Ontario

# *A Comparison of Red Pine Sawlog Management and Red Pine Pulpwood Management*

A Demonstration Forest Program Publication

# *A Comparison of Red Pine Sawlog Management and Red Pine Pulpwood Management*

A Demonstration Forest Program Publication

**Technical Report #12**

50902
ISBN 0-7778-5388-4

Published by
Northwest Science & Technology
R.R. #1, 25th Sideroad
Thunder Bay, Ontario,  P7C 4T9

Cette publication spécialisée
n’est disponible qu’en anglaise

# PREFACE

Demonstration Forest Technical Reports are a component of the Demonstration Forest Program and are intended to provide technical information for resource management staff. A Demonstration Forest Technical Report consists of a brief literature review of the relevant species' ecology and the silvicultural systems employed for their management, and concludes with case study information collected on-site at Demonstration Forest areas. Each Demonstration Forests Technical Report relates to one or more Demonstration Forest areas throughout northwestern Ontario.

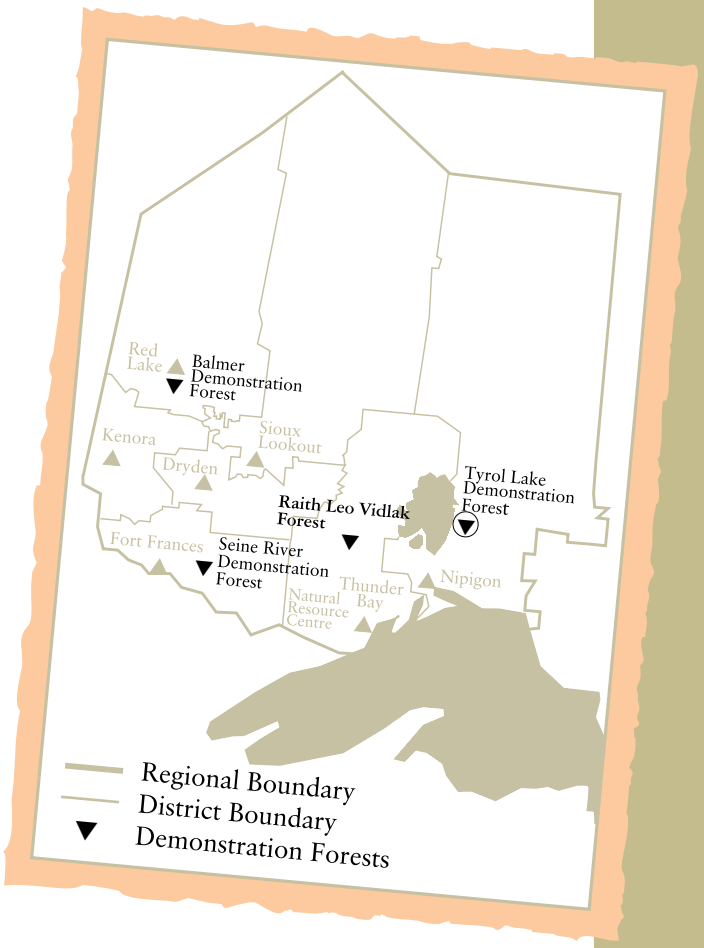
This Technical Report describes the Tyrol Lake Demonstration Forest.

## Tyrol Lake Demonstration Forest

### Nipigon District

From Nipigon travel 80 kilometres (km) north on Highway 11 to Beardmore, take Highway 580 for 6 km to Camp 72 Road, turn right and proceed 5.8 km to the Tyrol Lake Demonstration Forest entrance. The Tyrol Lake Demonstration Forest consists of six sites located along 20 km of the Camp 72 Road. Each site has a marked walking trail with information signs.

Case Study Site:
Sites 1 and 6 - Jack and Red Pine Plantations
Travel 3.3 km from Tyrol Lake Demonstration forest entrance on Camp 72 Road.



# INTRODUCTION

Different management regimes are often used whether growing timber for pulpwood or for sawlogs. Jack pine is an economically important species found throughout northwestern Ontario and is a primary source of pulpwood. Red pine is a valuable species, but not widely distributed in northwestern Ontario. It is usually found in relatively small stands and is most frequently used for sawlogs, veneer or other specialty products.

Efficient and effective forest management is essential today when forest managers must contend with increasing financial constraints and reforestation obligations. Prior to harvest, during planning for forest renewal activities, forest managers should consider the following:

- site quality and the species best suited to the site
- desired final products
- available markets
- planting stock availability
- plantation maintenance
- budget limitations

# SILVICS OF RED PINE

## Habitat

Red pine has limited distribution in northwestern Ontario, occurring infrequently in small localized stands. It grows on glaciofluvial and morainal landforms and requires sandy, well-drained to rapidly-drained coarse loamy soils (Sims *et al.* 1990).

Red pine is a dominant species in two vegetation types (V-type) of the Forest Ecosystem Classification for Northwestern Ontario (FEC) (Sims *et al.* 1989). The red pine conifer V-type (V27) is a red pine conifer stand with a sparse understory, thick litter layer, limited herb layer and a moderate cover of mosses and lichens (Sims *et al.* 1989). This stand type usually occurs on coarse-textured sandy soils (S-types S1, S2) (Sims *et al.* 1989). The red pine mixedwood vegetation type (V13) is a red pine mixedwood stand which occurs on more moist, nutrient rich, soil types (S-type S3). These sites have a richer and more diverse understory and lesser amounts of lichen and mosses on the forest floor (Sims *et al.* 1989).

## Reproduction and Establishment

Red pine begins producing seed at age 20 in open-grown stands and age 50 in closed stands (Bell 1991). Good cone crops usually occur every seven years, but are more often infrequent and irregular (Fowells 1965; Bell 1991). Successful germination of seeds occurs on moist mineral soil with partial sunlight and minimal competition. High levels of non-crop competition will cause seedlings to develop inadequate root systems and become susceptible to smothering by litter and herbs. Seedlings established in exposed areas often experience increased levels of mortality due to high surface temperatures and dry soil conditions (Sims *et al.* 1990; Bell 1991). Once established, red pine seedlings grow best in full sunlight and do not compete well with shrubs, herbs and tolerant hardwoods (Bell 1991).

## Stand Development

Red pine is a shade intolerant species; it is only slightly less so than jack pine. During the first five years after establishment, seedlings will exhibit good height growth under partial shade (45 percent); after that they require full sunlight (six hours of direct sunlight a day) to attain maximum height (Sims *et al.* 1990). Red pine height growth is very uniform, and seedlings may attain a height of one metre (m) by the end of five years (Chapeskie *et al.* 1989). The height growth of red pine is unaffected over a wide range of spacings, except on poor sites, or in extremely open or dense stands (Sims *et al.* 1990). Diameter growth is greatly affected by stand density, however. In red pine plantation management, initial planting density, timing of thinnings and stand density left after thinning have a direct influence on diameter growth (Benzie and McCumber 1983).

The height and diameter growth of red pine are adversely affected by competing vegetation or a hardwood overstory. Red pine will respond to release if the competition is light to moderate. Red pines overtopped by oaks and maples for as long as 40 years were found to respond to release (Fowells 1965). Roe (1951) found that an early release of overtopped red pine provided the greatest benefits.

Red pine shares essentially the same moisture, nutrient and heat requirements as jack pine (Sims *et al.* 1990). Red pine has a low tolerance to flooding and requires good soil aeration.

Mature red pine trees develop thick insulating bark and elevated crowns which enable them to survive ground fires. Fire also serves to prepare an excellent seedbed for red pine seeds.

Red pine is a long-lived species (up to 350 years) with a high productive capacity and a capability for outperforming jack pine (Sims *et al.* 1990). Red pine trees are tall and uniform, with little trunk taper and a clear bole if grown in closed stands. Trees are usually harvested between 80 to 110 years. Red pine is a poor self-pruner, but responds well to artificial pruning. Red pine can be used for pulp, but because of its high strength it is most often used for dimensional lumber and poles. A rotation age of 90 years is recommended for red pine sawlog plantations (Marcin and Frogness 1975). Red pine should be thinned initially between the ages of 15 and 30 years, followed by thinnings at intervals of at least ten years (Marcin and Frogness 1975; Lothner and Bradley 1984).

# SILVICS OF JACK PINE

## Habitat

Jack pine is found extensively throughout northwestern Ontario, often in pure stands, but also in association with black spruce, trembling aspen or white birch. Jack pine is a pioneer species which is well adapted to regeneration following fire. Jack pine grows best on deep, well-drained loams or very fine sands, where the water table is 1.2 to 1.8 m (four to six feet) below the surface (Fowells 1965; Sims *et al.* 1990).

Jack pine conifer stands (V-types V28, V29, V30, V31, and V32) are characterized by feathermoss ground cover and a moderate shrub and herb layer. These stands grow on moderately deep, dry sandy soils (S-types S1, S2, S3) (Sims *et al.* 1989).

## Reproduction and Establishment

Jack pine is a regular and prolific seeder and produces good cone crops every three to four years (Fowells 1965; Bell 1991). Jack pine seeds require exposed mineral soil and little to no shade for germination and seedling establishment. Seedlings are shade intolerant, fast-growing, and usually dominate the stand under optimum conditions (Fowells 1965).

Seedling mortality during the first four years is generally the result of climatic or establishment (microsite) factors; competition from grasses, herbaceous vegetation, shrubs and hardwood saplings will limit jack pine survival and growth (Bell 1991).

## Stand Development

Height growth of jack pine is relatively slow during the first three years of development, followed by rapid growth over the next 40 years. Growth then starts to decline to a level which is site and vegetation density dependant (Galloway *et al.* 1986). Although jack pine grows rapidly, it is extremely shade-intolerant and cannot survive with overstory shade (Benzie 1977). In shaded conditions, jack pine exhibits poor development, sparse crowns, spindly stems and shade-adapted needles (Bell 1991).

In dense jack pine stands, mortality usually occurs between 15 and 30 years of age as a result of inter-tree competition (self thinning) (Sims *et al.* 1990). Self thinning starts after crown closure and begins earlier in close-spaced stands (Berry 1984).

Jack pine has a rotation age of approximately 60 years (Fowells 1965). Wilde *et al.* (1951) found that jack pine from dense unmanaged stands had a high gross total volume, but individual trees were of small dimensions and low quality. On medium to good sites in the Lake States, jack pine can be grown for sawlog production on a 70 - 80 year rotation (Fowells 1965). Depending on site quality, the rotation age for pulpwood production can be decreased to 50 years (Fowells 1965).

Jack pine responds well to selective thinning and release during juvenile and intermediate stages of development (Sims *et al.* 1990). Vassov and Baker (1988) found that pre-

commercial thinning in high density stands, eight to 12 years old, was a cost-effective method of reducing the rotation age of the stand, and controlling stand stocking, density and health. This age guideline mimics the initiation of natural self-thinning, yet speeds up the process, thereby maintaining rapid stem growth. In a trial project of thinned versus unthinned jack pine stands near Atikokan, Ontario, Goble and Bowling (1993) determined that unthinned stands had significantly higher mortality rates (26 percent) than thinned stands (seven percent) over a five-year period. The thinned stands also had significantly higher five-year diameter increment and stem volume than the control stands.

Jack pine plantations established on dry, nutritionally poorer sites (V18, V29, V31 and V32) will generally not require release from competing vegetation. The nutritionally richer sites (V17 and V28) that have a trembling aspen component at maturity may require tending, especially if the area has been seeded (Bell 1991).

## A COMPARISON OF RED PINE AND JACK PINE

Red pine and jack pine are very similar species in many respects. Both will grow on a wide range of sites and under more restrictive conditions than many other species, although optimal soil conditions for both are well-drained, loamy-sandy soils. Jack pine and red pine are both classed as intolerant species, with red pine being slightly less intolerant than jack pine. Seeds of both species require mineral soil for successful germination, and seedlings require at least 30 percent full light intensity to survive (Fowells 1965).

Red and jack pine are well adapted to establishment following fire, although jack pine is more prevalent and invasive than red pine in northwestern Ontario. In the absence of fire, both red and jack pine will be succeeded by more tolerant hardwoods, except on poorer sites. Jack pine has serotinous cones which require extreme heat to open, and fire will often prepare sites that meet the particular seed and seedling requirements of this species. Mature red pine trees, whose wood is impregnated with resins, are very fire resistant, so that the trees are often scorched, but not killed, by fire. Fire will also eliminate slash and expose mineral soil, preparing the site for the exacting germination and seedling requirements of red pine (Fowells 1965).

Both red and jack pine are valuable commercial species in northern Ontario; jack pine for pulp, sawlogs and poles; red pine for poles, lumber and specialty products.

# RED AND JACK PINE MANAGEMENT FOR SAWLOGS AND PULPWOOD

Forest management styles can be classified as extensive or intensive. The two styles are differentiated by the amount of effort expended on the treatment and care of forest stands (Smith 1986). The degree of intensity is usually measured by the amount of money invested in silvicultural activities, the frequency of treatments during the rotation, and the value of the final product (Smith 1986).

Management of a stand for pulpwood production requires an extensive regime. Today, most pulpwood is chipped and the dimensions and form of the trees are not nearly as important as the fibre quality and gross volume which the stand will yield. Forest stands which are to be managed for pulpwood production can be established by broadcast seeding or planting, and will probably not require any further treatments before final harvest, except for a possible herbicide application to release seedlings from non-crop competition.

Sawlog production requires a more intensive, higher cost management regime, since the emphasis is not on the total gross volume of the stand but on individual tree size. Tree diameter, length of clear bole and form are critical. The value of the final product is usually higher than that of pulpwood. To produce quality sawlogs, the forest stand must be maintained regularly after planting and costly tending treatments in the form of thinning and/or pruning are usually required. When sawlog production is the management objective, therefore, careful planning and budgeting are required.

The resource manager must consider a number of factors when deciding upon a specific management regime. One consideration is the amount of merchantable volume that will be realized at harvest. Merchantable volumes are most affected by the number of trees planted, survival rates and tree form (Maeglin 1967). Therefore both the quantity and the quality of the wood to be harvested affect the final product and its corresponding value must be considered. In addition, the availability of markets, both for end products and the products of intermediate thinnings, will affect the management regime which the resource manager will select. Finally, budgetary considerations may affect the intensity of the management regime which the resource manager is able to implement.

Two criteria commonly used to compare and evaluate various management alternatives are the soil expectation value and the internal rate of return (Lothner and Bradley 1984; deNaurois and Buongiorno 1986). Brilliant *et al.* (1977) performed an economic analysis of red pine and jack pine plantations on very fertile sites and concluded that higher economic returns came from the red pine stands. They recommended a greater use of red pine and to concentrate these plantations on the most fertile sites available. Bolghari (1975) also found that the yield from red pine plantations was greater than that from jack pine plantations. However, he concluded that the difference between these two species decreased with

increasing age or at lower stocking rates. deNaurois and Buongiorno (1986) concluded that it was more economical to manage red pine plantations for both sawlogs and pulpwood, rather than pulpwood alone, even on poorer sites. They also determined that the most important factor influencing the economic return of a plantation was site quality.

## The Importance of Spacing

Spacing affects the productivity of individual trees as well as the plantation as a whole. Trees with greater available growing space will produce more wood on an individual tree basis. However, larger numbers of trees per unit area will produce a greater total volume of wood because all the available resources, such as water, nutrients and light, are being utilized more efficiently. Spacing also affects the quality of wood produced; at wide spacings trees produce more branches, resulting in knotty lumber.

Spacing influences the level of silvicultural investment required over the rotation period of the plantation. Widely spaced plantations are less expensive to establish, but may require costly pruning treatments to maintain high wood quality. Plantations with close spacings may only require an investment in a pre-commercial thinning treatment. In plantations with high initial densities, trees will develop slowly and have poor diameter growth. Wider initial spacings may result in very branchy trees, excessive taper and large diameters (Wilde *et al.* 1951; Maeglin 1967).

Maeglin (1967) found that increased spacing of seedlings (i.e. lower initial densities) resulted in a higher number of merchantable trees. At close spacings, 2' x 2' (0.61 m x 0.61 m) or 4' x 4' ( 1.22 m x 1.22 m), there is intense competition between seedlings for a limited supply of water and nutrients. The effects of close spacings were higher mortality rates and the production of high volumes of poorly formed, small dimension wood (Maeglin 1967). Wider initial spacings may be used with the assumption that further treatments, such as thinning, can be eliminated. However, plantations established with very wide spacings (12' x 12' or 3.66 m x 3.66 m) usually have higher mortality rates, possibly due to increased competition, and poor form (Stiell and Berry 1973).

A study of plantations in Petawawa, Ontario determined that closer initial spacings of trees, 4' x 4' (1.22 m x 1.22 m) or 6' x 6' (1.83 m x 1.83 m), yielded the highest gross volumes per acre, but low merchantable volumes per acre (Stiell and Berry 1973). Conversely, very wide spacings, 12' x 12' (3.66 m x 3.66 m) or 14' x 14' (4.27 m x 4.27 m), resulted in higher merchantable volumes but lower gross volumes. Planting at initial densities of approximately 10' x 10' (3.05 m x 3.05 m) was recommended for red pine.

Maeglin (1967) recommends that 6' x 6' (1.83 m x 1.83 m) initial spacing be used for both red and jack pine. Plantations at 4' x 4' (1.22 m x 1.22 m) spacing had twice as many stems as the 6' x 6' (1.83 m x 1.83 m) plantations, but only five percent more volume. Therefore, once the cost of establishment and maintenance are considered, the best balance between form and volume was 6' x 6' (1.83 m x 1.83 m) spacing.

# CASE STUDY

Tyrol Lake Demonstration Forest
Lake Nipigon Forest SFL
Domtar Forest Products Inc.
Nipigon District

Case Study Site:
Sites 1 and 6 - Jack Pine
and Red Pine Plantations

# SITE 1

## Stand History

| Date | Treatment |
|---|---|
| 1940 | Harvesting |
| 1941, 1945 and 1947 | Wildfires throughout the area |
| 1950 | Stop #1a planted with 3-0 bareroot red pine; Stop #1b, 2 and 3 with 3-0 bareroot jack pine |
| 1962 | Hand cleaning to eliminate the natural poplar and jack pine which were suppressing the planted trees. There was also some pruning of red pine, and selective thinning of jack pine |

## Objectives

Site #1 will be used to demonstrate and compare the growth responses of jack and red pine which were hand planted on light sandy soils following harvesting and a wildfire. The long-term response of jack pine to hand cleaning will also be evaluated.

# Stand Conditions

(1994 - based on 400 $m^2$ plot)

Table 1: Stand Conditions: Stops #1a, 1b, 2, and 3

| | Stop 1a | Stop 1b | Stop 2 | Stop 3 |
|---|---|---|---|---|
| Treatment | Planted with 3-0 red pine | Planted with 3-0 jack pine | Planted with 3-0 jack pine | Planted with 3-0 jack pine |
| Species composition | $Pr_9Sw_1$ | $Pj_9S_1$ | $Pj_8Po_2$ | $Pj_{10}$ |
| Density (stems/ha) | 1125 | 1050 | 1800 | 1325 |
| Height (m) | 17 | 19.2 | 19.3 | 18.5 |
| DBH (cm) | 21.9 | 17.4 | 15.6 | 16.6 |
| Age (years) | 35 | 41 | 44 | 42 |
| Shrub Layer | trailing arbutus, twinflower, blueberry | twinflower, blueberry, trailing arbutus | trailing arbutus, twinflower | trailing arbutus, blueberry, twinflower |
| Herbaceous Layer | feathermoss, bunchberry, wild lily-of-the-valley | feathermoss, bunchberry, cow wheat | feathermoss, bunchberry, wild lily-of-the-valley | feathermoss, bunchberry, wild lily-of-the-valley |
| S-Type | S1 | S2 | S1 | S1 |
| V-Type | V27 | V18 | V29 | V29 |

The topography of the Tyrol Lake area is flat to rolling, composed of well drained, light sandy soils with occasional gravel and some rocky outcrops. The moisture regime is dry to fresh. The plantations at Stop # 1b and 2 were both planted with jack pine, but Stop #2 is a shallower site than Stop #1b. The jack pine planted at Stop #3 had no competition present at initial planting and has remained free of competition to the present. Currently some of the co-dominant trees in this plantation are starting to die and fall out of the stand. The three jack pine plantations at Site #1 are quite similar in structure and treatment, so for comparison purposes, the data of these three blocks will be averaged and used as a representative of a treated jack pine block (Refer to Figures 1, 2, 3 and 4).

Figure 1: Diameter distribution in 2 cm classes in the red and jack pine plantations in the Tyrol Lake Demonstration Forest.

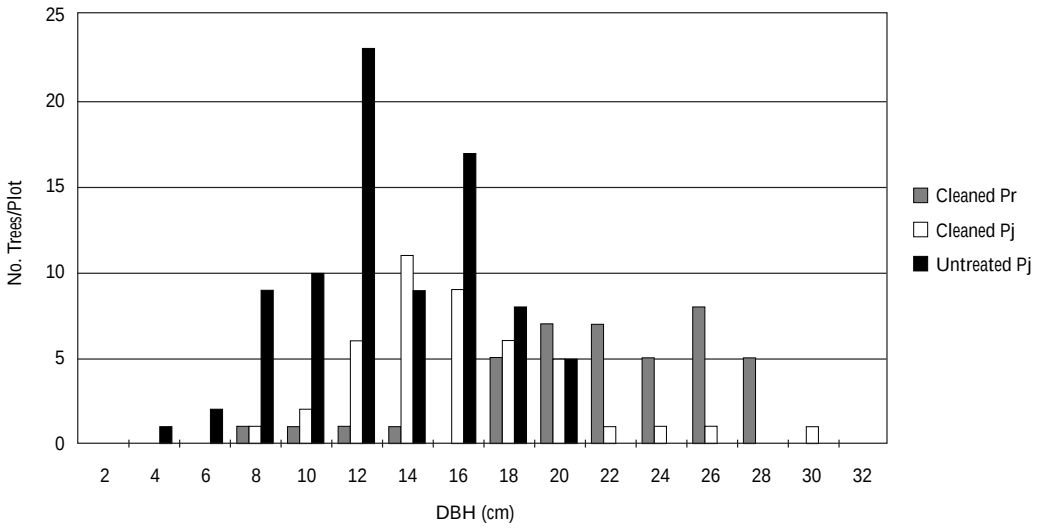



Figure 2: Gross volume distribution in 2 cm classes in the red and jack pine plantations in the Tyrol Lake Demonstration Forest.

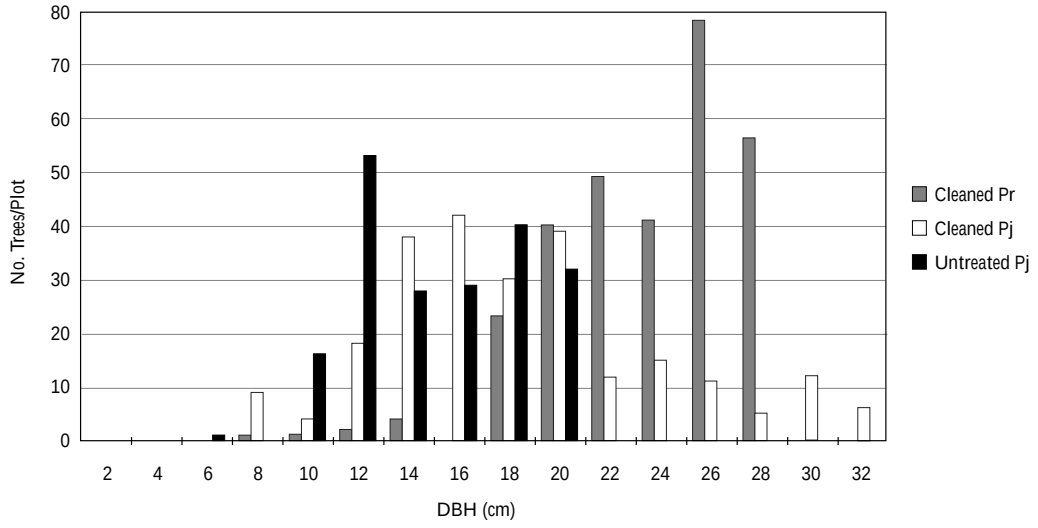


Figure 3: Gross merchantable volume distribution in 2 cm classes in the red and jack pine plantations in the Tyrol Lake Demonstration Forest.

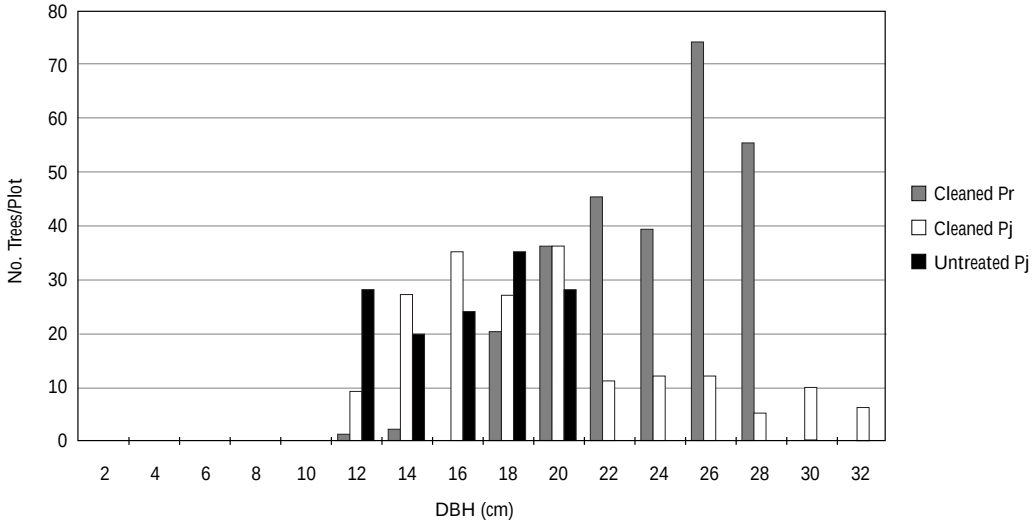
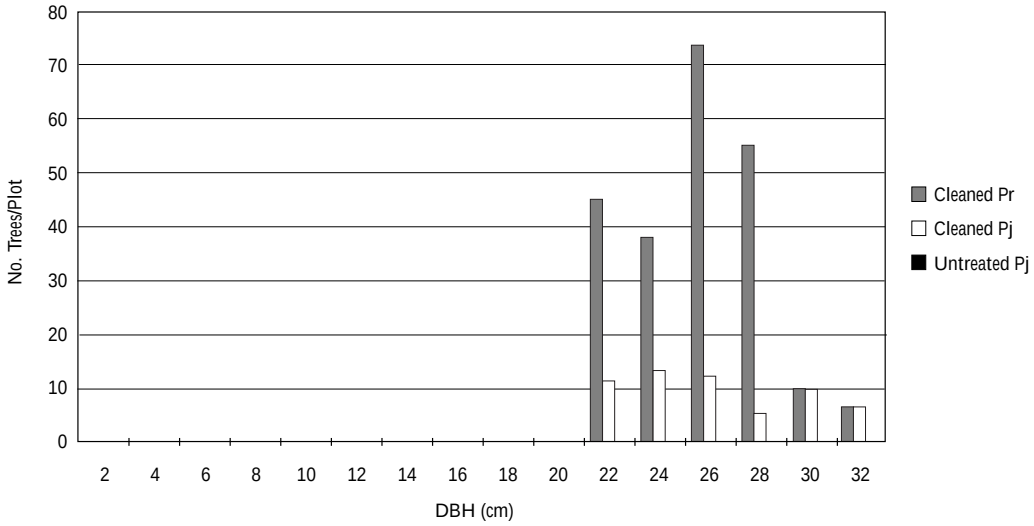



Figure 4: Net merchantable volume distribution in 2 cm classes in the red and jack pine plantations in the Tyrol Lake Demonstration Forest.



# SITE 2

## Stand History

On this site three plantations were established: a pure black spruce stand, a pure jack pine stand, and a mixed black spruce and jack pine stand. The jack pine plantation at this site will be used as a comparison with the plantations at Site #1.

| Date | Treatment |
|---|---|
| 1962 | Planted pure black spruce and jack pine plantations |
| 1962 | Heavy insect damage to the spruce |
| 1963 | Jack pine planted between rows of damaged black spruce, and extra black spruce planted beside the assumed dead spruce. However, much of the original black spruce stock survived, resulting in a heavily overstocked stand |
| 1979 | Herbicide application |
| 1991 | Bt application for spruce budworm |

## Objectives

The objective of this site is to compare the development and growth rates of jack pine with the jack pine at Site #1.

# Stand Conditions

(1994 - based on 400 m2 plot)

The topography of this area is flat to rolling, composed of well-drained light sandy soils with occasional gravel and some rocky outcrops. The moisture regime is fresh to dry.

Table 2: Stand Conditions: Stops 1,2,4

| | Stop 1 | Stop 2 | Stop 4 |
|---|---|---|---|
| Treatment | Mixed black spruce/ jack pine plantation | Black spruce plantation | Jack pine plantation |
| Species Composition | $Sb_6Pj_4$ | $Sb_8Bw_2$ | $Pj_8Bw_2$ |
| Density (stems/ha) | 5975 | 3450 | 2550 |
| Height (m) | Sb 10.7<br>Pj 14.5 | Sb 12.0 | Pj 16.2 |
| DBH (cm) | Sb 7.2;<br>Pj 12.0 | Sb 10.9 | Pj 13.2 |
| Age (years) | 30 | 30 | 30 |
| Shrub Layer | sparse; mainly black spruce seedlings | wild raspberry, beaked hazel | sparse |
| Herbaceous Layer | plume moss, hair cap moss, wild lily-of the-valley | blue bead lily, large leaf aster, feathermoss | large leaf aster, bracken fern, wild sarsaparilla |
| S-Type | SS6 | SS6 | SS5 |
| V-Type | V19 | V17 | V32 |

The jack pine plantation (Stop #4) has not been thinned, although it was treated with herbicide in 1979, and Bt in 1991.

# Discussion

According to Stiell and Berry (1973), height growth is more a function of site quality than of stand density, and as such is an unreliable parameter by which to compare red and jack pine growth rates.

A comparison of the Demonstration Forest site data to Plonski's yield tables shows the following information: planted red pine at 45 of age has an average height of 19.7 m and a gross volume of 396 $m^3$. Natural red pine on a site class 2 at 45 years of age has an average height of 14.5 m and a gross volume of 244 $m^3$. The site at stop #1a therefore compares favourably with the planted red pine stand in Plonski's and the lower volume is probably a result of lower densities on this site.

Site class 2 jack pine at 45 years of age averages 1905 trees/ha, 12.8 cm in diameter, 14.3 m tall with a gross volume of 212 $m^3$. The average height and diameter at stops #2 and 3, Site #1 have surpassed this and compare more favourably with site class 1 data. However, site class 1 jack pine in Plonski's has 1431 trees/ha as compared to the actual 1300 to 1800 on these sites; in addition, Plonski's gross volume is 269 $m^3$ and gross merchantable volume is 199$m^3$. The jack pine at Site #1, Stops 2 and 3 therefore exceed Plonski's average height and diameter for site class 1, but stand densities and subsequently volumes are lower.

Stop #4 at Site #6 was classed in the inventory as site class 3. However, when compared to 30 year old jack pine, site class 3 in Plonski's yield tables, this site far exceeds these values and compares more favourably with site class 1 stand information.

A comparison of average diameters shows that the red pine plantation had the greatest diameter growth. However, the red pine plantation also had lower densities than most of the jack pine plantations. The red pine stand had an average diameter of 22 cm and a density of 1125 trees/ha. The cleaned jack pine stands (Site #1, stops #1b, 2 and 3) had an average diameter of 16 cm, and a density of 1050 to 1800 trees/ha. The untreated jack pine stand (Site #6, stop #4) average DBH was only 13 cm, but was also stocked with 2550 trees/ha. It would appear that the higher the stocking level in the stand, the lower the average diameter. Therefore, the variances in diameter growth may only be due to differences in densities, and not related to species type.

According to the literature reviewed, diameter distribution is an accurate indicator of growth response to thinning. The unthinned jack pine diameters peaked in the lower diameter (18 to 20 cm) classes, while the red pine diameter distribution peaked in the 24 to 26 cm classes. From this it would appear that the red pine had the best growth, followed by the treated jack pine, and finally the untreated jack pine exhibited the poorest growth.

Based on the literature reviewed, the results should show that the most dense stand (i.e. the unthinned jack pine stand at Site #6), has a markedly higher gross volume than the cleaned/thinned jack or red pine plantations. However, in this case, the jack pine stand at Site #6 has a lower gross volume than two of the treated jack pine stands. This is probably due to the ten year age difference between the Site #1 and Site #6 jack pine plantations. Therefore, the jack pine stand on Site #6 cannot be used as a control. Any comparisons of these jack pine stand characteristics will not accurately reflect any growth or yield differences. The lack of detailed information on precisely how much planted jack or red pine was removed in 1962 made accurate data interpretation difficult. According to OMNR silvicultural records, only badly-formed natural jack pine was removed in 1962. If this is the case the difference in stocking levels between the jack pine plantations can only be due to differing initial planting densities.

An overall comparison of red and jack pine volumes does show the red pine has better gross yield as well as having significantly higher merchantable volume than any of the jack pine plantations. Pulpwood volumes (Gross merch. volume - Figure 3) were based on a 10 cm top and a DBH of 12 cm. Most of the volume in the treated stands (91 percent of the red pine and 83 percent of the jack pine) could theoretically be harvested for pulp. But only 65 percent of the untreated jack pine stand volume has reached merchantable size for pulpwood, probably as a result of the high stocking in this stand as compared to the others. Sawlog volumes (Net merchantable volume - Figure 4) were based on a 10 cm top and a DBH of 21 cm. Red pine had the highest gross and net merchantable volumes. Currently, 72 percent of the red pine volume is merchantable as sawlogs, whereas only 28 percent of the treated jack pine trees are sawlog size. The Site #6 jack pine stand has no sawlog volume at present. The yield and value of the wood to be harvested from the red pine plantations will likely be greater than those of the jack pine plantations. This trend accurately reflects current practices which recommend growing red pine rather than jack pine on highly productive sites.

# Conclusions and Recommendations

Due to the lack of a control block, and a more scientific treatment of these plantations, there are no clear-cut conclusions. However, there are a few trends which deserve some discussion.

The red pine in the Tyrol Lake Demonstration Forest had significantly better growth than jack pine on similar sites. This was also the case in most of the studies which were reviewed. Therefore, it would seem that on better quality sites, it is more advantageous to grow red pine. However, this is not a blanket recommendation to convert all high-quality sites to red pine stands. Red pine plantations require more intensive management regimes and produce a different value end product than pulpwood management systems. Therefore, if the objective is sawlog production, and the required resources are available, the forest manager may want to consider converting these sites to red pine. If the objective is the production of both sawlogs and pulpwood, the forest manager may want to consider concentrating sawlog crops on the better quality sites for a higher economic return.

Forest managers must begin to manage the more valuable and higher quality sites, especially when faced with increasing budget constraints. More effective use of high quality sites depends on the resources available and the desired end products, but crop diversification should be considered.

# LITERATURE CITED


Bell, F.W. 1991. Critical Silvics of Conifer Crop Species and Selected Competitive Vegetation in Northwestern Ontario. For. Can., Ont. Reg., Sault Ste. Marie, ON./Northwestern Ont. For. Tech. Dev. Unit, Ont. Min. Nat. Resour., Thunder Bay, ON. COFRDA Rep. 3310/NWOFTDU Tech. Rep. 19. 177 pp.

Benzie, J.W. 1977. Jack Pine in the North Central States. U.S.D.A. For. Serv., North Central For. Expt. Sta., St. Paul, Minnesota. 18 pp.

Benzie,, J.W. and J.E. McCumber. 1983. Red Pine. Pp. 89–91 *In* Burns, R.M. (Compiler). *Silvicultural Systems for the Major Forest Types of the United States.* U.S.D.A., For. Serv., Agric. Handbook No. 445. 191 pp.

Berry, A.B. 1984. Volume and Biomass Yield Tables for Unthinned Red Pine Plantations at the Petawawa National Forestry Institute. Can. For. Serv., Petawawa Nat. For. Inst. Info. Rep. No. PI-X-32. 27 pp.

Bolghari, H.A. 1976. Estimates of the production of young red pine and jack pine plantations in Southern Quebec. Can. Journ. of For. Res. 6(4):478–486.

Brilliant, C., P. Gendron, S. Tetreault, A. Castonguay, and F. Parent. 1977. Profitability of reforestation in Quebec. I. Plantations of red pine and jack pine. Memoire, Service de la Recherche, Ministre des Terres et Forets, Quebec. No. 36. 179 pp.

Chapeskie, D., D. Galley, J. Mihell, H. Struik and N. Quinn. 1988. A Silvicultural Guide for the White Pine and Red Pine Working Groups in Ontario. Ont. Min. Nat. Resour., Toronto, ON. 124 pp.

Fowells, H.A. 1965. The Silvics of Forest Trees of the United States. U.S.D.A., For. Serv., Agriculture Handbook No. 271. 762 pp.

Galloway, R. *et al.* 1986. Silvicultural Guide Series: Jack Pine Working Group. Ont. Min. Nat. Resour., Toronto, ON. 40 pp.

Goble, B.C. and C. Bowling. 1993. Five-year growth response of thinned jack pine near Atikokan, Ontario. Ont. Min. Nat. Resour., NW Ont. For. Tech. Dev. Unit, Thunder Bay, ON. Tech. Note TN-23. 13 pp.

Lothner, D.C. and D.P. Bradley. 1984. A new look at Red Pine financial returns in the Lake States. U.S.D.A., For. Serv., North Central For. Exp. Stn., Res. Paper NC-246. 4 pp.

Maeglin, R.R. 1967. Effect of tree spacing on weight yields for Red Pine and Jack Pine. J. For. 65(9):647–650.

Maley, M. And C. Bowling. 1993. A 30-year old remeasurement of a red pine provenance trial: Implications for management in northwestern Ontario. Ont. Min. Nat. Resour., N.W. Ont. For. Tech. Dev. Unit, Tech. Rep. No. 22. 9 pp.

Marcin, T.C. and D.M. Frogness. 1975. A case study showing potential supplies of red pine sawtimber in the Lake States. U.S.D.A. - For. Serv., North Central For. Exp. Stn., Gen. Tech. Rep. NC-19. 8 pp.

deNaurois, M. and J. Buongiorno. 1986. Economics of Red Pine plantation management in Wisconsin. N. J. of Applied Forestry 3(3):118–123.

Plonski, W.L. 1981. Normal Yield Tables (Metric) for Major Forest Species of Ontario. Ont. Min. Nat. Resour., Toronto, ON. 40 pp.

Roe, E.I. 1951. Early release from aspen improves yield of pine plantations. Lake States For. Exp. Stn. Tech. Note No. 353. 1 p.

Sims, R.A., W.D. Towill, K.A. Baldwin, and G.M. Wickware. 1989. Field Guide to the Forest Ecosystem Classification for Northwestern Ontario. For. Can. - Ont. Region, Sault Ste. Marie, ON., and Ont. Min. Nat. Resour., Toronto, ON. 191 pp.

Sims, R.A., H.M. Kershaw, and G.M. Wickware. 1990. The Autecology of Major Tree Species in the North Central Region of Ontario. Ont. Min. Nat. Resour., N.W. Ont. For. Tech. Dev. Unit, Tech. Rep. No. 48 / COFRDA Rep. No. 3302. 126 pp.

Smith, D.M. 1986. *The Practice of Silviculture* - Eighth Edition. John Wiley & Sons. Toronto, ON. 527 pp.

Stiell, W.M. and A.B. Berry. 1973. Yield of unthinned red pine plantations at the Petawawa Forest Experiment Station. Dept. of the Environ., Can. For. Serv., Public. No. 1320, 16 pp.

Vassov, R. and W.D. Baker. 1988. Precommercial thinning of jack pine. Ont. Min. Nat. Resour., NW Ont. For. Tech. Dev. Unit, Thunder Bay, ON. Tech. Rep. No. 12. 25 pp.

Wilde, S.A., B.H. Benson, and P. Mikola. 1951. Yield and quality of jack pine pulpwood produced on different types of sandy soils in Wisconsin. J. For. 49(12):878–881.

# ACKNOWLEDGEMENTS

The Northwest Region Demonstration Forest Program would like to thank the following people for their contribution to this technical report: staff of Mitig Forestry Services Ltd. for preparation of the initial draft; Matsy Kenney and Bill Towill for critical reviews; Yolanda Beaupre for technical assistance; Ruth Berzel for publication layout; and Gail Zanette for publication design.


# GLOSSARY OF SCIENTIFIC NAMES

| COMMON NAME | SCIENTIFIC NAME | ABBREVIATION |
|---|---|---|
| Black spruce | *Picea mariana* (Mill.) BSP. | Sb |
| Jack pine | *Pinus banksiana* Lamb. | Pj |
| Trembling aspen | *Populus tremuloides* Michx. | Po |
| White birch | *Betula papyrifera* Marsh. | Bw |
| Beaked hazel | *Corylus cornuta* Marsh. | |
| Blue bead lily | *Clintonia borealis* (Ait.) Raf. | |
| Bracken fern | *Pteridium aquilinum* (L.) Kuhn | |
| Bunchberry | *Cornus canadensis* L. | |
| Blueberry | *Vaccinium* spp. | |
| Cow wheat | *Melampyrum lineare* Desr. | |
| Hair cap moss | *Polytrichum* spp. | |
| Large leaf aster | *Aster macrophyllus* L. | |
| Plume moss | *Ptilium crista-castrensis* (Hedw.) De Not. | |
| Twinflower | *Linnaea borealis* L. | |
| Trailing arbutus | *Epigaea repens* L. | |
| Wild lily-of-the-valley | *Maianthemum canadense* Desf. | |
| Wild red raspberry | *Rubus idaeus* L. | |
| Wild sarsaparilla | *Aralia nudicaulis* L. | |

# OTHER PUBLICATIONS IN THIS SERIES

| | |
|---|---|
| Technical Report #1 | Natural Regeneration in Boreal Mixedwood Forests<br>Tyrol Lake Demonstration Forest |
| Technical Report #2 | Commercial Thinning of Jack Pine<br>Balmer Demonstration Forest<br>Seine River Demonstration Forest |
| Technical Report #3 | Establishment of Red and White Pine Plantations in Northwestern Ontario<br>Tyrol Lake Demonstration Forest |
| Technical Report #4 | Shelterwood Systems in Red Pine<br>Seine River Demonstration Forest |
| Technical Report #5 | The Establishment of Black and White Spruce on Ontario's Boreal Mixedwood Sites<br>Seine River Demonstration Forest |
| Technical Report #6 | Early Stand Tending in Jack Pine Plantations<br>Balmer Demonstration Forest<br>Tyrol Demonstration Forest<br>Seine River Demonstration Forest |
| Technical Report #7 | Clearcutting and Its Alternatives for Upland Black Spruce<br>Leo Vidlak Forest |
| Technical Report #8 | Spot Seeding of Jack Pine and Black Spruce<br>Balmer Demonstration Forest |
| Technical Report #9 | The Use of Fire for Natural Jack Pine Regeneration on Cutovers<br>Tyrol Lake Demonstration Forest |
| Technical Report #10 | Mixed Planting of Jack Pine, Black and White Spruce<br>Tyrol Lake Demonstration Forest |
| Technical Report #11 | Pre-Commercial Thinning in Black Spruce<br>Tyrol Lake Demonstration Forest |
| Technical Report #12 | A Comparison of Red Pine Sawlog Management and Jack Pine Pulpwood Management<br>Tyrol Lake Demonstration Forest |