be matched to the planting site (Ontario Ministry of Natural Resources 1996). Table 2 shows a summary of species grown in forest nurseries in Ontario by forest region. In addition, Ontario tree seed zones have been developed to ensure that seed and stock are climatically adapted to the local area. Figure 5 illustrates the climatically based seed zones for Ontario, adapted from Joyce (unpubl. 1995). Use the following seed and stock movement rules, developed by the Ontario Tree Seed Zone System when selecting stock for planting:

1) planting stock and seed can be moved within a seed zone without restrictions;

2) movement of general seed collections and planting stock across seed zones is not recommended;

3) when specific species guidelines become available, they can replace generic climatically based seed zones.

Having chosen an appropriate species and seed source based on species selection guidelines (Appendix III), a detailed site inspection and tree seed zones, the type of stock must be selected to ensure superior out-planting performance. The three most common types of stock used in Ontario are bareroot, container, and cuttings. Choosing a particular stock type depends on many factors including moisture availability, soil conditions, competition, and climate conditions for the site (Sidders 2003). Table 3 shows the relative advantages and disadvantages of bareroot and container seedling production and outplanting (Adapted from Cleary et al. 1978).

Bareroot Seedlings

Bareroot seedlings are germinated and grown in the same nursery bed (seedbed) for the entire nursery rotation. For bareroot transplants, the seedlings are transplanted from high density seedbeds to lower density nurserybeds. Transplants grown only outdoors are referred to as conventional transplants, whereas, greenhouse transplants, or accelerated transplants, are grown in the greenhouse under controlled conditions before being transplanted to an outdoor nursery bed (Ontario Ministry of Natural Resources 2001).

Bareroot stock age is identified by a two-part code. The first part refers to the amount of time the trees were grown in a seedbed and the second part refers to the length of time in a transplant bed (e.g., 2 + 0 seedlings would be grown for 2 seasons in a seedbed; 1+2 transplants would be grown for 1 season in a seedbed and 2 seasons in a transplant bed). Greenhouse transplants are also identified by the two-part code system with the first part assigned the letter G to signify that the seedling was germinated in the greenhouse. The second part refers to the length of time the seedling was grown in the transplant bed (e.g., G + 1.5 indicates that the trees were germinated in a greenhouse and transplanted part way through the first growing season (Ontario Ministry of Natural Resources 2001)).

Table 2. Summary of species grown in Ontario private forest nurseries by forest region. The list only includes species being considered under the Forest 2020 (PDA).

Species	Deciduous Forest	Great Lakes St. Lawrence Forest	Boreal Forest
CONIFER			
eastern hemlock	Y	Y	
European larch	Y	Y	
Japanese larch	Y	Y	
Norway Spruce	Y	Y	Y
red pine	Y	Y	Y
red spruce	Y	Y	
tamarack	Y	Y	
white pine	Y	Y	Y
white spruce	Y	Y	Y
HARDWOODS			
black walnut	Y		
green ash	Y	Y	
hybrid poplar	Y	Y	Y
red maple	Y	Y	
red oak	Y	Y	
silver maple	Y	Y	
tulip tree	Y		
white ash	Y	Y	

Y - Presently grown in Ontario private forest nurseries. (Ontario Ministry of Natural Resources 1996)

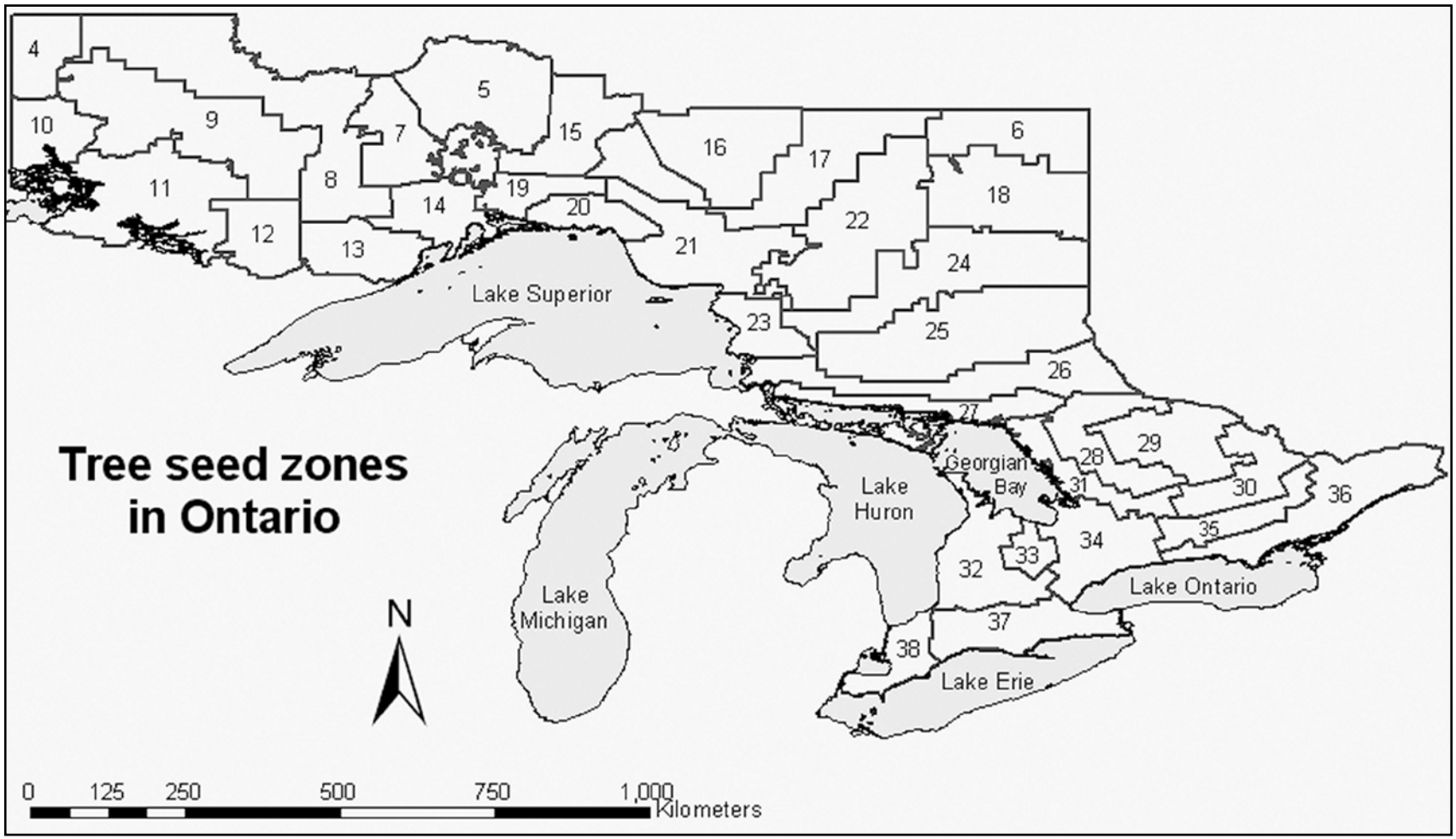

Figure 5. Climatically based Tree Seed Zones for Ontario. Adapted from Joyce (unpubl. 1995). Data provided by Ontario Ministry of Natural Resources

Table 3. Shows the relative advantages and disadvantages of bareroot and container production and outplanting. *(Adapted from Cleary et al. 1978).*

Compared Factors	Bareroot	Container
Area required to grow seedlings	-	+
Cost of production	-	+
Time it takes to produce seedlings	-	+
Amount of mechanized operations to grow	-	+
Flexibility of growing season	-	+
Planting season length	-	+
Planting on shallow or rocky sites	-	+
Handling disturbance to roots during planting	-	+
Root resistance to water flow between plant and soil	-	+
Relative growth rate	-	+
Root to soil contact	+	-
Rooting depth	+	-
Moisture retention in root zone during production	+	-
Burial potential during planting	+	-
Smothering potential from competing vegetation	+	-
Potential damage caused by insects and disease after outplanting	+	-
Root spiraling potential after outplanting	+	-
Soil anchorage properties	+	-
Frost heaving susceptibility	+	-
Tending cost after planting	+	-

Note: + indicates a relative advantage; - indicates a relative disadvantage

Container Seedlings

Container seedlings are usually grown inside greenhouses. Many different types of container seedlings have been produced in nurseries in Ontario, however only a few have been used operationally. These include Japanese Paperpots, Jiffy Pellets, Spencer-Lemaire Rootrainers, Beaver Plastics Styroblocks, and Multi-pots (Ontario Ministry of Natural Resources 2001). Container stock has been almost entirely produced in northern Ontario to cope with the demand of reforestation activities of northern forest industries.

Cuttings

Cuttings come from the current year's growth from material grown principally from hybrid poplar, and to a lesser extent willow. The material is usually grown in stool beds, and cut to a length of 25-30 cm, ranging from 1-3 cm in diameter (Ontario Ministry of Natural Resources 1991a). For stream bank restoration and wind breaks, longer 2-5 m cuttings called whips can be used to help stabilize the soil and filter runoff water (Ontario Ministry of Natural Resources 1991a). Some advantages associated with the use of cuttings include ease of handling and lower production costs. Other factors to consider when choosing cuttings to establish a plantation are increased site preparation and tending costs, and increased potential damage from deer and rodents (Morin 2003).

Rooted Cuttings

Rooted stock is usually grown from 13 cm cuttings principally from hybrid poplar material grown in stool beds. Rooted cuttings cost more to produce, but have some advantages over cuttings in certain applications (Ontario Ministry of Natural Resources 1991a). At lower planting densities, the cost of establishment and tending can be offset somewhat, as rooted stock has more advanced top growth than cuttings (Ontario Ministry of Natural Resources 1991a). It requires less tending and is well suited for establishing lower density, higher quality plantations grown for lumber and veneer products (Morin 2003). Deer and rodent damage is also less of a problem with larger rooted stock (Morin 2003). Large (>1 m high) rooted cuttings are more costly to plant than smaller stock.

Specialized Nursery Treatments

Some specialized nursery treatments can increase the quality of stock including, root culturing in bareroot production and nutrient loading in container production (Ontario Ministry of Natural Resources 2001). Root culturing creates a compact and fibrous root system that produces new roots after outplanting, and controls height growth of the seedlings. Other desirable effects include the conditioning of seedlings physiologically for outplanting and overwinter frozen storage. Root culturing also helps to create seedling characteristics that are similar to transplants (Ontario Ministry of Natural Resources 2001). For container production, 'nutrient loading' has become a favourable practice that increases the internal nutrient concentrations without changing total dry mass through intensive fertilization regimes (Timmer and Munson 1991). Nutrient loaded seedlings seem to grow faster initially, and are considered good candidates for sites that are prone to high competition from weeds, e.g., moist, heavy soils (Timmer and Munson 1991).

STOCK HANDLING

Having decided on the stock type, species, seed source and seedling quantity for your area, it is now imperative to ensure that trees are handled with care during planting and transportation.

To further ensure survival of seedlings after outplanting, it is important to minimize the amount of stress seedlings undergo before and during planting. This section will describe the key points in proper stock handling procedures from the time the stock is picked up at the nursery until they are planted. The following procedures and information have been adapted from the Stock Handling Guidelines for the Southern Region (Ontario Ministry of Natural Resources 1992).

Seedling Stress Factors

The four main stress factors that affect seedlings from nursery to planting are:

1) Moisture imbalance
2) Temperature fluctuations
3) Physical abuse
4) Storage duration

Even healthy seedlings have only a limited supply of stored energy, so minimizing these stresses can ensure higher survival rates and good growth and minimize expensive refill planting.

The roots of seedlings are more susceptible to stresses than the shoots. Any moisture loss from the shoots has to be replaced by the roots. Damage to foliage and shoots also taxes the roots' energy to heal the wounds.

It is important to know the starting condition of stock. Thoroughly inspect it upon delivery, taking note of any sour odours, mould, moisture content, and temperature.

The following procedures describe optimal handling conditions from the time the stock is picked up at the nursery to the time the trees are planted.

Stock Transportation

Refrigerator units sometimes referred to as 'reefers', are tractor-trailer units used to transport large quantities of tree stock to the field. Smaller reefer units come in handy for harder-to-access areas and smaller loads. Many landowners and delivery agents do not have access to such vehicles. When the distance is less than 3 hours from the nursery, non refrigerated vehicles can be used either to transport stock directly to the planting site (provided the trees are planted that day) or to cool storage facilities. If pick-up trucks are used, the seedlings should be stacked carefully to allow good air-flow around the bags or boxes then covered with a mylar tarp (plastic tarps with reflective foil laminated to a white plastic layer – white side up). At the planting site, the stock should be stored in a cool area protected from the sun, wind and freezing temperatures. Only the amount that will be planted within 24 hours should be shipped to the planting site if there is no cool storage reefer available. Dense conifer tree canopies can be used for shade in early spring. Later when temperatures rise, mylar tarps, or tents with no floor should be used to cover the seedlings. Trees should not be stored for more than 24 hours in

these conditions. Over-wintered outside container stock seedlings are usually transported to the field in the containers they were grown in and are kept moist with frequent watering. A close water source is beneficial during warm windy days. If the over-wintered container has been thawed from a frozen state, they should be kept under mylar tarps and planted that day or placed in cool storage at the site.

Key Points To Remember (Note: these apply principally to bareroot stock)

Loading and Transport

- For cold-stored stock, if the bag or box temperatures exceed 5 °C do not load the vehicle (leave in cold storage until the temperature has cooled to 1 °C or 2 °C)
- Elevate the bags / boxes using pallets
- Do not stack bags more than 2 high or boxes more than 3 high
- Optimum transport temperatures range between 1 °C and 2 °C

On-site Storage

- Dip bareroot trees in water for l minute or less and return to bags or boxes if they are not to be planted right away – longer soaking time can kill roots
- Stack bags no more than two high
- Avoid throwing bags filled with trees – stock is fragile
- Do not stack frozen stock or hardwood stock
- Cover stock that is in bags or boxes with mylar tarps
- If bag temperatures exceed 10°C plant trees immediately and reduce the quantity of onsite stock by ½ or suspend planting during the hottest part of the day

Handling by Planters

Many planters will be inexperienced so careful explanation on handling procedures and frequent follow up in the field is important.

- Do not prune roots on barerooted trees
- Be careful not to overfill the planting bags
- Ensure that bareroot trees are dipped in clean water for one minute before they are placed in the planting bags or loaded on the planting machine
- If available, place moist peat moss or sphagnum in the bottom of the tree planter bags/machine planter seedling receptacles to retain moisture on the roots while the planters are in the field. On machine planters, the trees should be covered with a mylar or similar tarp, ideally covering the planter operator as well to minimize moisture and heat stress on the operator and seedlings.

Handling and Conditioning of Cuttings

Each stock type requires a specific conditioning regime that must be followed to break dormancy, and to ensure the plants flush once they are planted (Sidders 2003). Cuttings can be stored in a frozen state between –2 to –5 °C (Sidders 2003), and should be transferred to a cool shaded area around 10 °C for 1 to 3 days prior to planting to break dormancy (McEwen 2002). Bud swelling on the lower stem and the appearance of root "bumps" on the lower portion of the cuttings are good indications that dormancy has been broken (McEwen 2002). The cuttings should then be soaked for 24 to 48 hours in water at about 15 °C, covering only the bottom ¾ of the stem, and with the buds pointing upward. The cuttings should be planted within four hours after being removed from conditioning (Sidders 2003).

PLANTING METHODS

Machine planting is often preferred to plant trees in agricultural field conditions; however, hand planting is an entirely acceptable option. An experienced planter can plant between 500 and 1200 or more good quality trees per day depending on site conditions whereas a machine planter and an experienced three person crew can achieve production rates of 6000 or more per day. The planting quality of either machine or manual planters must be consistently monitored. Problems must be corrected immediately to ensure successful plantation establishment.

Ensure that:

- trees are planted straight and firmly heeled in to eliminate air pockets around the roots;
- roots are vertical and at full depth in the planting slit or hole
- tree spacing is uniform.

Machine Planting

Limitations that can affect planting a site by machine include steep slopes, very wet soils, access, large stones and heavy clay sites (von Althen 1990). Hand planting should be used in any of these conditions. Other factors are the number of seedlings, species, and stock size. Generally, more than 1000 seedlings per site is required to make machine planting cost effective. Machines in which the planted seedling must pass under a bar or seat of the planter can damage the terminal bud of seedlings 30 cm high or more. In this case the seedlings tend to be planted on an angle causing unwanted vertical shoot growth at the root collar or along the stem. To avoid this problem, the machine should have an unobstructed passage behind the planting shoe (von Althen 1990). The types of machine planters vary widely, but the most common are units that can be pulled behind a small farm tractor using a simple three-point hitch system (Figure 6). In some areas, machine planters have been modified to handle hybrid poplar cuttings of various sizes and can increase production greatly (Ontario Ministry of Natural Resources 1991a). Some machines are equipped with band sprayers and can treat the area simultaneously with herbicide to control competing vegetation as the trees are being planted.

Hand Planting

The most successful hand planting method is wedge planting and is usually used for bareroot stock (Figure 7). A wedge of soil is removed with a spade and the roots are inserted into the hole and the wedge replaced. This method takes a bit more time but the trees planted will have good soil contact and have minimal air pockets, keeping the roots moist during drought conditions (von Althen 1990). Unrooted stock, such as cuttings or whips, require a different method of planting, usually the dibble method, where the planter inserts the end of the dibble into the ground in a stone free area to a depth predetermined by the foot pegs on the dibble. The dibble is then removed and the cutting or whip is inserted into the hole. A second insertion hole is then created 5 cm behind or in front of the planted cutting, then the dibble is moved back and forth to create good soil contact with the cutting to prevent moisture stress in drought conditions and to secure the cutting firmly (Ontario Ministry of Natural Resources 1991a).

Mulching

For smaller areas, mulching may be a viable option for controlling vegetation around your planted trees, however, this treatment becomes very expensive and labor intensive for larger areas. Common materials used for mulch include black or green plastic, woven black or green plastic, newspaper and straw, or wood chips. Apply the material at least 60 cm in diameter around the base of trees for sufficient weed control (Ontario Ministry of Natural Resources 1995b).

Figure 6. Machine planter attachment *(Photo: NRCan, GLFC)*

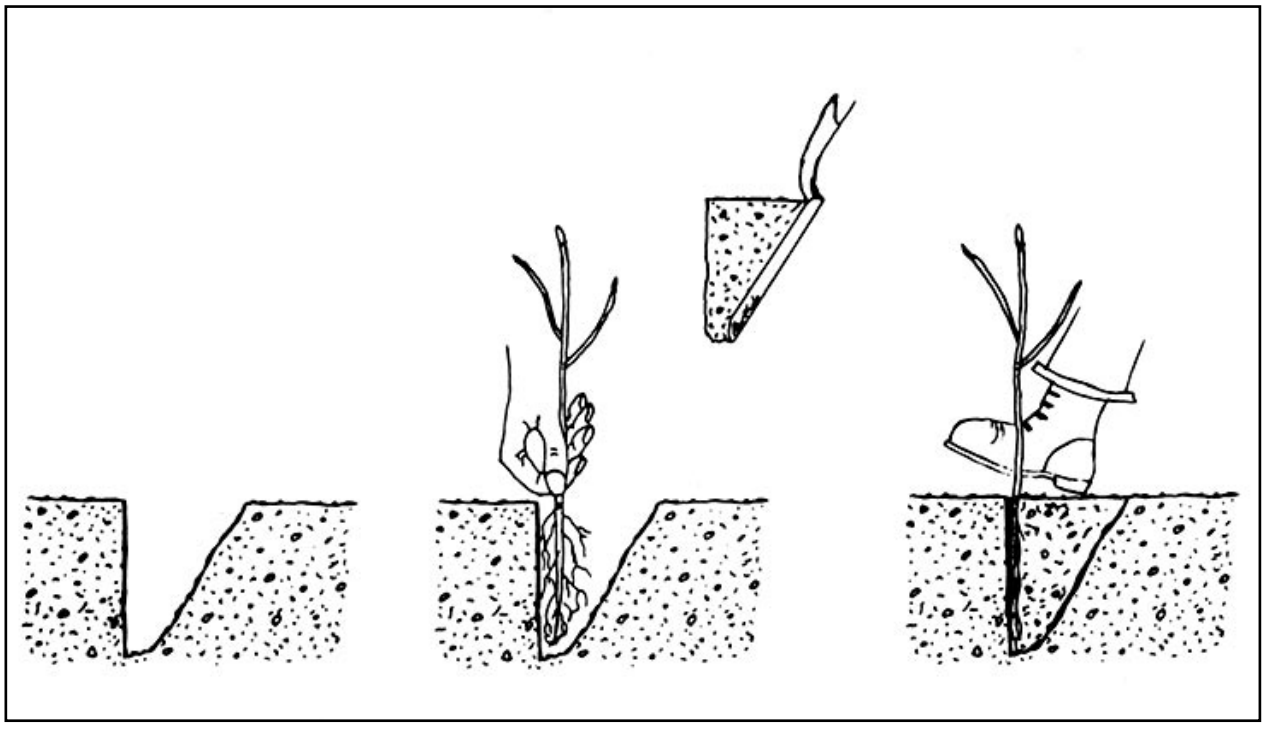

Figure 7. The wedge method of planting *(NRCan, GLFC)*

Tree Shelters And Tree Protectors

Tree shelters have been used successfully to protect hardwood seedlings from adverse weather, providing a warm, moist environment for accelerated tree growth (Ontario Ministry of Natural Resources 1995b). Tree shelters and tree protectors also shield the seedlings from browsing rodents, rabbits, deer, and herbicide effects. Due to the high cost product and labour rates, they are seldom used in large pure hardwood plantation settings, however, they can be a valuable tool to help establish smaller quantities of hardwood that may be susceptible to high rodent, deer or rabbit populations (Ontario Ministry of Natural Resources 1995c).

Timing of Plantation Establishment

The planting season varies throughout the province, but generally in the southern regions (south of North Bay) planting begins in mid to late April and lasts for about 3 to 4 weeks. Container or bareroot trees are normally planted when the soil temperatures reach 4°C to 5°C (Ontario Ministry of Natural Resources 1996). For the northern regions of Ontario the planting season usually starts in early May, depending on the weather and soil temperatures and can extend into June lasting anywhere from 4 to 8 weeks. For planting rooted cuttings, the soil should be at least 8°C, and 12°C for unrooted cuttings (Sidders 2003).

TENDING

Weed control is important to ensure good growth and survival throughout the establishment phase, usually 2 to 3 years of tending is required to reach the 'free to grow' stage, meaning that the trees are established based on a minimum stocking standard, a minimum height and freedom from competition that could impede growth (Ontario Ministry of Natural Resources 1998). The tending intensity depends on many factors, including site type, tree species, competing vegetation and site preparation methods used. Good site preparation can provide adequate competition control for 1 to 2 years. Conifers (pine and spruce) generally require less tending than deciduous (hardwoods, like walnut, oaks and maples). Hardwood trees are more sensitive to competition and require intensive tending, usually for 3 to 4 years (Ontario Ministry of Natural Resources 1998). Insect and disease control can also be important, particularly during severe infestations in high-value plantations. Although treatment with insecticides is not common, some general considerations are presented in Appendix V.

Mechanical Tending

Mechanical tending operations use tractors, mowers and rotary-tillers to control weed competition and are useful for large-scale plantations. For those who do not want to use herbicides, mechanical tending is a good option for controlling weeds and competition. This method may require several treatments throughout the growing season as the mixing action on the soil provides ideal conditions for new weed growth (Ontario Ministry of Natural Resources 1991a). Whether brushing, mowing, rotary-tilling, discing, or cultivating, optimum results are obtained by tending in both directions (Sidders 2003) (Figure 8).

Chemical Tending

This type of operation can be very effective in controlling competition, especially on fertile sites to help establish hardwood species. Herbicide treatments tend to outlast mechanical methods, achieving the same results with less effort and money. The chemical applications should be timed so that the trees are the least sensitive to the effects and the competition is the most sensitive. Boom and spot spraying

Figure 8. An Intensive mechanical tending operation performed in both directions to a maximum depth of 2" post planting in hybrid poplar *(Photo: NRCan, NoFC)*

are the most common methods of applying herbicides for chemical tending. Boom sprayers can be mounted on farm tractors or ATVs (Figure 9), optionally equipped with a shield to prevent over-spray onto planted trees. This is especially important for applying herbicides on hardwood plantations, as they are generally more sensitive to chemicals. A summary of the common herbicides used in forestry can be found in Appendix IV.

Figure 9. ATV with hooded attachment for applying herbicides *(Photo: NRCan, NoFC)*

SECTION TWO:

SPECIES CONSIDERATIONS

The following section gives some general background information on site requirements for the species considered under the Forest 2020 (PDA) Initiative. It lists potential damaging agents, common pest insects, diseases, and other points of interest that can affect plantation health and performance. It should be noted that forest productivity in Ontario generally declines northwards as a result of the shorter growing season. Consequently, the forest productivity target is more likely to be attained in more southerly areas. The six geographical regions used to describe planting suitability in Ontario include: 1) southwest (including Niagara); 2) southcentral (south of Barrie); 3) Eastern (East of Cobourg); 4) northcentral (Barrie to North Bay); 5) northeast (Nipigon to Quebec border); and 6) northwestern Ontario (Nipigon to Kenora).

Species	Suitable Regions for Planting in Ontario[2]	Suitable Site Types and Soils		Damaging Agents	Insects [1]	Disease [1]	Other Considerations
		Soil Type	Drainage				
RED PINE (*Pinus resinosa* Ait.)	All Regions of Ontario[2]	• Deep sandy loams and sand • Calcareous soils are not suitable • A pH of 4.5 to 6.0 in seedling rooting is ideal[3]	• Moderately- to well-drained	• White-tailed deer • Snowshoe hares and cottontail rabbits • Rodents, including porcupine[4]	• Pine false webworm • European pine shoot beetle[4] • European pine sawfly • Redheaded pine sawfly[5] • Pine engraver beetle[6] • White spotted sawyer beetle[7]	• *Fomes* root rot • *Armillaria* root rot[8] • The European race of *Scleroderris* canker[8] • Physiological needle drop[9]	• Suitable as a nurse crop for the development of hardwoods and white pine • Can be retained as a super canopy species • Is a good candidate for commercial thinning, provided the stumps are treated with borax to prevent root rot diseases[10] • Commonly planted at 2.1m x 2.1m spacing
WHITE PINE (*Pinus strobus* L.)	All regions of Ontario[2]	• Medium texture • Sands, sandy loams, fine sandy loams and well drained silty loams • Heavy clay soils and poorly drained bottom lands, or upland depressions are not suitable[4]	• Well-drained	• White-tailed deer • Snowshoe hares and cottontail rabbits • Rodents, including porcupine[4]	• White pine weevil[5] • Introduced pine sawfly[6] • Pine spittle bug[9] • Pine false webworm[6]	• White pine blister rust[5] • *Fomes* root rot and *Armillaria* root rot[8]	• Infrequently planted in the north-central region of Ontario due to blister rust damage[11] • Initial planting densities of 2500-3000 stems/ha helps mitigate weevil and blister rust damage • Can be planted in mixtures with red pine, Norway spruce, red spruce or white spruce

[1]See Appendix II – for scientific and common names [2]Burns and Honkala 1990 [3]Hosie 1969; Rudolf 1990 [4]Ontario Ministry of Natural Resources 1998a [5]Ontario Ministry of Natural Resources 1991b [6]Drooz 1985 [7]Ryall and Smith 2001 [8]Davis and Meyer 1997 [9]Boyce 1961 [10]Ontario Ministry of Natural Resources 2000 [11]Ohmann 1979

Species	Suitable Regions for Planting in Ontario [2]	Suitable Site Types and Soils		Damaging Agents	Insects [1]	Disease [1]	Other Considerations
		Soil Type	Drainage				
WHITE SPRUCE (*Picea glauca* (Moench) Voss)	All regions of Ontario	• Loams, silt loams and clays • Deep well drained sandy soils and sites with a high water table are not suitable[3] • A pH of 4.7 to 7.0 in seedling rooting is ideal[3]	• Moderately- to well-drained	• White-tailed deer in some areas • Snowshoe hares and cottontail rabbits • Livestock grazing • Rodents[4]	• Spruce budworm[5] • Eastern spruce gall adelgid • White pine weevil • Yellow headed sawfly • Spruce needle miner[6] • Spruce coneworm[7]	• Spruce canker [6] • *Tomentosus* root rot[8] • Spruce needle rust • *Armillaria* root rot[9]	• Resistant to ice and snow loads[10] • Larger planting stock may mitigate late spring frost damage on exposed sites [5] • High genetic variability in height and diameter evident after planting[5] • Can be planted with white pine, red spruce, Norway spruce and other species suitable to the site and soil conditions
RED SPRUCE (*Picea rubens* Ait.)	Southcentral[5] Southwest Eastern Northcentral	• Acidic loam and clay soils[5] • Very wet or very dry soils are not suitable	• Well-drained	• White-tailed deer in some areas • Snowshoe hares and cottontail rabbits • Livestock grazing • Rodents[4]	• White pine weevil • Spruce budworm • Eastern spruce budworm • European spruce sawfly • Eastern spruce beetle	• *Tomentosus* root rot[12]	• Susceptible to winter drying[13] • Can be planted with White pine, white spruce and Norway spruce

[1]See Appendix II – for scientific and common names [2]Burns and Honkala 1990 [3]Eyre 1980 [4]Ontario Ministry of Natural Resources 1995b [5]Johnson et al.1996 [6]Ontario Ministry of Natural Resources 1991b [7]Rose 1997 [8]Whitney 1977 [9]Davis and Meyer 1997 [10]Ontario Ministry of Natural Resources 2000 [11]Frank and Bjorkbom 1973 [12]Whitney 2000 [13]Ontario Ministry of Natural Resources 1998a

Species	Suitable Regions for Planting in Ontario[2]	Suitable Site Types and Soils		Damaging Agents	Insects[1]	Disease[1]	Other Considerations
		Soil Type	Drainage				
NORWAY SPRUCE (*Picea abies* (L.) Karst.)	• All regions of Ontario	• Cool humid climates on rich soils[3, 4] • Fresh and moist[6], sandy loams and clay loams[3,4, 5] • Very wet or very dry sites are not suitable	• Well-drained	• White-tailed deer in some areas • Snowshoe hares and cottontail rabbits • Livestock grazing • Rodents[7]	• Spruce budworm[8] • White pine weevil[9]	• Spruce canker[8] • Heart rot decay[10]	• Can be planted with white pine, white spruce and red spruce
TAMARACK or EASTERN LARCH (*Larix laricina* Du Roi. K. Koch)	• All regions of Ontario	• Loams to sandy loams[6] • not suitable for areas prone to prolonged periods of flooding[6]	• Well-drained to poorly-drained	• Porcupines[7] • Very intolerant to chemical herbicides	• Larch sawfly[11] • Larch casebearer[11] • Eastern larch beetle[11]	• No major disease associated with larches[7]	• Typical spacing for larch is 2.4m x 2.4m • An active thinning regime maintains good health and vigour

[1]See Appendix II – for scientific and common names [2]Burns and Honkala 1990 [3]Barrett et al.1961 [4]Collingwood et al.1964 [5]Kostler 1956 [6]Johnson et al. 1996 [7]Ontario Ministry of Natural Resources 1995b [8]Ontario Ministry of Natural Resources 1991b [9]Zobel and Talbert 1984 [10]Pers. Comm. S.D'Eon 2004 [11]Drooz 1985

Species	Suitable Regions for Planting in Ontario[2]	Suitable Site Types and Soils		Damaging Agents	Insects[1]	Disease[1]	Other Considerations
		Soil Type	Drainage				
EUROPEAN LARCH (*Larix dicidua* Mill.) and JAPANESE LARCH (*Larix leptolepis* (Sieb. Zucc.) Gord.)	• All regions of Ontario	• Uniformly moist, deep, fertile soils • Loamy sands, loams and silty loams[3] • Unsuitable on pure sand and poorly drained or very wet sites	• Well-drained	• White-tailed deer in some areas • Snowshoe hares and cottontail rabbits • Livestock grazing • Rodents[2]	• Seed weevils[4] • Larch casebearer • Larch sawfly • Eastern larch beetle[5]	• European larch canker[6] • Needle cast of larch disease[7]	• Less wood value than other conifer species • Typical spacing for larches is 2.4m x 2.4m • An active thinning regime maintains good health and vigour • Avoid planting in frost pockets[2]
RED OAK (*Quercus rubra* L.)	• All regions of Ontario	• Deep fertile moist fine sands, sandy loams, and loams[8] • Can tolerate poorly drained clay to well drained shallow or rocky sites[8] • Dry-mesic to mesic sites are also tolerable[9]	• Well-drained	• White-tailed deer in some areas • Snowshoe hares and cottontail rabbits • Livestock grazing • Rodents[2]	• Gypsy moth[7] • Forest tent caterpillar[7] • Orangestriped oakworm[7] • Oak skeletonizer[10] • Oak leaf shredder [10] • Two lined chestnut borer[11]	• Oak decline[12] • *Armillaria* root rot[13] • *Anthracnose*[13]	• Can be planted with white ash, sugar maple, or other hardwood species suitable to similar site conditions • Susceptible to frost damage

[1]See Appendix II – for scientific and common names [2]Johnson et al. 1996 [3]Kostler 1956 [4]Rudolf 1974 [5]Drooz 1985 [6]Canadian Food Inspection Agency 2004c [7]Ontario Ministry of Natural Resources 1991b [8]von Althen 1990 [9]Archambault et al. 1990 [10]Rose et al. 1997 [11]Drooz 1985 [12]Millers et al. 1989 [13]Davis and Meyer 1990

Species	Suitable Regions for Planting in Ontario[2]	Suitable Site Types and Soils		Damaging Agents	Insects[1]	Disease[1]	Other Considerations
		Soil Type	Drainage				
HYBRID POPLAR (*Populus* spp.)	• All regions of Ontario (depending on clone type)[2]	• Deep fertile moist loam soil with organic content between 3% and 8%, and on fields with less than 8% slope • Rich medium textured soils are also suitable • Avoid soils with hardpans in the rooting zone, soils of high salinity and fields treated with persistent herbicides in the preceding 12-24 months[3] • Suitable pH is between 5.5 and 7.5[3]	• Imperfectly to moderately well-drained	• Deer, moose and rodents[3] • Some clones susceptible to late spring frost[4] • Susceptible to sunscald and herbicide damage[2]	• Poplar and Willow borer[5] • Imported willow leaf borer[5] • Cotton wood leaf beetle[5] • Tarnished plant bug[5] • Forest tent caterpillar[5] • Eastern tent caterpillar[5] • Gypsy moth[5] • Large aspen Tortrix[6] • American aspen beetle[6]	• *Septoria* canker[5] • *Septoria* leaf spot[5] • *Cytospora* canker[5] • *Hypoxylon* canker[4] • Leaf and shoot blight[4]	• Clone types vary with respect to frost, disease and insect susceptibility • Intensive site preparation and weed control are essential [3] • Ensure that the clone is well adapted to local climate and growing conditions • Consult local forestry professionals for the latest pest information and disease hazards

[1]See Appendix II – for scientific and common names [2]Ontario Ministry of Natural Resources 1991a [3]McEwen 2002 [4]Ostry et al. 1988 [5]Ontario Ministry of Natural Resources 1991b [6]Rose et al. 1997

Species	Suitable Regions for Planting in Ontario[2]	Suitable Site Types and Soils		Damaging Agents	Insects[1]	Disease[1,6]	Other Considerations
		Soil Type	Drainage				
SILVER MAPLE (*Acer saccharinum* L.)	• Southcentral • Southwest • Eastern	• Moist loams or clay loams • Organic clays are also suitable provided that moisture is present throughout the entire growing season[3]	• Well-drained	• Deer, rabbit and moose browse • Rodents[3]	• Cankerworm[4] • Fall web worm[4] • Forest tent caterpillar[4] • June beetles[4] • Bladder gall mites[5]	• Tar spot • *Phyllostica* leaf spot • *Cytospora* canker • *Eutypella* canker • *Nectria* canker • *Anthracnose*	• Highly susceptible to ice damage • Wet and organic sites are best planted with silver maple alone[3] • Can be planted on moist sites with white ash, black walnut or other species suitable to the site conditions[3] • Intensive site preparation is required on sites prone to high levels of competition[7]

[1]See Appendix II – for scientific and common names [2]Burns and Honkala 1990 [3]von Althen 1990 [4]Ontario Ministry of Natural Resources 1991b [5]Rose et al. 1997 [6]Davis and Meyer 1997 [7]Johnson et al. 1996 [8]Farrar 1995

Species	Suitable Regions for Planting in Ontario[8]	Suitable Site Types and Soils		Damaging Agents	Insects[1]	Disease[1,6]	Other Considerations
		Soil Type	Drainage				
SUGAR MAPLE (*Acer saccharum* Marsh.)	• Southwest • Southcentral • Eastern • Northcentral • Northeast	• Deep, moist fertile sandy loams and loams[3] • Also grows on sands, clays and stony tills	• Well-drained	• Deer and moose • Rodents	• Gypsy moth[4] • Eastern tent caterpillar[4] • Potato leaf hopper[3] • Maple gall mite[4] • Sugar maple borer[4] • Maple leaf cutter[4] • Maple trumpet skeletonizer[4] • Norway maple aphid[4] • Saddled prominent[4] • Cankerworm[4] • Fall web worm[4] • Forest tent caterpillar[4]	• Tar spot • *Phyllosticta* leaf spot • *Hypoxylon* canker • *Cytospora* canker • Mossy top fungus • Spine tooth fungus • punk knot • coal fungus • Shoestring root rot • False tinder fungus • *Eutypella* canker of maple • *Nectria* canker of hardwoods	• Tree protectors may be required in areas where rodent populations are a problem • Plant only with other hardwoods favoring similar site conditions as conifers provide increased habitat for mice and rabbits

[1]See Appendix II – for scientific and common names [2]Burns and Honkala 1990 [3]von Althen 1990 [4]Ontario Ministry of Natural Resources 1991b [5]Rose et al. 1997 [6]Davis and Meyer 1997 [7]Johnson et al. 1996 [8]Farrar 1995

Species	Suitable Regions for Planting in Ontario[2]	Suitable Site Types and Soils		Damaging Agents	Insects [1]	Disease [1]	Other Considerations
		Soil Type	Drainage				
RED MAPLE (*Acer rubrum* L.)	• Southwest	• Wide range of moist soil types[3]	• Moderately well- drained[3]	• Deer, rabbit and moose • Rodents[3]	• Basswood looper (Linden looper)[2]	• *Inonotus* trunk rot[2] • *Oxyporus* trunk rot[2] • *Philinus* trunk rot[2] • *Nectria* canker[2] • *Eutypella* canker[2]	• Very susceptible to defect and poor form[2]
BLACK WALNUT (*Juglans nigra* L.)	• Southwest	• Deep neutral moist fertile soils • Deep loams and alluvial deposits • Good agricultural soils	• Well-drained	• Deer and rabbit browse • Rodents[3]	• Walnut caterpillar[4] • Fall webworm[5]	• European canker[6] • Yellow leaf blotch[4]	• High value wood products • Some conifers can be affected by a toxic substance found in the leaves, nut husks, and roots called juglone[9]; species affected can be used as a nurse crop • Can be interplanted with Black alder and Russian olive to increase yields[10] • Can also be planted with autumn olive, European alder, Norway spruce, or in random mixture with white ash, silver maple, or other hardwood species suitable to similar site conditions[11]

[1]See Appendix II – for scientific and common names[2] Burns and Honkala 1990 [3]von Althen 1990 [4]Ontario Ministry of Natural Resources 1991b [5]Rose et al. 1997 [6]Rink 1988; Williams 1990 [7]Boyce 1961[8]Davis and Meyer 1997 [9]Ferguson and Boyd 1988; Hosie 1969; Rice 1974 [10]Torrey 1978; Zitzer and Dawson 1989 [11]von Althen 1990

Species	Suitable Regions for Planting in Ontario[2]	Suitable Site Types and Soils		Damaging Agents	Insects[1]	Disease[1]	Other Considerations
		Soil Type	Drainage				
WHITE ASH (*Fraxinus americana* L.)	• Southwest	• Uniformly moist, deep loams, clay loams or clays high in nitrogen and calcium[3]	• Imperfectly to well-drained	• Deer and rabbit • Rodents[3]	• Emerald ash borer[4] • Fall webworm[5] • Forest tent caterpillar[5] • Ash flower gall[6] • Oystershell scale insect[7]	• *Marssonina* leaf spot[8] • Anthracnose[8] • Ash yellows	• Can be planted alone when managed intensively on fertile sites • Can also be planted with black walnut, silver maple and other hardwood species suitable to similar site conditions[3] *note: planting ash species in some areas is currently being avoided owing to the threat from the Emerald ash borer.*
GREEN ASH (*Fraxinus pennsylvanica* L.)	• Southwest	• Uniformly moist, deep loams, clay loams or clays[3] • Can also grow well on medium textured upland sands and loams with a good supply of moisture[3]	• Imperfectly to well-drained[3] • Can tolerate flooding up to two weeks[2]	• Deer and rabbit • Rodents[3]	• Emerald ash borer[4] • Fall webworm[5] • Forest tent caterpillar[5] • Ash flower gall[6] • Oystershell scale insect[7]	• *Marssonina* leaf spot[8] • Anthracnose[8] • Ash yellows	• Grows well on its own or in mixture with other hardwoods suited to similar site and soil conditions *note: planting ash species in some areas is currently being avoided owing to the threat from the Emerald ash borer.*

[1]See Appendix II – for scientific and common names [2]Johnson et al. 1996 [3]von Althen 1990 [4]Canadian Food Inspection Agency 2004b [5]Drooz 1985 [6]Ontario Ministry of Natural Resources 1991b [7]Rose et al. 1997 [8]Davis and Meyer 1997

Species	Suitable Regions for Planting in Ontario[2]	Suitable Site Types and Soils		Damaging Agents	Insects[1]	Disease[1]	Other Considerations
		Soil Type	Drainage				
YELLOW BIRCH (*Betula alleghaniensis* Britt.)	• All regions of Ontario	• Fertile loams[3] • Sandy loams[3]	• Well-drained • Moderately well-drained	• Deer and rabbit browse • Rodents[3]	• Birch leaf minor[4] • Bronze birch borer[4] • Yellow necked caterpillar[4] • Fall cankerworm[4] • Fall webworm[4] • Forest tent caterpillar[4] • White marked tussock moth • Gypsy moth[4] • Saddled prominent[4]	• *Hypoxylon* canker[5] • *Nectria* canker[5] • Stem decay[5] • *Armillaria* root rot[5] • False tinder fungus[5]	• Susceptible to ice and snow load damage • Vulnerable to late spring frosts • Susceptible to sulfur dioxide 3.5 ppm • Can be planted with white pine

[1]See Appendix II – for scientific and common names [2]Johnson et al. 1996 [3]Erdman 1990 [4]Ontario Ministry of Natural Resources 1991b [5]Davis and Meyer 1977

Species	Suitable Regions for Planting in Ontario[2]	Suitable Site Types and Soils		Damaging Agents	Insects[1]	Disease[1]	Other Considerations
		Soil Type	Drainage				
WHITE BIRCH (*Betula papyrifera* Marsh.)	• All regions of Ontario	• Deep sandy or silty soils[6]	• Well-drained or moderately well-drained	• Deer and rabbit browse • Rodents[3]	• Birch leaf minor[4] • Bronze birch borer[4] • Yellow necked caterpillar[4] • Fall cankerworm[4] • Fall webworm[4] • Forest tent caterpillar[4] • White marked tussock moth • Gypsy moth[4] • Saddled prominent[4]	• Susceptible to bacteria or decay fungi through wounds, branch stubs, and roots contacted with other infectious roots • Stem decay[5] • *Armillaria* root rot[5] • False tinder fungus[5]	• Often killed in low intensity fires

[1]See Appendix II – for scientific and common names [2]Johnson et al. 1996 [3]Erdman 1990 [4]Ontario Ministry of Natural Resources 1991b [5]Davis and Meyer 1997 [6]Haeussler and Coates 1986; Stafford et al. 1990

Species	Suitable Regions for Planting in Ontario[2]	Suitable Site Types and Soils		Damaging Agents	Insects[1]	Disease[1]	Other Considerations
		Soil Type	Drainage				
TULIP TREE (*Liriodendron tulipifera* L.)	• Southwest	• Deep fertile moist sandy loams, loams, silt loams or moulded tills with silt plus clay content of at least 35%	• Well-drained	• Deer and rabbit • Rodents[3]	• Tulip tree scale[4] • Yellow poplar weevil[4] • Root collar borer[4]	• Nursery root-rot disease • Sapwood stain	• Susceptible to late spring frosts • Indigenous to the Carolinian Forests of southcentral and southwestern Ontario

[1]See Appendix II – for scientific and common names [2]Johnson et al. 1996 [3]von Althen 1990 [4]Burns and Honkala 1990

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APPENDIX I

Forest 2020 Site and Species Eligibility

Definitions from the Kyoto Protocol

Forest

…is a minimum area of land of at least 1.0 hectare with tree cover (or equivalent stocking level) of more than 30% with trees with the potential to reach a minimum height of 5 metres at maturity in situ. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest. Young natural stands and all plantations which have yet to reach a crown density of 30 per cent or tree height of 2-5m are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural or unatural causes but which are expected to revert to forest.

Afforestation

…is the direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources.

Reforestation

…is the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forest land. For the first commitment period, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on the 31st of December 1989.

Species Eligibility

The following species are considered priority candidates for the Forest 2020 (PDA) Initiative. Other fast growing tree species could also be considered.

Hardwoods[I]

Silver maple, red maple, sugar maple, red oak, white birch, yellow birch and black walnut, white ash, green ash, and tulip poplar.

Conifers[I]

Red pine, white pine, Norway spruce, white spruce, red spruce, tamarack, European larch, and Japanese larch

APPENDIX II

Common and Scientific Names of Species

Tree Species

Common Name (abbreviation)	Scientific Name
Basswood (Bd)	*Tilia americana*
Beech (Be)	*Fagus sylvatica*
Bitternut hickory (Hib)	*Carya cordiformis* (Wangenh.) K. Koch
Black alder (Ab)	*Alnus glutinosa* (L.) Gaertn.
Black Cherry Cb)	*Rosaceae Prunus serotina*
Black Walnut (Wb)	*Juglans nigra* L.
European Larch (Le)	*Larix decidua* Mill.
Green Ash (Ag)	*Fraxinus pennsylvanica* Marsh.
Hybrid Poplar (Ph)	*Populus* spp.
Japanese larch (Lj)	*Larix leptolepis* (Sieb. Zucc.) Gord.
Norway Spruce (Sn)	*Picea abies* (L.) Karst.
Red Maple (Mr)	*Acer rubrum* L.
Red Oak (Or)	*Quercus rubra* L.
Red Pine (Pr)	*Pinus resinosa* Ait.
Red Spruce (Sr)	*Picea rubens* Ait.
Russian olive (Ol)	*Elaeagnus angustifolia* L.
Silver Maple (Ms)	*Acer saccharinum* L.
Sugar Maple (Mh)	*Acer saccharum* Marsh.
Tamarack or Eastern Larch (La)	*Larix laricina* Du Roi. K. Koch
Tulip-tree (Tp)	*Liriodendron tulipifera* L.
White Ash (Aw)	*Fraxinus americana* L.
White Birch Bw)	*Betula papyrifera* Marsh.
White Oak (Ow)	*Quercus alba*
White Pine (Pw)	*Pinus strobus* L.
White Spruce (Sw)	*Picea glauca* (Moench) Voss
Yellow Birch (By)	*Betula alleghaniensis* Britt.

Insects and Diseases

Common Name	Scientific Name
American aspen beetle	*Gonioctena americana* (Schaeff.)
Anthracnose spp.	*Aureobasidium apocrytum* (Ells & Everh.) Herm.-Nijh
Armillaria root rot	*Armillaria ostoyae* (Romagn.) Herink
Ash flower gall	*Eriophyes fraxiniflora* Felt
Basswood looper (linden looper)	*Erannis tiliaria* (Harr.)

Common Name	Scientific Name
Birch leaf miner	*Fenusa pusilla* (Lep.)
Birch skeletonizer	*Bucculatrix canadensisella* Cham.
Black vine weevil	*Otiorhynchus sulcatus* (F.)
Bronze birch borer	*Agrilus anxius* Gory
Brown spruce longhorn beetle (BSLB)	*Tetropium fuscum* Fabricius
Coal fungus	*Hypoxylon deustum* (Hoff. ex Fries) Grev
Cottonwood leaf beetle	*Crysomela scripta* Fabricius
Cylindrocadium root rot	*Cylindrocladium scoparium* Morgan
Cytospora canker	(*Cytospora chrysosperma*) (Pers.:Fr.)Fr
Damping off	*Cylindrocladium* spp.
Eastern larch beetle	*Dendroctonus simplex* LeC.
Eastern spruce beetle	*Dendroctonus rufipennis* (Kby.)
Eastern spruce gall *adelgid*	*Adelges abietis* (L.)
Eastern tent caterpillar	*Malacosoma americanum* (F.)
Elm bark beetles	*Scolytus* spp.
Emerald ash borer	*Agrilus planipennis* Fairmaire
European larch canker	*Lachnelluna willkommii* (Hartig.) Dennis
European pine sawfly	*Neodiprion sertifer* (Geoff.)
European pine shoot beetle	*Tomicus piniperda* (L.)
European pine shoot moth	*Rhyacionia buoliana* (Dennis & Schiffermuller)
European spruce sawfly	*Diprion hercyniae* Hartig.
Eutypella canker	*Eutypella parasitica* R.W. Davidson & R.C. Lorenz
Fall cankerworm	*Alsophila pometaria* (Harr.)
Fall webworm	*Hyphantria cunea* (Drury)
False tinder fungus	*Phellinus igniarious* (L.:Fr.) Quel.
False tinder fungus	*Phellinus igniarious* (L.:Fr.) Quel.
Fomes root rot	*Heterobasidion annosum* (Fr.:Fr.) Bref.
Forest tent caterpillar	*Malacosoma disstria* Hbn.
Gypsy moth	*Lymantria dispar* (L.)
Horse chestnut leaf blotch	(fungus) *Guignardia aesculi*
Hypoxylon canker	*Hypoxylon mammatum* (Wahlenb.) P. Karst.
Imported willow leaf beetle	*Plagiodera versicolora* (Laich.)
Introduced pine sawfly	*Diprion similes* (Htg.)
June beetles	*Phyllophaga errans* (Leconte)
Larch casebearer	*Coleophora laricella* (Hbn.)
Larch sawfly	*Pristiphora erichsonii* (Htg.)
Large aspen tortrix	*Choristoneura conflictana* (Wlk.)
Leaf and shoot blight	*Venturia macularis* (Fr.:Fr.) E. Mull. & Arx
Maple bladdergall mite	*Vasates quadripedes* Shimer
Maple leaf cutter	*Paraclemensia acerifoliella* (Fitch)
Maple trumpet skeletonizer	*Epinotia aceriella* (Clemens)
Marssonina leaf spot	*Marssonina populi* (Lib.) Magnus
Melampsora leaf rust	*Melampsora* spp.
Mossy top fungus	*Oxyporus populinus* (Schumach.:Fr.) Donk
Nectria canker	*Nectria galligena* Bres.
Needle cast of larch disease	*Meria laricis* Vuillemin
Norway maple aphid	*Periphylus lyropictus* (Kess.)
Northern pine weevil	*Pissodes approximatus* (H.)

Common Name	Scientific Name
Oak leaf shredder	*Croesia semipurpurana* (Kft.)
Oak skeletonizer	*Bucculatrix ainsliella* Murt.
Orangestriped oakworm	*Anisota senatoria* (J.E. Smith)
Oystershell scale	*Lepidosaphes ulmi* (Linnaeus)
Pales weevil	*Hylobius pales* (Herbst)
Phyllosticta leaf spot	*Phyllosticta minima* (Berk. z& M.A. Curtis) Underw. & Earle
Pine engraver beetle	*Ips pini* (Say)
Pine false webworm	*Acantholyda erythrocephala* (L.)
Pine root collar weevil	*Hylobius radicis* (Buchanan)
Pine spittle bug	*Aphrophora cribrata* (Wlk.)
Poplar and willow borer	*Cryptorhynchus lapathi* (L.)
Poplar borer	*Saperda calcarata* Say
Poplar Bracket	*Oxyporus populinus* (Schumach.) Donk
Potato leafhopper	*Empoasca fabae* (Harr.)
Punk knot	*Inonotus glomeratus* (Peck) Murrill
Redheaded pine sawfly	*Neodiprion lecontei* (Fitch)
Root collar borer	*Euzophera ostricolorella* Hulst
Rose chafer	*Macrodactylus subspinosus*
Saddled prominent	*Heterocampa guttivitta* (Wlk.)
Sapwood stain	*Ceratocystis pluriannulata* (Hedge.) C. Mor.
Satin moth	*Leucoma salicis* (L.)
Scleroderris canker	*Gremmeniella abietina* (Lagerb.) M. Morelet
Septoria leaf spot and canker	*Mycosphaerella populorum* G.E. Thomps.
Shoestring root rot	*Armillaria ostoyae* (Romagn.) Herink
Spine tooth fungus	*Climacodon septentrionalis* (Fr.) P. Karst.
Spruce budworm	*Choristoneura fumiferana* (Clem.)
Spruce canker	*Leucostoma kunzei* var. *piceae (Ascomycotina)*
Spruce coneworm	*Dioryctria reniculelloides* Mut. & Mun.
Spruce needle miner	*Endothenia albolineana* (Kft.)
Spruce needle rust	*Chrysomyxa ledi* (Alb. & Schwein.) de Bary var. ledi and *Chrysomyxa ledicola* Lagerh.
Strawberry root weevil	*Otiorhynchus ovatus* (L.)
Stem decay	*Inonotus obliquus* (Pers.:Fr.) Pilát
Sugar maple borer	*Glycobius speciosus* (Say)
Tar spot	*Rhytisma* spp.
Tarnished plant bug	*Lygus lineolaris* (P. de B.)
Tomentosus root rot	*Inonotus tomentosus* (Fr.:Fr.) S. Teng
Tulip tree scale	*Toumeyella liriodendri* (Gmel)
Two lined chestnut borer	*Agrilus bilineatus* (Weber)
Walnut caterpillar	*Datana integerrima* G. & R.
White marked tussock moth	*Orgyia leucostigma* (J.E. Smith)
White pine blister rust	*Cronartium ribicola* J.C. Risch.
White pine weevil	*Pissodes strobi* (Peck)
White spotted sawyer beetle	*Monochamus scutellatus* (Say)
Yellow headed sawfly	*Pikonema alaskensis* (Roh.)
Yellow necked caterpillar	*Datana ministra* (Drury)
Yellow-poplar weevil	*Odontopus calceatus* (Say)

APPENDIX III

Guide to Tree Species Suitability for Site Regions 6e & 7e using field recognizable soil properties[1]

[1]This information has been adapted from Addenda 1 in Taylor and Jones (1986) - Field Manual for Describing Soils in Ontario - with the permission of the Ontario Centre for Soil Resource Evaluation (OCSRE). The field manual and separate Addenda 1 are available from: Department of Land Resource Science University of Guelph Guelph, Ontario NIG 2W1, (519) 824-4120 ext. 54359

ORIENTATION TO GUIDE

Matching species to site is a critical task in forest management planning. Species well-suited to site conditions often demonstrate high levels of survivorship, good vigour and sustained growth. Off-site plantings (i.e., the planting of species unsuited to particular site conditions) pose serious problems for forest managers with the long term planning of future wood supply. For example, red or white pine planted on calcareous soils can die prior to reaching rotation age. This is true also for the management of naturally regenerated hardwood stands. This has been noted with the managed stands of sugar maple occurring on poorly drained soils. Frequently they demonstrate a decline in vigour, and in some cases mortality, prior to reaching maturity. The time spent on soil and site quality assessment helps to ensure that many of these problems are avoided.

This guide summarizes the measured and predicted site index values (height at age 50) using a simple framework of recognizable soil features for the major commercial species of Site Regions 6e and 7e, see figure 10.

The nine soil texture groups represent practical classes for evaluating the relative nutritional and moisture holding capacity of the soil for forest growth. The "Depth to Distinct Mottles" component of the matrix likewise represents a simple, direct means to evaluate available moisture supply using features which indicate the nature of the internal drainage and water table activity. "Depth to Bedrock" was found to be directly related to the effective rooting volume. In the case of red and white pine, the "Depth to Carbonates" and "Depth to Root Restricting Layer" are also incorporated in the on-site matrix due to their influence on productivity, particularly on severely eroded and compacted soils respectively.

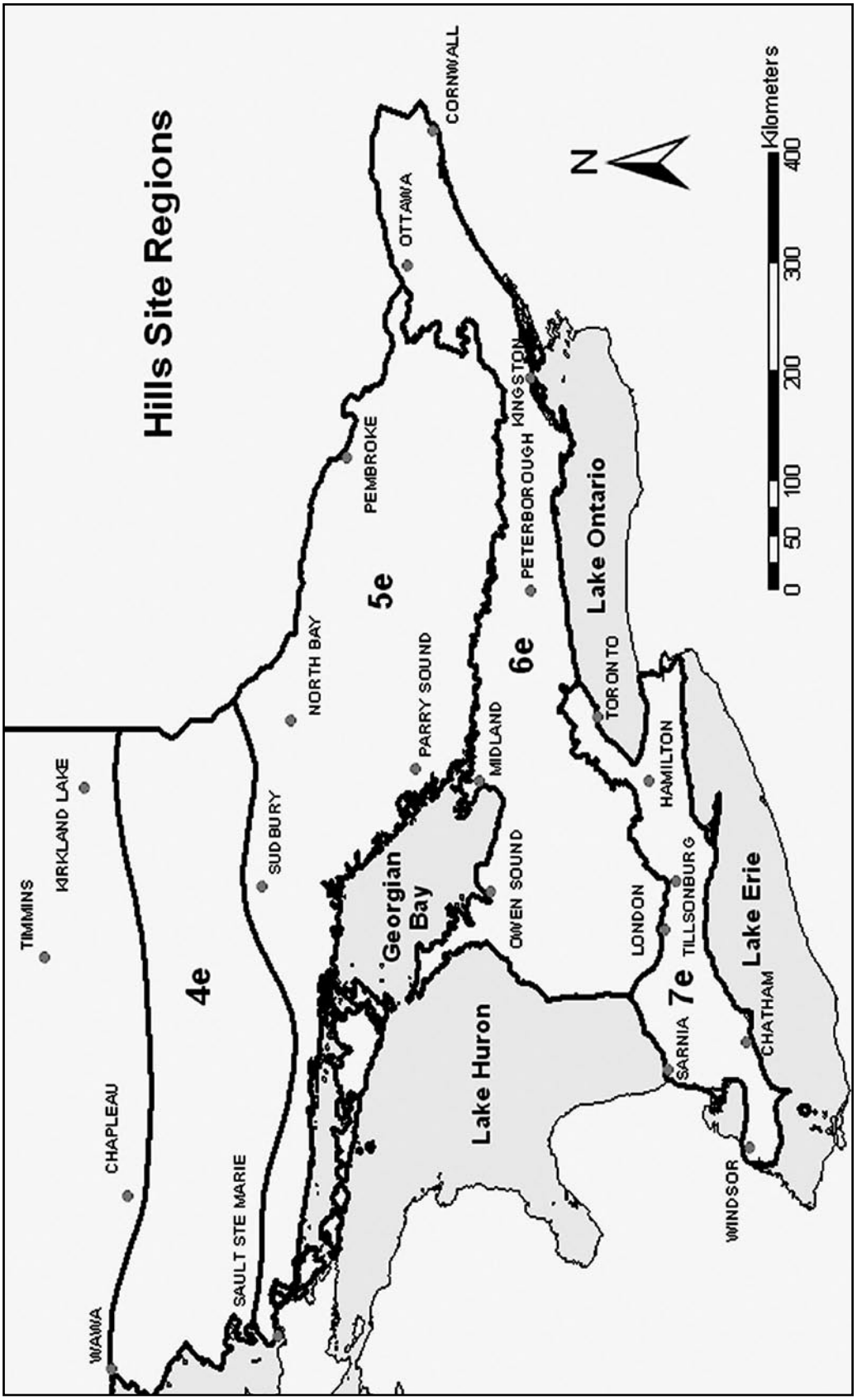

Figure 10. Map of study area showing Site Regions (Hills 1959). Data provided by Ontario Ministry of Natural Resources. Copyright: 2005 Queens Printer Ontario.

Description of Texture Groups

TEXTURE GROUP	DESCRIPTION
1. VGR–Very Gravelly	All textures with 50% of particles ≥2 mm in size
2. GSY–Gravelly Sandy	All sandy (SDY) textures with 20-50% of partcles ≥2 mm in size
3. SDY–Sandy	any of: vcs - very coarse sand cs - coarse sand ms - medium sand fs - fine sand lvcs - loamy very coarse sand lcs - loamy coarse sand lms - loamy medium sand lfs - loamy fine sand
4. GLY–Gravelly Loamy	all coarse loamy (C.LMY) textures with 20-50% of particles ≥2mm
5. C.LMY–Coarse Loamy	all of: vfs - very fine sand lvfs - loamy very fine sand sl - sandy loams (all) l – loam
6. SIY–Silty	all of: si - silt sil - silt loam
7. FLY–Fine Loamy	all of: cl - clay loam sicl - silty clay loam scl - sandy clay loam
8. CYY–Clayey	all of: sic - silty clay sc - sandy clay c - clay hc - heavy day
9. SHA–Shallow	any texture where depth to bedrock ≤50 cm

How To Use The Tree Species Suitability Tables

Use of Tables

These tables are designed to be used for:

1) Ranking species performance for plantation establishment or for the management of existing stands. Volume yield tables, when available, should also be considered.

2) Identifying the "best" and "poorest" local site conditions.

3) Identifying potential problem sites.

4) Predicting variation in stand performance due to local changes in soil and site quality.

5) Contributing to management considerations related to the scheduling of silvicultural operations like thinning and pruning.

6) Assisting with the communication of silvicultural prescriptions and experiences using a common soil and site framework.

Limitations of Species Suitability Tables

In applying the on-site tables, the user should be aware of some of the limitations of the data base and the results of the analysis:

1) The problem of sample replication. There are 29 tables and 60 potential matrix cells table for each table for a total of 1,740 cells. If at least 10 replications were considered a reasonable number for each cell, 17,400 would be required. Users of the tables should exercise caution when employing predictions of species performance based on a limited sample size.

2) The prediction tables have not been tested adequately with independent data other than informally during technology transfer sessions with forestry staff.

3) In the analysis of the data species performance was related to relatively easy to measure properties (e.g., texture, depth to mottling, etc.) and not the generally accepted yet difficult to measure soil properties such as available water and nutrients, soil temperature and soil aeration. The user should be aware that the results do not reflect the best predictive models but do represent a reasonable practical alternative to the operational needs of forest management staff.

4) These predictions are appropriate for Central and Southwestern Regions, Ontario. Beyond these Regions, absolute values may not hold however, the general trends of species performance may apply.

White pine/6e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm	4*/5c 20.3/16.4	2* 24.4	(2)	(3)	(3)	(4)	(5)
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	5 19.5	(3)	3/5c 22.4/15.6	(2)	4/5c 21.3/18.1	5* 17.3	(5)
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS	4 19.3	2 25.3	1 26.2	2 25.5	3 23.4	4* 21.6	5 18.3
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	(3)/5c -/18.5	2 25.1	(1)	(3)	4/5c 20.7/17.9	5 19.8	(5)
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	3/5c 22.3/19.6	1/5c* 27.4/16.7	2 24.3	2 25.9	3 22.0	3/5c 22.3/16.6	4/5c* 20.5/16.7
SIY-Silty SI and SIL	3 22.6	(2)	3* 22.6	3* 22.6	3/5cr 22.3/17.9	4* 21.0	5
FLY-Fine Loamy CL, SCL, SICL	4 21.0	2*/5cr 24.1/16.0	(2)	4cr* 21.3	3/5cr 23.8/17.1	5cr 19.0	(4)
CYY-Clayey C, SC, SIC, HC	 -	(3)	(3)/5cr -/15.1	(4)	(4)	4 20.5	(5)
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	-	4 20.0	(3)	1 28.3	(3)	5

SITE CLASSES (SI-50 yr:) 1:≥26.0 m 2: 24.0-25.9 m 3:22.0-23.9 m 4: 20.0-21.9 m 5: ≤19.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Red pine/6e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm	3/5c 19.4/16.0	3 19.8	(4)	(5)	(5)	(5)	(5)
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	3/4c 19.7/17.6	3* 20.4	3* 22.9	(4)	(4)	(5)	(5)
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS	3 20.6	2 21.9	1 26.1	1/3r 25.0/20.5	2 22.0	3 20.6	4 18.4
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	3 20	(3)	(2)	(3)	3 20.8	4 20.6	(5)
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	1 /(5)cr 23.0/-	(1)/(5)c	2/5r 22.6/16.7	1/5c 23.9/16.1	3 20.8	3* 20.8	(4)
SIY-Silty SI and SIL	2 21.4	3/4cr 20.8/18.5	1 23.1	2/5r 21.9/16.6	2/5r 21.8/15.8	(4)	(5)
FLY-Fine Loamy CL, SCL, SICL	1* 23.2	(3)	2* 21.6	2 21.3	2 21.4	4* 18.8	(5)
CYY-Clayey C, SC, SIC, HC	- -	(5)	3* 20.5	4* 18.1	(5)	(5)	(5)
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	- -	2 21.0	(3)	(5)	(5)	(5)

SITE CLASSES (SI-50 yr:) 1: ≥23.0 m 2:21.0-22.9 m 3:19.0-20.9 m 4:17.0-18.9 m 5:≤17.0 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

White spruce/6e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm	5 17.5	(4)	(3)	(3)	(4)	(5)	(5)
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	2*/5*c 25.2/17.8	(3)	(2)	(3)/(5)c -/18.3	(4)	5* 18.3	(5)
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS	3/5*c 22.5/19.4	3 22.6	2 25.6	1 26.1	3 22.5	(4)	(5)
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	(3)	2* 2.47	(2)	(3)/5cr -/19.5	5 19.0	(5)	(5)
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	3 23.9	2 24.7	(1)	3 22.8	3/5cr 23.0/16.6	4 20.8	5 19.0
SIY-Silty SI and SIL	1 28.6	2* 25.2	(1)	3 23.5	3 22.0	4 21.8	(4)
FLY-Fine Loamy CL, SCL, SICL	4 20.8	(3)	(3)	5 19.0	4 20.6	3 22.1	(4)
CYY-Clayey C, SC, SIC, HC	- -	5cr 19.5	(3)	(5)	(5)	5 18.2	(5)
SHA-Shallow All textures where depth to bedrock. ≤50 cm	-	- -	(4)	(3)	(4)	(5)	(5)

SITE CLASSES (SI-50 yr:) 1: ≥26.0 m 2:24.0-25.9 m 3: 22.0-23.9 m 4:20.0-21.9 m 5: ≤19.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Norway spruce/6e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm	(5)	(4)	(3)	(3)	(4)	(5)	(5)
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	3c* 23.4	2c* 26.5	(3)	(3)	(4)	5* 20.5	(5)
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS	4 22.9	1 27.6	1* 27.4	(2)	4 22.0	(4)	(5)
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	3 23.0	1 * 27.3	1 * 27.3	2/4cr* -/21	3* 23.8	3 24.4	5cr* 19.1
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	2 25.4	1 27.6	1* 30.6	2* 25.0	3 24.8	2 25.7	3 23.5
SIY-Silty SI and SIL	3* 24.7	(1)	(1)	3* 24.3	2 26.1	2* 25.3	(4)
FLY-Fine Loamy CL, SCL, SICL	3 23.8	(1)	(2)	(2)	(3)	(3)	(5)
CYY-Clayey C, SC, SIC, HC	- -	(3)	(2)	(3)	(3)	4 21.9	(5)
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	-	(3)	(4)	(3)	(5)	(5)
SITE CLASSES (SI-50 yr:) 1: ≥27.0 m 2: 25.0-26.9 m 3:23.0-24.9 m 4: 21.0-22.9 m 5: ≤20.9 m							

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

European larch/6e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm	5* 18.2cr	3* 22.2	(3)	(4)	(4)	(5)	(5)
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	(4)	(2)	(2)	(3)	(3)	(4)	(5)
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS	3 22.8	2 24.9	(1)	1 26.9	(2)	(3)	(5)
G**LY-Gravelly Loamy** All C.LMY textures with 20-50% of particles >2 mm	3* 21.4	(2)	3* 21.2	4* 20.3	4* 21.8	(4)	(5)
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	3 22.5	1* 25.1	1* 25.3	2 24.5	2 23.5	4 20.0	(5)
SIY-Silty SI and SIL	1 25.0	(1)	(2)	(3)	4 20.8	(4)	(5)
FLY-Fine Loamy CL, SCL, SICL	4* 20.6	(3)	(2)	3* 21.1	(4)	(5)	(5)
CYY-Clayey C, SC, SIC, HC	- -	(3)	(3)	(4)	(4)	(5)	(5)
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	- -	(3)	(4)	(4)	(5)	(5)
SITE CLASSES (SI-50 yr:) 1: ≥25.0 m 2: 23.0-24.9 m 3: 21.0-22.9 m 4:19.0-20.9 m 5: ≤18.9 m							

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Softwoods/6e (predicted Site Class by species)

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm	Pw 4*/5c	Pw 2*	Pw (2)	Pw (3)	Pw (3)	Pw (4)	Pw (5)
	Pr 3/5c	Pr 3	Pr (4)	Pr (5)	Pr (5)	Pr (5)	Pr (5)
	Sw 5	Sw (4)	Sw (3)	Sw (3)	Sw (4)	Sw (5)	Sw (5)
	Sn (5)	Sn (4)	Sn (3)	Sn (3)	Sn (3)	Sn (5)	Sn (5)
	Le 5cr*	Le 3*	Le (3)	Le (4)	Le (4)	Le (5)	Le (5)
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	Pw 5	Pw (3)	Pw 3/5c	Pw (2)	Pw (3)	Pw 4/5c	Pw (5)
	Pr 3/4c	Pr 3*	Pr 3*	Pr (4)	Pr (4)	Pr (5)	Pr (5)
	Sw 2/5cr*	Sw (3)	Sw (2)	Sw (3)/5c	Sw (4)	Sw 5*	Sw (5)
	Sn 3c*	Sn 2c*	Sn (3)	Sn (3)	Sn (4)	Sn 5	Sn (5)
	Le (4)	Le (2)	Le (2)	Le (3)	Le (3)	Le (4)	Le (5)
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS,LmS, LfS	Pw 4	Pw 2	Pw 1	Pw 2	Pw 3	Pw 4*	Pw 5
	Pr 3	Pr 2	Pr 1	Pr 1/3r	Pr 2	Pr 3	Pr 4
	Sw 3/5c*	Sw 3	Sw 2	Sw 1	Sw 3	Sw (4)	Sw (5)
	Sn 4	Sn 1	Sn 1 *	Sn (2)	Sn 4	Sn (4)	Sn (5)
	Le 3	Le 2	Le (1)	Le 1	Le (2)	Le (3)	Le (5)
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	Pw 3/5c*	Pw 2	Pw (1)	Pw (3)	Pw 4/5c	Pw 5	Pw (5)
	Pr 3	Pr (3)	Pr (2)	Pr (3)	Pr 3	Pr 3*	Pr (5)
	Sw (3)	Sw 2*	Sw (2)	Sw (3)/5cr	Sw 5	Sw (5)	Sw (5)
	Sn 3	Sn 1*	Sn 1*	Sn 2/4*cr	Sn 3*	Sn 3*	Sn 5cr*
	Le 3*	Le (2)	Le 3*	Le 4*	Le 4*	Le (4)	Le (5)
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	Pw 3/5c	Pw 1/5c*	Pw 2	Pw 2	Pw 3	Pw 3/5cr	Pw 4/5c*
	Pr 1 /5cr	Pr (1)/(5)c	Pr 2/5r	Pr 1/5c	Pr 3	Pr 3*	Pr (4)
	Sw 3	Sw 2	SW (1)	Sw 3	Sw 3/5cr	Sw 4	Sw (5)

Softwoods/6e Con't (predicted Site Class by species)

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
	Sn 2	Sn 1*	Sn 1*	Sn 2*	Sn 3	Sn 2	Sn 3
	Le 3	Le 1*	Le 1*	Le 2	Le 2	Le 4	Le (5)
SIY-Silty SI and SIL	Pw 3	Pw (2)	Pw 3r*	Pw 3*	Pw	Pw 4*	Pw 5
	Pr 2	Pr 3/4cr	Pr 1	Pr 2/5r	Pr 2/5r	Pr (4)	Pr (5)
	Sw 1	Sw 2*	Sw (1)	Sw 3	Sw 3	Sw 4	Sw (4)
	Sn 3*	Sn (1)	Sn (1)	Sn 3*	Sn 2	Sn 2	Sn (4)
	Le 1	Le (1)	Le (2)	Le (3)	Le 4	Le (4)	Le (5)
FLY-Fine Loamy CL, SCL, SICL	Pw 4	Pw 2*/5cr	Pw (2)	Pw 4cr*	Pw 3/5cr	Pw 5cr	Pw (4)
	Pr 1*	Pr (3)	Pr 2*	Pr 2	Pr 2	Pr 4	Pr (5)
	Sw 4	Sw (3)	Sw (3)	Sw 5	Sw 4	Sw 3	Sw 4
	Sn 3	Sn (1)	Sn (2)	Sn (2)	Sn (3)	Sn (3)	Sn (5)
	Le 4*	Le (3)	Le (2)	Le 3*	Le (4)	Le (5)	Le (5)
CYY-Clayey C, SC, SIC, HC		Pw (3)	Pw (3)/5cr	Pw (4)	Pw (4)	Pw 4	Pw (5)
		Pr (5)	Pr 3*	Pr 4	Pr (5)	Pr (5)	Pr (5)
		Sw 5cr	Sw (3)	Sw (5)	Sw (5)	Sw 5	Sw (5)
		Sn (3)	Sn (2)	Sn (3)	Sn (3)	Sn 4	Sn (5)
		Le (3)	Le (3)	Le (4)	Le (4)	Le (5)	Le (5)
SHA-Shallow All textures where depth to bedrock ≤50 cm			Pw 4	Pw (4)	Pw 1	Pw (3)	Pw (5)
			Pr 2	Pr (3)	Pr (5)	Pr (5)	Pr (5)
			Sw (4)	Sw (3)	Sw (4)	Sw (5)	Sw (5)
			Sn (3)	Sn (4)	Sn (3)	Sn (5)	Sn (5)
			Le (3)	Le (4)	Le (4)	Le (5)	Le (5)

Note: Species 0 = Textural group/depth to distinct mottle combination where species rarely exists.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Hard maple/6e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm	4 17.3	(3)	(3)	(3)	4 17.8		
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	3 18.5	(2)	(4)	(4)	(5)		
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS	3 19.5	1 23.9	3 18.2	4* 17.6	4* 17.7		
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	3 18.5	3* 19.6	(3)	2 20.0	(4)	(5)	
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	3 19.7	1 23.8	2 21.0	2 20.0	3 18.5	(5)	
SIY-Silty SI and SIL	3 19.8	1 23.6	2 20.7	2 21.5	3 19.8	(5)	
FLY-Fine Loamy CL, SCL, SICL	2 20.3	1 24.3	2* 21.3	3 19.6	3 18.0	(5)	
CYY-Clayey C, SC, SIC, HC	- -	4* 17.3	2 20.0	(4)	(5)		
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	- -	3 18.4	3 18.8	5 15.9		

SITE CLASSES (SI-50 yr): 1: ≥22.0 m 2: 20.0-20.9 m 3:18.0-19.9 m 4:16.0-17.9 m 5: ≤15.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

White ash/6e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm							
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	3* 22.6	(2)	(3)	(3)	(4)	(5)	(5)
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS	2 23.0	(3)	(2)	(3)	3 21.5	4 19.3	
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	3 21.7	1 25.0	(2)	2* 23.7	(3)	(4)	
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	3 21.3	1 25.2	2* 24.6	3 22.5	3 22.0	(4)	
SIY-Silty SI and SIL	2* 23.7	(1)	(1)	(3)	4* 19.0	(5)	
FLY-Fine Loamy CL, SCL, SICL	3 22.7	1* 25.3	3* 22.8	3* 21.1	(4)	5* 17.0	
CYY-Clayey C, SC, SIC, HC	- -	4* 19.8	(3)	(3)	(4)	(5)	
SHA-Shallow all textures where depth to bedrock ≤50 cm	- -	- -	5 18.6	3* 22.1	4* 19.8		

SITE CLASSES (SI-50 yr): 1: ≥ 25.0 m 2: 23.0-24.9 m 3:21.0-22.9 m 4:19.0-20.9 m 5: ≤ 18.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Red oak/6e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm	4* 18.7	2* 23.0	(2)	(3)	(4)		
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	4 19.8	(2)	(2)	(2)	(3)	(4)	
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS	4 18.7	2* 22.3	(1)	1 24.5	3 21.6	(4)	
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	(3)	(2)	(1)	2* 23.4	(3)	(4)	
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	3 21.0	1* 25.4	(1)	3* 21.8	3* 20.0	4* 18.6	(5)
SIY-Silty SI and SIL	(3)	(1)	(1)	(2)	(3)	(4)	(5)
FLY-Fine Loamy CL, SCL, SICL	(3)	(2)	3* 20.7	(3)	(4)	(5)	
CYY-Clayey C, SC, SIC, HC	- -						
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	-	(5)	(4)			

SITE CLASSES (SI-50 yr): 1: ≥ 24.0 m 2:22.0-23.9 m 3:20.0-21.9 m 4:18.0-19.9 m 5: ≤ 17.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Silver maple/6e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm							
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm							
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS					(3)	3* 20.4	(4)
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm					(4)	(3)	(4)
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)					3* 21.3	3 21.1	4* 19.8
SIY-Silty SI and SIL					(3)	(1)	(2)
FLY-Fine Loamy CL, SCL, SICL						3 21.7	(3)
CYY-Clayey C, SC, SIC, HC	- -					1 26.1	3 19.9
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	- -					

SITE CLASSES (SI-50 yr): 1: ≥24.0 m 2: 22.0-23.9 m 3: 20.0-21.9 m 4:18.0-19.9 m 5: ≤17.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Red maple/6e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm							
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	(3)	(2)	(3)	(4)			
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS	3* 21.7	(1)	2 23.3	3* 21.7	4* 18.5	4* 19.5	
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	(3)	(2)	(2)	(3)	(4)	(4)	
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	(3)	(1)	(2)	(3)	3* 20.3	4* 19.7	
SIY-Silty SI and SIL	(2)	(1)	(2)	(3)	(4)	(5)	
FLY-Fine Loamy CL, SCL, SICL	1* 28.3	(1)	(2)	(3)	5* 17.6	(5)	
CYY-Clayey C, SC, SIC, HC	- -						
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	-	4* 18.8	(4)	(3)		
SITE CLASSES (SI-50 yr):1: ≥24.0 m 2: 22.0-23.9 m 3:20.0-21.9 m 4:18.0-19.9 m 5:≤17.9 m							

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Hardwoods/6e (predicted Site Class by species)

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles > 2 mm	Mh 4 Aw 0 Or 4 Cb 4 Bd 0 Ms 0 Mr 0 Be 0	Mh 3 Aw 0 Or 2* Cb (3) Bd 0 Ms 0 Mr 0 Be 0	Mh (3) Aw 0 Or (2) Cb (3) Bd 0 Ms 0 Mr 0 Be 0	Mh (3) Aw 0 Or (3) Cb (3) Bd 0 Ms 0 Mr 0 Be 0	Mh 4 Aw 0 Or (4) Cb 0 Bd 0 Ms 0 Mr 0 Be 0	Mh 0 Aw 0 Or 0 Cb 0 Bd 0 Ms 0 Mr 0 Be 0	Mh 0 Aw 0 Or 0 Cb 0 Bd 0 Ms 0 Mr 0 Be 0
GSY-Gravelly Sandy All sandy textures 20-50% of particles > 2 mm	Mh 3 Aw 3 Or 4 Cb (3) Bd 4 Ms 0 Mr (3) Be 4*	Mh (2) Aw 2 Or (2) Cb 2 Bd 3* Ms 0 Mr (2) Be (3)	Mh (4) Aw 3 Or (2) Cb (3) Bd (4) Ms 0 Mr (3) Be (4)	Mh (4) Aw 3 Or (2) Cb (3) Bd (5) Ms 0 Mr (4) Be (5)	Mh (5) Aw 4 Or (3) Cb (4) Bd (5) Ms 0 Mr (0) Be (5)	Mh 0 Aw 5 Or (4) Cb 0 Bd 0 Ms 0 Mr (0) Be 0	Mh 0 Aw 5 0r 0 Cb 0 Bd 0 Ms 0 Mr (0) Be 0
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS	Mh 3 Aw 2 Or 4 Cb 4* Bd 4* Ms 0 Mr 3* Be 4*	Mh 1 Aw (3) Or 2* Cb (3) Bd 2* Ms 0 Mr (1) Be 2*	Mh 3 Aw (2) Or (1) Cb 2* Bd 3* Ms 0 Mr 2 Be (3)	Mh 4 Aw (3) Or 1 Cb 2* Bd (4) Ms 0 Mr 3* Be (4)	Mh 4* Aw 3 Or 3 Cb (3) Bd (4) Ms 0 Mr 4* Be (4)	Mh 0 Aw 4 Or (4) Cb (4) Bd (5) Ms 0 Mr 4* Be 0	Mh 0 Aw 0 Or 0 Cb 0 Bd 0 Ms 0 Mr 0 Be 0
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles > 2 mm	Mh 3 Aw 3 Or (3) Cb 4* Bd 4 Ms 0 Mr (3) Be (4)	Mh 3* Aw 1 Or (2) Cb (2) Bd (2) Ms 0 Mr (2) Be (3)	Mh (3) Aw (2) Or (1) Cb (2) Bd (3) Ms 0 Mr (2) Be (3)	Mh 2 Aw 2* Or 2* Cb (2) Bd 4* Ms 0 Mr (3) Be (3)	Mh (4) Aw (3) Or (3) Cb (3) Bd (4) Ms (4) Mr (4) Be (4)	Mh (5) Aw (4) Or (4) Cb (4) Bd (5) Ms (3) Mr (4) Be 0	Mh (0) Aw 0 Or 0 Cb 0 Bd 0 Ms (4) Mr 0 Be 0
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	Mh 3 Aw 3 Or 3 Cb 3 Bd 4 Ms 0 Mr (3) Be 3	Mh 1 Aw 1 Or 1* Cb 1 Bd 1 Ms 0 Mr (1) Be 3	Mh 2 Aw 2* Or (1) Cb (1) Bd (1) Ms 0 Mr (2) Be (1)	Mh 2 Aw 3 Or 3* Cb (2) Bd 4* Ms 0 Mr (3) Be (2)	Mh 3 Aw 3 Or 3* Cb 2* Bd 3 Ms 3* Mr 3* Be 2*	Mh (5) Aw (4) Or 4* Cb 3* Bd 5* Ms 3 Mr 4* Be 0	Mh 0 Aw 0 Or (5) Cb 0 Bd 0 Ms 4* Mr 0 Be 0

Hardwoods/6e Con't. (predicted Site Class by species)

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
SIY-Silty	Mh 3	Mh 1	Mh 2	Mh 2	Mh 3	Mh (5)	Mh 0
SI and SIL	Aw 2*	Aw (1)	Aw (1)	Aw (3)	Aw 4*	Aw (5)	Aw 0
	Or (3)	Or (1)	Or (1)	Or (2)	Or (3)	Or (4)	Or (5)
	Cb 3*	Cb (1)	Cb (2)	Cb (3)	Cb 4*	Cb (5)	Cb 0
	Bd 4*	Bd (3)	Bd (2)	Bd (3)	Bd (3)	Bd 3*	Bd 0
	Ms 0	Ms 0	Ms 0	Ms 0	Ms (3)	Ms (1)	Ms (2)
	Mr (2)	Mr 0	Mr (2)	Mr (3)	Mr (4)	Mr (5)	Mr 0
	Be 4*	Be (3)	Be (1)	Be (2)	Be (3)	Be 0	Be 0
FLY-Fine Loamy	Mh 2	Mh 1	Mh 2*	Mh 3	Mh 3	Mh (5)	Mh 0
CL,SCL,SICL	Aw 3	Aw 1*	Aw 3*	Aw 3*	Aw (4)	Aw 5*	Aw 0
	Or (3)	Or (2)	Or 3*	Or (3)	Or (4)	Or (5)	Or 0
	Cb 2	Cb 2*	Cb 4*	Cb 3*	Cb 4*	Cb 0	Cb 0
	Bd (4)	Bd 3	Bd 3	Bd 4*	Bd 4*	Bd 5*	Bd 0
	Ms 0	Ms 0	Ms 0	Ms 0	Ms 0	Ms 3	Ms (3)
	Mr 1*	Mr (1)	Mr (2)	Mr (3)	Mr 5*	Mr (5)	Mr 0
CYY-Clayey		Mh 4*	Mh 2	Mh (4)	Mh (5)	Mh 0	Mh 0
C, SC, SIC, HC		Aw 4*	Aw (3)	Aw (3)	Aw (4)	Aw (5)	Aw 0
		Or 0	Or 0	Or 0	Or 0	Or 0	Or 0
		Cb 0	Cb 0	Cb 0	Cb 0	Cb 0	Cb 0
		Bd (4)	Bd 4*	Bd (4)	Bd (5)	Bd (5)	Bd 0
		Ms 0	Ms 0	Ms 0	Ms 0	Ms 1	Ms 3
		Mr 0	Mr 0	Mr 0	Mr 0	Mr 0	Mr 0
		Be (3)	Be (3)	Be (2)	Be 0	Be 0	Be 0
SHA-Shallow			Mh 3	Mh 3	Mh 5	Mh 0	Mh 0
All textures where depth			Aw 5	Aw 3*	Aw 4*	Aw 0	Aw 0
to bedrock ≤50 cm			Or (5)	Or (4)	Or 0	Or 0	Or 0
			Cb 4*	Cb 3	Cb (5)	Cb 0	Cb 0
			Bd 3*	Bd (4)	Bd 4*	Bd (5)	Bd 0
			Ms 0	Ms 0	Ms 0	Ms 0	Ms 0
			Mr 4*	Mr (4)	Mr (3)	Mr 0	Mr 0
			Be 5*	Be (5)	Be (5)	Be 0	Be 0

Note: Species 0 = Textural group/depth to distinct mottle combination where species rarely exists.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

White pine/7e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm	5* 19.1	(4)	(3)	(3)	(4)	(5)	(5)
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	(4)	(4)	(2)	(3)	(3)	(4)	(5)
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS	4 22.7	4 22.4	1 28.3	3 25.9	3 25.8	4 23.9	(5)
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	5c 20.5	(3)/(5)c	(2)	(3)	(3)	(4)	(5)
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	3/(5)c 25.0/-	2* 27.2	2* 26.1	3 25.9	3 25.8	3 25.9	(4)
SIY-Silty **SI and SIL**	3* 25.5	(1)	2* 26.5	3 24.4	3 25.5	3 25.2	(4)
FLY-Fine Loamy CL, SCL, SICL	4 23.6	(2)	(2)	3* 25.4	3 25.2	4* 22.8	(5)
CYY-Clayey C, SC, SIC, HC	- -	(3)	(2)	(3)	(3)	3 23.9	(4)
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	- -	4* 22.0	3 25.3	2* 26.5	4 23.8	(5)

SITE CLASSES (SI-50 yr): 1: ≥28.0 m 2:26.0-27.9 m 3: 24.0-25.9 m 4:22.0-23.9 m 5:≤21.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Red pine/7e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravell All textures with >50% of particles >2 mm	5* 18.6	3* 21.6	(4)	(5)	(5)	(5)	(5)
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	(5)	(3)	(3)	(3)	(3)	(4)	(5)
SDY-Sandy vcS, cS, mS, IS, LvcS, LcS, LmS, LfS	4 19.7	2 24.1	1 25.0	2 24.3	2 23.3	3 21.7	(4)
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	5 18.6	(3)	1* 26.0	2 24.4	(3)	(4)	(5)
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	2/4c 23.6/ 19.5	2* 24.6	2 24.8	2 23.8	3 22.1	3 21.1	(5)
Sly-Silty SI and SIL	2/4r 24.2/ 19.7r	(2)/(4)	2*/4*r 23.6/ 19.9r	1 25.2	2* 24.6	3* 21.7	(4)
FLY-Fine Loamy CL, SCL, SICL	2 23.1	(2)	3* 22.2	(3)	3 22.8	3 22.6	(4)
CYY-Clayey C, SC, SIC, HC	- -	(3)	(3)	(4)	(5) 20.8	5	(5)
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	- -	4* 19.3	4* 20.4	3 22.4	(5)	(5)

SITE CLASSES (SI-50 yr): 1: ≥25.0 m 2:23.0-24.9 m 3: 21.0-22.9 m 4:19.0-20.9 m 5:≤18.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

White spruce/7e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm	(5)	(3)	(3)	(4)	(4)	(5)	(5)
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	(4)	(3)	(2)	(3)	(3)	(4)	(5)
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS	3 23.8	(2)	1 27.0	3 24.1	2 25.0	3 24.8	(4)
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	2 26.9	(2)	(1)	(3)	(3)	(3)	(4)
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	3 23.0	3 23.8	2* 25.0	4 22.7	3 23.4	3 24.0	(4)
SIY-Silty SI and SIL	3* 23.0	(2)	(1)	3 22.9	4 22.4	4 22.7	(4)
FLY-Fine Loamy CL, SCL, SICL	4* 22.6	(2)	(1)	(2)	3 23.6	4* 22.5	(4)
CYY-Clayey C, SC, SIC, HC	- -	(4)	(3)	(2)	2* 25.7	(3)	(4)
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	-	(4)	(4)	(3)	3* 23.4	4

SITE CLASSES (SI-50 yr): 1: ≥27.0 m 2:25.0-26.9 m 3: 23.0-24.9 m 4:21.0-22.9 m 5: ≤18.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Norway spruce/7e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm	(4)	(2)	(2)	(3)	(4)	(5)	(5)
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	(3)	(2)	(2)	(3)	(3)	(4)	(5)
SDY-Sandy vcS, cS, mS, fS, LvcS LcS, LmS, LfS	2 27.3	(1)	(1)	2 28.2	2 28.1	(3)	(4)
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	3 26.8	(2)	(1)	(2)	(3)	(3)	(4)
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	3 26.2	(1)	2* 28.2	(1)	2 28.0	4 24.8	(4)
SIY-Silty SI and SIL	2 27.0	(1)	(1)	3 25.4	3 25.0	(4)	(4)
FLY-Fine Loamy CL, SCL, SICL	4* 24.0	(2)	(1)	3* 26.8	(3)	5* 22.8	(5)
CYY-Clayey C, SC, SIC, HC	- -	(3)	(2)	(2)	(3)	4* 24.4	5
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	- -	(3)	2* 27.2	(3)	(4)	(5)

SITE CLASSES (SI-50 yr): 1: ≥29.0 m 2: 27.0-28.9 m 3:25.0-26.9 m 4: 23.0-24.9 m 5: ≤22.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

European larch/7e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm	(4) -	2* 24.4	(3)	(4)	(4)	(5)	(5)
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	(4)	(2)	(2)	(3)	(4)	(5)	(5)
SDY-Sandy vcS, cS, mS, fS, LvcS LcS, LmS, LfS	4* 21.5	(1)	2 24.2	3 22.6	2 24.2	(4)	(5)
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	3* 22.3	(2)	(1)	(2)	3 23.7	(4)	(5)
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	(3)	(2)	(1)	2* 25.2	4 21.4	4* 21.1	(5)
SIY-Silty SI and SIL	(3)	(1)	(1)	(2)	2 24.4	2* 25.4	3
FLY-Fine Loamy CL, SCL, SICL	(3)	(2)	(3)	(3)	(4)	(4)	(5)
CYY-Clayey C, SC, SIC, HC	- -	(3)	(3)	(4)	(4)	(5)	(5)
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	- -	5* 18.4	(4)	(4)	(5)	(5)

SITE CLASSES (SI-50 yr): 1: ≥26.0 m 2: 24.0-25.9 m 3:22.0-23.9 m 4: 20.0-21.9 m 5:≤19.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Softwoods/7e (predicted Site Class by species)

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles > 2 mm	Pw 5*	Pw (4)	Pw (3)	Pw (3)	Pw (4)	Pw (5)	Pw (5)
	Pr 5*	Pr 3*	Pr (4)	Pr (5)	Pr (5)	Pr (5)	Pr (5)
	Sw (5)	Sw (3)	Sw (3)	Sw (4)	Sw (4)	Sw (5)	Sw (5)
	Sn (4)	Sn (2)	Sn (2)	Sn (3)	Sn (4)	Sn (5)	Sn (5)
	Le (4)	Le 2*	Le (3)	Le (4)	Le (4)	Le (5)	Le (5)
GSY-Gravelly Sandy All sandy textures 20-50% of particles > 2 mm	Pw (4)	Pw (4)	Pw (2)	Pw (3)	Pw (2)	Pw (4)	Pw (5)
	Pr (5)	Pr (3)	Pr (3)	Pr (3)	Pr (3)	Pr (4)	Pr (5)
	Sw (4)	Sw (3)	Sw (2)	Sw (3)	Sw (3)	Sw (4)	Sw (5)
	Sn (3)	Sn (2)	Sn (2)	Sn (3)	Sn (3)	Sn (4)	Sn (5)
	Le (4)	Le (2)	Le (2)	Le (3)	Le (4)	Le (5)	Le (5)
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS	Pw 4	Pw 4	Pw 1	Pw 3	Pw 3	Pw 4	Pw (5)
	Pr 4	Pr 2	Pr 1	Pr 2	Pr 2	Pr 3	Pr (4)
	Sw 3	Sw (2)	Sw 1	Sw 3	Sw 2	Sw 3	Sw (4)
	Sn 2	Sn (1)	Sn (1)	Sn 2	Sn 2	Sn (3)	Sn (4)
	Le 4*	Le (1)	Le 2	Le 3	Le 2	Le (4)	Le (5)
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles > 2 mm	Pw 5c	Pw (3)/(5)c	Pw (2)	Pw (3)	Pw (3)	Pw (4)	Pw (5)
	Pr 5	Pr (3)	Pr 1*	Pr 2	Pr (3)	Pr (4)	Pr (5)
	Sw 2	Sw (2)	Sw (1)	Sw (3)	Sw (3)	Sw (3)	Sw (4)
	Sn 3	Sn (2)	Sn (1)	Sn (2)	Sn (3)	Sn (3)	Sn (4)
	Le 3*	Le (2)	Le (1)	Le (2)	Le 3	Le (4)	Le (5)
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	Pw 3/(5)c	Pw 2*	Pw 2*	Pw 3	Pw 3	Pw 3	Pw (4)
	Pr 2/4c	Pr 2*	Pr 2	Pr 2	Pr 3	Pr 3	Pr (5)
	Sw 3	Sw 3	Sw 2*	Sw 4	Sw 3	Sw 3	Sw (4)
	Sn 3	Sn (1)	Sn 2*	Sn (1)	Sn 2	Sn 4	Sn 4
	Le (3)	Le (2)	Le (1)	Le 2*	Le 4	Le 4*	Le (5)

Softwoods/7e Con't (predicted Site Class by species)

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
SIY-Silty SI and SIL	Pw 3*	Pw (1)	Pw 2*	Pw 3	Pw 3	Pw 3	Pw (4)
	Pr 2/4n	Pr (2)/(4)	Pr 2*/4*r	Pr 1	Pr 2*	Pr 3*	Pr (4)
	Sw 3*	Sw (2)	Sw (1)	Sw 3	Sw 4	Sw 4	Sw (4)
	Sn 2	Sn (1)	Sn (1)	Sn 3	Sn 3	Sn (4)	Sn (4)
	Le (3)	Le (1)	Le (1)	Le (2)	Le 2	Le 2*	Le 3
FLY-Fine Loamy CL,SCL,SICL	Pw 4	Pw (2)	Pw (2)	Pw 3*	Pw 3	Pw 4*	Pw (5)
	Pr 2	Pr (2)	Pr 3*	Pr (2)	Pr 3	Pr 3	Pr (4)
	Sw 4*	Sw (2)	Sw (1)	Sw (2)	Sw 3	Sw 4*	Sw (4)
	Sn 4*	Sn (2)	Sn (1)	Sn 3*	Sn (3)	Sn 5*	Sn (5)
	Le (3)	Le (2)	Le (3)	Le (3)	Le (4)	Le (4)	Le (5)
CYY-Clayey C, SC, SIC, HC		Pw (3)	Pw (2)	Pw (3)	Pw (3)	Pw 3	Pw (4)
		Pr (3)	Pr (3)	Pr (4)	Pr (5)	Pr 5	Pr (5)
		Sw (4)	Sw (3)	Sw (3)	Sw 2*	Sw (3)	Sw (4)
		Sn (3)	Sn (2)	Sn (2)	Sn (3)	Sn 4*	Sn (5)
		Le (3)	Le (3)	Le (4)	Le (4)	Le (5)	Le (5)
S**HA-Shallow** All textures where depth to bedrock ≤50 cm		Pw 4*	Pw 3	Pw 2*	Pw 4	Pw (5)	
		Pr 4*	Pr 4*	Pr 3	Pr (5)	Pr (5)	
		Sw (4)	Sw (4)	Sw (4)	Sw 3*	Sw (4)	
		Sn (3)	Sn 2*	Sn (3)	Sn (4)	Sn (5)	
		Le 5*	Le (4)	Le (4)	Le (5)	Le (5)	

Note: Species 0 = Textural group/depth to distinct mottle combination where species rarely exists.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Hard maple/7e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm							
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm							
SDY-Sandy vcS, cS, mS, fS, LvcS LcS, LmS, LfS	3* 23.8	2* 24.9	2&3 24.6	4 23.3	(5) 21.7		
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	4 21.4	(2)	(3)	(2)	(5)	(5)	
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	3 23.2	2 24.0	1 26.3	3 23.5	3 23.1	3 22.0	
SIY-Silty SI and SIL	2 25.1	1 26.2	(1)	2* 25.6	2* 24.0	3* 23.4	
FLY-Fine Loamy CL, SCL, SICL	3 22.8	(2)	3* 23.0	2* 24.7	2 24.4	3 22.9	4 21.9
CYY-Clayey C, SC, SIC, HC	- -	2* 25.1	1* 27.0	2* 24.0	2* 24.0	3 22.7	4* 21.4
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	- -	3* 22.8	1* 26.8	2* 24.4	4* 21.3	

SITE CLASSES (SI-50 yr): 1: ≥26.0 m 2: 24.0-25.9 m 3: 22.0-23.9 m 4: 20.0-21.9 m 5:≤19.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

White ash/7e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm							
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	4* 23.8	(3)	(3)	(2)	(4)		
SDY-Sandy vcS, cS, mS, fS, LvcS LcS, LmS, LfS	4* 23.6	3* 25.6	(2)	1* 28.8	3* 24.2	(5)	
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	4* 22.2	(3)	(2)	(2)	(3)	(4)	
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	3 25.2	2 26.6	1 28.2	2* 27.3	3 25.6	3 25.1	(4)
SIY-Silty SI and SIL	3* 24.2	(1)	2 27.6	3* 24.3	3 24.7	(4)	5* 20.4
FLY-Fine Loamy CL, SCL, SICL	4* 23.0	3* 25.5	(2)	1 28.5	1 28.2	3 25.8	2* 27.4
CYY-Clayey C, SC, SIC, HC	- -	3* 24.3	(2)	(2)	3 25.7	3 25.8	2 26.3
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	- -	4* 22.9	(3)	(2)	(3)	3* 25.3

SITE CLASSES (SI-50 yr):1: ≥28.0 m 2:26.0-27.9 m 3:24.0-25.9 m 4:22.0-23.9 m 5: ≤21.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Red oak/7e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm	(5)	(4)	(3)	(3)			
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	(4)	(3)	(2)	(2)	(3)	(3)	
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS	(3)	2* 25.5	1* 26.9	1 26.4	2* 24.8	2 25.4	(4)
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm	2* 25.3	(2)	(2)	(1)	(2)	(3)	(4)
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	2 24.8	(2)	3* 23.9	1 27.6	2 25.4	3 23.6	(4)
SIY-Silty SI and SIL	2 24.1	(1)	(2)	(3)	2* 25.2	1* 28.0	4 21.4
FLY-Fine Loamy CL, SCL, SICL	3* 22.5	(3)	3* 22.5	2* 25.8	2 24.6	2 24.7	2 25.1
CYY-Clayey C, SC, SIC, HC	- -	3* 23.2	(3)	3* 22.8	3 23.8	2 24.2	3 23.9
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	- -	2* 25.6	(2)	4* 21.9	(5)	(5)

SITE CLASSES (SI-50 yr): 1: ≥26.0 m 2: 24.0-25.9 m 3: 22.0-23.9 m 4: 20.0-21.9 m 5: ≤19.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Black walnut/7e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm							
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm							
SDY-Sandy vcS, cS, mS, fS, LvcS LcS, LmS, LfS							
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm							
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)	4* 21.4	1* 27.4	(1)	(2)	2* 26.1	4* 22.4	(5)
SIY-Silty SI and SIL	(3)	(2)	(1)	(1)	1* 26.7	(2)	(4)
FLY-Fine Loamy CL, SCL, SICL	4* 21.4	(2)	(1)	2* 25.0	3* 23.0	4* 22.8	5* 19.2
CYY-Clayey C, SC, SIC, HC	- -	1* 27.4	(2)	(2)	2* 25.6	3	4* 22.1
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	-					

SITE CLASSES (SI-50 yr): 1: ≥27.0 m 2: 25.0-26.9 m 3: 23.0-24.9 m 4: 21.0-22.9 m 5: ≤ 20.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

White oak/7e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm							
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm			(5)	(4)	(4)	4* 17.1	(3)
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS			(4)	(4)	(3)	2 21.5	1* 24.4
GLY-Gravelly Loamy All C.LMY textures with 20-50% of particles >2 mm		(5)	(4)	(4)	(3)	(2)	(2)
C.LMY-Coarse Loamy All SL and L (including vfS and LvfS)		(4)	(3)	3* 20.5	(2)	1* 23.2	(2)
SIY-Silty SI and SIL		(4)	(2)	3* 20.2	(2)	1*	(3)
FLY-Fine Loamy CL, SCL, SICL			(3)	2 22.2	1 23.3	3* 20.0	(4)
CYY-Clayey C, SC, SIC, HC	-		(5)	3* 20.3	2 21.7	2 21.9	4* 18.5
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	- -		(5)	(4)	2 22.6	(5)

SITE CLASSES (SI-50 yr): 1: ≥23.0 m 2:21.0-22.9 m 3:19.0-20.9 m 4:17.0-18.9 m 5: ≤16.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Silver maple/7e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm							
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm							
SDY-Sandy vcS, cS, mS fS, LvcS, LcS, LmS, LfS				3* 24.1	2 26.2	3 25.8	(4)
GLY-Gravelly Loamy All CLMY textures with 20-50% of particles >2 mm				(4)	(2)	(2)	(3)
CLMY-Coarse Loamy All SL and L (including vfS and LvfS)				3* 24.0	1 28.4	1 30.0	(3)
SIY-Silty SI and SIL					(2)	1* 28.8	(3)
FLY-Fine Loamy CL, SCL, SICL					3 25.6	2 27.0	5* 20.3
CYY-Clayey C, SC, SIC, HC	-				4* 23.7	2 26.8	3 25.0
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	-					

SITE CLASSES (SI-50 yr):1: ≥28.0 m 2:26.0-27.9 m 3:24.0-25.9 m 4:22.0-23.9 m 5: ≤21.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Red maple/7e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm							
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	4* 21.7	(3)	(3)	(3)	(4)		
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS	(4)	(2)	3* 23.5	2* 25.0	4* 20.7		
GLY-Gravelly Loamy All CLMY textures with 20-50% of particles >2 mm	5* 19.8	(3)	(2)	(2)	(3)		
CLMY-Coarse Loamy All SL and L (including vfS and LvfS)	3* 22.1	3* 23.8	(2)	2 24.4	2* 24.0	2 24.3	
SIY-Silty SI and SIL	(3)	(1)	(1)	(2)	(2)	(3)	(3)
FLY-Fine Loamy CL, SCL, SICL	(3)	(2)	(1)	(3)	(2)	3* 23.5	3* 23.5
CYY-Clayey C, SC, SIC, HC	- -	2* 25.4	(2)	(3)	(3)	3 22.8	4* 21.6
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	-					

SITE CLASSES (SI-50 yr): 1: ≥26.0 m 2: 24.0-25.9 m 3:22.0-23.9 m 4: 20.0-21.9 m 5: ≤19.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Bitternut hickory/7e (predicted species performance by Site Class[1])

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with >50% of particles >2 mm							
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm							
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, LmS, LfS			(3)	(3)	4* 22.8	(5)	
GLY-Gravelly Loamy All CLMY textures with 20-50% of particles >2 mm	4* 21.6	(3)	(2)	(2)	(3)	(4)	
CLMY-Coarse Loamy All SL and L (including vfS and LvfS)	3 24.9	1* 28.5	2* 25.6	2 25.5	3 24.6	4* 22.3	(5)
SIY-Silty SI and SIL	(3)	(1)	2* 25.0	(2)	2 25.1	(3)	(4)
FLY-Fine Loamy CL, SCL, SICL	3* 23.1	3* 24.8	2* 25.0	1* 27.8	3 24.5	(4)	
CYY-Clayey C, SC, SIC, HC	- 21.7	4*	(2)	(3) 23.8	3 21.1	4*	(5)
SHA-Shallow All textures where depth to bedrock ≤50 cm	- -	-	(4)	(3)	1* 27.3	3	5

SITE CLASSES (SI-50 yr): 1: ≥27.0 m 2:25.0-26.9 m 3:23.0-24.9 m 4:21.0-22.9 m 5: ≤20.9 m

[1]Upper value is site class; lower value is site index.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

Hardwoods/7e+ (predicted Site Class by species)

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
VGR-Very Gravelly All textures with 50% of particles >2 mm	Mh 0	Mh 0	Mh 0	Mh 0	Mh 0	Mh 0	Mh 0
	Aw 0	Aw 0	Aw 0	Aw 0	Aw 0	Aw 0	Aw 0
	Or (5)	Or (4)	Or (3)	Or (3)	Or 0	Or 0	Or 0
	Cb 0	Cb 0	Cb 0	Cb 0	Cb 0	Cb 0	Cb 0
	Bd 0	Bd 0	Bd 0	Bd 0	Bd 0	Bd 0	Bd 0
	Ms 0	Ms 0	Ms 0	Ms 0	Ms 0	Ms 0	Ms 0
	Wb 0	Wb 0	Wb 0	Wb 0	Wb 0	Wb 0	Wb 0
	Ow 0	Ow 0	Ow 0	Ow 0	Ow 0	Ow 0	Ow 0
	Hib 0	Hib 0	Hib 0	Hib 0	Hib 0	Hib 0	Hib 0
	Mr 0	Mr 0	Mr 0	Mr 0	Mr 0	Mr 0	Mr 0
	Be 0	Be 0	Be 0	Be 0	Be 0	Be 0	Be 0
GSY-Gravelly Sandy All sandy textures with 20-50% of particles >2 mm	Mh 0	Mh 0	Mh 0	Mh 0	Mh 0	Mh 0	Mh 0
	Aw 0	Aw 0	Aw 0	Aw 0	Aw 0	Aw 0	Aw 0
	Or (4)	Or (3)	Or (2)	Or (2)	Or (3)	Or (3)	Or 0
	Cb 0	Cb 0	Cb 0	Cb 0	Cb 0	Cb 0	Cb 0
	Bd 0	Bd 0	Bd (4)	Bd (4)	Bd (4)	Bd 5*	Bd 0
	Ms 0	Ms 0	Ms 0	Ms 0	Ms 0	Ms 0	Ms 0
	Wb 0	Wb 0	Wb 0	Wb 0	Wb 0	Wb 0	Wb 0
	Ow 0	Ow 0	Ow (5)	Ow (4)	Ow (4)	Ow 4*	Ow (3)
	Hib 0	Hib 0	Hib 0	Hib 0	Hib 0	Hib 0	Hib 0
	Mr 4*	Mr (3)	Mr (3)	Mr (3)	Mr (4)	Mr 0	Mr 0
	Be 0	Be 0	Be 0	Be 0	Be 0	Be 0	Be 0
SDY-Sandy vcS, cS, mS, fS, LvcS, LcS, Lms, LfS	Mh 3*	Mh 2*	Mh 2	Mh 3	Mh 4	Mh (5)	Mh 0
	Aw (4)	Aw (3)	Aw 1*	Aw 2*	Aw 3	Aw 3*	Aw 0
	Or (3)	Or 2*	Or 1*	Or 1	Or 2*	Or 2	Or (4)
	Cb (4)	Cb (3)	Cb 1*	Cb 2*	Cb 3	Cb 3*	Cb 0
	Bd 0	Bd (4)	Bd (3)	Bd (3)	Bd (3)	Bd 3*	Bd 0
	Ms 0	Ms 0	Ms 0	Ms 3*	Ms 2	Ms 3	Ms (4)
	Wb 0	Wb 0	Wb 0	Wb 0	Wb 0	Wb 0	Wb 0

Hardwoods/7e Con't. (predicted Site Class by species)

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
	Ow 0	Ow 0	Ow (4)	Ow (4)	Ow (3)	Ow 2	Ow 1*
	Hib 0	Hib 0	Hib (3)	Hib (3)	Hib 4*	Hib (5)	Hib 0
	Mr (4)	Mr (2)	Mr 3*	Mr 2*	Mr4*	Mr 0	Mr 0
	Be (4)	Be 3*	Be 2*	Be 2*	Be 5*	Be 0	Be 0
GLY -Gravelly Loamy All CLMY textures with 20-50% of particles >2 mm	Mh 4	Mh (2)	Mh (3)	Mh (4)	Mh (5)	Mh (5)	Mh 0
	Aw (4)	Aw (2)	Aw (2)	Aw (2)	Aw (3)	Aw (3)	Aw 0
	Or 2*	Or (2)	Or (2)	Or (1)	Or (2)	Or (3)	Or (4)
		Cb (2)	Cb (2)	Cb (2)	Cb (3)	Cb (3)	Cb 0
	Bd 0	Bd 3*	Bd (3)	Bd (3)	Bd (4)	Bd (4)	Bd 0
	Ms 0	Ms 0	Ms 0	Ms (4)	Ms (2)	Ms (2)	Ms (3)
	Wb 0	Wb 0	Wb 0	Wb 0	Wb 0	Wb 0	Wb 0
	Ow 0	Ow (5)	Ow (4)	Ow (4)	Ow (3)	Ow (2)	Ow (2)
	Hib 4*	Hib (3)	Hib (2)	Hib (2)	Hib (3)	Hib (4)	Hib 0
	Mr 5*	Mr (3)	Mr (2)	Mr (2)	Mr (3)	Mr 0	Mr 0
	Be (4)	Be (3)	Be (3)	Be (2)	Be (4)	Be 0	Be 0
C.LMY -Coarse Loamy All SL and L (including vfS and LvfS)	Mh 3	Mh 2	Mh 1	Mh 3	Mh 3	Mh 3	Mh 0
	Aw 3	Aw 2*	Aw 1*	Aw 2	Aw 2	Aw 3*	Aw 0
	Or 2	Or (2)	Or 3*	Or 1	Or 2	Or 3	Or (4)
	Cb 3	Cb 2*	Cb 1*	Cb 2	Cb 2	Cb 3*	Cb 0
	Bd 3	Bd 1	Bd (2)	Bd 3*	Bd 3	Bd 4*	Bd 0
	Ms 0	Ms 0	Ms 0	Ms 3*	Ms 1	Ms 1	Ms (3)
	Wb 4*	Wb 1*	Wb (1)	Wb (2)	Wb 2*	Wb 4*	Wb(5)
	Ow 0	Ow (4)	Ow (3)	Ow 3*	Ow (2)	Ow 1*	Ow (2)
	Hib 3	Hib 1*	Hib 2*	Hib 2	Hib 3	Hib 4*	Hib (5)
	Mr 3*	Mr 3*	Mr (2)	Mr 2	Mr 2*	Mr2	Mr0
	Be 3	Be (3)	Be 4*	Be 2	Be 3*	Be 4*	Be (5)
SIY-Silty SI and SIL	Mh 2	Mh 1	Mh (1)	Mh 2*	Mh 2*	Mh 3*	Mh0
	Aw 2*	Aw (1)	Aw 2*	Aw 3*	Aw 4*	Aw (5)	Aw 0
	Or 2	Or (1)	Or (2)	Or (3)	Or 2*	Or 1*	Or 4
	Cb 2*	Cb (1)	Cb 2*	Cb 3*	Cb 4*	Cb (5)	Cb 0

Hardwoods/7e Con't. (predicted Site Class by species)

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
SIY-Silty SI and SIL, continued	Bd (3)	Bd (1)	Bd 1*	Bd (2)	Bd 3*	Bd 3*	Bd 0
	Ms 0	Ms 0	Ms 0	Ms 0	Ms (2)	Ms 1*	Ms (3)
	Wb (3)	Wb (2)	Wb (1)	Wb (1)	Wb1*	Wb (2)	Wb (4)
	Ow 0	Ow (4)	Ow (2)	Ow 3*	Ow (3)	Ow (2)	Ow (3)
	Hib (3)	Hib (1)	Hib 2*	Hib (2)	Hib 2	Hib (3)	Hib (4)
	Mr (3)	Mr (1)	Mr (1)	Mr (2)	Mr (2)	Mr (3)	Mr (3)
	Be (4)	Be (3)	Be (2)	Be 1 *	Be 2*	Be 2	Be (4)
FLY-Fine Loamy CL, SCL, SICL	Mh 3	Mh (2)	Mh 3*	Mh 2*	Mh 2	Mh 3	Mh 4
	Aw 5*	Aw (3)	Aw (3)	Aw 2	Aw 4*	Aw 5*	Aw 0
	Or 3*	Or (3)	Or 3*	Or 2*	Or 2	Or 2	Or 2
	Cb 5*	Cb (3)	Cb (3)	Cb 3	Cb 4*	Cb 5*	Cb 0
	Bd 3*	Bd (2)	Bd (2)	Bd 3*	Bd 3	Bd 3	Bd 0
	Ms 0	Ms 0	Ms 0	Ms 0	Ms 3	Ms 2	Ms 5*
	Wb 4*	Wb (2)	Wb (1)	Wb 2*	Wb 3*	Wb 4*	Wb 5*
	Ow 0	Ow 0	Ow (3)	Ow 2	Ow 1	Ow 3*	Ow (4)
	Hib3*	Hib3*	Hib 2*	Hib 1*	Hlb 3	Hib (3)	Hib (4)
	Mr (3)	Mr (2)	Mr (1)	Mr (3)	Mr (2)	Mr 3*	Mr 3*
	Be 4	Be (3)	Be (3)	Be (2)	Be 3*	Be (4)	Be 5*
CYY-Clayey C, SC, SIC, HC		Mh 2*	Mh 1*	Mh 2*	Mh 3	Mh 4*	Mh 3
		Aw 0	Aw 0	Aw (3)	Aw 4	Aw 0	Aw 3*
		Or 3*	Or (3)	Or 3*	Or 2	Or 3	Or 2*
		Cb 0	Cb 0	Cb (3)	Cb 4	Cb 0	Cb 3*
		Bd 0	Bd (3)	Bd (3)	Bd 3*	Bd 0	Bd (4)
		Ms 0	Ms 0	Ms 0	Ms 2	Ms 3	Ms 0
		Wb1*	Wb (2)	Wb (2)	Wb (3)	Wb 4*	Wb 0
		Ow 0	Ow (5)	Ow 3*	Ow 2	Ow 4*	Ow 0
		Hib 4*	Hib (2)	Hib (3)	Hib 4*	Hib (5)	Hib (4)
		Mr 2*	Mr (2)	Mr (3)	Mr 3	Mr 4*	Mr 0
		Be 4*	Be (3)	Be 4*	Be 0	Be 0	Be (5)

Hardwoods/7e Con't. (predicted Site Class by species)

	DEPTH TO DISTINCT MOTTLES (cm)						
TEXTURE GROUP (TG)	**>150**	**100-150**	**80-100**	**50-80**	**30-50**	**15-30**	**<15**
SHA-Shallow All textures where depth to bedrock ≤50 cm				Mh 1*	Mh 2*	Mh 4*	Mh 0
				Aw (4)	Aw 4*	Aw (5)	Aw 0
				Or (2)	Or 4*	Or (5)	Or (5)
				Cb (4)	Cb 4*	Cb (5)	Cb 0
				Bd (4)	Bd 5*	Bd (5)	Bd 0
				Ms 0	Ms 0	Ms 0	Ms 0
				Wb 0	Wb 0	Wb 0	Wb 0
				Ow (5)	Ow (4)	Ow 2	Ow (5)
				Hib (3)	Hib 1*	Hib (3)	Hib (5)
				Mr 0	Mr 0	Mr 0	Mr 0
				Be (5)	Be (5)	Be 0	Be 0

Note: Species 0 = Textural group/depth to distinct mottle combination where species rarely exists.
"(5)" indicates subjective extrapolation of site class-no data collected
* insufficient data for proper site class prediction
"c" indicates site class when free carbonates are within 50 cm
"r" indicates site class when a root restricting layer occurs within 60 cm, e.g., a sandy soil overlying a clay
Blank boxes indicate textural group/depth to distinct mottle combination where species rarely exists.

APPENDIX IV

Common Herbicides Used in Forestry

HERBICIDE	SOIL TYPES	TARGET VEGETATION	MODE OF ACTION	APPLICATION CRITERIA	COMMENTS
Glyphosate	No restrictions	Broad spectrum control (annual and perennial grasses, annual and perennial herbs, poplar, birch, maple, cherry, hazel, blueberry, sweetfern, *Rubus* spp., bracken fern, willow, alder, etc.). Poor control of thick cuticle leaved species such as sugar maple. Control of red maple increases with late season application. Best results for bracken fern will be obtained from applications made after frond tips have uncurled but before senescence (Williamson and Lane 1989).	Inhibits the formation of an essential amino acid in plants, causing metabolic failure and death. *Vision*® or *Roundup*®: Absorbed through leaves, translocates though plant. *Ezject*®: If material in xylem, will move up to foliage, if material in phloem, will move to roots.	*Vision* ® or *Roundup*®: Aerial or ground application to actively growing vegetation. For site preparation (late June to late July) or release (after buds harden off in conifers, mid-Aug. to mid- Sept.). Better control later in growing season, when higher rates of translocation from crown to roots occurs. *Ezject*®: Inject the appropriate number of capsules evenly at base of tree or stump below all major branches. Can be treated any time of year, except when wood is frozen.	Apply before killing frost. Some autumn colours are acceptable, provided no major leaf fall has taken place in undesirable brush and tree species. Lowest rates can be used when incomplete control of competing vegetation is required. Lower rates are recommended when white pine is newly planted or when natural regeneration is 1-3 years old. Do not spray during drought, within 6 hours of rain for regular formulation or within 2 hours of rain for Transorb formulation, or when target vegetation is stressed or damaged. Need clean water to mix. Low spray volumes are more effective than high spray volumes. Completely biodegradable, does not leach and cannot accumulate in food chain (Monsanto Canada, Inc. 1992). More effective on moist vegetation, when RH is high and air is warm (>15°C) (Williamson and Lane 1989). Is most effective on broadleaved plants when they are close to flowering but before senescence (Williamson and Lane 1989).

Adapted from: Otchere-Boateng (1990); Arnup et al. (1995); McLaughlan et al. (1996).

HERBICIDE	SOIL TYPES	TARGET VEGETATION	MODE OF ACTION	APPLICATION CRITERIA	COMMENTS
2,4-D Ester: foliar Amine salt: cut surface	No restrictions	Ester: alders, balsam, birch, cherries, raspberries, elderberry, elm, hazel, poplars, sumac, willow and herbaceous broad-leaved species. Does not control sedges or grasses. Not effective on maple or oak species. Re-sprouting can be a problem (Sajdak 1985). Amine salt: alder, willow.	Ester absorbed through leaves and translocated within phloem, accumulates in meristematic regions of shoots and roots. Interferes with normal cell growth, impairs respiration, food reserves, and cell division. Amine salt absorbed through roots and moves through phloem.	Ester: Aerial or ground application for site preparation and conifer release. For conifer release, delay spray until crop tree buds have hardened-off and use lower rates. For site preparation, higher rates can be used and the application should be after full leaf expansion and during the period of active growth. Amine: Apply to frills or hacks cut into bark or tree. Can be applied to freshly cut stumps with brush or backpack sprayer.	Application must be made before frost. Can damage crop trees at high rates; lower rates should be used in pine plantations. Do not spray during rain or drought. Most effective between April and end of July. The ester formulation can vaporize and move off site when temperatures are greater than 32°C (Boyd et al. 1985).

Adapted from: Otchere-Boateng (1990); Arnup et al. (1995); McLaughlan et al. (1996).

HERBICIDE	SOIL TYPES	TARGET VEGETATION	MODE OF ACTION	APPLICATION CRITERIA	COMMENTS
Hexazinone	Do not use on gravelly or rocky soils, sandy or coarse textured soils or exposed sub-soils. Do not apply on coarse textured soils with less than 2% organic matter or on fine soils with less than 1% organic matter. The heavier the soil, the higher the rate of *Velpar L*® needed. Do not apply on frozen and snow covered soils and water saturated sites. Do not use on sloped sites with high run-off potential or on erosion-prone sites.	Annual, biennial, and perennial weeds, grasses and woody plants e.g., grasses, raspberry, and aster are very susceptible; maple, willow, poplar, and birch are intermediate in tolerance; hazel, alder, blueberry and dogwood are tolerant. The residual activity reduces germination of species with wind-borne seed and seedbanking species and can reduce sprouting of certain other species (McLaughlan, 1996).	Absorbed through the roots, translocated upward through the xylem. Photosynthetic inhibitor. Residual and contact control. Tolerant plant species are able to metabolize the herbicide into non-toxic metabolites (Campbell et al. 1996).	*Velpar L*®: Broadcast ground application and undiluted spot treatments for site preparation and conifer release. Aerial (since 1991) for site preparation. *Pronone*: Ground application for site preparation. For grass and herbs, apply broadcast in the spring before the leaves are fully expanded. For shrub and tree control, for conifer release, apply directly to the soil as close as possible to base of target vegetation.	Herbaceous vegetation will show effect within 2-6 weeks, depending on humidity and temperature. For brush and trees, effect appears within 3 weeks after sufficient rainfall has carried product to root zone. If dose if 9.0 L/ha or less, black spruce, white spruce or red pine can be planted. If rate is higher, wait one year before planting. Do not apply within 50 m of water. Moisture activates herbicide. Soil must be moist at time of application and 6-13 mm of rainfall is needed within 2 weeks after application. Application rates must be very precise. Do not apply within 1 m of susceptible crop trees. White pine and jack pine can be susceptible.

Adapted from: Otchere-Boateng [1990]; Arnup et al. [1995]; McLaughlan et al. [1996b)

HERBICIDE	SOIL TYPES	TARGET VEGETATION	MODE OF ACTION	APPLICATION CRITERIA	COMMENTS
Simazine	Highest rates are required on fine-textured soils and soils high in organic matter. Do not apply on frozen and snow covered soils and water saturated sites.	Annual grass, germinating perennial grass, and triazine-sensitive herbs. Resistant plant species may invade site (Ont. Weed Comm. 1995).	Absorbed through plant roots by mass flow with water and dissolved ions. Translocated upward in plant through xylem. Inhibits photosynthesis.	Ground application only. Most appropriate on lands formerly under agricultural cultivation. Apply broadcast or selectively in spring or fall before freeze-up.	Requires rainfall to be activated. Container stock is more susceptible to damage than bareroot stock because of shallower root position.
Triclopyr	No restrictions.	Alder, ash, aspen, birch (best control using foliar), cherry, maple (best control using basal bark), raspberry. Does not control grasses.	Auxin-type, systemic. Absorbed through green bark, leaves and roots and translocated throughout plant, causes plant's growth system to malfunction.	For site preparation or release, aerial (since 1992) and ground application as foliar spray, early June-July for site preparation, mid-Aug. to killing frost for release; basal bark, and stem treatment during active growing season or dormant season.	Do not spray within 2 hours of rain. No evidence of translocation across root grafts to untreated trees after a stem injection treatment (Williamson and Lane 1989). Extreme care must be taken around water bodies and water courses including intermittent streams that may provide brook trout habitat. Pines are more susceptible than spruces. Ensure that crop trees have hardened-off completely.

Adapted from: Otchere-Boateng (1990); Arnup et al. (1995); McLaughlan et al. (1996).

APPENDIX V

Common Pesticides used in Forestry

Adapted from Common Pests of Trees in Ontario (Ontario Ministry of Natural Resources 1991b)

INSECTICIDE CONTROL RECOMMENDATIONS

Insect and disease pests of trees can cause considerable economic damage. No species of tree, no part of a tree, and no stage in the development of a tree is immune to pest attack. From the time trees are set in the soil they are subject to the attacks, or the effects, of numerous agents which may kill them, retard their growth, deform their shape or symmetry, weaken or degrade the wood, or otherwise adversely affect their functioning or mar their attractiveness. The importance of the injury is relative to the purpose for which the trees are being grown, managed, or utilized. The intensity of control efforts undertaken is similarly determined by the value of the trees at risk and the type or degree of damage.

Prevention of attack is the first line of defence against pests. Good cultural practices should be emphasized as a means of maintaining tree vigour. Vigorously growing trees are generally better able to resist attack by insects and diseases or to withstand periods of adverse weather or other stress conditions. If attacked, they are better able to recover from the effects of the infestation or infection. However, when an outbreak or epidemic occurs or appears imminent, direct control through the use of pesticides is sometimes required to mitigate damage.

Pesticide products mentioned in this publication have been reviewed by the Ontario Pesticides Advisory Committee and have been classified under the Ontario Pesticides Act.

Chemical Safety

The usefulness of pesticides rests on their ability to interrupt the life process of insects and fungi. By their very nature, pesticides are poisons and must be handled properly to prevent unwanted and dangerous effects to humans, non-target organisms, and the environments. Pesticides may be taken into the body by breathing, swallowing, or absorption through the skin. However, even the most toxic compounds can be used safely if the recommended precautionary measures are observed.

- Purchase only the quantity of pesticide needed for a particular problem or for a single season.
- Inspect pesticide containers for leaks before handling them. Do not handle containers roughly or carelessly.
- Read the entire product label to ensure that the plants to be treated are not sensitive to the chemical. Follow the directions and safety precautions carefully. If seeking medical aid, take the label and/or container with you.
- Do not rub the eyes, touch the mouth, or smoke while working with pesticides. Wash hands thoroughly before eating, drinking, smoking, or using the toilet.
- Wear clean rubber gloves and protective clothing when handling pesticides, and use a respirator whenever recommended. Thoroughly wash contaminated clothing separately and discard faulty protective clothing.

- Clean up any pesticide spill immediately. Use dry soil, sawdust, or other absorbent material to remove excess liquid.
- Do not leave pesticide containers unguarded while spraying and ensure that children and pets are kept well away.
- Do not work alone with a hazardous chemical

Toxicity and Lethal Dose

Pesticides vary widely in their toxicity. Toxic effects may be acute or chronic. The susceptibility of animals to poisoning by a pesticide varies with the type of formulation used, the route of entry into the body (oral, dermal, or respiratory), and the weight, age, sex and nutritional state of the individual affected. The accepted method of recording the relative toxicity of a pesticide is the Lethal Dose 50% (LD50) value. This is a statistical estimate of a chemical dose which, when administered, will kill 50 percent of the test animals under stated conditions. The figures that designate the LD50 values are expressed in milligrams of dose per kilogram of body weight of the test animal. Therefore, the higher the LD50 value, the less acutely toxic the material. The acute oral LD50 values to rats of some currently used pesticides, common drugs, and other materials are:

CHEMICAL COMPOUND	ORAL LD VALUE $_{(50)}$
endosulfan	43
Gravol	500
2,4-D phenoxy acid	600
ferbam	1000
malathion	1375
aspirin	1750
common salt	3300
methoxychlor	6000
maneb	6750
benomyl	9590
Bacillus thuringiensis (Bt)	15 000

Storage of Pesticides

- Pesticides should be stored in their original containers in cool, dry, locked, well-ventilated area without floor drains.
- Pesticides should be stored away from food and drink used for human and animal consumption.
- Herbicides should be stored separately from other types of pesticides to prevent cross-contamination.
- A chemical-storage warning sign should be placed on the outside of each entrance leading into the storage area.
- Protective clothing and a first-aid kit should be available in the storage area.

Disposal of Pesticides

- Immediately after emptying a pesticide container, rinse it at least three times with the same dilutent used for mixing the spray. Pour the rinse into the spray tank and puncture the bottom of the container. Do not reuse pesticides containers or convert them to other uses.
- All empty containers and unused amounts of pesticides must be securely held in an isolated storage area until they can be disposed of correctly. Triple-rinsed or jet-rinsed containers of the most commonly used pesticides can be disposed of with household garbage.
- Where regular garbage disposal is not practical, dispose of empty pesticide containers in a landfill site or bury under at least 50 cm of soil, away from water.

Benefit/Risk Relationship of Pest Control

The aim of pest control is not the eradication of a pest species, but rather the maintenance of a balance between the pests and their host trees at a level below the threshold of serious injury. The decision to invoke control measures depends upon the benefits to be received in relation to the costs incurred. The value of the material saved must justify the expense involved, or the cost of control must be less than the loss that would result if no intervention were made. If the use of pesticides is the most efficient method of control, then:

- Select the least toxic material and use the lowest concentration that will do the job effectively.
- Apply the smallest amount necessary and in a manner that will have minimum effect on non-target organisms and non-target areas.
- Make application at the weakest point in the pest's life cycle.

Pesticide (common trade name in parentheses)	Pests Controlled	Remarks
Insecticides and Miticides		
• acephate (Orthene)	gypsy moth, oak leafshredder, spruce budworm, tent caterpillars	Material has temporary registration.
• *Bacillus thuringiensis* (*Bt*)	cankerworms, gypsy moth, oak leafshredder, spruce budworm, tent caterpillars	A bacterial insecticide for control of larvae that develop into moths. Must be eaten to be effective.
• carbaryl (Sevin)	cankerworms, gypsy moth, oak leafshredder, sawflies, skeletonizers, spruce gall aphids, web worms	Effective against exposed defoliators and some sucking insects. Extremely toxic to honey bees.
• chlorpyrifos (Dursban)	elm bark beetles, white grubs	
• diazinon	European pine shoot moth, white grubs	
• dicofol	mites only	Available only as one of the ingredients in a pesticide mixture.
• dimethoate (Cygon)	European pine shoot moth, leaf miners, spruce budworm, spruce gall adelgids, some mites	A systemic insecticide that is absorbed into the vascular system of the plant and translocated to the site of insect activity.
• endosulfan	black vine weevil, bronze birch borer, cankerworms, linden looper, locust borer, spruce gall aphids, strawberry root weevil	For control of exposed defoliators and adult borers. Do not apply on Anderson yew.
• lindane	bark beetles, borers, northern pine weevil, pales weevil, pine root collar weevil, white pine weevil	Has long residual activity.
• malathion	exposed defoliators, sucking insects, spruce gall adelgids, some mites	One of the most commonly used insecticides.
• methoxychlor	exposed defoliators, adult bark beetles and borers, rose chafer, white pine weevil	

Pesticide (common trade name in parentheses)	Pests Controlled	Remarks
• dormant oil (Superior oil)	aphids, scales, mites	Used as dormant spray to kill eggs and overwintering nymphs. Apply in early spring before buds break, but when temperatures will remain above freezing for several hours. Do not apply on sugar maple.
Fungicides		
• benomyl	apple scab, powdery mildew	A systemic fungicide with protective and eradicant action, for control of a wide range of fungi.
• borax (Sodium borate decahydrate)	Fomes root rot	Applied as a stump protectant.
• chlorothalonil	Scleroderris canker	A protectant fungicide; so total foliage coverage is vital to ensure effective disease control.
• mancozeb	powdery mildew	A general foliage protectant available as one of the ingredients in a pesticide mixture.
• ferbam	anthracnose, juniper rusts, apple scabs	A general foliage protectant available as one of the ingredients in a pesticide mixture.
• sulphur	juniper rusts, powdery mildew	Available as one of the ingredients in a pesticide mixture.
• zineb	anthracnose, hawthorn leaf blight, horse-chestnut leaf blotch, juniper rusts, leafspots	A general foliage protectant available as one of the ingredients in a pesticide mixture.

GLOSSARY OF TERMS

acidic. Having a pH factor of less than 7; having a relatively high concentration of hydrogen ions (contrasted with alkaline especially as a characteristic of soil).

aeration. The replacement of air in the soil with air from the surface. Aeration is affected by the amount and size of pores within the soil, which may in turn be affected by moisture and texture. Poorly aerated soils contain relatively more carbon dioxide and less oxygen on a percentage basis.

annual. A plant that lives for only one year.

antagonism. The mutual killing, injury, or inhibition of growth of dissimilar organisms occupying the same ecological niche.

basic. Having a pH factor of greater than 7; having a relatively low concentration of hydrogen ions (contrasted with acidic especially as a characteristic of soil).

calcareous soil. Soil containing sufficient calcium carbonate, often with magnesium carbonate, to effervesce visibly when treated with cold 10 percent hydrochloric acid (HCL).

carbon sequestration. The process of increasing the carbon stored in a carbon pool other than the atmosphere.

commercial thinning. Removing trees from a developing young stand, so that remaining trees will have more growing space; dead and dying trees will be salvaged; and the operation will make a net profit.

conifer. A tree belonging to the order Coniferae, usually evergreen with cones, needle-shaped leaves and producing wood known commercially as 'softwood.'

coppice. Sprout growth originating from the cut stem of a tree.

cover crop. Any crop grown primarily to provide ground cover or to improve soil properties, rather than provide a harvestable yield; nearly any crop can be used as a cover crop, but some are more useful than others, for example legumes (e.g., clover, alfalfa) can improve soil fertility.

deciduous. Term applies to trees (commonly broad-leaved trees) that drop all their leaves sometime during the year; wood known commercially as 'hardwood'

diameter. Refers to the diameter of the main stem of the tree at breast height, which is 1.3 metres above ground level, also abbreviated as DBH.

dibble. A round metal tool used to make a hole for planting cuttings.

dormancy. A biological process in which a plant ceases most growth activities and simply maintains existing tissue. Caused by periods of moisture and /or temperature stress.

drainage. Drainage refers to how excess water flows "internally" through the soil, in a downward direction. It may be affected by soil texture, structure and depth. In addition, drainage may be seasonally affected by precipitation and /or runoff. Drainage classifications are determined by assessing mottles, gley colours, texture, depth and structure.

duff. Forest litter and other organic debris in various stages of decomposition on top of the mineral soil; typical of coniferous forests in cool climates, where rate of decomposition is slow and where litter accumulation exceeds decay.

efficacy. The achievement of the desired results or effects (e.g., the efficacy of herbicide treatments).

fertility. Rich in material needed to sustain plant growth.

floodplain. The land bordering a waterway, that has a build-up of sediment and is subject to periodic flooding.

flush. Describes bud break and leaf expansion in the spring.

forest region. A geographic zone with a vegetation cover that is fairly uniform in terms of dominant species and stand types.

furrow. A long, narrow, shallow trench made in the ground by site preparation equipment.

germination. The resumption of active growth in the embryo of a seed, as demonstrated by the protrusion of a radicle (embryonic root axis).

gley. A blue-gray colour in soil due to the reduction of iron. Formed in a process characterized by low oxygen conditions caused by the soil being waterlogged. If the soil is waterlogged on a seasonal rather than permanent basis, the periodic oxidation will give rise to mottles.

glyphosate. A broad spectrum, nonselective herbicide that is applied as a post emergent spray to actively growing vegetation. It is absorbed through stems and foliage to be translocated throughout the entire plant. Plant death occurs within two to four weeks with no residual activity in the soil.

growing medium. A vital component of container culture, providing nutrients, water, air, and the rooting environment essential for the development of a healthy seedling.

hardpan. A compacted layer of soil usually caused by repeated tillage operations. The amount of pore space in a hardpan is much less than the layers of soil above or below it, thus causing drainage problems.

herb. A non-woody flowering plant.

herbicide. Any chemical preparation used to kill or inhibit the growth of forbs, grasses, woody plants, and their seeds.

hybrid. The product of crossing two parents of different species that can result in a more desirable individual.

litter. The uppermost layer of the soil, made up of freshly fallen or slightly decomposed organic materials.

mesic. Describing the sites that are neither humid (hydric) nor very dry (xeric). The average moisture conditions for a given climate.

mineral soil. Soil consisting predominately of, and having its properties determined by, inorganic matter. Usually contains less than 20% organic matter.

mottles. Spots or blotches of different colour or shade of colour interspersed with the dominant soil colour, usually the result of alternating aerobic and anaerobic soil conditions and indicative of poor drainage. In surveying soils, the colour of the matrix and the principle mottles, and the pattern of mottling are noted. The latter is indicated in terms of abundance (few, common, many), size (fine, medium, coarse), and contrast with the matrix (faint, distinct, prominent). The depth of mottles in soils of different types is a diagnostic indication of moisture regime.

organic matter. The portion of the soil which contains decayed or partly decayed plant material.

perennial. A plant that lives more than 2 years.

pH. A measure of the hydrogen ions on a scale of 0 (very acidic) to 14 (very basic). A pH value of 7 is neutral. Every change in one unit of measure indicates a 10x change in the quantity of hydrogen ions (e.g., a pH of 5.0 is 10 times more acidic than a pH of 6.0.

post-emergent herbicides. A chemical that kills actively growing herbaceous plants.

pre-emergent herbicide. A chemical that is applied before weeds emerge. It acts by (i) killing weed seedlings and /or (ii) establishing a layer of chemical on or near the soil surface that is toxic to germinating seeds and young seedlings.

rhizome. A creeping stem lying, usually horizontally, at or under the surface of the soil and differing from a root in having scale leaves, bearing leaves or aerial shoots near its tips and producing roots from its undersurface.

root collar. Position on a plant where there is a junction with where the roots begin to grow and where the stem begins.

roots. The below-ground tree or plant parts that provide physical support, absorb water and nutrients from the soil and store food produced by photosynthesis.

rotation. The period of years required to establish and grow a timber crop to a specified condition of maturity, when it may be harvested and a new tree crop started.

rotation age. The age at which a stand is considered ready for harvesting under an adopted plan of management.

seed zone. Area of similar climatic and elevation conditions, used to specify where tree seed was collected and where trees from such seed are most likely to be successfully grown.

seedbed. In natural plant reproduction, the soil or forest floor on which seed falls; in nursery practice, a prepared area in which seed is sown.

seedling. A small tree grown from seed. Usually the term is restricted to trees equal to or less than 1 cm DBH.

Simazine. A herbicide used to control grasses and other herbaceous species on old-field sites. It has no efficacy on woody species.

site productivity. The rate of production of wood of given specifications, by volume or weight, for a given area.

soil moisture. The relative amount of water in the soil; usually applied to upper levels of soil, occasionally to humus layer.

soil texture. The proportion of sand, silt and clay in a soil sample constitutes its textural class. Textural classes may be determined by chemical and physical analyses completed at a commercial facility. Alternatively, soil texture may be determined by various "feel tests", (e.g., If a soil feels "floury", it probably has a relatively high percent of silt).

stem. The trunk of a tree.

stool. Stump from which a coppice originates.

stool bed. A number of stools of one-year-old coppice that are harvested each year (to produce cuttings) and then allowed to coppice again the following year.

sun scald. Death of cambial tissue on one side of a tree, caused by exposure to direct sunlight.

tending. Generally, any operation carried out for the benefit of a forest crop at any stage of its life, e.g., cleaning, thinning, pruning.

veneer. A thin sheet of wood cut on a lathe or slicing machine.