

Taxon: <i>Blechnum appendiculatum</i> Willd.	Family: Blechnaceae
Common Name(s): hammock fern palm fern	Synonym(s): <i>Blechnum glandulosum</i> Kaulf. ex Link <i>Blechnum occidentale</i> (Misapplied)

Assessor: Chuck Chimera	Status: Assessor Approved	End Date: 16 Apr 2021
WRA Score: 16.0	Designation: H(Hawai'i)	Rating: High Risk

Keywords: Understory Fern, Naturalized, Environmental Weed, Escaped Ornamental, 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	?
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		
401	Produces spines, thorns or burrs	y=1, n=0	n
402	Allelopathic		
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals		
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	y

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		
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	y
607	Minimum generative time (years)		
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)		
702	Propagules dispersed intentionally by people	y=1, n=-1	y
703	Propagules likely to disperse as a produce contaminant		
704	Propagules adapted to wind dispersal	y=1, n=-1	y
705	Propagules water dispersed	y=1, n=-1	y
706	Propagules bird dispersed	y=1, n=-1	n
707	Propagules dispersed by other animals (externally)		
708	Propagules survive passage through the gut	y=1, n=-1	n
801	Prolific seed production (>1000/m ²)	y=1, n=-1	y
802	Evidence that a persistent propagule bank is formed (>1 yr)		
803	Well controlled by herbicides	y=-1, n=1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire		
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	y=-1, n=1	n

Supporting Data:

Qsn #	Question	Answer
101	Is the species highly domesticated?	n
	Source(s)	Notes
	Palmer, D.D. (2003). Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[No evidence] "This fern has uniformly been called <i>Blechnum occidentale</i> L. since it was first reported in Hawaii; however, the rachises of <i>B. occidentale</i> are entirely glabrous but those of <i>B. appendiculatum</i> Willd. are minutely pubescent and glandular, as is the naturalized Hawaiian species. <i>Blechnum appendiculatum</i> Willd., from the American Tropics, is part of the taxonomically difficult <i>B. occidentale</i> complex. A. R. Smith, who is working on regional floras of the Central and South America area, has found that the name <i>B. glandulosum</i> Link, which has been used for this fern, must be replaced by the legitimate, older name that has priority, <i>B. appendiculatum</i> Willd."

102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. (2021). Personal Communication	NA

103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. (2021). 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
	Palmer, D.D. (2003). Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	"Represented in Hawaii by a single widespread naturalized species from Mexico and tropical Central and South America."

202	Quality of climate match data	High
	Source(s)	Notes
	Palmer, D.D. (2003). Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	

Qsn #	Question	Answer
203	Broad climate suitability (environmental versatility)	y
	Source(s)	Notes
	Dave's Garden. (2021). <i>Blechnum</i> Species, Hammock Fern, Hard Fern, Palm Fern - <i>Blechnum appendiculatum</i> . https://davesgarden.com/guides/pf/go/57620/ . [Accessed 16 Apr 2021]	"Hardiness: USDA Zone 9a: to -6.6 °C (20 °F) USDA Zone 9b: to -3.8 °C (25 °F) USDA Zone 10a: to -1.1 °C (30 °F) USDA Zone 10b: to 1.7 °C (35 °F) USDA Zone 11: above 4.5 °C (40 °F)"
	Palmer, D.D. (2003). <i>Hawaii's Ferns and Fern Allies</i> . University of Hawaii Press, Honolulu, HI	[Environmentally versatile. Elevation range exceeds 1000 m] "Common as clones forming large colonies in closed-canopy mesic forests, especially on rock or rocky substrates, and occurring in all but the most extreme habitats, 30-1,560 m, all major islands."

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	Notes
	Palmer, D.D. (2003). <i>Hawaii's Ferns and Fern Allies</i> . University of Hawaii Press, Honolulu, HI	"Represented in Hawaii by a single widespread naturalized species from Mexico and tropical Central and South America."

205	Does the species have a history of repeated introductions outside its natural range?	?
	Source(s)	Notes
	Palmer, D.D. (2003). <i>Hawaii's Ferns and Fern Allies</i> . University of Hawaii Press, Honolulu, HI	"This tropical American fern, first collected in Hawaii in 1918, has escaped from gardens and spread extensively."
	Dave's Garden. (2021). <i>Blechnum</i> Species, Hammock Fern, Hard Fern, Palm Fern - <i>Blechnum appendiculatum</i> . https://davesgarden.com/guides/pf/go/57620/ . [Accessed 16 Apr 2021]	[California] "This is a spreading groundcover fern that is great for shady Southern California gardens... sorry, can't comment on the rest of the country. It is particularly nice in the spring when all the new reddish fronds shoot up around the garden. It does swarm and can become invasive, but stays low and is easy to pull up. It is NOT easy to completely eradicate, though I have never felt I had to. Some growers just 'mow' it down in the fall and by late spring it's all back and then some (tends to get a bit ratty over a cold, wet winter). It was just renamed recently, and before was known as <i>B. occidentale</i> ."

301	Naturalized beyond native range	y
	Source(s)	Notes
	Randall, R.P. (2017). <i>A Global Compendium of Weeds</i> . 3rd Edition. Perth, Western Australia. R.P. Randall	" <i>Blechnum appendiculatum</i> Willd. Blechnaceae Accepted name: <i>Blechnum occidentale</i> L. Total N° of Refs: 15 References: United States of America-N-301, United States of America-N-839, United States of America-N-101, United States of America-N-1292, Azores-N-1721, Global--1324."

Qsn #	Question	Answer
	Wilson, K. A. (2002). Continued pteridophyte invasion of Hawaii. <i>American Fern Journal</i> , 92(2), 179-183	" <i>Blechnum appendiculatum</i> Willd.—The <i>Blechnum</i> species that grows in Hawaii has been known as <i>B. occidentale</i> L. since its occurrence was first reported. Recent studies, however, have shown that the rachises of <i>B. occidentale</i> are glabrous on the abaxial surface, whereas those of <i>B. appendiculatum</i> are pubescent and glandular. <i>Blechnum appendiculatum</i> also differs in having more pinnae and darker rhizome scales than does <i>B. occidentale</i> (A. R. Smith, pers. comm.; see also Hoshizaki & Moran, 2001, p. 216). The species naturalized in Hawaii is <i>B. appendiculatum</i> (syn. <i>B. glandulosum</i> Kaulf. ex Link). Both species are natives of tropical America." ... "TABLE 1. Naturalized ferns and fern allies in Hawaii arranged by year of their first collection." [<i>Blechnum appendiculatum</i> recorded on Kaua'i, O'ahu, Molokai, Maui, Hawai'i]
	Palmer, D.D. (2003). <i>Hawaii's Ferns and Fern Allies</i> . University of Hawaii Press, Honolulu, HI	"Common as clones forming large colonies in closed-canopy mesic forests, especially on rock or rocky substrates, and occurring in all but the most extreme habitats, 30-1,560 m, all major islands."

302	Garden/amenity/disturbance weed	n
	Source(s)	Notes
	Wilson, K.A. (1996). Alien Ferns in Hawaii. <i>Pacific Science</i> 50(2): 127-141	[A disturbance adapted weed with environmental impacts] "It is now a common weedy fern along trail sides, stream banks, forested slopes, and gulches on all islands, often growing in solid stands."

303	Agricultural/forestry/horticultural weed	n
	Source(s)	Notes
	Vernon, A., & Ranker, T. (2013). Current Status of the Ferns and Lycophytes of the Hawaiian Islands. <i>American Fern Journal</i> , 103(2), 59-111	[Environmental weed] "Single, invasive fern species have caused major problems in many parts of the world (Robinson et al., 2010). By contrast, at least 18 species in the Hawaiian Islands have become invasive based on their abundance and widespread distribution throughout the islands (Palmer, 2003). Invasive species often are highly detrimental to native ecosystems due to their ability to outcompete and displace the native flora. For example, the introduced tree fern <i>Sphaeropteris cooperi</i> (Cyatheaceae) grows faster and produces more leaves than the native tree ferns, <i>Cibotium</i> spp. (Cibotiaceae) (Durand and Goldstein, 2001). Another example is of the common, naturalized fern <i>Blechnum appendiculatum</i> , reported as one of the two plants completely overgrowing a population of the endangered fern <i>Asplenium dielpallidum</i> (Aguraju et al., 2004)."
	Randall, R.P. (2017). <i>A Global Compendium of Weeds</i> . 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence

304	Environmental weed	y
	Source(s)	Notes

Qsn #	Question	Answer
	<p>Weller, S. G., Cabin, R. J., Lorence, D. H., Perlman, S., Wood, K., Flynn, T., & Sakai, A. K. (2011). Alien plant invasions, introduced ungulates, and alternative states in a mesic forest in Hawaii. <i>Restoration Ecology</i>, 19(5): 671-680</p>	<p>"Four alien species appeared to respond differently to drought, based on changes in percent cover." ... "Potentially, the most significant responses occurred in two widespread alien fern species, <i>Adiantum hispidulum</i> and <i>Blechnum appendiculatum</i>. Both of these species increased in percent cover during a drought period when native ferns decreased substantially. <i>Blechnum appendiculatum</i> also responded positively to fencing, suggesting that removal of ungulates favored this fern species. <i>Blechnum appendiculatum</i> forms thick mats that prevent establishment of seeds and spores (Wilson 1996). An alien species that prevents establishment of natives and thrives under drought conditions that result in mortality of native species, represents an obvious threat to the integrity of these mesic forests."</p>
	<p>Palmer, D.D. (2003). <i>Hawaii's Ferns and Fern Allies</i>. University of Hawaii Press, Honolulu, HI</p>	<p>"This tropical American fern, first collected in Hawaii in 1918, has escaped from gardens and spread extensively. It is a serious weed that competes with many native fern species and is especially threatening to species of the rare endemic genus <i>Diellia</i>."</p>
	<p>Agurajuja, R., Zobel, M., Zobel, K., & Moora, M. (2008). Conservation of the endemic fern lineage <i>Diellia</i> (Aspleniaceae) on the Hawaiian Islands: can population structure indicate regional dynamics and endangering factors?. <i>Folia Geobotanica</i>, 43(1), 3-18</p>	<p>[Competes with native <i>Diellia</i> spp.] "<i>Diellia</i> species grow in mesic forests, usually on steep leeward and north-facing slopes. We studied potential habitats for <i>Diellia</i> species on five islands where they had been recorded earlier: Kauai, Oahu, Molokai, Maui, Hawaii." ... "Most of the sites suffer due to the expansion of invasive ferns (<i>Blechnum appendiculatum</i>, <i>Christella parasitica</i>, <i>Adiantum hispidulum</i>, <i>Phlebodium aureum</i>), herbs (<i>Erigeron karvinskianus</i>, <i>Kalanchoe pinnata</i>), grasses (<i>Ehrharta stipoides</i>, <i>Melinis minutiflora</i>, <i>Oplismenus hirtellus</i>), vines (<i>Passiflora mollissima</i>, <i>P. suberosa</i>), shrubs and trees (<i>Clidemia hirta</i>, <i>Psidium cattleianum</i>, <i>Schinus terebinthifolius</i>, <i>Casuarina equisetifolia</i>), as well as due to the trampling and browsing of feral pigs, goats and deer (Agurajuja et al. 2004)."</p>
	<p>Agurajuja, R., Moora, M., & Zobel, M. (2004). Population stage structure of Hawaiian endemic fern taxa of <i>Diellia</i> (Aspleniaceae): implications for monitoring and regional dynamics. <i>Canadian Journal of Botany</i>, 82(10), 1438-1445</p>	<p>[Competes with native <i>Diellia</i> spp.] "From 36 investigated sites on four islands, <i>Diellia</i> ferns were found growing in 24 sites (Table 1, Fig. 1). Among sites without recorded finds, the habitat of Puu Ka Pele on Kauai (<i>D. pallida</i>) was significantly degraded. The site at Makaha on Kauai (<i>D. pallida</i>) was completely overgrown by <i>Erigeron karvinskianus</i> DC and <i>Blechnum appendiculatum</i> Willd."</p>
	<p>Havran, J. C., Oppenheimer, H., Keaton, J., & Piotrowski, K. (2012). Interisland Range Expansion of <i>Viola lanaiensis</i> (Violaceae: Malpighiales), an Endangered Hawaiian Violet. <i>Pacific Science</i>, 6 (4): 447-456</p>	<p>[Threatens rare native violet] "Six individuals of <i>V. lanaiensis</i> with a small number of seedlings are known from Lānaʻi. A second population with 12 plants recently was extirpated, probably due to one or a combination of the following factors: extreme drought, axis deer (<i>Axis axis</i>), and alien plant invasion by <i>Psidium cattleianum</i>, <i>Morella faya</i>, <i>Leptospermum scoparium</i>, <i>Blechnum appendiculatum</i>, and <i>Rubus rosifolius</i>."</p>
	<p>Oppenheimer, H., & Bustamente, K. (2014). Rediscovery, Ecology, and Habitat of <i>Deparia kaalaana</i> (Copel.) M.Kato (Athryiaceae). <i>American Fern Journal</i>, 104(2), 103-107</p>	<p>[Threatens the rare fern <i>Deparia kaalaana</i>] "The low elevation riparian habitat is directly threatened by invasive plants such as <i>Adiantum raddianum</i>, <i>Blechnum appendiculatum</i> Willd., <i>Clidemia hirta</i> (L.) D. Don, <i>Hedychium gardnerianum</i> Sheppard ex Ker Gawl., <i>Prunella vulgaris</i> L., <i>Rubus argutus</i> Link, and <i>Tibouchina herbacea</i> (DC) Cogn., all of which occur in the immediate vicinity and are capable of displacing all of the riparian habitat elements."</p>

305	Congeneric weed	
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Qsn #	Question	Answer
	Source(s)	Notes
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	[<i>Blechnum pyramidatum</i>] "Weed of: Bananas, Orchards & Plantations, Pastures" [Several other <i>Blechnum</i> species are listed as naturalized and/or weeds, the evidence of detrimental impacts is uncertain or unverified]

401	Produces spines, thorns or burrs	n
	Source(s)	Notes
	Palmer, D.D. (2003). Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[No evidence] " <i>Blechnum appendiculatum</i> , a colony-forming fern, may be recognized by its 1-pinnate fronds with pinnae having two long sori close to and parallel with the midribs, and stolon-bearing rhizomes."

402	Allelopathic	n
	Source(s)	Notes
	Wilson, K.A. (1996). Alien Ferns in Hawaii. Pacific Science 50(2): 127-141	[Unknown if allelopathy contributes to the suppression of other species] "This aggressive, fast-growing fern is now widely naturalized in Hawai'i, often in large populations, effectively preventing the germination and growth of native species where it occurs."

403	Parasitic	n
	Source(s)	Notes
	Palmer, D.D. (2003). Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	" <i>Blechnum appendiculatum</i> , a colony-forming fern..." [<i>Blechnaceae</i>]

404	Unpalatable to grazing animals	n
	Source(s)	Notes
	Weller, S. G., et al. (2018). The effects of introduced ungulates on native and alien plant species in an island ecosystem: Implications for change in a diverse mesic forest in the Hawaiian Islands. Forest Ecology and Management, 409, 518-526	[Fencing increases cover. <i>Blechnum</i> may be palatable, or impacted by ungulate disturbance indirectly] "Ungulate removal may benefit two mat-forming alien fern species that appear to have particularly detrimental effects on recruitment of native plant species (Wilson, 1996). <i>Adiantum hispidulum</i> has increased steadily in percent cover since 1998, and its cover appears to have increased more in fenced plots without ungulates. <i>Blechnum appendiculatum</i> , another mat-forming, alien fern, also increased in cover more in fenced than unfenced plots from 1998 to 2005 (Weller et al., 2011), and the negative relationship between percent cover of <i>B. appendiculatum</i> and small individuals of canopy species in one of the fenced plots suggests that this species may inhibit establishment of natives."
	Coomes, D. A., Allen, R. B., Forsyth, D. M., & Lee, W. G. (2003). Factors preventing the recovery of New Zealand forests following control of invasive deer. Conservation Biology, 17(2): 450-459	[Possibly Yes. Other <i>Blechnum</i> species are unpalatable] "For example, there is evidence that browsing of woody saplings has promoted the spread of the unpalatable ground ferns <i>Blechnum discolor</i> and <i>Blechnum procerum</i> (Wardle 1984; Wardle et al. 2001), which provide an effective barrier against further regeneration of woody species (Wardle 1984)."

Qsn #	Question	Answer
	Mehrtreter, K., Walker, L.R. & Sharpe, J.M. (2010). Fern Ecology. Cambridge University Press, Cambridge, UK	[Possibly Yes] "Young leaves are white or red, supposedly an adaptation against herbivory or fungal attack..."
	Weller, S. G., Cabin, R. J., Lorence, D. H., Perlman, S., Wood, K., Flynn, T., & Sakai, A. K. (2011). Alien plant invasions, introduced ungulates, and alternative states in a mesic forest in Hawaii. Restoration Ecology, 19(5): 671-680	[Unknown whether trampling or browsing suppresses Blechnum in unfenced areas] "Blechnum appendiculatum also responded positively to fencing, suggesting that removal of ungulates favored this fern species."

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. Although may be unpalatable

406	Host for recognized pests and pathogens	n
	Source(s)	Notes
	WRA Specialist. (2021). Personal Communication	Unknown

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	No evidence
	Wagstaff, D.J. (2008). International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	No evidence

408	Creates a fire hazard in natural ecosystems	n
	Source(s)	Notes
	Wilson, K.A. (1996). Alien Ferns in Hawaii. Pacific Science 50(2): 127-141	[No evidence] "It is now a common weedy fern along trail sides, stream banks, forested slopes, and gulches on all islands, often growing in solid stands."

409	Is a shade tolerant plant at some stage of its life cycle	y
	Source(s)	Notes
	Jones, D. L. 1987. Encyclopedia of Ferns. Timber Press, Portland, OR	"Most ferns of this group will grow in shady conditions and a few are easily damaged by sun..." [Blechnum included in this group]

Qsn #	Question	Answer
	Jones, E. J. (2019). Terrestrial alien ferns (Polypodiophyta): A global assessment of traits associated with invasiveness and their distribution and status in South Africa. MSc Thesis. Nelson Mandela University, Gqeberha, South Africa	"Supplementary 1 Global inventory of terrestrial alien true ferns (Polypodiophyta)." [Blechnum appendiculatum - Light condition = Shade]
	Palmer, D.D. (2003). Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[Occurs in closed-canopy forests] "Common as clones forming large colonies in closed-canopy mesic forests, especially on rock or rocky substrates, and occurring in all but the most extreme habitats, 30-1,560 m, all major islands."

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y
	Source(s)	Notes
	Jones, D. L. 1987. Encyclopedia of Ferns. Timber Press, Portland, OR	"Ferns of this group are not fussy regarding soil type and will grow in almost any well-drained garden loam."
	Palmer, D.D. (2003). Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[Broad distribution suggests tolerance of a wide range of soil conditions] "Common as clones forming large colonies in closed-canopy mesic forests, especially on rock or rocky substrates, and occurring in all but the most extreme habitats, 30-1,560 m, all major islands."

411	Climbing or smothering growth habit	n
	Source(s)	Notes
	Palmer, D.D. (2003). Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[Carpet forming on forest understory] "Common as clones forming large colonies in closed-canopy mesic forests, especially on rock or rocky substrates..."

412	Forms dense thickets	y
	Source(s)	Notes
	Palmer, D.D. (2003). Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	"Common as clones forming large colonies in closed-canopy mesic forests, especially on rock or rocky substrates, and occurring in all but the most extreme habitats, 30-1,560 m, all major islands."
	Wilson, K.A. (1996). Alien Ferns in Hawaii. Pacific Science 50(2): 127-141	"It is now a common weedy fern along trail sides, stream banks, forested slopes, and gulches on all islands, often growing in solid stands." ... "This aggressive, fast-growing fern is now widely naturalized in Hawai'i, often in large populations, effectively preventing the germination and growth of native species where it occurs."

501	Aquatic	n
	Source(s)	Notes
	Wilson, K.A. (1996). Alien Ferns in Hawaii. Pacific Science 50(2): 127-141	[Terrestrial] "...a common weedy fern along trail sides, stream banks, forested slopes, and gulches on all islands..."

502	Grass	n
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Qsn #	Question	Answer
	Source(s)	Notes
	Palmer, D.D. (2003). Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	" <i>Blechnum appendiculatum</i> , a colony-forming fern..." [Blechnaceae]
503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	Palmer, D.D. (2003). Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	" <i>Blechnum appendiculatum</i> , a colony-forming fern..." [Blechnaceae]
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	Notes
	Gordon, D. R., Mitterdorfer, B., Pheloung, P. C., Ansari, S., Buddenhagen, C., Chimera, C., ... & Williams, P. A. 2010). Guidance for addressing the Australian Weed Risk Assessment questions. <i>Plant Protection Quarterly</i> , 25(2): 56-74	"This question addresses taxa that have specialized organs and should not include plants with just rhizomes/ stolons"
601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	Notes
	CABI. (2021). <i>Blechnum appendiculatum</i> . In: <i>Invasive Species Compendium</i> . Wallingford, UK: CAB International. www.cabi.org/isc	[No evidence] " <i>B. occidentale</i> is currently found in the Americas, from Texas and Florida in the USA, down as far south as Argentina and Paraguay in South America, and including some islands in the Caribbean (Dittrich et al., 2015; USDA-ARS, 2015). It is introduced and invasive in Hawaii (PIER, 2015). While USDA-ARS (2015) lists it as native throughout its range in the Americas, Seigler and Lockwood (1975) suggested that the USA populations had probably arisen from spores blown by the wind from Mexico or the West Indies. Diggs and Lipsocmb (2015) list it as rare and with limited distribution in Texas."
	Tropicos.org. (2021). Missouri Botanical Garden. http://www.tropicos.org/ . [Accessed 16 Apr 2021]	No evidence
602	Produces viable seed	y
	Source(s)	Notes
	Juárez-Orozco, S., Orozco-Segovia, A., Mendoza-Ruiz, A., & Pérez-García, B. (2013). Spore germination of eight homosporous ferns in a temperature gradient. <i>South African Journal of Botany</i> , 87, 112-117	"Germination of <i>A. formosa</i> , <i>T. glandulosa</i> , <i>T. serrata</i> and <i>B. appendiculatum</i> spores was high for all of the temperatures tested (15, 20, 25, 30 and 35 °C) (Fig. 2A–C, G)."
	Staples, G.W. & Herbst, D.R. (2005). <i>A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places</i> . Bishop Museum Press, Honolulu, HI	[Produces viable spores] "Propagation is by spores or rhizome division."
603	Hybridizes naturally	y

Qsn #	Question	Answer
	Source(s)	Notes
	Kramer, K.U. & Green, P.S. (1990). The Families and Genera of Vascular Plants. Volume 1. Pteridophytes and Gymnosperms. Springer-Verlag, Berlin, Heidelberg, New York	"A hybrid was reported in <i>Doodia</i> (Parris 1972). The variability of many species in the <i>Blechnum occidentale</i> complex is largely due to hybridization..."
	Dittrich, V. A. O., Salino, A., & Monteiro, R. (2015). The <i>Blechnum occidentale</i> (<i>Blechnaceae</i> , <i>Polypodiopsida</i>) species group in southern and southeastern Brazil. <i>Phytotaxa</i> , 231(3), 201-229	"The genus is taxonomically complex, with hybridization occurring frequently among the species (Walker 1966, Chambers & Farrant 1998) and the occurrence of introgressive hybridization, as noted by Sota & Pazos (1983). Furthermore, through asexual reproduction, the hybrids tend to become locally numerous (Walker 1966, 1985, Moran 1995a)."

604	Self-compatible or apomictic	
	Source(s)	Notes
	Mehltreter, K., Walker, L.R. & Sharpe, J.M. (2010). Fern Ecology. Cambridge University Press, Cambridge, UK	[Probably yes. Ferns in the <i>Blechnum</i> genus are homosporous] "Homosporous ferns produce one type of spore that gives rise to potentially bisexual gametophytes. A mature gametophyte of a homosporous fern can reproduce sexually in three ways (Pryer et al., 2008): (1) gametophytic selfing, when a sperm fertilizes an egg cell of the same gametophyte; (2) sporophytic selfing, when a sperm fertilizes an egg cell of a different gametophyte that developed from spores of the same sporophyte; or (3) outcrossing, when a sperm fertilizes an egg cell of another gametophyte that came from a different sporophyte."
	Soltis, D.E. & Soltis, P.S. (1992). The Distribution of Selfing Rates in Homosporous Ferns. <i>American Journal of Botany</i> 79(1): 97-100	[Unknown. Self-compatibility present in other <i>Blechnum</i> species] "The distribution of intragametophytic selfing rates among species of homosporous ferns is clearly uneven. Most species of homosporous ferns would be classified as extreme outcrossers. In contrast, a few species are nearly exclusively inbreeding. In only a few populations of <i>Dryopteris expansa</i> and <i>Hemionitis palmata</i> and a single population of <i>Blechnum spicant</i> do we see convincing evidence of a mixed mating system. The uneven distribution of selfing rates we observed for homosporous ferns, coupled with a corresponding bimodality of the magnitude of genetic load, strongly supports the model."

605	Requires specialist pollinators	n
	Source(s)	Notes
	Mehltreter, K., Walker, L.R. & Sharpe, J.M. (2010). Fern Ecology. Cambridge University Press, Cambridge, UK	[Requires water for fertilization] "For fertilization, the sperm cell must swim through water to an egg cell (Fig. 1.2). Most fern species cross-fertilize (i.e., sperm fertilizes an egg cell from a different gametophyte), but the gametophytes are potentially bisexual. If the gametophyte has simultaneously functioning archegonia and antheridia it may self-fertilize (i.e., sperm fertilizes an egg cell from the same gametophyte), which is of advantage after long distance dispersal."
	WRA Specialist. (2021). Personal Communication	No pollinators required in pteridophytes

Qsn #	Question	Answer
606	Reproduction by vegetative fragmentation	y
	Source(s)	Notes
	Palmer, D.D. (2003). Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	"Plants medium-sized. Rhizomes erect, stoloniferous, stolons subterranean, long-creeping. Fronds 20-60 cm long, clustered at tips of rhizomes," ... "Blechnum appendiculatum, a colony-forming fern, may be recognized by its 1- pinnate fronds with pinnae having two long sori close to and parallel with the midribs, and stolon-bearing rhizomes."
	Jones, E. J. (2019). Terrestrial alien ferns (Polypodiophyta): A global assessment of traits associated with invasiveness and their distribution and status in South Africa. MSc Thesis. Nelson Mandela University, Gqeberha, South Africa	Blechnum appendiculatum - Mode of regeneration = Both Sexual and Vegetative

607	Minimum generative time (years)	
	Source(s)	Notes
	Wilson, K.A. (1996). Alien Ferns in Hawaii. Pacific Science 50(2): 127-141	[Unknown] "This aggressive, fast-growing fern is now widely naturalized in Hawaii" [Probably capable of spreading vegetatively by rhizomes within 1 year]

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	
	Source(s)	Notes
	Wilson, K.A. (1996). Alien Ferns in Hawaii. Pacific Science 50(2): 127-141	[Possibly Yes, or adapted to disturbance conditions along trails] "It is now a common weedy fern along trail sides, stream banks, forested slopes, and gulches on all islands, often growing in solid stands."

702	Propagules dispersed intentionally by people	y
	Source(s)	Notes
	Staples, G.W. & Herbst, D.R. (2005). A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	"The reddish young leaves make it an attractive bedding plant, and it can also be grown in containers." [Ornamental]
	Palmer, D.D. (2003). Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[Formerly Yes] "This tropical American fern, first collected in Hawaii in 1918, has escaped from gardens and spread extensively."

703	Propagules likely to disperse as a produce contaminant	
	Source(s)	Notes
	WRA Specialist. (2021). Personal Communication	Unknown, but possible if wind-blown spores contaminate potted plants or soil used in horticulture.

704	Propagules adapted to wind dispersal	y
	Source(s)	Notes

Qsn #	Question	Answer
	Gómez-Noguez, F., Pérez-García, B., Mendoza-Ruiz, A., & Orozco-Segovia, A. (2017). Fern and lycopod spores rain in a cloud forest of Hidalgo, Mexico. <i>Aerobiologia</i> , 33(1), 23-35	"The main sporulation occurred in the dry season with strong winds."
	Gordon, D. R., Mitterdorfer, B., Pheloung, P. C., Ansari, S., Buddenhagen, C., Chimera, C., ... & Williams, P. A. 2010). Guidance for addressing the Australian Weed Risk Assessment questions. <i>Plant Protection Quarterly</i> , 25(2): 56-74	"This group includes tumbling plants and fern spores."

705	Propagules water dispersed	y
	Source(s)	Notes
	Juárez-Orozco, S., Orozco-Segovia, A., Mendoza-Ruiz, A., & Pérez-García, B. (2013). Spore germination of eight homosporous ferns in a temperature gradient. <i>South African Journal of Botany</i> , 87, 112-117	[Common along streams. Likely water dispersed] "Table 1 Habitat reported by Mickel and Smith (2004) and Mendoza-Ruiz and Pérez-García (2009) and localities where the spores of the eight terrestrial fern species were collected." [Blechnum appendiculatum - Habitat = Along roadsides, moist slopes and stream banks, in montane rain forest, pine-oak forests, cloud forest and tropical rain forest, 400–2550 m a.s.l.]
	Wilson, K.A. (1996). Alien Ferns in Hawaii. <i>Pacific Science</i> 50(2): 127-141	[Distribution suggests spores are probably moved by water] "It is now a common weedy fern along trail sides, stream banks, forested slopes, and gulches on all islands, often growing in solid stands."

706	Propagules bird dispersed	n
	Source(s)	Notes
	WRA Specialist. (2021). Personal Communication	Although spores may adhere to birds, the likely vectors of dispersal for spores are wind, and possibly water, and locally by vegetative spread from the rhizomes.

707	Propagules dispersed by other animals (externally)	
	Source(s)	Notes
	WRA Specialist. (2021). Personal Communication	Unknown. Possible that spores may adhere to fur or mud on animals

708	Propagules survive passage through the gut	n
	Source(s)	Notes
	WRA Specialist. (2021). Personal Communication	Unlikely to be consumed and not adapted for internal dispersal

Qsn #	Question	Answer
801	Prolific seed production (>1000/m ²)	y
	Source(s)	Notes
	Gordon, D. R., Mitterdorfer, B., Pheloung, P. C., Ansari, S., Buddenhagen, C., Chimera, C., ... & Williams, P. A. 2010). Guidance for addressing the Australian Weed Risk Assessment questions. Plant Protection Quarterly, 25(2): 56-74	"Assume 'yes' for fern taxa unless contradictory evidence exists."

802	Evidence that a persistent propagule bank is formed (>1 yr)	
	Source(s)	Notes
	Juárez-Orozco, S., Orozco-Segovia, A., Mendoza-Ruiz, A., & Pérez-García, B. (2013). Spore germination of eight homosporous ferns in a temperature gradient. South African Journal of Botany, 87, 112-117	[Longevity unknown] "In <i>B. appendiculatum</i> , <i>D. globulifera</i> , <i>P. pectinata</i> and <i>P. mickelii</i> secondary dormancy was possibly induced by high temperatures (35 °C), although further studies would need to be carried out to confirm this. Species of these taxa are able to grow in shaded areas of the tropical rain forest and the montane cloud forest (Mickel and Smith, 2004)."
	Dyer, A.F. & Lindsay, S. 1992. Soil Spore Banks of Temperate Ferns. American Fern Journal 82(3): 89-123	[Unknown for <i>B. appendiculatum</i>] "However, although it has now been established that spore banks lasting at least one year are widespread, there is still no direct evidence that any spore banks persist for much more than two years." ... "Other evidence confirms that some fern spores can remain viable for several decades under various artificial storage conditions."

803	Well controlled by herbicides	y
	Source(s)	Notes

Qsn #	Question	Answer
	Aguilar-Dorantes, K., Mehltreter, K., Mata-Rosas, M., Vibrans, H., & Esqueda-Esquivel, V. (2015). Glyphosate Susceptibility of Different Life Stages of Three Fern Species. <i>American Fern Journal</i> , 105(3), 131-144	"ABSTRACT.-Glyphosate, a systemic herbicide, is used against weeds in agricultural fields as well as against invasive plants in pastures, forest plantations, and urban environments. Its frequent and widespread use can negatively impact the surrounding natural non-target vegetation following the accidental drift of spray droplets, leaching, or persistence as residues in the soil. Because ferns possess a life cycle with independent sporophytic and gametophytic generations, herbicides may cause a different impact on each life stage. The objective of the present study was to evaluate the effect of four concentrations of glyphosate (0.33, 0.65, 2.72, and 10.89 g active ingredient L-1) and water as control treatments on spores, gametophytes, and two sporophyte size classes of one native (<i>Blechnum appendiculatum</i> Willd.) and two introduced fern species in Mexico (<i>Macrothelypteris torresiana</i> (Gaudich.) Ching and <i>Thelypteris dentata</i> (Forssk.) E.P. St.John). Spore germination was evaluated 10 days after herbicide treatment and the percentage of remaining green tissue was measured at 7, 30, and 90 days after herbicide treatment. Plant survival was determined at the end of the experiment. Glyphosate suppressed spore germination nearly completely and increased tissue discoloration of all green life stages at higher concentrations and after longer time intervals. After 7 and 30 days, small sporophytes of all three species were significantly more discolored than gametophytes and large sporophytes at concentrations ,s 0.65 g a.i. L-1, although after 90 days differences among life stages were no longer significant, and no life stage survived at concentrations 2: 2.72 g a.i. L-1 . At the lowest concentration (0.33 g a.i. L-1), however, 50-69% of the plants of all three species and life stages survived after 90 days post-treatment. <i>Macrothelypteris torresiana</i> was significantly more tolerant to glyphosate than the other two species during the first 30 days after treatment, mainly because of its less damaged small sporophytes, perhaps due to a thicker waxy cuticle that may initially reduce herbicide absorption in this species. We conclude that even glyphosate concentrations of 0.33 g a.i. L-1 may negatively impact natural spore banks of ferns and result in mortality of 31-50% of all green life stages. Such negative effects may also eliminate at least the most susceptible fern species in habitats that are frequently exposed to such glyphosate concentrations."
	Motooka, P., Castro, L., Nelson, D., Nagai, G. & Ching,L. (2003). <i>Weeds of Hawaii's Pastures and Natural Areas: An Identification and Management Guide</i> . CTAHR, UH Manoa, Honolulu, HI	"Management: Probably susceptible to dicamba and glyphosate." [Control methods described for <i>Blechnum occidentale</i> L., synonym of <i>Blechnum appendiculatum</i>]

804	Tolerates, or benefits from, mutilation, cultivation, or fire	
	Source(s)	Notes
	Invasive Species Specialist Group. (2012). Ch 4 Appendix Weed treatment spreadsheet. www.issg.org	[Possibly No] "Control Methods. Mechanical. Largely ineffective given vegetative reproduction via stolons. Useful for only small, isolated plants."

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	n
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Qsn #	Question	Answer
	Source(s)	Notes
	Palmer, D.D. (2003). <i>Hawaii's Ferns and Fern Allies</i> . University of Hawaii Press, Honolulu, HI	[No evidence] "...Common as clones forming large colonies in closed-canopy mesic forests, especially on rock or rocky substrates, and occurring in all but the most extreme habitats..."

Summary of Risk Traits:

High Risk / Undesirable Traits

- Thrives in tropical climates
- Broad elevation range (exceeds 1000 m)
- Naturalized in the Hawaiian Islands
- Environmental weed (threatens rare and endangered native Hawaiian species)
- Shade tolerant
- Tolerates many soil conditions (and potentially able to exploit many different habitat types)
- Forms solid stands in understory
- Reproduces by prolific spore production
- Hybridizes with other *Blechnum* species
- Spreads vegetatively by rhizomes
- Spores dispersed by wind, and water

Low Risk / Desirable Traits

- Unarmed (no spines, thorns, or burrs)
- Non-toxic
- Herbicides may provide effective control