Family: ***Pinaceae***

Taxon: ***Abies guatemalensis***

Synonym: *Abies guatemalensis var. jaliscana Martínez* ***Common Name:*** abeto de Guatemala, pinabete Guatemalan Fir Pacachaque

Questionaire : current 20090513 **Assessor:** Chuck Chimera **Designation:** L

Status: Assessor Approved **Data Entry Person:** Chuck Chimera **WRA Score -2**

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)**	**Intermediate**
203	**Broad climate suitability (environmental versatility)**	**y=1, n=0**	**y**
204	**Native or naturalized in regions with tropical or subtropical climates**	**y=1, n=0**	**y**
205	**Does the species have a history of repeated introductions outside its natural range?**	**y=-2, ?=-1, n=0**	**n**
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)**	**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**	
409	**Is a shade tolerant plant at some stage of its life cycle**	**y=1, n=0**	
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**	**n**
602	**Produces viable seed**	**y=1, n=-1**	**y**
603	**Hybridizes naturally**	**y=1, n=-1**	
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**	**n**
706	**Propagules bird dispersed**	**y=1, n=-1**	**n**
707	**Propagules dispersed by other animals (externally)**	**y=1, n=-1**	
708	**Propagules survive passage through the gut**	**y=1, n=-1**	
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**	
804	**Tolerates, or benefits from, mutilation, cultivation, or fire**	**y=1, n=-1**	**n**
805	**Effective natural enemies present locally (e.g. introduced biocontrol agents)**	**y=-1, n=1**	

Designation: L **WRA Score** -2

Supporting Data:

101	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Is the species highly domesticated?? No] "Abstract. This is the first review on taxonomy, morphology, ecology, conservation and utilisation of Abies guatemalensis, an endangered endemic conifer in Central America. The species became recently split up in seven varieties with a distinct geographic pattern. A number of morphological traits separate the species from the co occurring A. hickelii and A. religiosa. The species is used for charcoal production, as valuable timber and (more recently) as highly priced greenery. However, utilisation is not sustainable and may lead to regional extinction within few decades. Protection of the species seems to be most efficient if based on community forest management. As a new conservation tool we suggest establishment of Christmas tree and greenery plantations which could generate significant income for the local farmers. The existing knowledge on A. guatemalensis should be used to steer utilisation, to generate livelihood improvements for the local Maya communities, and to optimise regional and national conservation efforts. Conservation of the species is urgent because it occurs in endangered highland forests which provide significant ecosystem services including erosion control and supply of drinking water. Inconsistencies in description of the species and gaps in knowledge are highlighted and future research directions suggested."
102	2012. WRA Specialist. Personal Communication.	NA
103	2012. WRA Specialist. Personal Communication.	NA
201	1986. FAO. Databook On Endangered Tree And Shrub Species And Provenances Fao Forestry Paper 77. Forest Resources Division , FAO Forestry Department, Rome. Italy	[Species suited to tropical or subtropical climate(s) 0-Low] "The climate is distinctly temperate - rainy with dry winters."
201	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Species suited to tropical or subtropical climate(s) 0-Low] "The rarer species Abies guatemalensis, A. religiosa Lindl. and Juniperus standleyii Steyerm. are found at high altitudes. Precipitation in the area decreases from north-east to south west due to the prevailing trade wind direction, with some areas receiving less rain, and others with an annual precipitation of about 1500 mm (Villar Anleu 1994)." … "The mountains in Central America are relatively cool and moist, and the climate is 'oceanic' with a somehow reduced annual variation. Most precipitation occurs as rain in summer or as fog all year round. Precipitation is >1000 mm for all populations and probably between 1500 and 3000 at most stands (CAMCORE 1985; INAB 1999a). It is interesting that the species is often found on northern slopes and in humid valleys. This suggests that desiccation effects are more important than low temperatures at the upper altitudinal limit (INAB 1999a)."
202	1986. FAO. Databook On Endangered Tree And Shrub Species And Provenances Fao Forestry Paper 77. Forest Resources Division , FAO Forestry Department, Rome. Italy	[Quality of climate match data? 1-intermediate] "Germination is improved by cold moist stratification for about 1 month. Without this treatment germination is of the order of 10-25%." [For the special cases of a temperate species whose seeds have been reported to require cold-stratification for germination, the answer to this question is 0(low) and the answer to question 2.02 is 1 (intermediate) regardless of knowledge of the species native range. C. Daehler pers. comm.]
202	2002. Vozzo, J.A.. Tropical Tree Seed Manual. USDA Forest Service, Washington, D.C.	[Quality of climate match data? 1-intermediate] "Cold and humid stratification improves the viability to 30 percent (Donahue and others 1985). Seed stratification on moist blotter paper at 4 °C for 40 days and application of gibberellic acid at 200 ppm (mg per L) proved to be the most effective treatment of A. guatemalensis to improve germination from 17 percent (no treatment) to 37 percent (Salazar 1991). A 40-day stratification period alone produced a higher total germination than 0, 20, or 60 days (Dvorak and Donahue 1992)." [For the special cases of a temperate species whose seeds have been reported to require cold-stratification for germination, the answer to this question is 0(low) and the answer to question 2.02 is 1 (intermediate) regardless of knowledge of the species native range. C. Daehler pers. comm.]
203	1997. Farjon, A./Styles, B.T.. Pinus (Pinaceae). Flora Neotropica. 75: 1-291.	[Broad climate suitability (environmental versatility)? Yes] "On cool, cloudy, wet mountain summits up to 3000 m, or in belts on larger sierras or taller mountains, species of Abies-mainly A. guatemnalensis in Mesoamerica and A. religiosa further north in Mexico-dominate the coniferous forest." [Could establish in higher elevations of tropical islands]

203	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Broad climate suitability (environmental versatility)? Yes] "The species occurs at an altitude of 1200 – 3600 m based on 70 of the 95 populations included in this review (Table 5); it seems to thrive best at 2400 – 3400 m but is registered from up to 4100 m in Guatemala (Liu 1971; Farjon 1990). Average altitude of the populations decreases linearly with latitude from southern Guatemala to central Mexico (Figure 2a) which is most likely related to changes in mean annual temperature. There is also a positive relationship between population altitude and longitude (Figure 2b), i.e. stands in the western mountain ranges of Central America are found at higher altitude, which is caused by decreasing precipitation due to the prevailing NE trade winds (Walter et al. 1975; Villar Anleu 1994). Abies guatemalensis var. tacanensis, for example, occurs between 3500 and 3800 m in the mountains of Chiapas, probably due to a more continental climate at a greater distance from the Caribbean Sea." [Elevation range exceeds 1000 m, demonstrating environmental versatility]
204	1986. FAO. Databook On Endangered Tree And Shrub Species And Provenances Fao Forestry Paper 77. Forest Resources Division , FAO Forestry Department, Rome. Italy	[Native or naturalized in regions with tropical or subtropical climates? Yes] "It is one of the few boreal species of fir found wild within the subtropics."
204	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Native or naturalized in regions with tropical or subtropical climates? High Elevation Tropics] "The species occurs at an altitude of 1200 – 3600 m based on 70 of the 95 populations included in this review (Table 5); it seems to thrive best at 2400 – 3400 m but is registered from up to 4100 m in Guatemala (Liu 1971; Farjon 1990)." … The mountains in Central America are relatively cool and moist, and the climate is 'oceanic' with a somehow reduced annual variation."
205	1980. Skolmen, R.G.. Plantings on the forest reserves of Hawaii: 1910–1960. Institute of Pacific Islands Forestry, Pacific Southwest Forest & Range Experiment Station, US Forest Service, Honolulu, HI	[Does the species have a history of repeated introductions outside its natural range? No] No evidence of introduction
205	1998. Conifer Specialist Group. Abies guatemalensis. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. http://www.iucnredlist.org/apps/redlist/details/42285/0	[Does the species have a history of repeated introductions outside its natural range? No] "There has been heavy timber exploitation throughout the range. Isolated stands continue to be exploited heavily by local inhabitants and the deep fertile soils, on which the tree grows, are attractive to agricultural development. Cone crops are irregular and germination is poor. "
205	2008. Strandby Andersen, U./Prado Cordova, J.P./Brauner Nielsen, U./Smith Olsen, C./Nielsen, C./Sorensen, M./Kollmann, J.. Conservation through utilization: a case study of the Vulnerable Abies guatemalensis in Guatemala. Oryx. 42(2): 206–213.	Does the species have a history of repeated introductions outside its natural range? No] No evidence
301	2007. Randall, R.P.. Global Compendium of Weeds - Index [Online Database]. http://www.hear.org/gcw/	[Naturalized beyond native range? No] No evidence
302	2007. Randall, R.P.. Global Compendium of Weeds - Index [Online Database]. http://www.hear.org/gcw/	[Garden/amenity/disturbance weed? No] No evidence
303	2007. Randall, R.P.. Global Compendium of Weeds - Index [Online Database]. http://www.hear.org/gcw/	[Agricultural/forestry/horticultural weed? No] No evidence
304	2007. Randall, R.P.. Global Compendium of Weeds - Index [Online Database]. http://www.hear.org/gcw/	[Environmental weed? No] No evidence
305	2004. Richardson, D.M./Rejmánek, M.. Conifers as invasive aliens: a global survey and predictive framework. Diversity and Distributions. 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: Abies grandis , Abies procera ," … "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." … "Abies alba (Great Britain; Ireland; New Zealand); A. cephalonica (Great Britain); A. concolor (USA (New England)); A. grandis (Great Britain, Ireland; Sweden); A. nordmanniana (Great Britain; New Zealand); A. procera (Great Britain); A. sibirica (Finland)"

305	2010. Poindexter, D.B.. Abies firma (Pinaceae) naturalize in North America. Phytoneuron. 41: 1–7.	[Congeneric weed> Potentially] "In North Carolina, Abies firma, an introduced fir from Japan, is reported as escaping and establishing for the first time in North America. Momi Fir is an infrequently introduced taxon that has been proposed as a highly suitable ornamental tree, particularly in the southeastern United States. This recent discovery of its ability to naturally produce viable progeny suggests that widespread horticultural use of this coniferous species needs further evaluation. A description and photographs are provided to aid in identification of this taxon."
401	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Produces spines, thorns or burrs? No] "It is a tall tree reaching 35 – 40 m in height and 1.0 – 1.5 m diameter at breast height. The trunk is straight with branches spreading more or less horizontally, the lower ones curve downward; the crown is conical or dome shaped. The bark is smooth, grey–brown, becoming scaly in old individuals. Young branchlets are reddish-brown to deep blackish-red, with linear ridges and sparse brownish hairs. The buds are globular ovoid, resinous and <5 mm long. The leaves are pectinate to subdistichous at right angles to the shoot reaching 1.2 – 5.5 cm in length and 1.2 – 2.0 mm in width; they are narrowly linear with emarginate or sometimes obtuse apex. Stomata are usually absent on the adaxial leaf side, but occur as two white bands on the abaxial side; leaf cross-sections show two marginal resin canals and discontinuous hypodermal cells."
402	2012. WRA Specialist. Personal Communication.	[Allelopathic? Unknown]
403	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Parasitic? No] "It is a tall tree reaching 35 – 40 m in height and 1.0 – 1.5 m diameter at breast height."
404	1958. Standley, P.C./Steyermark, J.A.. Flora of Guatemala Vol. 24 - Part I. Fieldiana. 24: 1-478.	[Unpalatable to grazing animals? No] "The isolated trees at Cumbre del Aire have been found repeatedly loaded with cones, but the constant grazing by sheep probably destroys the seedlings."
404	1986. FAO. Databook On Endangered Tree And Shrub Species And Provenances Fao Forestry Paper 77. Forest Resources Division , FAO Forestry Department, Rome. Italy	[Unpalatable to grazing animals? No] "The cone crop is frequently poor, and what regeneration does emerge is grazed by sheep, and other livestock."
404	2004. Quintana-Ascencio, P.F./Ramírez-Marcial, N./González-Espinosa, M./Martínez-Icó, M.. Sapling survival and growth of coniferous and broad-leaved trees in successional highland habitats in Mexico. Applied Vegetation Science. 7: 81-88.	[Unpalatable to grazing animals? No] "The favourable survival and growth of saplings in GR suggests that other, more critical, factors limiting natural recruitment of Abies could be: (1) low density of reproductive adults and their clumped distribution; (2) low seed viability and germination (N. Ramírez-Marcial pers. obs.); (3) grazing by rabbits and pocket gophers; (4) grazing and trampling by free-ranging cattle; (5) fire incidence for agricultural purposes."
404	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Unpalatable to grazing animals? No] "Most forests containing A. guatemalensis are strongly influenced by wood cutting and grazing which almost inhibits natural regeneration. Prevalence of old individuals is typical to forests which have been exposed to grazing for long periods – here saplings and seedlings are almost absent. However, in areas with no grazing, abundant recruitment has been observed with up to 9500 seedlings ha 1 (Standley and Steyermark 1958; Veblen 1976; CAMCORE 1985; INAB 1999a)." [presumably palatable]
405	1958. Standley, P.C./Steyermark, J.A.. Flora of Guatemala Vol. 24 - Part I. Fieldiana. 24: 1-478.	[Toxic to animals? No] "The isolated trees at Cumbre del Aire have been found repeatedly loaded with cones, but the constant grazing by sheep probably destroys the seedlings."
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	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Host for recognized pests and pathogens? Possibly] "The species seems to be little affected by diseases, but the literature on both diseases and pests is sparse (Haack and Paiz Schwartz 1997). However, occasional insect attacks by Dendroctonus spp. In A. guatemalensis have been reported especially when growing in combination with Pinus rudis Endl. (CAMCORE 1985). Furthermore, insects such as Megastigmus spp. May reduce cone production."

406	2008. Strandby Andersen, U./Prado Cordova, J.P./Brauner Nielsen, U./Smith Olsen, C./Nielsen, C./Sorensen, M./Kollmann, J.. Conservation through utilization: a case study of the Vulnerable Abies guatemalensis in Guatemala. Oryx. 42(2): 206–213.	[Host for recognized pests and pathogens? Possibly] "In 1995 an aphid was recorded causing damage in several plantations of A. guatemalensis (C. Escobar & R. Estrada, pers. comm.) and in 2005 the insect was identified as belonging to the Mindarus abietinus complex (Hemiptera: Aphididae; O. Heie & S. Harding, pers. comm.), and recent morphological evidence suggests that it is a new subspecies or species of Mindarus (C. Nielsen, unpubl. data). Mindarus spp. are a serious pest of plantations in the USA (Fondren & McCullough, 2003) and we therefore investigated the extent of the problem in Guatemala. Ten plantation owners were interviewed in 2007 about infestation problems during 2002–2006. Only one respondent claimed that severe problems had been caused by M. abietinus, whereas most owners stated that the pest occurs regularly but is of minor importance (U. Strandby Andersen, unpubl. data)."
407	2002. Vozzo, J.A.. Tropical Tree Seed Manual. USDA Forest Service, Washington, D.C.	[Causes allergies or is otherwise toxic to humans? No] "This handsome fir has been used for decades as a Christmas tree. Since 1973, A. guatemalensis has been listed in Appendix I of the Convention of International Trade of Endangered Species (CITES), and data obtained from the U.S. Department of the Interior (1979) lists A. guatemalensis as a threatened gymnosperm." [No evidence. Regularly used and heavily exploited tree with no mention of adverse health impacts]
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. Fir (Abies). IMS Health Incorporated, http://www.pollenlibrary.com/GENUS/Abies/	[Causes allergies or is otherwise toxic to humans? No] "Firs produce very large amounts of pollen annually in the spring and early summer, but have been reported to have little allergenic importance."
408	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Creates a fire hazard in natural ecosystems? Potentially] "Usually A. guatemalensis is sparsely distributed and monospecific stands occur rarely. However, in the departments of Huehuetenango and San Marcos in Guatemala vast coherent monospecific stands have been observed (U. Strandby Andersen, unpubl. records)." [Dense stands may create a fire hazard, but there is no evidence that this forest type was adapted to frequent fires]
409	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Is a shade tolerant plant at some stage of its life cycle? Possibly No] "It is argued by INAB (1999a) that germination and growth during the first 2 – 3 years depend on shade to a certain extent. However, Quintana-Ascenico et al. (2004) studied survival and growth of transplant saplings of A. guatemalensis in a field experiment and found that regeneration depends on the existence of natural forest gaps or partial canopy clearings as caused, for example, by selective logging or fuel wood extraction. After 8 years the transplants had a survival of 32% in grassland and in old-growth oak forest, and 75% in mid-successional oak forests. However, the transplants had a highest 'integrated response index' (a combination of survival, diameter increment and height growth) in open habitats compared to at least partly closed forests, indicating good conditions for regeneration in fragmented forests or open grasslands if seed supply is sufficient."
410	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Tolerates a wide range of soil conditions? Yes] "There is no evidence of strong linkage between the distribution of A. guatemalensis and certain soil types. We have found it both on slightly acidic and calcareous soil (pH 5.8 – 9.2; J. Kollmann, unpubl. records). Nevertheless, the species is most often reported from well drained mountain soils of volcanic origin with medium depths (Farjon 1990; INAB 1999a)."
411	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Climbing or smothering growth habit? No] "It is a tall tree reaching 35 – 40 m in height and 1.0 – 1.5 m diameter at breast height. The trunk is straight with branches spreading more or less horizontally, the lower ones curve downward; the crown is conical or dome shaped."
412	1958. Standley, P.C./Steyermark, J.A.. Flora of Guatemala Vol. 24 - Part I. Fieldiana. 24: 1-478.	[Forms dense thickets? Yes] "The best forests are so dense that little vegetation is found on the ground beneath the trees only a few low shrubs of rather weak growth, mosses, and a limited number of herbs."
412	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Forms dense thickets? Yes] "Usually A. guatemalensis is sparsely distributed and monospecific stands occur rarely. However, in the departments of Huehuetenango and San Marcos in Guatemala vast coherent monospecific stands have been observed (U. Strandby Andersen, unpubl. records)."

501	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Aquatic? No] "It is a tall tree reaching 35 – 40 m in height and 1.0 – 1.5 m diameter at breast height." [Terrestrial]
502	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Grass? No] Pinaceae
503	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Nitrogen fixing woody plant? No] Grass
504	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)? No] "It is a tall tree reaching 35 – 40 m in height and 1.0 – 1.5 m diameter at breast height. The trunk is straight with branches spreading more or less horizontally, the lower ones curve downward; the crown is conical or dome shaped."
601	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Evidence of substantial reproductive failure in native habitat? No] "...in natural remote stands in Guatemala with little or strictly monitored human utilisation and grazing, plenty of regeneration of both saplings and seedlings has been observed (U. Strandby Andersen, unpubl. records)."
601	2008. Strandby Andersen, U./Prado Cordova, J.P./Brauner Nielsen, U./Smith Olsen, C./Nielsen, C./Sorensen, M./Kollmann, J.. Conservation through utilization: a case study of the Vulnerable Abies guatemalensis in Guatemala. Oryx. 42(2): 206–213.	[Evidence of substantial reproductive failure in native habitat? No. But rare due to over-exploitation] "A. guatemalensis is listed by the FAO as threatened throughout its entire range and, as it is included in CITES Appendix 1, all national and international trade and usage is banned (FAO, 1986). The forests in which the species occurs have a long history of intensive exploitation for pasture and clearing for agriculture, and A. guatemalensis is used for timber, shingles and for charcoal production. In addition, since 1960, the species has become popular as a Christmas tree (Strandby Andersen et al., 2006). Branches of adults, and also whole young trees, are illegally harvested, seriously threatening the remaining populations. The clandestine nature of this harvest and the practicalities of local control by communities, means that management of the native stands to allow for regrowth is not an option for conservation. Poachers penetrate protected forests and smuggle branches into urban markets where they are sold as bundles or turned into festoons, wreaths, or Christmas trees made by arranging branches on a lath as assembled semi-natural trees (INAB, 1999). Market surveys carried out in 1995 and 1999 estimated the demand for semi-natural A. guatemalensis Christmas trees at 120,000 and 30,000, respectively (INAB, 1999; Aguilar, 2003)."
602	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Produces viable seed? Yes] "The seeds are cuneate-obovoid, light brown and have a length of 8 – 9 mm. Seed wings are obliquely obovate, light brown in colour and have a length · width 10 – 23 times 10 – 21 mm."
603	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Hybridizes naturally? Unknown] "Abies guatemalensis may be confused with A. religiosa and A. hickelii Flous et Gaussen which co-occur at least in some of the montane conifer forests (Table 4). The ranges of A. guatemalensis and A. religiosa overlap in the Mexican States Jalisco, Guerrero, Oaxaca and in western Guatemala. However, A. guatemalensis is readily distinguished from A. religiosa by the emarginate leaves, shorter cones, longer male strobili and by the bracts being enclosed (not exerted) (Rehder 1939; Standley and Steyermark 1958; Farjon 1990). Abies hickelii is found at 2500 – 3000 m in the Mexican States Guerrero, Oaxaca, Veracruz and Chiapas. Compared to A. hickelii, A. guatemalensis differs by having only two resin canals (not 4 – 10) in the leaf cross-sections, bracts being enclosed (not exerted) larger cones and the more narrow and shorter seed scales (Farjon 1990; Debreczy and Ra´ cz 1995)."

604	2002. Vozzo, J.A.. Tropical Tree Seed Manual. USDA Forest Service, Washington, D.C.	[Self-compatible or apomictic? Possibly] "All species of Abies are monoecious (Dallimore and Jackson 1974). The erect cones are subsessile, cylindrical, and up to 12 cm long and 5 cm wide. The bracts are cuneate obovate, shorter than the cone scales, and concealed by them. The scales are broader than they are long, with external puberulous margins (Dallimore and Jackson 1974)."
604	2008. Bonner, F.T./Karrfalt, R.P. (eds.). The Woody Plant Seed Manual. USDA FS Agriculture Handbook 727. Government Printing Office, Washington, D.C.	[Self-compatible or apomictic? Possibly] "Fir strobili are unisexual and are typically borne on the uppermost branches. Both male (microsporangiate) and female (megasporangiate) strobili in grand fir develop from axillary buds (Owens 1984)." … "Usually, female strobili occur singly or in small groups on the upper side of the previous year's twigs on the highest branches, whereas male strobili cluster densely along the undersides of the previous year's twigs lower down in the crown. This arrangement promotes cross-fertilization but may reduce pollination (Singh and Owens 1982). However, both male and female strobili may be found on the same branchlet."
605	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Requires specialist pollinators? No] "The male strobili are produced laterally on young branches; they are 2.0 – 2.5 cm long and have a yellowish colour. The female cones are subsessile, oblong-cylindrical, reaching 8 – 12 cm in length and 4.5 – 5.0 cm in width. The female cone rachis is persistent and blackish brown. The seed scales are oblong to reniform with length · width at mid-cone as 2.0 – 2.5 times 3.0 cm; the upper margin is entire or erose-denticulate, the base auriculate and pedicellate." [Wind-pollinated]
606	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Reproduction by vegetative fragmentation? No] No evidence. Reproduction is by seed.
607	1986. FAO. Databook On Endangered Tree And Shrub Species And Provenances Fao Forestry Paper 77. Forest Resources Division , FAO Forestry Department, Rome. Italy	[Minimum generative time (years)? 4+] "Growth is relatively fast; even though the tree grows rather slowly during the first eight years, it develops quite rapidly thereafter." [Presumably does not produce cones during this time period]
607	2000. Aguirre-Planter, E./Furnier, G.R./Eguiarte, L.E.. Low Levels of Genetic Variation within and High Levels of Genetic Differentiation among Populations of Species of Abies from Southern Mexico and Guatemala. American Journal of Botany. 87(3): 362-371.	[Minimum generative time (years)? 20+] "...Abies species are long-lived perennials with reproductive maturity at 20 yr and an average life span of 60 yr (Jacobs, Werth, and Guttman, 1984)."
607	2008. Bonner, F.T./Karrfalt, R.P. (eds.). The Woody Plant Seed Manual. USDA FS Agriculture Handbook 727. Government Printing Office, Washington, D.C.	[Minimum generative time (years)? 20+] "Seed production in most fir species typically begins on trees 20 to 30 years old (table 3), although individual trees may produce some cones at a younger age, for example, 12 years in noble fir (Franklin 1974b) and 15 years in balsam fir (Roe 1948a). However, heavy cone production in noble fir begins when trees are 30 to 35 years old (Franklin 1982b). Seed production by Spanish fir in Czechoslovakia does not begin until trees are 50 years old (Holubcik 1969)." [Table 3. Unspecified for A. guatemalensis, but presumably in excess of 4 years]
701	2002. Vozzo, J.A.. Tropical Tree Seed Manual. USDA Forest Service, Washington, D.C.	[Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)? No] "The seeds are light brown, up to 8 or 10 mm long; the wings are 15 mm long and 1.5 mm wide (Dallimore and Jackson 1974)." [No evidence, and unlikely, as seeds lacka means of external attachment and lose viability quickly]
702	2008. Strandby Andersen, U./Prado Cordova, J.P./Brauner Nielsen, U./Smith Olsen, C./Nielsen, C./Sorensen, M./Kollmann, J.. Conservation through utilization: a case study of the Vulnerable Abies guatemalensis in Guatemala. Oryx. 42(2): 206–213.	[Propagules dispersed intentionally by people? Yes] "As a conservation tool we suggest establishment of additional A. guatemalensis Christmas tree plantations. These could generate income for local farmers and help halt poaching from natural stands. So far, 51 such plantations have been established in Guatemala but practical knowledge of cultivation is limited and production dominated by a few large plantations. Seed for Christmas tree plantations needs to be carefully selected because there are marked differences among populations in germination, seedling height increment and greenery quality." …"Conservation through domestication seems a feasible strategy in the case of A. guatemalensis. Establishment of additional plantations to meet increasing demand, combined with enforcement of existing legislation to prevent trade in branches, could make foliage poaching unprofitable in the long-term." [Limited to native range, but may increase in the future if seeds become more widely available]

703	2002. Vozzo, J.A.. Tropical Tree Seed Manual. USDA Forest Service, Washington, D.C.	[Propagules likely to disperse as a produce contaminant? No] "The seeds are light brown, up to 8 or 10 mm long; the wings are 15 mm long and 1.5 mm wide (Dallimore and Jackson 1974)." … "Like most Abies, the germination rate is poor (Donahue and others 1985, Dvorak and Donahue 1992, U.S. Department of Agriculture 1974)." [No evidence, and unlikely, as seeds lose viability quickly]
704	1997. Farjon, A./Styles, B.T.. Pinus (Pinaceae). Flora Neotropica. 75: 1-291.	[Propagules adapted to wind dispersal? Yes] "The cones of these conifers are placed high in the treetops, as in Abies, or toward the end of higher branches in the pines, to facilitate long-distance dispersal of the seeds."
704	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Propagules adapted to wind dispersal? Yes] "The seeds are cuneate-obovoid, light brown and have a length of 8 – 9 mm. Seed wings are obliquely obovate, light brown in colour and have a length · width 10 – 23 times 10 – 21 mm."
705	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Propagules water dispersed? No] "The seeds are cuneate-obovoid, light brown and have a length of 8 – 9 mm. Seed wings are obliquely obovate, light brown in colour and have a length · width 10 – 23 times 10 – 21 mm." [Possible, but unlikely, as seeds are primarily adapted for wind dispersal]
706	2002. Vozzo, J.A.. Tropical Tree Seed Manual. USDA Forest Service, Washington, D.C.	[Propagules bird dispersed? No] "The scales are broader than they are long, with external puberulous margins (Dallimore and Jackson 1974). The seeds are light brown, up to 8 or 10 mm long; the wings are 15 mm long and 1.5 mm wide (Dallimore and Jackson 1974)." [Unlikely. Not fleshy-fruited]
707	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Propagules dispersed by other animals (externally)? Unknown] "The seeds are cuneate-obovoid, light brown and have a length of 8 – 9 mm. Seed wings are obliquely obovate, light brown in colour and have a length · width 10 – 23 times 10 – 21 mm." [Seed predators may disperse seeds by seed caching, but no evidence was found]
708	2012. WRA Specialist. Personal Communication.	[Propagules survive passage through the gut? Unknown] Consumption would likely result in seed predation, as seeds are not adapted for internal dispersal
801	1998. Conifer Specialist Group. Abies guatemalensis. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. http://www.iucnredlist.org/apps/redlist/details/42285/0	[Prolific seed production (>1000/m2)? No] "There has been heavy timber exploitation throughout the range. Isolated stands continue to be exploited heavily by local inhabitants and the deep fertile soils, on which the tree grows, are attractive to agricultural development. Cone crops are irregular and germination is poor. "
801	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Prolific seed production (>1000/m2)? No. Unlikely] "For example, Veblen (1976) reported that A. guatemalensis has irregular cone production. This is supported by Standley and Steyermark (1958) who declared that A. guatemalensis does not reproduce freely and that only few young plants are found in the typical habitats of the species. However, in natural remote stands in Guatemala with little or strictly monitored human utilisation and grazing, plenty of regeneration of both saplings and seedlings has been observed (U. Strandby Andersen, unpubl. records). On the other hand, it is claimed by CAMCORE (1985) that good seed crops occur every second or third year." …"The seed production in most stands might be sufficient to allow for some regeneration but seedling establishment is often restrained by unfavourable forest utilisation. Most forests containing A. guatemalensis are strongly influenced by wood cutting and grazing which almost inhibits natural regeneration. Prevalence of old individuals is typical to forests which have been exposed to grazing for long periods – here saplings and seedlings are almost absent. However, in areas with no grazing, abundant recruitment has been observed with up to 9500 seedlings ha 1 (Standley and Steyermark 1958; Veblen 1976; CAMCORE 1985; INAB 1999a)."
802	1986. FAO. Databook On Endangered Tree And Shrub Species And Provenances Fao Forestry Paper 77. Forest Resources Division , FAO Forestry Department, Rome. Italy	[Evidence that a persistent propagule bank is formed (>1 yr)? Probably No] "The seed can remain viable for 5 years or more if stored at a low moisture content (9-12%) in sealed containers at or near -15^0 C. Under ordinary storage conditions (room temperature, open containers) Abies seed retains little or no viability after 1 year."
802	2006. Strandby Andersen, U./Prado Córdova, J.P./Sørensen, M./Kollmann, J.. Conservation and utilisation of Abies guatemalensis Rehder (Pinaceae) – an endangered endemic conifer in Central America. Biodiversity and Conservation. 15: 3131–3151.	[Evidence that a persistent propagule bank is formed (>1 yr)? Probably No] "Percentage germination of fresh seeds is about 15%. One year of cold storage without prior stratification reduces germination rates to 2%, whereas stratification improves germination to about 30%. Application of gibberellic acid together with stratification enhanced germination to 37% (de MacVean 2002)."

802	2008. Strandby Andersen, U./Prado Cordova, J.P./Brauner Nielsen, U./Smith Olsen, C./Nielsen, C./Sorensen, M./Kollmann, J.. Conservation through utilization: a case study of the Vulnerable Abies guatemalensis in Guatemala. Oryx. 42(2): 206–213.	[Evidence that a persistent propagule bank is formed (>1 yr)? No] "Table 1 Summary of the ecological and socio economic constraints and opportunities for Christmas tree production and marketing in Guatemala." ... "Low germination & short seed viability"
803	2012. WRA Specialist. Personal Communication.	[Well controlled by herbicides? Unknown] No evidence of herbicide efficacy or chemical control of this species
804	2003. Rodríguez-Trejo, D.A./Fulé , P.Z.. Fire ecology of Mexican pines and a fire management proposal. International Journal of Wildland Fire. 12(1): 23-37.	[Tolerates, or benefits from, mutilation, cultivation, or fire? Apparently No] "Few Mexican pine ecosystems appear to be maintained by the prevailing anthropogenic and/or natural fire regimes. For example, Minnich and Franco-Vizcaino (1998) suggested that P. jeffreyi dominance of mixed conifer forests in Baja California may be due to its thick bark, high canopy, and good regeneration following surface fires, in contrast to competing species of Abies and Calocedrus that are more fire-susceptible." [Abies species identifies as intolerant of fire. Abies guatemalensis would presumably share this trait.]
804	2004. Quintana-Ascencio, P.F./Ramírez-Marcial, N./González-Espinosa, M./Martínez-Icó, M.. Sapling survival and growth of coniferous and broad-leaved trees in successional highland habitats in Mexico. Applied Vegetation Science. 7: 81-88.	[Tolerates, or benefits from, mutilation, cultivation, or fire? No] "...critical, factors limiting natural recruitment of Abies could be: (1) low density of reproductive adults and their clumped distribution; (2) low seed viability and germination (N. Ramírez-Marcial pers. obs.); (3) grazing by rabbits and pocket gophers; (4) grazing and trampling by free-ranging cattle; (5) fire incidence for agricultural purposes."
805	2002. Vozzo, J.A.. Tropical Tree Seed Manual. USDA Forest Service, Washington, D.C.	[Effective natural enemies present locally (e.g. introduced biocontrol agents)? Unknown] "Trees can be severely infested by bark beetles (Dendroctonus spp.) (Donahue and others 1985) and seeds can be attacked by seed wasps (Megastigmus spp.) (Donahue and others 1985, Hiratsuka and others 1995)." [Unknown whether these pests occur in Hawaiian Islands]