Taxon: Cunninghamia lanceolata (Lamb.) Hook. **Family:** Cupressaceae

Common Name(s): China fir
Chinese fir

Synonym(s): Abies lanceolata (Lamb.) Poir.
Belis lanceolata (Lamb.) Hoffmanns.
Cunninghamia unicanaliculata
Larix chinensis Mill.
Pinus abies Lour.
Pinus lanceolata Lamb.

Assessor: Chuck Chimera **Status:** Assessor Approved **End Date:** 11 Jan 2019

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

Keywords: Subtropical Tree, Spiny Foliage, Self-Fertile, Wind-Dispersed, Coppices

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)	High
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	y
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		
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)	n
401	Produces spines, thorns or burrs	y=1, n=0	y
402	Allelopathic		
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals	y=1, n=-1	n
405	Toxic to animals	y=1, n=0	n
406	Host for recognized pests and pathogens	y=1, n=0	n

Qsn #	Question	Answer Option	Answer
407	Causes allergies or is otherwise toxic to humans	y=1, n=0	n
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		
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		
604	Self-compatible or apomictic	y=1, n=-1	y
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	y
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	y=1, n=-1	n
707	Propagules dispersed by other animals (externally)	y=1, n=-1	n
708	Propagules survive passage through the gut	y=1, n=-1	n
801	Prolific seed production (>1000/m2)	y=1, n=-1	n
802	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1	n
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**
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	[Cultivated for a long time, but no evidence of domestication] "C. lanceolata has been cultivated for more than 8000 years in China (Guangzhou Cultural Relics Management Department, 1977; Hunan Cultural Relics and Archeology Institute, 1990a, 1990b; Jiangxi Historical Museum, 1980; Jiangxi Cultural Relics Management Commission, 1962; Jiangxi Wood Science Research Institute, 1973). Samset (1976) mentions archaeological evidence for the existence of large C. lanceolate trees in Hunan some 2000 years ago."

102	**Has the species become naturalized where grown?**	
	Source(s)	**Notes**
	WRA Specialist. (2019). Personal Communication	NA

103	**Does the species have weedy races?**	
	Source(s)	**Notes**
	WRA Specialist. (2019). 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"**	**High**
	Source(s)	**Notes**
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	"C. lanceolata is widely distributed in the Chinese subtropics. The limits of its natural distribution are marked in the north by the southern part of the Qinling Range, Tongbai Shan Range, Dabie Shan Range and the Ning-Zhen Range; in the east by Taiwan, Fujian and Zhejiang; in the south by Hainan Island, Guangdong and Guangxi; and in the west by southwest Yunnan, the Anning River, and the middle and lower reaches of the Dadu River. It occurs at altitudes from sea level up to 700 m in the eastern part of the distribution, up to 1800 m in the western part of the distribution, and up to 2600 m on Mount Cangshan in Dali, Yunnan."
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 8 Jan 2019]	"Native Asia-Temperate CHINA: China [Anhui, Fujian, Gansu, Guangdong, Guangxi, Guizhou, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Shaanxi, Sichuan, Yunnan, Zhejiang] EASTERN ASIA: Taiwan Asia-Tropical INDO-CHINA: Cambodia (possibly), Laos, Vietnam (n.)"

202	**Quality of climate match data**	**High**

Qsn #	Question	Answer
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed]	

203	**Broad climate suitability (environmental versatility)**	**y**
	Source(s)	**Notes**
	Wu, Z. Y. & Raven, P. H. (eds.) 1999. Flora of China. Vol. 4 (Cycadaceae through Fagaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Mixed broad-leaved forests or forming small, pure stands, rocky hillsides, roadsides; 200–2800 m."
	Gilman, E.F. & Watson, D.G. (1993). Cunninghamia lanceolate: China-Fir. Fact Sheet ST-220. Institute of Food and Agricultural Sciences, University of Florida, Gainesville FL. http://hort.ufl.edu. [Accessed 10 Jan 2019]	"USDA hardiness zones: 6B through 9A"
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	[Elevation range exceeds 1000 m, demonstrating environmental versatility] "It occurs at altitudes from sea level up to 700 m in the eastern part of the distribution, up to 1800 m in the western part of the distribution, and up to 2600 m on Mount Cangshan in Dali, Yunnan."

204	**Native or naturalized in regions with tropical or subtropical climates**	**y**
	Source(s)	**Notes**
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	"C. lanceolata is widely distributed in the Chinese subtropics. The limits of its natural distribution are marked in the north by the southern part of the Qinling Range, Tongbai Shan Range, Dabie Shan Range and the Ning-Zhen Range; in the east by Taiwan, Fujian and Zhejiang; in the south by Hainan Island, Guangdong and Guangxi; and in the west by southwest Yunnan, the Anning River, and the middle and lower reaches of the Dadu River." … "The typical climate in the natural range of C. lanceolata is subtropical moist, or warm moist. The mean annual temperature for the whole distribution ranges from 12.6 to 22.9°C, and from 16 to 19°C for most of the distribution."
	Wu, Z. Y. & Raven, P. H. (eds.) 1999. Flora of China. Vol. 4 (Cycadaceae through Fagaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Mixed broad-leaved forests or forming small, pure stands, rocky hillsides, roadsides; 200–2800 m. Exact native distribution uncertain owing to widespread planting: Anhui, Fujian, Gansu, Guangdong, Guangxi, Guizhou, Hainan, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Shaanxi, Sichuan, C and N Taiwan, Yunnan, Zhejiang [?Cambodia, Laos, N Vietnam]."

205	**Does the species have a history of repeated introductions outside its natural range?**	**y**
	Source(s)	**Notes**

Qsn #	Question	Answer
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	"C. lanceolata has been introduced to many countries since the 18th century and currently there is interest in introducing C. lanceolata elsewhere. Experimental plantations have been established in a number of countries, including: Japan (where the species was introduced very early), Malaysia (promising), South Africa (promising), Argentina, Brazil (Santa Catarina and Sao Paulo; some small-scale commercial plantings - see Golfari, 1970; Golfari et al., 1978) and New Zealand. C. lanceolata has also been planted as an ornamental in the UK, France, Netherlands, Germany and the USA (North Carolina and Washington). It suffers from frost damage in the UK (Dallimore et al., 1966; Honda, 1974; Krussmann, 1985; den Ouden and Boom, 1965; Sakaguchi, 1970; Streets, 1962)."
	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	11,040 trees planted on Kauai (199 between 1931-1933), Oahu (30 in 1956), Molokai (519 between 1941 to 1957), Maui (1234 between 1931 to 1955) and Hawaii (9058 between 1931 to 1939)

301	Naturalized beyond native range	y
	Source(s)	**Notes**
	Feng, Y., & van Kleunen, M. (2014). Responses to shading of naturalized and non-naturalized exotic woody species. Annals of Botany, 114(5), 981-989	"TABLE 1. Family, growth form, year of introduction, naturalization status and seed source (botanic garden) of the 38 study species" [Cunninghamia lanceolate NOT documented as naturalized in this study]
	Fung, L. E. (1993). Cunninghamia lanceolata (Chinese fir): a study of its potential as a commercial plantation species in New Zealand. PhD Dissertation. University of Canterbury, Christchurch, New Zealand	"The species has become naturalised on the Black Sea coast of Adzhania (Caucasia) but regeneration usually fails (Mandzavidze and Matinjan, 1964)."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	[Cited as naturalized] "References: United States of America-N- 101, New Zealand-UW-280, United States of America-E-151, New Zealand-N-823, New Zealand-U-919, India-N-976, Laos-N- 1102, United States of America-E-1736, New Zealand-U-2048, India-W-1977, Lao People's Democratic Republic-W-1977."
	Lance, R. 2004. Woody Plants of the Southeastern United States: A Winter Guide. University of Georgia Press, Athens, GA	[Rarely naturalizing] "An exotic conifer widely cultivated in the SE, rarely naturalizing. Included here since it is so often encountered as a remnant of cultivation and suspected of being naturalized."
	Howell, C. J., & Sawyer, J. W. (2006). New Zealand naturalised vascular plant checklist. New Zealand Plant Conservation Network, Wellington, NZ	Cunninghamia lanceolata - Casual [Casual is the name given to taxa that are: passively regenerating only in the immediate vicinity of the cultivated parent plant, or more widespread but only known as isolated or few individuals]
	Wagner, W.L., Herbst, D.R.& Lorence, D.H. (2019). Flora of the Hawaiian Islands. Smithsonian Institution, Washington, D.C. http://botany.si.edu/. [Accessed 10 Jan 2019]	No evidence in Hawaiian Islands to date

302	Garden/amenity/disturbance weed	
	Source(s)	**Notes**

Qsn #	Question	Answer
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	[Cited as a weed in a few references. Evidence of negative impacts requires verification] "References: United States of America-N- 101, New Zealand-UW-280, United States of America-E-151, New Zealand-N-823, New Zealand-U-919, India-N-976, Laos-N- 1102, United States of America-E-1736, New Zealand-U-2048, India-W-1977, Lao People's Democratic Republic-W-1977."

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**
	Swearingen, J., C. Bargeron. 2016. Invasive Plant Atlas of the United States. University of Georgia Center for Invasive Species and Ecosystem Health. http://www.invasiveplantatlas.org/. [Accessed 10 Jan 2019]	Included in list of invasive species, but no negative impacts are specified. Needs verification
	Global Register of Introduced and Invasive Species. 2019. Cunninghamia lanceolata. http://griis.org/. [Accessed 10 Jan 2019]	Reported from India and Lao People's Democratic Republic. No evidence of impacts

305	Congeneric weed	n
	Source(s)	**Notes**
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence

401	Produces spines, thorns or burrs	y
	Source(s)	**Notes**
	Dave's Garden. (2019). Cunninghamia, China-fir, China Fir - Cunninghamia lanceolata. https://davesgarden.com/guides/pf/go/56683/. [Accessed 11 Jan 2019]	"Danger: Plant has spines or sharp edges; use extreme caution when handling"
	Wu, Z. Y. & Raven, P. H. (eds.) 1999. Flora of China. Vol. 4 (Cycadaceae through Fagaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	[Leaf apex with spines] "Leaves glossy deep green adaxially, narrowly linear-lanceolate, straight or slightly falcate, 0.8–6.5(–7) cm × 1.5–5 mm, midvein green abaxially, 0.3–1.2 mm wide, flat with median longitudinal keel throughout, stomatal bands present on both surfaces, bands on adaxial surface 0.5–1.5 mm wide, of 7–28 rows of stomatal, white powdery or not, bands on abaxial surface 1.2–2.8 mm apart, 0.3–0.8(–1) mm from leaf margin, not or rarely white powdery, base decurrent, margin denticulate, sometimes indistinctly so, especially on old trees, with 18–5 (–90) teeth per side, apex usually symmetric and spinescent, spine 0.3–2 mm."

402	Allelopathic	

Qsn #	Question	Answer
	Source(s)	**Notes**
	Zhang, Q. (1993). Potential role of allelopathy in the soil and the decomposing root of Chinese-fir replant woodland. Plant and Soil, 151(2), 205-210	"The role of allelopathy in the Chinese-fir (Cunninghamia lanceolata) replant problem was studied. The failure of Chinese-fir seedlings to grow normally in Chinese-fir replant woodland was not only caused by the depletion of nutrients and the deterioration of the structure of replant woodland soil, but also by biotic factors and allelopathy. Extracts of soils collected from replant woodlands significantly reduced the growth of Chinese-fir seedlings. Extracts and decomposing root residues also significantly inhibited the growth of Chinese-fir seedlings. Extracts of the replant soil and of the decomposing roots from Chinese-fir replant woodland were both toxic to other plants. The combination of the decomposing root residues and the pathogenic fungi reduced the growth of Chinese-fir seedlings the most when compared to the decomposing root residue alone and the control. It appears that allelopathy is at least partly involved in the Chinese-fir replant problem."
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	[Grown with other crops, suggesting allelopathy is not an issue] "C. lanceolata is widely used in agroforestry systems in China. In some montane areas it is frequently interplanted with crops or mixed with other tree species. C. lanceolata is commonly grown in agroforestry systems with the following crops: maize, beans, wheat, Chinese sorghum, buckwheat, potato, 'ground chestnut' (Arachis hypogaea), tobacco and upland rice, especially in Fujian, Hunan, Guizhou and Guangdong. It is also often interplanted with tree or shrub species such as the tung oil tree (Aleurites fordii), tea and Litsea cubeba. Agroforestry systems not only increase the income of farmers during early stages of plantations and decrease the costs of tending juvenile stands, but also maintain soil fertility."

Qsn #	Question	Answer
	Kong, C. H., Chen, L. C., Xu, X. H., Wang, P., & Wang, S. L. (2008). Allelochemicals and activities in a replanted Chinese fir (Cunninghamia lanceolata (Lamb.) Hook) tree ecosystem. Journal of Agricultural and Food Chemistry, 56 (24), 11734-11739	[May be allelopathic against other Chinese fir recruitment] "Autotoxicity is a major reason for replant problems in managed tree ecosystems. Studies have related phenolics-based allelochemicals to autotoxicity. We selected a 20-year-old replanted Chinese fir [Cunninghamia lancealata (Lamb.) Hook] tree ecosystem to isolate, identify, determine the biological activity of, and quantify soil phytotoxins. Eight common phenolics (coumarin, vanillin, isovanillin, and p-hydroxybenzoic, vanillic, benzoic, cinnamic, and ferulic acids), friedelin, and a novel cyclic dipeptide (6-hydroxy-1,3-dimethyl-8-nonadecyl-[1,4]-diazocane-2,5-diketone) were obtained by using the bioassay- guided isolation technique from toxic soil of the replanted Chinese fir tree ecosystem. Chemical structures were determined by spectroscopic means, including 2D-NMR (COSY, HMQC, HMBC, and NOESY) experiments. High concentrations of soil phenolics and friedelin were observed in the natural evergreen broadleaf forest (CK) rather than in the Chinese fir tree ecosystem. The phenolics and friedelin were not phytotoxic to Chinese fir trees. However, the cyclic dipeptide inhibited Chinese fir growth at soil concentrations determined in the replanted Chinese fir tree ecosystem. There was a significantly higher soil concentration of cyclic dipeptide in the replanted Chinese fir tree ecosystem than in a fresh Chinese fir tree ecosystem. The results suggest that phenolics and friedelin are not key allelochemicals since they are weakly phytotoxic and are detected in low concentrations in the replanted Chinese fir tree ecosystem, while cyclic dipeptide is a highly active allelochemical with a phytotoxic effect that limits offspring growth in the replanted Chinese fir tree ecosystem. The discovery of cyclic dipeptide, as well as a further understanding of its potential action mechanism in the replanted Chinese fir tree ecosystem, may contribute to solving the replant problems in managed tree ecosystems."

403	Parasitic	n
	Source(s)	**Notes**
	Wu, Z. Y. & Raven, P. H. (eds.) 1999. Flora of China. Vol. 4 (Cycadaceae through Fagaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Trees or shrubs to 50 m tall; trunk to 3 m d.b.h.; bark dark gray to dark brown, or reddish brown, longitudinally fissured, cracking into irregular flakes; crown pyramidal." [No evidence. Cupressaceae. Formerly Taxodiaceae]

404	Unpalatable to grazing animals	n
	Source(s)	**Notes**

Qsn #	Question	Answer
	Fung, L. E. (1993). Cunninghamia lanceolata (Chinese fir): a study of its potential as a commercial plantation species in New Zealand. PhD Dissertation. University of Canterbury, Christchurch, New Zealand	[Browsed by a number of animals in Australia] "Long term exposure of opossums to C. lanceolata may give a different response to that obtained in this experiment. It is somewhat surprising that such a marked preference should be exhibited for P. radiata; in China and Taiwan C. lanceolata is browsed by squirrels (WU and Tai, 1982) and appear to be preferred over most other conifers (Kuo et al.,1984). Details are given in chapter II, section 3.1. Similarly browsing pests (it) conjunction with frost and drought) appeared to limit the prospects for C. lanceolata in Queensland where it has been tried experimentally (Nielson, Dept. For., Queensland, pers. comm.); pests were wallabies, opossums and rats indicating appeal to a broad range of browsing animals. Browsing of C. lanceolate was in preference to native vegetation such as Hoop pine (Araucaria cunninghamiz), and was important at establishment and during early years (R. Yule, Dept. For., Queensland, pers. comm.)."
	Gray, D. (2017). Deer Damage to Woody Plants-the Benmore Solution to Damage Limitation. Sibbaldia: the Journal of Botanic Garden Horticulture, 15: 109-119	[Browsed by deer] "There is a myth that conifers are amongst the plants exempt from attack. Close inspection will reveal that Abies alba, A. veitchii, Athrotaxis laxifolia, Calocedrus decurrens, Cephalotaxus harringtonii, Cunninghamia lanceolata, Chamaecyparis pisifera, Fitzroya cupressoides, Pseudolarix amabilis, Sequoia sempervirens, Taxodium distichum and Tsuga sieboldii are all regular targets for attention."

405	Toxic to animals	n
	Source(s)	**Notes**
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	No evidence

406	Host for recognized pests and pathogens	n
	Source(s)	**Notes**

Qsn #	Question	Answer
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	"The major pests of C. lanceolata are Semanotus sinoauster, Callidium villosulum and Lobesia cunninghamiacola. Semanotus sinoauster is a cerambycid borer, and is controlled by artificial capture, by spraying insecticide on stems, or by physical removal of the pests (by scraping the bark) in combination with insecticide application. Callidium villosulum, a borer, is effectively controlled by filling the boring holes with insecticide. Lobesia cunninghamiacola, which eats the terminal buds on new shoots, can be effectively controlled by releasing parasitoids, such as Trichogramma dendrolimi, during egg production, by spraying insecticides during the larval stage, or by fumigation during the imago stage. The main pests affecting C. lanceolata in nurseries are Macrotermes barneyi, Odontotermes formosanus, Gryllotalpa africana and Agrotis ipsilon. Detailed control methods for pests of C. lanceolata are described by Yan (1984). The main diseases of C. lanceolata are caused by Rhizoctonia solani, Glomerella cingulata, Pseudomonas cunninghamiae and Lophodermium uncinatum. These diseases frequently occur on weak trees or on lower-quality plantation sites, where the trees are susceptible to attack by these pathogens. Control methods for these diseases are documented in Tan (1977)." … "C. lanceolata is widely used for landscaping in public gardens, parks and temples because of its fast growth, beautiful crown shape, and resistance to pests and diseases."
	Gilman, E.F. & Watson, D.G. (1993). Cunninghamia lanceolate: China-Fir. Fact Sheet ST-220. Institute of Food and Agricultural Sciences, University of Florida, Gainesville FL. http://hort.ufl.edu. [Accessed 10 Jan 2019]	"Verticillium wilt susceptibility: not known to be susceptible Pest resistance: no pests are normally seen on the tree" "Pests and Diseases - No pests or diseases are of major concern. Brown foliage stays on the interior branches but this is a normal condition, usually not caused by insects or disease."

407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	**Notes**
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	No evidence

408	Creates a fire hazard in natural ecosystems	y
	Source(s)	**Notes**
	Xiaorui, T., Lifu, S., & Qingtang, H. (2001). Selection of fire-resistant tree species for southwestern China. Forestry Studies in China, 3(2), 32-38	" … Lithocapus thalassica, Tsoongiodendron odorum, Cunninghamia lanceolata and Pinus massoniana are weak in fire- resistance."

Qsn #	Question	Answer
	Zhang, S., & Chen, G. (2011). Sustainable Utilization of the Biomass Energy Based on Forest Fire Prevention in Pure and Mixed Cunninghamia lanceolata Plantations. Forest Resources Management, 6, 017	"The fuel load and the bioenergy in the pure Cunninghamia lanceolata plantation, and a mixed Cunninghamia lanceolata-Pinus massoniana, or Schima superba, or Pinus massoniana-Schima superba plantation were surveyed and determined. And the per hectare production of surface bioenergy of four stands was estimated. Results indicated that the fuel load and the bioenergy decreased by the order of Cunninghamia lanceolata-Pinus massoniana,Cunninghamia lanceolata-Pinus massoniana-Schima superba, Cunninghamia lanceolata and Cunninghamia lanceolata-Schima superba plantation. The results further verified that the per hectare production of surface bioenergy of four surveyed plantation will reach 252.81kg,293.81kg,201.56kg,249.39kg of standard coal. The author holds that the bioenergy utilization could take account to the dual goal of preventing forest fire and getting the economic, social and ecological benefits."
	Dave's Garden. (2019). Cunninghamia, China-fir, China Fir - Cunninghamia lanceolata. https://davesgarden.com/guides/pf/go/56683/. [Accessed 11 Jan 2019]	[Anecdotal report that tree may pose a fire risk to houses] "On May 6, 2010, runnow from Sevierville, TN wrote: … Probably should not be planted next your house since it can be a fire hazard."
	Cornwell, W. K., Elvira, A., van Kempen, L., van Logtestijn, R. S. P., Aptroot, A. and Cornelissen, J. H. C. (2015), Flammability across the gymnosperm phylogeny: the importance of litter particle size. New Phytologist, 206(2), 672-681	[Litter is flammable, but less so relative to Cryptomeria] "The terpene-rich Cryptomeria burned hotter and the fire front moved faster than in Cunninghamia (Table 2; Fig. 3). The total burning time was also dependent on species: in general, the burning time for Cryptomeria litter was twice that of Cunninghamia litter."

409	Is a shade tolerant plant at some stage of its life cycle	
	Source(s)	**Notes**
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	"C. lanceolata is slightly tolerant of shade when young, but grows best in full sunlight during later growth stages."
	Gilman, E.F. & Watson, D.G. (1993). Cunninghamia lanceolate: China-Fir. Fact Sheet ST-220. Institute of Food and Agricultural Sciences, University of Florida, Gainesville FL. http://hort.ufl.edu. [Accessed 10 Jan 2019]	"Light requirement: tree grows in part shade/part sun; tree grows in full sun"
	Zhang, D & Christian, T. 2013. Cunninghamia lanceolata. The IUCN Red List of Threatened Species 2013: e.T42215A2962265. http://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T42215A2962265.en. [Accessed 10 Jan 2019]	"The capacity to coppice and relative intolerance to shade will ensure its survival in cutover forest areas."

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	n
	Source(s)	**Notes**
	Orwa C,, Mutua, A., Kindt R., Jamnadass, R, & Anthony, S. 2009 Agroforestree Database: a tree reference and selection guide version 4.0. http://www.worldagroforestry.org. [Accessed 11 Jan 2019]	"Soil type: Best growth is obtained on well-drained loamy soils with topsoil pH of 4.7-6.4 and Carbon–Nitrogen ratio of 6.8-16."

Qsn #	Question	Answer
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	"The soil on which C. lanceolata grows can be classified into three main types: mountain yellow-brown soil, mountain red-yellow soil and latosolic red soil. C. lanceolata grows best in well-drained loamy soil, under slightly acid conditions (pH of the topsoil in the range 4.7-6.4), and where the C:N ratio of the topsoil is in the range 6.8-16. C. lanceolata has also been found on some non-regional soil types such as purple soil and black limestone soil, but the species does not usually grow well on these soil types (Yang, 1960). Soil descriptors - Soil texture: medium - Soil drainage: free - Soil reaction: acid; neutral - Soil types: limestone soils"

411	Climbing or smothering growth habit	n
	Source(s)	**Notes**
	Wu, Z. Y. & Raven, P. H. (eds.) 1999. Flora of China. Vol. 4 (Cycadaceae through Fagaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Trees or shrubs to 50 m tall; trunk to 3 m d.b.h.; bark dark gray to dark brown, or reddish brown, longitudinally fissured, cracking into irregular flakes; crown pyramidal."

412	Forms dense thickets	y
	Source(s)	**Notes**
	Wu, Z. Y. & Raven, P. H. (eds.) 1999. Flora of China. Vol. 4 (Cycadaceae through Fagaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	[Forms pure stands in native range] "Mixed broad-leaved forests or forming small, pure stands, rocky hillsides, roadsides; 200–2800 m."

501	Aquatic	n
	Source(s)	**Notes**
	Wu, Z. Y. & Raven, P. H. (eds.) 1999. Flora of China. Vol. 4 (Cycadaceae through Fagaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	[Terrestrial] "Trees or shrubs to 50 m tall… Mixed broad-leaved forests or forming small, pure stands, rocky hillsides, roadsides; 200–2800 m."

502	Grass	n
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 8 Jan 2019]	Family: Cupressaceae Alternate family(ies): Taxodiaceae, Cunninghamiaceae

Qsn #	Question	Answer
503	**Nitrogen fixing woody plant**	**n**
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 8 Jan 2019]	Family: Cupressaceae Alternate family(ies): Taxodiaceae, Cunninghamiaceae

504	**Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)**	**n**
	Source(s)	**Notes**
	Wu, Z. Y. & Raven, P. H. (eds.) 1999. Flora of China. Vol. 4 (Cycadaceae through Fagaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Trees or shrubs to 50 m tall; trunk to 3 m d.b.h.; bark dark gray to dark brown, or reddish brown, longitudinally fissured, cracking into irregular flakes; crown pyramidal."

601	**Evidence of substantial reproductive failure in native habitat**	**n**
	Source(s)	**Notes**
	Zhang, D & Christian, T. 2013. Cunninghamia lanceolata. The IUCN Red List of Threatened Species 2013: e.T42215A2962265. http://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T42215A2962265.en. [Accessed 10 Jan 2019]	"Red List Category & Criteria: Least Concern … The species is very widely distributed and cultivated throughout southern China and adjacent countries. It is very difficult to distinguish between areas where it is naturalized and areas where it is truly indigenous. Throughout its range there is no evidence of decline and as a result it is assessed as Least Concern."

602	**Produces viable seed**	**y**
	Source(s)	**Notes**
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	"Flowering and seed set first occurs in 6- to 8-year-old trees. Mature trees flower from late February to late March, and produce mature seeds during late October and early November. Seeds account for about 3-5% of the dry cone weight. Treated (drying to 8-10% moisture content) seeds retain a high germination rate after storage in airtight plastic containers for one year at low temperatures or under normal temperature conditions."

603	**Hybridizes naturally**	
	Source(s)	**Notes**
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	"Distant hybridization has been observed between C. lanceolata and Cryptomeria japonica var. sinensis. Haploids of both C. lanceolata and Cryptomeria japonica var. sinensis were observed to have 11 chromosomes (Sugihara, 1941). Yeh (1963) indicated that C. lanceolata, Cryptomeria japonica var. sinensis, Taiwania flousiana and T. cryptomerioides are all closely related." [Unknown if natural hybridization currently occurs]

604	**Self-compatible or apomictic**	**y**

Qsn #	Question	Answer
	Source(s)	**Notes**
	Fung, L. E. (1993). Cunninghamia lanceolata (Chinese fir): a study of its potential as a commercial plantation species in New Zealand. PhD Dissertation. University of Canterbury, Christchurch, New Zealand	"Seed vigour is variable and under strong genetic control (Ye et al., 1981c), selfing was the main factor in determining the number of tannin-like containing seeds (and presumably a correspondingly lesser number of healthy seeds)."
	Müller-Starck, G., & Liu, Y. Q. (1989). Inferences on the reproductive system of Cunninghamia lanceolata. Forest Ecology and Management, 29(3), 187-198	[Inbreeding occurs] "Ten-locus genotypes of endosperm and corresponding embryo of two provenance seed samples of Cunninghamia lanceolata were studied in an attempt to describe predominant characteristics of the reproductive system as realized in the respective populations. The empirical genotypic structures were compared with three types of reference structures: Hardy Weinberg; multiplica-tive; and inbreeding. Strong deviations from the hypothesis of random fusion of gametes are ob-tained. This phenomenon cannot be explained by assuming sexually asymmetrical fertility selec-tion. Results clearly indicate that inbreeding is the most prominent component of the underlying reproductive conditions in both seed samples. Of the additional phenomena involved, the most probable is viability selection. Some general consequences of these results are discussed."

605	**Requires specialist pollinators**	**n**
	Source(s)	**Notes**
	Kramer, K.U. & Green, P.S. 1990. The Families and Genera of Vascular Plants. Volume 1. Pteridophytes and Gymnosperms. Springer-Verlag, Berlin, Heidelberg, New York	"All species of Taxodiaceae are monoecious and wind-pollinated." [Cunninghamia formerly placed in Taxodiaceae]

606	**Reproduction by vegetative fragmentation**	**y**
	Source(s)	**Notes**
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	"Ability to sucker; regenerate rapidly; self-prune; coppice; pollard"

607	**Minimum generative time (years)**	**>3**
	Source(s)	**Notes**
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	"Flowering and seed set first occurs in 6- to 8-year-old trees. Mature trees flower from late February to late March, and produce mature seeds during late October and early November."

Qsn #	Question	Answer
701	**Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)**	**n**
	Source(s)	**Notes**
	New Zealand Plant Conservation Network. (2019). Flora Details - Cunninghamia lanceolata. http://www.nzpcn.org.nz. [Accessed 11 Jan 2019]	"Dispersal - Wind and gravity."
	Wu, Z. Y. & Raven, P. H. (eds.) 1999. Flora of China. Vol. 4 (Cycadaceae through Fagaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Seeds dark brown, oblong or narrowly ovate, 5–6 × ca. 4 mm, narrowly winged laterally." [No means of external attachment]

702	**Propagules dispersed intentionally by people**	**y**
	Source(s)	**Notes**
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	"C. lanceolata has been introduced to many countries since the 18th century and currently there is interest in introducing C. lanceolata elsewhere. Experimental plantations have been established in a number of countries, including: Japan (where the species was introduced very early), Malaysia (promising), South Africa (promising), Argentina, Brazil (Santa Catarina and Sao Paulo; some small-scale commercial plantings - see Golfari, 1970; Golfari et al., 1978) and New Zealand. C. lanceolata has also been planted as an ornamental in the UK, France, Netherlands, Germany and the USA (North Carolina and Washington). It suffers from frost damage in the UK (Dallimore et al., 1966; Honda, 1974; Krussmann, 1985; den Ouden and Boom, 1965; Sakaguchi, 1970; Streets, 1962)." … "C. lanceolata is widely used for landscaping in public gardens, parks and temples because of its fast growth, beautiful crown shape, and resistance to pests and diseases."
	Orwa C,, Mutua, A., Kindt R., Jamnadass, R, & Anthony, S. 2009 Agroforestree Database: a tree reference and selection guide version 4.0. http://www.worldagroforestry.org. [Accessed 11 Jan 2019]	"Ornamental: It is widely used for landscaping in public gardens, along the roads, parks and temples because of its fast growth, beautiful crown shape, and resistance to pests and diseases"

703	**Propagules likely to disperse as a produce contaminant**	**n**
	Source(s)	**Notes**
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Major Pathway/s: Forestry, Herbal, Ornamental Dispersed by: Humans"
	Wu, Z. Y. & Raven, P. H. (eds.) 1999. Flora of China. Vol. 4 (Cycadaceae through Fagaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Trees or shrubs to 50 m tall … Seeds dark brown, oblong or narrowly ovate, 5–6 × ca. 4 mm, narrowly winged laterally." [Unlikely. Large tree with relatively large, wind-dispersed seeds]

704	**Propagules adapted to wind dispersal**	**y**
	Source(s)	**Notes**
	Wu, Z. Y. & Raven, P. H. (eds.) 1999. Flora of China. Vol. 4 (Cycadaceae through Fagaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Seeds dark brown, oblong or narrowly ovate, 5–6 × ca. 4 mm, narrowly winged laterally."

Qsn #	Question	Answer
705	**Propagules water dispersed**	**n**
	Source(s)	**Notes**
	New Zealand Plant Conservation Network. (2019). Flora Details - Cunninghamia lanceolata. http://www.nzpcn.org.nz. [Accessed 11 Jan 2019]	"Dispersal - Wind and gravity." [Secondary dispersal by water could occur, but trees do not naturally occur in riparian habitats]

706	**Propagules bird dispersed**	**n**
	Source(s)	**Notes**
	New Zealand Plant Conservation Network. (2019). Flora Details - Cunninghamia lanceolata. http://www.nzpcn.org.nz. [Accessed 11 Jan 2019]	"Dispersal - Wind and gravity."
	Wu, Z. Y. & Raven, P. H. (eds.) 1999. Flora of China. Vol. 4 (Cycadaceae through Fagaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Seeds dark brown, oblong or narrowly ovate, 5–6 × ca. 4 mm, narrowly winged laterally." [Not fleshy-fruited]

707	**Propagules dispersed by other animals (externally)**	**n**
	Source(s)	**Notes**
	New Zealand Plant Conservation Network. (2019). Flora Details - Cunninghamia lanceolata. http://www.nzpcn.org.nz. [Accessed 11 Jan 2019]	"Dispersal - Wind and gravity."
	Wu, Z. Y. & Raven, P. H. (eds.) 1999. Flora of China. Vol. 4 (Cycadaceae through Fagaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Seeds dark brown, oblong or narrowly ovate, 5–6 × ca. 4 mm, narrowly winged laterally." [No means of external attachment, but rodents or other seed predators could possibly carry seeds away from parent trees for consumption]

708	**Propagules survive passage through the gut**	**n**
	Source(s)	**Notes**
	New Zealand Plant Conservation Network. (2019). Flora Details - Cunninghamia lanceolata. http://www.nzpcn.org.nz. [Accessed 11 Jan 2019]	"Dispersal - Wind and gravity."

801	**Prolific seed production (>1000/m2)**	**n**
	Source(s)	**Notes**
	Wang, J., Ren, H., Yang, L., Li, D., & Guo, Q. (2009). Soil seed banks in four 22-year-old plantations in South China: Implications for restoration. Forest Ecology and Management, 258(9), 2000-2006	"Table 2 The mean cover of seed plant species (%) in the aboveground vegetation (av) and mean seed density (seeds m□2) in the soil seed bank (sb)." [Cunninghamia lanceolata - no seeds found in the seed bank]

802	**Evidence that a persistent propagule bank is formed (>1 yr)**	**n**
	Source(s)	**Notes**

Qsn #	Question	Answer
	Orwa C,, Mutua, A., Kindt R., Jamnadass, R, & Anthony, S. 2009 Agroforestree Database: a tree reference and selection guide version 4.0. http://www.worldagroforestry.org. [Accessed 11 Jan 2019]	"Seeds storage behaviour is orthodox. If stored in airtight containers, the seeds normally retain full viability for one year. They can be stored at 5°C and 8-10% moisture content to prolong viability." [Seeds can be stored, but apparently don't form a persistent seed bank under natural conditions]
	Wang, J., Li, D., Ren, H., & Yang, L. (2010). Seed supply and the regeneration potential for plantations and shrubland in southern China. Forest Ecology and Management, 259 (12), 2390-2398	"Some species, such as the overstory S. superba at the NP site and C. lanceolata at the CP site, were represented in the seed rain but not in the seed bank. Such findings indicate that seeds of these planted species do not enter the soil or they do not persist after entering the soil. For these kinds of plantation species, natural recruitment will depend more on the seed rain than on the seed bank."
	Baskin, C.C. & Baskin, J.M. 2014. Seeds Ecology, Biogeography, and Evolution of Dormancy and Germination. Second Edition. Academic Press, San Francisco, CA	"TABLE 10.10 … Cunninghamia lanceolata … ND" [nondormant]

803	Well controlled by herbicides	
	Source(s)	**Notes**
	Fung, L. E. (1993). Cunninghamia lanceolata (Chinese fir): a study of its potential as a commercial plantation species in New Zealand. PhD Dissertation. University of Canterbury, Christchurch, New Zealand	[Treating weeds in plantations, Cunninghamia seedlings were damaged by Roundup and Velpar. May be effective if control is desired] "As has been mentioned, intercropping is used during early stages as an alternative to standard releasing. Releasing, where carried out, is done by hand; chemical sprays are generally not used. There is a need for intensive tending as young seedlings are not considered able to compete with weeds, especially in the fIrst three years; early losses without proper tending can be 20 - 30 % and result in delayed canopy closure (China, Forestry Sector Loan Project, 1989b). In a trial using Velpar and Roundup, seedlings died after treatment with Roundup (although seedlings resprouted and commenced growth 40 - 60 days after treatment) and were less resistant to Velpar than pines (Kuo, 1984a). There is however, possible use for herbicide control. Root and shoot growth of seedlings in transplanting beds treated with 2, 4 - D and atrazine was better than those weeded by hand and there was no significant differences in survival between treatments (Kuo and Yao, 1971). Similarly chemical control of weeds at the nursery stage was 24 - 36 % cheaper than by manual weeding, although only 75 % of the weeds were eliminated (Zhou, 1989)."

804	Tolerates, or benefits from, mutilation, cultivation, or fire	y
	Source(s)	**Notes**
	Orwa C,, Mutua, A., Kindt R., Jamnadass, R, & Anthony, S. 2009 Agroforestree Database: a tree reference and selection guide version 4.0. http://www.worldagroforestry.org. [Accessed 11 Jan 2019]	"C. lanceolata is a fast growing species and coppices well. It is topophytic, meaning if cuttings are taken from lateral growth, they grow laterally and if taken from vertical growth, they grow vertically. It also sprouts from the roots if cut down. It requires protection from windswept sites."
	Xiang, W., Liu, S., Lei, X., Frank, S. C., Tian, D., Wang, G., & Deng, X. (2013). Secondary forest floristic composition, structure, and spatial pattern in subtropical China. Journal of Forest Research, 18(1), 111-120	"In this study, the existence of some C. lanceolata trees within the forest primarily was because of re-sprouting on the remains of stumps, indicating that the original site was an abandoned C. lanceolata plantation site that had been clearcut."

Qsn #	Question	Answer
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	"Propagation is easily achieved by coppicing (unusual for conifers) and from root cuttings." … "Ability to sucker; regenerate rapidly; self-prune; coppice; pollard"

805	**Effective natural enemies present locally (e.g. introduced biocontrol agents)**	
	Source(s)	**Notes**
	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	Unknown [11,040 trees planted on Kauai (199 between 1931-1933), Oahu (30 in 1956), Molokai (519 between 1941 to 1957), Maui (1234 between 1931 to 1955) and Hawaii (9058 between 1931 to 1939)]

Summary of Risk Traits:

High Risk / Undesirable Traits
• Elevation range exceeds 1000 m, demonstrating environmental versatility
• Grows in subtropical climates
• Naturalized outside native range, but no evidence from Hawaiian Islands to date (despite numerous plantings statewide 80+ years ago)
• Leaf-tips spiny
• Flammable and may increase fir risk in fire prone areas
• Forms pure stands in native range (but no evidence of naturally occurring dense stands outside native range)
• Reproduces by seeds and vegetatively by suckering
• Capable of self-pollination, but seed set may be reduced
• Seeds dispersed by wind & intentionally by people
• Able to coppice & resprout after cutting

Low Risk Traits
• No verified reports of detrimental impacts outside native range
• Palatable to some browsing animals (but spiny leaves may deter browsing)
• Non-toxic
• Valued for ornamental and forestry uses
• Reaches maturity in 6-8 years
• Does not form a persistent soil seed bank
• Herbicides may provide effective control of seedlings and younger plants (further evaluation needed)

Second Screening Results for Tree/tree-like shrubs

(A) Shade tolerant or known to form dense stands?> Yes. Tolerates partial shade when young, and forms pure stands in native range
(B) Bird or clearly wind-dispersed?> Yes. Wind-dispersed
(C) Life cycle 4 years? No. Reaches maturity in 6-8 years
Outcome = Evaluate (Moderate Risk)