

**Family:** *Dryopteridaceae*

**Taxon:** *Diplazium esculentum*

**Synonym:** *Hemionitis esculenta* Retz.  
 *Athyrium esculentum* (Retz.) Copeland

**Common Name:** vegetable fern  
paca  
paku-sayur  
Hō`i`o

<b>Questionnaire Status:</b>	current 20090513 Assessor Approved	<b>Assessor:</b>	Chuck Chimera	<b>Designation:</b>	H(HPWRA)
		<b>Data Entry Person:</b>	Chuck Chimera	<b>WRA Score</b>	<b>8</b>
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)	
303	Agricultural/forestry/horticultural weed			n=0, y = 2*multiplier (see Appendix 2)	
304	Environmental weed			n=0, y = 2*multiplier (see Appendix 2)	
305	Congeneric weed			n=0, y = 1*multiplier (see Appendix 2)	
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	
405	Toxic to animals			y=1, n=0	n
406	Host for recognized pests and pathogens			y=1, n=0	n
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
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	n
602	Produces viable seed	y=1, n=-1	y
603	Hybridizes naturally	y=1, n=-1	n
604	Self-compatible or apomictic	y=1, n=-1	
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	y
607	Minimum generative time (years)	1 year = 1, 2 or 3 years = 0, 4+ years = -1	
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y=1, n=-1	
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	y
706	Propagules bird dispersed	y=1, n=-1	n
707	Propagules dispersed by other animals (externally)	y=1, n=-1	
708	Propagules survive passage through the gut	y=1, n=-1	
801	Prolific seed production (>1000/m2)	y=1, n=-1	y
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	

Designation: H(HPWRA)

WRA Score **8**

## Supporting Data:

101	2003. Palmer, D.D.. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[Is the species highly domesticated? No] No evidence
102	2011. WRA Specialist. Personal Communication.	NA
103	2011. WRA Specialist. Personal Communication.	NA
201	2003. Palmer, D.D.. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[Species suited to tropical or subtropical climate(s) 2-high] "...commonly eaten fern from Southeast Asia and the Pacific..."
202	2003. Palmer, D.D.. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[Quality of climate match data 2-high] "...commonly eaten fern from Southeast Asia and the Pacific..."
203	2003. Palmer, D.D.. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[Broad climate suitability (environmental versatility)? No] "Usually found in large, untidy, straggly stands in shady valleys with wet, swampy soils, often along streams, at lower elevations..."
203	2011. Dave's Gardern. PlantFiles: Vegetable Fern - Diplazium esculentum. <a href="http://davesgarden.com/guides/pf/go/54948/">http://davesgarden.com/guides/pf/go/54948/</a>	[Broad climate suitability (environmental versatility)? No] "Hardiness: USDA Zone 8b: to -9.4 °C (15 °F) 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)
203	2011. OnlinePlantGuide.com. Diplazium esculentum / Vegetable Fern. <a href="http://www.onlineplantguide.com/PlantDetails.aspx?Plant_id=791">http://www.onlineplantguide.com/PlantDetails.aspx?Plant_id=791</a>	[Broad climate suitability (environmental versatility)? No] "Comments: This oriental fern is grown for its fronds which are edible and said to be quite tasty. Killed to ground with freezing temperatures."
204	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	[Native or naturalized in regions with tropical or subtropical climates? Yes] "...native to tropical Asia, ranging eastward to the islands of the South Pacific, where it grows near waterways and in moist or wet ground in open, disturbed areas...probably introduced to Hawaii as a food plant in the late 1800s or early 1900s and has since escaped cultivation and become naturalized on the larger islands, typically at lower elevations"
205	2001. Hoshizaki, B.J./Moran, R.C.. Fern grower's manual. Timber Press, Portland, OR	[Does the species have a history of repeated introductions outside its natural range? Yes] "it has been introduced in Florida and Louisiana."
205	2003. Palmer, D.D.. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[Does the species have a history of repeated introductions outside its natural range? Yes] "This commonly eaten fern from Southeast Asia and the Pacific was probably purposely introduced as a garden vegetable and was first collected on Kauai in 1910."
301	1976. Morton, J.F.. Pestiferous spread of many ornamental and fruit species in South Florida. Proceedings of the Florida State Horticultural Society. 89: 348-353.	[Naturalized beyond native range? Yes] "Naturalized in moist woods, Dade and DeSoto Counties"
301	2001. Hoshizaki, B.J./Moran, R.C.. Fern grower's manual. Timber Press, Portland, OR	[Naturalized beyond native range? Yes] "This Asian species has become naturalized in Louisiana and Florida. It is cultivated in Florida and California."
301	2003. Palmer, D.D.. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[Naturalized beyond native range? Yes] "Naturalized...Usually found in large, untidy, straggly stands in shady valleys with wet, swampy soils, often along streams, at lower elevations, on all major islands except Molokai, where it may be present but remains undocumented."
302	2006. Barcelona, J.F./Dolotina, N.E./Madroñero, G.S./Granert, W.G./Sopot, D.D.. The Ferns and Fern Allies of the Karst Forests of Bohol Island, Philippines. American Fern Journal. 96(1): 1-20.	[Garden/amenity/disturbance weed? Possibly] "Table 2...Diplazium esculentum...Ecology, Frequency, and Location...Terrestrial. Weedy in exposed, disturbed areas." [impacts as a weed unknown]
303	2007. Randall, R.P.. Global Compendium of Weeds - Diplazium esculentum [Online Database]. <a href="http://www.hear.org/gcw/species/diplazium_esculentum/">http://www.hear.org/gcw/species/diplazium_esculentum/</a>	[Agricultural/forestry/horticultural weed? Possibly] Listed as a weed of rubber plantations in Thailand, but no further details found regarding impacts
304	2000. Staples, G.W./Herbst, D.R./Imada, C.T.. Survey of invasive or potentially invasive cultivated plants in Hawai'i. Bishop Museum Occasional Papers. 65: 1-35.	[Environmental weed? Potentially]

305	2007. Randall, R.P.. Global Compendium of Weeds - Diplazium japonicum [Online Database]. <a href="http://www.hear.org/gcw/species/diplazium_japonicum/">http://www.hear.org/gcw/species/diplazium_japonicum/</a>	[Congeneric weed? Possibly] Diplazium japonicum listed as a weed of unknown impacts
401	2003. Palmer, D.D.. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[Produces spines, thorns or burrs? No] "Plants medium-sized, terrestrial" [No evidence]
402	2011. WRA Specialist. Personal Communication.	[Allelopathic? Unknown]
403	2001. Hoshizaki, B.J./Moran, R.C.. Fern grower's manual. Timber Press, Portland, OR	[Parasitic? No] "A medium-sized fern, to 60 cm (2 ft.) tall, with erect rhizomes that can become trunk-like on older plants."
404	2011. WRA Specialist. Personal Communication.	[Unpalatable to grazing animals? Unknown]
405	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	[Toxic to animals? No] "Diplazium esculentum, on the other hand, is not known to have any harmful properties; in fact, it is reported to be an excellent source of phosphorus." [No evidence]
406	1987. Jones, D. L.. Encyclopedia of Ferns. Timber Press, Portland, OR.	[Host for recognized pests and pathogens? No] No evidence
406	2001. Hoshizaki, B.J./Moran, R.C.. Fern grower's manual. Timber Press, Portland, OR	[Host for recognized pests and pathogens? No] No evidence
406	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	[Host for recognized pests and pathogens? No] No evidence
407	1987. Jones, D. L.. Encyclopedia of Ferns. Timber Press, Portland, OR.	[Causes allergies or is otherwise toxic to humans? No] "The developing croziers and young fronds of this fern are eaten as a cooked vegetable or raw in salads in many countries of the Pacific regions and are even sold in local markets."
407	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	[Causes allergies or is otherwise toxic to humans? No] "Two common names correctly applied to other edible fern species have been incorrectly (though widely) applied to D. esculentum, which could be a source of confusion...Of greater concern is the misapplication of the Japanese name warabi for the shoots of D. esculentum. In Japan, warabi refers to the fiddleheads of the bracken fern, Pteridium, which are available fresh in markets and sometimes exported in pickled or dried form. Pteridium leaves are known to be carcinogenic and to contain a nerve poison, and their consumption should be avoided. Diplazium esculentum, on the other hand, is not known to have any harmful properties; in fact, it is reported to be an excellent source of phosphorus."
408	2003. Palmer, D.D.. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[Creates a fire hazard in natural ecosystems? No] "Usually found in large, untidy, straggly stands in shady valleys with wet, swampy soils, often along streams, at lower elevations..." [No evidence, and unlikely moist habitats]
409	2011. Dave's Gardern. PlantFiles: Vegetable Fern - Diplazium esculentum. <a href="http://davesgarden.com/guides/pf/go/54948/">http://davesgarden.com/guides/pf/go/54948/</a>	[Is a shade tolerant plant at some stage of its life cycle? Yes] "Sun Exposure: Partial to Full Shade"
409	2011. OnlinePlantGuide.com. Diplazium esculentum / Vegetable Fern. <a href="http://www.onlineplantguide.com/PlantDetails.aspx?Plant_id=791">http://www.onlineplantguide.com/PlantDetails.aspx?Plant_id=791</a>	[Is a shade tolerant plant at some stage of its life cycle? Yes] "Light Exposure: Part Sun, Filtered Shade, Shade"
410	2011. Dave's Gardern. PlantFiles: Vegetable Fern - Diplazium esculentum. <a href="http://davesgarden.com/guides/pf/go/54948/">http://davesgarden.com/guides/pf/go/54948/</a>	[Tolerates a wide range of soil conditions ? No] "Other details: Requires consistently moist soil; do not let dry out between waterings. Soil pH requirements: 5.6 to 6.0 (acidic) 6.1 to 6.5 (mildly acidic) 6.6 to 7.5 (neutral)"
411	2001. Hoshizaki, B.J./Moran, R.C.. Fern grower's manual. Timber Press, Portland, OR	[Climbing or smothering growth habit? No] "A medium-sized fern, to 60 cm (2 ft.) tall, with erect rhizomes that can become trunk-like on older plants."
412	1993. Chaudhuri, A.B.. Forest plants of eastern India. Ashish Publishing House, New Delhi, India	[Forms dense thickets? Yes] "Deep soil where grazing is heavy - Such areas are very common in Central and South Diana. Principal weeds are Diplazium esculentum and Mikania cordata which form thick impenetrable low masses with grazing tracts zigzagged in between Clerodendrum viscosum which has scattered distribution and is conspicuous."
501	2003. Palmer, D.D.. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[Aquatic? No] "Plants medium-sized, terrestrial"
502	2001. Hoshizaki, B.J./Moran, R.C.. Fern grower's manual. Timber Press, Portland, OR	[Grass? No] "A medium-sized fern, to 60 cm (2 ft.) tall, with erect rhizomes that can become trunk-like on older plants." [Dryopteridaceae, or Woodsiaceae]

503	2001. Hoshizaki, B.J./Moran, R.C.. Fern grower's manual. Timber Press, Portland, OR	[Nitrogen fixing woody plant? No] "A medium-sized fern, to 60 cm (2 ft.) tall, with erect rhizomes that can become trunk-like on older plants." [Dryopteridaceae, or Woodsiaceae]
504	2001. Hoshizaki, B.J./Moran, R.C.. Fern grower's manual. Timber Press, Portland, OR	[Geophyte (herbaceous with underground storage organs? No) "A medium-sized fern, to 60 cm (2 ft.) tall, with erect rhizomes that can become trunk-like on older plants."
601	1987. Jones, D. L.. Encyclopedia of Ferns. Timber Press, Portland, OR.	[Evidence of substantial reproductive failure in native habitat? No] No evidence
602	1948. Diddell, M.W.. Diplazium esculentum in Florida. American Fern Journal. 38(1): 16-19.	[Produces viable seed? Yes. Spores] "A few months later, in midsummer, the sporophylls appeared, so it seems that the plant when deprived of its means of vegetative propagation starts to produce spores."
602	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	[Produces viable seed? Yes. Spores] "Vegetable fern needs no special care in Hawaii and is easily propagated by spores."
603	1999. Takamiya, M./Takaoka, C./Ohta, N.. Cytological and Reproductive Studies on Japanese Diplazium woodsiaecae; Pteridophyta): Apomictic Reproduction in Diplazium with Evergreen Bi- to Tripinnate Leaves. Journal of Plant Research. 112: 419-436.	[Hybridizes naturally? No] "Three putative hybrids were examined here. Their hybridity were presumed from intermediate morphological characteristics of their putative parents in texture of leaves, form and position of sori, and color and form of scales (Kurata 1961,1968)." [No evidence that D. esculentum forms hybrids]
604	1999. Takamiya, M./Takaoka, C./Ohta, N.. Cytological and Reproductive Studies on Japanese Diplazium woodsiaecae; Pteridophyta): Apomictic Reproduction in Diplazium with Evergreen Bi- to Tripinnate Leaves. Journal of Plant Research. 112: 419-436.	[Self-compatible or apomictic? Unknown] "...Diplazium ammanum and D. esculentum are sexual diploids (2n= 82, n=41)..." [Not apomictic, but self-compatibility of gametophytes unknown]
605	2003. Palmer, D.D.. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[Requires specialist pollinators? No] Pteridophyte
606	1987. Jones, D. L.. Encyclopedia of Ferns. Timber Press, Portland, OR.	[Reproduction by vegetative fragmentation? Yes] "Plants grow vigorously and are spread by stolons."
606	2001. Hoshizaki, B.J./Moran, R.C.. Fern grower's manual. Timber Press, Portland, OR	[Reproduction by vegetative fragmentation? Yes] "New plants frequently arise from root buds."
607	2011. WRA Specialist. Personal Communication.	[Minimum generative time (years)? Unknown]
701	2011. WRA Specialist. Personal Communication.	[Propagules likely to be dispersed unintentionally?] No evidence, although spores may potentially be inadvertently dispersed
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] "...probably introduced to Hawaii as a food plant in the late 1800s or early 1900s...It is a frequent volunteer in gardens, making it difficult to ascertain how often it is cultivated deliberately."
703	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 likely to disperse as a produce contaminant? No] "...bunches of young fiddleheads can be purchased in produce markets in Honolulu as well as at the local farmer's markets..." [No evidence that ferns have contaminated other produce]
704	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 adapted to wind dispersal? Yes] "Vegetable fern needs no special care in Hawaii and is easily propagated by spores." [Spores presumably wind dispersed]
705	1993. Chaudhuri, A.B.. Forest plants of eastern India. Ashish Publishing House, New Delhi, India	[Propagules water dispersed? Probably] "Diplazium esculentum Sw...grow along water courses."
705	1996. Wilson, K.A.. Alien Ferns in Hawaii. Pacific Science. 50 (2): 127-141.	[Propagules water dispersed? Probably] "Diplazium esculentum grows in large stands in wet areas, such as along stream banks; for instance, it occurs abundantly in valleys along the Hamakua Coast of Hawai'i and in wet areas of Pu'u 'Ohi'a and Manoa Valley, O'ahu."
705	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 water dispersed? Probably] "...grows near waterways and in moist or wet ground in open...is easily propagated by spores." [Spores likely transported by water]

705	2006. Boonkerd, T./Pollawatn, R.. Pteridophyte Flora of Thong Pha Phum National Park, Kanchanaburi Province, Thailand. The Natural History Journal of Chulalongkorn University. 6(1): 17-30.	[Propagules water dispersed? Probably] "Along stream banks, where air humidity is high, large terrestrial ferns or tree ferns, such as <i>Angiopteris evecta</i> , <i>Cibotium barometz</i> and <i>Cyathea gigantea</i> typically grow. <i>Cyclosorus interruptus</i> , <i>Pronephrium nudatum</i> , and <i>Diplazium esculentum</i> were found on wet ground, especially along stream banks where sunlight can penetrate to the forest floor."
706	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 bird dispersed? No] "...easily propagated by spores." [Although possible, there is no evidence that bird dispersal is a likely dispersal vector]
707	2011. WRA Specialist. Personal Communication.	[Propagules dispersed by other animals (externally)? Possible] Spores may adhere to mud in hooves, feet of fur, but no direct evidence found
708	2011. WRA Specialist. Personal Communication.	[Propagules survive passage through the gut? Unknown]
801	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	[Prolific seed production (>1000/m <sup>2</sup> )? Yes] "Vegetable fern needs no special care in Hawaii and is easily propagated by spores." [Spores presumably produced in great abundance]
802	2011. WRA Specialist. Personal Communication.	[Evidence that a persistent propagule bank is formed (>1 yr)? Unknown]
803	2011. WRA Specialist. Personal Communication.	[Well controlled by herbicides? Unknown] No information on chemical control or herbicide efficacy
804	2011. WRA Specialist. Personal Communication.	[Tolerates, or benefits from, mutilation, cultivation, or fire? Unknown]
805	2011. WRA Specialist. Personal Communication.	[Effective natural enemies present locally (e.g. introduced biocontrol agents)? Unknown]