

Taxon: <i>Wollemia nobilis</i> W. G. Jones et al.	Family: Araucariaceae
Common Name(s): wollemi pine wollemia	Synonym(s):

Assessor: Chuck Chimera	Status: Assessor Approved	End Date: 16 Aug 2017
WRA Score: -1.0	Designation: L	Rating: Low Risk

Keywords: Endangered Tree, Gymnosperm, Monoecious, Wind-Dispersed, Self-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)	Intermediate
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	n
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	?
301	Naturalized beyond native range	y = 1*multiplier (see Appendix 2), n= question 205	n
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)	n
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		
405	Toxic to animals	y=1, n=0	n
406	Host for recognized pests and pathogens		
407	Causes allergies or is otherwise toxic to humans	y=1, n=0	n
408	Creates a fire hazard in natural ecosystems		
409	Is a shade tolerant plant at some stage of its life cycle	y=1, n=0	y

Qsn #	Question	Answer Option	Answer
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)		
411	Climbing or smothering growth habit	y=1, n=0	n
412	Forms dense thickets	y=1, n=0	n
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	n
604	Self-compatible or apomictic	y=1, n=-1	y
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation		
607	Minimum generative time (years)		
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	y
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)		
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
	Boland, D.J. , Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., McDonald, M.W. & Turner, J.D. 2006. Forest Trees of Australia. CSIRO Publishing, Collingwood, Australia	[No evidence of domestication] "The Wollemi pine was only discovered in 1994. It belongs to the family Araucariaceae, which was previously known to consist only of two extant genera, Araucaria and Agathis. Fossil leaves of this species were first discovered over 100 years ago in Jurassic sediments deposited 150 million years ago near Gulgong in New South Wales."

102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. 2017. Personal Communication	NA

103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. 2017. 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"	Intermediate
	Source(s)	Notes
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	"Wollemi Pine occurs in the warm temperate rainforest and rainforest margins in a Eucalyptus spp. forest/woodland complex within the Sydney Sandstone Biome of the eastern coast and tablelands of New South Wales. The rainforest is included in suballiances 36 or 37 in Floyd (1990)." ... "Climate is typical of low altitude Blue Mountains. Air temperature data recorded in Stand 1 for one year is presented in Figure 8, showing highest air temperatures recorded at the site in the months November-February, maximum 30°C. In winter the recorded maximum temperatures were 15°C and minimum near freezing from June to August."

202	Quality of climate match data	High
	Source(s)	Notes
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	

203	Broad climate suitability (environmental versatility)	n
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Qsn #	Question	Answer
	Source(s)	Notes
	Boland, D.J. , Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., McDonald, M.W. & Turner, J.D. 2006. Forest Trees of Australia. CSIRO Publishing, Collingwood, Australia	"Climate: Altitudinal range: c. 900 m; Hottest/coldest month: c. 24–26°C/ c. 0–1°C; Frost incidence: moderate to high; Rainfall: c. 800–1000 mm per year, mainly uniform but with a slight summer max."
	Oregon State University. 2017. Landscape Plants - <i>Wollemia nobilis</i> . http://landscapeplants.oregonstate.edu/plants/wollemia-nobilis . [Accessed 16 Aug 2017]	"Hardy to USDA Zone 9, or possibly Zone 8. Native to semi-tropical Australia"
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2015. Growing Native Plants. <i>Wollemia nobilis</i> . https://www.anbg.gov.au/gnp/interns-2004/wollemia-nobilis.html . [Accessed 15 Aug 2017]	"Wollemi Pines can be grown outdoors in most climates of Australia."

204	Native or naturalized in regions with tropical or subtropical climates	n
	Source(s)	Notes
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	"Wollemi Pine occurs in the warm temperate rainforest and rainforest margins in a Eucalyptus spp. forest/woodland complex within the Sydney Sandstone Biome of the eastern coast and tablelands of New South Wales."

205	Does the species have a history of repeated introductions outside its natural range?	?
	Source(s)	Notes
	Thomas, P. 2011. <i>Wollemia nobilis</i> . The IUCN Red List of Threatened Species 2011: e.T34926A9898196. http://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T34926A9898196.en . [Accessed 15 Aug 2017]	"Protective measures include restricting access to the site and strict phytosanitary precautions for all researchers visiting the sites to undertake approved research and monitoring. An ex-situ conservation and research programme was also initiated. As part of this programme, commercial propagation was undertaken and the resultant plants distributed for sale worldwide. The primary purpose of the commercialisation programme was to protect the wild stands from impacts associated with illegal collections and generate income for the continued conservation of <i>W. nobilis</i> and other threatened species."

Qsn #	Question	Answer
301	Naturalized beyond native range	n
	Source(s)	Notes
	Thomas, P. 2011. <i>Wollemia nobilis</i> . The IUCN Red List of Threatened Species 2011: e.T34926A9898196. http://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T34926A9898196.en . [Accessed 15 Aug 2017]	" <i>Wollemia nobilis</i> is only known from Wollemi National Park in New South Wales, Australia. Its EOO is less than 100 km ² and the AOO is under 10 km ² ."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence
	Wagner, W.L., Herbst, D.R.& Lorence, D.H. 2017. Flora of the Hawaiian Islands. Smithsonian Institution, Washington, D.C. http://botany.si.edu/ . [Accessed 15 Aug 2017]	No evidence to date

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
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence

305	Congeneric weed	n
	Source(s)	Notes
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	" <i>Wollemia</i> is a monotypic genus with only a single extant species known. Wollemi Pine is of considerable significance in the study of the evolutionary relationships of early Gondwanan flora. It has contributed to understanding of structures in fossil Araucariaceae (Macphail et al. 1995; Chambers et al. 1998; Dettmann and Jarzen 2000). Its survival has informed our understanding of long-term regional floristic change (Briggs 2000)."

Qsn #	Question	Answer
401	Produces spines, thorns or burrs	n
	Source(s)	Notes
	Boland, D.J. , Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., McDonald, M.W. & Turner, J.D. 2006. Forest Trees of Australia. CSIRO Publishing, Collingwood, Australia	[No evidence] "Distinctive features: A rare erect tree with narrow, columnar crown widest at about one-third of total height. Rough bark of dense, soft, spongy nodules or tubercules. Adult leaves in 4 rows. Male strobili cylindrical, female globular to broadly ellipsoidal."

402	Allelopathic	
	Source(s)	Notes
	Biggs, L. E. (2009). Mycorrhizal inoculation, endophytic colonization, and allelopathic potential of Wollemi Pine (<i>Wollemia nobilis</i>) roots. MSc Thesis. University of British Columbia, Vancouver, BC	[Possibly Yes. Further study needed] "This study presents the first preliminary evidence of the production of allelochemicals by Wollemi Pines that are toxic to some plants. This work has shown that leek seed germination is adversely affected by phytotoxins released by Wollemi Pines into the soil, while sorghum seed germination is not. More work is required to reveal how the seed germination process in leeks is targeted by the allelochemicals. The findings of this study also raise the question of the ecological impact of Wollemi Pine allelopathic potential. The phytotoxins released by <i>W. nobilis</i> may provide a competitive advantage over some plants while also being potentially self damaging. A better understanding of the allelopathic activity of Wollemi Pines will be fundamental in future studies on this endangered conifer."
	Seal, A. N., Pratley, J. E., Haig, T. J., An, M., & Wu, H. (2010). Plants with phytotoxic potential: Wollemi pine (<i>Wollemia nobilis</i>). <i>Agriculture, Ecosystems & Environment</i> , 135(1), 52-57	[Potentially] "Herbicide resistance in annual ryegrass (<i>ARG</i> , <i>Lolium rigidum</i>) threatens the quality and yield of winter wheat crops in Australia, prompting research to discover novel natural plant compounds with herbicidal properties. Due to its novel nature and potentially interesting chemistry, the Australian native, Wollemi pine (<i>Wollemia nobilis</i>), was tested for its ability to suppress <i>ARG</i> growth and its feasibility for use in weed control strategies. The leaf extract of Wollemi pine significantly inhibited the growth of <i>ARG</i> and wild radish (<i>Raphanus raphanistrum</i>) in laboratory bioassays at concentrations above 1% extract. In soil trials, the 100% extract (100 g dried plant material/L) inhibited the dry weight of <i>ARG</i> by 25%. The addition of a wetting agent to the extract increased the suppression of <i>ARG</i> to 80% which was as phytotoxic as a 4-fold increase in the extract concentration ("400%" extract). Using bioassay guided fractionation, the most phytotoxic fraction was identified and further analysed via GC/MS. Several compounds not previously identified in Wollemi pine leaf extracts have been identified, namely, 2-propylphenol, 3,4-dimethoxyphenol, 2-methoxybenzoic acid, vanillyl alcohol and isovanillic acid. These results suggest that Wollemi pine is an important potential source of compounds for the control of <i>ARG</i> and wild radish in winter crops."

Qsn #	Question	Answer
403	Parasitic	n
	Source(s)	Notes
	Boland, D.J. , Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., McDonald, M.W. & Turner, J.D. 2006. Forest Trees of Australia. CSIRO Publishing, Collingwood, Australia	"Wollemi pine is an erect tree up to 40 m tall, frequently coppicing from the base." [Araucariaceae. No evidence]

404	Unpalatable to grazing animals	
	Source(s)	Notes
	Boland, D.J. , Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., McDonald, M.W. & Turner, J.D. 2006. Forest Trees of Australia. CSIRO Publishing, Collingwood, Australia	[Palatability unknown. Extremely rare tree with limited distribution] "Wollemi pine is one of the world's rarest plants with fewer than 40 adult trees presently known. These occur in two small groves in a remote part of Wollemi National Park, within 200 km north-west of Sydney, in the Central Tablelands of New South Wales. The sandstone massif of the site is crisscrossed with many narrow canyons some only a few metres wide and hundreds of metres deep. The extremely rugged nature of the terrain, coupled with the low fertility of the soils has discouraged exploitation and the area remains undisturbed."

405	Toxic to animals	n
	Source(s)	Notes
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	No evidence
	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

Qsn #	Question	Answer
406	Host for recognized pests and pathogens	
	Source(s)	Notes
	Bullock, S., Summerell, B. A., & Gunn, L. V. (2000). Pathogens of the Wollemi pine, <i>Wollemia nobilis</i> . <i>Australasian Plant Pathology</i> , 29(3), 211-214	"Cuttings of the Wollemi Pine, <i>Wollemia nobilis</i> , were inoculated with <i>Phytophthora cinnamomi</i> , <i>Botryosphaeria</i> sp., <i>Rhizoctonia</i> sp., <i>Fusarium oxysporum</i> and <i>F. solani</i> . <i>P. cinnamomi</i> and the <i>Botryosphaeria</i> sp. were pathogenic causing plant death over a period of up to 5 weeks. None of the other fungi caused significant disease although two out of nine plants inoculated with <i>F. oxysporum</i> died during the experimental period. The results confirm the necessity to maintain strict hygiene and entry controls on the site where this extremely rare plant is found."
	Thomas, P. 2011. <i>Wollemia nobilis</i> . The IUCN Red List of Threatened Species 2011: e.T34926A9898196. http://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T34926A9898196.en . [Accessed 16 Aug 2017]	"The small population size and very restricted distribution mean that <i>W. nobilis</i> very susceptible to the effects of human activities or stochastic events. Specific threats include exotic pathogens such as <i>Phytophthora cinnamoni</i> , the introduction of exotic weeds, trampling and other forms of disturbance associated with unauthorised access."

407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	Notes
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	No evidence
	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	
	Source(s)	Notes
	Boland, D.J. , Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., McDonald, M.W. & Turner, J.D. 2006. <i>Forest Trees of Australia</i> . CSIRO Publishing, Collingwood, Australia	"The gorge where Wollemi pine occurs is surrounded by sandstone cliffs of the Triassic Narrabeen Group." ... "The local microclimate is wet with a permanent creek."

Qsn #	Question	Answer
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	[Currently, trees are rare and occur in habitat that may be a refugium from fire. Flammability of trees in fire-prone ecosystems unknown] "The response of Wollemi Pine to fire is unknown. It is likely that intense fires that kill all foliage will kill individuals of Wollemi Pine and hence, catastrophic fire is a threat to the known stands. However, all stands show evidence of previous fires as indicated by fire scars on the trees or burnt out remains of <i>Eucalyptus piperita</i> (Sydney Peppermint). Small scale spot fires may occasionally occur at or in the vicinity of known stands. The role of such small scale fires on the competitive interaction between Wollemi Pines and angiosperms and in creating gaps for recruitment of new plants is currently under investigation (Auld and Hughes unpubl.). An appropriate disturbance regime may be required to ensure the long-term viability of stands in the wild. Further monitoring is required to provide information on the role of fire in the survival of Wollemi Pine." ... "Wollemi Pine is restricted to specialized habitats in rainforest communities in deep sandstone gorges. These wet microhabitats act as refugia for species which are not tolerant to drought or to high fire frequencies or intensities because they are sheltered from the hot, dry, fire-prone conditions of the surrounding forest and woodland. Conditions within these microhabitats have enabled Wollemi Pine to survive and to share the habitat with other canopy species, particularly coachwood and eucalypt species. A regime of disturbance is operating within this habitat. It appears to consist of major events over a long time frame such as catastrophic events (fire events, rock falls and tree falls) and individual tree deaths, which produce the canopy gaps that may be necessary for successful regeneration."

409	Is a shade tolerant plant at some stage of its life cycle	y
	Source(s)	Notes
	Missouri Botanical Garden. 2017. <i>Wollemia nobilis</i> . http://www.missouribotanicalgarden.org . [Accessed 16 Aug 2017]	"Sun: Part shade" ... " Best in part shade locations with protection from wind and afternoon sun."
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	[Establishes in shade. Eventually becomes emergent tree] "Light controls the growth of seedlings in glasshouse conditions, with good growth rates in cultivation at between 25 and 75% ambient light. However, growth rates in the wild are very slow (see 7.3.5). High light causes 'sunburn' (photoinhibition) in seedlings in cultivation (Meagher, Offord and Martyn unpubl.)." ... "The Wollemi pines are emergent above temperate rainforest dominated by coachwood (<i>Ceratopetalum apetalum</i>) and sassafras (<i>Doryphora sassafras</i>)."

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	
	Source(s)	Notes
	Oregon State University. 2017. Landscape Plants - <i>Wollemia nobilis</i> . http://landscapeplants.oregonstate.edu/plants/wollemia-nobilis . [Accessed 16 Aug 2017]	"Prefers acid soils but adaptable to other soil types."

Qsn #	Question	Answer
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2015. Growing Native Plants. <i>Wollemia nobilis</i> . https://www.anbg.gov.au/gnp/interns-2004/wollemia-nobilis.html . [Accessed 16 Aug 2017]	"Sandy soil with good drainage is recommended. Be wary of waterlogged soil, either through over watering or poor drainage."
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	"Soils are sandstone-derived boulder alluvium, with high organic matter and some shale component (Jones et al. 1995). The soil is very shallow. In some areas there is little or no soil layer. Roots of Wollemi Pine plants grow into rock fissures or extend for tens of metres away from the main groups of trunks. Nutrient levels are low and the soil is extremely acidic, often in the range pH 3-4, with low levels of most elements although high in aluminium, sulphate and iron. There are patches of highly saline soil (Offord et al. 1996; C. Offord unpubl.)."

411	Climbing or smothering growth habit	n
	Source(s)	Notes
	Boland, D.J. , Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., McDonald, M.W. & Turner, J.D. 2006. Forest Trees of Australia. CSIRO Publishing, Collingwood, Australia	"Wollemi pine is an erect tree up to 40 m tall, frequently coppicing from the base. Trunks can be up to 1.2 m in diameter at a third of the height of the tree. The crown is extensive and slender, tapering towards the top. It consists of numerous separate lateral crowns giving a characteristic clumpy aspect to the whole tree. Lateral or primary branches are terminated by male or female cones. As with <i>Araucaria</i> the leaves are not shed individually, and entire leafy branches fall and litter the forest floor."

412	Forms dense thickets	n
	Source(s)	Notes
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	"In all, there are fewer than 100 adult plants in the wild, distributed between several stands. All non-reproductive plants in the population, which are not identified as seedlings by the presence of cotyledons or cotyledon scars, have been classified as juveniles. Seedlings and juveniles are present at all stands indicating that successful sexual reproduction and the establishment of new plants can occur at all stands (Auld and Benson unpubl.)."
	Thomas, P. 2011. <i>Wollemia nobilis</i> . The IUCN Red List of Threatened Species 2011: e.T34926A9898196. http://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T34926A9898196.en . [Accessed 16 Aug 2017]	"There are currently estimated to be 80 mature individuals or multistemmed clumps. Additionally, 300 seedlings and juveniles have been recorded. Some individual trees may reach almost 40 m in height with diameters up to 1 m. Coppicing from the base is frequent (Department of Environment and Conservation NSW, 2006). Genetic studies indicate that there is very little variation within the population (Peakall et al. 2003)."

501	Aquatic	n
	Source(s)	Notes

Qsn #	Question	Answer
	Boland, D.J. , Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., McDonald, M.W. & Turner, J.D. 2006. Forest Trees of Australia. CSIRO Publishing, Collingwood, Australia	[Terrestrial tree] "Wollemi pine is one of the world's rarest plants with fewer than 40 adult trees presently known. These occur in two small groves in a remote part of Wollemi National Park, within 200 km north-west of Sydney, in the Central Tablelands of New South Wales. The sandstone massif of the site is crisscrossed with many narrow canyons some only a few metres wide and hundreds of metres deep. The extremely rugged nature of the terrain, coupled with the low fertility of the soils has discouraged exploitation and the area remains undisturbed."

502	Grass	n
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2017. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 15 Aug 2017]	Family: Araucariaceae

503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2017. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 15 Aug 2017]	Family: Araucariaceae

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	Notes
	Boland, D.J. , Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., McDonald, M.W. & Turner, J.D. 2006. Forest Trees of Australia. CSIRO Publishing, Collingwood, Australia	"Wollemi pine is an erect tree up to 40 m tall, frequently coppicing from the base. Trunks can be up to 1.2 m in diameter at a third of the height of the tree. The crown is extensive and slender, tapering towards the top. It consists of numerous separate lateral crowns giving a characteristic clumpy aspect to the whole tree. Lateral or primary branches are terminated by male or female cones."

601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	Notes

Qsn #	Question	Answer
	Thomas, P. 2011. <i>Wollemia nobilis</i> . The IUCN Red List of Threatened Species 2011: e.T34926A9898196. http://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T34926A9898196.en . [Accessed 15 Aug 2017]	[Restricted range. Highly endangered, but able to reproduce in wild] "There are currently estimated to be 80 mature individuals or multistemmed clumps. Additionally, 300 seedlings and juveniles have been recorded. Some individual trees may reach almost 40 m in height with diameters up to 1 m. Coppicing from the base is frequent (Department of Environment and Conservation NSW, 2006). Genetic studies indicate that there is very little variation within the population (Peakall et al. 2003)." ... "The small population size and very restricted distribution mean that <i>W. nobilis</i> is very susceptible to the effects of human activities or stochastic events. Specific threats include exotic pathogens such as <i>Phytophthora cinnamoni</i> , the introduction of exotic weeds, trampling and other forms of disturbance associated with unauthorised access. Intense catastrophic fires are a significant threat. Changes in rainfall and temperature patterns associated with climate change represent further potential threats (Department of Environment and Conservation NSW, 2006). "

602	Produces viable seed	y
	Source(s)	Notes
	Boland, D.J. , Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., McDonald, M.W. & Turner, J.D. 2006. <i>Forest Trees of Australia</i> . CSIRO Publishing, Collingwood, Australia	"Cones: Globular to broadly ellipsoidal, to 12.5 × 10 cm, mid-green becoming brown; scales finally shedding individually leaving a persistent thick central axis. Seeds— circumferentially winged, to 1.1 × 0.7 cm, wing 0.1–0.2 cm wide. Germination is epigeal."
	Australian National Botanic Gardens and Centre for Australian National Biodiversity Research. 2015. <i>Growing Native Plants. Wollemia nobilis</i> . https://www.anbg.gov.au/gnp/interns-2004/wollemia-nobilis.html . [Accessed 15 Aug 2017]	"The cultivation of the Wollemi Pine is similar to other conifer species. Plants can be grown from seed or struck from tip cuttings. If growing plants from cuttings then a strong breeding hormone is recommended (5,000-10,000 gms/litre) to promote root growth."

Qsn #	Question	Answer
	Offord, C. A., Porter, C. L., Meagher, P. F., & Errington, G. (1999). Sexual reproduction and early plant growth of the Wollemi pine (<i>Wollemia nobilis</i>), a rare and threatened Australian conifer. <i>Annals of Botany</i> , 84(1): 1-9	"The two known populations of the recently discovered rare and threatened Wollemi Pine (<i>Wollemia nobilis</i> Jones, Hill and Allen) consist of a small number of large multi-stemmed adult trees and small seedlings. Female and male cones are produced on adult trees with pollen release occurring in spring (October ± November). Seed cones mature 16±19 months later in late summer and autumn and appear to be produced annually. Approximately 10% of seed produced in two consecutive years was viable, 25% of which was damaged by animals. Glasshouse studies showed that seed germination at 25 °C (day)}16 °C (night) proceeded slowly but steadily at approx. 4% per week until, after 6 months, 88% of apparently viable seed had germinated with the remainder of the seed rotting. Growth of potted seedlings in this temperature regime was continuous (after a lag period of 4±6 months) with the monopodial axis growing 0±05±0±25 m in the first year, 0±5±0±6 m in the second year and 0±25±0±35 m in the third year, attaining a total height of 0±8±1±2 m. Multiple orthotropic shoots developed on some plants at this stage, some of which outgrew the primary shoot in height. The diameter of the stem below the cotyledon (just above the soil) grew 3±7 mm in the first year, 10±14 mm in the second and 15±20 mm in the third at which time it was 25±34 mm. The average number of lateral branches produced was [®] ve±17 in the first year, 25±36 in the second year and 24±30 in the third year giving a total of 60±77. The establishment of Wollemi Pine in the wild does not appear limited by the inherent viability of seed and potential for early growth of seedlings."

603	Hybridizes naturally	n
	Source(s)	Notes
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	" <i>Wollemia</i> is a monotypic genus with only a single extant species known. Wollemi Pine is of considerable significance in the study of the evolutionary relationships of early Gondwanan flora. It has contributed to understanding of structures in fossil Araucariaceae (Macphail et al. 1995; Chambers et al. 1998; Dettmann and Jarzen 2000). Its survival has informed our understanding of long-term regional floristic change (Briggs 2000)."

604	Self-compatible or apomictic	y
	Source(s)	Notes
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	[Selfing observed] "Because of a lack of reproductive material available, it has been difficult to study the breeding system of Wollemi Pine. Recent female cone production in cultivated plants has enabled some manipulations and easier access for repeated preliminary observations. The long time to seed cone maturity, around two years, means that no trends have yet been established although selfing has been observed (Meagher and Offord unpubl.)."

605	Requires specialist pollinators	n
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Qsn #	Question	Answer
	Source(s)	Notes
	Boland, D.J. , Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., McDonald, M.W. & Turner, J.D. 2006. Forest Trees of Australia. CSIRO Publishing, Collingwood, Australia	[Wind-pollinated] "Strobili: Male and female strobili borne on the same tree (monoecious), female above the male. Male—terminal on first-order leafy shoots, to 11 × 1.9 cm, subtended by about 8 spirally arranged, broadly triangular to semi-circular bracts to 0.5 × 0.5 cm; scales greater than 500, with 4–9 pendulous pollen cells on the undersurface. Female—terminal on first-order leafy shoots; bract (ovuliferous) scales greater than 300, to 1.7 × 2.2 cm, and 0.3–0.5 cm thick, bearing a single inverted ovule on the upper surface. Cones are wind-pollinated."

606	Reproduction by vegetative fragmentation	
	Source(s)	Notes
	Offord, C. A., Porter, C. L., Meagher, P. F., & Errington, G. (1999). Sexual reproduction and early plant growth of the Wollemi pine (<i>Wollemia nobilis</i>), a rare and threatened Australian conifer. <i>Annals of Botany</i> , 84(1): 1-9	[Possibly. Confirmation needed] "There is also some evidence of asexual regeneration of <i>W. nobilis</i> trees through self-coppicing and there is the possibility of re-establishment through root suckering. Although there is no definite evidence as yet that the latter occurs in Wollemi Pine populations, root suckering has been observed in <i>Agathis robusta</i> (Haley 1957, quoted by Whitmore, 1977), <i>Araucaria cunninghamii</i> (Burrows, 1990) and <i>A. araucana</i> (Burns, 1993)."

607	Minimum generative time (years)	
	Source(s)	Notes
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	"In cultivation, male cones have developed on plants as young as five years of age with some branches producing cones again. Female cones have developed on two seedlings, one at eight years and the other at ten years (Meagher and Offord unpubl.)."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	n
	Source(s)	Notes
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	"Seeds of Wollemi Pine are light (ranging from 10-44 mg (Meagher & Offord unpubl.) and winged and it is most probable that they are dispersed within existing stands by wind."
	Boland, D.J. , Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., McDonald, M.W. & Turner, J.D. 2006. Forest Trees of Australia. CSIRO Publishing, Collingwood, Australia	[No means of external attachment] "Cones: Globular to broadly ellipsoidal, to 12.5 × 10 cm, mid-green becoming brown; scales finally shedding individually leaving a persistent thick central axis. Seeds— circumferentially winged, to 1.1 × 0.7 cm, wing 0.1–0.2 cm wide."

702	Propagules dispersed intentionally by people	y
	Source(s)	Notes

Qsn #	Question	Answer
	Thomas, P. 2011. <i>Wollemia nobilis</i> . The IUCN Red List of Threatened Species 2011: e.T34926A9898196. http://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T34926A9898196.en . [Accessed 16 Aug 2017]	"Protective measures include restricting access to the site and strict phytosanitary precautions for all researchers visiting the sites to undertake approved research and monitoring. An ex-situ conservation and research programme was also initiated. As part of this programme, commercial propagation was undertaken and the resultant plants distributed for sale worldwide. The primary purpose of the commercialisation programme was to protect the wild stands from impacts associated with illegal collections and generate income for the continued conservation of <i>W. nobilis</i> and other threatened species."

703	Propagules likely to disperse as a produce contaminant	n
	Source(s)	Notes
	NSW Department of Environment and Conservation. 2006. <i>Wollemi Pine (Wollemia nobilis) Recovery Plan</i> . Department of Environment and Conservation (NSW), Hurstville NSW	[No evidence. Slow growth rate & seeds relatively large] "In cultivation, male cones have developed on plants as young as five years of age with some branches producing cones again. Female cones have developed on two seedlings, one at eight years and the other at ten years (Meagher and Offord unpubl.)" ... "Seeds of <i>Wollemi Pine</i> are light (ranging from 10-44 mg (Meagher & Offord unpubl.) and winged and it is most probable that they are dispersed within existing stands by wind."

704	Propagules adapted to wind dispersal	y
	Source(s)	Notes
	Boland, D.J. , Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., McDonald, M.W. & Turner, J.D. 2006. <i>Forest Trees of Australia</i> . CSIRO Publishing, Collingwood, Australia	"Seeds— circumferentially winged, to 1.1 × 0.7 cm, wing 0.1–0.2 cm wide."
	Offord, C. A., Porter, C. L., Meagher, P. F., & Errington, G. (1999). Sexual reproduction and early plant growth of the <i>Wollemi pine (Wollemia nobilis)</i> , a rare and threatened Australian conifer. <i>Annals of Botany</i> , 84(1): 1-9	"Wind may play a part in the distribution of poorly winged but relatively light <i>W. nobilis</i> seeds and they may also be carried away by running water in the creek into which some seeds fall. Despite some potential for dispersal, establishment of seedlings more than 50 m away from the main group of trees has not been observed."

705	Propagules water dispersed	y
	Source(s)	Notes
	Offord, C. A., Porter, C. L., Meagher, P. F., & Errington, G. (1999). Sexual reproduction and early plant growth of the <i>Wollemi pine (Wollemia nobilis)</i> , a rare and threatened Australian conifer. <i>Annals of Botany</i> , 84(1): 1-9	"Wind may play a part in the distribution of poorly winged but relatively light <i>W. nobilis</i> seeds and they may also be carried away by running water in the creek into which some seeds fall."

706	Propagules bird dispersed	n
	Source(s)	Notes

Qsn #	Question	Answer
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	[Birds are seed predators] "Birds, mainly parrots such as Crimson Rosellas (<i>Platycercus elegans</i>), have a significant impact on seed fall. Crimson rosellas have been observed in the wild grazing along the leafy branches and disturbing the shattered strobili. The coats of many seeds falling into the seed traps (erected 1996 and 1997) had been neatly split and the seed contents removed." ... "Seeds of Wollemi Pine are light (ranging from 10-44 mg (Meagher & Offord unpubl.) and winged and it is most probable that they are dispersed within existing stands by wind."

707	Propagules dispersed by other animals (externally)	n
	Source(s)	Notes
	Boland, D.J. , Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., McDonald, M.W. & Turner, J.D. 2006. Forest Trees of Australia. CSIRO Publishing, Collingwood, Australia	"Seeds— circumferentially winged, to 1.1 × 0.7 cm, wing 0.1–0.2 cm wide." [No means of external attachment]
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	"Seeds of Wollemi Pine are light (ranging from 10-44 mg (Meagher & Offord unpubl.) and winged and it is most probable that they are dispersed within existing stands by wind."

708	Propagules survive passage through the gut	n
	Source(s)	Notes
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	[Seeds are depredated] "Birds, mainly parrots such as Crimson Rosellas (<i>Platycercus elegans</i>), have a significant impact on seed fall. Crimson rosellas have been observed in the wild grazing along the leafy branches and disturbing the shattered strobili. The coats of many seeds falling into the seed traps (erected 1996 and 1997) had been neatly split and the seed contents removed. Rodent or marsupial toothmarks have also been found on apparently viable seed. Predation from these sources appears to destroy at least 37% of putative viable seed (Offord et al. 1999)."

801	Prolific seed production (>1000/m2)	n
	Source(s)	Notes
	Offord, C. A., Porter, C. L., Meagher, P. F., & Errington, G. (1999). Sexual reproduction and early plant growth of the Wollemi pine (<i>Wollemia nobilis</i>), a rare and threatened Australian conifer. <i>Annals of Botany</i> , 84(1): 1-9	"Based on our observations of approx. 150 cones produced at Site 1 and 10% viability (25 seeds per cone), we estimate that there were 3 ± 4000 viable seeds produced in 1996."
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	"Female cones and seeds mature from late summer to early winter. Generally, less than 10% of the approx. 250 ovules in female cones develop into viable seeds. In Stand 1, approximately 300 cones matured and dropped seed in the 1996 season, producing an estimated 4000 seeds (Offord et al. 1999). Cones have been observed with up to 22% viable seeds (Grace, Hargreaves and Meagher, unpubl.)."

Qsn #	Question	Answer
802	Evidence that a persistent propagule bank is formed (>1 yr)	
	Source(s)	Notes
	NSW Department of Environment and Conservation. 2006. Wollemi Pine (<i>Wollemia nobilis</i>) Recovery Plan. Department of Environment and Conservation (NSW), Hurstville NSW	"Seeds are orthodox in regards to their storage capability i.e. they can be dried down to less than 10% moisture content and stored at low temperature (-18°C) for up to five years, and possibly longer. Wollemi Pine seeds contain around 40% oil, including a short chain omega 3 fatty acid not commonly found in plants. Seeds stored at sub-optimal temperatures (> 0°C) show decreased germinability and viability, which correlates with an increase in lipid degradation (Offord et al. 2005)."
	Offord, C. A., & Meagher, P. F. (2001). Effects of temperature, light and stratification on seed germination of Wollemi pine (<i>Wollemia nobilis</i> , Araucariaceae). Australian Journal of Botany, 49(6), 699-704	"Site climate data and the laboratory germination pattern, coupled with preliminary field observations, indicate that seeds of <i>W. nobilis</i> germinate during periods of high temperature, such as during early seed fall, but that germination is especially rapid when the temperature is high following a period of low temperature. Seed germination is therefore most likely from November onwards, but there are high rates of predation by animals and microbial breakdown (Offord et al. 1999) and few seeds may persist from the previous season in the soil seed bank."

803	Well controlled by herbicides	
	Source(s)	Notes
	WRA Specialist. 2017. Personal Communication	Unknown. Extremely rare tree. No information on herbicide efficacy or chemical control of this species

804	Tolerates, or benefits from, mutilation, cultivation, or fire	y
	Source(s)	Notes
	Thomas, P. 2011. <i>Wollemia nobilis</i> . The IUCN Red List of Threatened Species 2011: e.T34926A9898196. http://dx.doi.org/10.2305/IUCN.UK.2011-2.RLTS.T34926A9898196.en . [Accessed 15 Aug 2017]	"Coppicing from the base is frequent (Department of Environment and Conservation NSW, 2006)."
	Boland, D.J. , Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., McDonald, M.W. & Turner, J.D. 2006. Forest Trees of Australia. CSIRO Publishing, Collingwood, Australia	"Wollemi pine is an erect tree up to 40 m tall, frequently coppicing from the base."

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	Source(s)	Notes
	WRA Specialist. 2017. Personal Communication	Unknown

Summary of Risk Traits:

High Risk / Undesirable Traits

- Grows in temperate to subtropical climates
- Potentially allelopathic
- May be a host of and susceptible to several fungal pathogens
- Shade tolerant
- Reproduces by seeds & potentially by root suckering
- Reported to be self-compatible
- Seeds dispersed by wind, water & intentionally by people
- Coppices frequently

Low Risk Traits

- No reports of invasiveness or naturalization, but limited evidence of widespread introduction outside native range
- Unarmed (no spines, thorns or burrs)
- Non-toxic
- Slow-growing; reaches reproductive maturity in 5+ years