

Taxon: <i>Woodwardia radicans</i> (L.) Sm.	Family: Blechnaceae
Common Name(s): chain fern European chain fern rooting chainfern	Synonym(s): <i>Blechnum radicans</i> L.

Assessor: Chuck Chimera	Status: Assessor Approved	End Date: 3 Nov 2016
WRA Score: 9.0	Designation: H(HPWRA)	Rating: High Risk

Keywords: Naturalized, Ornamental, Shade-Tolerant, Rooting Bulbils, 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	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)	n
303	Agricultural/forestry/horticultural weed	n=0, y = 2*multiplier (see Appendix 2)	n
304	Environmental weed	n=0, y = 2*multiplier (see Appendix 2)	n
305	Congeneric weed		
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	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

Qsn #	Question	Answer Option	Answer
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)		
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		
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)	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		
704	Propagules adapted to wind dispersal	y=1, n=-1	y
705	Propagules water dispersed	y=1, n=-1	y
706	Propagules bird dispersed		
707	Propagules dispersed by other animals (externally)	y=1, n=-1	n
708	Propagules survive passage through the gut		
801	Prolific seed production (>1000/m ²)	y=1, n=-1	y
802	Evidence that a persistent propagule bank is formed (>1 yr)		
803	Well controlled by herbicides		
804	Tolerates, or benefits from, mutilation, cultivation, or fire		
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)		

Supporting Data:

Qsn #	Question	Answer
101	Is the species highly domesticated?	n
	Source(s)	Notes
	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	No evidence of domestication in genus

102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. 2016. Personal Communication	NA

103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. 2016. Personal Communication	NA

201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	High
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network, 2016. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 3 Nov 2016]	"Native: Africa Macaronesia: Portugal - Azores Northern Africa: Algeria Europe Southeastern Europe: Italy Southwestern Europe: Portugal; Spain"
	Pyner, T. (2015). <i>Woodwardia</i> in cultivation. <i>Plantsman</i> . September 2015: 184-191	"The natural range of this species is Macaronesia and southern Europe. It is found abundantly in the Azores, Madeira and high rainfall areas of the Canary Islands. It also occurs rarely in Portugal, Spain, Italy and also on the islands of Corsica, Sicily and Crete." [W. radicans has a Mediterranean-Atlantic subtropical distribution.]

202	Quality of climate match data	High
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network, 2016. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 3 Nov 2016]	

203	Broad climate suitability (environmental versatility)	n
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Qsn #	Question	Answer
	Source(s)	Notes
	Dave's Garden. (2016). European chain fern - Woodwardia radicans. http://davesgarden.com/guides/pf/go/1808/ . [Accessed 2 Nov 2016]	"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)"
	Quintanilla, L. G., Amigo, J., Pangua, E., & Pajaron, S. (2002). Effect of storage method on spore viability in five globally threatened fern species. <i>Annals of Botany</i> , 90(4), 461-467	"Wet storage at 5 or 20 °C was the only method that maintained the viability of <i>C. macrocarpa</i> and <i>W. radicans</i> spores after 1 year (Table 3 and Fig. 1). This may be related to the autecology of these two species, both of which are hygrophilous, i.e. require very high levels of soil moisture and relative humidity."

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	Notes
	Pyner, T. (2015). Woodwardia in cultivation. <i>Plantsman</i> . September 2015: 184-191	"The natural range of this species is Macaronesia and southern Europe. It is found abundantly in the Azores, Madeira and high rainfall areas of the Canary Islands. It also occurs rarely in Portugal, Spain, Italy and also on the islands of Corsica, Sicily and Crete." [<i>W. radicans</i> has a Mediterranean-Atlantic subtropical distribution.]
	DeSoto, L., Quintanilla, L., & Méndez, M. (2008). Environmental Sex Determination in Ferns: Effects of Nutrient Availability and Individual Density in <i>Woodwardia radicans</i> . <i>Journal of Ecology</i> , 9 (6), 1319-1327	" <i>Woodwardia radicans</i> (Blechnaceae) is an evergreen fern found in riparian forests of the northern Iberian Peninsula, Macaronesia and some Mediterranean localities."

205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	Notes
	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	"A genus of 12 species, Woodwardia is primarily from the temperate Northern Hemisphere. Two species are cultivated in Hawaii."
	USDA, ARS, Germplasm Resources Information Network, 2016. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 2 Nov 2016]	"Cultivated: . also cult."
	Stace, C. 2010. <i>New Flora of the British Isles</i> . Third Edition. Cambridge University Press, Cambridge, UK	"regenerates in gardens in S Kerry and W Cornwall and might escape into the wild"
	Dave's Garden. (2016). European chain fern - Woodwardia radicans. http://davesgarden.com/guides/pf/go/1808/ . [Accessed 2 Nov 2016]	"Regional This plant has been said to grow in the following regions: San Francisco, California Thousand Oaks, California Bellevue, Washington"

301	Naturalized beyond native range	y
	Source(s)	Notes

Qsn #	Question	Answer
	Watson, L., and Dallwitz, M.J. 2004 onwards. British ferns (Filicopsida). Version: 4th January 2012. http://delta-intkey.com . [Accessed 2 Nov 2016]	"Distribution and habitat. A mainland-european species, perhaps naturalized. Regenerates in gardens in S. Kerry and W. Cornwall."
	Stace, C. 2010. New Flora of the British Isles. Third Edition. Cambridge University Press, Cambridge, UK	"regenerates in gardens in S Kerry and W Cornwall and might escape into the wild"
	Flora of North America Editorial Committee. 1993. Flora of North America: Volume 2: Pteridophytes and Gymnosperms. Oxford University Press, Oxford, UK	"Woodwardia radicans (Linnaeus) Smith has been reported as an escape from cultivation in Florida and in the Sierra Nevada in California; it has not persisted."
	Gann, G.D., and Collaborators. 2001-2016. The Floristic Inventory of South Florida Database Online. The Institute for Regional Conservation. Delray Beach, Florida. http://regionalconservation.org . [Accessed 3 Nov 2016]	"Woodwardia radicans ... SOUTH FLORIDA Native Status: Not Native, Naturalized"
	Wagner, W.L., Herbst, D.R.& Lorence, D.H. 2016. Flora of the Hawaiian Islands. Smithsonian Institution, Washington, D.C. http://botany.si.edu/ . [Accessed 2 Nov 2016]	No evidence to date

302	Garden/amenity/disturbance weed	n
	Source(s)	Notes
	Randall, R.P. 2012. A Global Compendium of Weeds. 2nd Edition. Department of Agriculture and Food, Western Australia	No evidence

303	Agricultural/forestry/horticultural weed	n
	Source(s)	Notes
	Randall, R.P. 2012. A Global Compendium of Weeds. 2nd Edition. Department of Agriculture and Food, Western Australia	No evidence

304	Environmental weed	n
	Source(s)	Notes
	Randall, R.P. 2012. A Global Compendium of Weeds. 2nd Edition. Department of Agriculture and Food, Western Australia	No evidence

305	Congeneric weed	n
	Source(s)	Notes
	Randall, R.P. 2012. A Global Compendium of Weeds. 2nd Edition. Department of Agriculture and Food, Western Australia	Woodwardia areolata cited as a weed, but no evidence of impacts found

401	Produces spines, thorns or burrs	n
	Source(s)	Notes

Qsn #	Question	Answer
	Watson, L., and Dallwitz, M.J. 2004 onwards. British ferns (Filicopsida). Version: 4th January 2012. http://delta-intkey.com . [Accessed 2 Nov 2016]	[No evidence] "Sporophyte. The rhizomes bearing scales. Plants with no clear distinction into fertile and sterile leaves. Leaves aggregated terminally; rooting at their tips from a scaly bud; to 30–200 cm long; persistent; compound; complexly divided; once pinnate, with conspicuously divided pinnae (approaching bipinnate, the pinnae being deeply and acutely lobed). Pinnae numerous. The petioles shorter than the blades (not more than a third as long as the blade and often much less); vascularised by several discrete strands. Leaf blades in outline ovate-triangular, or lanceolate, or lanceolate-triangular; somewhat leathery. The longest pinnae near the base of the blade. The adjacent pinnae distant from one another and not at all overlapping. The venation of the lamina mostly open. The sporangia marginal to superficial; aggregated in sori. The sori stout, in a row on either side of the pinna-lobe midribs; remaining discrete at maturity; with a true indusium (this the same shape as the sorus, opening towards the mid-rib). The mature spores monoletate; without a perispore."

402	Allelopathic	
	Source(s)	Notes
	WRA Specialist. 2016. Personal Communication	Unknown. No evidence found

403	Parasitic	n
	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	"Terrestrial or epilithic ferns. Stem short-creeping to ascending, or slender and long-creeping, bearing nonclathrate scales. Petiole well-developed, usually stramineous with dark base, often ± scaly, adaxially sulcate." [Generic description. Blechnaceae. No evidence]

404	Unpalatable to grazing animals	
	Source(s)	Notes
	Arosa, M. L., Ramos, J. A., Valkenburg, T., Ceia, R., Laborda, H., Quintanilla, L. G., & Heleno, R. (2009). Fern feeding ecology of the Azores bullfinch "Pyrrhula murina": the selection of fern species and the influence of nutritional composition in fern choice. <i>Ardeola</i> , 5 (1), 71-84	"In winter and early spring the Azores bullfinch foraged on sporangia of <i>Woodwardia radicans</i> , <i>Culcita macrocarpa</i> and <i>Pteris incompleta</i> , and in spring/early summer, it took leaves of <i>Osmunda regalis</i> and <i>Pteridium aquilinum</i> and sporangia of <i>O. regalis</i> . From the three leaf phonological stages, expanding leaves and recently expanded leaves were preferred over croziers. The spores of consumed fern species were significantly higher in lipids than leaves of consumed species, but leaves had a higher content in protein and phenolics than spores. The lipid content of spores was nearly significantly different between consumed and non-consumed species, but the nutritional composition of leaves was similar between consumed and non consumed fern species."
	Plants for a Future. (2016). <i>Woodwardia radicans</i> . http://www.pfaf.org/user/Plant.aspx?LatinName=Woodwardia+radicans . [Accessed 3 Nov 2016]	"Members of this genus are rarely if ever troubled by browsing deer" [Possibly unpalatable]

405	Toxic to animals	n
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Qsn #	Question	Answer
	Source(s)	Notes
	Plants for a Future. (2016). <i>Woodwardia radicans</i> . http://www.pfaf.org/user/Plant.aspx?LatinName=Woodwardia+radicans . [Accessed 3 Nov 2016]	"Although we have found no reports of toxicity for this species, a number of ferns contain carcinogens so some caution is advisable [200]. Many ferns also contain thiaminase, an enzyme that robs the body of its vitamin B complex. In small quantities this enzyme will do no harm to people eating an adequate diet that is rich in vitamin B, though large quantities can cause severe health problems. The enzyme is destroyed by heat or thorough drying, so cooking the plant will remove the thiaminase"
	Wagstaff, D.J. 2008. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	No evidence
	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 [<i>Woodwardia unigemmata</i> used medicinally]

406	Host for recognized pests and pathogens	n
	Source(s)	Notes
	The Royal Horticultural Society. (2016). <i>Woodwardia radicans</i> . https://www.rhs.org.uk/plants/details?plantid=6180 . [Accessed 3 Nov 2016]	"Pests - Generally trouble free Diseases - Generally trouble free"
	Malumphy, C., & Halstead, A. J. 2012. First incursions in Europe of four Australasian species of armoured scale insect (Hemiptera: Diaspididae). <i>British Journal of Entomology and Natural History</i> , 2 (4), 193-197	"The first incursions in Britain (and Europe) of four species of Australasian armoured scale insect (Hemiptera: Diaspididae) are reported. <i>Chionaspis xanthorrhoeae</i> Fuller was found breeding indoors on two 100+ year old <i>Xanthorrhoea</i> sp. plants at private premises in Biddenham, Bedfordshire, England, in 2009. The plants had been bought from a commercial plant nursery in Wales in 2003, and the scales had been breeding in Britain for at least six years. <i>Fusilaspis phymatodidis</i> (Maskell) was found causing chlorosis and brown necrotic spotting to the foliage of <i>Dicksonia antarctica</i> and <i>Woodwardia radicans</i> , and to a lesser degree <i>Blechnum</i> sp. and <i>Dryopteris</i> sp., grown in polytunnels at Rosemoor, the Royal Horticultural Society's Garden near Great Torrington, North Devon, England, in 1994, and outdoors in 1995. <i>Parlatoria pittospori</i> Maskell was found causing chlorosis to the foliage of a mature <i>Aloe glauca</i> grown indoors at the Royal Botanic Gardens, Kew, Surrey, England, in 1995. <i>Pseudaulacaspis brimblecombei</i> Williams was found breeding indoors on two <i>Telopea</i> 'Golden Globe' plants at a commercial premises in Cambridge, Cambridgeshire, England, in September 2012. The infested plants had been imported from Italy six months earlier, although <i>P. brimblecombei</i> is not known to occur in Italy. The biology, host plants and geographical range for each of these scale insects are reviewed and their potential economic and environmental impact in Britain discussed."

407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	Notes

Qsn #	Question	Answer
	Plants for a Future. (2016). <i>Woodwardia radicans</i> . http://www.pfaf.org/user/Plant.aspx?LatinName=Woodwardia+radicans . [Accessed 3 Nov 2016]	"Although we have found no reports of toxicity for this species, a number of ferns contain carcinogens so some caution is advisable [200]. Many ferns also contain thiaminase, an enzyme that robs the body of its vitamin B complex. In small quantities this enzyme will do no harm to people eating an adequate diet that is rich in vitamin B, though large quantities can cause severe health problems. The enzyme is destroyed by heat or thorough drying, so cooking the plant will remove the thiaminase"
	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
	Pyner, T. (2015). <i>Woodwardia</i> in cultivation. <i>Plantsman</i> . September 2015: 184-191	"The natural range of this species is Macaronesia and southern Europe. It is found abundantly in the Azores, Madeira and high rainfall areas of the Canary Islands." [Unlikely given habitat]
	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	" <i>W. radicans</i> is easily grown in moist, shaded areas."

409	Is a shade tolerant plant at some stage of its life cycle	y
	Source(s)	Notes
	Tutin, T. G. (1953). The vegetation of the Azores. <i>The Journal of Ecology</i> , 41(1): 53-61	"Damp and shady places ... <i>Woodwardia radicans</i> "
	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	" <i>W. radicans</i> is easily grown in moist, shaded areas."

Qsn #	Question	Answer
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	
	Source(s)	Notes
	Pyner, T. (2015). <i>Woodwardia</i> in cultivation. <i>Plantsman</i> . September 2015: 184-191	"In the wild chain ferns are found most frequently in areas of high rainfall and humidity with relatively mild winters. Soil should ideally be acidic to neutral."
	The Royal Horticultural Society. (2016). <i>Woodwardia radicans</i> . https://www.rhs.org.uk/plants/details?plantid=6180 . [Accessed 3 Nov 2016]	"Soil Clay, Loam pH Neutral"
	Practical Plants. (2016). <i>Woodwardia radicans</i> . http://practicalplants.org/wiki/Woodwardia_radicans . [Accessed 3 Nov 2016]	"Soil PH acid, neutral Soil Texture sandy, loamy, clay"
	Dave's Garden. (2016). European chain fern - <i>Woodwardia radicans</i> . http://davesgarden.com/guides/pf/go/1808/ . [Accessed 3 Nov 2016]	"Soil pH requirements: 6.6 to 7.5 (neutral)"

411	Climbing or smothering growth habit	n
	Source(s)	Notes
	Watson, L., and Dallwitz, M.J. 2004 onwards. <i>British ferns (Filicopsida)</i> . Version: 4th January 2012. http://delta-intkey.com . [Accessed 3 Nov 2016]	"Sporophyte. The rhizomes bearing scales. Plants with no clear distinction into fertile and sterile leaves. Leaves aggregated terminally; rooting at their tips from a scaly bud; to 30–200 cm long; persistent; compound; complexly divided; once pinnate, with conspicuously divided pinnae (approaching bipinnate, the pinnae being deeply and acutely lobed). Pinnae numerous. The petioles shorter than the blades (not more than a third as long as the blade and often much less); vascularised by several discrete strands. Leaf blades in outline ovate-triangular, or lanceolate, or lanceolate-triangular; somewhat leathery. The longest pinnae near the base of the blade. The adjacent pinnae distant from one another and not at all overlapping. The venation of the lamina mostly open."

412	Forms dense thickets	y
	Source(s)	Notes
	Pyner, T. (2015). <i>Woodwardia</i> in cultivation. <i>Plantsman</i> . September 2015: 184-191	"It can form huge stands on steep, forested mountain slopes. The large fronds arch over and downwards, often resulting in the apical bulbil rooting when it touches the ground."

501	Aquatic	n
	Source(s)	Notes
	Pyner, T. (2015). <i>Woodwardia</i> in cultivation. <i>Plantsman</i> . September 2015: 184-191	[Terrestrial] " <i>Woodwardia radicans</i> is very common in parts of the Canarian and Madeiran archipelagos. It can form huge stands on steep, forested mountain slopes. The large fronds arch over and downwards, often resulting in the apical bulbil rooting when it touches the ground."

502	Grass	n
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Qsn #	Question	Answer
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network, 2016. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 2 Nov 2016]	"Family: Blechnaceae Subfamily: Woodwardioideae"

503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network, 2016. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 2 Nov 2016]	"Family: Blechnaceae Subfamily: Woodwardioideae"

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	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	"Terrestrial or epilithic ferns. Stem short-creeping to ascending, or slender and long-creeping, bearing nonclathrate scales. Petiole well-developed, usually stramineous with dark base, often ± scaly, adaxially sulcate."
	Pyner, T. (2015). Woodwardia in cultivation. Plantsman. September 2015: 184-191	"The thick rhizome is erect or ascending and carries large, arched, evergreen, bipinnatifid fronds of one type, to 2m long, rarely to 3m. These usually bear one to three large, scaly bulbils in the axils of pinnae near the frond apex. The stipe (frond stalk) is up to half as long as the leaf blade."

601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	Notes
	Pyner, T. (2015). Woodwardia in cultivation. Plantsman. September 2015: 184-191	"Woodwardia radicans is very common in parts of the Canarian and Madeiran archipelagos. It can form huge stands on steep, forested mountain slopes. The large fronds arch over and downwards, often resulting in the apical bulbil rooting when it touches the ground."

602	Produces viable seed	y
	Source(s)	Notes
	Dave's Garden. (2016). European chain fern - Woodwardia radicans. http://davesgarden.com/guides/pf/go/1808/ . [Accessed 2 Nov 2016]	"Propagation Methods: By stooling or mound layering From spores"

Qsn #	Question	Answer
	Carafa, A. M. (1984). Light dependent spore germination in <i>Woodwardia radicans</i> (L.) Sm. <i>Plant Biosystems</i> , 118(5-6), 245-253	"The spores of <i>Woodwardia radicans</i> can germinate indifferently either in water or in culture media containing mineral salts at temperatures (15-24°C) falling within a range believed optimal for many other ferns (15-30 C). The spores are photosensitive, will not germinate in the dark and the addition of gibberellic acid is ineffective in substituting a light requirement. Spore germination was induced by white and red light and phytochrome seems to be implicated in the control of germination since far-red light (and not the blue irradiation) can reverse the stimulating effect of the red light. Spore morphology and spore germination pattern was studied using light and scanning electron microscopes. It was concluded that the progressive disappearance of <i>W. radicans</i> from the Italian localities is not due to difficulties in spore germination but is related to problems that arise during the subsequent stages."

603	Hybridizes naturally	
	Source(s)	Notes
	Pyner, T. (2015). <i>Woodwardia</i> in cultivation. <i>Plantsman</i> . September 2015: 184-191	[Unknown] "It is now known that <i>W. orientalis</i> is a fertile allotetraploid species derived from a sterile hybrid between diploid <i>W. prolifera</i> and a second, as yet uncertain, species (Takamiya et al. 1992)."

604	Self-compatible or apomictic	
	Source(s)	Notes
	Peck, C. J. (1985). Reproductive biology of isolated fern gametophytes. PhD Dissertation. Iowa State University, Ames, Iowa	"Homosporous ferns produce a single kind of spore which gives rise to a gametophyte that is viewed as potentially bisexual. Theoretically, a single gametophyte of a homosporous fern could self-fertilize to establish a new population."
	DeSoto, L., Quintanilla, L., & Méndez, M. (2008). Environmental Sex Determination in Ferns: Effects of Nutrient Availability and Individual Density in <i>Woodwardia radicans</i> . <i>Journal of Ecology</i> , 9 (6), 1319-1327	"Under rich growing conditions heart-shaped gametophytes become several cell-layers thick in the centre - i.e. below the meristem notch - and develop as females, before turning into bisexuals (Quintanilla et al. 2005)." [Probably self-fertile]

605	Requires specialist pollinators	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	"Also assume 'no' for fern, grass, and sedge taxa even if direct evidence is lacking."

606	Reproduction by vegetative fragmentation	y
	Source(s)	Notes

Qsn #	Question	Answer
	Future is Written in Green. (2011). <i>Woodwardia radicans</i> , the giant of laurel forest. http://mundani-garden.blogspot.com/2011/02/woodwardia-radicans-giant-of-rain.html . [Accessed 2 Nov 2016]	"Its scientific name refers to the ability of this fern to reproduce vegetatively from small bulblets, buds and shoots, that as small rhizomes brown paleae covered grow in the apical end of the fronds. When these bulblets come into contact with the ground, take root and begin to grow as independent ferns. Thus botanists gave it the name "radicans" = that takes roots."
	DeSoto, L., Quintanilla, L., & Méndez, M. (2008). Environmental Sex Determination in Ferns: Effects of Nutrient Availability and Individual Density in <i>Woodwardia radicans</i> . <i>Journal of Ecology</i> , 9 (6), 1319-1327	"Sporophytes can propagate asexually via adventitious buds formed on the rachis. In the northern Iberian Peninsula, sporangium dehiscence occurs around February-March, when temperatures are suitable for spore germination"
	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	"Tiny bulbs produced near the frond tips root readily when placed in contact with the soil, and the species may also be propagated by rhizome division or spores."

607	Minimum generative time (years)	
	Source(s)	Notes
	Pyner, T. (2015). <i>Woodwardia</i> in cultivation. <i>Plantsman</i> . September 2015: 184-191	"The large fronds arch over and downwards, often resulting in the apical bulbil rooting when it touches the ground" [Unknown. May be able to reproduce vegetatively prior to sexual maturity]

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	n
	Source(s)	Notes
	WRA Specialist. 2016. Personal Communication	Possible that spores could be carried on equipment, shoes, etc. but unlikely given habitat preferences

702	Propagules dispersed intentionally by people	y
	Source(s)	Notes
	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	"A genus of 12 species, <i>Woodwardia</i> is primarily from the temperate Northern Hemisphere. Two species are cultivated in Hawaii."
	Pyner, T. (2015). <i>Woodwardia</i> in cultivation. <i>Plantsman</i> . September 2015: 184-191	" <i>Woodwardia radicans</i> ... This species is the most frequently encountered in gardens, although it is being usurped by <i>W. fimbriata</i> , and has been grown since the late 18th century. Several large gardens in Cornwall, Ireland and Scotland host spectacular colonies."

703	Propagules likely to disperse as a produce contaminant	
	Source(s)	Notes
	WRA Specialist. 2016. Personal Communication	Unknown. Spores could potentially contaminate soil or potting media of any plants growing in the vicinity of reproductive age individuals

704	Propagules adapted to wind dispersal	y
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Qsn #	Question	Answer
	Source(s)	Notes
	Arosa, M. L., Quintanilla, L. G., Ramos, J. A., Ceia, R., & Sampaio, H. (2009). Spore maturation and release of two evergreen Macaronesian ferns, <i>Calcitra macrocarpa</i> and <i>Woodwardia radicans</i> , along an altitudinal gradient. <i>American Fern Journal</i> , 99(4), 260-272	"In ferns, both indusia and sporangia openings are passively caused by evaporative forcing. This must be an adaptation to favor long-distance wind dispersal of spores in warm dry days. <i>Calcitra macrocarpa</i> and <i>W. radicans</i> released spores a month earlier at low altitude than at high altitude."
	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
	DeSoto, L., Quintanilla, L., & Méndez, M. (2008). Environmental Sex Determination in Ferns: Effects of Nutrient Availability and Individual Density in <i>Woodwardia radicans</i> . <i>Journal of Ecology</i> , 9 (6), 1319-1327	" <i>Woodwardia radicans</i> (Blechnaceae) is an evergreen fern found in riparian forests of the northern Iberian Peninsula" [Likely yes. Small spores likely moved by wind and water]

706	Propagules bird dispersed	
	Source(s)	Notes
	Arosa, M. L., Quintanilla, L. G., Ramos, J. A., Ceia, R., & Sampaio, H. (2009). Spore maturation and release of two evergreen Macaronesian ferns, <i>Calcitra macrocarpa</i> and <i>Woodwardia radicans</i> , along an altitudinal gradient. <i>American Fern Journal</i> , 99(4), 260-272	[Possibly one species may disperse spores in the Azores] "We have not observed spore-feeding insects in the study species but consumption by the Azores bullfinch is significant (Ramos, 1995; Arosa et al., in press). Given that Azores bullfinch consumes mature spores, we have studied its potential disperser role and the results will be reported elsewhere. In short, many droppings contained high amounts of viable (able to germinate) spores of <i>C. macrocarpa</i> and <i>W. radicans</i> and thus may provide a vehicle for dispersal. The pattern of autumn spore maturation and late winter release occurs throughout the range of both ferns (own observation), while the Azores bullfinch is present only in a small fraction (one island). Thus, the negative (predation) or positive (dispersal) interaction with the Azores bullfinch may not be important for determining the timing of spore dispersal."

707	Propagules dispersed by other animals (externally)	n
	Source(s)	Notes
	WRA Specialist. 2016. Personal Communication	Possibly, but unlikely. Although spores may potentially adhere to animal fur or feet, the primary vector of dispersal is wind & water.

Qsn #	Question	Answer
708	Propagules survive passage through the gut	
	Source(s)	Notes
	Arosa, M. L., Quintanilla, L. G., Ramos, J. A., Ceia, R., & Sampaio, H. (2009). Spore maturation and release of two evergreen Macaronesian ferns, <i>Calcitra macrocarpa</i> and <i>Woodwardia radicans</i> , along an altitudinal gradient. <i>American Fern Journal</i> , 99(4), 260-272	[Possibly if consumed by bullfinches. Unknown for other animals] "In short, many droppings contained high amounts of viable (able to germinate) spores of <i>C. macrocarpa</i> and <i>W. radicans</i> and thus may provide a vehicle for dispersal."

801	Prolific seed production (>1000/m2)	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. <i>Plant Protection Quarterly</i> , 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
	Quintanilla, L. G., Amigo, J., Pangua, E., & Pajaron, S. (2002). Effect of storage method on spore viability in five globally threatened fern species. <i>Annals of Botany</i> , 90(4), 461-467	[Spores will lose viability if allowed to dry out] "In general, wet storage at 5 or 20 °C was the procedure that best preserved viability (Table 3, Fig. 1). Indeed, for spores of <i>W. radicans</i> and <i>C. macrocarpa</i> , these were the only storage procedures that avoided a decline in germination percentage after 12 months' storage." ... "Wet storage at 5 or 20 °C was the only method that maintained the viability of <i>C. macrocarpa</i> and <i>W. radicans</i> spores after 1 year (Table 3 and Fig. 1)." ... "The present and previous findings also suggest that for species with spores sensitive to desiccation, such as <i>C. macrocarpa</i> and <i>W. radicans</i> , herbarium sheets are likely to be an inadequate source of spores"

803	Well controlled by herbicides	
	Source(s)	Notes
	WRA Specialist. 2016. Personal Communication	Unknown. No information on herbicide efficacy or chemical control of this species.

804	Tolerates, or benefits from, mutilation, cultivation, or fire	
	Source(s)	Notes
	The Royal Horticultural Society. (2016). <i>Woodwardia radicans</i> . https://www.rhs.org.uk/plants/details?plantid=6180 . [Accessed 3 Nov 2016]	"Pruning - Cut down old fronds when they deteriorate"

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
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Qsn #	Question	Answer
	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	[Unknown] "A genus of 12 species, Woodwardia is primarily from the temperate Northern Hemisphere. Two species are cultivated in Hawaii."

Summary of Risk Traits:

High Risk / Undesirable Traits

- Able to grow in temperate to subtropical climates
- Naturalized in the British Isles and Florida,
- Shade tolerant
- Forms dense stands in native range
- Reproduces by spores and vegetatively by adventitious bulbils
- Spores dispersed by wind & water
- Intentionally propagated
- Presumably prolific spore production
- Possibly bird-dispersed in Azores

Low Risk Traits

- Despite naturalization, no negative impacts documented
- Cultivated, but not reported as naturalized, in Hawaiian Islands
- Unarmed (no spines, thorns or burrs)
- Ornamental