

**Australia/New Zealand Weed Risk Assessment adapted for United States (see Gordon and Gantz 2008)**

Data used for analysis published in: Gordon, D.R., K.J. Tancig, D.A. Onderdonk and C.A. Gantz. In press. Assessing the invasive potential of biofuel species proposed for Florida and the United States using the Australian weed risk assessment. Biomass and Bioenergy. doi:10.1016/j.biombioe.2010.08.029.

<i>Eucalyptus grandis</i> -- United States test			
	Question	Answer	Score
1.01	Is the species highly domesticated?	n	0
1.02	Has the species become naturalised where grown?		
1.03	Does the species have weedy races?		
2.01	Species suited to U.S. climates (USDA hardiness zones; 0-low, 1-intermediate, 2-high)	2	
2.02	Quality of climate match data (0-low; 1-intermediate; 2-high)	2	
2.03	Broad climate suitability (environmental versatility)	?	
2.04	Native or naturalized in regions with an average of 11-60 inches of annual precipitation	y	1
2.05	Does the species have a history of repeated introductions outside its natural range?	y	
3.01	Naturalized beyond native range	y	2
3.02	Garden/amenity/disturbance weed	n	0
3.03	Weed of agriculture	n	0
3.04	Environmental weed	y	4
3.05	Congeneric weed	y	2
4.01	Produces spines, thorns or burrs	n	0
4.02	Allelopathic	?	
4.03	Parasitic	n	0
4.04	Unpalatable to grazing animals	?	
4.05	Toxic to animals	n	0
4.06	Host for recognised pests and pathogens	?	
4.07	Causes allergies or is otherwise toxic to humans	n	0
4.08	Creates a fire hazard in natural ecosystems	?	

4.09	Is a shade tolerant plant at some stage of its life cycle	n	0
4.10	Grows on one or more of the following soil types: alfisols, entisols, or mollisols	y	1
4.11	Climbing or smothering growth habit	n	0
4.12	Forms dense thickets	?	
5.01	Aquatic	n	0
5.02	Grass	n	0
5.03	Nitrogen fixing woody plant	n	0
5.04	Geophyte	n	0
6.01	Evidence of substantial reproductive failure in native habitat	n	0
6.02	Produces viable seed	y	1
6.03	Hybridizes naturally	y	1
6.04	Self-compatible or apomictic	y	1
6.05	Requires specialist pollinators	n	0
6.06	Reproduction by vegetative fragmentation	n	-1
6.07	Minimum generative time (years)	3	0
7.01	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)		
7.02	Propagules dispersed intentionally by people	y	1
7.03	Propagules likely to disperse as a produce contaminant	n	-1
7.04	Propagules adapted to wind dispersal	n	-1
7.05	Propagules water dispersed		
7.06	Propagules bird dispersed		
7.07	Propagules dispersed by other animals (externally)	n	-1
7.08	Propagules dispersed by other animals (internally)		
8.01	Prolific seed production	n	-1
8.02	Evidence that a persistent propagule bank is formed (>1 yr)	n	-1
8.03	Well controlled by herbicides	y	-1
8.04	Tolerates, or benefits from, mutilation or cultivation	y	1

8.05	Effective natural enemies present in U.S.		
Total Score			8

Outcome	Reject
---------	--------

section	# questions answered	satisfy minimum?
A	7	Yes
B	10	Yes
C	19	Yes
total	36	Yes

Data collected 2008

Question number	Reference	Source data
1.01		Cultivated, but no evidence of selection for reduced weediness.
1.02		
1.03		
2.01	<p>1. PERAL NAPPFAST Global Plant Hardiness (<a href="http://www.nappfast.org/Plant_hardiness/NAPPFAST%20Global%20zones/10-year%20climate/PLANT_HARDINESS_10YR%20lnd.tif">http://www.nappfast.org/Plant_hardiness/NAPPFAST%20Global%20zones/10-year%20climate/PLANT_HARDINESS_10YR%20lnd.tif</a>). 2. USDA, ARS, National Genetic Resources Program. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. URL: <a href="http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?15924">http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?15924</a> (02 June 2008). 3. Pacific Island Ecosystems at Risk (PIER). <a href="http://www.hear.org/pier/species/eucalyptus_grandis.html">http://www.hear.org/pier/species/eucalyptus_grandis.html</a>. Accessed June 3, 2008. 4. Henderson, L. 2001. Alien Weeds and Invasive Plants. Plant Protection Research Institute/Agricultural Research Council, Pretoria, South Africa. 5. Soerianegara, I, Lemmens, RHMJ, eds. (1994) Plant Resources of South-East Asia. No 5. Timber Trees: Major</p>	<p>1. Global plant hardiness zones 9-13. 2. "Distributional range: Native: Australasia: Australia- New South Wales, Queensland". 3. "Native range: New South Wales and Queensland, Australia". 4. "Origin: E&amp; NE Australia." 5. "Distribution: Native to coastal areas in southern Queensland and northern New South Wales, Australia. Plantations exist in Peninsular Malaysia." 6. "It is relatively disease free but somewhat frost tender."; "The species occurs in the coastal areas of eastern Australia from new Newcastle in New South Wales (30°S) into southeastern Queensland. Isolated populations occur in north Queensland near Mackay and on the Atherton tableands (17°S)."; "Winter minimum may be -1°C to -3°C." 7. "<i>Eucalyptus grandis</i>, as recognized by</p>

	<p>Commercial Timbers. Bogor, Indonesia. 6. National Academy of Sciences (1980) Firewood Crops: Shrub and Tree Species for Energy Production. Washington, D.C. 7. Eldridge, K, et al. (1994) Eucalypt Domestication and Breeding. Clarendon Press, Oxford. 8. Food and Agriculture Organization of the United Nations (1979) Eucalypts for Planting. Rome. 9. Flora Zambesiaca (<a href="http://apps.kew.org/efloras/namedetail.do?flora=fz&amp;taxon=3494&amp;nameid=8420">http://apps.kew.org/efloras/namedetail.do?flora=fz&amp;taxon=3494&amp;nameid=8420</a>). 10. Flora of Zimbabwe: Species Information: Eucalyptus grandis. URL: <a href="http://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=142450">http://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=142450</a>. Accessed July 15, 2008. 11. George, AS, ed. (1980) Flora of Australia. Vol. 19, Myrtaceae-Eucalyptus, Angophora. Australian Government Publishing Service, Canberra. 12. Chaix, G, et al. (2007) Are phenological observations sufficient to estimate the quality of seed crops from a Eucalyptus grandis open-pollinated seed orchard? Consequences for seed collections. New Forests 33 (1): 41-52. [Since E. grandis can survive in hardiness zones 9-13, it would be able to survive in all 3 zones.]</p>	<p>Pryor and Johnson (1971), has its southern limit of distribution at Minmi near Newcastle, New South Wales, at 32 degrees S. Distribution from there is almost continuous up the New South Wales coast into southern Queensland to latitude 26 degrees S. Further north the species is absent until about 18 degrees S. Its distribution in the northern area is patchy with populations on the Eungella Tableland near Mackay, near Ingham, on the Atherton Tableland, and on the Windsor Tableland at the northern extreme of its range, 16 degrees S (Burgess, 1983)."; "For example, the range of mean annual temperature was from 14 degrees to 22 degrees C". 8. "In Kerala it remains healthy and grows excellently...mean monthly temperatures drop from 29°C in the summer to 13°C in the winter." 9. "Distribution: Malawi, Zambia, Zimbabwe" [cultivated range]. 10. "Worldwide distribution: Coastal parts of Queensland and New South Wales, Australia"; "Zimbabwe distribution: E". 11. "Occurs in Qld and N.S.W. in several disjunct areas: in the Atherton area, W of Townsville, W of Mackay, and with the main area from near Bundaberg southwards to near Port Stephens." 12. "The mean annual air temperature is 19°C"; "This study demonstrates that E. grandis is well adapted to local environmental conditions in Madagascar."</p>
2.02		Native range is well known. See 2.02.
2.03	<p>1. Köppen-Geiger climate map (<a href="http://www.hydrol-earth-syst-sci.net/11/1633/2007/hess-11-1633-2007.pdf">http://www.hydrol-earth-syst-sci.net/11/1633/2007/hess-11-1633-2007.pdf</a>). 2. USDA, ARS, National Genetic Resources Program. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. URL: <a href="http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?15924">http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?15924</a> (02 June 2008). 3. Pacific Island Ecosystems at Risk (PIER).</p>	<p>1. Possibly three climatic groups, but most likely only two (distribution range is not specific enough to determine for certain). 2. "Distributional range: Native: Australasia: Australia- New South Wales, Queensland". 3. "Native range: New South Wales and Queensland, Australia". 4. "Origin: E &amp; NE Australia." 5. "Distribution: Native to coastal areas in southern Queensland and northern New</p>

	<p><a href="http://www.hear.org/pier/species/eucalyptus_grandis.html">http://www.hear.org/pier/species/eucalyptus_grandis.html</a>. Accessed June 3, 2008. 4. Henderson, L (2001) Alien Weeds and Invasive Plants. Agricultural Research Council. 5. Soerianegara, I, Lemmens, RHMJ, eds. (1994) Plant Resources of South-East Asia. No 5. Timber Trees: Major Commercial Timbers. Bogor, Indonesia. 6. National Academy of Sciences (1980) Firewood Crops: Shrub and Tree Species for Energy Production. Washington, D.C. 7. Eldridge, K, et al. (1994) Eucalypt Domestication and Breeding. Clarendon Press, Oxford. 8. Food and Agriculture Organization of the United Nations. (1979) Eucalypts for Planting. Rome. 9. Flora Zambesiaca (<a href="http://apps.kew.org/efloras/namedetail.do?flora=fz&amp;taxon=3494&amp;nameid=8420">http://apps.kew.org/efloras/namedetail.do?flora=fz&amp;taxon=3494&amp;nameid=8420</a>). 10. Flora of Zimbabwe: Species Information: Eucalyptus grandis. URL: <a href="http://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=142450">http://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=142450</a>. Accessed July 15, 2008. 11. George, AS, ed. (1980) Flora of Australia. Vol. 19, Myrtaceae-Eucalyptus, Angophora. Australian Government Publishing Service, Canberra. 12. Chaix, G, et al. (2007) Are phenological observations sufficient to estimate the quality of seed crops from a Eucalyptus grandis open-pollinated seed orchard? Consequences for seed collections. New Forests 33 (1): 41-52.</p>	<p>South Wales, Australia. Plantations exist in Peninsular Malaysia." 6. "The species occurs in the coastal areas of eastern Australia from near Newcastle in New South Wales (30°S) into southeastern Queensland. Isolated populations occur in north Queensland near Mackay and on the Atherton tablelands (17°S)." 7. "Eucalyptus grandis, as recognized by Pryor and Johnson (1971), has its southern limit of distribution at Minmi near Newcastle, New South Wales, at 32°S. Distribution from there is almost continuous up the New South Wales coast into southern Queensland to latitude 26°S. Further north the species is absent until about 18°S. Its distribution in the northern area is patchy with populations on the Eungella Tableland near Mackay, near Ingham, on the Atherton Tableland, and on the Windsor Tableland at the northern extreme of its range, 16°S (Burgess, 1983)." 8. "In Kerala it remains healthy and grows excellently". 9. "Distribution: Malawi, Zambia, Zimbabwe" [cultivated range]. 10. "Worldwide distribution: Coastal parts of Queensland and New South Wales, Australia"; "Zimbabwe distribution: E". 11. "Occurs in Qld and N.S.W. in several disjunct areas: in the Atherton area, W of Townsville, W of Mackay, and with the main area from near Bundaberg southwards to near Port Stephens." 12. "This study demonstrates that E. grandis is well adapted to local environmental conditions in Madagascar."</p>
2.04	<p>1. Australian Government, Bureau of Meteorology (<a href="http://www.bom.gov.au/cgi-bin/climate/cgi_bin_scripts/annual-monthly-rainfall.cgi">http://www.bom.gov.au/cgi-bin/climate/cgi_bin_scripts/annual-monthly-rainfall.cgi</a>). 2. Atlapedia Online (<a href="http://www.atlapedia.com/online/countries/malawi.htm">http://www.atlapedia.com/online/countries/malawi.htm</a>). 3. Atlapedia Online (<a href="http://www.atlapedia.com/online/countries/zambia.htm">http://www.atlapedia.com/online/countries/zambia.htm</a>). 4. Atlapedia Online (<a href="http://www.atlapedia.com/online/countries/zimbabwe.htm">http://www.atlapedia.com/online/countries/zimbabwe.htm</a>). 5. National Academy of Sciences.</p>	<p>1. For Eastern New South Wales: average annual precipitation ranges from 600 - 2000 mm/year (23.62 - 78.7 inches/year); For E Queensland, the average annual precipitation ranges from 600 - 3200 mm/year (23.62 - 125.98 inches/year). 2. For Malawi: average annual precipitation is 740 mm (29 inches). 3. For Zambia: average annual precipitation varies between 1,000 mm</p>

	<p>(1980) Firewood crops: Shrub and Tree Species for Energy Production. Washington, D.C. 6. Food and Agriculture Organization of the United Nations. (1979) Eucalypts for Planting. Rome. 7. Chaix, G, et al. (2007) Are phenological observations sufficient to estimate the quality of seed crops from a Eucalyptus grandis open-pollinated seed orchard? Consequences for seed collections. New Forests 33 (1): 41-52. 8. Podberscek, M (1991) Field Guide to the Eucalypts of the Gympie, Imbil and Maryborough Forestry Districts. Technical Paper. No. 48. Queensland Forest Service. [In the native range the variation in precipitation includes all of the precipitation limits set for all 3 zones in Florida; no zonal differences.]</p>	<p>and 1,400 mm (40 and 50 inches) in the north decreasing to 510 mm (21 inches) in the south. 4. For Zimbabwe: rainfall is highest on the High Veld with an average annual precipitation of up to 1,020 mm (40 inches) while the Middle Veld receives 410 mm to 610 mm (16 to 24 inches) and the Low Veld receives less than 400 mm (12 inches). 5. "Rainfall, Mean annual rainfall in the native habitat varies between 1,000 and 1,800 mm [39.37 inches and 70.87 inches] with a summer/autumn predominance and a spring dry period." 6. "Most countries specify a minimum of 800 mm [31.50 inches], and for best growth over 1,000 mm [39.37 inches] are preferable."; "In Kerala...rainfall is over 2,500 mm [98.43]". 7. "The summer rainfall around 1,500 mm [59.05 inches] (January to April) with fine drizzle during winter (July to September)."; "1500 mm [59.06 inches] of summer rainfall". 8. "Grows well near water, but not on waterlogged flats."</p>
2.05	<p>1. National Academy of Sciences. (1980) Firewood Crops: Shrub and Tree species for Energy Production. Washington, D.C. 2. Food and Agriculture Organization of the United Nations (1979) Eucalypts for Planting. Rome. 3. Chaix, G, et al. (2007) Are phenological observations sufficient to estimate the quality of seed crops from a Eucalyptus grandis open-pollinated seed orchard? Consequences for seed collections. New Forests 33 (1): 41-52. 4. Podberscek, M (1991) Field Guide to the Eucalypts of the Gympie, Imbil and Maryborough Forestry Districts. Technical Paper. No. 48. Queensland Forest Service.</p>	<p>1. "The tree grown in African and Brazilian plantations has been selected from several generations of cultivated crops and is markedly superior to wild types in yield and stem straightness."; "The species is widely cultivated in South America, the East African highlands, and South Africa as well as in numerous small plantings in other countries. It is so important in Brazil that huge plantations are being established with an annual planting program on the order of 100,000 ha." 2. "E. grandis...[has] been grown in very successful industrial plantations in Brazil, South Africa and India." 3. "In Madagascar, fast-growing eucalypt plantations were established, via the introduction of Eucalyptus grandis genetic resources as an exotic species." 4. "A suitable tree for ornamental and broadscale plantings."</p>
3.01	1. Henderson, L. 2001. Alien Weeds and	1. "Declared invader (category 2)." 2.

	<p>Invasive Plants. Plant Protection Research Institute/Agricultural Research Council, Pretoria, South Africa. 2. New Zealand Plant Conservation Network (2005) New Zealand Adventive Vascular Plant List. 3. Forsyth, GG, et al. (2004) A rapid assessment of the invasive status of Eucalyptus species in two South African provinces. South African Journal of Science 100: 75-77.</p>	<p>Fully naturalized in New Zealand. 3. E. grandis is naturalized in Mpumalanga, South Africa.</p>
3.02		No evidence.
3.03		No evidence.
3.04	<p>1. Forsyth, G.G. et al. 2004. A rapid assessment of the invasive status of Eucalyptus species in two South African provinces. South African Journal of Science 100: 75-77. 2. Henderson, L. 2001. Alien Weeds and Invasive Plants. Plant Protection Research Institute/Agricultural Research Council, Pretoria, South Africa.</p>	<p>1. "All the eucalypts encountered were "naturalized", but only Red River gum (E. camaldulensis) and flooded gum (E. grandis) were clearly "invasive"...Flooded gum invades river courses in Mpumalanga, where it was classified as invasive at 50% of our sites...Our findings concur with Henderson, who classifies these three species [Red river gum, flooded gum and spider gum] as habitat transformers...As far as the management of eucalypts as invasive alien species is concerned, we recommend that clearing projects should focus on removing these trees from riparian areas (where water use is likely to be excessive) and nature reserves (where all eucalypts have undesirable effects on biodiversity), but that clearing projects outside of these areas should focus only on Red river gum, flooded gum and spider gum." 2. "Declared invader (category 2) [Category 2 plants (commercially used plants) may be grown in demarcated areas providing that there is a permit and that steps are taken to prevent their spread]...Invasive status: Transformer [Plants which can as monospecies dominate or replace any canopy or subcanopy layer of a natural or semi-natural ecosystem, thereby altering its structure, integrity and functioning. The most serious environmental weeds are in this group, which includes trees, aggressive</p>

		climbers, thicket-forming shrubs and dense herbs]."
3.05	1. Holm, L. et al. (1979) A Geographical Atlas of World Weeds. John Wiley and Sons, New York. 2. Henderson, L. 2001. Alien Weeds and Invasive Plants. Plant Protection Research Institute/Agricultural Research Council, Pretoria, South Africa.	1. Eucalyptus cambageana is a Principal weed in Australia. 2. Eucalyptus diversicolor is an Invader in South Africa.
4.01		No description of these traits.
4.02	USDA, NRCS (2008) The PLANTS Database ( <a href="http://plants.usda.gov">http://plants.usda.gov</a> , 1 July 2008). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.	"Known allelopath: Yes".
4.03		No description of parasitism.
4.04	USDA, NRCS (2008). The PLANTS Database ( <a href="http://plants.usda.gov">http://plants.usda.gov</a> , 1 July 2008). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.	"Palatable Browse Animal: Low"; "Palatable Graze Animal: N/A".
4.05	USDA, NRCS (2008) The PLANTS Database ( <a href="http://plants.usda.gov">http://plants.usda.gov</a> , 1 July 2008). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.	"Toxicity: None". [no other evidence of toxicity.]
4.06	1. National Academy of Sciences (1980) Firewood Crops: Shrub and Tree Species for Energy Production. Washington, D.C. 2. Food and Agriculture Organization of the United Nations (1979) Eucalypts for Planting. Rome. 3. George, AS, ed. (1980) Flora of Australia. Vol. 19, Myrtaceae-Eucalyptus, Angophora. Australian Government Publishing Service, Canberra.	1. "Most exotic plantations of the species are as yet free of any serious pests and diseases. In Brazil the fungus Diaportha cubensis attacks the species, and termites will attack the young trees." 2. "E. grandis is not often attacked and then only lightly."; "Numbers 16 and 17 - Nieuw Nickerie and Alleppey - may give excellent initial growth, but there is a severe risk of epidemic fungal pathogens."; "In Suriname a serious disease, the fungus Diaporthe cubensis, has caused stem cankers and deaths in plantings of E. grandis and E. saligna. The fungus was identified as Endothia havanensis. In Brazil in the wetter areas E. grandis is classed as moderately susceptible to the fungus Diaporthe cubensis, which causes a canker disease...In Kerala the fungus Corticium salmonicolor has caused severe losses



		in low altitude plantations with uniformly high temperatures and high rainfall." 3. "The wood being resistant to borers".
4.07	USDA, NRCS (2008) The PLANTS Database ( <a href="http://plants.usda.gov">http://plants.usda.gov</a> , 1 July 2008). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.	"Toxicity: None". [no other evidence of toxicity.]
4.08	National Academy of Sciences (1980) Firewood Crops: Shrub and Tree Species for Energy Production. Washington, D.C.	"E. grandis...is very sensitive to fire."
4.09	USDA, NRCS (2008) The PLANTS Database ( <a href="http://plants.usda.gov">http://plants.usda.gov</a> , 1 July 2008). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.	"Shade Tolerance: Intolerant".
4.10	<p>1. USDA, National Resources Conservation Services (NRCS), Soil Survey Division, World Soil Resources (<a href="http://soils.usda.gov/use/worldsoils/mapindex/order.html">http://soils.usda.gov/use/worldsoils/mapindex/order.html</a>). 2. Soerianegara, I, Lemmens, RHMJ, eds. (1994) Plant Resources of South-East Asia. No 5. Timber Trees: Major Commercial Timbers. Bogor, Indonesia. 3. National Academy of Sciences (1980) Firewood Crops: Shrub and Tree Species for Energy Production. Washington, D.C. 4. Food and Agriculture Organization of the United Nations (1979) Eucalypts for Planting. Rome. 5. Podberscek, M (1991) Field Guide to the Eucalypts of the Gympie, Imbil and Maryborough Forestry Districts. Technical Paper. No. 48. Queensland Forest Service.</p>	<p>1. Queensland (E coast): mostly alfisols with some ultisols, a small amount of entisols, and very small amounts of inceptisols and mollisols; New South Wales (E coast): mostly alfisols with some entisols, inceptisols, mollisols, and ultisols (and also possibly small amounts of oxisols and spodosols); Malawi: mostly oxisols and alfisols with a small amount of inceptisols and ultisols; Zambia: mostly oxisols with some alfisols, entisols, inceptisols, and ultisols (also a small amount of the shifting sands soil order type); Zimbabwe: almost entirely alfisols with some aridisols, entisols, and inceptisols, and a very small amount of ultisols (also with a very small amount of oxisols). 2. "Performs best on deep, well-drained, fertile loam or clay-loam soils, in natural conditions". 3. "<i>Eucalyptus grandis</i> is a fast-growing tree, adapted to a wide range of soil types."; "<i>E. grandis</i> prefers moist, well-drained soils derived from a variety of parent materials such as shales, slates, sandstones, some granite, and occasionally basalt." 4. "<i>E. grandis</i> needs a deep free-draining soil, and does best on fertile loam or clay-loam soils, but will also perform well on the lighter sandy soils, provided these are of</p>

		adequate depth. On fertile soils a depth of 1 m may be sufficient but on the less fertile sandy soils in Zambia a depth of 2 m is considered desirable. In Uruguay excellent growth has been obtained on deep sandy soils near the River Uruguay where soil/moisture relations are excellent." 5. "On moist, well-drained deep sandy loam soils of alluvial or volcanic origin."
4.11	<p>1. USDA, NRCS (2008) The PLANTS Database (<a href="http://plants.usda.gov">http://plants.usda.gov</a>, 1 July 2008). National Plant Data Center, Baton Rouge, LA 70874-4490 USA. 2. PIER. URL: <a href="Http://www.hear.org/peir/species/eucalyptus_grandis.html">Http://www.hear.org/peir/species/eucalyptus_grandis.html</a>. Accessed June 3, 2008. 3. Henderson, L. 2001. Alien Weeds and Invasive Plants. Plant Protection Research Institute/Agricultural Research Council, Pretoria, South Africa. 4. Soerianegara, I, Lemmens, RHMJ, eds. (1994) Plant Resources of South-East Asia. No 5. Timber Trees: Major Commercial Timbers. Bogor, Indonesia. 5. National Academy of Sciences (1980) Firewood Crops: Shrub and Tree Species for Energy Production. Washington, D.C. 6. Food and Agriculture Organization of the United Nations (1979) Eucalypts for Planting. Rome. 7. George, AS, ed. (1980) Flora of Australia. Vol. 19, Myrtaceae-Eucalyptus, Angophora. Australian Government Publishing Service, Canberra. 8. Flora Zambesiaca (<a href="http://apps.kew.org/efloras/namedetail.do?flora=fz&amp;taxon=3494&amp;nameid=8420">http://apps.kew.org/efloras/namedetail.do?flora=fz&amp;taxon=3494&amp;nameid=8420</a>). 9. Flora of Zimbabwe: Species Information: Eucalyptus grandis. URL: <a href="http://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=142450">http://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=142450</a>. Accessed July 15, 2008. 10. Podberscek, M (1991) Field Guide to the Eucalypts of the Gympie, Imbil and Maryborough Forestry Districts. Technical Paper. No. 48. Queensland Forest Service.</p>	<p>1. "Growth Habit: Tree". 2. "Tree to 55 m." 3. "Tall, evergreen tree with shaft-like trunk, 22--55(-72)m high". 4. "A medium-sized to very large tree of up to 55 m tall, bole straight, up to 30 m long and up to 200 cm in diameter." 5. "E. grandis is a straight, white-trunked eucalypt"; "In virgin natural stands, trees may reach 50-60 m tall, with trunk diameter up to 2 m." 6. "Tree height in Australia: 45-55 m; usually with an excellent trunk and a widespreading rather thin crown." 7. "Tree to 55 m." 8. "Tall tree." 9. "Tree." 10. "Growth Habit: Tree bole is generally clean and straight...Tree height 45 to 55 m."</p>
4.12	Food and Agriculture Organization of the United Nations (1979) Eucalypts for Planting. Rome.	"Tree height in Australia: 45-55 m; usually with an excellent trunk and a widespreading rather thin crown."

5.01		Terrestrial.
5.02	USDA, ARS, National Genetic Resources Program. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. URL: <a href="http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?15924">http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?15924</a> (02 June 2008).	Myrtaceae
5.03	USDA, ARS, National Genetic Resources Program. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. URL: <a href="http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?15924">http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?15924</a> (02 June 2008).	Myrtaceae
5.04	1. USDA, NRCS (2008) The PLANTS Database ( <a href="http://plants.usda.gov">http://plants.usda.gov</a> , 1 July 2008). National Plant Data Center, Baton Rouge, LA 70874-4490 USA. 2. PIER. <a href="http://www.hear.org/peir/species/eucalyptus_grandis.html">Http://www.hear.org/peir/species/eucalyptus_grandis.html</a> . Accessed June 3, 2008. 3. Henderson, L. 2001. Alien Weeds and Invasive Plants. Plant Protection Research Institute/Agricultural Research Council, Pretoria, South Africa. 4. Soerianegara, I, Lemmens, RHMJ, eds. (1994) Plant Resources of South-East Asia. No 5. Timber Trees: Major Commercial Timbers. Bogor, Indonesia. 5. National Academy of Sciences (1980) Firewood Crops: Shrub and Tree Species for Energy Production. Washington, D.C. 6. Food and Agriculture Organization of the United Nations (1979) Eucalypts for Planting. Rome. 7. George, AS, ed. (1980) Flora of Australia. Vol. 19, Myrtaceae-Eucalyptus, Angophora. Australian Government Publishing Service, Canberra. 8. Flora Zambesiaca ( <a href="http://apps.kew.org/efloras/namedetail.do?flora=fz&amp;taxon=3494&amp;nameid=8420">http://apps.kew.org/efloras/namedetail.do?flora=fz&amp;taxon=3494&amp;nameid=8420</a> ). 9. Flora of Zimbabwe: Species Information: Eucalyptus grandis. URL: <a href="http://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=142450">http://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=142450</a> . Accessed July 15, 2008.	1. "Growth Habit: Tree"; "Propagated by Tubers: No". 2. "Tree to 55 m." 3. "Tall, evergreen tree with shaft-like trunk, 22--55(-72)m high". 4. "A medium-sized to very large tree of up to 55 m tall, bole straight, up to 30 m long and up to 200 cm in diameter." 5. "E. grandis is a straight, white-trunked eucalypt"; "In virgin natural stands, trees may reach 50-60 m tall, with trunk diameter up to 2 m." 6. Tree height in Australia: 45-55 m; usually with an excellent trunk and a widespreading rather thin crown." 7. "Tree to 55 m." 8. "Tall tree." 9. "Tree."
6.01		No evidence.
6.02	1. USDA, NRCS (2008) The PLANTS Database	1. "Propagated by Seed: Yes". 2.

	<p>(<a href="http://plants.usda.gov">http://plants.usda.gov</a>, 1 July 2008). National Plant Data Center, Baton Rouge, LA 70874-4490 USA. 2. PIER. <a href="Http://www.hear.org/peir/species/eucalyptus_grandis.html">Http://www.hear.org/peir/species/eucalyptus_grandis.html</a>. Accessed June 3, 2008. 3. Soerianegara, I, Lemmens, RHMJ, eds. (1994) Plant Resources of South-East Asia. No 5. Timber Trees: Major Commercial Timbers. Bogor, Indonesia. 4. Food and Agriculture Organization of the United Nations (1979) Eucalypts for Planting. Rome.</p>	<p>"Propagation: Seed". 3. "Eucalypts can be propagated easily from seed and sometimes from cuttings. Seeds germinate in 4-20 days. Seedlings are best raised in trays filled with sterile, fine, loamy sand." 4. Viable seeds per gram: 632."</p>
6.03	<p>1. National Academy of Sciences (1980) Firewood Crops: Shrub and Tree Species for Energy Production. Washington, D.C. 2. Food and Agriculture Organization of the United Nations (1979) Eucalypts for Planting. Rome. 3. Flora Zambesiaca (<a href="http://apps.kew.org/efloras/namedetail.do?flora=fz&amp;taxon=3494&amp;nameid=8420">http://apps.kew.org/efloras/namedetail.do?flora=fz&amp;taxon=3494&amp;nameid=8420</a>). 4. Flora of Zimbabwe: Species Information: Eucalyptus grandis. URL: <a href="http://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=142450">http://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=142450</a>. Accessed July 15, 2008.</p>	<p>1. "A natural hybrid between <i>E. grandis</i> and <i>E. robusta</i>, known as <i>E. grandis</i> var. <i>grandiflora</i>". 2. "<i>E. grandis</i> [is] likely to hybridize with close relatives in the subgenus <i>Symphomyrtus</i> which occur over the same latitudes and are in adjacent localities."; "Some hybridization between <i>E. grandis</i> and <i>E. saligna</i> probably takes place from time to time. Another hybrid...is that between <i>E. grandis</i> and <i>E. tereticornis</i>." 3. "It appears that most of the stands of <i>E. grandis/salinga</i> in southern Africa are of hybrid origin, though closer to the former." 4. "This species and its hybrids with <i>Eucalyptus salinga</i> are commonly planted in Zimbabwe."</p>
6.04	<p>1. Food and Agriculture Organization of the United Nations (1979) Eucalypts for Planting. Rome. 2. Chaix, G, et al. (2007) Are phenological observations sufficient to estimate the quality of seed crops from a <i>Eucalyptus grandis</i> open-pollinated seed orchard? Consequences for seed collections. <i>New Forests</i> 33 (1): 41-52. 3. Horsley, TN, Johnson, SD (2007) Is <i>Eucalyptus</i> cryptically self-incompatible? <i>Annals of Botany</i> 100 (6): 1373-1378. 4. Hodgson, L.M. 1976a. Some aspects of flowering and reproductive behaviour in <i>Eucalyptus grandis</i> (Hill) Maiden at J.D.M. Keet Forest Research Station (formerly Zomerkomst Forest Research Station). 1. Flowering, controlled pollination methods, pollination and receptivity. <i>South African Forestry Journal</i> 97: 18-28. 5. Hodgson, L.M. 1976b. Some aspects of flowering and reproductive behaviour</p>	<p>1. "Germination [in seedling seed orchards] is lower than that of commercial plantations. This may be due to an increased degree of selfing. In one test selfing varied from 10 percent to 33 percent under seed orchard conditions during the main flowering season; selfing results in decreased seed yield (20 percent of outcrossing) and a reduction of 8-49 percent in growth rate of surviving seedling, as well as an increase in the number of abnormal seedlings." 2. "Monoecious with slight protandry, has a stigma receptive two to three days after anthesis. This mechanism, which largely prevents self-pollination at the flower level, is not efficient at the tree level due to asynchronous flowering along branches."</p>

	<p>in <i>Eucalyptus grandis</i> (Hill) Maiden at J.D.M. Keet Forest Research Station (formerly Zomerkomst Forest Research Station). 2. The fruit, seed, seedlings, self-fertility, percent selfing and inbreeding effects. <i>South African Forestry Journal</i> 98: 32-33.</p>	<p>3. "The aim of the present study was to examine the breeding systems of...<i>E. grandis</i>, by using...controlled self- and cross- pollinations."; "No evidence of self-incompatibility was found at the stage of pollen adhesion and germination in the stigmatic exudate."; However, "Late-acting self-incompatibility in...<i>E. grandis</i> also seems likely on account of the low number of seeds set following self-pollination relative to the number of self-pollen tubes". 4. "Pollen is present on the anthers at and even before anthesis and it is obvious that self-pollination takes place within a flower (without insect visits) at the time the stigma is ringed by anthers." 5. "Despite such barriers, the species is known to be self fertile and, like most eucalypts, can be considered to have a mixed mating system. In natural stands of <i>E. grandis</i>, inbreeding to various degrees can be a common occurrence, both through selfing and through mating between neighbouring close relatives."</p>
6.05	<p>Chaix, G, et al. (2007) Are phenological observations sufficient to estimate the quality of seed crops from a <i>Eucalyptus grandis</i> open-pollinated seed orchard? Consequences for seed collections. <i>New Forests</i> 33 (1): 41-52.</p>	<p>"Insect pollinated <i>Eucalyptus</i> do not express specificity regarding the pollinating insects."</p>
6.06	<p>1. Virtue, J.G. and Melland, R.L. 2003. The Environmental Weed Risk of Revegetation and Forestry Plants. Report DWLBC 2003-02. Animal and Plant Control Commission/The Department of Water, Land and Biodiversity Conservation &amp; Cooperative Research Centre for Australian Weed Management. South Africa. 2. USDA, NRCS (2008) The PLANTS Database (<a href="http://plants.usda.gov">http://plants.usda.gov</a>, 1 July 2008). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.</p>	<p>1. "No vegetative reproduction occurs in this species." 2. "Resprout ability: Yes"; "Propagated by Bare Root: Yes"; "Propagated by Bulb: No"; "Propagated by Corm: No"; "Propagated by Cuttings: No"; "Propagated by Sprigs: No"; "Propagated by Tubers: No"; "Vegetative Spread Rate: None" [no other evidence of vegetative propagation]</p>
6.07	<p>1. Hodgson, L.M. 1976a. Some aspects of flowering and reproductive behaviour in <i>Eucalyptus grandis</i> (Hill) Maiden at J.D.M. Keet Forest Research Station (formerly Zomerkomst Forest Research Station). 1. Flowering,</p>	<p>1. "Reproductive behaviour: <i>E. grandis</i> typically flowers within 2-3 years after seed germination." 2. "It flowers and seeds early, normally after 4 or 5 years." 3. "<i>Eucalyptus grandis</i> is considered to</p>

	<p>controlled pollination methods, pollination and receptivity. South African Forestry Journal 97: 18-28. 2. Food and Agriculture Organization of the United Nations (1979) Eucalypts for Planting. Rome. 3. Chaix, G, et al. (2007) Are phenological observations sufficient to estimate the quality of seed crops from a Eucalyptus grandis open-pollinated seed orchard? Consequences for seed collections. New Forests 33 (1): 41-52. [Note: In Brazil, E. grandis can flower at 6-10 months of age, but no information on seed set is provided. Zobel, B.J., G. van Wyk, P. Stahl. 1987. Growing Exotic Forests. Wiley Interscience, New York.]</p>	<p>be sexually mature before age 10 years."</p>
7.01		No evidence.
7.02	<p>1. Henderson, L. 2001. Alien Weeds and Invasive Plants. Plant Protection Research Institute/Agricultural Research Council, Pretoria, South Africa. 2. Soerianegara, I, Lemmens, RHMJ, eds. (1994) Plant Resources of South-East Asia. No 5. Timber Trees: Major Commercial Timbers. Bogor, Indonesia. 3. National Academy of Sciences. (1980) Firewood Crops: Shrub and Tree Species for Energy Production. Washington, D.C. 4. Food and Agriculture Organization of the United Nations (1979) Eucalypts for Planting. Rome. 5. Chaix, G, et al. (2007) Are phenological observations sufficient to estimate the quality of seed crops from a Eucalyptus grandis open-pollinated seed orchard? Consequences for seed collections. New Forests 33 (1): 41-52. 6. Podberscek, M (1991) Field Guide to the Eucalypts of the Gympie, Imbil and Maryborough Forestry Districts. Technical Paper. No. 48. Queensland Forest Service.</p>	<p>1. "Cultivated for: Timber, shelter, shade, firewood; honey source." 2. "It is an important plantation tree in the tropics and subtropics." 3. "The tree grown in African and Brazilian plantations has been selected from several generations of cultivated crops and is markedly superior to wild types in yield and stem straightness."; "The species is widely cultivated in South America, the East African highlands, and South Africa as well as in numerous small plantings in other countries. It is so important in Brazil that huge plantations are being established with an annual planting program on the order of 100,000 ha." 4. "Prospects for planting. Already widely planted and plantations are being rapidly extended"; "E. grandis...[has] been grown in very successful industrial plantations in Brazil, South Africa and India." 5. "In Madagascar, fast-growing eucalypt plantations were established, via the introduction of Eucalyptus grandis genetic resources as an exotic species." 6. "A suitable tree for ornamental and broadscale plantings."</p>
7.03		No evidence.
7.04	<p>1. Cremer, K.W. (1977) Distance of seed dispersal in eucalypts estimated from seed</p>	<p>1. Measurements of wt. and terminal velocity (Vt) of viable seeds of 15</p>

	<p>weights. Australian Forest Research: 7(4): 225-228. 2. PIER. URL: <a href="http://www.hear.org/peir/species/eucalyptus_grandis.html">Http://www.hear.org/peir/species/eucalyptus_grandis.html</a>. Accessed June 3, 2008. 3. Henderson, L. 2001. Alien Weeds and Invasive Plants. Plant Protection Research Institute/Agricultural Research Council, Pretoria, South Africa. 4. Soerianegara, I, Lemmens, RHMJ, eds. (1994) Plant Resources of South-East Asia. No 5. Timber Trees: Major Commercial Timbers. Bogor, Indonesia. 5. Food and Agriculture Organization of the United Nations (1979) Eucalypts for Planting. Rome. 6. George, AS, ed. (1980) Flora of Australia. Vol. 19, Myrtaceae-Eucalyptus, Angophora. Australian Government Publishing Service, Canberra. 7. Flora Zambesiaca (<a href="http://apps.kew.org/efloras/namedetail.do?flora=fz&amp;taxon=3494&amp;nameid=8420">http://apps.kew.org/efloras/namedetail.do?flora=fz&amp;taxon=3494&amp;nameid=8420</a>). 8. Flora of Zimbabwe: Species Information: Eucalyptus grandis. URL: <a href="http://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=142450">http://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=142450</a>. Accessed July 15, 2008. 9. Podberscek, M (1991) Field Guide to the Eucalypts of the Gympie, Imbil and Maryborough Forestry Districts. Technical Paper. No. 48. Queensland Forest Service.</p>	<p>eucalypt species were used to construct an equation relating Vt to wt. for other eucalypt species with wingless seeds. Vt can be used to estimate seed dispersal distance on level terrain for specified wind speeds and ht. of release. Twelve of the 15 species had seed dispersal distances of less than 30 m for a wind speed of 10 km/h and release ht. of 40 m. 2. "Fruits subpyriform, 5-8 mm long, 4-7 mm wide; disc narrow, level or descending; valves 4 or 5, exerted, incurved". 3. "Fruits: Capsules, brown with bluish-grey bloom, pear-shaped, 7-10 mm long, with protruding valves that arch inwards." 4. "Fruit somewhat pear-shaped, 5-8 mm x 4-7 mm, with 4-5 exerted, incurved valves." 5. "Fruits clearly pear-shaped with very gradual taper to ill-defined stalk." 6. "Fruits subpyriform, 5-8 mm long, 4-7 mm wide; disc narrow, level or descending; valves 4 or 5, exerted, incurved." 7. "Fruit 0.7-0.8 x 0.6-0.8 cm., glaucous, cyathiform, rather thin, slightly contracted at the orifice; valves 4-6, rather thin, inserted just below the orifice." 8. "Fruit 7-8 mm, glaucous; valves 4-6, clearly visible at the mouth." 9. "Fruit: woody, slightly pyriform. Disc narrow, level. Valves 4 or 5, broad, exerted and incurved. Sometimes the fruit is glaucous." [#s 2-9: no evidence of adaptation to wind dispersal.]</p>
7.05		No evidence.
7.06		No evidence.
7.07	<p>1. PIER. URL: <a href="http://www.hear.org/peir/species/eucalyptus_grandis.html">Http://www.hear.org/peir/species/eucalyptus_grandis.html</a>. Accessed June 3, 2008. 2. Henderson, L. 2001. Alien Weeds and Invasive Plants. Plant Protection Research Institute/Agricultural Research Council, Pretoria, South Africa. 3. Soerianegara, I, Lemmens, RHMJ, eds. (1994) Plant Resources of South-East Asia. No 5. Timber Trees: Major Commercial Timbers. Bogor, Indonesia. 4.</p>	<p>1. "Fruits subpyriform, 5-8 mm long, 4-7 mm wide; disc narrow, level or descending; valves 4 or 5, exerted, incurved". 2. "Fruits: Capsules, brown with bluish-grey bloom, pear-shaped, 7-10 mm long, with protruding valves that arch inwards." 3. "Fruit somewhat pear-shaped, 5-8 mm x 4-7 mm, with 4-5 exerted, incurved valves." 4. "Fruits clearly pear-shaped with very gradual</p>

	<p>Food and Agriculture Organization of the United Nations (1979) <i>Eucalypts for Planting</i>. Rome. 5. George, AS, ed. (1980) <i>Flora of Australia</i>. Vol. 19, Myrtaceae-Eucalyptus, Angophora. Australian Government Publishing Service, Canberra. 6. <i>Flora Zambesiaca</i> (<a href="http://apps.keew.org/efloras/namedetail.do?flora=fz&amp;taxon=3494&amp;nameid=8420">http://apps.keew.org/efloras/namedetail.do?flora=fz&amp;taxon=3494&amp;nameid=8420</a>). 7. <i>Flora of Zimbabwe: Species Information: Eucalyptus grandis</i>. URL: <a href="http://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=142450">http://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=142450</a>. Accessed July 15, 2008. 8. Podberscek, M (1991) <i>Field Guide to the Eucalypts of the Gypie, Imbil and Maryborough Forestry Districts</i>. Technical Paper. No. 48. Queensland Forest Service.</p>	<p>taper to ill-defined stalk." 5. "Fruits subpyriform, 5-8 mm long, 4-7 mm wide; disc narrow, level or descending; valves 4 or 5, exerted, incurved." 6. "Fruit 0.7-0.8 x 0.6-0.8 cm., glaucous, cyathiform, rather thin, slightly contracted at the orifice; valves 4-6, rather thin, inserted just below the orifice." 7. "Fruit 7-8 mm, glaucous; valves 4-6, clearly visible at the mouth." 8. "Fruit: woody, slightly pyriform. Disc narrow, level. Valves 4 or 5, broad, exerted and incurved. Sometimes the fruit is glaucous." [No evidence of adaptation to external dispersal.]</p>
7.08		No evidence.
8.01	<p>Virtue, J.G. and Melland, R.L. 2003. <i>The Environmental Weed Risk of Revegetation and Forestry Plants</i>. Report DWLBC 2003-02. Animal and Plant Control Commission/The Department of Water, Land and Biodiversity Conservation &amp; Cooperative Research Centre for Australian Weed Management. South Africa.</p>	<p>"The species produces an average of 6700 seeds per 10 grams (ATSC 2001), but the slow release of seeds from capsules means that seed rain is likely to be less than 1000 seeds/m<sup>2</sup>/year."</p>
8.02	<p>1. Friday, J.B. 2000. <i>Seed Technology for Forestry in Hawaii</i>. Resource Management RM-4. College of Tropical Agriculture and Human Resources (CTAHR), University of Hawaii at Manoa. Honolulu, Hawaii. URL: <a href="http://www2.ctahr.hawaii.edu/oc/freepubs/pdf/RM-4.pdf">http://www2.ctahr.hawaii.edu/oc/freepubs/pdf/RM-4.pdf</a>. Accessed November 7, 2008. 2. Gill, A.M. 1997. <i>Eucalyptus and Fires: Interdependent or Independent</i>. In: <i>Eucalyptus Ecology: Individuals to Ecosystems</i>. Williams J.E. and Woinarski, J. (eds.) pp. 151-167. 3. <i>Water for a Healthy Country. Taxon Attribute Profiles: Eucalyptus camaldulensis Dehnh.</i> (<a href="http://www.csiro.au/files/files/pbsl.pdf">http://www.csiro.au/files/files/pbsl.pdf</a>).</p>	<p>1. Lacks recalcitrant seeds and germination time is 14-29 days. 2. Seed of Eucalyptus species examined in this study do not have dormancy barriers to prevent seed germination. Seed viability and storage in the soil is less than one year. 3. "Eucalyptus species store little or none of their seed in the soil."</p>
8.03	<p>1. Little, K, du Toit, B (2002) <i>Management of Eucalyptus grandis Coppice Regeneration of Seedling Parent Stock in Zululand, South Africa</i>. Institute for Commercial Forestry Research (Scottsville, Pietermaritzburg, South Africa). 2. Virtue, J.G. and Melland, R.L. 2003. <i>The Environmental Weed Risk of Revegetation and</i></p>	<p>1. "Glyphosate, a systemic herbicide, resulted in the death of the coppice regrowth following translocation of the active ingredient without negatively affecting the performance of the remaining coppice stems." 2. "Control of seedling eucalypts is relatively easy and</p>



	Forestry Plants. Report DWLBC 2003-02. Animal and Plant Control Commission/The Department of Water, Land and Biodiversity Conservation & Cooperative Research Centre for Australian Weed Management. South Africa.	there is no persistent soil seedbank."
8.04	1. Soerianegara, I, Lemmens, RHMJ, eds. (1994) Plant Resources of South-East Asia. No 5. Timber Trees: Major Commercial Timbers. Bogor, Indonesia. 2. National Academy of Sciences (1980) Firewood Crops: Shrub and Tree Species for Energy Production. Washington, D.C. 3. Food and Agriculture Organization of the United Nations (1979) Eucalypts for Planting. Rome.	1. "Other species such as...E. grandis...coppice well." 2. "It is common practice to regenerate E. grandis forests by coppice from the stumps. Most of them will shoot within 3 months." 3. "It coppices freely when young".
8.05		No evidence.