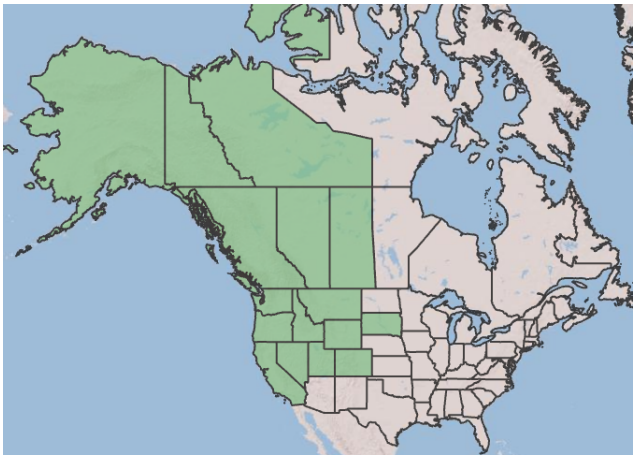
Plant Propagation Protocol for *Pinus contorta*
ESRM 412 – Native Plant Production
URL: https://courses.washington.edu/esrm412/protocols/2022/PICO.pdf

North America Distribution



Washington State Distribution

Source: USDA Plants Database, accessed May 24, 2022[10]

TAXONOMY	
Plant Family	
Scientific Name	Pinaceae
Common Name	Pine Family
Species Scientific Name	
Scientific Name	*Pinus contorta* Douglas ex Loudon
Varieties	*Pinus contorta* Douglas ex Loudon var. *contorta* *Pinus contorta* Douglas ex Loudon *var. latifolia* Engelm. ex S. Watson *Pinus contorta* Douglas ex Loudon *var. bolanderi* (Parl.) Vasey *Pinus contorta* Douglas ex Loudon var. *murrayana* (Balf.) Engelm. *Pinus contorta* Douglas ex Loudon var. *yukonensis* W.L. Strong
Sub-species	NA
Cultivar	NA
Common Synonym(s)	NA
Common Name(s)	Lodgepole Pine, Shore Pine, Beach Pine, Yukon Pine, Tamarack Pine, Black Pine[4, 10]
Species Code (as per USDA Plants database)	PICO
GENERAL INFORMATION	

Geographical range	Lodgepole Pine has a wide geographical distribution throughout western North America, ranging as far north as the Yukon, as far south as California, and as far east to the Black Hills in South Dakota[4]. See the maps above for the range of distribution in North America and Washington State.
Ecological distribution	Lodgepole pine inhabits a wide range of habitats. The coastal variant (*Pinus contorta* var. *contorta*) often lives in nutrient poor soils and sands near the shore, being buffeted by high winds and salt spray[8]. This leads to a smaller and more twisted form near the coast[7]. *Pinus contorta* var. *latifolia* grows in more mountainous, inland areas, being much taller and straighter than *Pinus contorta* var. *contorta*[4, 8]. This species also inhabits marshy, boggy areas both in the lowlands and in the mountains[4, 8].
Climate and elevation range	*Pinus contorta* is an extremely hardy species, withstanding temperatures between -70° F in the Northern Rockies to 100° F in some inland, lowland areas[4]. This species has a very wide elevation range, from right next to the shore to 11,600 feet up in the mountains[9]. The average amount of precipitation also can vary greatly throughout the range of *Pinus contorta*, from 200 inches in along the northern, coastal parts of its range to a measly 10 inches in some inland areas[4].
Local habitat and abundance	This species can be commonly found along sandy or rocky coastal areas, and it forms extensive stands in interior, mountainous areas[4]. Commonly associated species include *Pseudotsuga menziesii* (Douglas Fir), *Pinus ponderosa* (Ponderosa Pine), *Pinus monticola* (Western White Pine), *Tsuga mertensiana* (mountain hemlock), *Picea engelmannii* (Engelmann Spruce), *Tsuga heterophylla* (Western Hemlock), *Arctostaphylos uva-urs* (Bearberry), *Vaccinium occidentale* (Western Huckleberry) and *Pinus jeffreyi* (Jeffery Pine)[4, 9].
Plant strategy type / successional stage	This species is reliant upon its tolerance to various conditions that would kill most other trees. It is highly resistant to frost[1], forest fires[4, 8], and salt spray[8]. Lodgepole Pine is famous for having cones that open up from the heat of forest fires, allowing this shade-intolerant species to quickly colonize areas burnt by fire before other species can become established[4, 5]. The ability for Lodgepole Pine to regenerate after fire is also related to the vigorous germination of seeds, wide adaptation to a variety of environments and rapid

	early growth of the seedlings[5]. One will also find stands of *Pinus contorta* in areas with lots of salt spray or extreme frost where other species are unable to survive and reproduce[4, 8]. In other words, Lodgepole pine is both a stress-tolerator and an early colonizer of disturbed sites; this species requires periodic disturbances to avoid becoming replaced by more shade tolerant species[4].
Plant characteristics	*Pinus contorta* has two primary forms. Along the coast, this species often takes the form of a small tree no more than 20 meters tall, often with a twisted or bent trunk[8]. Inland, this species grows far straighter, reaching up to 40 meters in height[4, 8]. This species is a conifer with narrow, needle-shaped leaves arranged in bundles of two[8]. These needles are about 2 to 7 centimeters long and are often twisted or slightly curved[8]. Seed cones are about 3 to 5 cm long, are egg-shaped, and have tightly-interlocking scales sealed with resin[8]. Pinus contorta is monoecous, with both female and male cones on the same plant; female (seed) cones are generally located towards the top of the crown, while male (pollen) cones are located further down[7]. *Pinus contorta* usually lives to be about 150-200 years old, though some exceptional individuals live to be about 400[1]. Seed production begins at around 5 to 10 years of age[8].
Propagation of *Pinus contorta* via seed, as described by Luna[6] (All information sourced from Luna unless noted otherwise)	
Ecotype	Glacier National Park (Northern Rockies), 1585m elevation
Propagation Goal	Plants
Propagation Method	Seed
Product Type	Container (plug)
Stock Type	Conetainers (172 ml)
Time to Grow	9 months
Target Specifications	A height of 16 cm and a firm root plug
Propagule Collection Instructions	Seed cones should be collected in early September. Both sealed (serotinous) and unsealed (non-serotinous) cones can be collected; mature cones are firm and brown. Since seed cones are located towards the top of the crown[7] and seeds dropped on the ground quickly go bad[1], long pruning poles can be used to cut branches containing mature cones. After cutting the cone-bearing branches, the cones can be removed with shears and stored in a dry, well-ventilated area.

Propagule Processing/Propagule Characteristics	Cones that are serotinous can be opened up by heating them in kilns or placing them in boiling water; they can then be air dried to allow for seed removal. A tumbler can be used to remove large quantities of seed from opened cones. Seeds can last up to 25 years if refrigerated and kept in a sealed container, with there being roughly 208,000 seeds per kilogram.
Pre-Planting Propagule Treatments	Before planting seeds should be disinfected by dunking them in a 8:1 (by volume) water/bleach solution for ten minutes. After disinfecting the seeds they should be rinsed for 48 hours in water followed by 45 days of cold, moist stratification. For stratification, the seeds can be placed in moist peat moss in refrigerated mesh bags.
Growing Area Preparation / Annual Practices for Perennial Crops	The growing medium used by Luna consists of 6:1:1 of sphagnum peat moss, perlite, and vermiculite respectively. 1 gram of Osmocote controlled release fertilizer (13N:13P2O5:13K2O) and 0.2 grams of Micromax fertilizer (12%S, 0.1%B, 0.5%Cu, 12%Fe, 2.5%Mn, 0.05%Mo, 1%Zn) should be added to each container when sowing. The containers used are 172 ml conetainers. Both a greenhouse and an outdoor nursery are used in Luna's protocol. Luna specifically calls for hand watering.
Establishment Phase Details	Luna does not give too many details in regards to the establishment phase. The medium should remain moist and one should be careful not to bury or cover the seeds too deep.
Length of Establishment Phase	8 weeks
Active Growth Phase	The seedlings should be fertilized with liquid fertilizer (25-10-10 NPK at 200 ppm) during the active growth phase; how often and how exactly this fertilizer should be applied is not specified. Luna also calls for inoculation with mycorrhizal fungi, though no details are given on how to inoculate with mycorrhizal fungi.
Length of Active Growth Phase	16 weeks
Hardening Phase	The seedlings should be moved outside and be fertilized with liquid fertilizer (10-20-20 NPK at 200 ppm); exactly how often this fertilizer should be applied is not specified. Irrigation should be reduced about mid-way through hardening, and water should be flushed through the medium before winter storage.
Length of Hardening Phase	4 weeks
Harvesting, Storage and Shipping	Seedlings can be stored outside under snow and insulated foam. No information is given by Luna in

	regards to shipping. The seedlings are ready to outplant at the end of hardening, but it is best to wait until spring to plant.
Length of Storage	5 months
Guidelines for Outplanting / Performance on Typical Sites	No information is given by Luna on outplanting performance, time before sexual maturity etc.
Other Comments	While this protocol for *Pinus contorta* is quite comprehensive, it covers the inland, mountain variant, *Pinus contorta* var. *latifolia*. Nurseries working with different variants of *Pinus contorta*. such as *Pinus contorta* var. *contorta*, are advised to take the protocol above as a general guide for propagating *Pinus contorta* as opposed to a rigid set of rules. There is also some ambiguity in how often fertilizer should be applied, so nursery practitioners are advised to take the fertilization schedules in this protocol as a general guide. Individual nurseries and practitioners should experiment to see what fertilization schedule works best for their individual circumstances.
Production of *Pinus contorta* cuttings as described by Fries & Kaya[3] (All sourced from Fries & Kaya unless noted otherwise)	
Ecotype	Northern British Columbia and the southern portions of the Yukon
Propagation Goal	Cuttings
Propagation Method	Vegetative
Product Type	Propagules (Cuttings)
Stock Type	Containers (size not specified, but presumably small pots or containers)
Time to Grow	1.5-3.5 years
Target Specifications	2-10 cm long annual shoots that can be harvested as cuttings and be rooted
Propagule Collection Instructions	Cuttings should be taken about a month into the growing season. The growing season in question can be natural or artificial, with the latter case pertaining to seedlings and trees grown in a greenhouse over the winter. The green, soft shoots at the end of the branches, as well as off the top of the tree, can be taken as cuttings by clipping them with shears.
Propagule Processing/Propagule Characteristics	Fries & Kaya do not give much detail on the cuttings themselves, such as how long they can be stored for, as their paper consists of a scientific experiment into rooting *Pinus contorta* cuttings; cuttings were planted immediately after harvesting.
Pre-Planting Propagule Treatments	After taking the cuttings, re-cut the bottom of each cutting underwater so that the exposed flesh does not

	come in contact with air. Then, dip the ends of each cutting in a hormone solution for five seconds. This hormone solution should contain 4000 ppm Indole-3-butyric Acid (a rooting hormone) dissolved in a solution of 30% water and 70% ethanol. Remove the lowermost needles, but keep the bark intact. After preparation, the cuttings should immediately be planted in medium.
Growing Area Preparation / Annual Practices for Perennial Crops	The media used should consist of 60% unfertilized peat and 40% perlite. The size and shape of the containers is not specified. Rooting is done in an indoor misting chamber with 90-100% humidity, while active growth was done in a regular greenhouse.
Establishment Phase Details	The cuttings should be rooted in a misting chamber to prevent the cuttings from drying out before they establish roots. As mentioned above, the humidity of this misting chamber should be at about 90-100%. The medium should be kept at a temperature of 25 degrees celsius, and the air temperature should be at about 15-18 degrees celsius. Rotate the containers within the misting chamber twice a week; this is to prevent uneven rooting amongst the cuttings as a result of small environmental differences.
Length of Establishment Phase	7-11 weeks
Active Growth Phase	Cuttings should be moved to a regular greenhouse after rooting. The top shoots should be removed during the first growing season (6 months) to encourage a well-developed crown with many different potential cuttings. Rooted cuttings become sources of cuttings themselves, with two growing seasons per year, one natural one over the summer, and an artificial one over the winter.
Length of Active Growth Phase	1.5-3.5 years (depending on the number of total cuttings desired)
Hardening Phase	The purpose of this protocol is to maximize cutting production, not to produce plants that will be outplanted. As such, there is no overwintering or hardening described by Fries & Kaya.
Length of Hardening Phase	NA
Harvesting, Storage and Shipping	Not specified by Fries & Kaya
Length of Storage	Not specified by Fries & Kaya
Guidelines for Outplanting / Performance on Typical Sites	Cuttings were not outplanted by Fries & Kaya
Other Comments	This protocol for vegetative production is very situation specific. Unless there is a pressing need to create as many of one clone as possible, it is advisable

	to utilize the seed propagation protocol described earlier. About a quarter of the cuttings are lost to fungi during rooting, and even under ideal circumstances (requiring a significant amount of labor and special equipment), only about 45-65% of the cuttings end up rooting. Still, those that want to preserve a specific genotype of *Pinus contorta* may find this protocol extremely helpful.
INFORMATION SOURCES	
References	[1]Anderson, M. D. (2003). *Pinus contorta var. latifolia*. US Forest Service Fire Effects Information System. https://www.fs.fed.us/database/feis/plants/tree/pinconl/all.html [2]Cochran, P. H., & Berntsen, C. M. (1973). Tolerance of Lodgepole and Ponderosa Pine Seedlings to Low Night Temperatures. *Forest Science*, *19*(4), 272–280. https://doi.org/10.1093/forestscience/19.4.272 [3]Fries, A., & Kaya, Z. (1996). Parameters affecting shoot production and rooting of cuttings from lodgepole pine hedges. *New Forests*, *12*(2), 101–111. https://doi.org/10.1007/BF00036623 [4]Lotan, J. E., & Critchfield, W. E. (1990). Lodgepole pine. In R. M. Burns & B. H. Honkala (Eds.), *Silvics of North America*. US Forest Service. https://www.srs.fs.usda.gov/pubs/misc/ag_654/volume_1/pinus/contorta.htm [5]Lotan, J. E. (1976). Cone serotiny-fire relationships in lodgepole pine. In *Proceedings, Fourteenth Annual Tall Timbers Fire Ecology Conference*. p. 267-278. Tall Timbers Research Station, Tallahassee, FL. [6]Luna, T. (2008). Pinus (contorta). Retrieved from https://npn.rngr.net/renderNPNProtocolDetails?selectedProtocolIds=pinaceae-pinus-236 [7]Organisation for Economic Co-operation and Development. (2010). Section 5—Lodgepole pine (Pinus contorta). *OECD Safety Assessment of Transgenic Organisms, 3*, 152-175. https://doi.org/10.1787/9789264095434-9-en

	[8]Pojar, J., & Mackinnon, A. (1994). *Plants of the pacific northwest coast: Washington, Oregon, British Columbia & Alaska (Revised ed.)*. B.C. Ministry of Forests and Lone Pine Publishing. [9]University of California. (2022). Lodgepole pine (Pinus contorta). Retrieved from https://ucanr.edu/sites/forestry/California_forests/http__ucanrorg_sites_forestry_California_forests_Tree_Identification_/Lodgepole_pine_Pinus_contorta/ [10]USDA Natural Resources Conservation Service. (2022). *Pinus contorta Douglas ex Loudon: Lodgepole pine*. Natural Resources Conservation Service. https://plants.usda.gov/home/plantProfile?symbol=PICO
Other Sources Consulted	Dahms, W. G., & Barrett, J. W. (1975). S*eed production of Central Oregon ponderosa and lodgepole pines*. US Forest Service. http://www.fsl.orst.edu/rna/Documents/publications/Seed%20production%20of%20central%20Oregon%20Ponderosa%20and%20Lodgepole%20pines%201975.PDF
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Note: This propagation protocol template was modified by J.D. Bakker from that available at: http://www.nativeplantnetwork.org/network/SampleBlankForm.asp