

Family: *Pinaceae*

Taxon: *Abies grandis*

Synonym: *Picea grandis* (Douglas ex D. Don) Loudon
Pinus grandis Douglas ex D. Don (basionym)

Common Name: Grand fir
 Giant fir
 Lowland white fir
 Silver fir

Questionnaire : current 20090513 **Assessor:** Chuck Chimera **Designation:** EVALUATE
Status: Assessor Approved **Data Entry Person:** Chuck Chimera **WRA Score 1**

101	Is the species highly domesticated?	y=-3, n=0	n
102	Has the species become naturalized where grown?	y=1, n=-1	
103	Does the species have weedy races?	y=1, n=-1	
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	(0-low; 1-intermediate; 2-high) (See Appendix 2)	Low
202	Quality of climate match data	(0-low; 1-intermediate; 2-high) (See Appendix 2)	High
203	Broad climate suitability (environmental versatility)	y=1, n=0	y
204	Native or naturalized in regions with tropical or subtropical climates	y=1, n=0	n
205	Does the species have a history of repeated introductions outside its natural range?	y=-2, ?=-1, n=0	y
301	Naturalized beyond native range	y = 1*multiplier (see Appendix 2), n= question 205	y
302	Garden/amenity/disturbance weed	n=0, y = 1*multiplier (see Appendix 2)	n
303	Agricultural/forestry/horticultural weed	n=0, y = 2*multiplier (see Appendix 2)	n
304	Environmental weed	n=0, y = 2*multiplier (see Appendix 2)	
305	Congeneric weed	n=0, y = 1*multiplier (see Appendix 2)	y
401	Produces spines, thorns or burrs	y=1, n=0	n
402	Allelopathic	y=1, n=0	
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	
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	y=1, n=0	y
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y=1, n=0	y

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	
602	Produces viable seed	y=1, n=-1	y
603	Hybridizes naturally	y=1, n=-1	y
604	Self-compatible or apomictic	y=1, n=-1	
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	n
607	Minimum generative time (years)	1 year = 1, 2 or 3 years = 0, 4+ years = -1	>3
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y=1, n=-1	n
702	Propagules dispersed intentionally by people	y=1, n=-1	y
703	Propagules likely to disperse as a produce contaminant	y=1, n=-1	n
704	Propagules adapted to wind dispersal	y=1, n=-1	y
705	Propagules water dispersed	y=1, n=-1	
706	Propagules bird dispersed	y=1, n=-1	n
707	Propagules dispersed by other animals (externally)	y=1, n=-1	y
708	Propagules survive passage through the gut	y=1, n=-1	n
801	Prolific seed production (>1000/m2)	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	y=-1, n=1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire	y=1, n=-1	
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	y=-1, n=1	

Designation: EVALUATE

WRA Score **1**

Supporting Data:

101	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Is the species highly domesticated? No] "There are no recognized varieties of <i>A. grandis</i> , although a green coastal form and a grey interior form are often recognized. Five fairly distinct climatic forms differing in physiological and ecological characters were described by Foiles (1965). Provenance trials in Europe have resulted in ranking Washington and Oregon seed origins. Seed sources west of the Cascade crest (Washington, Oregon) are preferred for planting in the UK and Europe (Lines, 1979). Significant differences in height growth between trees from sources east and west of the Cascade crest have been reported, but the average growth of western and more inland interior seedlings is generally about the same (Steinhoff, 1978a). Most of the genetic variation available for tree improvement appears to be among stands, but genetic gains can also be made by selecting individuals within stands."
102	2012. WRA Specialist. Personal Communication.	NA
103	2012. WRA Specialist. Personal Communication.	NA
201	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Species suited to tropical or subtropical climate(s) 0-Low] " <i>A. grandis</i> is a western North American (both Pacific and Cordilleran) species (Klinka et al., 1999a). It grows in coastal (maritime) and interior (continental) regions from latitude 39 51° N and at a longitude of 125-114° W. In coastal regions, it grows in southern British Columbia (Canada) mainly on the lee side of Vancouver Island and the adjacent mainland, in the interior valleys and lowlands of western Washington and Oregon (USA), and in northwestern California (USA) as far south as Sonoma County. Inland, its range extends from the Okanagan and Kootenay Lakes in southern British Columbia south through eastern Washington, northern Idaho, western Montana, and northeastern Oregon, USA (Foiles, 1965; Little, 1979)."
202	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Quality of climate match data 2-High]
203	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Broad climate suitability (environmental versatility)? Yes] "Grand fir is found on a wide variety of sites. Average annual precipitation in its territory ranges from 510 to more than 2540 mm (20 to 100 in) in western Washington and on Vancouver Island. Annual precipitation in the Blue Mountains of eastern Oregon averages 360 to 990 mm (14 to 39 in). In northern Idaho, average annual precipitation is 510 to 1270 mm (20 to 50 in). Most of this precipitation occurs during winter. Generally 15 to 25 percent of the annual precipitation occurs during the growing season, May through August."
203	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Broad climate suitability (environmental versatility)? Yes] "Climatic amplitude (estimates) - Altitude range: 0 - 1830 m - Mean annual rainfall: 360 - 2540 mm - Rainfall regime: summer; winter - Dry season duration: 0 - 3 months - Mean annual temperature: 6 - 10°C - Mean maximum temperature of hottest month: 13 - 20°C - Mean minimum temperature of coldest month: -11 - 5°C - Absolute minimum temperature: > -46°C" [Potential elevation range exceeds 1000 m, suggesting species possesses environmental versatility]
204	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Native or naturalized in regions with tropical or subtropical climates? No] " <i>A. grandis</i> has an intermediate climatic amplitude within cool to temperate climates (maritime-drier cool, warm mesothermal, continental) (Krajina, 1969; Klinka et al., 1999b). Mean annual precipitation ranges from 510 to 2540 mm in western Washington and on Vancouver Island, but considerably less in northern Idaho (510-1270 mm) and the Blue Mountains of eastern Oregon (360-990 mm). Most of the precipitation in continental areas of its range occurs during winter and, in general, only 15-25% of the annual precipitation occurs during the growing season (Foiles, 1965)."
205	2002. Simberloff, D./Relva, M.A./Nunez, M.. Gringos en el bosque: introduced tree invasion in a native <i>Nothofagus/Austrocedrus</i> forest. Biological Invasions. 4: 35-53.	[Does the species have a history of repeated introductions outside its natural range? Yes] Argentina
205	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Does the species have a history of repeated introductions outside its natural range? Yes] " <i>A. grandis</i> (grand fir) is a fast-growing and very large fir of secondary and old growth forests of western North America. It is a very productive and valued species on a wide range of sites. It is a Pacific Northwest tree that has been introduced to Europe, where it is grown in arboreta and parks, and also on a limited scale as a timber crop (Hermann, 1987)."

205	2006. Howell, C.J./Sawyer, J.W.D.. New Zealand naturalised vascular plant checklist. New Zealand Plant Conservation Network, Wellington, NZ www.nzpcn.org.nz	[Does the species have a history of repeated introductions outside its natural range? Yes] New Zealand
205	2006. Krivanek, M./Pysek, P./Jarosik, V.. Planting History and Propagule Pressure as Predictors of Invasion by Woody Species in a Temperate Region. <i>Conservation Biology</i> . 20(5): 1487–1498.	[Does the species have a history of repeated introductions outside its natural range? Yes] Czech Republic
301	2004. Richardson, D.M./Rejmánek, M.. Conifers as invasive aliens: a global survey and predictive framework. <i>Diversity and Distributions</i> . 10: 321–331.	[Naturalized beyond native range? Yes] "Only four species with a Z score of 1.5 or less are known to be invasive (<i>Abies grandis</i> , <i>A. procera</i> and <i>Tsuga heterophylla</i> , all in Great Britain"
301	2006. Howell, C.J./Sawyer, J.W.D.. New Zealand naturalised vascular plant checklist. New Zealand Plant Conservation Network, Wellington, NZ www.nzpcn.org.nz	[Naturalized beyond native range? Yes] " <i>Abies grandis</i> " ... "Naturalised plant status = Fully naturalised"
301	2006. Krivanek, M./Pysek, P./Jarosik, V.. Planting History and Propagule Pressure as Predictors of Invasion by Woody Species in a Temperate Region. <i>Conservation Biology</i> . 20(5): 1487–1498.	[Naturalized beyond native range? No evidence from Czech Republic] "Naturalized beyond native range" [<i>Abies grandis</i> = not escaped]
301	2009. Ison, J./Braithwaite, M.. The Status of some Alien Trees and Shrubs in Britain (a report on a questionnaire to BSBI vice-county recorders). Botanical Society of the British Isles, http://www.bsbi.org.uk/TreesShrubsReport.pdf	[[Naturalized beyond native range? Yes]? Partially?] "The ten most widely planted species were familiar forest trees, all of them conifers" ... "All these ten conifers regenerate freely in suitable conditions (with <i>Abies grandis</i> as yet possibly a partial exception), but it is the spruces and <i>Pinus contorta</i> which are particularly reported outside their plantations."
301	2012. Manual of the Alien Plants of Belgium. <i>Abies grandis</i> . http://alienplantsbelgium.be/content/abies-grandis-0	[Naturalized beyond native range? Possibly Belgium] "Sometimes cultivated as an ornamental or for timber production. Very rarely self-sown but possibly overlooked or merely neglected."
302	2007. Randall, R.P.. Global Compendium of Weeds - <i>Abies grandis</i> . http://www.hear.org/gcw/species/abies_grandis/	[Garden/amenity/disturbance weed? No] No evidence
303	2007. Randall, R.P.. Global Compendium of Weeds - <i>Abies grandis</i> . http://www.hear.org/gcw/species/abies_grandis/	[Agricultural/forestry/horticultural weed? No] No evidence
304	2004. Richardson, D.M./Rejmánek, M.. Conifers as invasive aliens: a global survey and predictive framework. <i>Diversity and Distributions</i> . 10: 321–331.	[Environmental weed? Unknown] "Only four species with a Z score of 1.5 or less are known to be invasive (<i>Abies grandis</i> , <i>A. procera</i> and <i>Tsuga heterophylla</i> , all in Great Britain" [Listed as invasive in Great Britain, but impacts are unspecified]
305	2004. Richardson, D.M./Rejmánek, M.. Conifers as invasive aliens: a global survey and predictive framework. <i>Diversity and Distributions</i> . 10: 321–331.	[Congeneric weed? Yes] "The 15 non pine conifers (out of 507 species; 3%) known to be invasive (seven in the Pinaceae; six in Cupressaceae, one in Araucariaceae, one in Podocarpaceae) are: <i>Abies grandis</i> , <i>Abies procera</i> ," ... "Appendix List of naturalized or invasive (in bold) conifers (Pinopsida), based on hundreds of published and unpublished sources and the unpublished data and personal observation of the authors over more than a decade." ... " <i>Abies alba</i> (Great Britain; Ireland; New Zealand); <i>A. cephalonica</i> (Great Britain); <i>A. concolor</i> (USA (New England)); <i>A. grandis</i> (Great Britain, Ireland; Sweden); <i>A. nordmanniana</i> (Great Britain; New Zealand); <i>A. procera</i> (Great Britain); <i>A. sibirica</i> (Finland)"
401	2005. CAB International. <i>Forestry Compendium</i> . CAB International, Wallingford, UK	[Produces spines, thorns or burrs? No] " <i>A. grandis</i> grows to 30-50 m tall (the tallest living specimen is 81 m), and 70-130 cm d.b.h. (up to 220 cm). It has a lifespan of up to 300 years, older specimens having a slightly tapered bole, which is long compared with the length of the crown. The crown is cylindrical or oval, irregular in old trees, and rounded at the top. The principal branches are horizontal, lower ones drooping. The bark is smooth, greyish-brown, with resin blisters and white blotches when young, becoming thick, scaly and ridged. The twigs are slender, light brown to dark orange-brown, and puberulent to pubescent." ... "Needles are 2-6 cm long and 1.5-2.5 mm wide, 2-ranked, flexible, with distinct long and short leaves intermixed. Needles exposed to full sun are spiralled and 1-ranked. Cross section is flat, upper surface grooved and without stomata except occasionally near needle apex; lower surface has 5-7 whitish rows of stomata on each side of a midrib; apex is distinctly notched. Resin canals small, near margins and lower epidermal layer; odour pungent."

402	1971. Del Moral, R./Cates, R.G.. Allelopathic Potential of the Dominant Vegetation of Western Washington. <i>Ecology</i> . 52(6): 1030-1037.	[Allelopathic? Possibly] "Abstract. Forty plant species common in western Washington were investigated for the presence of allelopathic chemicals capable of influencing the distribution of subordinate species. Under laboratory conditions most species contained inhibitory volatile compounds and many contained effective water-soluble compounds" [<i>Abies grandis</i> demonstrated allelopathic potential in experimental conditions]
403	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Parasitic? No] "A. grandis grows to 30-50 m tall (the tallest living specimen is 81 m), and 70-130 cm d.b.h. (up to 220 cm)." [Pinaceae]
404	2000. Howard, J.L./Alekssoff, K.C.. <i>Abies grandis</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/abigra/all.html	[Unpalatable to grazing animals? No] "Browsing: Livestock seldom browse grand fir but do use it for shade [108]. Deer, elk, and moose may resort to eating fir (<i>Abies</i> spp.) needles in winter [127]. Fir needles are a major part of the diet of blue, ruffed, and sharp-tailed grouse. Squirrels, other rodents, and some birds such as nuthatches and chickadees eat the seeds [127,179]." ... "Firs (<i>Abies</i> spp.) are generally unpalatable to big game animals. Deer, especially white-tailed deer, browse grand fir in winter when more palatable forage is unavailable [127]."
405	2000. Howard, J.L./Alekssoff, K.C.. <i>Abies grandis</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/abigra/all.html	[Toxic to animals? No evidence] "Browsing: Livestock seldom browse grand fir but do use it for shade [108]. Deer, elk, and moose may resort to eating fir (<i>Abies</i> spp.) needles in winter [127]. Fir needles are a major part of the diet of blue, ruffed, and sharp-tailed grouse. Squirrels, other rodents, and some birds such as nuthatches and chickadees eat the seeds [127,179]."
405	2008. Wagstaff, D.J.. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	[Toxic to animals? No] No evidence
406	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Host for recognized pests and pathogens? Potentially] "Susceptibility to heart rot and decay is one of the more important factors in the management of <i>Abies grandis</i> . The Indian paint fungus, <i>Echinodontium tinctorium</i> , is the most destructive fungus affecting <i>A. grandis</i> in Washington and Oregon, USA (Hepting, 1971), but it is rare where rapid growth rates close branch stubs quickly (Etheridge and Craig, 1976). <i>E. tinctorium</i> causes a brown stringy rot, but in the early stages decay appears as a light-brown or water-soaked stain in the heartwood. The occurrence of decay is closely related to logging scars, frost cracks, broken tops and other mechanical injuries (Maloy, 1967). <i>Armillaria</i> sp. and <i>Inonotus weirii</i> [<i>Phellinus weirii</i>] are the two most important root rot fungi (Hepting, 1971). The parasitic dwarf mistletoe, <i>Arceuthobium abietinum</i> f.sp. <i>concoloris</i> occurs on <i>A. grandis</i> throughout much of the western portion of its geographic range (Hawksworth and Wiens, 1996). Insects Two defoliating insects are serious pests of <i>A. grandis</i> : western spruce budworm, <i>Choristoneura occidentalis</i> , and Douglas fir tussock moth, <i>Orgyia pseudotsugata</i> . Both can reach epidemic levels and cause severe damage over large areas, resulting in growth loss, top kill and tree mortality. Early instar larvae of <i>C. occidentalis</i> mine and kill the buds and late instar larvae feed on the current years' foliage. They are voracious and wasteful feeders, often consuming only parts of needles, chewing them off at their bases (Fellin and Dewey, 1983). Outbreaks of <i>O. pseudotsugata</i> are typically short lived, usually of 2-3 years duration. However, the larvae feed on all of the foliage and heavy populations can strip a tree in a single growing season (Brookes et al., 1978). The most damaging bark beetle of <i>A. grandis</i> is the fir engraver, <i>Scolytus ventralis</i> . This beetle often reaches outbreak proportions following drought or defoliator outbreaks. Centres of root disease caused by <i>Armillaria</i> sp. Often serve as focal points for fir engraver attack. The western balsam bark beetle, <i>Dryocoetes confusus</i> , can also be damaging to <i>A. grandis</i> (Furniss and Carolin, 1977)."
407	2008. Wagstaff, D.J.. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	[Causes allergies or is otherwise toxic to humans? No] No evidence
407	2012. Pollen Library. Grand Fir (<i>Abies grandis</i>). IMS Health Inc., http://www.pollenlibrary.com/Specie/Abies+grandis/	[Causes allergies or is otherwise toxic to humans? No] "Allergenicity: No allergy has been reported for Grand Fir (<i>Abies grandis</i>) species".
408	2000. Howard, J.L./Alekssoff, K.C.. <i>Abies grandis</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/abigra/all.html	[Creates a fire hazard in natural ecosystems? Yes] "Fire regimes: Fires in grand fir types were historically of mixed severity, with fire behaviors ranging from frequent low-severity, nonlethal surface fire to infrequent, stand-replacing crown fire [9,3,5,18,139,12,166,19]. The grand fir series can roughly be divided into warm/dry types and warm/moist types. In warm/dry types, the historical fire regime was frequent (5-50 year), low-severity fire that favored Pacific ponderosa pine and western larch [11,34,170,190]."

409	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Is a shade tolerant plant at some stage of its life cycle? Yes] "Reaction to Competition- Grand fir is classed as shade-tolerant in all associations in which it occurs."
409	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Is a shade tolerant plant at some stage of its life cycle? Yes] "A. grandis is either an early or late successional species on different sites within its range. On dry sites and in dry climates, it is shade-tolerant and eventually assumes dominance in later stages of stand development. In the wet climates of western British Columbia, Washington and Oregon, it grows with fast-growing, shade-tolerant and long-lived species such as <i>Abies amabilis</i> , <i>Tsuga heterophylla</i> and <i>Thuja plicata</i> "
410	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Tolerates a wide range of soil conditions? Yes] "Grand fir seems to grow equally well on soils derived from a variety of parent materials, including sandstone, weathered lava (rock), or granite and gneiss. In the Pacific coast region and in the Willamette Valley of Oregon it grows most abundantly on deep, rich alluvial soils along streams and valley bottoms and on moist soils provided with seepage. In the inland regions it grows best on rich mineral soils of the valley bottoms, but it also grows well on shallow, exposed soils of mountain ridges and pure pumice soils in central and eastern Oregon, provided moisture is adequate (9). Most of the soils that support grand fir have been classified as Spodosols."
410	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Tolerates a wide range of soil conditions? Yes] "Soil descriptors - Soil texture: light; medium; heavy - Soil drainage: free; impeded; seasonally waterlogged - Soil reaction: acid; neutral - Soil types: alluvial soils; cambisols; colluvial soils; gleysols; granite soils; mountain soils; podzoluvisols; podzols; regosols"
411	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Climbing or smothering growth habit? No] "A. grandis grows to 30-50 m tall (the tallest living specimen is 81 m), and 70-130 cm d.b.h. (up to 220 cm)."
412	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Forms dense thickets? Yes] "A. grandis sometimes grows in pure stands, but is much more common in mixed coniferous and broadleaf forests."
501	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Aquatic? No] Terrestrial
502	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Grass? No] Pinaceae
503	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Nitrogen fixing woody plant? No] Pinaceae
504	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)? No] "A. grandis grows to 30-50 m tall (the tallest living specimen is 81 m), and 70-130 cmd.b.h. (up to 220 cm)."
601	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Evidence of substantial reproductive failure in native habitat? Possibly during certain years] "Seedling Development- Grand fir seeds germinate in the spring following one overwinter period on the ground. In natural stands, germination is quite variable but is seldom greater than 50 percent because of embryo dormancy, insect infestation, and the perishable nature of the seeds. Seeds are often so heavily infested with insects that an entire crop may be classed as a failure (9)."
602	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Produces viable seed? Yes] "Propagation by seed is the most popular method currently for regenerating grand fir; techniques for collection, processing, testing and storage of seed are provided in Schopmeyer (1974). Natural regeneration (where applicable) and/or planting (using containerized stock) can also be used, however."
603	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Hybridizes naturally? Yes] "A. grandis hybridizes with <i>A. concolor</i> and several studies have shown hybridization and introgression in a broad zone extending from the Klamath Mountains of northern California through southwestern Oregon, and through the Oregon Cascade Range into northeastern Oregon and west-central Idaho (Steinhoff, 1978b). <i>A. grandis</i> has been crossed with several European and Asiatic species (Klaehn and Winieski, 1962). Natural hybrids have been reported between <i>A. grandis</i> and <i>A. lasiocarpa</i> in northern Idaho (Daubenmire and Daubenmire, 1968)."
604	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Self-compatible or apomictic? Possibly. Related species <i>A. procera</i> is self-fertile] "Noble fir has a high self-fertility (27). Selfing produced 69 percent of the sound seeds produced by outcross pollination; there was no difference between selfed and outcrossed progeny in weight and germination of seeds or in survival after 3 years."

605	1990. Burns, R.M./Honkala, B.H.. <i>Silvics of North America</i> . Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Requires specialist pollinators? No. Wind-pollinated] "Flowering and Fruiting- Grand fir trees are monoecious; male and female flowers are borne in clusters on branchlets of the previous season's growth in different parts of the same tree. Female flowers, producing cones and seeds, are short, spherical to cylindrical, and stand singly and erect on the uppermost part of the crown. Male flowers, pollen-bearing only, are ovoid or cylindrical and hang singly from the lower side of branches below the female flowers. This arrangement favors cross fertilization. The cones mature in one season. Time of flowering may vary over several months, depending on temperatures during the weeks preceding flowering. Flowering occurs from late March to mid-May at lower elevations of most coastal locations, and in June at the higher elevations of the inland locations. The cones, mostly yellowish green and occasionally greenish-purple, ripen from August to September of the same year, and seeds are dispersed approximately 1 month later (32)."
606	2000. Howard, J.L./Alekssoff, K.C.. <i>Abies grandis</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/abigra/all.html	[Reproduction by vegetative fragmentation? No] "Vegetative reproduction: Grand fir reproduces solely from seed and does not sprout from the root crown [71,155]. It may produce epicormic branches on the lower bole if light and space become available. Epicormic sprouting may contribute considerable volume to a disturbed stand [14]."
607	2000. Howard, J.L./Alekssoff, K.C.. <i>Abies grandis</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/abigra/all.html	[Minimum generative time (years)? 20+] "Cones: Cone and seed production begins at 20 to 50 years of age, and cone productivity increases with age [54,174,183]."
607	2005. CAB International. <i>Forestry Compendium</i> . CAB International, Wallingford, UK	[Minimum generative time (years)? 20+] "A. grandis starts producing cones after 20 years, with low seed dissemination and a low percentage of viable seed."
701	2005. CAB International. <i>Forestry Compendium</i> . CAB International, Wallingford, UK	[Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)? Unlikely] "Seeds are 6-8 x 3-4 mm, tan coloured, with a rosy-tinged wing about 10 mm long; cotyledons (4) 5-6 (7) mm (Hunt, 1993)." [No evidence, and unlikely as seeds lack means of external attachment]
702	2000. Howard, J.L./Alekssoff, K.C.. <i>Abies grandis</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/abigra/all.html	[Propagules dispersed intentionally by people? Yes] "Grand fir is grown commercially for Christmas trees [71,175]. It is also planted as an ornamental [71,120]."
702	2005. CAB International. <i>Forestry Compendium</i> . CAB International, Wallingford, UK	[Propagules dispersed intentionally by people? Yes] "The luxuriant foliage, symmetry and shiny deep green colour of A. grandis make it one of the preferred species for Christmas trees grown in the Pacific Northwest, USA. The attractive appearance of grand fir makes it valuable in recreation areas and urban plantings."
703	2005. CAB International. <i>Forestry Compendium</i> . CAB International, Wallingford, UK	[Propagules likely to disperse as a produce contaminant? No] "Seeds are 6-8 x 3-4 mm, tan coloured, with a rosy-tinged wing about 10 mm long; cotyledons (4) 5-6 (7) mm (Hunt, 1993)." [Unlikely. Trees grown commercially for Christmas trees would be harvested long before reproductive maturity was reached]
704	2005. CAB International. <i>Forestry Compendium</i> . CAB International, Wallingford, UK	[Propagules adapted to wind dispersal? Yes] "Seeds are 6-8 x 3-4 mm, tan coloured, with a rosy-tinged wing about 10 mm long; cotyledons (4) 5-6 (7) mm (Hunt, 1993)." ... "The seeds are large-winged and dispersed by wind and rodents, with most seeds being disseminated in the early autumn."
705	1990. Burns, R.M./Honkala, B.H.. <i>Silvics of North America</i> . Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Propagules water dispersed? Possibly] "Grand fir grows in the stream bottoms, valleys, and mountain slopes of northwestern United States and southern British Columbia." [Although adapted for wind dispersal, seeds may be moved by water along riparian corridors]
706	1990. Burns, R.M./Honkala, B.H.. <i>Silvics of North America</i> . Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Propagules bird dispersed? No] "Seeds are dispersed by the wind and rodents."
707	2005. CAB International. <i>Forestry Compendium</i> . CAB International, Wallingford, UK	[Propagules dispersed by other animals (externally)? Yes] "The seeds are large-winged and dispersed by wind and rodents, with most seeds being disseminated in the early autumn." [Presumably moved by seed caching rodents. Introduced <i>Rattus</i> species may serve a similar role in the Hawaiian Islands]

708	2000. Howard, J.L./Alekssoff, K.C.. <i>Abies grandis</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/abigra/all.html	[Propagules survive passage through the gut? No] "Squirrels, other rodents, and some birds such as nuthatches and chickadees eat the seeds" [Animals act as seed predators]
801	1990. Burns, R.M./Honkala, B.H.. <i>Silvics of North America</i> . Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Prolific seed production (>1000/m ²)? Possibly. Some years Yes. Other years No] "Seed Production and Dissemination- Seed production begins at about 20 years of age and increases with age, diameter, and vigor of the tree. Eight-year observations of permanent sample plots in Idaho show that grand fir produced the fewest seeds of the species associated with western white pine. Grand fir produced no good crops and only two fair crops, while western white pine produced two good crops and three fair crops. During the same 8-year period, western hemlock produced five good crops and two fair crops (9). In the coastal forests of Washington, grand fir ranked higher than western white pine and intermediate among upper slope species in number of seeds produced per tree (22). Other sources place the interval between good seed crops at 2 to 3 years (10,32). In the Inland Empire, a good cone crop for grand fir is considered to be more than 40 cones per tree. A fair crop is 21 to 40 cones per tree. Grand fir seeds caught annually in seed traps on two sample plots averaged 42,000/ha (17,000 acre) on the Kaniksu National Forest and 58,100/ha (23,500 acre) on the Coeur d'Alene National Forest. Eight-year observations of seed traps under a 300-year-old stand on the Priest River Experimental Forest yielded 31,600 grand fir seeds per hectare (12,800 acre) annually (9). The yield of cleaned seeds ranges from 26,200 to 63,100/kg (11,900 to 28,700/ lb) and averages 40,500/kg (18,400/lb) (32)."
801	2000. Howard, J.L./Alekssoff, K.C.. <i>Abies grandis</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/abigra/all.html	[Prolific seed production (>1000/m ²)? No] "The winged seeds are of medium weight compared to other conifers and are wind dispersed a few hundred feet from the parent [14,183]. Over 4 years (1974-1977), grand fir seed rain in central Oregon ranged from 810 to 60,718 seeds per acre (2025- 151,795/ha) per year; sound seed ranged from 4.5 to 33.3% [158]." [0.2025 - 15.1795 seeds/square meter]
802	2005. CAB International. <i>Forestry Compendium</i> . CAB International, Wallingford, UK	[Evidence that a persistent propagule bank is formed (>1 yr)? No] "Seeds on the forest floor remain viable for only one winter period (Franklin, 1968). Grand fir seeds germinate in the spring after overwintering. Germination is epigeal and quite variable, but seldom >50% because of embryo dormancy, insect infestation and the perishable nature of the seeds."
803	2000. Howard, J.L./Alekssoff, K.C.. <i>Abies grandis</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/abigra/all.html	[Well controlled by herbicides? Yes] "Herbicides: Grand fir is rated intermediate in sensitivity to glyphosate [22]."
804	2000. Howard, J.L./Alekssoff, K.C.. <i>Abies grandis</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/abigra/all.html	[Tolerates, or benefits from, mutilation, cultivation, or fire? Not severe fires] "Grand fir does not survive crowning or severe fire. Its low, dense branching habit, flammable foliage, and tendency to develop dense stands with heavy lichen growth increase the likelihood of torching and mortality from crown fire [44,50,69,169]."
804	2005. CAB International. <i>Forestry Compendium</i> . CAB International, Wallingford, UK	[Tolerates, or benefits from, mutilation, cultivation, or fire? Moderately] "A. grandis is rated medium in fire resistance compared to common associated trees, although this is influenced by habitat (Foiles et al., 1990). Frost cracks and lightning scars appear more frequently on A. grandis than on associated vegetation; this damage causes little direct mortality but contributes to the spread of infection by fungal pathogens."
805	2012. WRA Specialist. Personal Communication.	[Effective natural enemies present locally (e.g. introduced biocontrol agents)? Unknown]

Summary of Risk Traits

High Risk / Undesirable Traits

- Naturalized in New Zealand and Great Britain
- Possibly allelopathic
- Flammable
- Tolerates many soil conditions (and potentially able to exploit many different habitat types)
- Shade tolerant
- Forms dense stands in native range
- Able to hybridize with other *Abies* species
- Wind-dispersed seeds

Low Risk / Desirable Traits

- Despite ability to spread, no negative impacts have been documented
- Palatable to browsing animals (may limit spread outside cultivated areas)
- Landscaping and ornamental value
- Popular Christmas tree
- Long time to reproductive maturity (20+ years)
- Seeds do not persist longer than 1 year