Plant Propagation Protocol for *[Pinus banksiana]*
ESRM 412 – Native Plant Production Spring 2020
Protocol URL: https://courses.washington.edu/esrm412/protocols/*[PIBA2.pdf]*

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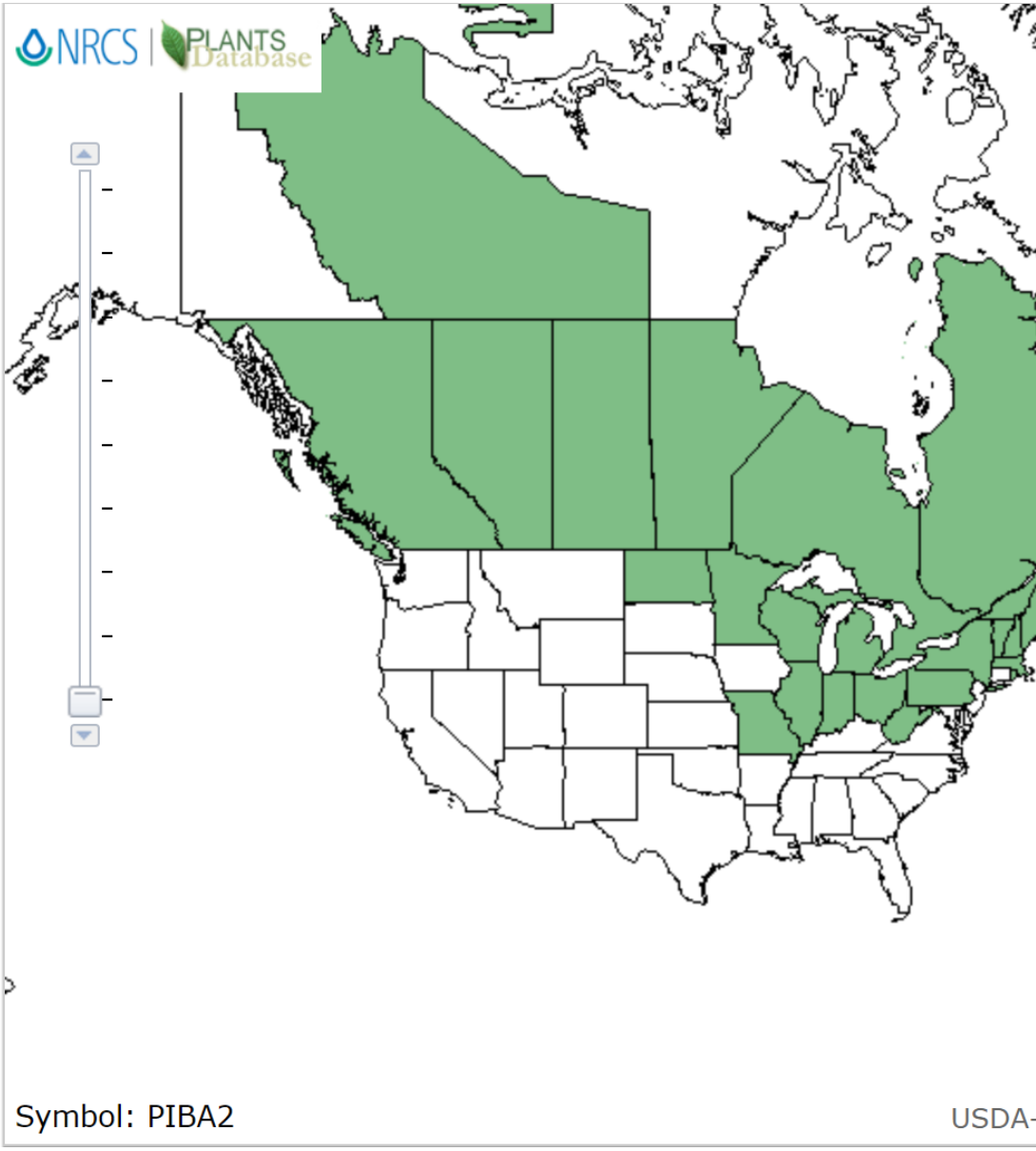
TAXONOMY	
Plant Family	
Scientific Name	Pinaceae (pine family)
Common Name	Pine
Species Scientific Name	
Scientific Name	*Pinus banksiana*
Varieties	*banksiana* Lamb
Sub-species	
Cultivar	
Common Synonym(s)	
Common Name(s)	Jack pine
Species Code (as per USDA Plants database)	PIBA2

GENERAL INFORMATION	
Geographical range)	Distributed in the United States from Illinois eastward to New Hampshire and Maine, Columbia to Nova Scotia (USDA, n.d.).  (Retrieved from https://plants.sc.egov.usda.gov/core/profile?symbol=PIBA2)
Ecological distribution	The USDA (n.d.) writes, that Jack Pine is "widespread throughout Northwestern Onta found on sandy soils of the Spodosol and Entisol soil orders. It also grows on loamy s granites and metamorphosed rocks of the Canadian Shield, over limestone, on peat, ar
Climate and elevation range	OECD (2010) writes "Across its broad range, jack pine tolerates a wide range of clim eastern portion of its range has a maritime climate, most of the range is inland and co summers, very cold winters, and low rainfall: Average temperatures range from -29ºC 13ºC to 22ºC in July. Average annual minimum and maximum temperatures range fro to 38ºC respectively, with annual mean temperatures ranging from -5ºC to 4ºC. Avera

	ranges from 250 to 1,400 mm, with 380 to 890 mm more common. Summer droughts States and western portion of the range. The northern limit of the species' range close annual isotherm, extending into the permafrost zone in the northwest. The frost-free p to 120 days, with extremes ranging from 50 to 173 days. The date of the last killing sp April to 1 July, and of the first killing autumn frost from 10 August to 20 October" (p Lake States jack pine generally occurs at elevations between 300 m and 460 m above portion of its range, it grows from near sea level to 850 m in elevation" (p. 58)
Local habitat and abundance	The USDA (n.d.) writes that Jack Pine "grows in mono-specific stands or in associati common in mixed woods with trembling aspen and other species" (p. 2). Wildflower. can grow farther north than any other North American pine. It is susceptible to rusts, i is intolerant of wet or alkaline soils, shade and heat."
Plant strategy type / successional stage	USDA (n.d.) writes, "Jack pine is the best adapted of all boreal conifers to fire. With r individuals have only moderate fire tolerance, but populations survive because of dela serotinous cones, early reproductive maturity, fast growth in full sun, and preference f Jack pine invades areas where mineral soil has been exposed by major disturbance suc adapted and becomes a dominate species in areas that are exposed to frequently burne OECD (2010) writes "7.3. Competition, succession, and stand structure Jack pine is a seral, relatively fast-growing and short-lived species. It is slightly more tolerant than a but less so than many other conifers it is associated with such as black spruce, white s Throughout much of its range, the major causes of catastrophic tree mortality and star and a mix of fire and budworm in the east. Jack pine stands are particularly susceptibl drier sites, foliage is highly combustible and the bark thin. Indeed, the species may be spread. Trees are often girdled and killed by fire. In the central and northern portions succession is closely linked to forest fire regimes. With its serotinous cones, multi-col early rapid growth, the species is well adapted to re-establishing sites following fire. I burns where it was present in the pre-fire landscape. As most seedlings establish with result is often extensive even-aged stands… Fire frequency is critical in determining j dynamics. Long-term maintenance of local populations depends on fire return interval average lifespan of individual trees, but long enough for the development of adequate less than 15 to 20 years may result in local elimination, because of inadequate seed ba future seed producers" (p. 71).
Plant characteristics	USDA writes that the Jack Pine is a "fast-growing tree that matures in 60 years. It is r grows in soils too poor for most plants. Susceptible to the disease dwarf mistletoe, wh produces thick witches brooms." The OECD (2010) writes "Jack pine is monoecious. cross-fertilising species, although some natural selfing can occur. Ovulate (female) str are typically found on vigorous primary and secondary branches in the upper crown, a on the less vigorous tertiary branches of the lower crown. Like most other pines, jack reproduction cycle. Staminate cone primordia are initiated in early or mid-July, ovula Time of anthesis varies from year to year, ranging from mid-May to early June, and is with female cone receptivity" (p. 57). OECD goes on to write Jack pine is "a relativel m tall with a dbh of 30 cm, occasionally reaching 25 m tall with a dbh of 35 cm. The b to gray, becoming dark brown and flaky with age" (p. 68).
PROPAGATION DETAILS	
Ecotype	
Propagation Goal	Plants
Propagation Method	Direct Seeding

Product Type	Bareroot (field grown)
Stock Type	
Time to Grow	OECD (2010) writes that Shoot growth begins from late April to early May and is cor 68)
Target Specifications	Seedlings should be (0.5-1.2m tall) with distinct taproot and
Propagule Collection Instructions	USDA (n.d.) writes “bud initiation for the following year's shoot systems begins in la Staminate cone primordia are initiated in early or mid-July but ovulate primordia are By early September the staminate cone primordia are about 1 mm (0.04 in) long and Then they elongate to about 5 mm (0.2 in) by the middle of May and early June just b elongation up to several more millimeters occurs as the pollen is shed. Time of pollen greatly from year to year depending on the weather. Fertilization occurs about 13 months after pollination when the female cone is approa Jack pine is normally a wind-pollinated, cross-fertilizing species but up to 25 percent selfing can occur. Under natural conditions, however, survival of selfed and other inb reduced by natural selection against the semilethal and other deleterious characteristic seedlings. Cones mature and the seeds ripen late in the growing season of the year after pollinati characteristics, including cone color, volume, fresh and dry weight, specific gravity, s embryo length, can aid in determining seed ripeness. In northeastern Wisconsin the be seed ripeness are cone color, 75 percent brown; insides of the cone scales, reddish bro black; and cone moisture content, less than 45 percent of fresh weight. These indicato coincide with the beginning of cone harvesting by squirrels about September 10. Beca serotinous cones usually remains above 1.0 at least until February, flotation technique cone and seed ripeness in jack pine. In naturally regenerated stands, jack pine typically begins to flower at 5 to 10 years u but not until later in closed stands. Once cone production in jack pine begins, it is fair until crown competition becomes a factor. Seed production differs from year to year b produced every year and total crop failures are rare. Seed yields per cone range from about 15 to 75. Strongly curved cones yield less seed abortion on the inner curvature of cones is twice that on the outer curvature. The aver cone can be more than 80 but usually only a little more than one-third of the scales, th cones, bear seeds. Over much of its natural range jack pine bears predominantly serotinous cones, but in nonserotinous. Total seeds stored on the trees in serotinous cones can reach more than per hectare (13.0 lb or 1.6 million/acre) in well stocked mature stands. As viability aft significantly reduced, however, only cones 6 years old or less should be collected. The melting temperature of the resinous bonding material of the cone scales is 50° C the bonding resin softens at lower temperatures in the nonserotinous types in the south range. The mechanism of cone opening in both serotinous and nonserotinous cones is bonding material of the cone scales is broken, the quantity of water in the scales is the movement and flexing outward under drying condition. Jack pine cones open most readily during dry weather when the temperature is at leas many of them remain closed until they are exposed to fire or high temperatures near th breakage or logging. Over most of its range where serotinous cones are common, up t the sunny part of the crown. Cones may also open in very cold winters when the temp colder.

	Cone and seed crops in jack pine may be reduced by numerous agents. Rainy weather reduce seed set. Cone and seed production are also reduced by cone and ovulate abort previously attributed to abortion may be partially the result of insect attacks. Within a base of the cone abort and abortion decreases toward the tip .”
Propagule Processing/Propagule Characteristics	USDA (n.d.) writes “Under forest conditions with adequate moisture, seeds germinate reach 18° C (64° F) but light also influences germination. Under continuous light, ger range of temperatures from 16° to 27° C (60° to 80° F). Germination was markedly re when light was excluded. The shade cast by slash and snags on burned-over or cut-ov temperature and drying undoubtedly contributes substantially to the good germination areas. Type of seedbed is an important factor affecting jack pine seed germination. In northe germination under clearcut and partially cut jack pine stands averaged 60 percent on r burned duff, 47 percent on scarified and shaded duff, and 17 percent on undisturbed d on litter and humus is caused by poor moisture conditions and it can be satisfactory in precipitation. Germination may be delayed by spring drought. Associated species can and growth of jack pine differentially, probably as a result of allelopathy. Survival on various seedbeds shows the same trend as germination. Optimum conditio establishment and survival are provided by mineral soil and burned seedbeds where c vegetation is not severe, the water table is high, and there is some shade. Competition vegetation, together with smothering by fallen leaves, are important causes of seedling Ontario. On clay soils in Manitoba and Saskatchewan, competition from aspen and ha survival. On similar soils in western Manitoba competing grasses kill many seedlings
Pre-Planting Propagule Treatments	Wildflower.org writes “seeds have no dormancy, or only a slight one, and will germin collection after a light stratification. Pretreatment is usually not necessary, but germin exhibiting dormancy can be hastened by cold stratification.”
Growing Area Preparation / Annual Practices for Perennial Crops	OECD (2010) writes “Forest fire may enhance seedbed quality by reducing accumula plant competition and pest populations, and providing nutrients. Prescribed burns that raw humus depth, while exposing mineral soil and reducing aerial parts of competing stocking and subsequent height growth. Scarification to expose mineral soil and reduc following harvesting may enhance germination. The level of rainfall can affect the qu manner that varies with soil type and level of the water table; early seedling height gr vegetation competition and the soil moisture regime. The importance of an appropriat pronounced when weather conditions are less favourable for germination and early gr mortality due to heat and drought can be substantial, particularly on dry sites, althoug
Establishment Phase Details	OECD (2010) writes “The following factors as contributors to optimum early growth: well-drained but moist soils; (3) moderate summer temperatures; and (4) freedom fro Young seedlings are very sensitive to shade and root competition. Compared to assoc Lake States, juvenile growth rates are high. With the exception of tamarack (Larix lar first 20 years is generally greater than for any other conifer in its natural range” (p. 68
Length of Establishment Phase	USDA (n.d.) writes that “germination is epigeal. Jack pine seed usually germinates w favorable conditions, but some seeds require more than 100 days to germinate. Delay seeding increased stocking between the first and third year after sowing”.
Active Growth Phase	USDA (n.d.) writes that “young seedlings grow tallest in full sunlight, although under abundance may be greatest in light intensities of 11 to 30 percent of full sunlight, but percent and higher crown cover.

	Shoot growth begins in late April and early May. Essentially all height growth is com the three locations. Maximum growth rate approaches 1 cm (0.4 in) per day. Althoug ceases long before the end of the frost-free season, the remaining time may be necessa growth, lignification, terminal bud development, and hardening off to resist frost. If favorable moisture conditions prevail in late summer, jack pine frequently has a sec elongation and produces lammas and proleptic shoots. Trees with lammas shoots had those without them but did not grow significantly less the following year. The late gro detectable increases in diameter growth and it may or may not result in false rings. Fa frost rings, however, may be frequent in the current shoots of trees with lammas grow
Length of Active Growth Phase	61-68 days
Hardening Phase	USDA (n.d.) writes "Under forest conditions, seedling growth is slow in the first 3 ye beginning in the fourth and fifth years. Seedlings attain a height of about 5 cm (2 in) t 2 years, and 30 to 90 cm (12 to 36 in) at 4 years. Early growth of 2-0 seedlings in plan amounting to 30 to 45 cm (12 to 18 in) per year on medium sites."
Length of Hardening Phase	3 years
Harvesting, Storage and Shipping	Handle with care, keep warm and moist
Length of Storage	<28 days (Grossnickel, 1987)
Guidelines for Outplanting / Performance on Typical Sites	OECD writes that "a variety of insects affect the survival and growth of jack pine. Jac pinus pinus) is one of the most significant defoliators in central Canada and the Lake new growth, preferring male strobili clusters and new foliage, and can cause growth l Swaine jack pine sawfly (Neodiprion swainei) is also an economically important pest Canada. Feeding on needles, it causes top kill, and if populations are sufficient, tree m year or more typically 3 to 4 years. In jack pine seed orchards in Wisconsin, the mirid Platylygus luridus has caused cone 87% (Rauf et al., 1984). White pine weevil and eastern pine shoot borer respectively c of trees in an openpollinated family test in Ontario. These two pests may significantly Lake States . Other damaging insects include root borers (e.g. pales weevil, Hylobius borers (e.g. northern pine weevil, Pissodes approximatus), needle miners (e.g. Argyro feeders (Phyllophaga spp.). Armillaria root rot (Armillaria mellea) frequently kills seedlings and juvenile stands. I blister rust results in cankers that reduce the commercial value of trees; volume growt and younger trees killed. Scleroderris canker occurs throughout the range of jack pine of infected seedlings. Common foliar diseases include needle rust (Coleosporium aste Diplodia tip blight (Sphaeropsis sapines). A number of vertebrate species may damage or kill jack pine. Snowshoe hares (Lepus more than 40% of natural and seeded seedlings, although most damaged plants surviv seedlings may be damaged by elk (Cervus canadensis) when its population levels are considered a food of medium preference for deer (Odocoileus). Red squirrels (Tamias frequently harvest jack pine cones".
Other Comments	USDA (n.d.) writes that "under natural conditions jack pine does not reproduce veget from young trees can be rooted but rooting ability decreases rapidly with increasing o month-old seedlings gave 75 percent rooting but average rooting was only 7 percent i ortets and 5 percent in those from 10-year-old ortets. Clonal variation in rooting perce

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