United States Department of Agriculture

United States
Department of
Agriculture

Animal and Plant
Health Inspection
Service

February 18, 2014

Version 1

Weed Risk Assessment for *Cortaderia jubata* (Lemoine ex Carrière) Stapf (Poaceae) – Jubata grass

Left: Invasion of a coastal habitat in California by *Cortaderia jubata* in (source: Mandy Tu, The Nature Conservancy, Bugwood.org). Right: Habit of *C. jubata* (source: John M. Randall, The Nature Conservancy, Bugwood.org).

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Introduction Plant Protection and Quarantine (PPQ) regulates noxious weeds under the authority of the Plant Protection Act (7 U.S.C. § 7701-7786, 2000) and the Federal Seed Act (7 U.S.C. § 1581-1610, 1939). A noxious weed is defined as "any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment" (7 U.S.C. § 7701-7786, 2000). We use weed risk assessment (WRA)—specifically, the PPQ WRA model (Koop et al., 2012)—to evaluate the risk potential of plants, including those newly detected in the United States, those proposed for import, and those emerging as weeds elsewhere in the world.

Because the PPQ WRA model is geographically and climatically neutral, it can be used to evaluate the baseline invasive/weed potential of any plant species for the entire United States or for any area within it. As part of this analysis, we use a stochastic simulation to evaluate how much the uncertainty associated with the analysis affects the model outcomes. We also use GIS overlays to evaluate those areas of the United States that may be suitable for the establishment of the plant. For more information on the PPQ WRA process, please refer to the document, *Background information on the PPQ Weed Risk Assessment*, which is available upon request.

***Cortaderia jubata* (Lemoine ex Carrière) Stapf. – Jubata grass**

Species Information

Family: Poaceae

Synonyms: *Cortaderia atacamensis* (Phil.) Pilg. (NRCS, 2013); *Gynerium jubatum* Lemoine ex Carrière (basionym; NGRP, 2013)

Common Names: Jubatagrass, jubata grass, Andean pampas grass, purple pampas (Bossard et al., 2000; MPI, 2012).

Initiation: APHIS Public Affairs relayed a media inquiry to PPQ about PPQ's policy on *Cortaderia selloana* and *C. jubata*, which are cultivated and invasive in the United States (Curlett, 2013). Given the media request for information on this species and its invasive status in the United States, the PPQ Weed Team prioritized both species for assessment.

Foreign distribution: *Cortaderia jubata* is native to South America in the countries of Argentina, Bolivia, Chile, Ecuador, and Peru (NGRP, 2013; Parsons and Cuthbertson, 2001). It has been introduced to and become naturalized in Australia, New Zealand, and South Africa (NGRP, 2013; Robinson, 1984). It is also present in Ireland and Spain (Bossard et al., 2000; NGRP, 2013).

U.S. distribution and status: *Cortaderia jubata* is present in the United States. It was introduced for cultivation during the mid to late 1800s but it never entered commercial production like its congener, *C. selloana* (Lambrinos, 2001). We searched a national plant finder database (Univ. of Minn., 2014) and found no listings of it by either retail or wholesale U.S. nurseries, but seeds are available on line on Amazon (Anonymous, 2013b). In California, *C. jubata* first naturalized in 1946, later spreading rapidly throughout coastal habitats (Lambrinos, 2001). It is also naturalized in Hawaii, Oregon, Texas, and Washington (Kartesz, 2013; Motooka et al., 2003; NGRP, 2013). *Cortaderia jubata* is a state noxious weed in Hawaii (NRCS, 2013): it is being managed by an interagency invasive species committee (Penniman et al., 2011; Starr et al., 2003; Strohecker, 2011). "With *C. selloana*, *C. jubata* comprises the second highest plant priority for MISC [Maui Invasive Species Committee]; management efforts span thousands of hectares and involve ground work in residential and wildland areas and aerial operations in more remote areas" (Penniman et al., 2011). *Cortaderia jubata* is a state noxious weed in California (3 CCR § 4500, 2013) and is being managed on public lands and private lands (DiTomaso et al., 2008; Madison, 1993, 1994). The U.S. Bureau of Land Management manages this species at Fort Ord National Monument in coastal California (BLM, 2013). It is also a state noxious weed in Oregon (ODA, 2013). We did not find any evidence this species is perceived as a weed in Washington or Texas, but those authorities and managers may have not yet evaluated this species.

WRA area[1]: Entire United States, including territories.

1. *Cortaderia jubata* analysis

Establishment/Spread Potential

Although perhaps not as invasive as its congener, *C. selloana*, *C. jubata* has demonstrated its ability to establish and spread in the United States (Lambrinos, 2001) and elsewhere (Bossard et al., 2000; Connor, 1965; Gosling et al., 2000; NGRP, 2013). In California, this species was first recorded as having naturalized in 1946, and thereafter rapidly spread through coastal habitats (Lambrinos, 2001). *Cortaderia jubata* forms dense populations (DiTomaso et al., 2008; Drewitz and DiTomaso, 2004; Motooka et al., 2003), produces hundreds of thousands of seeds per clump (Drewitz and DiTomaso, 2004) without needing to be pollinated (Connor, 1965; Okada et al., 2009), and typically reaches reproductive maturity in its first year (Parsons and Cuthbertson, 2001; Timmins and Mackenzie, 1995). Seeds are readily dispersed by wind (Connor, 1973; Drewitz and DiTomaso, 2004), but may also be dispersed by people because the mature inflorescences are used in dried floral arrangements (Bossard et al., 2000). Plants are resilient to fire because the large tussocks insulate plant meristems (Drewitz and DiTomaso, 2004; Lambrinos, 2000; Timmins and Mackenzie, 1995). Because this species has been well studied by scientists, our uncertainty was very low for this risk element.
Risk score = 17 Uncertainty index = 0.05

Impact Potential

Cortaderia jubata obtained a relatively high impact potential risk score because impacts in natural, anthropogenic, and production systems have been documented for it. In natural systems, it changes native plant communities (Drewitz and DiTomaso, 2004; Lambrinos, 2000), converts shrubland habitats to grasslands (Gosling et al., 2000; Lambrinos, 2000, 2006; Underwood et al., 2003), and "prevents forest re-establishment in forests that have been burned or clear cut" (Weber, 2003). In cities and suburban regions, it colonizes roadsides, graded areas, quarry sites, and other disturbed areas (Connor, 1965; DiTomaso et al., 2008; Parsons and Cuthbertson, 2001). It also reduces the aesthetic and recreational value of natural areas (Bossard et al., 2000) and blocks access (MPI, 2012; ODA, 2013). In production systems, such as cut-over coastal redwood forests in northern California, it suppresses the establishment of seedling conifers (Bossard et al., 2000) and retards the establishment and growth of seedling trees (ODA, 2013). In

[1] "WRA area" is the area in relation to which the weed risk assessment is conducted [definition modified from that for "PRA area"] (IPPC, 2012).

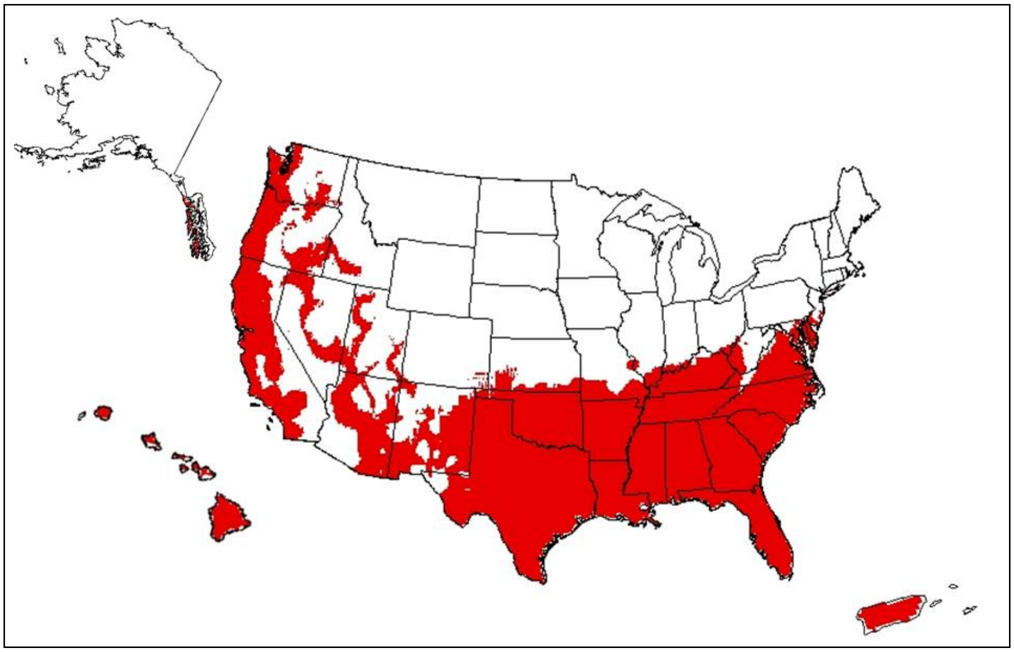
California *C. jubata* is categorized as having severe impacts (Cal-IPC, 2006). Scientists there did a detailed analysis of the efficacy and cost of various control strategies (DiTomaso et al., 2008). *Cortaderia jubata* is managed in natural (Wotherspoon and Wotherspoon, 2002), anthropogenic (Madison, 1993, 1994), and production systems (Bossard et al., 2000; Knowles, 1991; West and Dean, 1990). Furthermore, it is classified as a noxious weed in three U.S. states and as a quarantine pest or declared weed in Australia, New Zealand, and South Africa (Henderson, 2001; MPI, 2012; Parsons and Cuthbertson, 2001). We had average uncertainty for this risk element.
Risk score = 4.1 Uncertainty index = 0.16

Geographic Potential Based on three climatic variables, we estimate that about 36 percent of the United States is suitable for the establishment of *C. jubata* (Fig. 1). That predicted distribution is based on the species' known distribution elsewhere in the world and includes point-referenced localities and areas of occurrence. The map for *C. jubata* represents the joint distribution of Plant Hardiness Zones 7-13, areas with 0-100+ inches of annual precipitation, and the following Köppen-Geiger climate classes: steppe, humid subtropical, Mediterranean, marine west coast, tropical savanna, and tropical rainforest. In this assessment we answered that *C. jubata* could occur in Plant Hardiness Zone 13 and precipitation band 0-10 inches, but we had high uncertainty. This was due to the limited amount of geo-referenced data points for this species, and the difficulty in evaluating a species' climatic tolerances in regions dominated by rapid elevation changes, including those found in Hawaii.

The area estimated likely represents a conservative estimate as it only uses three climatic variables. Other environmental variables, such as soil and habitat type, may further limit the areas in which this species is likely to establish. *Cortaderia jubata* grows in grassland valley regions of tropical and cool temperate mountainous regions (Parsons and Cuthbertson, 2001). In its native range it grows in mountainous regions between 2800 and 3400 meters above sea level in the Andes (Kaufman and Kaufman, 2007; Parsons and Cuthbertson, 2001). Beyond its native range, it naturalizes in ditches, road cuts, cliffs, mudslides, forest clear-cuts, shrublands, forest margins, dunes, cliffs, bluffs, and riverbeds (Bossard et al., 2000; Cal-IPC, 2006; Timmins and Mackenzie, 1995). In California, *C. jubata* is restricted to coastal evergreen scrub communities, and logged coastal redwood forests, possibly because of increased moisture availability associated with these habitats (Lambrinos, 2002).

Entry Potential We did not assess the entry potential of *C. jubata*, because it is already present in the United States (Jepson Flora Project, 2013; Lambrinos, 2001).

Figure 1. Predicted distribution of C*ortaderia jubata* in the United States. Map insets for Alaska, Hawaii, and Puerto Rico are not to scale.



2. Results and Conclusion

Model Probabilities: P(Major Invader) = 91.2%
P(Minor Invader) = 8.5%
P(Non-Invader) = 0.3%

Risk Result = High Risk
Secondary Screening = Not Applicable

Figure 2. *Cortaderia jubata* risk score (black box) relative to the risk scores of species used to develop and validate the PPQ WRA model (other symbols). See Appendix A for the complete assessment.

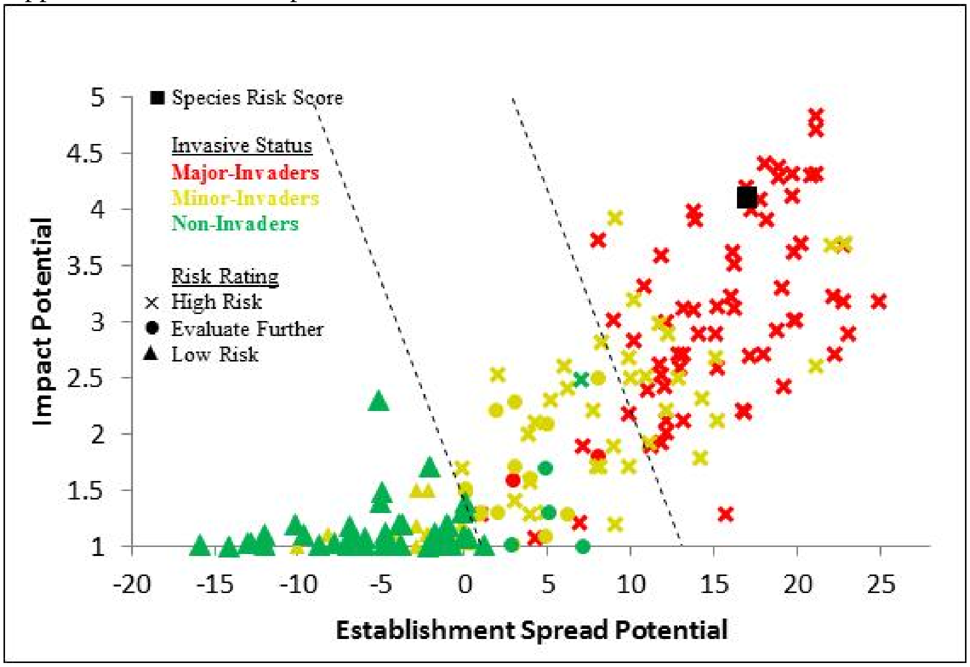
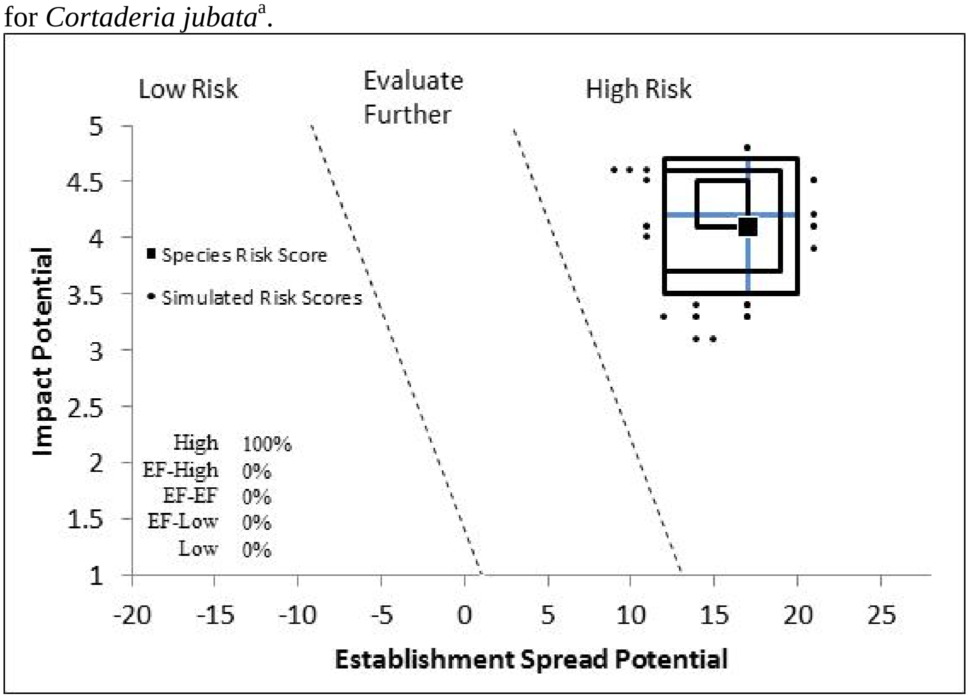


Figure 3. Model simulation results (N=5,000) for uncertainty around the risk score for *Cortaderia jubata*[a].



[a] The blue "+" symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

3. Discussion

The result of the weed risk assessment for *C. jubata* is High Risk (Fig. 2). We are confident in that outcome based on the results of our uncertainty simulation (Fig. 3) and because an independent evaluation using the Australian weed risk assessment system also gave a high risk (reject) rating (UH, 2013). *Cortaderia jubata* has already demonstrated an ability to be invasive and to cause impacts to natural, production, and anthropogenic systems. Although a significant portion of the United States is suitable for its establishment, it is not clear if it will behave invasively in most of those habitats. Unlike its invasive congener *C. selloana*, *C. jubata* has primarily invaded coastal evergreen scrub communities and logged coastal redwood forests in California, possibly because of increased moisture availability associated with these habitats (Lambrinos, 2002). In Hawaii, this species has established in numerous areas of rainforest and bogs, and in Haleakala National Park (Motooka et al., 2003; Penniman et al., 2011).

Genetic evidence indicates that only a single genotype of *C. jubata* was introduced for cultivation into California, Maui, and New Zealand, resulting in a significant genetic bottleneck (Okada et al., 2009). Since *C. jubata* primarily occurs in coastal areas in California, it is believed that only the low-elevation biotype was introduced (Bossard et al., 2000). Introduction of any other biotypes could increase the range of habitats it is able to invade in the United States. *Cortaderia jubata*, which is regulated California, Hawaii, and Oregon, is sometimes mistakenly sold under the name of *C. selloana* (cited in Bossard et al., 2000).

4. Literature Cited

3 CCR § 4500. 2013. California Code of Regulations, Title 3, Division 4, Chapter 6, Subchapter 6 (§ 4500 - Noxious Weed Species). State of California.

7 U.S.C. § 1581-1610. 1939. The Federal Seed Act, Title 7 United States Code § 1581-1610.

7 U.S.C. § 7701-7786. 2000. Plant Protection Act, Title 7 United States Code § 7701-7786.

Anonymous. 2013a. Dried natural pampas grass. DriedDecour.com - Nature's Beauty. Last accessed December 17, 2013, http://www.drieddecor.com/.

Anonymous. 2013b. Pampas grass pink *Cortaderia jubata* 50 seeds. Amazon.com. Last accessed December 30, 2013, http://www.amazon.com/PAMPAS-GRASS-Cortaderia-jubata-seeds/dp/B00480KMME.

Anonymous. 2013c. Purple pampas grass: *Cortaderia jubata*. Invasive Species South Africa. Last accessed December 30, 2013, http://www.invasives.org.za/invasive-species/item/226-purple-pampas-grass%7Ccortaderia-jubata.html.

BLM. 2013. Jubata grass (*Cortaderia jubata*). United States Department of Interior, Bureau of Land Management (BLM). Last accessed December 30, 2013, http://www.blm.gov/ca/st/en/fo/hollister/noxious_weeds/nox_weeds_list/jubatagrass.html.

Bossard, C. C., J. M. Randall, and M. C. Hoshovsky (eds.). 2000. Invasive Plants of California's Wildlands. University of California Press, Berkeley, CA, U.S.A. 360 pp.

Burrows, G. E., and R. J. Tyrl. 2001. Toxic Plants of North America. Iowa State University Press, Ames, IA. 1342 pp.

Cal-IPC. 2006. California invasive plant inventory. California Invasive Plant Council (Cal-IPC), CA, U.S.A. 44 pp.

Connor, H. E. 1965. Breeding systems in New Zealand grasses. V. Naturalised species of

Cortaderia. New Zealand Journal of Botany 3:17-23.
Connor, H. E. 1973. Breeding Systems in *Cortaderia* (Gramineae). Evolution 27(4):663-678.
Curlett, E. 2013. Response to media request about PPQ's policy on several weed issues. Personal communication to A. L. Koop on September 24, 2013, from Ed Curlett, APHIS-Public Affairs.
D'Antonio, C. M., and P. M. Vitousek. 1992. Biological invasions by exotic grasses, the grass / fire cycle, and global change. Annual Review of Ecology and Systematics 23:63-87.
Dave's Garden. 2013. Plant files database. Dave's Garden. http://davesgarden.com/guides/pf/go/1764/. (Archived at PERAL).
DiTomaso, J. M., J. J. Drewitz, and G. B. Kyser. 2008. Jubatagrass (*Cortaderia jubata*) control using chemical and mechanical methods. Invasive Plant Science and Management 1(1):82-90.
Domènech, R., M. Vilà, J. Gesti, and I. Serrasolses. 2006. Neighbourhood association of *Cortaderia selloana* invasion, soil properties and plant community structure in Mediterranean coastal grasslands. Acta Oecologica 29(2):171-177.
Drewitz, J. J., and J. M. DiTomaso. 2004. Seed biology of jubatagrass (*Cortaderia jubata*). Weed Science 52(4):525-530.
Gadgil, R. L., A. M. Sandberg, and P. J. Allen. 1992. Nutritional relationships between pampas grass (*Cortaderia* spp.) and *Pinus radiata*. New Zealand Journal of Forestry Science 22(1):3-11.
GBIF. 2013. GBIF, Online Database. Global Biodiversity Information Facility (GBIF). http://data.gbif.org/welcome.htm. (Archived at PERAL).
Gosling, D. S., W. B. Shaw, and S. M. Beadel. 2000. Review of control methods for pampas grasses in New Zealand (Science for Conservation: 165). New Zealand Department of Conservation, Wellington, New Zealand. 32 pp.
Heap, I. 2013. The international survey of herbicide resistant weeds. Weed Science Society of America. www.weedscience.com. (Archived at PERAL).
Heide-Jorgensen, H. S. 2008. Parasitic Flowering Plants. Brill, Leiden, The Netherlands. 438 pp.
Henderson, L. 2001. Alien Weeds and Iinvasive Plants: A Complete Guide to Declared Weeds and Invaders in South Africa. Agricultural Research Council, South Africa. 300 pp.
IPPC. 2012. International Standards for Phytosanitary Measures No. 5: Glossary of Phytosanitary Terms. Food and Agriculture Organization of the United Nations, Secretariat of the International Plant Protection Convention (IPPC), Rome, Italy.
ISSG. 2013. Global Invasive Species Database. The World Conservation Union (IUCN), Invasive Species Specialist Group (ISSG). http://www.issg.org/database/welcome/. (Archived at PERAL).
ISSG. 2014. Global Invasive Species Database. The World Conservation Union (IUCN), Invasive Species Specialist Group (ISSG). http://www.issg.org/database/welcome/. (Archived at PERAL).
Jepson Flora Project. 2013. Jepson eFlora [Online Database]. University of California, Berkeley. http://ucjeps.berkeley.edu/IJM.html. (Archived at PERAL).
Kartesz, J. 2013. The Biota of North America Program (BONAP). North American Plant Atlas. http://www.bonap.org/MapSwitchboard.html. (Archived at PERAL).
Kaufman, S. R., and W. Kaufman. 2007. Invasive Plants: Guide to Identification and the Impacts and Control of Common North American Species. Stackpole Books, Mechanisburg, PA. 458 pp.
Knowles, B., and J. D. Tombleson. 1987. Replacing pampas grass--Alternative species for

low shelter and amenity plantings (What's New In Forest Research, No. 150.). Forest Research Institute, New Zealand. 4 pp.
Knowles, R. L. 1991. New Zealand experience with silvopastoral systems: A review. Forest Ecology and Management 45(1-4):251-267.
Koop, A., L. Fowler, L. Newton, and B. Caton. 2012. Development and validation of a weed screening tool for the United States. Biological Invasions 14(2):273-294.
Lambrinos, J. G. 2000. The impact of the invasive alien grass *Cortaderia jubata* (Lemoine) Stapf on an endangered mediterranean-type shrubland in California. Diversity and Distributions 6(5):217-231.
Lambrinos, J. G. 2001. The expansion history of a sexual and asexual species of *Cortaderia* in California, USA. Journal of Ecology 89(1):88-98.
Lambrinos, J. G. 2002. The variable invasive success of *Cortaderia* species in a complex landscape. Ecology 83(2):518-529.
Lambrinos, J. G. 2006. Spatially variable propagule pressure and herbivory influence invasion of chaparral shrubland by an exotic grass. Oecologia 147(2):327-334.
Linder, H. P., M. Baeza, N. P. Barker, C. Galley, A. M. Humphreys, K. M. Lloyd, D. A. Orlovich, M. D. Pirie, B. K. Simon, N. Walsh, and G. A. Verboom. 2010. A generic classification of the danthonioideae (Poaceae). Annals of the Missouri Botanical Garden 97(3):306-364.
Madison, J. H. 1993. Pampas eradication program - P. E. P. CalEPPC News 1(4):4-5.
Madison, J. H. 1994. Pampas eradication program - P. E. P. CalEPPC News 2(2):4-6.
Martin, P. G., and J. M. Dowd. 1990. A protein sequence study of the dicotyledons and its relevance to the evolution of the legumes and nitrogen fixation. Australian Systematic Botany 3:91-100.
Motooka, P., L. Castro, D. Nelson, G. Nagai, and L. Ching. 2003. Weeds of Hawai'i's Pastures and Natural Areas: An Identification and Management Guide. College of Tropical Agriculture and Human Resources, University of Hawai'i at Manoa, Honolulu, HI. 184 pp.
MPI. 2012. National Pest Plant Accord 2012. Ministry of Primary Industries (MPI), Wellington, New Zealand. 148 pp.
NGRP. 2013. Germplasm Resources Information Network (GRIN). United States Department of Agriculture, Agricultural Research Service, National Genetic Resources Program (NGRP). http://www.ars-grin.gov/cgi-bin/npgs/html/index.pl?language=en. (Archived at PERAL).
Nickrent, D. 2009. Parasitic plant classification. Southern Illinois University Carbondale, Carbondale, IL. Last accessed June 12, 2009, http://www.parasiticplants.siu.edu/ListParasites.html.
NRCS. 2013. The PLANTS Database. United States Department of Agriculture, Natural Resources Conservation Service (NRCS), The National Plant Data Center. http://plants.usda.gov/cgi_bin/. (Archived at PERAL).
ODA. 2013. Noxious Weed Quarantine. Oregon Department of Agriculture (ODA). Last accessed December 30, 2013, http://www.oregon.gov/ODA/PLANT/pages/603_052_1200.aspx.
Okada, M., M. Lyle, and M. Jasieniuk. 2009. Inferring the introduction history of the invasive apomictic grass *Cortaderia jubata* using microsatellite markers. Diversity and Distributions 15(1):148-157.
Parsons, W. T., and E. G. Cuthbertson. 2001. Noxious weeds of Australia (2nd edition). CSIRO Publishing, Collingwood, Victoria, Australia. 698 pp.
Penniman, T. M., L. Buchanan, and L. L. Loope. 2011. Recent plant eradications on the islands of Maui County, Hawai‘i. Pages 325-331 *in* C. R. Veitch, M. N. Clout, and D. R. Towns, (eds.). Island Invasives: Eradication and Management.

Proceedings of the International Conference on Island Invasives. International Union for Conservation of Nature (IUCN), Gland, Switzerland.
Randall, R. P. 2012. A Global Compendium of Weeds, 2nd edition. Department of Agriculture and Food, Western Australia, Perth, Australia. 1107 pp.
Richardson, B., A. Vanner, J. Ray, N. Davenhill, and G. Coker. 1996. Mechanisms of *Pinus radiata* growth suppression by some common forest weed species. New Zealand Journal of Forestry Science 26(3):421-437.
Ricketts, T. H., E. Dinerstein, D. M. Olson, C. J. Loucks, W. Elchbaum, D. DellaSala, K. Kavanagh, P. Hedao, P. T. Hurley, K. M. Carney, R. Abell, and S. Walters. 1999. Terrestrial Ecoregions of North America: A Conservation Assessment. Island Press, Washington D.C. 485 pp.
Robinson, E. R. 1984. Naturalized species of *Cortaderia* (Poaceae) in southern Africa. South African Journal of Botany 3:343-346.
Santi, C., D. Bogusz, and C. Franche. 2013. Biological nitrogen fixation in non-legume plants. Annals of Botany 111(5):743-767.
Starr, F., K. Starr, and L. Loope. 2003. *Cortaderia* spp: Pampas grass (Poaceae). United States Geological Survey, Biological Resources Division, Hawai'i, Maui, Haleakala Field Station.
Strohecker, L. F. 2011. Pampas grass - All species on Maui are invasive! Maui Invasive Species Committee. Last accessed December 30, 2013, http://mauiinvasive.org/tag/cortaderia-jubata/.
Timmins, S. M., and I. W. Mackenzie. 1995. Weeds in New Zealand protected natural areas database. New Zealand Department of Conservation, Wellington, New Zealand. 287 pp.
UH. 2013. Weed risk assessments for Hawaii and Pacific Islands. University of Hawaii (UH). http://www.botany.hawaii.edu/faculty/daehler/wra/default2.htm. (Archived at PERAL).
Underwood, E., S. Ustin, and D. DiPietro. 2003. Mapping nonnative plants using hyperspectral imagery. Remote Sensing of Environment 86(2):150-161.
Univ. of Minn. 2014. Plant Information Online Database. University of Minnesota. https://plantinfo.umn.edu/default.asp. (Archived at PERAL).
Weber, E. 2003. Invasive Plant Species of the World: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK. 548 pp.
West, G. G., and M. G. Dean. 1990. The use of livestock to control weeds in New Zealand forests [Abstract]. FRI Bulletin - New Zealand Ministry of Forestry, Forest Research Institute 155:128-132.
Wotherspoon, S. H., and J. A. Wotherspoon. 2002. The evolution and execution of a plan for invasive weed eradication and control on an island, Rangitoto Island, Hauraki Gulf, New Zealand. Pages 381-388 *in* C. R. Veitch and M. N. Clout, (eds.). Turning the Tide: The Eradication of Invasive Species. IUCN SSC Invasive Species Specialist Group., Gland, Switzerland, and Cambridge, UK.
Young, S. L. 2003. Exploring alternative methods for vegetation control and maintenance along roadsides. Hopland Research and Extension Center; University of California, Hopland, California. 39 pp.

Appendix A. Weed risk assessment for *Cortaderia jubata* (Lemoine ex Carrière) Stapf. (Poaceae). The following information came from the original risk assessment, which is available upon request (full responses and all guidance). We modified the information to fit on the page.

Question ID	**Answer - Uncertainty**	**Score**	**Notes (and references)**
ESTABLISHMENT/SPREAD POTENTIAL			
ES-1 (Status/invasiveness outside its native range)	f - negl	5	*Cortaderia jubata* is native to the South American countries of Argentina, Bolivia, Chile, Ecuador, and Peru (NGRP, 2013; Parsons and Cuthbertson, 2001). It has been introduced to and become naturalized in Australia, New Zealand, and South Africa (NGRP, 2013). It is also present in Ireland and Spain (Bossard et al., 2000; NGRP, 2013). In California, this species was first recorded as having naturalized in 1946, and thereafter rapidly spread throughout coastal habitats (Lambrinos, 2001). This species rapidly spread through New Zealand (Connor, 1965) and is still expanding into new areas there (Gosling et al., 2000). It is also spreading rapidly in South Africa (Robinson, 1984). Alternate answers for the Monte Carlo simulation were both "e."
ES-2 (Is the species highly domesticated)	n - negl	0	This species is cultivated; however, it never entered into commercial production like its congener *C. selloana* (Lambrinos, 2001). We found no evidence of breeding or selection for traits associated with reduced weed potential.
ES-3 (Weedy congeners)	y - negl	1	There are about 25 species in the genus *Cortaderia* (Parsons and Cuthbertson, 2001). Six species, including *C. selloana*, have been classified as weeds to some extent (Randall, 2012), although three of these have recently been moved to the genus *Austroderia* (Linder et al., 2010). *Cortaderia jubata* and *A. richardii* appear to be significant weeds (Randall, 2012) and both are quarantine pests in Australia (Parsons and Cuthbertson, 2001). *Cortaderia selloana* is a significant environmental weed that alters plant communities (Domènech et al., 2006; Parsons and Cuthbertson, 2001). It also interferes with forestry operations and competes with young plantation trees (Gadgil et al., 1992; Knowles, 1991; Richardson et al., 1996).
ES-4 (Shade tolerant at some stage of its life cycle)	n - low	0	*Cortaderia jubata* grows in open areas in California (Bossard et al., 2000). Seed germination rates drop from 26 percent under full light to 8 percent in complete darkness (Drewitz and DiTomaso, 2004). Seedling survival is low in shaded areas (Bossard et al., 2000) and it will not grow in the dense shade created by Redwood trees in California (Kaufman and Kaufman, 2007). One report notes it is tolerant to light shade (Timmins and Mackenzie, 1995), but because we are only interested in deeper shade, we are not considering this as evidence for shade tolerance, particularly in light of the other evidence for shade intolerance.
ES-5 (Climbing or smothering growth form)	n - negl	0	This species is neither a vine nor an herb with a basal rosette. It is a tussock-forming grass growing from 3 to 7 meters high (Bossard et al., 2000; Motooka et al., 2003; Parsons and Cuthbertson, 2001).
ES-6 (Forms dense thickets)	y - negl	2	Forms dense populations in Hawaii (Motooka et al.,

Question ID	Answer - Uncertainty	Score	Notes (and references)
			2003), California (DiTomaso et al., 2008; Drewitz and DiTomaso, 2004), and New Zealand (Gosling et al., 2000). "Adult *C. jubata* individuals formed narrow but often dense infestations along two of the three roadside edges" of a research plot (Lambrinos, 2006).
ES-7 (Aquatic)	n - negl	0	This species is not an aquatic plant; it is a terrestrial tussock-forming grass (Bossard et al., 2000; Motooka et al., 2003; Parsons and Cuthbertson, 2001).
ES-8 (Grass)	y - negl	1	It is in the grass family (NGRP, 2013; NRCS, 2013).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	We found no evidence that this species fixes nitrogen. Furthermore, it does not belong to a plant family known to fix nitrogen (Martin and Dowd, 1990; Santi et al., 2013).
ES-10 (Does it produce viable seeds or spores)	y - negl	1	Reproduces by seed (Connor, 1965; Parsons and Cuthbertson, 2001).
ES-11 (Self-compatible or apomictic)	y - negl	1	All plants are female and produce seeds apomictically while the inflorescence is still in the sheath; the seeds are maturing by the time the inflorescence emerges (Bossard et al., 2000; Parsons and Cuthbertson, 2001). Plants produce seeds through apomixis (Connor, 1965; Drewitz and DiTomaso, 2004; Okada et al., 2009).
ES-12 (Requires special pollinators)	n - negl	0	Plants produce seeds vegetatively through apomixis (Timmins and Mackenzie, 1995); thus, pollinators are not required. This species is agamospermous (Lambrinos, 2001).
ES-13 (Minimum generation time)	b - low	1	This is a perennial grass, reproducing by seeds and rhizome fragments (Parsons and Cuthbertson, 2001), but seeds are asexually produced (Bossard et al., 2000). Seeds germinate in spring, and the seedlings develop rapidly, producing several tillers and rhizomes (Parsons and Cuthbertson, 2001). Most plants flower in their first growing season (Bossard et al., 2000; Parsons and Cuthbertson, 2001; Timmins and Mackenzie, 1995). It can also reproduce vegetatively from fragmented tillers (Bossard et al., 2000). Alternate answers for the Monte Carlo simulation were “a” and “c.” We used low instead of negligible uncertainty, because we don't know if multiple generations of tillers may be produced in a year.
ES-14 (Prolific reproduction)	y - negl	1	One study estimated that total annual seed production ranges between approximately 300,000 and 1,300,000 seeds (average of 924,000) per square meter (Drewitz and DiTomaso, 2004). In a 100 x 100 meter plot, another researcher estimated seed rain densities ranging between 1000 seeds to 4300 seeds per square meter per day, depending on microhabitat type (Lambrinos, 2006); note that these are seed rain estimates and not estimates of seed production per crown area. In some sites, seed rain may deposit up to 3 million seeds per square meter (Lambrinos, 2000). Laboratory-derived estimates of germination on soils from four different habitats ranged between 21 percent and 36 percent (Lambrinos, 2002). Another study estimated germination rates of 19 percent to 33 percent (Drewitz and DiTomaso, 2004). If we

Question ID	Answer - Uncertainty	Score	Notes (and references)
			assumed the lowest fertility and viability rates, this species would still meet the threshold for this question.
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - mod	1	"Spread occurs by wind-blown seed or by humans using mature inflorescences in decorative arrangements" (Bossard et al., 2000). Dried plumes of pampas grass (exact species is unknown) are available for sale on the internet (e.g., Anonymous, 2013a).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	y - high	2	The congener *Cortaderia selloana* was grown commercially for its decorative plumes in the late 1800s in the United States (Lambrinos, 2001). Although *C. jubata* was never grown in the United States commercially, it may be grown for this purpose at low, non-commercial levels. Furthermore, it may be harvested elsewhere in the world for this purpose and introduced into the United States. Dried plumes of pampas grass (exact species is unknown) are available for sale on the internet (e.g., Anonymous, 2013a). The seeds of *C. selloana* cling to kiwi fruit destined for export (Knowles and Tombleson, 1987 cited in ISSG, 2013); the plumose seeds of *C. jubata* may as well (ISSG, 2014).
ES-17 (Number of natural dispersal vectors)	1	-2	Seed and fruit description for ES-17a through ES-17e: Seeds are elliptical at about 0.5 mm by 2-2.5 mm (Parsons and Cuthbertson, 2001).
ES-17a (Wind dispersal)	y - negl		Seeds are readily dispersed by wind (Bossard et al., 2000; Connor, 1973; Drewitz and DiTomaso, 2004; MPI, 2012; Parsons and Cuthbertson, 2001).
ES-17b (Water dispersal)	n - low		We found no evidence. Because this species is well characterized, we used low uncertainty.
ES-17c (Bird dispersal)	n - low		We found no evidence. Because seeds are plumose and clearly adapted for wind-dispersal (Drewitz and DiTomaso, 2004), we used low uncertainty.
ES-17d (Animal external dispersal)	n - low		We found no evidence. Because this species is well characterized, we used low uncertainty.
ES-17e (Animal internal dispersal)	n - low		We found no evidence. Because we found no evidence of traits typically associated with frugivory (e.g., fleshy fruit), we used low uncertainty.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	n - negl	-1	A seed burial experiment demonstrated that all seeds lost viability after four months (Drewitz and DiTomaso, 2004). This result coupled with a lack of primary dormancy indicates seeds are unlikely to persist for more than a year under natural conditions (Drewitz and DiTomaso, 2004). Unlikely to form a long-term seed bank (Timmins and Mackenzie, 1995).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	y - negl	1	Plants are relatively resilient to fire because the large tussocks effectively insulate plant meristems (Lambrinos, 2000). Resprouts after fire (Drewitz and DiTomaso, 2004; Timmins and Mackenzie, 1995), presumably from the short underground rhizomes it produces (Parsons and Cuthbertson, 2001). If cut with their stalks, young inflorescences can mature some seed due to residual energy in the stalk (Madison, 1994).
ES-20 (Is resistant to some herbicides or has the potential to	n - negl	0	We found no evidence it is resistant to herbicides (e.g., Bossard et al., 2000; DiTomaso et al., 2008; Motooka et

Question ID	**Answer - Uncertainty**	**Score**	**Notes (and references)**
become resistant)			al., 2003). "Various herbicides can be used to treat pampas infestations successfully" (Gosling et al., 2000). Furthermore, it is not listed by Heap (2013).
ES-21 (Number of cold hardiness zones suitable for its survival)	7	0	
ES-22 (Number of climate types suitable for its survival)	6	2	
ES-23 (Number of precipitation bands suitable for its survival)	11	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - low	0	We found no evidence. Because this species is well known, we used low uncertainty.
Imp-G2 (Parasitic)	n - negl	0	We found no positive evidence this species is parasitic. Because it is not a member of one of the plant families known to contain parasitic species (Heide-Jorgensen, 2008; Nickrent, 2009), we used negligible uncertainty.
Impacts to Natural Systems			
Imp-N1 (Change ecosystem processes and parameters that affect other species)	? - max		Some species accounts state that *C. jubata* is a fire hazard due to buildup of dry fuel (Bossard et al., 2000; MPI, 2012). This is not surprising given that invasive exotic grasses generally alter fire regimes in natural communities, as well as change rates of nutrient supply (D'Antonio and Vitousek, 1992). However, we found no direct evidence in the primary literature supporting these claims that *C. jubata* changes ecosystem processes. Furthermore, one report states that leaves of this species have high levels of silica, which helps it retard fire to some extent (Madison, 1994). Consequently, we answered unknown.
Imp-N2 (Change community structure)	y - negl	0.2	In California and Oregon where it has invaded, it sometimes transforms bushland habitats into grasslands, which affects populations of vertebrates and invertebrates (Kaufman and Kaufman, 2007). In some California chaparral habitats, it is reported to have a mean cover of 27 percent (Underwood et al., 2003). In one California study aerial photographs indicated that the invaded plots had previously been shrubland. Invasion by *C. jubata* "created a structurally less complex perennial grassland that was markedly depauperate in native shrub species" (Lambrinos, 2000). Within a maritime chaparral research plot over nine years, the cover of *C. jubata* increased from 3 to 16 percent, while that of shrubs decreased from 80 to 62 percent (Lambrinos, 2006). It "prevents forest re-establishment in forests that have been burned or clear cut" (Weber, 2003). In New Zealand it changes the structure of communities with high conservation value (Gosling et al., 2000).
Imp-N3 (Change community composition)	y - negl	0.2	Replaces native plant communities (Bossard et al., 2000; Parsons and Cuthbertson, 2001). "Forms dense monotypic stands in mesic to humid areas with the potential to replace or compete with native species" (Motooka et al., 2003). "It becomes dense and can suppress the growth of

Question ID	Answer - Uncertainty	Score	Notes (and references)
			other species. Replaces ground cover, shrubs, and ferns" (MPI, 2012). Populations "interfere with conifer seedling recruitment, and occupy space otherwise inhabited by native plant species" (Drewitz and DiTomaso, 2004). One study in a California site showed that its invasion decreased the species richness of native shrubs, but increased richness of both native and alien herbaceous species (Lambrinos, 2000).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	y - low	0.1	In central California, large infestations of *C. jubata* have invaded relatively undisturbed stands of maritime chaparral, displacing a suite of regionally and locally endemic shrub species (Lambrinos, 2000). In conjunction with habitat loss and fragmentation, *C. jubata* is likely to affect Threatened and Endangered species in California.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions)	y - low	0.1	*Cortaderia jubata* threatens sensitive coastal ecosystems in California (Bossard et al., 2000), including some of the state's most diverse and unique shrub communities (Lambrinos, 2000). Based on the impacts described under Imp-N2 and Imp-N3, we believe this species is affecting globally outstanding ecoregions in California (Ricketts et al., 1999).
Imp-N6 (Weed status in natural systems)	c - negl	0.6	Considered a serious plant pest of natural communities in New Zealand (Gosling et al., 2000) and elsewhere (Weber, 2003). Colonizes burnt-over forests and scrublands (Parsons and Cuthbertson, 2001). Weed of logged redwood forests in California (Bossard et al., 2000) and conservation areas in Hawaii (Motooka et al., 2003). Several control strategies are described in Bossard et al. (2000), but it is not clear in which systems they have been used. Control is sought for Hawaiian forests (Motooka et al., 2003). Targeted for containment on the island of Maui in Hawaii (Penniman et al., 2011). Prioritized for sustained control on Rangitoto Island, New Zealand (Wotherspoon and Wotherspoon, 2002). A detailed analysis of the efficacy and cost of various control strategies is reported by DiTomaso et al. (2008) for California sites. Gosling et al. (2000) reviewed control strategies for this species and *C. selloana* in natural areas. Alternate answers for the Monte Carlo simulation were both "b."
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Impacts human property, processes, civilization, or safety)	n - mod	0	We found no evidence.
Imp-A2 (Changes or limits recreational use of an area)	y - negl	0.1	It reduces the aesthetic and recreational value of natural areas (Bossard et al., 2000). Impedes access (MPI, 2012). Blocks access and fire management activities by blocking vehicles (ODA, 2013).
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	n - mod	0	Although two of the three posts on this species in a popular gardening forum were negative, the comments were really about this species' impacts in natural systems (Dave's Garden, 2013). We did not find any evidence of this particular impact in anthropogenic areas.
Imp-A4 (Weed status in	c - negl	0.4	Colonizes roadsides, graded areas, quarry sites, and other

Question ID	Answer - Uncertainty	Score	Notes (and references)
anthropogenic systems)			disturbed areas (Connor, 1965; DiTomaso et al., 2008; Parsons and Cuthbertson, 2001). In a study sponsored by the California Department of Transportation for alternative methods for controlling roadside vegetation, *C. jubata* was one of two weed species specifically targeted for study (Young, 2003). In California, a public group comprised of individuals from different organizations organized to control *C. jubata* on private and public lands; the California Department of Transportation controlled the plants growing on roadways in the managed region (Madison, 1993, 1994). Alternate answers for the Monte Carlo simulation were both "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	y - mod	0.4	In cut-over coastal redwood forests in northern California, it suppresses establishment of seedling conifers (Bossard et al., 2000). In forestry operations, it is very competitive and can retard the establishment and growth of seedling trees (ODA, 2013).
Imp-P2 (Lowers commodity value)	y - low	0.2	Control of *Cortaderia* spp. weeds, including *C. jubata*, in New Zealand forest plantations with herbicides is costly and only provides a temporary solution (Knowles, 1991). In the past, *C. jubata* was planted in commercial forests in California to keep deer away from young forest trees, but later it became a significant weed (Madison, 1993). For those California forests, "[i]n the 1960s, Georgia Pacific had to abandon 1100 acres in Humboldt County to jubatagrass as there was, as then, no economical way to control it. At that time 7000 additional acres were severely infested" (Madison, 1993).
Imp-P3 (Is it likely to impact trade)	y - high	0.2	In Australia, *Cortaderia jubata* is a regulated quarantine pest and prohibited entry (Parsons and Cuthbertson, 2001). This species is listed in New Zealand's National Pest Plant Accord and accordingly is banned from sale, propagation, and distribution in the country (MPI, 2012). Regulated weed in South Africa where it must be controlled or eradicated where possible (Henderson, 2001). However, we found no specific evidence this species has affected trade. Under ES-16, we answered yes (with high uncertainty) that it is likely to be a contaminant in trade because plumes of *Cortaderia* species are available online as floral arrangements (e.g., Anonymous, 2013a). We also note that "the great quantity of fluffy seed [of *C. selloana*] has caused problems for kiwifruit growers since it clings to the fruit and causes it to be rejected for export" (Knowles and Tombleson, 1987 cited in ISSG, 2013). Based on this congeneric information, we answered yes, but with high uncertainty for *C. jubata*.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - mod	0	We found no evidence.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - low	0	We found no evidence that it is toxic to animals (e.g., Burrows and Tyrl, 2001).
Imp-P6 (Weed status in production	c - negl	0.6	This species is a significant weed problem in forestry

Question ID	Answer - Uncertainty	Score	Notes (and references)
systems)			operations in other countries (cited in Bossard et al., 2000) and a weed in U.S. forestry (ODA, 2013). Cattle and herbicides are used to control *C. jubata* and *C. selloana* in New Zealand forest plantations (Bossard et al., 2000; Knowles, 1991; West and Dean, 1990). Alternate answers for the Monte Carlo simulation were both "b."
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically-referenced points obtained from the Global Biodiversity Information Facility (GBIF, 2013).
Plant cold hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence that it occurs in this zone.
Geo-Z2 (Zone 2)	n - negl	N/A	We found no evidence that it occurs in this zone.
Geo-Z3 (Zone 3)	n - negl	N/A	We found no evidence that it occurs in this zone.
Geo-Z4 (Zone 4)	n - negl	N/A	We found no evidence that it occurs in this zone.
Geo-Z5 (Zone 5)	n - high	N/A	Dave's Garden forum indicates that it can survive in zones 5 to 9 (Dave's Garden, 2013). But another source states that "several consecutive nights of frost will generally not kill the plant, but can severely damage it" (ISSG, 2013). Given that we found no other evidence that it occurs in this zone, we answered no with high uncertainty.
Geo-Z6 (Zone 6)	n - high	N/A	We found no evidence it occurs in this zone. Also see reasoning under Geo-Z5.
Geo-Z7 (Zone 7)	y - low	N/A	Argentina.
Geo-Z8 (Zone 8)	y - negl	N/A	Bolivia and Peru.
Geo-Z9 (Zone 9)	y - negl	N/A	Argentina, Australia, Lesotho, Peru, South Africa, and the United States.
Geo-Z10 (Zone 10)	y - negl	N/A	Australia, Ecuador, New Zealand, Peru, and the United States. Seedlings are vulnerable to frost, but not adults (Timmins and Mackenzie, 1995).
Geo-Z11 (Zone 11)	y - negl	N/A	New Zealand, Peru, and the United States.
Geo-Z12 (Zone 12)	y - low	N/A	Ecuador. Reported to occur in east and west Maui (Hawaii), United States (Strohecker, 2011).
Geo-Z13 (Zone 13)	y - high	N/A	Reported to occur in east and west Maui (Hawaii), United States (Strohecker, 2011).
Köppen -Geiger climate classes			
Geo-C1 (Tropical rainforest)	y - low	N/A	A few points in Ecuador and Peru. One point for Hawaii (GBIF, 2013), and regional occurrence for Maui (Strohecker, 2011).
Geo-C2 (Tropical savanna)	y - negl	N/A	Ecuador, Peru, and the United States (GBIF, 2013; Strohecker, 2011).
Geo-C3 (Steppe)	y - low	N/A	Argentina, Bolivia, and the United States.
Geo-C4 (Desert)	n - negl	N/A	We found no evidence it occurs in this climate class.
Geo-C5 (Mediterranean)	y - negl	N/A	Australia and the United States.
Geo-C6 (Humid subtropical)	y - negl	N/A	Argentina and Australia. South Africa (Guateng region; Anonymous, 2013c).
Geo-C7 (Marine west coast)	y - negl	N/A	Argentina, Australia, New Zealand, and Peru.
Geo-C8 (Humid cont. warm sum.)	n - mod	N/A	We found no evidence that it occurs in this climate class.
Geo-C9 (Humid cont. cool sum.)	n - negl	N/A	We found no evidence that it occurs in this climate class.
Geo-C10 (Subarctic)	n - negl	N/A	We found no evidence that it occurs in this climate class.
Geo-C11 (Tundra)	n - negl	N/A	We found no evidence that it occurs in this climate class.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence that it occurs in this class.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	y - high	N/A	Ecuador, one point in Argentina, one point on edge in the United States.
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	Argentina, Bolivia, Ecuador, Lesotho, Peru, South Africa, and the United States.
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	Australia, New Zealand, Peru, and the United States.
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	Argentina, Australia, Bolivia, and the United States.
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	Australia, Bolivia, and New Zealand.
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	New Zealand.
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	Bolivia, Ecuador, New Zealand, Peru, and the United States.
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	Ecuador.
Geo-R9 (80-90 inches; 203-229 cm)	y - negl	N/A	Ecuador and Peru.
Geo-R10 (90-100 inches; 229-254 cm)	y - negl	N/A	Ecuador and Peru.
Geo-R11 (100+ inches; 254+ cm))	y - negl	N/A	Ecuador.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	This species is cultivated and naturalized in the United States (Jepson Flora Project, 2013; Lambrinos, 2001).
Ent-2 (Plant proposed for entry, or entry is imminent)	-	N/A	
Ent-3 (Human value & cultivation/trade status)	-	N/A	Introduced as an ornamental to Tasmania (Parsons and Cuthbertson, 2001). Seeds are available for sale on Amazon (Anonymous, 2013b).
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	-	N/A	
Ent-4b (Contaminant of plant propagative material (except seeds))	-	N/A	
Ent-4c (Contaminant of seeds for planting)	-	N/A	
Ent-4d (Contaminant of ballast water)	-	N/A	
Ent-4e (Contaminant of aquarium plants or other aquarium products)	-	N/A	
Ent-4f (Contaminant of landscape products)	-	N/A	
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	-	N/A	
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	-	N/A	
Ent-4i (Contaminant of some other pathway)	-	N/A	
Ent-5 (Likely to enter through natural dispersal)	-	N/A	