**Taxon:** Pinus jeffreyi A. Murray bis et al. **Family:** Pinaceae

**Common Name(s):** Jeffrey pine **Synonym(s):** Pinus deflexa Torr.
Pinus malletii Mottet
Pinus peninsularis (Lemmon)

**Assessor:** Chuck Chimera **Status:** Assessor Approved **End Date:** 24 Oct 2018

**WRA Score:** 3.0 **Designation:** EVALUATE **Rating:** Evaluate

**Keywords:** Temperate Tree, Shade-Intolerant, Pure Stands, Wind-Dispersed, Fire Tolerant

| Qsn # | Question | Answer Option | Answer |
|---|---|---|---|
| 101 | Is the species highly domesticated? | y=-3, n=0 | n |
| 102 | Has the species become naturalized where grown? | | |
| 103 | Does the species have weedy races? | | |
| 201 | Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical" | (0-low; 1-intermediate; 2-high) (See Appendix 2) | Low |
| 202 | Quality of climate match data | (0-low; 1-intermediate; 2-high) (See Appendix 2) | High |
| 203 | Broad climate suitability (environmental versatility) | y=1, n=0 | y |
| 204 | Native or naturalized in regions with tropical or subtropical climates | y=1, n=0 | n |
| 205 | Does the species have a history of repeated introductions outside its natural range? | y=-2, ?=-1, n=0 | y |
| 301 | Naturalized beyond native range | y = 1*multiplier (see Appendix 2), n= question 205 | y |
| 302 | Garden/amenity/disturbance weed | n=0, y = 1*multiplier (see Appendix 2) | n |
| 303 | Agricultural/forestry/horticultural weed | n=0, y = 2*multiplier (see Appendix 2) | n |
| 304 | Environmental weed | n=0, y = 2*multiplier (see Appendix 2) | n |
| 305 | Congeneric weed | n=0, y = 1*multiplier (see Appendix 2) | y |
| 401 | Produces spines, thorns or burrs | y=1, n=0 | n |
| 402 | Allelopathic | | |
| 403 | Parasitic | y=1, n=0 | n |
| 404 | Unpalatable to grazing animals | y=1, n=-1 | n |
| 405 | Toxic to animals | | |
| 406 | Host for recognized pests and pathogens | | |
| 407 | Causes allergies or is otherwise toxic to humans | | |
| 408 | Creates a fire hazard in natural ecosystems | y=1, n=0 | y |
| 409 | Is a shade tolerant plant at some stage of its life cycle | y=1, n=0 | n |

| Qsn # | Question | Answer Option | Answer |
|---|---|---|---|
| 410 | Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island) | y=1, n=0 | n |
| 411 | Climbing or smothering growth habit | y=1, n=0 | n |
| 412 | Forms dense thickets | y=1, n=0 | y |
| 501 | Aquatic | y=5, n=0 | n |
| 502 | Grass | y=1, n=0 | n |
| 503 | Nitrogen fixing woody plant | y=1, n=0 | n |
| 504 | Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers) | y=1, n=0 | n |
| 601 | Evidence of substantial reproductive failure in native habitat | y=1, n=0 | n |
| 602 | Produces viable seed | y=1, n=-1 | y |
| 603 | Hybridizes naturally | y=1, n=-1 | y |
| 604 | Self-compatible or apomictic | | |
| 605 | Requires specialist pollinators | y=-1, n=0 | n |
| 606 | Reproduction by vegetative fragmentation | y=1, n=-1 | n |
| 607 | Minimum generative time (years) | 1 year = 1, 2 or 3 years = 0, 4+ years = -1 | >3 |
| 701 | Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas) | y=1, n=-1 | n |
| 702 | Propagules dispersed intentionally by people | y=1, n=-1 | y |
| 703 | Propagules likely to disperse as a produce contaminant | y=1, n=-1 | n |
| 704 | Propagules adapted to wind dispersal | y=1, n=-1 | y |
| 705 | Propagules water dispersed | y=1, n=-1 | n |
| 706 | Propagules bird dispersed | | |
| 707 | Propagules dispersed by other animals (externally) | y=1, n=-1 | y |
| 708 | Propagules survive passage through the gut | y=1, n=-1 | n |
| 801 | Prolific seed production (>1000/m2) | | |
| 802 | Evidence that a persistent propagule bank is formed (>1 yr) | | |
| 803 | Well controlled by herbicides | | |
| 804 | Tolerates, or benefits from, mutilation, cultivation, or fire | y=1, n=-1 | y |
| 805 | Effective natural enemies present locally (e.g. introduced biocontrol agents) | | |

**Supporting Data:**

| Qsn # | Question | Answer |
|---|---|---|
| **101** | **Is the species highly domesticated?** | **n** |
| | **Source(s)** | **Notes** |
| | Burns, R.M. & Honkala, B.H. 1990. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC | [No evidence of domestication] "Jeffrey pine is genetically variable. Estimates of the average number of alleles and average heterozygosity per enzyme locus show its allelic variation is high (7)." |

| | | |
|---|---|---|
| **102** | **Has the species become naturalized where grown?** | |
| | **Source(s)** | **Notes** |
| | WRA Specialist. 2018. Personal Communication | NA |

| | | |
|---|---|---|
| **103** | **Does the species have weedy races?** | |
| | **Source(s)** | **Notes** |
| | WRA Specialist. 2018. Personal Communication | NA |

| | | |
|---|---|---|
| **201** | **Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"** | **Low** |
| | **Source(s)** | **Notes** |
| | USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 23 Oct 2018] | "Native<br>Northern America<br>NORTHWESTERN U.S.A.: United States [Oregon (s.w.)]<br>SOUTHWESTERN U.S.A.: United States [California, Nevada (w.)]<br>NORTHERN MEXICO: Mexico [Baja Norte (n.)]" |

| | | |
|---|---|---|
| **202** | **Quality of climate match data** | **High** |
| | **Source(s)** | **Notes** |
| | USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 23 Oct 2018] | |

| | | |
|---|---|---|
| **203** | **Broad climate suitability (environmental versatility)** | **y** |
| | **Source(s)** | **Notes** |
| | Gucker, C. L. (2007). Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html. [Accessed 23 Oct 2018] | "Elevation: Throughout its range, Jeffrey pine primarily occupies sites from 490 to 9,500 feet (150-2,900 m) [63]. Jeffrey pine is most common above the ponderosa pine zone [32]." [Elevation ranges exceeds 2000 m, demonstrating environmental versatility] |

| Qsn # | Question | Answer |
|---|---|---|
| | Burns, R.M. & Honkala, B.H. 1990. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC | "Jeffrey pine grows well in diverse temperature regimes. Cold winters largely distinguish its range east of the Sierra-Cascade crest from that in the Klamath Mountains, western Sierra Nevada, and southern California. Most populations east of the crest are exposed to January mean minima between -13° and -5° C (8° and 23° F), while those in the west and south are between -7° and 2° C (19° and 36° F)." |
| | CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK | Climatic amplitude (estimates)<br>- Altitude range: 1500 - 3050 m<br>- Mean annual rainfall: 380 - 1500 mm<br>- Rainfall regime: summer; winter<br>- Dry season duration: 3 - 5 months<br>- Mean annual temperature: 4 - 16ºC<br>- Mean maximum temperature of hottest month: 25 - 30ºC<br>- Mean minimum temperature of coldest month: -13 - 2ºC<br>- Absolute minimum temperature: -45 - -30ºC |

| 204 | Native or naturalized in regions with tropical or subtropical climates | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Burns, R.M. & Honkala, B.H. 1990. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC | "Jeffrey pine grows well in diverse temperature regimes. Cold winters largely distinguish its range east of the Sierra-Cascade crest from that in the Klamath Mountains, western Sierra Nevada, and southern California. Most populations east of the crest are exposed to January mean minima between -13° and -5° C (8° and 23° F), while those in the west and south are between -7° and 2° C (19° and 36° F)." |
| | USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 23 Oct 2018] | "Native<br>Northern America<br>NORTHWESTERN U.S.A.: United States [Oregon (s.w.)]<br>SOUTHWESTERN U.S.A.: United States [California, Nevada (w.)]<br>NORTHERN MEXICO: Mexico [Baja Norte (n.)]" |

| Qsn # | Question | Answer |
|---|---|---|
| **205** | **Does the species have a history of repeated introductions outside its natural range?** | **y** |
| | **Source(s)** | **Notes** |
| | Lorite, J. (2016). An updated checklist of the vascular flora of Sierra Nevada (SE Spain). Phytotaxa, 261(1), 1-57 | "A total of 121 alien species (mostly cultivated species) were listed, the rest of taxa (2232) being native to the area." [Pinus jeffreyi listed among alien plants. Presumably naturalized] |
| | CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK | "P. jeffreyi has not shown good success as a plantation tree outside of its natural range, and thus introductions are limited. It was introduced to England in 1853, but there are reports that some trees were planted as early as 1838 (Dallimore and Jackson, 1966). If true, these may well have been originally introduced as P. ponderosa. In New Zealand, P. jeffreyi has grown more slowly in trials than P. ponderosa (Burdon and Low, 1991). It has also been introduced in trials in Europe, South Africa and Japan." |
| | Skolmen, R.G. 1980. Plantings on the forest reserves of Hawaii: 1910–1960. Institute of Pacific Islands Forestry, Pacific Southwest Forest & Range Experiment Station, US Forest Service, Honolulu, HI | A total of 64 trees (9 on Maui & 55 on Hawaii island) planted from 1909-1910 |

| 301 | Naturalized beyond native range | y |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Lorite, J. (2016). An updated checklist of the vascular flora of Sierra Nevada (SE Spain). Phytotaxa, 261(1), 1-57 | "A total of 121 alien species (mostly cultivated species) were listed, the rest of taxa (2232) being native to the area." [Pinus jeffreyi listed among alien plants. Presumably naturalized] |
| | Oppenheimer, Hank L. 2003. New plant records from Maui and Hawai'i Counties. Bishop Museum Occasional Papers. 73: 3-30 | "Key to the species of Pinus reproducing on Maui" [P. jeffreyi* - unvouchered record. Possibly naturalized or naturalizing; further documentation needed] |
| | Medeiros, A.C., Loope, L.L. & Chimera, C.G. 1998. Flowering Plants and Gymnosperms of Haleakala National Park. Technical Report 120. Pacific Cooperative Studies Unit, Honolulu, HI | "West slope, planted at Hosmer Grove (6800 ft) and headquarters area (7000 ft). Trees at Hosmer Grove were planted in 1909-1911 (Park records). Sparsely reproducing west of Hosmer Grove in the Park." |

| 302 | Garden/amenity/disturbance weed | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall | No evidence |

| 303 | Agricultural/forestry/horticultural weed | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall | No evidence |

| 304 | Environmental weed | n |
|---|---|---|
| | **Source(s)** | **Notes** |

| Qsn # | Question | Answer |
|---|---|---|
| | Medeiros, A.C., Loope, L.L. & Chimera, C.G. 1998. Flowering Plants and Gymnosperms of Haleakala National Park. Technical Report 120. Pacific Cooperative Studies Unit, Honolulu, HI | "West slope, planted at Hosmer Grove (6800 ft) and headquarters area (7000 ft). Trees at Hosmer Grove were planted in 1909-1911 (Park records). Sparsely reproducing west of Hosmer Grove in the Park." [No evidence of impacts. The authors list 3 other Pinus species as being invasive within Haleakala National Park, but not P. jeffreyi] |
| | Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall | Although listed as an environmental weed, a subsequent review of the literature cited did not provide evidence that this species has had any detrimental impacts where it was reported to be naturalized and/or weedy. |
| | Oppenheimer, Hank L. 2003. New plant records from Maui and Hawai'i Counties. Bishop Museum Occasional Papers. 73: 3-30 | Reported to be reproducing. No impacts documented |

| 305 | Congeneric weed | y |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Farjon, A. & Styles, B.T. 1997. Pinus (Pinaceae). Flora Neotropica 75: 1-291 | "After Pinus radiata, P. patula has now become one of the most troublesome invasive species of pine threatening natural vegetation and biodiversity in the highlands of southern Africa." |
| | Richardson, D. M., Williams, P. A., & Hobbs, R. J. (1994). Pine invasions in the Southern Hemisphere: determinants of spread and invadability. Journal of Biogeography 21(5): 511-527 | "Pinus banksiana is invasive in New Zealand in scrub and open places on and near forest margins, shrublands, tussok grassland. At least 16 Pinus species are invasive in the Southern hemisphere: P. banksia, P. canariensis, P. contorta, P. elliottii, P. halepensis, P. muricata, P. nigra P. patula, P. pinaster, P. pinea, P. ponderosa, P. radiata, P. roxburghii, P. strobus, P. sylvestris, P. taeda." |
| | Loope, L.L., Nagata, R.J. & Medeiros, A.C. 1992. Alien plants in Haleakala National Park Pp. 551-576 in Stone et al (eds) Alien plant invasions in native ecosystems of Hawaii. Coop. Nat. Park Resources Studies Unit, University of Hawaii, Honolulu, HI | "Pinus radiata from California, Pinus patula from Mexico, and Pinus pinaster from southern Europe are the only conifers (of many planted species in the Hosmer Grove area) to aggressively establish seedlings in native shrubland of the Park along the boundary adjacent to an experimental watershed improvement project on ranchland. On favorable sites these species can grow in height at a rate of about 12 in./yr (30 cm/year) and start to produce cones after six to eight years." |
| | Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK | "Pinus radiata" ... "It establishes well in burned areas and forms dense stands that may cover large areas. The native vegetation is eliminated and transformed into species-poor woodland. A thick litter layer accumulates beneath stands of this tree, preventing establishment of native plants" |
| | Medeiros, A.C., Loope, L.L. & Chimera, C.G. 1998. Flowering Plants and Gymnosperms of Haleakala National Park. Technical Report 120. Pacific Cooperative Studies Unit, Honolulu, HI | "The most serious weeds of the subalpine zone appear to be Cortaderia jubata (Andean pampas grass), Eucalyptus globulus (blue gum), Pinus radiata (Monterey pine), Pinus pinaster (maritime pine), Pinus patula (Mexican weeping pine), and Ulex europaeus (gorse);" |
| | Richardson, D. M., & Rejmánek, M. 2004. Conifers as invasive aliens: a global survey and predictive framework. Diversity and Distributions, 10(5-6): 321-331 | "We summarize information on naturalized and invasive conifers (class Pinopsida) worldwide (data from 40 countries, some with remote states/territories), and contrast these findings with patterns for other gymnosperms (classes Cycadopsida, Gnetopsida and Ginkgoopsida) and for woody angiosperms." ... "Twenty-eight of the known invasive conifers belong to one family (Pinaceae) and 21 of these are in one genus (Pinus)." |

| Qsn # | Question | Answer |
|---|---|---|
| | CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc | [Pinus caribaea] "The main impacts of invasive pines result from the increased abundance of trees in habitats where they were previously absent or less common (Richardson, 1998). ... P. caribaea has escaped from plantations and grows forming dense stands excluding native vegetation and altering hydrology, nutrient cycling, and fire regimes. This species also has the potential to displace native species due to the production of large amounts of litter that results in the acidification ofsoils on areas beneath pine trees (Richardson, 1998, 1998b; Simberloff et al., 2010)." |

| 401 | Produces spines, thorns or burrs | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Flora of North America Editorial Committee. 1993. Flora of North America: Volume 2: Pteridophytes and Gymnosperms. Oxford University Press, Oxford, UK | [No evidence] "Trees to 61m; trunk to 2.5m diam., usually straight; crown conic to rounded. Bark yellow-brown to cinnamon, deeply furrowed and cross-checked, forming large irregular scaly plates. Branches spreading-ascending; twigs stout (to 2cm thick), purple-brown, often glaucous, aging rough. Buds ovoid, tan to pale red-brown, 2--3cm, not resinous; scale margins conspicuously fringed. Leaves 3 per fascicle, spreading-ascending, persisting (2--)4--6(--7) years, 12--22(--25)cm ´ ca. 1.5--2mm, slightly twisted, gray- to yellow-green, all surfaces with fine stomatal lines, margins finely serrulate, apex acute to acuminate; sheath (1--)1.5--2.5(--3)cm, base persistent. Pollen cones lance-cylindric, 20--35mm, yellow to yellow- or purple-brown or yellow." |

| 402 | Allelopathic | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Gucker, C. L. (2007). Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html. [Accessed 23 Oct 2018] | [Unknown. Allelopathy effects on P. jeffreyi are mentioned, but no reports of the allelopathic properties of P. jeffreyi on other plants are documented] "Interference/allelopathy: Jeffrey pine seedling survival and growth were greater on montane chaparral than woolly mule-ears dominated sites on the east slope of Boca Hill near Truckee, California. One-year-old seedlings grown from locally collected seed were planted in the spring of 1978 and evaluated 5 and 8 years later. Survival was significantly greater 5 and 8 years later (P<0.005 and P<0.02, respectively) in montane chaparral than in woolly mule-ears vegetation. Seedling height was also significantly greater 5 and 8 years later (P<0.005 and P<0.001, respectively) in montane chaparral than in woolly mule-ears vegetation [126]." |

| 403 | Parasitic | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Flora of North America Editorial Committee. 1993. Flora of North America: Volume 2: Pteridophytes and Gymnosperms. Oxford University Press, Oxford, UK | "Trees to 61m; trunk to 2.5m diam., usually straight; crown conic to rounded." [Pinaceae. No evidence] |

| 404 | Unpalatable to grazing animals | n |
|---|---|---|

| Qsn # | Question | Answer |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Burns, R.M. & Honkala, B.H. 1990. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC | "Deer, jack rabbits and snowshoe hares, pocket gophers, porcupines, and domestic livestock damage and kill young Jeffrey pine. Resident, mobile populations of these mammals make substantial losses likely in most areas. Pocket gophers consume whole seedlings, feed on the roots, stem, and crown of saplings, and often annihilate young plantations (11). Porcupines commonly eat the inner bark and cambium of saplings and poles and either kill them outright or cause a spiketop above the girdled stem." |
| | CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK | "Mammalian herbivores are a significant cause of damage and mortality in seedlings and saplings of P. jeffreyi. These include deer, rabbits, snowshoe hares, pocket gophers, porcupines and domestic livestock." |

| 405 | Toxic to animals | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK | "Mammalian herbivores are a significant cause of damage and mortality in seedlings and saplings of P. jeffreyi. These include deer, rabbits, snowshoe hares, pocket gophers, porcupines and domestic livestock." [No evidence of toxicity] |
| | Burrows, G. E., & Tyrl, R. J. (2013). Toxic Plants of North America. Second Edition. Wiley-Blackwell, Hoboken, NJ | [Suspected to possibly have toxic effects on cattle that ingest the plant. No direct evidence documented] "In addition to P. ponderosa, P. contorta, P. jeffreyi, P. koraiensis, and P. radiata are also considere to be reproductive risks for cattle. Pinus radiata is suspected as a cause of disease in New Zealand, where it has been cultivated (Knowles and Dewes 1980). Needles are readily eaten and are reported by producers to cause effects in the last 2 months of gestation. Dead newborn calves, small weak calves, and some ill cows have been observed. Likewise, P. koraiensis has been shown to cause mid - to late-term abortions in Korea (Kim et al. 2003). This latter species may be encountered as an ornamental in North America. Although field reports of reproductive effects caused by P. contorta are limited (Panter et al. 2002), its toxicity potential is clearly shown by the abortions produced in 2 cows after administration of 4.5 –5.5 kg/day of needles for 8 –10 days (Gardner et al. 1998a)." … "Appreciable concentrations of isocupressic acid have also been shown for P. contorta and P. jeffreyi (Gardner et al. 1997, 1998b ), and it would not be surprising to find other pine species, including P. radiata, with toxicity potential, because resin acids are not unique to these species of pine." |

| 406 | Host for recognized pests and pathogens | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | | "P. jeffreyi is subject to a large number of serious pests and pathogens that impact growth rates and survivorship. Infections by western dwarf mistletoe (Arceuthobium campylopodum) are a serious problem throughout the range of P. jeffreyi. Heavy infections of this parasite cause severe witches' brooms and severely reduce tree growth, eventually leading to death. Infected older trees pass on the infection to understorey saplings. Dwarf mistletoe also |

| | | |
|---|---|---|
| | CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK | predisposes many stands to bark beetle attack. Byler (1978) has suggested that 60-80% of all P. jeffreyi mortality in drought years is induced by dwarf mistletoe. The most damaging insect pest on P. jeffreyi is the Jeffrey pine beetle, (Dendroctonus jeffreyi). This bark beetle causes severe damage throughout the range of the species and may cause huge tree mortality under epidemic conditions. The susceptibility to attack from the Jeffrey pine beetle is increased significantly by any conditions that reduce tree vigour. Such conditions include Annosus root disease, mistletoe (Arceuthobium campylopodum), and Elytroderma disease, as well as drought stress, fire damage and overstocking. Other species of bark beetle whose attacks precede or accompany the Jeffrey pine beetle include the California flat-headed borer (Melanophila californica), the red turpentine beetle (Dendroctonus valens), and two pine engravers, the emarginate ips (Ips emarginatus) and the Oregon pine engraver (Ips pini). The maintenance of stand health and vigour is the most effective control from Jeffrey pine beetle damage (Furniss and Carolin, 1977). Other insect pests impacting P. jeffreyi include twig and needle scales, various defoliators, borers and tip moths, as well as a diversity of cone and seed feeders. The most destructive of the scale insects is the ponderosa pine twig scale (Matsucoccus bisetosus) which feeds on branches and trees of all ages. Two serious defoliators are common. Larvae of the pine needle sheathminer (Zelleria haimbachi) may destroy more than 75% of new needle production in local outbreak areas. Larvae of the pandora moth (Coloradia pandora) cause heavy defoliation in outbreaks lasting 2-4 years that occur with a frequency of 20-30 years. The western pineshoot borer (Eucosma sonomana) stunts needle growth, thereby retarding height growth of infected trees by as much as 30% annually. The ponderosa pine tip moth (Rhyacionia zozana) kills current shoots of saplings and young trees, chronically retarding growth. The fir coneworm (Dioryctria abietivorella) kills the terminal buds of saplings and poles, causing a forked main stem. Larvae of the pine reproduction weevil (Cylindrocopturus eatoni) may significantly increase mortality of saplings and young trees under conditions of water stress. Jeffrey pine seed worm (Laspeyresia injectiva) and ponderosa pine seed worm (Cydia piperana) are major seed predators in immature cones. Fungal pathogens are also a major problem for P. jeffreyi, with this species subject to two needle diseases, a limb canker, five different rust diseases, three major root diseases and various heart rots. Elytroderma disease caused by Elytroderma deformans. This needle cast disease, which causes premature death of one-year-old needles, has reached epidemic proportions in specific environmental sites, most notably lake basins and stream valleys with cold air drainage (Scharpf and Bega, 1981). Medusa needle blight (Davisomycella medusa) is a serious pest in local areas, particularly on poor sites in drought years, and may cause a significant decline in tree growth. Rust disease may also have serious outbreaks in stands of P. jeffreyi. These include stalactiform rust (Peridermium stalactiforme) which infects lower limbs and eventually crowns of young trees, filamentose rust (Peridermium filamentosum) in the crowns of mature trees, sweetfern rust (Cronartium comptoniae) which may kill young trees, tarweed rust (Coleosporium madiae) causing heavy defoliation in wet years, and western gall rust (Endocronartium harknessii) forming large galls and trunk cankers leading to mortality on both young and mature trees. Although major outbreaks of this last species may be decades apart, this rust is ubiquitous through the range of P. jeffreyi (Bega, 1978). |

| | | |
|---|---|---|
| | | Fungal root diseases of P. jeffreyi include annosus (Heterobasidion annosum), armillaria (Armillaria ostoyae), and black stain (Leptographium wageneri). Heart rot fungi infecting P. jeffreyi include species of Lentinus, Fomes and Polyporus. Red rot (Dichomitus squalens) attacks P. jeffreyi in southern California. " |

| 407 | Causes allergies or is otherwise toxic to humans | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | SelecTree. "Pinus jeffreyi Tree Record." 1995-2018. https://selectree.calpoly.edu/tree-detail/pinus-jeffreyi. [Accessed 23 Oct 2018] | "Allergy Health Hazard." [Pollen may be allergenic to susceptible individuals] |

| 408 | Creates a fire hazard in natural ecosystems | y |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Gucker, C. L. (2007). Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html. [Accessed 23 Oct 2018] | "Fire regimes: Jeffrey pine occurs in many habitats and with a variety of other species throughout its range. While low-severity surface fires are common in open-canopy forests with limited understory fuels, increased forest densities and an increased presence of ladder fuels in the understory fuel higher-severity fires. On a landscape scale, a mixed-severity fire regime occurs in Jeffery pine habitats." … "Fire severity: Low-severity fires are described in most qualitative Jeffrey pine fire literature, but Jeffrey pine forests have experienced fire severities ranging from low-severity surface fires to severe, stand-replacing surface and crown fires. In the northern Sierra Nevada, stand-replacing fires occurred even before the practice of fire exclusion, but crown fires were less common than moderate- and low-severity fires [144]. The 2002 Biscuit Fire in southwestern Oregon burned 14.4% of Jeffrey pine forests in the area: 5.3% burned severely, 7.6% burned at moderate severity, and 1.5% burnec with low severity. Low-severity fires lightly scorched the vegetation, killed only a few large trees that were present on the burned site, and consumed very small diameter fuels. Moderate-severity fires killed 40% to 80% of trees, consumed most litter and fine ground fuels. High-severity fires killed nearly 100% of trees [6]." |

| 409 | Is a shade tolerant plant at some stage of its life cycle | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Gucker, C. L. (2007). Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html. [Accessed 23 Oct 2018] | "Jeffrey pine is shade intolerant [7,63] and typically replaced by shade-tolerant conifers in the absence of canopy-opening disturbances [106,172]. On exceptionally harsh sites, Jeffrey pine may be a climax species [2,129]." |
| | Burns, R.M. & Honkala, B.H. 1990. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC | [Intolerant of shade] "Jeffrey pine occasionally regenerates beneath open, overmature stands, but growth is checked until the overstory is removed. The species is intolerant of shade, and root competition from old-growth trees is intense. In such circumstances, saplings 40 or more years old and less than 1 m (3 ft) tall are common. After release, suppressed saplings take 3 to 7 years to extend root systems, produce efficient crowns, and begin rapid height growth (24)." |

| Qsn # | Question | Answer |
|---|---|---|
| **410** | **Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)** | **n** |
| | **Source(s)** | **Notes** |
| | Burns, R.M. & Honkala, B.H. 1990. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC | "Perhaps one-fifth of the distribution of Jeffrey pine is on ultramafic soils. At middle elevations on the western slope of the northern Sierra Nevada and in the North Coast Range and Klamath Mountains, Jeffrey pine often dominates and is almost entirely restricted to soils derived from ultramafic rocksperidotites and their alteration products, serpentinites. The typical forest soils formed on such rocks are fine, fine loamy, and clayey texture skeletal surface soils. On these highly infertile, mostly shallow soils, Jeffrey pine descends to low elevations: 490 m (1,600 ft) in Butte County, 260 m (850 ft) in Humboldt County, 60 m (200 ft) in Del Norte County, CA, and 183 m (600 ft) in Douglas County, OR. The only native Jeffrey pine in California's South Coast Range grows on an isolated mass of sterile serpentine in San Benito County (19). Jeffrey pine's innately short growing season, limited nutrient and water demands, and extensive root growth probably ensure its presence on poor sites." |
| | Gucker, C. L. (2007). Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html. [Accessed 23 Oct 2018] | "Soils: Jeffrey pine typically grows on shallow, rocky, infertile soils [63] and survives on dry pumice and bare granite substrates [81]. About 20% of Jeffrey pine's distribution occurs on ultramafic soils; the rest occurs on volcanic and granitic parent materials [64]. In southwestern Oregon and northwestern California, Jeffrey pine is most typical of ultramafic soils, including serpentine [2,5,22]. Kruckeberg [76] considers Jeffrey pine a "faithful" indicator of serpentine soils at low to moderate elevations in northwestern California and southwestern Oregon. Kruckeberg also suggests that the main Jeffrey pine range is on nonserpentine soils, but that outlier populations are often restricted to serpentine soils [76]." |
| | CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK | Soil descriptors<br>- Soil texture: light; medium; heavy<br>- Soil drainage: free<br>- Soil reaction: neutral<br>- Special soil tolerances: shallow; infertile<br>- Soil types: granite soils; mountain soils; sandstone soils; serpentine soils; volcanic soils |

| 411 | Climbing or smothering growth habit | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Flora of North America Editorial Committee. 1993. Flora of North America: Volume 2: Pteridophytes and Gymnosperms. Oxford University Press, Oxford, UK | "Trees to 61m; trunk to 2.5m diam., usually straight; crown conic to rounded." |

| Qsn # | Question | Answer |
|---|---|---|
| **412** | **Forms dense thickets** | **y** |
| | **Source(s)** | **Notes** |
| | CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK | "P. jeffreyi provides important forest cover for montane habitats throughout its range, where it may occur either in relatively pure stands or in mixed conifer associations." |

| | | |
|---|---|---|
| **501** | **Aquatic** | **n** |
| | **Source(s)** | **Notes** |
| | Flora of North America Editorial Committee. 1993. Flora of North America: Volume 2: Pteridophytes and Gymnosperms. Oxford University Press, Oxford, UK | [Terrestrial tree] "High, dry montane forests mostly above the Pinus ponderosa zone; 2000--2500m; Calif., Nev., Oreg.; Mexico in Baja California." |

| | | |
|---|---|---|
| **502** | **Grass** | **n** |
| | **Source(s)** | **Notes** |
| | USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 23 Oct 2018] | Family: Pinaceae |

| | | |
|---|---|---|
| **503** | **Nitrogen fixing woody plant** | **n** |
| | **Source(s)** | **Notes** |
| | USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 23 Oct 2018] | Family: Pinaceae |

| | | |
|---|---|---|
| **504** | **Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)** | **n** |
| | **Source(s)** | **Notes** |
| | Flora of North America Editorial Committee. 1993. Flora of North America: Volume 2: Pteridophytes and Gymnosperms. Oxford University Press, Oxford, UK | "Trees to 61m; trunk to 2.5m diam., usually straight; crown conic to rounded." |

| Qsn # | Question | Answer |
|---|---|---|
| **601** | **Evidence of substantial reproductive failure in native habitat** | **n** |
| | **Source(s)** | **Notes** |
| | Gucker, C. L. (2007). Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html. [Accessed 23 Oct 2018] | [No evidence] "Jeffrey pine occupies sites throughout much of California and in southwestern Oregon, western Nevada, and northern Baja California [24]. In Nevada, Jeffrey pine is restricted to Washoe and Mineral counties. In Oregon, Jeffrey pine occurs in Curry, Josephine, Jackson, and Douglas counties [5]. The Laguna Mountains of San Diego County are the southern limit of Jeffrey pine in the United States [130], but Jeffrey pine is common further south in the Sierra Juárez and the Sierra San Pedro of Baja California Norte [211]. The US Geological Survey provides a distributional map of Jeffrey pine." |

| 602 | Produces viable seed | y |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Gucker, C. L. (2007). Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html. [Accessed 23 Oct 2018] | "Jeffrey pine reproduces sexually through seed production and germination. Trees do not sprout after the loss of aboveground stems." … "Germination: Jeffrey pine seed germinates readily in the spring [64], and while stratification may not be necessary [77,168] it can decrease the time required for successful germination [168]. The best germination is said to occur in mineral soils in full sun conditions [103]. Seed burial and cache site selection by small mammals and Clark's nutcracker can improve the emergence success of Jeffrey pine seed." |
| | CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK | "P. jeffreyi typically begins to bear seeds when it reaches a height of 18-55 m, and produces a large seed crop at intervals of 2-8 years. Seeds germinate quickly in the spring after seedfall, but seedlings are shade intolerant and thus subject to intense competition from a variety of understorey species. Variable degrees of dormancy are present depending on the provenance of the seed source. Some seed populations from east of the Sierra Nevada-Cascade crest apparently do not require stratification, but most sources germinate best after 60 days of cold, moist stratification (Krugman and Jenkinson, 1974). Although seeds are adapted for wind dispersal, a secondary dispersal by vertebrates caching seeds is also significant (vander-Wall, 1992, 1993)." |

| 603 | Hybridizes naturally | y |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Gucker, C. L. (2007). Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html. [Accessed 23 Oct 2018] | "Jeffrey pine hybridizes with ponderosa pine (P. ponderosa) and Coulter pine (P. coulteri) where distributions overlap [43,48,112,214]." … "Hybrids: Jeffrey pine hybrids are not especially common. They are described in Haller [48] and Zobel [214]." |

| Qsn # | Question | Answer |
|---|---|---|
| | Zobel, B. (1951). The Natural Hybrid Between Coulter and Jeffrey Pines. Evolution, 5(4), 405-413 | "The occurrence of natural hybridization between these two pines is uncommon. In no area do the hybrids or hybrid derivatives approach either parent in numbers; on the contrary, usually an extensive search of many trees was necessary to find a single hybrid. In some localities ~here the. two species grow together, there is no evidence of hybridization, while nearby areas show a considerable amount of it. However, it seems significant that some hybrids were found in all five geographic regions studies where the two species occur in association. Hybrids usually were found in areas where Coulter pines greatly outnumber Jeffrey pines." |

| 604 | Self-compatible or apomictic | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Gucker, C. L. (2007). Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html. [Accessed 23 Oct 2018] | "Breeding system: Jeffrey pines are monoecious. A study of endemic and near-endemic California conifers revealed that Jeffrey pine was the most genetically diverse [91]. Outcrossing rates were high in 3 Klamath Mountain and 2 Sierra Nevada populations. Density of Jeffrey pine did not affect outcrossing rates, and evidence of severe inbreeding depression was lacking [38]. Jeffrey pine populations from serpentine soils in the Klamath Mountains and ultramafic soils in the southern Sierra Nevada were genetically similar, suggesting that directional selection likely has occurred on these sites. Klamath Mountain populations had lower heterozygosity levels than those in the southern Sierra Nevada, suggesting stronger directional selection or a past population bottleneck in the Klamath Mountain populations [37]." |
| | Furnier, G., & Adams, W. (1986). Mating System in Natural Populations of Jeffrey Pine. American Journal of Botany, 73(7), 1002-1008 | [Some selfing expected to occur, but few offspring from self-pollination are believed to survive] "The genetic structure of adult Jeffrey pine populations did not reveal significant inbreeding effects. In fact, with the exception of Got1 in population S3, all significant deviations of observed genotype frequencies from those expected under mating-system equilibrium were due to excess heterozygotes. The heterozygote excess at many loci in population S2 is most likely attributable to selection that moved the population out of mating-system equilibrium. Most viable seed resulting from self-fertilization is probably lost due to inbreeding depression in seedlings (Franklin, 1970; Sorensen and Miles, 1974, 1982), leaving few selfs to survive to the adult stage and an adult population composed almost exclusively of outcrossed individuals." |

| 605 | Requires specialist pollinators | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Gucker, C. L. (2007). Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html. [Accessed 23 Oct 2018] | "Pollination: Cones are wind pollinated." |

| 606 | Reproduction by vegetative fragmentation | n |
|---|---|---|

| Qsn # | Question | Answer |
|---|---|---|
| | **Source(s)** | **Notes** |
| | CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK | "P. jeffreyi does not reproduce vegetatively by either sprouting or layering under natural conditions." |
| | Burns, R.M. & Honkala, B.H. 1990. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC | "Vegetative Reproduction- Jeffrey pine does not sprout." |

| 607 | Minimum generative time (years) | >3 |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Burns, R.M. & Honkala, B.H. 1990. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC | "Although trees as young as 8 years have borne a cone crop, typical cone-bearing Jeffrey pines are 18 to 55 m (60 to 180 ft) tall and produce a large seed crop every 2 to 8 years (30)." |

| 701 | Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas) | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Gucker, C. L. (2007). Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html. [Accessed ] | "Seed dispersal: Jeffrey pine seeds are often moved through a combination of methods including gravity, wind, and small animals. A single seed may be dispersed through all 3 methods and relocated up to 6 times by animals. Observed and calculated dispersal distances through gravity and wind alone range from 3.48 feet (1.06 m) [67] to 89 feet (27 m) [85]. Dispersal distances reported from seed caching studies range from 8.5 feet (2.6 m) [192] to 206 feet (62.9 m) [190]." [No means of external attachment] |

| 702 | Propagules dispersed intentionally by people | y |
|---|---|---|
| | **Source(s)** | **Notes** |
| | CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK | "P. jeffreyi has not shown good success as a plantation tree outside of its natural range, and thus introductions are limited. … It has also been introduced in trials in Europe, South Africa and Japan." |

| 703 | Propagules likely to disperse as a produce contaminant | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Gucker, C. L. (2007). Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html. [Accessed 23 Oct 2018] | "Seed dispersal: Jeffrey pine seeds are often moved through a combination of methods including gravity, wind, and small animals. A single seed may be dispersed through all 3 methods and relocated up to 6 times by animals." |

| 704 | Propagules adapted to wind dispersal | y |
|---|---|---|
| | **Source(s)** | **Notes** |

| Qsn # | Question | Answer |
|---|---|---|
| | Burns, R.M. & Honkala, B.H. 1990. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC | "When shed, the winged seeds drop about 2.2 m/s (7.2 ft/s) (49), indicating that winds of 8 km/h (5 mi/h) carry them no further than the height of seedfall. Seeds can be widely spread, however. Fall storms are common in California's mountains, and winds average 13 to 26 km/h (8 to 16 mi/h) in September and October. Gusts occasionally exceed 64 to 113 km/h (40 to 70 mi/h), enough to blow seeds up to 15 times the height of seedfall, even 750 m (2,460 ft) from a tree height of 50 m (164 ft)." |

| 705 | Propagules water dispersed | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Gucker, C. L. (2007). Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html. [Accessed 23 Oct 2018] | "Seed dispersal: Jeffrey pine seeds are often moved through a combination of methods including gravity, wind, and small animals. A single seed may be dispersed through all 3 methods and relocated up to 6 times by animals." |

| 706 | Propagules bird dispersed | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Burns, R.M. & Honkala, B.H. 1990. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC | [In native range, certain bird seed predators may also disperse seeds. In the Hawaiian Islands, such secondary dispersal may be limited or absent] "Besides wind, certain seed eaters also disseminate seeds. In the Sierra Nevada, Clark's nutcracker harvests and stores substantial quantities of ripe Jeffrey pine seeds, burying them in many small clusters in a wide variety of microsites, and often where snow accumulates least and melts rapidly in spring (54). At least eight other common birds also extract and eat seeds of Jeffrey pine." |

| 707 | Propagules dispersed by other animals (externally) | y |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Burns, R.M. & Honkala, B.H. 1990. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC | [In native range, seed predators may cache and disperse some seeds which escape predation. Introduced rodents may serve a similar role in the Hawaiian Islands] "Several kinds of squirrels cut and store large quantities of Jeffrey cones for their seeds, including the widespread golden-mantled ground squirrel and western gray squirrel. The chickaree cuts whole cones and buries them in the ground, and chipmunks harvest seeds by gnawing cones in the tree. Mice and voles efficiently gather, cache, and consume large quantities of shed seed." |

| 708 | Propagules survive passage through the gut | n |
|---|---|---|
| | **Source(s)** | **Notes** |

| Qsn # | Question | Answer |
|---|---|---|
| | Gucker, C. L. (2007). Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html. [Accessed 23 Oct 2018] | [Seed predators carry seeds externally & cache seeds that may escape predation. No evidence that whole seeds are ingested or survive gut passage] "Seed dispersal: Jeffrey pine seeds are often moved through a combination of methods including gravity, wind, and small animals. A single seed may be dispersed through all 3 methods and relocated up to 6 times by animals." ... "Animal: Yellow-pine chipmunks rapidly dispersed and cached Jeffrey pine seeds from Jeffrey pine/antelope bitterbrush vegetation in western Nevada. From a bait station seed source, 0.5% of radioactively-labeled seeds were eaten and 98.1% were cached. The average number of seeds in cheek pouches ranged from 18.5 to 29.9 based on 4 yellow-pine chipmunks. There were 36 to 91 caches made with 3 to 9.9 seeds. Caches were separated by distances of 4.6 to 16 feet (1.4-4.9 m). Transport distance ranged from 8.5 to 195 feet (2.6-59.3 m) and averaged 82 feet (25 m). Yellow-pine chipmunks typically cached seeds more than 16 to 33 feet (5-10 m) from the source and only "sparingly" cached in areas with thick pine needle litter [192]. In the same study area using similar methods, Vander Wall [195] found that seeds were moved farther in a mast (x=87.9 feet (26.8 m)) than in a nonmast (x=68.2 feet (20.8 m)) year. Often seeds were moved from primary caches to secondary or up to sixth-order caches. Recaching was 3 times more common in a nonmast than in a mast year. In a mast year, the highest order cache was 3, and in a nonmast year was 6 [195]." |

| 801 | Prolific seed production (>1000/m2) | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Gucker, C. L. (2007). Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html. [Accessed 24 Oct 2018] | [Potentially yes during mast years] "Seed production: Jeffrey pine has a "strong masting habit". Numerous seeds are shed within a few weeks every several years. Large cone crops occur at 2- to 4-year intervals [77,84]. Trees as young as 8 years old have produced cones, according to Krugman [77], but Rundel [142] reports that Jeffrey pine cones are not common until trees are at least 20 years old. In open Jeffrey pine/antelope bitterbrush forests in western Nevada's Whittell Forest and Wildlife Management Area, cone crop production ranged from 175 to less than 25 cones/tree over a 3-year period [195]. From cones produced on the eastern slopes of the Sierra Nevada in Mono and Madera counties, the number of fertile seeds/cone before seed dispersal averaged 222 and ranged from 160 to 338. From fallen cones collected at the end of April, the number of seeds/cone averaged 11 and ranged from 0 to 55. Of the available seeds, 14.8% were sound, 15.9% were aborted, and 69.2% had insect damage [180]." |

| 802 | Evidence that a persistent propagule bank is formed (>1 yr) | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Royal Botanic Gardens Kew. (2018) Seed Information Database (SID). Version 7.1. Available from: http://data.kew.org/sid/. [Accessed 24 Oct 2018] | "Storage Behaviour: Orthodox<br>Storage Conditions: 62% germination following 18 years hermetic storage at 5°C with 10% mc (Harrington, 1972)" |

| Qsn # | Question | Answer |
|---|---|---|
| | Vander Wall, S. B., & Joyner, J. W. (1998). Recaching of Jeffrey pine (Pinus jeffreyi) seeds by yellow pine chipmunks (Tamias amoenus): potential effects on plant reproductive success. Canadian Journal of Zoology, 76(1), 154-162 | [Rarely persist for >1 year] "Jeffrey pine cones ripen and shed seeds in September. These wind-dispersed seeds are available to foragers either on the ground surface or in surface caches for 23 months until winter snow accumulates. In the spring, the surviving seeds break dormancy and produce a seedling. Long-term dormancy (>1 year) is rare." |

| 803 | Well controlled by herbicides | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Williams, M. C., & Wardle, G. M. (2007). Pinus radiata invasion in Australia: identifying key knowledge gaps and research directions. Austral Ecology, 32(7), 721-739 | [Unknown. Other Pinus species are effectively controlled] "A range of chemicals are also capable of controlling young P. radiata individuals (Minko 1985). Spraying of low concentrations of amitrole plus ammonium thiocyanate, dicamba, fosamine ammonium, glysophosate or paraquet result in the death of pines. In New Zealand, metsulphuron (100-120 g ha-1) is mixed with a surfactant and either glyphosate (5 kg ha-1) or paraquet (5.6 L ha-1) to spray and kill wildings less than 3 m tall (Ledgard 2004). Chemical treatment involves injecting wildlings with herbicide and may be preferred to mechanical removal as it requires less physical effort. Sodium chlorate is used to kill stumps of wildling pines when it is not possible to remove all live foliage (Ledgard 2004). In Australia, treatments involving mechanical cutting combined with herbicide application have enjoyed 100% success rates (N.Westman & C. Banffy, pers. comm. 2005)." |

| 804 | Tolerates, or benefits from, mutilation, cultivation, or fire | y |
|---|---|---|
| | **Source(s)** | **Notes** |
| | CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK | - Tolerates fire<br>- Ability to regenerate rapidly |
| | Fonda, R. W. (2001). Burning characteristics of needles from eight pine species. Forest Science, 47(3), 390-396 | "Ponderosa pine (Pinus ponderosa), Jeffrey pine (P. jeffreyi), longleaf pine (P. palustris), and south Florida slash pine (P. elliottii var. densa) are fire resisters. Trees of these species are able to survive the direct effects of wildfires." … "Jeffrey pine is common in the eastern Sierra Nevada and mountains in Nevada. Fire return intervals in Jeffrey pine forests may be shorter than in ponderosa pine forests (Vogl 1967), and as a resister Jeffrey pine clearly is favored (Sweeney 1967, Vogl 1967). As with ponderosa pine, Jeffrey pine forests are fire-stable, and frequent surface burns are supported by the nonwoody fuels. Fires in Jeffrey pine forests should have shorter flames and longer burning fuels than in ponderosa pine forests (Table 2)." |

| Qsn # | Question | Answer |
|---|---|---|
| | Gucker, C. L. (2007). Pinus jeffreyi. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. https://www.fs.fed.us/database/feis/plants/tree/pinjef/all.html. [Accessed 23 Oct 2018] | "Vegetative regeneration: Jeffrey pine does not sprout from adventitious buds or spread through vegetative means. However, regrowth of needles from surviving terminal buds can occur following crown scorch [121]." … "Fire adaptations: Jeffrey pine resists fire kill through a variety of structural and physiological adaptations. Rapid taproot growth and early development of insulating bark offer protection to Jeffrey pine seedlings and young trees [61]. Jeffrey pine is considered moderately fire resistant as a sapling (2-4 inch (5-10 cm) DBH) and highly resistant as an adult [99]. Thick bark, protected terminal buds, self-pruning branches, open crowns, and high moisture content of needles minimize Jeffrey pine fire damage [61]. There is some speculation that deep bark fissures may be a fire adaptation [197]. Jeffrey pine's ability to shed burning bark scales as a means to reduce fire damage has received mention in the literature [81], and firefighters have reported observing fires extinguished by shedding bark scales [197]. Bark shedding processes have not been tested experimentally [81]. " |

| 805 | **Effective natural enemies present locally (e.g. introduced biocontrol agents)** | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | WRA Specialist. 2018. Personal Communication | Unknown |

**Summary of Risk Traits:**

High Risk / Undesirable Traits
• Elevation range exceeds 2000 m, demonstrating environmental versatility
• Naturalizing on West Maui and Haleakala National Park, Maui (Hawaiian Islands) and reported to be naturalized in Spain
• Other Pinus species are invasive
• Potentially toxic to cattle
• Pollen may be allergenic
• Increases fire risk in natural ecosystems
• Forms relatively pure stands in native range
• Reproduces by seeds
• Hybridizes with ponderosa pine (P. ponderosa) and Coulter pine (P. coulteri)
• Seeds dispersed by wind, seed caching animals and intentionally by people
• Potential for prolific seed production during mast years (every 2 to 4 years)
• Tolerates fire

Low Risk Traits
• No reports of invasiveness or negative impacts where introduced
• Unarmed (no spines, thorns, or burrs)
• Palatable to browsing and grazing animals
• Shade-intolerant
• Not reported to spread vegetatively
• Long time to reproductive maturity (>8 years)

Second Screening Results for Tree/tree-like shrubs

(A) Shade tolerant or known to form dense stands?> Yes. Shade-intolerant, but can form pure stands in native range
(B) Bird or clearly wind-dispersed?> Yes. Wind-dispersed.
(C) Life cycle <4 years? No. Reaches maturity in 8+ years.
Outcome = Evaluate