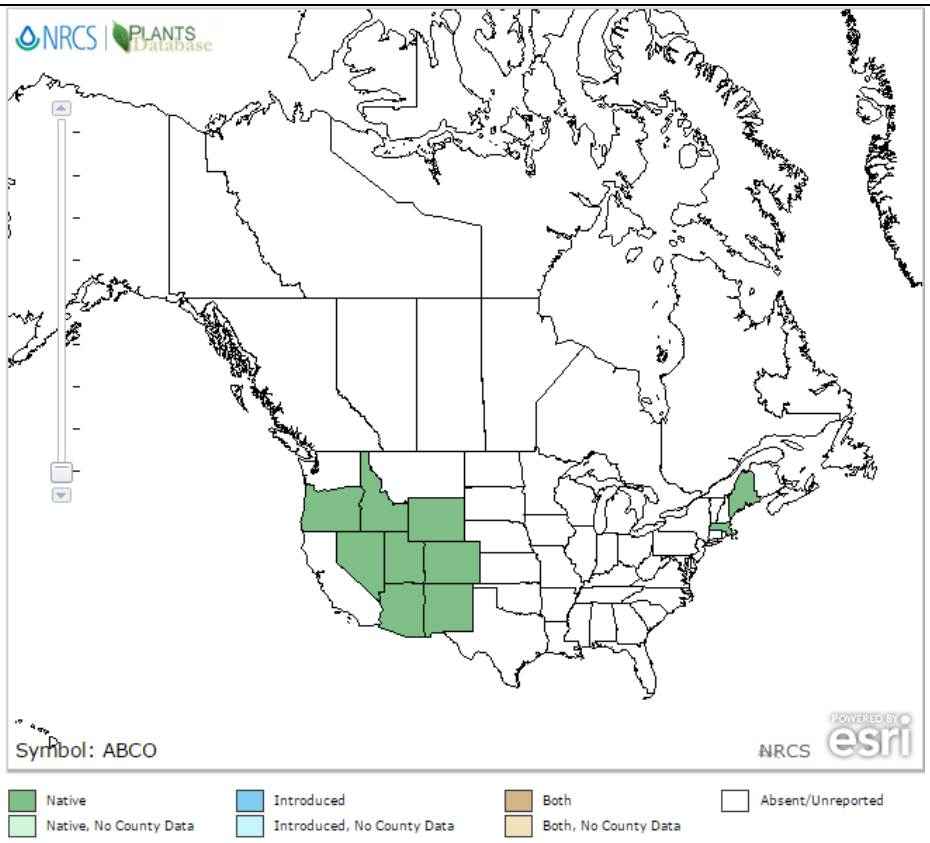
Plant Propagation Protocol for *Abies concolor*
ESRM 412 – Native Plant Production
Protocol URL: https://courses.washington.edu/esrm412/protocols/*ABCO.pdf*

***Abies concolor* needles. Photo credit: Paul S. Drobot, 2015.**

TAXONOMY	
Plant Family	
Scientific Name	Pinaceae
Common Name	Pine Family
Species Scientific Name	
Scientific Name	*Abies concolor* (Gord. & Glend.) Lindl. Ex Hildebr.
Varieties	*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr. var. *concolor* (Rocky Mountain White fir) *Abies concolor* var. *lowiana* (Gord.) Lemm. (California white fir)
Sub-species	N/A
Cultivar	
Common Synonym(s)	*Abies lowiana* (Gordon) A. Murray
Common Name(s)	white fir California white fir Rocky Mountain white fir
Species Code (as per USDA Plants database)	ABCO
GENERAL INFORMATION	
Geographical range	The native range of *A. concolor* extends from the mountainous regions of the Pacific coast to central Colorado, and from central Oregon and southeastern Idaho to northern Mexico[1]. *A. concolor* is not native to Washington state.

	
Ecological distribution	White fir occurs in the following ecosystem types: Douglas-fir, Ponderosa Pine, Fir-spruce, Lodgepole pine, Western hardwoods, Chaparral-mountain shrub, Pinyon-juniper, and Mountain meadows[2].
Climate and elevation range	*Abies concolor* requires a minimum of 20 inches of precipitation a year to grow, but does best in areas with 35 to 75 inches annually. White fir occurs at higher elevations from 4,000 to 10,000 feet[3].
Local habitat and abundance	The majority of *Abies concolor* trees are found on the western side of the Sierra Nevadas, but are also found in Oregon and Idaho. It is an overstory tree found on wide variety of parent materials and soil types[3]. It is often found with other western conifer species such as *Tsuga mertensiana* and *Pseudotsuga menziesii*[4].
Plant strategy type / successional stage	California white fir is a major climax component throughout the mixed conifer forests within its range. It is displaced successionally only at its northern limits in Oregon, where western hemlock *(Tsuga heterophylla)* and perhaps western red cedar *(Thuja plicata)* replace white fir as a climax species on moister sites[5].
Plant characteristics	*Abies concolor* is a large tree up to 200 ft tall. Its needles appear two-ranked, are silver-blue to silvery green, and are 2 to 3 inches long, the longest needles of any fir species[6]. The needles point out from the branches at 45 degrees making a v- or u-shaped valley. Cones are upright, 2 to 5 inches long and mature in the fall. The bark of young trees has conspicuous resin blisters. Bark on old trees is ashy gray and deeply and irregularly furrowed. *Abies concolor* may live up to 300 years[7]. Often

	used as a Christmas tree because it retains its needles after being cut and the needles are not sharp[8].
PROPAGATION DETAILS	
Ecotype	The protocol described is adapted from Professor John T. Harrington's plant protocol from the Native Plant Network, available at http://www.nativeplantnetwork.org/Network/ViewProtocols.aspx?ProtocolID=3692 The method was experimentally tested with seeds from and under environmental conditions of New Mexico.
Propagation Goal	Plants
Propagation Method	Seed
Product Type	Container: plug
Stock Type	
Time to Grow	12 months
Target Specifications	Height: 15 to 20 cm Caliper: 2 to 3 mm Root System: Firm root plug.
Propagule Collection Instructions	Seeds are collected with the entire cone before the cone scales open up and the seeds are dispersed. The seed matures in September when they turn tan or brown, up to 3 weeks before seedfall[9]. Seeds are delicate and require special care when working with them. Each cone scale contains two winged seeds[6].
Propagule Processing/Propagule Characteristics	The average seed density is 11,000 seeds per pound[10]. The unopened cones are placed into cone cages in a greenhouse and allowed to mature until the cones open. The greenhouse is set to low temperatures not to exceed 27^{o}C. Once the cones open, there will be a large amount of seeds and cone fragments. To separate the seeds from chaff, an air column is used. If plants will be used within the next 12 months they can be refrigerated at 2 to 4 ^{o}C. If storing for longer than 12 months before use they should be stored at -9 to -12 ^{o}C[9].
Pre-Planting Propagule Treatments	Before being placed in cold stratification, seeds are soaked in room temperature water for 12 to 18 hours[9]. Seeds are placed in cold moist stratification for 28 to 60 days.
Growing Area Preparation / Annual Practices for Perennial Crops	Germination occurs in a greenhouse where the seedlings remain through the spring and in the summer they are moved to a shade house. The seeds are sown in beginning of April and moved in August once the seedlings are 15 to 20 cm tall. Exposure to full light may cause light stress. Recommended growing medium is 2:1:1 of peat : perlite : vermiculite. The peat can be replaced with coco coir in order to be more sustainable. Incorporating controlled release fertilizer into the growing medium, is recommended at a rate of 4 kg/m3 and a concentration of 14-14-14 N-P-K[9].
Establishment Phase Details	The establishment phase occurs in the greenhouse. Multiple seeds are placed on top of the medium and covered with a fine layer (2 to 5mm) of

	mulch such as chicken grit or vermiculite. Containers are misted 4 to 8 times per day. No supplemental light is necessary. Temperatures are to range from 18 to 26°C. After 14 days, seedlings are thinned to one per plug[9].
Length of Establishment Phase	28 days
Active Growth Phase	Seedlings need limited irrigation for the first few weeks, only once every 4 to 5 days, as needed. Then from weeks three through 18 they need to be irrigated once every 2 to 3 days. In each stage the soil is allowed to dry moderately between watering. Irrigation is to be done in the early morning. Additional fertilizer is applied through the irrigation system, at a 20-20-10 NPK concentration and then ramped up during the remained of the active growth phase. The first 2 weeks, the seedlings receive 25 ppm N and receive an additional 25 ppm each week until week 13 when 175ppm N is applied and this rate is held constant until the seedlings are moved to the shade house. The fertilizer rate is then reduced to 150 ppm with every third irrigation until the end of August[9].
Length of Active Growth Phase	14 to 18 weeks
Hardening Phase	Typically at the end of August the hardening phases is started. For the initial part of hardening the plants subjected to heavy irrigation increasing amount to limit further above ground growth. Then the second phase of hardening commences and the water plants are water limited to reduce growth. Fertilization continues through the fertigation system at a rate of 10-30-20 NPK at rate of 25 ppm N[9].
Length of Hardening Phase	9 to 12 weeks
Harvesting, Storage and Shipping	In late October of early November the plants are transferred from the shade house to cold frames for storage. Irrigation is limited to every 4 to 5 days. No supplemental light is required. Seedlings are removed from the cold frame in late February or early March when they are ready for outplanting[9].
Length of Storage	3-4 months
Guidelines for Outplanting / Performance on Typical Sites	
Other Comments	
INFORMATION SOURCES	
References	[1] Fowells, H. A., comp. 1965. Silvics of forest trees of the United States. U.S. Department of Agriculture, Agriculture Handbook 271. Washington, DC. p. 762.

[2] Zouhar, Kris. 2001. *Abies concolor*. In: Fire Effects Information System. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Retrieved: 23 April 2015. <http://www.fs.fed.us/database/feis/>

[3] USDA NRCS Plant Material Program. 2002. White Fir *Abies concolor* (Gord. & Glend.) Lindle. Ex Hidebr. Retrieved: 7 June 2015. <http://plants.usda.gov/factsheet/pdf/fs_abco.pdf>

[4] Giblin, David**.** *Abies concolor*. Burke Herbarium. Burke Museum of Natural History and Culture, 2015. Retrieved: 7 June 2015. <http://biology.burke.washington.edu/herbarium>

[5] Franklin, Jerry F., and C. T. Dyrness. 1973. Natural vegetation of Oregon and Washington. USDA Forest Service, General Technical Report PNW-8. Pacific Northwest Forest and Range Experiment Station, Portland, OR. p. 417.

[6] "*Abies Concolor*." Lady Bird Johnson Wildflower Center. N.p., 1 Jan. 2007. Retrieved: 27 April 2015. <http://www.wildflower.org/plants/result.php?id_plant=ABCO>.

[7] USDA NRCS Plant Materials Program (2012). Plant Fact Sheet: *White fir Abies concolor (Gord. & Glend.) Lindl. Ex Hildebr.* U.S. Deparment of Agriculture, Natural Resources Conservation Service

[8] McKinley, C. R. (2013). *Concolor fir (White fir)*. National Christmas Tree Association. Retrieved: 25 April 2015 <http://www.realchristmastrees.org/dnn/Education/TreeVarieties/ConcolorFir.aspx>

[9] Harrington, John T.; Loveall, Mark W. 2008. Propagation protocol for production of container *Abies concolor* (Gord. and Glend.) Lindl. ex Hildebr. plants (164 ml conetainer); New Mexico State University-Mora Research Center, Mora, New Mexico. In: Native Plant Network. Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery. Retrieved: 23 April 2015 < http://www.nativeplantnetwork.org>

[10] Dumrose, R. K., Landis, T.D. and T. Luna 2012 Raising Native Plants in Nurseries: Basic Concepts. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Gen. Tech. Report RMRS-GTR-274.

[11]Baskin, Carol C.; Baskin, Jerry M. 2002. Propagation protocol for

	production of container *Abies concolor* (G&G) Lindl. plants; University of Kentucky, Lexington, Kentucky. In: Native Plant Network. Moscow (ID): University of Idaho, College of Natural Resources, Forest Research Nursery. Retrieved: 8 June 2008. <http://www.nativeplantnetwork.org>
Other Sources Consulted	
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