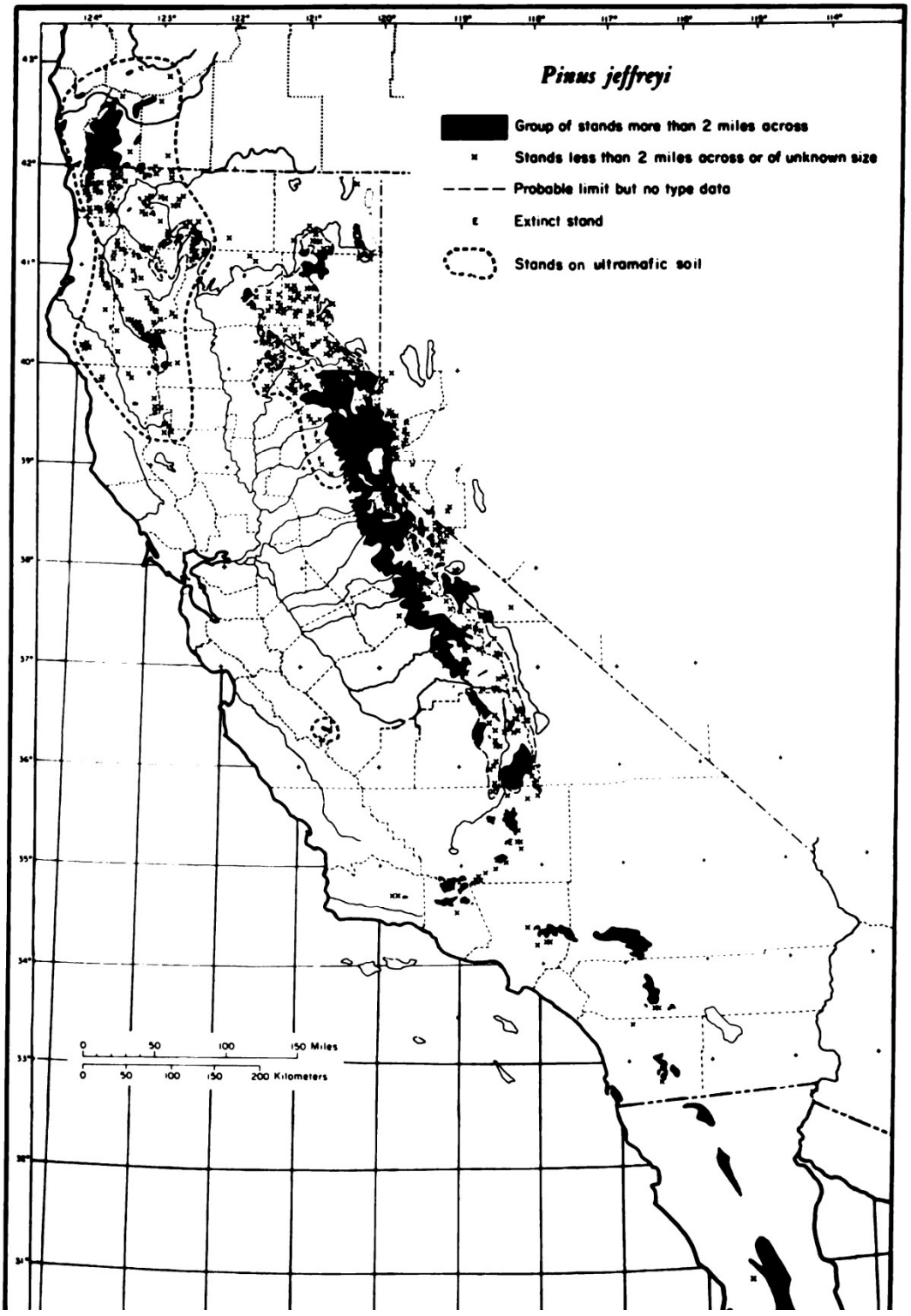
Plant Propagation Protocol for *Pinus jeffreyi*
ESRM 412 – Native Plant Production
URL: https://courses.washington.edu/esrm412/protocols/2021/PIJE.pdf



Native range of *Pinus jeffreyi.* From Jenkinson (1990).

TAXONOMY	
Plant Family	
Scientific Name	*Pinaceae*
Common Name	Pine Family
Species Scientific Name	
Scientific Name	*Pinus jeffreyi* Grev. & Balf.
Varieties	
Sub-species	
Cultivar	
Common Synonym(s)	*Pinus ponderosa* subsp. *jeffreyi* (Grev. & Balf.) E. Murr.
Common Name(s)	Jeffrey Pine
Species Code (as per USDA Plants database)	PIJE
GENERAL INFORMATION	
Geographical range	See accompanying map. Occurs in pockets in the Klamath Mountains (northwestern California/ southwestern Oregon), the Sierra Nevada (eastern California/ western Nevada), Transverse range (southern California), and Peninsular Range (southern California and Baja California) (Jenkinson, 1990).
Ecological distribution	Occurs in pure stands or mixed conifer stands and forests in mountain areas, especially in disturbed sites or unproductive, well-drained soils (Jenkinson, 1990)
Climate and elevation range	Most competitive in cold, dry sites and poor soils. In very poor soils, it can be found as low as 200 ft in the Klamath Mountains (Jenkinson, 1990). Throughout its range, it more typically occurs at elevations of 1200-9000 ft, but is found as high as 10,600 ft in parts of California. (Gucker, 2007)
Local habitat and abundance	Dominant species in cold, dry, infertile sites. Because it occurs in a wide range of elevations and different conditions, it can be found among a variety of different conifer and other species (Jenkinson, 1990). Typically occurs above the ponderosa pine zone, but the distribution of ponderosa and Jeffrey pine can overlap (Gucker, 2007).
Plant strategy type / successional stage	Often occurs as the dominant, climax species in very dry, serpentine soils. Jeffrey Pine is fire tolerant but shade intolerant. Where competition with other species occurs, a disturbance such as fire is needed to open the canopy in order for Jeffrey pine to grow. In the absence of disturbance, in such sites it will eventually be replaced by more shade-tolerant species. (Gucker, 2007)
Plant characteristics	Coniferous tree with deeply furrowed, often reddish bark, with 7.6-28 cm long needles in bundles of three, but occasionally two. Seeds are 10-12 mm long, with wings up to 3 cm long. (Gucker, 2007) Often lives 400-500 years in

	the best-suited sites, where it typically reaches 1.2-1.8 m in diameter and 52-61m tall (Jenkinson, 1990). Jeffrey pine resembles ponderosa pine, with which it can hybridize (Gucker, 2007). Compared to ponderosa pine, Jeffrey pine has grayer, less shiny needles. Its bark fissures are deeper with narrower plates. Both sides of its cone scales are the same color, whereas in ponderosa, the dorsal surface is noticeably darker. Jeffrey pine has larger cones (15-25 cm long, compared to ponderosa's 7-13 cm) and a smaller wing to seed length ratio (2.4-1.5 compared to ponderosa's 4.5-2.9). (Parrat, 1967)
PROPAGATION DETAILS	
Ecotype	
Propagation Goal	Plants
Propagation Method	Seed
Product Type	Container (plug)
Stock Type	1 L container
Time to Grow	1 year
Target Specifications	Height: > 8cm, Caliper/ diameter > 2.5 mm (Schubert, 1971), firm root plug
Propagule Collection Instructions	Ripe cones are removed from trees in September and/or October (Schubert, 1971). Ripe cones are light brown to light purple, compared to the darker color of unripe cones (Krugman & Jenkinson, 1974). Cones can generally be collected from stands in which 1 or 2 trees are found to have cones with seed scales separating. The most prolific trees are usually 18-55 m tall. A large seed crop is usually produced once every 2-8 years (Jenkinson, 1990).
Propagule Processing/Propagule Characteristics	Cones are immediately air-dried in a well-ventilated area for 5-7 days, then heated in a kiln at 120 F for 24 hrs to open. Seeds are removed from cones by shaking and de-winged by tumbling or other methods. They can be cleaned using screens, gravity separators, etc. On average, there are 3700 seeds/ lb. Seeds are ideally stored at 0-5 F, at 5-10% moisture content. Under these conditions, 50% of seeds remain viable after 18 years (Krugman & Jenkinson, 1974).
Pre-Planting Propagule Treatments	Seeds are sterilized by soaking in 10% H2O2 for 30 minutes, then soaked in cold running water for 24 hr (Walker, 1997). Seeds are stratified 28-60 days in moist medium at 33-41 F (Krugman & Jenkinson, 1974) then treated with Captan to inhibit fungal pathogens (Walker, 1997).

	Seeds can be stratified in fine mesh bags buried in moist peat moss in ventilated containers (Luna et al., 2008). Seeds from some areas east of the Sierra-Cascade crest may not require stratification (Jenkinson, 1990), but seeds from most sources germinate faster and more uniformly after 60 days of stratification (Jenkinson, 1990; Stone, 1957) Germination is about 65% after stratification (Gucker, 2007)
Growing Area Preparation / Annual Practices for Perennial Crops	Seeds are sown in April (Jenkinson, 1990). 7x7x21 cm (~1L) containers filled with a sterilized mixture of 50% sphagnum, 40% coarse vermiculite, and 10% perlite by volume have been used to facilitate formation of desired root plug (Walker 1997, 1999). Seeds are sown 1/4- 3/8 in deep (Krugman & Jenkinson, 1974).
Establishment Phase Details	Containers are misted until germination (Walker, 1997)
Length of Establishment Phase	3 weeks (Luna et al., 2008)
Active Growth Phase	Inoculation with *Pisolithius tinctorius* has been shown to increase root volume in seedlings, which is associated with improved survival at outplanting sites. This mycorrhiza is commercially available (Walker, 1997) or spores can be collected from fruiting bodies at the outplanting site (Walker, 1999). Plants are inoculated at 4 and 16 weeks after emergence (Walker, 1997) In a study comparing different fertilization methods and formulations, the most effective was a one-time application of Sierra 16-6-10 controlled release fertilizer. This is formulated to fertilize for a 12- month period. It was applied 8 weeks after emergence, 3g per seedling, as a top dressing. (Walker, 1997) Seedlings are grown in a greenhouse at 19-23 C and watered twice weekly. (Walker, 1997)
Length of Active Growth Phase	5 months (Luna et al., 2008)
Hardening Phase	Growing temperature is lowered to 13-17 C to induce dormancy. (Walker,1997)
Length of Hardening Phase	1 month
Harvesting, Storage and Shipping	Plants are held in cold storage during the winter and planted in spring (Jenkinson, 1990)
Length of Storage	5 months
Guidelines for Outplanting / Performance on Typical Sites	Competition with any other vegetation greatly decreases seedling survival (Jenkinson, 1990). Partial shade increases growth at outplanting site-- this can be provided by a temporary mesh barrier (Walker 1999). Fertilization at the outplanting site is associated with lower survival rates, in part because it benefits competing vegetation. In low N

	soils, application of certain N-containing controlled release formulations directly into the planting holes has led to increased growth with minimal increase in mortality. However, different formulations used at the same sites showed increased mortality and little to no benefit (Walker, 1999). Beneficial formulations are likely highly site-dependent.
Other Comments	
INFORMATION SOURCES	
References	Gucker, Corey L. 2007. Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html [2021, May 21]. Jenkinson J. L.1990. Pinus jeffrey. Jeffrey Pine. in: Burns, R. M. and Honkala, B. H., tech. coords. Silvics of North America. Volume 1, Conifers. Washington, DC: USDA Forest Service; 1990; pp. 359-369. Krugman, Stanley L., and James L. Jenkinson. 1974. Pinus L. pine. In Seeds of woody plants in the United States. C. S. Schopmeyer, tech. coord. p. 598-638. U.S. Department of Agriculture, Agriculture Handbook 450. Washington, DC Luna, Tara; Evans, Jeff; Wick, Dale. 2008. Propagation protocol for production of Container (plug) Pinus ponderosa Dougl. plants 172 ml conetainers; USDI NPS - Glacier National Park West Glacier, Montana. In: Native Plant Network. URL: http://NativePlantNetwork.org (accessed 2021/05/22). US Department of Agriculture, Forest Service, National Center for Reforestation, Nurseries, and Genetic Resources. Parratt, Mark W. 1967. "Hybridization and Variation of Ponderosa and Jeffrey Pines on Mt. San Antonio, California," Aliso: A Journal of Systematic and Evolutionary Botany: Vol. 6: Iss. 3, Article 3. Available at: http://scholarship.claremont.edu/aliso/vol6/iss3/3 Schubert, G.H.; Adams, R.S. 1971. Reforestation practices for conifers in California. California Div. For., Sacramento, CA.

	Stone, Edward C. 1957. Embryo dormancy of Pinus jeffreyi Murr. seed as affected by temperature, water uptake, stratification, and seed coat. Plant Physiology. 32: 93-99. [67938] Walker, R.F. and L.M. Kane. 1997. Containerized Jeffrey pine growth and nutrient uptake in response to mycorrhizal inoculation and controlled release fertilization. Western Journal of Applied Forestry12:33-40 Walker, R. F. 1999. Reforestation of an eastern Sierra Nevada surface mine with containerized Jeffrey pine: seedling growth and nutritional responses to controlled released fertilization and ectomycorrhizal inoculation. Journal of Sustainable Forestry. 9(3/4): 127-147. [36449] Walker, R.F. 1999. Artificial Regeneration of Jeffrey Pine in the Sierra Nevada, Journal of Sustainable Forestry, 9:3-4, 23-38, DOI: 10.1300/J091v09n03_02
Other Sources Consulted	North, Malcolm; Oakley, Brian; Chen, Jiquan; Erickson, Heather; Gray, Andrew; Izzo, Antonio; Johnson, Dale; Ma, Siyan; Marra, Jim; Meyer, Marc; Purcell, Kathryn; Rambo, Tom; Rizzo, Dave; Roath, Brent; Schowalter, Tim. 2002. Vegetation and ecological characteristics of mixed-conifer and red fir forests at the Teakettle Experimental Forest. Gen. Tech. Rep. PSW-GTR-186. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 52 p. [47226]
Protocol Author	Frances Reno
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