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Northwestern Ontario Boreal Forest Management

Technical Notes

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CRITICAL SILVICS OF WHITE PINE AS RELATED TO VEGETATION MANAGEMENT

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INTRODUCTION

This technical note is designed to assist resource managers in developing site specific vegetation management strategies. It follows the general format established by Bell (1991) and is one in a series of technical notes intended as addenda to the above mentioned document. Readers may wish to refer to Bell (1991) for background information.

DESCRIPTION

General: large-sized (averaging 30 m high, up to 50 m), evergreen conifer with a wide spreading irregular crown. Branches long, isolated and usually nearly horizontal. Trunk may be crooked or forked by weevilling.

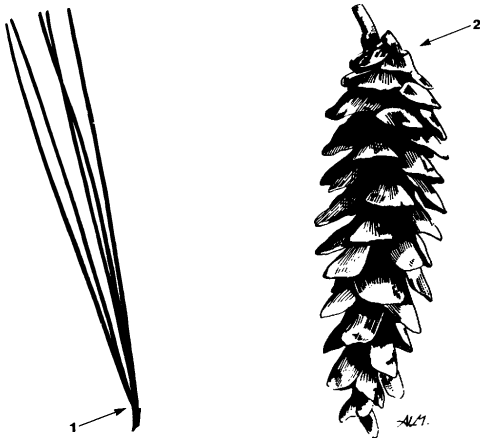

Figure 1. Leaves and fruit of white pine.

Leaves: needle-like, straight, slender, flexible, soft to touch; in clusters of five[1], long (10-15 cm); bluish-green, edges finely toothed; mature clusters without basal sheath (Figure 1).

Flowers: male and female flowers produced separately on the same tree; yellowish-white; female flowers are cones with scales arranged in five spiral rows; appearing in May.

Fruit: winged seeds are enclosed by woody scales of the mature female cone; cylindrical[2] (Figure 1); thin tipped without spines; cones open to release seeds in the autumn of the year of pollination (year 3) and fall from the tree in winter.

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VMAP
Vegetation Management Alternatives Program

Figure 2. Distribution of white pine in Ontario.

HABITAT

Distribution in Ontario: Northern commercial range corresponds with northern boundary of Great Lakes - St. Lawrence forest and the deciduous forest regions (Horton and Bedell 1960, Rowe 1972) (Figure 2). The northern botanical range closely parallels the 2° C mean annual isotherm (Haddow 1948).

Climate: Restricted to areas where mean frost free season is above 833 degree days Celcius (Boughner 1964). In Ontario, it grows in areas with moderate temperatures (annual average daily mean 4.4°C) and low precipitation (77 cm) with warm, droughty summers (Horton and Bedell 1960).

Site and Soil Relations: In NW Ontario, white pine occurs primarily on morainal materials (Sims et al. 1990). It grows mainly on deep, dry to fresh, non-calcareous coarse upland soils that have good drainage and aeration (Figure 3b). Productivity decreases where root restricting layers occur (Horton and Bedell 1960). White pine is found primarily on Northwestern Ontario Forest Ecosystem Classification System (NWO FEC) vegetation types V12 (white pine conifer) and V26 (white pine mixedwood) and soil types S1, S2 (deep, fresh coarse and fine sandy), S3 (coarse loamy) and SS6 (shallow, fresh coarse loamy) (Sims *et al.*1989).

Nutrient Requirements: White pine is found on soils of moderate to high fertility (Figure 3a). The optimum soil pH range for white pine is 4.7 to 7.3 (Stiell 1978). White pine grows well on soils which have a base exchange capacity of 6 meq. per 100 grams, total nitrogen content of at least 0.1%, available phosphorous of 34 kg/ha and potassium of 112 kg/ha (Wilde 1966). It is tolerant of calcareous conditions but height growth and vigour decrease where free carbonates are located within 60 cm of the soil surface (Taylor and Jones 1986).

Moisture Requirements: White pine grows best on fresh to moist well-drained soils but is found on a broad range of conditions (Stiell 1978). It is not very drought resistant but can tolerate wet soil (Shirley 1943). Except at the extremes of soil moisture gradient, more moisture results in better growth.

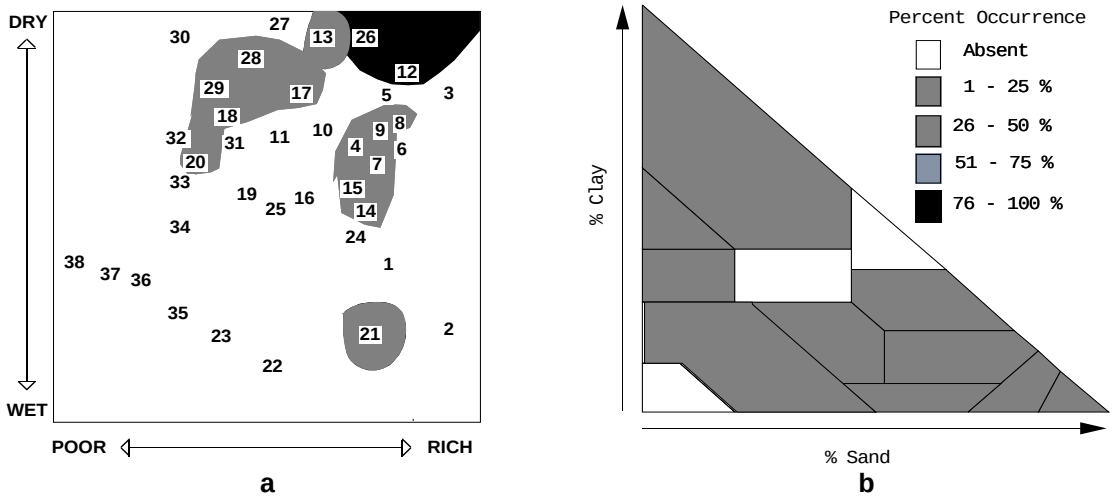

Figure 3. Percent occurrence of white pine in northwestern Ontario by a) NWO FEC vegetation type and b) soil texture.

Light Requirements: White pine has intermediate shade tolerance. It can survive with as little as 20-25% full light (Smith 1940) and maximum height growth continues at 55% full light (Logan 1959). Diameter and volume growth increase with increasing light levels to full light (Logan 1966). Shade conditions reduce susceptibility of young trees to attack by white pine weevil (*Pissodes strobi* Peck) because leaders remain slender (Sullivan 1961, Berry and Stiell 1976).

REPRODUCTION

SEXUAL REPRODUCTION: White pine is monoecious with male and female flowers borne on the same tree (Anon. 1974). Female flowers develop near the apices of vigorous twigs in the upper portion of the crown, and male flowers are borne in groups around the base of branches in the middle to lower crown (Wright 1970). Female flowers may be produced for up to 20 years before male flowers appear (Stiell 1978).

Seed Bearing Age: Seed production normally begins at 15-20 years. Optimum seed production occurs between 50 and 150 years (Anon. 1974).

Frequency and Size of Seed Crops: Good crops of white pine seed occur every 3-5 years with light crops in most intervening years (Fowells 1965).

Cone yields associated with good seed years are estimated to be 1.8 hl/tree or approximately 65,000 viable seed/tree (OMNR 1977). Open grown trees produce more cones than those in dense stands. Younger trees produce more viable seeds per cone than older trees. Wet cold weather during flower initiation or pollen shed will decrease the cone crop (Stiell 1978).

Pollen and Seed Dispersal: Pollination occurs in mid-June of year prior to ripening. Seed dispersal is primarily by wind about one month after cones mature, usually in September. Seeds usually land at a distance no greater than the height of the tree (Stiell 1978); however, seeds may be disseminated up to 80 m from seed trees within a stand and 200 m in the open (Chapeskie *et al.* 1989).

Seed Viability and Germination Requirements: Average germinative capacity is 75%. Seeds require stratification to break embryo dormancy, usually 30 days at 15°C or 60 days at 4°C. Seedlings germinate in spring or early summer. Optimum temperatures for germination are 20-30°C (Anon. 1974). Optimum conditions are partial shade, light vegetation or litter cover, and moist mineral soil or moss (*Polytrichum* spp.) (Smith 1940, Wilson and McQuilkin 1963). Heavier seed germinates earlier and survives better than lighter seed (Spurr 1944).

VEGETATIVE REPRODUCTION: White pine does not generally reproduce vegetatively, although it can layer (Fowells 1965).

GROWTH AND DEVELOPMENT

White pine usually produces one flush of height growth each year. It exhibits a preformed terminal shoot growth pattern in which the current year's height growth is determined by the previous year's growing conditions. However, moisture stress and effects of competing vegetation can limit elongation of internodes (Chapeskie *et al.* 1989).

White pine seedling growth is slow initially; it may require up to 10 years to reach breast height (McCormack 1956). Diameter growth is controlled by crown size (Hosie 1969) and thus indirectly by competition levels.

White pine is usually deep rooted (2-4 m) and therefore is windfirm but maintenance of a tap root is dependent on soil conditions (Brown and Lacate 1959). Tap root and laterals form during the first few years. On wet soils, white pine forms a shallow platelike root system. It often develops natural grafts with root systems of neighbouring trees of the same species (Stiell 1978). Grafts delay mortality of suppressed trees (Borman 1966) but may serve as a mode of transmission for root rot (Gross 1970).

PHENOLOGY

Roots, Shoots and Foliage: Root elongation occurs in spring and fall, with little or none occurring in the dry months of summer (Horton and Bedell 1960).

Bud expansion starts in April, with bud break and shoot elongation occurring in May. Cataphyll deposition begins in mid- to late May. By mid- to late June, shoot elongation is 90% complete. Budset occurs in late June or early July at which time shoot elongation ceases. Cataphyll deposition for the following year's bud continues into fall (Owston 1969).

An annual whorl of branches is produced from lateral buds formed at the end of the leading shoot. Occasionally a second flush of lammas growth occurs in late summer (Harlow and Harrar 1941). Needles flush shortly after elongation starts (usually in May) and continue until mid-August (Owston 1969).

Height growth is related to current or previous year's weather. One flush of growth occurs generally in May; initiation is temperature dependent. After breast height, white pine averages 0.3 - 0.6 m height growth per year and up to 1 m in good conditions. Up to 2.5 cm diameter growth per year is possible (Harlow and Harrar 1941). Under optimum conditions, white pine accumulates more volume per year than any other native conifer in eastern Canada.

Reproductive Structures: Flower initials of white pine are formed in the year preceding flowering. Cone primordia are differentiated in July (Year 1) and become visible at the end of the growing shoot late the following spring (in late May or early June). They are pollinated in late June (Year 2). They complete their growth by mid-July of year three, after which fertilization takes place. The cones ripen in September of year three (Horton and Bedell 1960). Most seed is dispersed in the fall of ripening (Graber 1970).

COMPETITION

Response to Competition: White pine can survive at <7% full light but poor growth results (Smith 1940). Maximum height growth requires 55% full light; maximum volume growth requires full light (Logan 1959).

Shade is favourable to germination and initial survival of white pine because of partial darkness, or increased soil moisture or % RH. Hardwood litter can smother young seedlings. Grasses, sedges (*Carex* spp.), herbs and shrubs all compete with young seedlings, reducing growth. White pine cannot tolerate heavy over topping by shrubs such as raspberry (*Rubus ideaus* L.) or beaked hazel (*Corylus cornuta* Marsh.). Underplanted white pine will suffer heavy mortality, especially on moist sites if shrubs are not controlled until crop reaches 1.3 m (Clements 1966).

In mixed stands, pine is subject to whipping in sapling stage (Horton and Bedell 1960). Terminals may be destroyed repeatedly resulting in decreased growth and forked stems, but 30-35 year old stems will thicken and resume growth if released (Shirley 1941). However, pine is better able to compete in sapling than seedling stage because of a faster growth rate. It can compete with thin-crowned species such as birch (*Betula papyrifera* Marsh.) but is not able to compete with aspen (*Populus tremuloides* Michx.) or maple (*Acer* spp.) (Engle 1951).

Response to Release: White pine can respond to release after many years of suppression. Response will be rapid if pine is less than 30 years old and at least one third of crown is living. Response decreases proportionately with increasing age and decreasing crown length (Wilson and McQuilkin 1963). If leader growth rate has been decreasing, response will be slower (Lancaster 1984).

Release after planting provides better results than pre-plant treatments because shrubs will quickly outgrow young white pine (Plass and Green 1963). White pine should be 2 to 3 m tall before released from hardwoods to be able to compete with sprouts, as it requires 2 to 3 years to respond with improved height growth (Engle 1951). For a single manual release from hardwoods to be successful, white pine should be 3.5 to 4.5 m in height (Spaeth 1922). After release from hardwoods by girdling, 30 to 35 cm dbh white pine stems will have same radial growth as stems dominant throughout life and 80% greater growth than unreleased stems within six years of release (Plice and Hedden 1931). White pine requires minimum 50% release for increased survival and height growth to result (Stoeckler and Limstrom 1950).

Two years following spraying, released young white pine seedlings had three times the diameter of control seedlings (McConkey 1958). Six years following release at time of planting, released seedlings can attain almost twice the height of unreleased seedlings but there is generally little difference in survival (Yawney 1961, Sterrett and Adams 1977).

CHEMICAL TREATMENTS

White pine is relatively susceptible to damage by herbicides.

2,4-D: 2,4-D will kill or suppress white pine during periods of active growth but white pine is relatively resistant at other times (Leinfelder and Hansen 1959). May decrease height growth but increases survival of young seedlings under intense competition (Parker and Moyers 1982).

Hexazinone: White pine is very susceptible to hexazinone; rates are critical. White pine is tolerant of hexazinone applied as a dormant basal bark spray in early spring at 1 kg/ha but is injured at 2 kg/ha (Ahrens and Dwyer 1982). Hexazinone decreases height growth and survival when broadcast onto young white pine seedlings (Wright *et al.* 1982).

Glyphosate: Will kill or suppress white pine during periods of active growth. Glyphosate applied at 1-2 kg/ha in fall will not injure or suppress white pine growth (Ahrens 1974). August applications at 1-2 kg/ha may cause some growth suppression (Parker and Moyers 1982; Ahrens and Dwyer 1982) but survival will be increased (Wright *et a*l. 1982).

Triclopyr: Triclopyr applied at 1-2 kg/ha in August may result in some growth suppression (Ahrens and Dwyer 1982). Fall applications at rates greater than 2.0 kg/ha may result in injury (Ahrens 1986).

USES BY WILDLIFE

White pine stands are used for winter shelter by moose and white-tailed deer (Timmerman and McNichol 1988). Bear use large hollow pines for den sites (Rogers 1987).

Porcupines eat the stems of pine, often girdling the upper crown. Rabbits and rodents can destroy young seedlings by girdling stems. Seedlings are often browsed in winter in areas that are overpopulated by deer (Horton and Bedell 1960, Stiell 1978).

Raptors such as osprey, eagles and many species of hawk often nest in pines, especially along shorelines.

LITERATURE CITED

Ahrens, J.F. 1974. Selectivity of glyphosate and asulam in ornamental plantings and Christmas trees. Pp. 361-368 *in* Proc. NE. Weed Sci. Soc. Vol. 28. Connecticut.

Ahrens, J.F. 1986. Selectivity of fall applied herbicides in Christmas trees: (abstract). Pp. 253 *in* Proc. 40th Annual Mtg. N.E. Weed Sci. Soc. Connecticut, U.S.A.

Ahrens, J.F. and J.B. Dwyer. 1982. Post-emergence herbicides for Christmas tree plantings. Pp. 215-216 *in* Proc. N.E. Weed Sci. Soc. Connecticut, U.S.A.

Anon. 1974. Seeds of woody plants of the United States. U.S.D.A. Agric. Handb. No. 450. 416 pp.

Bell, F.W. 1991. Critical silvics of conifer crop species and selected competitive vegetation in northwestern Ontario. For. Can., Ont. Min. Nat. Resour. COFRDA Rep. 3310/NWOFTDU Tech. Rep. 19. 177 pp.

Berry, A.B. and W.M. Stiell. 1976. Control of white pine weevil damage through manipulation of stand climate: preliminary results. Dep. Environ., Can. For. Serv. Info. Rep. PS-X-61. 8 pp.

Borman, F.H. 1966. The structure, function and ecological significance of root grafts in *Pinus strobus* L. Ecol. Monogr. 36(1):1-26.

Boughner, C.C. 1964. The distribution of degree growing days in Canada. Can. Dep. Transp., Can. Meteorol. Mem. 17.

Brown, W.G.E. and D.S. Lacate. 1959. Rooting habits of white and red pine. Can. Dept. North. Aff. Natl. Resour., For. Br., For. Res. Div., Mines Rep.

Chapeskie, D.J., D.F. Galley, J.R. Mihell, N.W. Quinn, and H.H. Struik. 1989. A silvicultural guide for the white pine and red pine working groups in Ontario. Ont. Min. Nat. Resour., For. Res. Group, Sci. Tech. Series, Vol 6. 101 pp.

Clements, J.R. 1966. Development of white pine underplantation in thinned and unthinned aspen. For. Chron. 42:244-250.

Engle, L.G. 1951. Releasing white pine from oak and aspen. U.S.D.A. For. Serv., Lake States For. Expt. Stn., Tech. Note No. 346. 2 pp.

Fowells, H.A. (comp.) 1965. Silvics of forest trees of the United States. U.S.D.A. For. Serv., Agric. Handb. No. 271.

Graber, R.E. 1970. Natural seed fall in white pine (*Pinus strobus* L.) stands of varying density. U.S.D.A. For. Serv., N.E. For. Expt. Stn., Res. Note NE-119. 6 pp.

Gross, H.L. 1970. Root diseases of forest trees in Ontario. Can. Dep. Fish For., Can. For. Serv. Info. Rep. 0-X-137.

Haddow, W.R. 1948. Distribution and occurrence of white pine (*Pinus strobus* L.) and red pine (*Pinus resinosa* Ait.) at the northern limit of their range in Ontario. J. Arnold Arbor. XXIX:217-226. (Cited in Stiell 1978)

Harlow, W.M. and E.S. Harrar. 1941. Textbook of dendrology covering the important forest trees of the United States and Canada, 2nd ed. McGraw-Hill Book Co. Inc., New York. 542 pp.

Horton, K.W. and G.H.D. Bedell. 1960. White and red pine: Ecology, silviculture and management. Can. Dept. North. Aff. Natl. Resour., For. Br., Bull. 124. 185 pp.

Hosie, R.C. 1969. Native trees of Canada. Dep. Environ., Can. For. Serv., Ottawa, Ont. 380 pp.

Lancaster, K.F. 1984. White pine management - A quick review. U.S.D.A. For. Serv., NE Area State and Private Forestry, Durham, NH. (Cited in Chapeskie *et al.* 1989)

Leinfelder, R.P. and H.L. Hansen. 1959. Tolerance of conifers to various applications of 2,4-D and 2,4,5-T in Minnesota (abstract). Pp. 133-135 *in* 11th Ann. North Central Weed Control Conf.

Logan, K.T. 1966. Growth of tree seedlings as affected by light intensity. II. Red pine, white pine, jack pine, and eastern larch. Can. Dep. For. Publ. 1160. 19 pp.

Logan, K.T. 1959. Some effects of light on growth of white pine seedlings. Can. Dept. North. Aff. Natl. Resour., For. Br., For. Res. Div., Tech. Note No. 82. 20 pp.

McConkey, T.W. 1958. Helicopter spraying with 2,4,5-T to release young white pines. U.S.D.A. For. Serv., N.E. For. Expt. Stn. Pap. No. 101. 14 pp.

McCormack, R.J. 1956. Growth and yield of red and white pine. Can. Dept. North. Aff. Natl. Resour., For. Br., For. Res. Div., S. & M. 56-5. 31 pp.

Ontario Ministry of Natural Resources. 1977. Manual of seed collecting. Ont. Min. Nat. Resour., For. Res. Br., Toronto.

Owston, P.W. 169. The shoot apex in eastern white pine: Its structure, seasonal development, and variation within the crown. Can. J. Bot. 47:1181-1188.

Parker, J.A. and G.B. Moyers. 1982. White pine release with glyphosate. Pp. 181-184 *in* Proc. 35th Annual Mtg. South. Weed Sci. Soc.

Plass, W.T. and A.W. Green. 1963. Preplanting treatments for brushy old fields in southern Illinois. U.S.D.A. For. Serv., Central States For. Expt. Stn., Res. Pap. CS-1. 8 pp.

Plice, M.J. and G.W. Hedden. 1931. Selective girdling of hardwoods to release young growth of conifers. J. For. 29(1):32-40.

Rogers. L.L. 1987. Effects of food supply and kinship on social behaviour, movements and population growth of black bears in Minnesota. Wildl. Monogr. 97.

Rowe, J.S. 1972. Forest regions of Canada. Can. For. Serv. Publ. 1300. 172 pp.

Shirley, H.L. 1941. Restoring conifers to aspen lands in the Lake States. U.S.D.A. For. Serv., Lake States For. Expt. Stn., Tech. Bull. No. 763. 36 pp.

Shirley, H.L. 1943. Is tolerance the capacity to endure shade? J. For. 41(5): 339-345.

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., Ont. Min. Nat. Resour. Toronto, Ont. 191 pp.

Sims, R.A., H.M. Kershaw and G.M. Wickware. 1990. The autecology of major tree species in the North Central Region. For. Can. - Ont. Region., Ont. Min. Nat. Resour., Thunder Bay, Ont. COFRDA Rep. No. 3302/NWOFTDU Tech. Rep. No. 48. 126 pp.

Smith, L.F. 1940. Factors controlling the early survival of eastern white pine in central New England. Ecol. Monog. 10:373-420.

Spaeth, J.N. 1922. Notes on release of white pine in Harvard Forest, Massachussetts. J. For. 20(2):117-121.

Spurr, S.H. 1944. Effect of seed weight and seed origin on the early development of eastern white pine. J. Arnold Arbor. 25:467-480.

Sterrett, J.P. and R.E. Adams. 1977. The effect of forest conversion with herbicides on pine (*Pinus* spp.) establishment, soil moisture and understory vegetation. 25(6):521-523.

Stiell, W.M. 1978. Characteristics of eastern white pine and red pine. Pp. 7-50 *in* Cameron, D.A. (comp.) White and Red Pine Symp. Can. For. Serv., Sault Ste. Marie, Ont., Symp. Proc 0-P-6.

Stoeckler, J.H. and G.A. Limstrom. 1950. Reforestation research findings in northern Wisconsin and upper Michigan. U.S.D.A. For. Serv., Lake States For. Expt. Stn., Pap. No. 23. 34 pp.

Sullivan, C.R. 1961. The effects of weather and the physical attributes of white pine leaders on the behaviour and survival of the white pine weevil *Pissodes strobi* (Peck) in mixed stands. Can. Entomol. 93:721-741.

Taylor, E.P. and P.K. Jones. 1986. Soil interpretation and training sessions (1981-1985) in the Central and Southwestern regions. Site Region 6E and 7C. Ont. Inst. Ped., Guelph, Ont. (Cited in Chapeskie *et al.* 1989)

Timmermann, H.R. and J.G. McNichol. 1988. Moose habitat needs. For. Chron. 64:238-245.

Wilde, S.A. 1966. Soil standards for planting Wisconsin conifers. J. For. 64(6):389-391.

Wilson, R.W. Jr. and W.E. McQuilkin. 1963. Silvical characteristics of eastern white pine (*Pinus strobus*). U.S.D.A. For. Serv., N.E. For. Expt. Stn., Res. Pap. NE-13. 29 pp.

Wright, G.M., J.R. Seifert, H.A. Holt and B.C. Fischer. 1982. Comparing vegetation control programs for Christmas trees. Pp. 129-130 *in* Proc. North Central Weed Control Conf. Indianapolis.

Wright, J.W. 1970. Genetics of eastern white pine. U.S.D.A. For. Serv. Res. Pap. WO-9. 16 pp.

Yawney, H.W. 1961. Introducing white pine into poor-site hardwood stands in West Virginia. U.S.D.A. For. Serv., N.E. For. Expt. Stn. Pap. No. 154. 10 pp.

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