

Taxon: <i>Pinus caribaea</i> Morelet	Family: Pinaceae
Common Name(s): Caribbean pine pitch pine	Synonym(s): <i>Pinus taeda</i> var. <i>heterophylla</i> Elliott

Assessor: Chuck Chimera	Status: Assessor Approved	End Date: 19 Mar 2018
WRA Score: 15.0	Designation: H(HPWRA)	Rating: High Risk

Keywords: Tropical Pine, Naturalized, Allelopathic, Dense Stands, Wind-Dispersed

Qsn #	Question	Answer Option	Answer
101	Is the species highly domesticated?	y=-3, n=0	n
102	Has the species become naturalized where grown?		
103	Does the species have weedy races?		
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	(0-low; 1-intermediate; 2-high) (See Appendix 2)	High
202	Quality of climate match data	(0-low; 1-intermediate; 2-high) (See Appendix 2)	High
203	Broad climate suitability (environmental versatility)	y=1, n=0	y
204	Native or naturalized in regions with tropical or subtropical climates	y=1, n=0	y
205	Does the species have a history of repeated introductions outside its natural range?	y=-2, ?=-1, n=0	y
301	Naturalized beyond native range	y = 1*multiplier (see Appendix 2), n= question 205	y
302	Garden/amenity/disturbance weed	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)	y
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	y
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		
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	n
409	Is a shade tolerant plant at some stage of its life cycle	y=1, n=0	n

Qsn #	Question	Answer Option	Answer
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	y
604	Self-compatible or apomictic	y=1, n=-1	y
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	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	y
707	Propagules dispersed by other animals (externally)	y=1, n=-1	y
708	Propagules survive passage through the gut		
801	Prolific seed production (>1000/m ²)	y=1, n=-1	y
802	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1	y
803	Well controlled by herbicides	y=-1, n=1	y
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)		

Supporting Data:

Qsn #	Question	Answer
101	Is the species highly domesticated?	n
	Source(s)	Notes
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	[Not domesticated, or selected for traits that would significantly alter the tree's competitive ability] "Intensive research on provenance variation of <i>P. caribaea</i> was initiated by the Oxford Forestry Institute (then the Commonwealth Forestry Institute) in the early 1970s. Range-wide seed collections were made representing all distribution ranges of the three varieties of <i>P. caribaea</i> . More than 180 trials were established in over 50 countries." ... " <i>P. caribaea</i> has been the subject of large-scale tree breeding programmes in Brazil. Dos Santos et al. (1996) summarise the breeding strategies since the late 1970s. Dvorak et al. (1993) report on performance of <i>P. caribaea</i> var. <i>hondurensis</i> in Brazil, Colombia and Venezuela. In Bahia, Brazil, data on height, stem diameter at breast height (d.b.h.) and stem form at age 5.5 years were used to compare genetic improvement and selection strategies for open-pollinated for open-pollinated half-sibs families of <i>P. caribaea</i> var. <i>hondurensis</i> . Combined selection resulted in genetic gains of between 16 and 30% (Cornacchia et al., 1995)."
102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. 2018. Personal Communication	NA
103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. 2018. Personal Communication	NA
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	High
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 16 Mar 2018]	"Native Northern America Southern Mexico: Mexico Quintana Roo Southern America Caribbean: Bahamas ; Cuba Central America: Belize ; Guatemala ; Honduras ; Nicaragua"

Qsn #	Question	Answer
202	Quality of climate match data	High
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 16 Mar 2018]	

203	Broad climate suitability (environmental versatility)	y
	Source(s)	Notes
	Orwa C., Mutua, A., Kindt R., Jamnadass, R., & Anthony, S. 2009 Agroforestry Database: a tree reference and selection guide version 4.0. http://www.worldagroforestry.org . [Accessed 19 Mar 2018]	"Altitude: 0-1 500 m, Mean annual temperature: 22-37 deg. C, Mean annual rainfall: 1 000-3 000 mm"
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	" <i>P. caribaea</i> var. <i>hondurensis</i> grows on a wide variety of sites in the tropics and subtropics at altitudes below 800 m (Whitmore and Liegel, 1980), although it also grows well up to altitudes of 1500 m or more." "Climatic amplitude (estimates) - Altitude range: 0 - 1500 m - Mean annual rainfall: 660 - 4000 mm - Rainfall regime: summer - Dry season duration: 0 - 6 months - Mean annual temperature: 20 - 27°C - Mean maximum temperature of hottest month: 28 - 34°C - Mean minimum temperature of coldest month: 8 - 23°C - Absolute minimum temperature: > 5°C"

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	Notes
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	" <i>P. caribaea</i> , especially <i>P. caribaea</i> var. <i>hondurensis</i> , is widely planted throughout the American, Asian, and African tropics and subtropics. It is fast growing and has very versatile wood. <i>P. caribaea</i> var. <i>hondurensis</i> is the most productive of the three varieties of <i>P. caribaea</i> ." ... " <i>P. caribaea</i> has a wide though very disjunct distribution in the Caribbean basin. The tree varies much, both morphologically and silviculturally, in the various parts of its range. <i>P. caribaea</i> var. <i>caribaea</i> is confined to Cuba and the Isla de la Juventud (formally Isla de Pinos) which lies 56 km south of Havana across the shallow Gulf of the Batabano. The island is sufficiently distant from the main island to have a genetically distinct population (Birks and Barnes, 1990)."

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

Qsn #	Question	Answer
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	" <i>Pinus caribaea</i> occurs naturally in eastern Central America, Cuba and the Bahama Islands. It is planted throughout the tropics, including many countries of tropical Africa, and in Australia and New Zealand. <i>Pinus caribaea</i> occurs naturally in eastern Central America, Cuba and the Bahama Islands. It is planted throughout the tropics, including many countries of tropical Africa, and in Australia and New Zealand."
	Skolmen, R.G. 1980. Plantings on the forest reserves of Hawaii: 1910–1960. Institute of Pacific Islands Forestry, Pacific Southwest Forest & Range Experiment Station, US Forest Service, Honolulu, HI	27,112 planted on the Hawaiian Islands (Kauai = 6; Molokai = 26,041; Maui = 731; Hawaii Island = 334]

301	Naturalized beyond native range	y
	Source(s)	Notes
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	" <i>P. caribaea</i> is a tree which is widely commercialised for its wood and which has been intentionally introduced worldwide to establish forestry plantations since the second part of the nineteenth century. It is classified as an invasive species causing serious problems to natural habitats in Bangladesh, Brazil, Australia, the Cook Islands, Hawaii, Guam, New Caledonia and French Polynesia (Oppenheimer, 2003; Afrin et al., 2010; Queensland Department of Agriculture, Fisheries and Forestry, 2010; Simberloff et al., 2010; PIER, 2013). <i>P. caribaea</i> is a fast-growing tree that grows forming dense monocultures over extensive areas of land displacing native vegetation and altering hydrology, nutrient cycling, and fire regimes (Richardson, 1998, 1998b; Simberloff et al., 2010)."
	Oppenheimer, Hank L. 2003. New plant records from Maui and Hawai'i Counties. Bishop Museum Occasional Papers. 73: 3-30	"This taxon is native to the Caribbean coast of Central America, from Belize to Nicaragua. It is commonly used in forestry plantations in Australia and many Pacific islands. Caribbean pine has escaped from plantings on Maui and has been observed to be spreading in French Polynesia as well. Material examined: MAUI: West Maui, Lahaina Dist, Kuholilea, near Kahoma Cabin, 549 m, spreading from plantings, 6 Apr 2000, Oppenheimer et al. H40008 (BISH); East Maui, Makawao Dist, Makawao F.R., near Pīiholo Water Treatment plant, 866 m, naturalized from forestry plantings, 15 Jul 2001, H. & M. Oppenheimer & F. & R. Duvall H70127 (BISH)."

302	Garden/amenity/disturbance weed	n
	Source(s)	Notes
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	[Environmental weed] " <i>P. caribaea</i> has escaped from plantations and grows forming dense stands excluding native vegetation and altering hydrology, nutrient cycling, and fire regimes. This species also has the potential to displace native species due to the production of large amounts of litter that results in the acidification of soils on areas beneath pine trees (Richardson, 1998, 1998b; Simberloff et al., 2010)."

303	Agricultural/forestry/horticultural weed	n
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Qsn #	Question	Answer
	Source(s)	Notes
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	[Environmental weed] "The main impacts of invasive pines result from the increased abundance of trees in habitats where they were previously absent or less common (Richardson, 1998). ... <i>P. caribaea</i> has escaped from plantations and grows forming dense stands excluding native vegetation and altering hydrology, nutrient cycling, and fire regimes. This species also has the potential to displace native species due to the production of large amounts of litter that results in the acidification of soils on areas beneath pine trees (Richardson, 1998, 1998b; Simberloff et al., 2010)."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence

304	Environmental weed	y
	Source(s)	Notes
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	" <i>P. caribaea</i> has escaped from plantations and grows forming dense stands excluding native vegetation and altering hydrology, nutrient cycling, and fire regimes. This species also has the potential to displace native species due to the production of large amounts of litter that results in the acidification of soils on areas beneath pine trees (Richardson, 1998, 1998b; Simberloff et al., 2010). Pine forest habitats generally offer fewer benefits to native wildlife than native vegetation, and contribute to an overall reduction in native biodiversity in many of the areas invaded (Richardson, 1998, 1998b)."

305	Congeneric weed	y
	Source(s)	Notes
	Farjon, A. & Styles, B.T. 1997. <i>Pinus</i> (Pinaceae). <i>Flora Neotropica</i> 75: 1-291	"After <i>Pinus radiata</i> , <i>P. patula</i> has now become one of the most troublesome invasive species of pine threatening natural vegetation and biodiversity in the highlands of southern Africa."
	Richardson, D. M., Williams, P. A., & Hobbs, R. J. (1994). Pine invasions in the Southern Hemisphere: determinants of spread and invadability. <i>Journal of Biogeography</i> 21(5): 511-527	" <i>Pinus banksiana</i> is invasive in New Zealand in scrub and open places on and near forest margins, shrublands, tussock grassland. At least 16 <i>Pinus</i> species are invasive in the Southern hemisphere: <i>P. banksia</i> , <i>P. canariensis</i> , <i>P. contorta</i> , <i>P. elliottii</i> , <i>P. halepensis</i> , <i>P. muricata</i> , <i>P. nigra</i> , <i>P. patula</i> , <i>P. pinaster</i> , <i>P. pinea</i> , <i>P. ponderosa</i> , <i>P. radiata</i> , <i>P. roxburghii</i> , <i>P. strobus</i> , <i>P. sylvestris</i> , <i>P. taeda</i> ."
	Loope, L.L., Nagata, R.J. & Medeiros, A.C. 1992, Alien plants in Haleakala National Park Pp. 551-576 in Stone et al (eds) Alien plant invasions in native ecosystems of Hawaii. Coop. Nat. Park Resources Studies Unit, University of Hawaii, Honolulu, HI	" <i>Pinus radiata</i> from California, <i>Pinus patula</i> from Mexico, and <i>Pinus pinaster</i> from southern Europe are the only conifers (of many planted species in the Hosmer Grove area) to aggressively establish seedlings in native shrubland of the Park along the boundary adjacent to an experimental watershed improvement project on ranchland. On favorable sites these species can grow in height at a rate of about 12 in./yr (30 cm/year) and start to produce cones after six to eight years."

Qsn #	Question	Answer
	Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Pinus radiata" ... "It establishes well in burned areas and forms dense stands that may cover large areas. The native vegetation is eliminated and transformed into species-poor woodland. A thick litter layer accumulates beneath stands of this tree, preventing establishment of native plants"
	Medeiros, A.C., Loope, L.L. & Chimera, C.G. 1998. Flowering Plants and Gymnosperms of Haleakala National Park. Technical Report 120. Pacific Cooperative Studies Unit, Honolulu, HI	"The most serious weeds of the subalpine zone appear to be Cortaderia jubata (Andean pampas grass), Eucalyptus globulus (blue gum), Pinus radiata (Monterey pine), Pinus pinaster (maritime pine), Pinus patula (Mexican weeping pine), and Ulex europaeus (gorse);"
	Richardson, D. M., & Rejmánek, M. 2004. Conifers as invasive aliens: a global survey and predictive framework. Diversity and Distributions, 10(5-6): 321-331	"We summarize information on naturalized and invasive conifers (class Pinopsida) worldwide (data from 40 countries, some with remote states/territories), and contrast these findings with patterns for other gymnosperms (classes Cycadopsida, Gnetopsida and Ginkgoopsida) and for woody angiosperms." ... "Twenty-eight of the known invasive conifers belong to one family (Pinaceae) and 21 of these are in one genus (Pinus)."

401	Produces spines, thorns or burrs	n
	Source(s)	Notes
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	[No evidence] "Evergreen, monoecious, medium-sized tree up to 30 (-45) m tall, but in plantations usually much smaller; bole branchless for up to 21 m, up to 80(-135) cm in diameter, usually straight, cylindrical; bark surface reddish brown to pale brownish grey, deeply fissured, inner bark very resinous; crown thin, rounded to pyramidal, slightly spreading; twigs orange brown, later turning grey-brown. Leaves in bundles of (2-)3(-5) in whorls at the end of the shoots, needle-shaped, 15-25 cm long, minutely toothed, stiff, dark or yellowish green, slightly shiny."

402	Allelopathic	y
	Source(s)	Notes
	Martínez, V., & Álvarez, P. (2004). Allelopathic effects of <i>Pinus caribaea</i> Morelet var. <i>Caribaea</i> on coffee weeds under the sun. In III Congreso 2004 Sociedad Cubana de Malezología, Memorias, Jardín Botánico Nacional, Ciudad Habana, 28, 29 y 30 de abril del 2004 (pp. 119-122). Asociación Latinoamericana de Malezas	"Abstract : The present paper reports the results of an experiment carried out during the dry season in a coffee field with a 40° slope in Topes de Collantes, Trinidad, Cuba, with the objective of assessing the allelopathic effects of <i>Pinus caribaea</i> on weed germination. A randomized block design with 5 treatments and 4 replicates was used. The treatments included the control (water) and treatment with glyphosate, grounded pine needles (58 g) and pine solution at 50% and 100% (58 g in a litre of water). In the plots, prepared in the coffee field using homogenized soil, the different treatments were applied 3 times and only water for the rest of the experiment to maintain the moisture. Application of glyphosate as control and the pine solution at 100% resulted in the control of weeds in the coffee field. Side effects of pine on the pH, microorganisms and mineral elements of the soil were not detected."

Qsn #	Question	Answer
	Nissanka, S. P., Mohotti, K. M., & Wijetunga, A. S. T. B. (2005). Alleopathic influences of <i>Pinus caribaea</i> on vegetation regeneration and soil biodiversity. In Fourth World Congress on Allelopathy, Australia. http://www.regional.org.au . [Accessed 19 Mar 2018]	[Suspected of allelopathy] "Vegetation diversity was lower, and soil organism populations of mycorrhizae, fungi, bacteria, free living nematodes and earth worms were reduced by 2.3, 2.4, 1.6, and 4 folds respectively in <i>Pinus</i> compared to natural forest. Soil microbial activities were also reduced 4 fold in <i>Pinus</i> forest indication lower soil biodiversity and activity. VAM associations were found in all ten understorey plant species in both <i>Pinus</i> plantation and natural forests. However, Mean Percentage Occurrences of VAM for all the ten species were significantly different and number of VAM present were lower in all species in <i>Pinus</i> plantations than the same species from natural forests. These lower vegetation diversity and soil biodiversity under <i>Pinus</i> plantation may be associated with their allelopathic effects compared to the natural vegetations. "

403	Parasitic	n
	Source(s)	Notes
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	"Evergreen, monoecious, medium-sized tree up to 30(-45) m tall, but in plantations usually much smaller"

404	Unpalatable to grazing animals	n
	Source(s)	Notes
	Rudeen, D. P. (1978). Compatibility of sheep and deer grazing with lodgepole pine regeneration in the pumice region of central Oregon. MSc Thesis. Oregon State University, Corvallis, Oregon	[Palatable, but not preferred] "A study by Pearson et al. (1971) on slash pine (<i>Pinus caribaea</i>) regeneration involved various levels of grazing intensity by cattle. They found that light and moderate grazing (33 and 47 percent utilization, respectively) did not affect establishment or survival of seedlings. Heavy grazing (56 percent utilization) on the other hand resulted in 124 fewer trees per acre after five years of use. They also determined that 80 percent of the mortality occurred in the months immediately after planting but that browsing of the pines "virtually" stopped once green herbage became available."

405	Toxic to animals	n
	Source(s)	Notes
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	No evidence
	Wagstaff, D.J. 2008. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	No evidence

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

Qsn #	Question	Answer
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	"Needle blight caused by <i>Cercospora pini-densiflorae</i> can seriously attack plantations. Damage by <i>Armillaria mellea</i> has been recorded in Tanzania, Malawi and Mauritius. In nurseries damping off may occur. <i>Pinus caribaea</i> is resistant to pitch canker (<i>Fusarium circinatum</i>), a serious disease threatening pine plantations in South Africa."

407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	Notes
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	"(Oil used in inhalers. Love potion, inner bark.)" [No evidence of toxicity]
	Global Species. 2018. <i>Pinus caribaea</i> (Caribbean pine; pino colorado). https://www.globalspecies.org/ntaxa/386740 . [Accessed 19 Mar 2018]	"Allergen Potential ... Medium-Low"

408	Creates a fire hazard in natural ecosystems	n
	Source(s)	Notes
	Orwa C., Mutua, A., Kindt R., Jamnadass, R., & Anthony, S. 2009 Agroforestry Database: a tree reference and selection guide version 4.0. http://www.worldagroforestry.org . [Accessed 19 Mar 2018]	" <i>P. caribaea</i> is rated as moderately fire resistant."
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	" <i>P. caribaea</i> var. <i>hondurensis</i> is well adapted to fire and can survive under a frequent fire regime. The pure forests of this species along the Atlantic coastal regions of Honduras and Nicaragua are referred to as pine savannas because of their open character. This landscape is the result of extensive and repeated fires. Total fire exclusion will result in a gradual conversion of these pine savannas to broadleaf species (Denevan, 1961, Monro 1966)." [Fires do not kill this species, but keep fire intolerant species from establishing & replacing the pine forests]

409	Is a shade tolerant plant at some stage of its life cycle	n
	Source(s)	Notes
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	" <i>P. caribaea</i> requires full sunlight, therefore the planting site needs to be cleared completely. Weeding can be necessary if weeds are likely to smother young trees. Weeding can be done mechanically, provided that the spacing of the trees is ample."

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y
	Source(s)	Notes

Qsn #	Question	Answer
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	<p>"The species occurs on a wide variety of sites and soils. On the Bahamas and Caicos Islands, where soil is minimal, the trees are rooted in a porous limestone formation with a very high water table that fluctuates with the tides. In Cuba, the species is found on shallow but well-drained loams overlying shales and sandstones and on deep, lateritic soils derived from serpentine. On Isla de la Juventud and on the coastal plains of Belize, where soil characteristics largely determine its distribution, the tree is partially confined to leached, shallow sand overlying clay. This type of site is subject to waterlogging during the rainy season but becomes very dry in times of drought. In the interior of Belize, Guatemala and Honduras, the soils, though leached, are of somewhat better quality, consisting of clays, sandy-clays or loams derived from granites, porphyries and tuffs. On the Mosquito coast, as in the coastal districts of Belize, the distribution of the species is strongly influenced by edaphic factors, the pine savannas being confined to very infertile, rather poorly-drained, water-worn, quartz-gravel beds and giving way to dense stands of hardwoods on the better-drained, more fertile soils (Poynton, 1977). Sites are often level or have gentle topography, however steep slopes present no particular difficulty for <i>P. caribaea</i>.</p> <p>Soil descriptors</p> <ul style="list-style-type: none"> - Soil texture: medium; heavy - Soil drainage: free; seasonally waterlogged - Soil reaction: acid; neutral; alkaline - Special soil tolerances: shallow; saline; infertile - Soil types: gravelly soils; lateritic soils; limestone soils; sandstone soils; clay soils"

411	Climbing or smothering growth habit	n
	Source(s)	Notes
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	"A tree of moderately large size, <i>P. caribaea</i> is seldom higher than 30 m with a diameter of 25 to 75 cm on sites of average quality. Under particularly favourable conditions the diameter can swell to 135 cm and the tree can grow to be as tall as 45 m. It forms a straight, clean bole sometimes free of branches for the first 12 m when mature. In South Africa, var. <i>hondurensis</i> has displayed more crooked stems than the other two varieties. "

412	Forms dense thickets	y
	Source(s)	Notes
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	" <i>P. caribaea</i> is a fast-growing tree that grows forming dense monocultures over extensive areas of land displacing native vegetation and altering hydrology, nutrient cycling, and fire regimes (Richardson, 1998, 1998b; Simberloff et al., 2010)."
	Smith, C.W. 1985. Impact of Alien Plants on Hawaii's Native Biota. Pp. 180-250 in Stone & Scott (eds.). Hawaii's terrestrial ecosystems: preservation & management. CPSU, Honolulu, HI	" <i>Pinus caribaea</i> ... This evergreen tree can form dense monotypic stands reaching 15 m in height displacing all other plants."

Qsn #	Question	Answer
501	Aquatic	n
	Source(s)	Notes
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	[Terrestrial] "Evergreen, monoecious, medium-sized tree up to 30(–45) m tall ... <i>Pinus caribaea</i> is mostly grown up to 1000(–1500) m altitude"
502	Grass	n
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 16 Mar 2018]	Genus: <i>Pinus</i> Subgenus: <i>Pinus</i> Section: <i>Trifoliae</i> Subsection: <i>Australes</i> Family: <i>Pinaceae</i>
503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 16 Mar 2018]	Family: <i>Pinaceae</i>
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	Notes
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	"Evergreen, monoecious, medium-sized tree up to 30(–45) m tall, but in plantations usually much smaller"
601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	Notes
	Farjon, A. 2013. <i>Pinus caribaea</i> . The IUCN Red List of Threatened Species 2013: e.T42348A2974430. http://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T42348A2974430.en . [Accessed 19 Mar 2018]	"Despite the fact that two of the three varieties recognized under this species have been assessed as Endangered, the species as a whole is not threatened, due to the widespread abundance of one variety: var. <i>hondurensis</i> . Given the fact that the latter is probably increasing in abundance, with a decline in the smaller populations of the two island varieties, the situation is at least stable for the whole species and it is therefore assessed as Least Concern."
602	Produces viable seed	y
	Source(s)	Notes
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	" <i>P. caribaea</i> is grown very easily in nurseries. The germination capacity of seed is good."

Qsn #	Question	Answer
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	" <i>Pinus caribaea</i> is easily propagated from seed. The 1000- seed weight is 12–33 g. To obtain seed, cones can be collected as soon as they begin to change from green to brown on the tree; cones collected earlier may give seeds with short viability. Seeds are collected after sun-drying the cones in the sun or in open-sided sheds covered with plastic roofs."

603	Hybridizes naturally	y
	Source(s)	Notes
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	"It has been found that var. <i>hondurensis</i> crossed naturally with <i>P. oocarpa</i> , and <i>P. oocarpa</i> var. <i>ochoterenai</i> produces progeny that have better form and are faster growers than their parents (Perry, 1991). <i>P. elliottii</i> crossed with <i>P. caribaea</i> var. <i>hondurensis</i> has made a major contribution to the success of commercial forestry in Queensland, Australia. These successes have also stimulated interest in hybrids in other countries such as South Africa, Brazil and Fiji."
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	" <i>Pinus caribaea</i> var. <i>hondurensis</i> forms natural hybrids with <i>Pinus oocarpa</i> Schiede ex Schltdl. <i>Pinus caribaea</i> has often been mistaken for <i>Pinus elliottii</i> Engelm. in the past."

604	Self-compatible or apomictic	y
	Source(s)	Notes
	Zheng, Y. Q., & Ennos, R. A. (1999). Genetic variability and structure of natural and domesticated populations of Caribbean pine (<i>Pinus caribaea</i> Morelet). <i>Theoretical and Applied Genetics</i> , 98(5), 765-771	[Capable of self-fertilization] "Seed from a seed orchard population of var 'caribaea' established within its natural range showed no change in genetic diversity but did show a reduced inbreeding coefficient ($F_{is}=0.09$) compared with its progenitor populations, suggesting a decrease in selfing and/or biparental inbreeding. A bulked seed sample from an exotic plantation of var 'bahamensis' in Australia displayed a large increase in the inbreeding coefficient ($F_{is}=0.324$) compared with that found in natural populations, possibly due to elevated self-fertilization. Finally, a bulked seed sample from an exotic plantation population of var 'caribaea' from China showed enhanced genetic diversity, an increase in the inbreeding coefficient and more linkage disequilibrium than its presumed progenitor populations."

605	Requires specialist pollinators	n
	Source(s)	Notes
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	"Pollination is by wind. The time between pollination and ripening of the female cones is 18–21 months. Cones are readily shed from the branches, but sometimes persistent for over one year."

Qsn #	Question	Answer
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	"Strobili appear before the new leaves in January or February, when pollination occurs. The male strobili are many, sessile and in whorled, short, crowded clusters near ends of twigs mostly in the lower part of the crown. Male strobili are 20 to 32 mm long, 5 mm broad with 12 to 18 ovate, scarious margined with reddish-brown bracts at the base. Female strobili are mostly in upper part of the crown and appear near the apex of elongated twigs. However, female strobili become lateral, (1-) 2 to 4 (-8) in a whorl, and 1 to 3 whorls form per year. Year old cones are erect to reflexed on scaly stalks 1 to 1.5 cm long. Ellipsoidal cones are 1.5 to 2 cm long and 1 cm broad with shiny tan scales and a minute prickle which is curved upwards toward the apex of the cone."

606	Reproduction by vegetative fragmentation	n
	Source(s)	Notes
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	[No evidence of natural vegetative spread] "Studies on the vegetative propagation of <i>P. caribaea</i> have shown that cuttings from stems of trees 2.5-years-old will produce interfascicular shoots if repeatedly sprayed with 100 mg/litre BAP. Solutions of 0.8% IBA will produce longer roots and, generally, more and longer roots are produced when cuttings are larger (Inglis, 1984)."

607	Minimum generative time (years)	3
	Source(s)	Notes
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	"In southern Africa female flowering starts when trees are 3–4 years old, but male flowering starts later."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	n
	Source(s)	Notes
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	"Seed dispersal is by wind, but sometimes birds, rodents and people, who gather the seeds for food, also disperse them." [No means of external attachment]

702	Propagules dispersed intentionally by people	y
	Source(s)	Notes
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	" <i>Pinus caribaea</i> occurs naturally in eastern Central America, Cuba and the Bahama Islands. It is planted throughout the tropics, including many countries of tropical Africa, and in Australia and New Zealand." ... "Seed dispersal is by wind, but sometimes birds, rodents and people, who gather the seeds for food, also disperse them."

703	Propagules likely to disperse as a produce contaminant	n
	Source(s)	Notes

Qsn #	Question	Answer
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	[No evidence] "Seed dispersal is by wind, but sometimes birds, rodents and people, who gather the seeds for food, also disperse them."
704	Propagules adapted to wind dispersal	y
	Source(s)	Notes
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	"Seed dispersal is by wind, but sometimes birds, rodents and people, who gather the seeds for food, also disperse them."
705	Propagules water dispersed	n
	Source(s)	Notes
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	"Seed dispersal is by wind, but sometimes birds, rodents and people, who gather the seeds for food, also disperse them."
706	Propagules bird dispersed	y
	Source(s)	Notes
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	"Seed dispersal is by wind, but sometimes birds, rodents and people, who gather the seeds for food, also disperse them."
707	Propagules dispersed by other animals (externally)	y
	Source(s)	Notes
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	[Rodents likely act as seed predators, but may cache seeds that can escape predation] "Seed dispersal is by wind, but sometimes birds, rodents and people, who gather the seeds for food, also disperse them."
708	Propagules survive passage through the gut	
	Source(s)	Notes
	Oteng-Amoako, A.A. & Brink, M. 2008. <i>Pinus caribaea</i> Morelet. In: Louppe, D., Oteng-Amoako, A.A. & Brink, M. (Editors). PROTA. Wageningen, Netherlands	[Birds & rodents likely act as seed predators. Those that escape predation most likely were cached and not dispersed internally] "Seed dispersal is by wind, but sometimes birds, rodents and people, who gather the seeds for food, also disperse them."
801	Prolific seed production (>1000/m²)	y
	Source(s)	Notes
	CABI. 2018. Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc	" <i>P. caribaea</i> spreads by seeds. Each tree is able to produce thousands of seeds which can be dispersed over long distances by the wind."

Qsn #	Question	Answer
802	Evidence that a persistent propagule bank is formed (>1 yr)	y
	Source(s)	Notes
	Orwa C., Mutua, A., Kindt R., Jamnadass, R., & Anthony, S. 2009 Agroforestry Database: a tree reference and selection guide version 4.0. http://www.worldagroforestry.org . [Accessed 19 Mar 2018]	"Seed storage behaviour is orthodox; viability is lost within 1 year in hermetic storage with seeds at room temperature with 13 ± 2% mc; no loss in viability during 2 years hermetic storage at room temperature; no loss in viability after 5 years of storage at 0-5 deg. C with over 8% mc; hermetic storage at 4.5% mc recommended; about 16% viability lost after 2.7 years of hermetic storage at 8 deg. C."
	CABI. 2018. Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc	"Seed will remain viable in the soil for about three years, although it can remain viable in cones for much longer (Barrett and Golfari, 1962; Francis, 1992; Soerianegara and Lemmens, 1993; Oteng Amako and Brink, 2008)."

803	Well controlled by herbicides	y
	Source(s)	Notes
	CABI. 2018. Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc	"The Department of Agriculture, Fisheries and Forestry from Queensland ... suggests the following treatments: Stem injections of N-phosphonomethyl-glycine (glyphosate), 3,5,6-trichloro-2-pyridinyloxyacetic acid (triclopyr) or 4-amino-3,5,6-trichloro-2-pyridinecarboxylic acid (picloram). The cut of the injection must be through the bark and deep enough to place the chemical in contact with the sapwood. Basal bark treatment with 3,5,6-trichloro-2-pyridinyloxyacetic acid (triclopyr) or 4-amino-3,5,6-trichloro-2-pyridinecarboxylic acid (picloram). To increase the uptake of herbicide, remove the bark of the part of the tree trunk to be treated with an axe prior to basal barking"

804	Tolerates, or benefits from, mutilation, cultivation, or fire	n
	Source(s)	Notes
	Orwa C., Mutua, A., Kindt R., Jamnadass, R., & Anthony, S. 2009 Agroforestry Database: a tree reference and selection guide version 4.0. http://www.worldagroforestry.org . [Accessed 19 Mar 2018]	" <i>P. caribaea</i> is rated as moderately fire resistant."
	CAB International, 2005. Forestry Compendium. CAB International, Wallingford, UK	" <i>P. caribaea</i> var. <i>hondurensis</i> is well adapted to fire and can survive under a frequent fire regime. The pure forests of this species along the Atlantic coastal regions of Honduras and Nicaragua are referred to as pine savannas because of their open character. This landscape is the result of extensive and repeated fires. Total fire exclusion will result in a gradual conversion of these pine savannas to broadleaf species (Denevan, 1961, Monro 1966)."

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	Source(s)	Notes

Qsn #	Question	Answer
	Smith, C.W. 1985. Impact of Alien Plants on Hawaii's Native Biota. Pp. 180-250 in Stone & Scott (eds.). Hawaii's terrestrial ecosystems: preservation & management. CPSU, Honolulu, HI	[Unknown] "This evergreen tree can form dense monotypic stands reaching 15 m in height displacing all other plants. The seeds are dispersed by wind, and it is rapidly destroyed by fire. Control in native ecosystems is by felling. It has not been evaluated for biological control because it is still hoped that it will produce timber for a forest industry. The principal infestation is on Molokai."

Summary of Risk Traits:

High Risk / Undesirable Traits

- Elevation range exceeds 1000 m, demonstrating environmental versatility
- Thrives in tropical climates
- Naturalized on Maui (Hawaiian Islands), & elsewhere
- An environmental weed that competes with native species
- Other pine species are invasive
- Allelopathic
- Tolerates many soil types
- Forms dense, monotypic stands
- Reproduces by seeds
- Hybridizes with *P. oocarpa*
- Capable of self-pollination
- Seeds dispersed by wind, sometimes by birds, rodents & intentionally by people
- Capable of prolific seed production
- Seeds may remain viable in soil for up to 3 years
- Tolerates fire

Low Risk Traits

- Unarmed (no spines, thorns, or burrs)
- Planted as a timber tree, windbreak, & ornamental
- Not reported to spread vegetatively
- Herbicides may provide effective control