

Key Words: High Risk, Naturalized, Ornamental Tree, Thicket-forming, Bird-dispersed

Family: *Cupressaceae*

Taxon: *Juniperus bermudiana*

Synonym: *Juniperus virginiana* var. *bermudiana* (L.) Va **Common Name:** Bemuda juniper
Sabina bermudiana (L.) Antoine Bemuda cedar

Questionnaire : Status:	current 20090513 Assessor Approved	Assessor: Data Entry Person:	Chuck Chimera Chuck Chimera	Designation: H(HPWRA) WRA Score 7
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)	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	n	
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)	y	
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		
409	Is a shade tolerant plant at some stage of its life cycle	y=1, n=0	n	
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y=1, n=0	n	
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	y
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	n
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	n
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	
708	Propagules survive passage through the gut	y=1, n=-1	y
801	Prolific seed production (>1000/m2)	y=1, n=-1	
802	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1	
803	Well controlled by herbicides	y=-1, n=1	
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	n
Designation: H(HPWRA)		WRA Score	7

Supporting Data:

101	1989. Little Jr., E.L./Skolmen, R.G.. Common forest trees of Hawaii: (native and introduced). USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Is the species highly domesticated? No evidence]
101	2008. Louppe, D./Oteng-Amoako, A.A./Brink, M.. Timbers 1: volume 7 of Plant Resources of Tropical Africa. PROTA, Wageningen, Netherlands	[Is the species highly domesticated? No evidence]
102	2012. WRA Specialist. Personal Communication.	NA
103	2012. WRA Specialist. Personal Communication.	NA
201	1989. Little Jr., E.L./Skolmen, R.G.. Common forest trees of Hawaii: (native and introduced). USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Species suited to tropical or subtropical climate(s) 2-High] "Native only to the island of Bermuda. Formerly abundant there, but now rare because of a disease as well as cutting."
202	1989. Little Jr., E.L./Skolmen, R.G.. Common forest trees of Hawaii: (native and introduced). USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Quality of climate match data 2-High]
203	1989. Little Jr., E.L./Skolmen, R.G.. Common forest trees of Hawaii: (native and introduced). USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Broad climate suitability (environmental versatility)? No] "This subtropical species is not hardy northward in temperate regions."
203	2008. Louppe, D./Oteng-Amoako, A.A./Brink, M.. Timbers 1: volume 7 of Plant Resources of Tropical Africa. PROTA, Wageningen, Netherlands	[Broad climate suitability (environmental versatility)? No] "In Bermuda <i>Juniperus bermudiana</i> occurs near sea-level, on sandy soils and limestone rocks."
204	1989. Little Jr., E.L./Skolmen, R.G.. Common forest trees of Hawaii: (native and introduced). USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Native or naturalized in regions with tropical or subtropical climates? Yes] "This subtropical species is not hardy northward in temperate regions."
205	1989. Little Jr., E.L./Skolmen, R.G.. Common forest trees of Hawaii: (native and introduced). USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Does the species have a history of repeated introductions outside its natural range?? Hawaiian Islands] "In Hawaii, Bermuda juniper is grown as an ornamental and in hedges. It is also planted in the Forest Reserves on a small scale. Between 1921 and 1953, 6500 trees were planted in the forests on all islands. Examples may be seen at Waiahole, Oahu, Waiahou Spring Reserve (Olinda), Maui, and Pepeekeo Arboretum, Hawaii."
205	2008. Louppe, D./Oteng-Amoako, A.A./Brink, M.. Timbers 1: volume 7 of Plant Resources of Tropical Africa. PROTA, Wageningen, Netherlands	[Does the species have a history of repeated introductions outside its natural range? Yes] " <i>Juniperus bermudiana</i> originates from Bermuda and is occasionally grown elsewhere, e.g. in the Mascarene islands. It is fairly often planted in Reunion and Mauritius, somewhat less often in Rodrigues; it has sometimes become naturalized."
301	2000. Kendle, A.D./Rose, J.E.. The aliens have landed! What are the justifications for 'native only' policies in landscape plantings?. Landscape and Urban Planning. 47: 19-31.	[Naturalized beyond native range? Yes] "It is, however, worth balancing this point with a recognition that from a global perspective non-natives may represent a resource of genetic diversity that has been lost or suffered massive depletion in its country of origin. One example is the Bermuda Cedar (<i>Juniperus bermudiana</i>), which is a self regenerating timber tree in St Helena but is a threatened species in Bermuda (Spooner et al., 1993)."
301	2004. Richardson, D.M./Rejmánek, M.. Conifers as invasive aliens: a global survey and predictive framework. Diversity and Distributions. 10: 321-331.	[Naturalized beyond native range? Yes] "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>Juniperus bermudiana</i> (Hawaii; St Helena)" [Listed as invasive in Hawaii and St. Helena]
301	2005. Wagner, W.L./Herbst, D.R./Lorence, D.H.. Flora of the Hawaiian Islands website. Smithsonian Inst., Washington, D.C. http://botany.si.edu/pacificislandbiodiversity/hawaiianflora/index.htm	[Naturalized beyond native range? Yes] " <i>Juniperus bermudiana</i> L. Status: Naturalized Distribution: L/ WM (Mahinahina Gulch)"

301	2008. Woo, E.. The Role of Plant-Bird Interactions in the Invasion of <i>Juniperus bermudiana</i> in Hawaii: Integrating Experiments, Behavior, and Models. PhD Dissertation. Stony Brook University, Stony Brook, NY	[Naturalized beyond native range? Yes] "J. bermudiana is also known to be invasive on the mid-Atlantic island of St. Helena where it was introduced in the 1930s (Ashmole and Ashmole 2000)."
301	2009. McWilliams, J.P.. Implications of climate change for biodiversity in the UK Overseas Territories. JNCC Report, No. 427. Joint Nature Conservation Committee, Peterborough	[Naturalized beyond native range? Yes] "The Bermuda cedar, <i>Juniperus bermudiana</i> , naturally endemic to Bermuda, is now slowly spreading in some parts of Ascension."
302	2003. The Nature Conservancy - Hawaii Operating Unit. Kapunakea Preserve West Maui, Hawaii. Long-Range Management Plan Fiscal Years 2004-2009. 2nd Revision.	[Garden/amenity/disturbance weed? Potential environmental weed] "TABLE 1: Priority Weed Species in Kapunakea Preserve" ... "Other Important Pest Species:" [List includes <i>Juniperus bermudiana</i>]
302	2008. Stow, S.J.C.. Non-native plant distribution in Montserrat: Conservation and Ecological aspects. MSc Thesis. Imperial College of London, London, UK	[Garden/amenity/disturbance weed? Disturbance adapted] "Native species may become invasive if conditions change as in the case of the endemic Bermuda cedar (<i>Juniperus bermudiana</i>) which was able to spread across Bermuda after humans arrived and caused mass deforestation (Kairo et al., 2003)."
302	2008. Woo, E.. The Role of Plant-Bird Interactions in the Invasion of <i>Juniperus bermudiana</i> in Hawaii: Integrating Experiments, Behavior, and Models. PhD Dissertation. Stony Brook University, Stony Brook, NY	[Garden/amenity/disturbance weed? Potential environmental weed with a long lag phase] "J. bermudiana is also known to be invasive on the mid-Atlantic island of St. Helena where it was introduced in the 1930s (Ashmole and Ashmole 2000). Although J. bermudiana is not at this point a major invasive pest in the West Maui Mountains, a similar fate could occur in Hawaii. The distribution of J. bermudiana in the study site exhibits at least 3 distinct levels of invasion: monotypic stands are present where J. bermudiana was first introduced, clumped individuals are present where J. bermudiana has now successfully established, and sparse individuals are starting to colonize at the invasion front of the J. bermudiana distribution." ... "J. bermudiana is an example of an exotic species that is not likely to be 1 of the 10 established species that becomes an invasive pest. Although it has been introduced in the wild, it has been slow to establish in the West Maui Mountains and will not likely become aggressively invasive in the near future. The slow spread of J. bermudiana in the West Maui Mountains is ultimately limited by the establishment phase of the invasion process. However, since J. bermudiana has been introduced across Hawaii since the 1920s, future studies comparing the effects of different environmental conditions on seedling emergence and survival on different islands may shed some light on how this stage of the seed dispersal cycle can affect J. bermudiana invasion."
302	2011. Adams, R./Gardner, M./Wingate, D.B.. <i>Juniperus bermudiana</i> . In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. Downloaded on 08 August 2012. www.iucnredlist.org	[Garden/amenity/disturbance weed? Yes. Potential environmental weed] "Perhaps the biggest planting is in St Helena and on Ascension Island where seed was introduced during the mid-19th century to establish timber tree plantations (Adams 2008). Ironically on these islands J. bermudiana is now becoming an invasive problem. <i>Juniperus virginiana</i> has also been introduced on St. Helena so there is the potential for hybridization (Adams 2008)."
303	2007. Randall, R.P.. Global Compendium of Weeds - <i>Juniperus bermudiana</i> . http://www.hear.org/gcw/species/juniperus_bermudiana/	[Agricultural/forestry/horticultural weed? No evidence]
304	2008. Woo, E.. The Role of Plant-Bird Interactions in the Invasion of <i>Juniperus bermudiana</i> in Hawaii: Integrating Experiments, Behavior, and Models. PhD Dissertation. Stony Brook University, Stony Brook, NY	[Environmental weed? Not in West Maui] "J. bermudiana is also known to be invasive on the mid-Atlantic island of St. Helena where it was introduced in the 1930s (Ashmole and Ashmole 2000). Although J. bermudiana is not at this point a major invasive pest in the West Maui Mountains, a similar fate could occur in Hawaii. The distribution of J. bermudiana in the study site exhibits at least 3 distinct levels of invasion: monotypic stands are present where J. bermudiana was first introduced, clumped individuals are present where J. bermudiana has now successfully established, and sparse individuals are starting to colonize at the invasion front of the J. bermudiana distribution." ... "J. bermudiana is an example of an exotic species that is not likely to be 1 of the 10 established species that becomes an invasive pest. Although it has been introduced in the wild, it has been slow to establish in the West Maui Mountains and will not likely become aggressively invasive in the near future. The slow spread of J. bermudiana in the West Maui Mountains is ultimately limited by the establishment phase of the invasion process. However, since J. bermudiana has been introduced across Hawaii since the 1920s, future studies comparing the effects of different environmental conditions on seedling emergence and survival on different islands may shed some light on how this stage of the seed dispersal cycle can affect J. bermudiana invasion."

304	2011. Adams, R./Gardner, M./Wingate, D.B.. Juniperus bermudiana. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. Downloaded on 08 August 2012. www.iucnredlist.org	[Environmental weed? Potentially] "Perhaps the biggest planting is in St Helena and on Ascension Island where seed was introduced during the mid-19th century to establish timber tree plantations (Adams 2008). Ironically on these islands J. bermudiana is now becoming an invasive problem. Juniperus virginiana has also been introduced on St. Helena so there is the potential for hybridization (Adams 2008). "
305	2005. Ansley, R.J./Rasmussen, G.A.. Managing Native Invasive Juniper Species Using Fire. Weed Technology. 19(3): 517-522.	[Congeneric weed? Yes] "Abstract: Junipers (Juniperus spp.) are native woody shrubs that have expanded beyond their normal historical ranges in the western and southwestern United States since the late 1800s. Most ecologists and resource managers agree that juniper has become a deleterious native invasive plant that threatens other vegetation ecosystems, such as grasslands, through a steady encroachment and ultimate domination. The use of fire in managing junipers is based on a management goal to increase the disturbance return interval and thereby reduce the abundance and/or competitive impact of juniper in an ecosystem. In this paper, we discuss rates of juniper encroachment in relation to presettlement fire regimes, juniper encroachment and soil health, postfire vegetation responses, and long-term potential of different juniper treatment scenarios that involve prescribed fire."
305	2007. Randall, R.P.. Global Compendium of Weeds - Index. http://www.hear.org/gcw/	[Congeneric weed? Yes] Multiple species listed as naturalized and/or invasive
305	2010. Pierce, A.M./Reich, P.B.. The effects of eastern red cedar (Juniperus virginiana) invasion and removal on a dry bluff prairie ecosystem. Biol Invasions. 12: 241-252.	[Congeneric weed? Yes] "Abstract Eastern red cedar (Juniperus virginiana) establishment increased dramatically in the tallgrass prairie biome of North America during the last 30 years. Since many of the remaining remnant prairies occur on steep, dry, and nutrient poor sites, threatened by the invasion of native and non native woody species, it is important to understand how an invasive species such as eastern red cedar influences key environmental factors that may determine the future trajectory of these systems and whether abiotic and biotic components of the system are resilient following cedar removal. To address these issues we: (1) investigated the influence of eastern red cedar on micro-environmental factors; (2) evaluated how these micro-environmental factors responded to eastern red cedar removal; and (3) assessed the effect of eastern red cedar on herbaceous species germination and distribution. The invasion of eastern red cedar was associated with lower surface light availability and soil temperature, as seen in prior studies, but otherwise had effects distinct from those observed in prior studies. There was no effect of cedar on soil pH, and unlike prior studies, cedar patches had higher soil moisture compared to native C4 prairie grass plots. Moreover, these effects had strong spatial signatures, with impacts of invasion on micro environment and native vegetation differing dramatically with slope position and aspect. Three years after eastern red cedar was removed, micro environmental factors and species composition became similar to the tree-free grass-dominated plots, indicating a significant capacity for recovery following possible cedar control. In a broader context, this study sheds light on the pathways and mechanisms driving the impacts of this biological invasion on dry, steep, nutrient poor systems and illustrates the capability of these systems to recover once the invading species is removed."
401	1989. Little Jr., E.L./Skolmen, R.G.. Common forest trees of Hawaii: (native and introduced). USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Produces spines, thorns or burrs? No] "Small to medium-sized introduced evergreen tree with small scalelike leaves. Trunk straight, with many branches in compact cone-shaped crown to 40 ft (12 m) high. Bark brown, furrowed into scaly ridges and peeling. Inner bark with dead brown outer layer, whitish, fibrous, resinous. Twigs four-angled, stout, more than 1/16 inch (1.5 mm) wide."
402	2009. Young, G.P./Bush, J.K.. Assessment of the Allelopathic Potential of Juniperus ashei on Germination and Growth of Bouteloua curtipendula. Journal of Chemical Ecology. 35(1): 74-80.	[Allelopathic? Unknown. Other Juniperus species demonstrate allelopathy] "Potential allelopathic compounds of Juniperus ashei Buchh. (Ashe juniper) and their effect on a native grass were determined in laboratory and field studies." ... "Chemical analyses indicate that monoterpenes are released through leaching and volatilization from J. ashei, and germination and field studies suggest that these compounds inhibit B. curtipendula. "
403	1989. Little Jr., E.L./Skolmen, R.G.. Common forest trees of Hawaii: (native and introduced). USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Parasitic? No] "Small to medium-sized introduced evergreen tree with small scalelike leaves." [Cupressaceae]

404	1997. Ueckert, D.N.. Chapter 5. Juniper Control and Management. In: Proc. 1997 Juniper Symposium. Jan. 9-10, 1997. San Angelo, Tex. Texas Agr. Exp. Sta.. http://texnat.tamu.edu/library/symposia/juniper-ecology-and-management/juniper-control-and-management	[Unpalatable to grazing animals? No. Palatable to goats] "Even though junipers are protected from grazers and insects by secondary plant compounds called monoterpenes that render them of relatively low palatability and that interfere with their digestibility (Launchbaugh et al. 1997; Taylor et al. 1997), it has been known for 40 to 50 yr that goats can effectively control junipers and other brush species that are relatively unpalatable to other livestock species (Magee 1957). Research at Sonora has shown that the winter diets of goats generally include about 10% juniper (in some years as much as 20 to 30%) and that Spanish goats are much more efficient than Angora goats for controlling woody plants (Straka and Taylor 1994)."
405	2008. Wagstaff, D.J.. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	[Toxic to animals? No evidence]
405	2012. Specialized Information Services, U.S. National Library of Medicine. TOXNET toxicology data network [online database]. National Institutes of Health, http://toxnet.nlm.nih.gov/	[Toxic to animals? No evidence]
406	2008. Adams, R.P./Morris, J.A./Schwarzbach, A.E.. The Evolution of Caribbean Juniperus (Cupressaceae): Terpenoids, RAPDS and DNA SNPs Data. Phytologia. 90(1): 103-120.	[Host for recognized pests and pathogens] "Juniperus bermudiana, endemic to Bermuda, has been subject to attack by two scale insects, Lepidosaphes newsteadi and Carulaspis minima, that were apparently introduced from the U.S. mainland prior to 1942 (Bennett and Hughes, 1959; Groves, 1955). These insects cause defoliation and death. Groves (1955) estimated that 90% of the trees were dead by 1955. In 1978, William E. Sterrer, Bermuda Biological Station, (pers. comm.) estimated that perhaps 99% of the original trees were dead."
406	2008. Louppe, D./Oteng-Amoako, A.A./Brink, M.. Timbers 1: volume 7 of Plant Resources of Tropical Africa. PROTA, Wageningen, Netherlands	[Host for recognized pests and pathogens] "In Mauritius Juniperus bermudiana is attacked by the aphid Cinara cupressi, which damages the terminal growing points, thus retarding new growth, causing desiccation of stems, and progressive die-back. The aphids are easily transported on planting stock, and can multiply rapidly."
407	2006. Durham, G.. Trees of Bermuda. Bermuda Zoological Society, Bermuda	[Causes allergies or is otherwise toxic to humans? No evidence] "Berries were eaten or made into cough syrup."
407	2008. Louppe, D./Oteng-Amoako, A.A./Brink, M.. Timbers 1: volume 7 of Plant Resources of Tropical Africa. PROTA, Wageningen, Netherlands	[Causes allergies or is otherwise toxic to humans? No evidence] "A decoction of the leafy branches is taken to treat cough; the leafy branches are also applied in steam baths for inhalation against respiratory diseases." [Medicinal properties, but no evidence of toxicity]
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 evidence]
407	2012. Specialized Information Services, U.S. National Library of Medicine. TOXNET toxicology data network [online database]. National Institutes of Health, http://toxnet.nlm.nih.gov/	[Causes allergies or is otherwise toxic to humans? No evidence]
408	1998. Owens, M.K./Lin, C.-D./Taylor, C.A./Whisenant, S.G.. Seasonal Patterns of Plant Flammability and Monoterpenoid Content in Juniperus ashei. Journal of Chemical Ecology. 24(12): 2115-2129,.	[Creates a fire hazard in natural ecosystems? Possibly. Juniperus species contain flammable compounds] "The susceptibility of Juniperus communities to prescribed fires can vary greatly throughout the year. The objective of this project was to determine the relationship between the seasonal concentration and composition of volatile oils and plant flammability in two Ashe juniper (Juniperus ashei) populations. Total monoterpenoid concentration was significantly affected by season and by plant population. Mean monoterpenoid concentration of a population from each central Texas was 9.16 mg/g fresh weight of juniper needles while the mean concentration of a west central Texas population was 11.62 mg/g of fresh weight. Monoterpenoid concentrations were typically lowest during the summer and highest during the spring and winter in the western population, but there was no seasonal pattern in the eastern population. The eastern population of trees was slightly (4.8%) more flammable than the western population, and male trees were slightly (3.8%) more flammable than female trees. The concentration of limonene was positively related to plant flammability and could increase flammability by 30% over the range of concentrations found in this species. Bornyl acetate was negatively related to flammability with each 1 mg/g increase in concentration resulting in a 2% decrease in flammability. Caloric energy content and percent leaf moisture were not significant factors in determining the percentage of the Ashe juniper plant actually burned. Secondary chemicals, usually considered as antiherbivore mechanisms, may also serve an important role in determining the likelihood of a plant being consumed by fire."

409	2008. Woo, E.. The Role of Plant-Bird Interactions in the Invasion of <i>Juniperus bermudiana</i> in Hawaii: Integrating Experiments, Behavior, and Models. PhD Dissertation. Stony Brook University, Stony Brook, NY	[Is a shade tolerant plant at some stage of its life cycle? No] "However, greenhouse experiments also suggest that water is less of a significant resource for <i>J. bermudiana</i> compared to light. As a result, seedling growth may be more dependent on surrounding vegetation structure as opposed to the rainfall gradient. For example, tall thickets of the nitrogen-fixing <i>Dicranopteris linearis</i> (Ulue/Falses Staghorn Fern) in areas of high rainfall may shade out any potential <i>J. bermudiana</i> seedlings. Research on a related species show that <i>J. ashei</i> seedlings grow at significantly higher rates on edge habitats, probably due to more light availability (Van Auken et al. 2004, Burkhardt and Tisdale 1976). The presence of high light availability— as opposed to rainfall—for <i>J. bermudiana</i> seedlings may therefore be a better predictor of its distribution and spread in the study site."
409	2011. Adams, R./Gardner, M./Wingate, D.B.. <i>Juniperus bermudiana</i> . In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. Downloaded on 08 August 2012. www.iucnredlist.org	[Is a shade tolerant plant at some stage of its life cycle? No] "Invasive broadleaf plant competitors (which create too deep a shade for seed germination or growth), are now by far the greatest factors limiting the junipers distribution and self seeding potential. Likewise, germination of the naturalized <i>Ficus retusa</i> in rot hollows of old junipers (which leads to eventual overshadowing and strangulation) and overshadowing by taller growing invasive broadleaved trees, especially in sheltered valley situations, is now the major cause of adult mortality."
410	2008. Louppe, D./Oteng-Amoako, A.A./Brink, M.. <i>Timbers 1: volume 7 of Plant Resources of Tropical Africa</i> . PROTA, Wageningen, Netherlands	[Tolerates a wide range of soil conditions? No] "In Bermuda <i>Juniperus bermudiana</i> occurs near sea-level, on sandy soils and limestone rocks."
410	2011. Adams, R./Gardner, M./Wingate, D.B.. <i>Juniperus bermudiana</i> . In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. Downloaded on 08 August 2012. www.iucnredlist.org	[Tolerates a wide range of soil conditions? No] "Grows in shallow, calcareous soils on hillsides and along marshes and coastlines."
411	1989. Little Jr., E.L./Skolmen, R.G.. <i>Common forest trees of Hawaii: (native and introduced)</i> . USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Climbing or smothering growth habit? No] "Small to medium-sized introduced evergreen tree with small scalelike leaves. Trunk straight, with many branches in compact cone shaped crown to 40 ft (12 m) high"
412	1918. Britton, N.L.. <i>Flora of Bermuda</i> . Charles Scribner's Sons, New York	[Forms dense thickets? Formerly Yes] "Abundant and forming nearly pure forests on hillsides and along marshes in all parishes."
412	2003. Kairo, M./Ali, B./Cheesman, O./Haysom, K./Murphy, S.. <i>Invasive Species Threats in the Caribbean Region – Report to the Nature Conservancy</i> . CAB International, Curepe, Trinidad& Tobago	[Forms dense thickets? Yes] "Indigenous species, as well as alien species, may become invasive, usually in response to environmental change (typically human mediated habitat disturbances). For example, the Bermuda Cedar <i>Juniperus bermudiana</i> , an endemic tree, spread across Bermuda after human colonisation, establishing a virtual monoculture in many areas that had previously supported more diverse plant communities (Wingate, 2001). Ironically, the Bermuda Cedar was subsequently almost wiped out by an invasive exotic scale insect, and has now largely been displaced in the local plant community by non native <i>Casuarina</i> ."
412	2008. Woo, E.. The Role of Plant-Bird Interactions in the Invasion of <i>Juniperus bermudiana</i> in Hawaii: Integrating Experiments, Behavior, and Models. PhD Dissertation. Stony Brook University, Stony Brook, NY	[Forms dense thickets? Yes] " <i>J. bermudiana</i> has formed dense monotypic stands on one of the ridges in the Pu'u Kukui Watershed area since its time of introduction in the early 1930s."
501	1989. Little Jr., E.L./Skolmen, R.G.. <i>Common forest trees of Hawaii: (native and introduced)</i> . USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Aquatic? No] "Small to medium-sized introduced evergreen tree with small scalelike leaves." [Terrestrial]
502	2012. USDA ARS National Genetic Resources Program. Germplasm Resources Information Network - (GRIN). http://www.ars-grin.gov/cgi-bin/npgs/html/index.pl	[Grass? No] Cupressaceae
503	2012. USDA ARS National Genetic Resources Program. Germplasm Resources Information Network - (GRIN). http://www.ars-grin.gov/cgi-bin/npgs/html/index.pl	[Nitrogen fixing woody plant? No] Cupressaceae
504	1989. Little Jr., E.L./Skolmen, R.G.. <i>Common forest trees of Hawaii: (native and introduced)</i> . USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)? No] "Small to medium-sized introduced evergreen tree with small scalelike leaves. Trunk straight, with many branches in compact cone-shaped crown to 40 ft (12 m) high. Bark brown, furrowed into scaly ridges and peeling. Inner bark with dead brown outer layer, whitish, fibrous, resinous. Twigs four-angled, stout, more than 1/16 inch (1.5 mm) wide."

601	1989. Little Jr., E.L./Skolmen, R.G.. Common forest trees of Hawaii: (native and introduced). USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Evidence of substantial reproductive failure in native habitat? Yes] "Native only to the island of Bermuda. Formerly abundant there, but now rare because of a disease as well as cutting."
601	2003. Kairo, M./Ali, B./Cheesman, O./Haysom, K./Murphy, S.. Invasive Species Threats in the Caribbean Region – Report to the Nature Conservancy. CAB International, Curepe, Trinidad& Tobago	[Evidence of substantial reproductive failure in native habitat? Yes] "Indigenous species, as well as alien species, may become invasive, usually in response to environmental change (typically human mediated habitat disturbances). For example, the Bermuda Cedar <i>Juniperus bermudiana</i> , an endemic tree, spread across Bermuda after human colonisation, establishing a virtual monoculture in many areas that had previously supported more diverse plant communities (Wingate, 2001). Ironically, the Bermuda Cedar was subsequently almost wiped out by an invasive exotic scale insect, and has now largely been displaced in the local plant community by non native <i>Casuarina</i> ."
601	2011. Adams, R./Gardner, M./Wingate, D.B.. <i>Juniperus bermudiana</i> . In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. Downloaded on 08 August 2012. www.iucnredlist.org	[Evidence of substantial reproductive failure in native habitat? Yes] " <i>Juniperus bermudiana</i> underwent a catastrophic decline of almost 95% between 1946 and 1956. Over the last 30 years, the population has started to recover as a result of natural resistance in part of the remnant population and intensive conservation efforts. Invasive plant species still pose a significant threat. <i>Juniperus bermudiana</i> has an estimated generation length of 25 years so three generations is the equivalent of 75 years. Some of the causes of reduction are not reversible due to urbanisation and habitat loss. This species is therefore currently listed as Critically Endangered. Provided that the recovery is maintained, future re-assessments after the three generation period has expired should result in downlisting. "
602	2008. Woo, E.. The Role of Plant-Bird Interactions in the Invasion of <i>Juniperus bermudiana</i> in Hawaii: Integrating Experiments, Behavior, and Models. PhD Dissertation. Stony Brook University, Stony Brook, NY	[Produces viable seed? Yes] "In Maui, <i>J. bermudiana</i> produces copious ripe seed cones (with 2-3 seeds per seed cone) annually from the end of September to December, a period when several different species of avian foragers visit <i>J. bermudiana</i> adults."
603	2008. Adams, R.P./Wingate, D.. Hybridization between <i>Juniperus bermudiana</i> and <i>J. virginiana</i> in Bermuda. <i>Phytologia</i> . 90(2): 123-133.	[Hybridizes naturally? Yes] "In 1942 two scale insects were accidentally introduced into Bermuda with devastating effects on <i>Juniperus bermudiana</i> , endemic to Bermuda. In an effort to repopulate junipers on Bermuda, two cultivated junipers from Florida were introduced by J. D. C. Darrell in 1940s (Darrell's cedar) and Reeve Smith in the 1950s (Smith's cedar). Analysis of SNPs of nrDNA and trnC-trnD cp DNA determined that Darrell's cedar is <i>Juniperus virginiana</i> var. <i>silicicola</i> and Smith's cedar is <i>Juniperus</i> v. var. <i>virginiana</i> . SNPs analysis reveal what appears to be F1 hybrids between Darrell's cedar (<i>J. v. var. silicicola</i>) and <i>J. bermudiana</i> . In addition, two individuals were found that contained nucleotides from Darrell's cedar, Smith's cedar and <i>J. bermudiana</i> , suggestive of hybridization with backcrossing to the third taxon."
604	1989. Little Jr., E.L./Skolmen, R.G.. Common forest trees of Hawaii: (native and introduced). USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Self-compatible or apomictic? No] "Trees male and female, the male (pollen bearing) cones cylindrical, about 3/16 inch (5 mm) long. Female (seed-bearing) cones berrylike, rounded or slightly two lobed, about 1/4 inch (6 mm) long, whitish blue, composed of few united scales, maturing in 1 year."
604	2005. Staples, G.W./Herbst, D.R.. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	[Self-compatible or apomictic? No] "Dioecious trees or shrubs..."
605	2009. Williams, C.G.. Conifer reproductive biology. Springer, New York	[Requires specialist pollinators? No] "All conifers rely on wind to move pollen to ovule but form matters as much as chance; pollination is more akin to coordination and synchrony than it resembles a stochastic process."
606	1978. Lucas, G./Synge, H.(eds.). The IUCN plant red data book: comprising red data sheets on 250 selected plants threatened on a world scale. IUCN, Gland, Switzerland	[Reproduction by vegetative fragmentation? No] "Vegetative methods of propagation have not been successful."
606	2012. Department of Conservation Services. Bermuda Cedar (<i>Juniperus bermudiana</i>). [Accessed 08 August 2012]. Government of Bermuda, Ministry of Public Works, http://www.conservation.bm/bermuda-cedar/	[Reproduction by vegetative fragmentation? No evidence] "Bermuda Cedars can be propagated from seed or cuttings."
607	2008. Louppe, D./Oteng-Amoako, A.A./Brink, M.. Timbers 1: volume 7 of Plant Resources of Tropical Africa. PROTA, Wageningen, Netherlands	[Minimum generative time (years)? 4+] "Germination takes 3-6 months; growth during the first 10 years is slow."

607	2011. Adams, R./Gardner, M./Wingate, D.B.. Juniperus bermudiana. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. Downloaded on 08 August 2012. www.iucnredlist.org	[Minimum generative time (years)? >4] "It is estimated that the natural predisturbance generation length is 25 years - this is based on the length of time taken for a naturally regenerating stand of trees to reach harvestable age. "
701	2008. Louppe, D./Oteng-Amoako, A.A./Brink, M.. Timbers 1: volume 7 of Plant Resources of Tropical Africa. PROTA, Wageningen, Netherlands	[Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)? No evidence] "Female cone terminal on erect ultimate branchlets, mature one irregularly globose or pear-shaped to almost kidney-shaped, 4-6 mm x 5-8 mm, pulpy, resinous, pruinose-blue or dark purplish blue, 1-2(-3) seed; scales 6, decussately opposite, fused. Seeds ovoid-globose, 2-3 mm long, more or less keeled, lustrous brown." [Small seeds lack means of external attachment, but could potentially be moved in soil]
702	2005. Staples, G.W./Herbst, D.R.. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	[Propagules dispersed intentionally by people? Yes] "In Hawaii, Bermuda juniper is grown ornamentally and as a hedge or windbreak and is used sparingly in reforestation."
703	2012. WRA Specialist. Personal Communication.	[Propagules likely to disperse as a produce contaminant? No] No evidence that this tree has become a contaminant of produce.
704	1989. Little Jr., E.L./Skolmen, R.G.. Common forest trees of Hawaii: (native and introduced). USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Propagules adapted to wind dispersal? No] "Female (seed-bearing) cones berrylike, rounded or slightly two lobed, about 1/4 inch (6 mm) long, whitish blue, composed of few united scales, maturing in 1 year. Seeds 2-3, egg-shaped, pointed, shiny brown, grooved."
705	2012. WRA Specialist. Personal Communication.	[Propagules water dispersed? No] No evidence based on distribution of plant or morphology of propagule (berrylike cone with small seeds)
706	1989. Little Jr., E.L./Skolmen, R.G.. Common forest trees of Hawaii: (native and introduced). USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Propagules bird dispersed? Yes] "Female (seed-bearing) cones berrylike, rounded or slightly two lobed, about 1/4 inch (6 mm) long, whitish blue, composed of few united scales, maturing in 1 year. Seeds 2-3, egg-shaped, pointed, shiny brown, grooved."
706	2008. Woo, E.. The Role of Plant-Bird Interactions in the Invasion of Juniperus bermudiana in Hawaii: Integrating Experiments, Behavior, and Models. PhD Dissertation. Stony Brook University, Stony Brook, NY	[Propagules bird dispersed? Yes] "Introduced to forest reserves in all Hawaiian Islands by 1921 (Little and Skolmen 1989), J. bermudiana is known to depend on avian seed dispersal in its home range in Bermuda (D.B. Wingate, personal communication) as well as in Hawaii (Woo, personal observation)." ... "Field studies revealed seed guplers and seed predators to be the only two functional foragers for J. bermudiana seed cones, with seed guplers being far more abundant than seed predators. Additionally, seed cone removal rates between seed guplers and seed predators were not significantly different. Further, the low abundance of fairly sedentary foragers compared to the abundant flock-feeding foragers suggests that seeds are likely to be dispersed across the West Maui Mountains of Hawaii. Different movement patterns within the flock-feeding foragers (i.e., Zosterops japonicus) reveal different dispersal patterns that may affect seed shadows. Results of this study suggest effective seed dispersal by J. bermudiana foragers is not likely limiting its invasion success in the study site." ... "In its home range, J. bermudiana is dispersed by Sturnus vulgaris (European Starling), Dumetella carolinensis (Gray Catbird), and Sialia sialis (Eastern Bluebird) (D.B. Wingate, personal communication). My initial field observations on Maui, Hawaii revealed two dominant foragers of J. bermudiana seed cones: Zosterops japonicus (Japanese White-Eye) and Cardinalis cardinalis (Northern Cardinal), both which are exotic to the Hawaiian Islands." ... "As long as Z. japonicus consistently forages for J. bermudiana seed cones and disperses seeds across the study site, Z. japonicus will be a highly effective disperser in terms of quantity and quality of seed dispersal."
706	2011. Adams, R./Gardner, M./Wingate, D.B.. Juniperus bermudiana. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. Downloaded on 08 August 2012. www.iucnredlist.org	[Propagules bird dispersed? Yes] "The main seed disseminator seems to be the Starling, Sturnus vulgaris, which became naturalized in the 1950s, increased explosively in the 1960s, and is highly mobile."
707	1989. Little Jr., E.L./Skolmen, R.G.. Common forest trees of Hawaii: (native and introduced). USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Propagules dispersed by other animals (externally)? Possibly] "Female (seed-bearing) cones berrylike, rounded or slightly two lobed, about 1/4 inch (6 mm) long, whitish blue, composed of few united scales, maturing in 1 year. Seeds 2-3, egg-shaped, pointed, shiny brown, grooved." [Rodents, mongoose, or other ground dwelling animals may disperse berrylike cones]
708	1989. Little Jr., E.L./Skolmen, R.G.. Common forest trees of Hawaii: (native and introduced). USDA Agriculture Handbook No. 679. USDA Forest Service, Washington, D.C.	[Propagules survive passage through the gut? Presumably Yes] "Female (seed-bearing) cones berrylike, rounded or slightly two lobed, about 1/4 inch (6 mm) long, whitish blue, composed of few united scales, maturing in 1 year. Seeds 2-3, egg-shaped, pointed, shiny brown, grooved."

708	2008. Woo, E.. The Role of Plant-Bird Interactions in the Invasion of <i>Juniperus bermudiana</i> in Hawaii: Integrating Experiments, Behavior, and Models. PhD Dissertation. Stony Brook University, Stony Brook, NY	[Propagules survive passage through the gut? Presumably Yes, depending on bird] "Seed handling between the main foragers of <i>J. bermudiana</i> seed cones differed and could be categorized into two different functional seed handling techniques: seed gulpers and seed predators. For example, <i>Z. japonicus</i> was categorized as seed gulpers, where they were consistently seen to ingest whole seed cones during tree watches. <i>C. cardinalis</i> , on the other hand, can be considered a seed predator, where their seed crushing behaviors have been documented to leave <i>Lonicera maackii</i> seeds inviable after defecation (Bartuszevige and Gorchov 2006). In this study, both <i>C. cardinalis</i> and <i>C. mexicanus</i> were categorized as seed predators, as they were consistently seen crushing seed cones and likely destroying <i>J. bermudiana</i> seeds and preventing successful germination." ... "As seen in the greenhouse experiments, seed treatments mimicking avian seed gut passage had significantly higher germination rates compared to intact seed cones. That is, removal of pulp from seed cones by the avian gut will positively affect germination rates of <i>J. bermudiana</i> seeds in the field."
801	2008. Woo, E.. The Role of Plant-Bird Interactions in the Invasion of <i>Juniperus bermudiana</i> in Hawaii: Integrating Experiments, Behavior, and Models. PhD Dissertation. Stony Brook University, Stony Brook, NY	[Prolific seed production (>1000/m ²)? Possibly] " <i>J. bermudiana</i> typically produces ripe seed cones annually from mid-September to mid-December in the study site. The large variation in seed cone production can range from 0 seed cones to an estimated 24000 seed cones per individual adult tree."
802	2008. Royal Botanic Gardens Kew. Seed Information Database (SID). Version 7.1. http://data.kew.org/sid/	[Evidence that a persistent propagule bank is formed (>1 yr)? Unknown] No information on seed storage or longevity found
803	2012. BugwoodWiki. <i>Juniperus bermudiana</i> . Accessed 08 August 2012. http://wiki.bugwood.org/Juniperus_bermudiana	[Well controlled by herbicides? Possibly] "No control methods are published for <i>J. bermudiana</i> . However, it is closely related to <i>J. virginiana</i> , and control methods effective for <i>J. virginiana</i> should also be effective for <i>J. bermudiana</i> (Adams 1995)."
803	2012. WRA Specialist. Personal Communication.	[Well controlled by herbicides? Unknown] No information on herbicide efficacy or chemical control of this species
804	2005. Horncastle, V.J./Hellgren, E. C./Mayer, P. M. et al.. Implications of Invasion by <i>Juniperus virginiana</i> on Small Mammals in the Southern Great Plains. U.S. Environmental Protection Agency Papers. Paper 67: http://digitalcommons.unl.edu/usepapapers/6	[Tolerates, or benefits from, mutilation, cultivation, or fire? Possibly No. Related species, <i>J. virginiana</i> intolerant of fire] "Fire historically limited the spread of eastern red cedar, a fire intolerant species that reproduces solely by seed. In contrast, most native woody plants of the Great Plains reproduce vegetatively and can resprout after fire (Briggs et al. 2002)."
804	2012. Department of Conservation Services. Bermuda Cedar (<i>Juniperus bermudiana</i>). [Accessed 08 August 2012]. Government of Bermuda, Ministry of Public Works, http://www.conservation.bm/bermuda-cedar/	[Tolerates, or benefits from, mutilation, cultivation, or fire? Possibly Yes] "Bermuda Cedars have widely spreading roots, which allow them to survive Bermuda's winter gales and summer hurricanes. They are also resistant to salt spray." [Suggests ability to resprout after hurricane damage]
805	2008. Woo, E.. The Role of Plant-Bird Interactions in the Invasion of <i>Juniperus bermudiana</i> in Hawaii: Integrating Experiments, Behavior, and Models. PhD Dissertation. Stony Brook University, Stony Brook, NY	[Effective natural enemies present locally (e.g. introduced biocontrol agents)? Apparently No] " <i>J. bermudiana</i> has formed dense monotypic stands on one of the ridges in the Pu'u Kukui Watershed area since its time of introduction in the early 1930s."

Summary of Risk Traits

High Risk / Undesirable Traits

- Naturalized in Hawaiian Islands, St. Helena, and possibly elsewhere
- Thrives in tropical climates
- Other *Juniperus* species have become invasive
- Able to form dense stands
- May hybridize with other *Juniperus* species
- Seeds, inside berrylike cones, dispersed by birds

Low Risk / Desirable Traits

- Unarmed
- Palatable to goats (may limit ability to spread)
- Non-toxic
- Shade-intolerant
- Specific soil requirements
- Dioecious (requires male and female trees to reproduce)
- No evidence of vegetative spread
- Long time to reproductive maturity
- Landscaping and ornamental value
- Timber tree