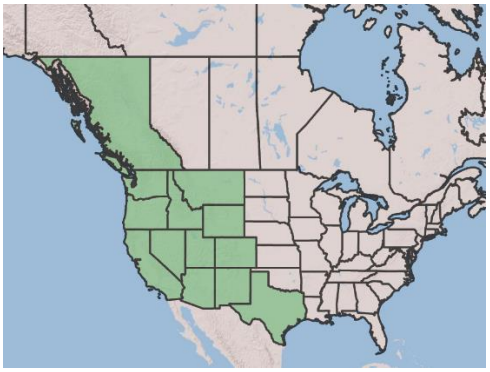
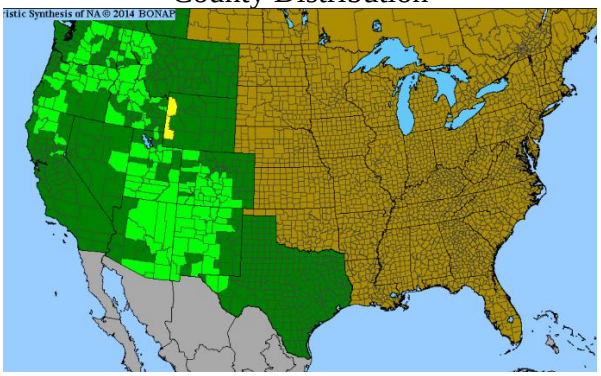
Plant Propagation Protocol for *Arceuthobium douglasii*
ESRM 412 – Native Plant Production
URL: https://courses.washington.edu/esrm412/protocols/2023/ARDO.pdf

Female shoots

Female shoots of A. douglasii fruiting on Douglas fir (Pseudotsuga menziesii).

Male shoots

Male flowering shoots of A. douglasii on Douglas fir (Pseudotsuga menziesii).

TAXONOMY	
Plant Family	*Viscaceae*
Scientific Name	*Viscaceae* Batsch
Common Name	Christmas Mistletoe family
Species Scientific Name	*Arceuthobium douglasii*
Scientific Name	*Arceuthobium douglasii* Engelm. [2]
Varieties	*Arceuthobium douglasii* var. douglasii *Arceuthobium douglasii* var. laricis [3]
Sub-species	N/A
Cultivar	N/A
Common Synonym(s)	N/A
Common Name(s)	Douglas-fir dwarf mistletoe
Species Code (as per USDA Plants database)	ARDO
GENERAL INFORMATION	
North American Distribution  [10]	County Distribution  [http://bonap.net/MapGallery/County/Arceuthobium%20douglasii.png] Dark green = species present in state and native, light green = species present and not rare, yellow = species present and rare
Geographical Range	*Arceuthobium douglasii* is native to British Columbia and Alberta in Canada, east to Montana and New Mexico [8]. In the United States, *A. douglasii* can be found in Arizona, California, Colorado, Idaho, Montana, New Mexico, Oregon, Texas, Utah, Washington, and Wyoming [9].
Ecological Distribution	Conifer limbs, most often on *Pseudotsuga menziesii* in any ecosystem where Douglas-fir is present [8].
Climate and Elevation Range	Elevation: 300-3300 m [5]
Local Habitat and Abundance	Commonly found in the same habitats as *Pseudotsuga menziesii*, in terrestrial managed forests, plantations, orchards, and terrestrial natural/semi-natural forests [1]. Douglas-fir is the main host for *A. douglasii*, but it can also affect *Abies amabalis, Abies bifolia, and Abies lasiocarpa* var. Arizonica [1].

Plant Strategy Type / Successional Stage	Parasitic
Plant Characteristics	*Arceuthobium douglasii* is a dicot, perennial shrub/subshrub [2]. *A. douglasii* is a small, glabrous shrub that is a parasite on the branches of *Pseudotsuga menziesii*. The stems are greenish or blueish green, they are 0.5-3 cm long and the segments are 1mm thick and 3-6 times as long. *A. douglasii* has staminate flowers paired at the nodes on short pedicle-like joints, they are greenish-yellow, and 2mm broad. The fruit is an ovoid berry that is 3 mm long, maturing the second summer after its establishment. The fruit is 1-seeded, explosively expels itself, and sticks to the surface that it lands on [8]. These fruit capsules develop on the aerial shoots of the female plant. These aerial shoots function as "reproductive structures" but contain chlorophyll and create some carbohydrates for the individual [9]. *A. douglasii* is a very common pathogen in the blue mountains and is the greatest threat to the long-term successful management of Douglas-fir. *A. douglasii* causes large witches' brooms on Douglas-firs to form because of profuse bud and branch stimulations. These brooms serve as nutrient sinks, limiting photosynthates and water availability to the rest of the tree. The seeds germinate in the spring, each producing a single radicle under which a penetration wedge grows into the cortex of the host and develops into bark strands. Bark strands grow through the cortex, producing sinkers that penetrate the cambium and that year's xylem. The network of these bark strands and sinkers is known as the endophytic system. This perennial system remains active if the host tissue is alive. *A. douglasii* becomes systemic in the host and will spread through the entire broom host branch without causing the host tissue to swell. New growth is infected after the endophytic system spreads into dormant and stimulates the formation of the witches' brooms. This endophytic system grows with its host, infecting new terminal buds [10]. While *A. douglasii* is very parasitic, it doesn't spread rapidly so it cannot be considered invasive. *A. douglasii* produces fruit annually for at least 2 years, often for 5 years or more. It has peak anthesis in April or May. *A. douglasii* exhibits latitudinal variation in flowering, March in Mexico, late April to early May in Arizona and New Mexico, late May in Colorado, Utah, and Oregon, and early to mid-June in Washington. No

	true seed is formed as there isn't any testa, the embryo is embedded in chlorophyllous endosperm which is surrounded by viscin. Though this structure is still referred to as a seed for the ease of communication. The embryo is green, a few millimeters long, and has a meristematic radicular apex without a root cap [1]. *A. douglasii* has the widest latitudinal distribution of any North American dwarf mistletoe [5]. *A. douglasii* has coevolved with Douglas-fir since the Miocene era, continuing the parasitic relationship [9].
PROPAGATION DETAILS – VEGETATIVE [7]	
Ecotype	N/A
Propagation Goal	Plants
Propagation Method	Vegetative
Product Type	Propagules (grafts)
Stock Type	N/A
Time to Grow	N/A
Target Specifications	N/A
Propagule Collection Instructions	Take cuttings of witches' brooms on infected *Pseudotsuga menziesii*
Propagule Processing/Propagule Characteristics	N/A
Pre-Planting Propagule Treatments	Infected buds with small stem pieces were grafted onto stems of healthy *Pseudotsuga menziesii*
Growing Area Preparation / Annual Practices for Perennial Crops	N/A
Establishment Phase Details	Stem developed from the scion
Length of Establishment Phase	~ 6 months
Active Growth Phase	Mistletoe buds appear along the scion
Length of Active Growth Phase	1 year
Hardening Phase	N/A
Length of Hardening Phase	N/A
Harvesting, Storage and Shipping	N/A
Length of Storage	N/A
Guidelines for Outplanting / Performance on Typical Sites	N/A
Other Comments	N/A
PROPAGATION DETAILS - SEED	
Ecotype	Naturally expelled seeds of *A. douglasii* were individually collected from the branches of Douglas-fir trees in the Thatuna Mountain Range 3 miles east of Viola, Idaho in December 1959. [11]
Propagation Goal	N/A
Propagation Method	Seed

Product Type	Propagules
Stock Type	N/A
Time to Grow	4-6 years [4]
Target Specifications	N/A
Propagule Collection Instructions	Seeds should be mature when collected, the seeds will have to be “trapped” as they are forcibly ejected from the fruits. They are collected in September and October during normal times of seed expulsion. The expelled seeds are adhered to the inner surface of sausage-casing bags, these bags are porous and allow for gas and H20 exchange with the atmosphere [11].
Propagule Processing/Propagule Characteristics	307 seeds collected, 83.7% germination after dry cold storage [11]
Pre-Planting Propagule Treatments	Dry cold storage: seeds were aired for 1-4 days counted into lots of 100 and scattered in open petri plates (15x90mm). No storage medium was used. The seeds were refrigerated in the dark at 4-5 C and 35-45% relative humidity. The air in the refrigerator room was recycled at 5-minute intervals [11]
Growing Area Preparation / Annual Growing Practices for Perennial Crops	N/A
Establishment Phase Details	Seeds mature in late August to late September [10]
Length of Establishment Phase	Fruit maturation is 17-18 months [1]
Active Growth Phase	Mature fruits detach from the aerial shoots and the seeds are explosively discharged as the result of high hydrostatic pressure within the capsule [10].
Length of Active Growth Phase	N/A
Hardening Phase	Aerial shoots of the parasite will form after branch tissue is 3 years old and will be found scattered along infected branches, aerial shoot emergence may take longer on shaded branches. Aerial shoots elongate, mature, and produce either staminate or pistillate flowers depending on whether the plant is male or female between March and late June. In the autumn of the following year, seed capsules mature, beginning the cycle again. [10]
Length of Hardening Phase	N/A
Harvesting, Storage & Shipping	N/A
Length of Storage	N/A
Guidelines for Outplanting / Performance on Typical Sites	N/A
Other Comments	N/A
INFORMATION SOURCES	

References	[1] *Arceuthobium Douglasii (Douglas-Fir Dwarf Mistletoe)*, www.cabidigitallibrary.org/doi/10.1079/cabicomp Endium.6834. Accessed 19 May 2023. [2] "*Arceuthobium Douglasii* Engelm." *USDA Plants Database*, plants.usda.gov/home/plantProfile?symbol=ARDO. Accessed 19 May 2023. [3] "Arceuthobium+douglasii – Encyclopedia of Life." *EOL*, eol.org/search?utf8=%E2%9C%93&q=Arceuthobium%2Bdouglasii. Accessed 19 May 2023. [4] Dooling, O.J., and R.G. Eder. "An Assessment of Dwarf Mistletoes in Montana." United States Department of Agriculture, July 1981. [5] Engelmann, and Daniel L. Nickrent. "Arceuthobium Douglasii." *Arceuthobium Douglasii – FNA*, floranorthamerica.org/Arceuthobium_douglasii. Accessed 19 May 2023. [6] Gill, Lake S., and Frank G. Hawksworth. "The Mistletoes A Literature Review." United States Department of Agriculture, June 1961. [7] Job, Kuijt, Vegetative Propagation of Dwarf Mistletoes, *Forest Science*, Volume 10, Issue 1, March 1964, Pages 78-79, https://doi.org/10.1093/forestscience/10.1.78 [8] Knoke, Don. "Arceuthobium Douglasii." *Arceuthobium Douglasii – Burke Herbarium Image Collection*, burkeherbarium.org/imagecollection/taxon.php?Taxon=Arceuthobium+douglasii. Accessed 19 May 2023. [9] "Plant Database." *Lady Bird Johnson Wildflower Center – The University of Texas at Austin*, www.wildflower.org/plants/result.php?id_plant=ARDO. Accessed 19 May 2023. [10] Schmitt, Craig L. "Management of Douglas-Fir Infected with Dwarf Mistletoe in the Blue Mountains of Northeastern Oregon and Southeastern Washington." *United States Department of Agriculture*, Mar. 1997, www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev2_026324.pdf. [11] Wicker, Ed F. *Seed Collection and Storage for Arceuthobium Spp.*, Intermountain Forest & Range Experiment Station, Forest Service, U.S. Dept. of Agriculture, 1967.

Other Sources Consulted	Lemons, Daniel Eugene, "Small mammal dissemination of dwarf mistletoe seeds" (1978). Dissertations and Theses. Paper 2845. https://doi.org/10.15760/etd.2839 Roth, Lewis F., and James W. Barrett. “Response of Dwarf Mistletoe-Infested Ponderosa Pine to Thinning: 2. Dwarf Mistletoe Propagation.” *US Forest Service Research and Development*, 1 Jan. 1985, www.fs.usda.gov/research/treesearch/25234.
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