United States Department of Agriculture

Weed Risk Assessment for *Luziola subintegra* Swallen. (Poaceae) – Tropical American watergrass

United States Department of Agriculture

Animal and Plant Health Inspection Service

March 4, 2014

Version 2

Top left: *Luziola subintegra* infestation in Lake Okeechobee, Florida. Top right: A sward crowding out *Eichhornia crassipes*. Bottom right: Prostrate immature form. Bottom left: Herbicide application in Lake Okeechobee (source: Bodle, 2012).

Agency Contact:
Plant Epidemiology and Risk Analysis Laboratory
Center for Plant Health Science and Technology

Plant Protection and Quarantine
Animal and Plant Health Inspection Service
United States Department of Agriculture
1730 Varsity Drive, Suite 300
Raleigh, NC 27606

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.

Luziola subintegra Swallen. – Tropical American watergrass

Species Information

Family: Poaceae

Synonyms: None (NGRP, 2014).

Common names: Tropical American watergrass (Wunderlin and Hansen, 2014).

Botanical description: *Luziola subintegra* is a floating or emergent perennial, aquatic grass with decumbent culms to about one meter in length. Leaf sheaths are somewhat spongy and help it float in aquatic environments, although it can occur in savannas as well (Martínez-y-Pérez et al., 2008).

Initiation: Michael Bodle, South Florida Water Management District, notified the Plant Epidemiology and Risk Analysis Laboratory (PERAL) that *L. subintegra*, not previously known to occur in the United States, was recently detected in the United States (Bodle, 2009). Here we updated the format of the original 2011 WRA and revised it to include additional scientific information.

Foreign distribution: *Luziola subintegra* is native to the Americas, from Mexico southward through Central America and into South America as far south as Brazil, Bolivia, and Argentina (Martínez-y-Pérez et al., 2008; Nicora, 1993). It is also indigenous to several countries throughout the Caribbean (Martínez-y-Pérez et al., 2008).

U.S. distribution and status: This species occurs in three sites in south Florida. The principal population is in Fisheating Bay, Lake Okeechobee, in southern Florida (Kunzer and Bodle, 2008). There, it occurs in two monospecific populations occupying areas of 2 and 80 hectares. It also occurs at one site on the Caloosahatchee River (downriver from Lake Okeechobee) and one site in Miami-Dade County (Bodle, 2009). Populations at all three sites are being controlled and monitored by the South Florida Water Management District, which has already spent approximately $631,000 in control costs since the species' discovery in Lake Okeechobee (SFWMD, 2014). The Florida Exotic

Pest Plant Council placed this species in Category 1 of their list of invasive species (FLEPPC, 2013). Category 1 corresponds to "[i]nvasive exotics that are altering native plant communities by displacing native species, changing community structures or ecological functions, or hybridizing with natives."

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

1. *Luziola subintegra* analysis

Establishment/Spread Potential *Luziola subintegra* is a floating and emergent aquatic plant that is native to Mexico, and Central and South America (Kunzer and Bodle, 2008; Leon and Young, 1996). The U.S. population is the first one known outside of its native range (Kunzer and Bodle, 2008; Martínez-y-Pérez et al., 2008). This species has demonstrated its invasive ability by establishing a breeding population in a relatively remote area of Florida, and by rapidly expanding its population over a few years (Bodle, 2009, 2012). *Luziola subintegra* reproduces through vegetative fragmentation and by seed (Cayon and Aristizabal, 1990). It is very likely wind pollinated (Faegri and Van der Pijl, 1979; Martínez-y-Pérez et al., 2008; Zomlefer, 1994), which implies it does not depend on specialist pollinators. Seeds are spread by water (Bodle, 2009; Martínez-y-Pérez et al., 2008; Piepenbring and Stein, 2000) and unintentionally by people planting rice or moving contaminated equipment (Bodle, 2009; Tascon and Fischer, 1997). Seeds can remain viable for 2.5 years under flooded conditions, with some likely persisting for up to 6.5 years (Hutchinson and Langeland, 2012). Because this species is stoloniferous and roots from nodes (Kunzer and Bodle, 2008), it is likely to respond well to mutilation by regrowing from cut fragments. We had an above average level of uncertainty for this risk element.

Risk score = 14 Uncertainty index = 0.24

Impact Potential Despite the limited amount of information for this species, the score for *L. subintegra* was relatively high because it can affect production, environmental and anthropogenic systems. In its native range, it is a weed of rice and dominates paddies (Fischer, 1997), impedes the flow of water (Fischer, 1997), and helps reduce yields (Marnotte and Téoulet, 2004). In the United States, *L. subintegra* creates dense mats on the water surface that change habitat structure and crowd out native species (Bodle, 2009; Kunzer and Bodle, 2008). The thick mat of vegetation, it creates restricts recreational access to areas (Bodle, 2009). The South Florida Water Management District is controlling this species in Lake Okeechobee (Bodle, 2009, 2012; Ferriter et al., 2009). We had a very high level of uncertainty for this risk element.

Risk score = 3.7 Uncertainty index = 0.31

Geographic Potential Based on three climatic variables, we estimate that about 9 percent of the United States is suitable for the establishment of *L. subintegra* (Fig. 1). This predicted distribution is based on its known distribution elsewhere in the world and includes point-referenced localities and areas of occurrence. The map for *L. subintegra* represents the joint distribution of Plant Hardiness Zones 9-13, areas with 10-100+ inches of annual precipitation, and the following Köppen-Geiger climate classes: tropical rainforest, tropical savanna, humid subtropical, and steppe. Although we

[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)].

found no direct evidence that *L. subintegra* occurs in Plant Hardiness Zone 9, we assumed that this zone is likely suitable (with high uncertainty) because submersion may insulate aquatic plants from extreme minimum temperatures.

The area estimated in Fig. 1 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. *Luziola subintegra* is a tropical/subtropical species (Kunzer and Bodle, 2008) that is likely to be limited by cold temperatures and restricted to aquatic and riparian habitats. In its native range, it occurs in savannas, ponds, rice plantations, and irrigation canals (Martínez-y-Pérez et al., 2008). We found no evidence that this species occurs in Mediterranean or marine west coast climates but we suspect that because it is an aquatic it could survive in these two climate class types in Zones 9 or higher. This would include portions of the western coastal region of the United States that are shown in red in Fig. 1.

Entry Potential We did not assess the entry potential of *L. subintegra*, because it is already present in the United States (Kunzer and Bodle, 2008; Wunderlin and Hansen, 2014).

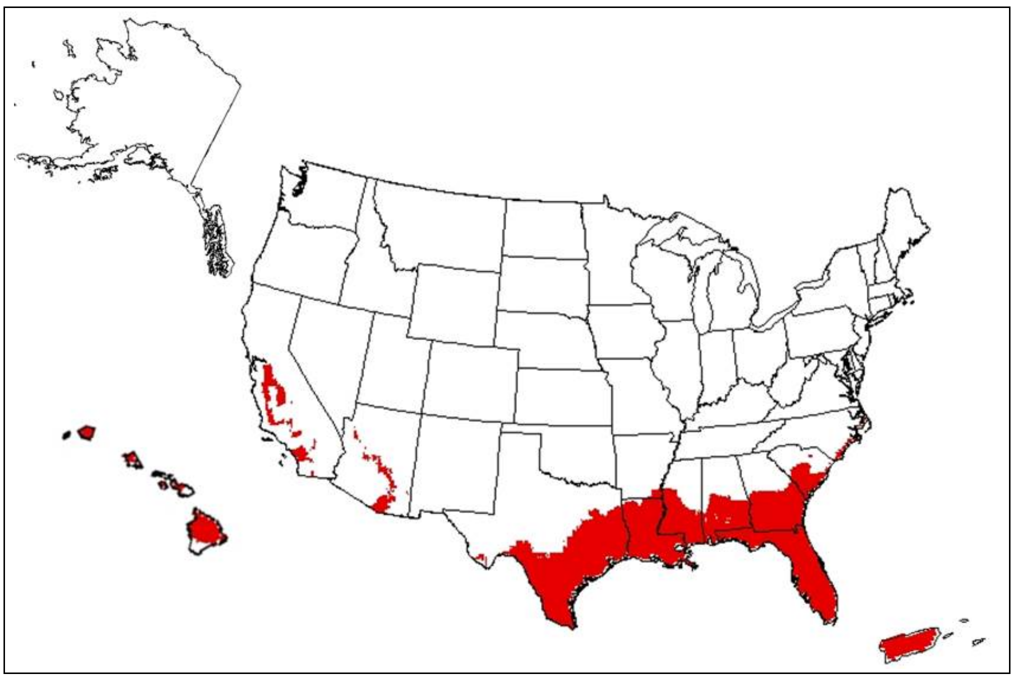

Figure 1. Predicted distribution of *L. subintegra* in the United States. Map insets for Alaska, Hawaii, and Puerto Rico are not to scale.

2. Results and Conclusion

Model Probabilities: P(Major Invader) = 80.1%
P(Minor Invader) = 19.2%
P(Non-Invader) = 0.7%

Risk Result = High Risk
Secondary Screening = Not Applicable

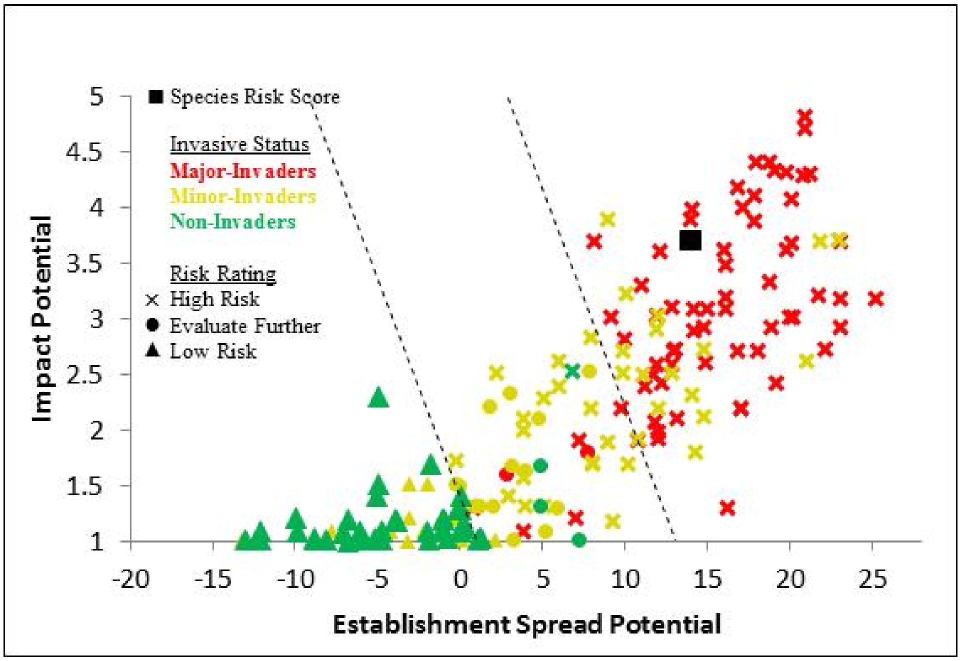

Figure 2. *Luziola subintegra* risk score (black box) relative to the risk scores of species used to develop and validate the PPQ WRA model (other symbols). See Appendix A for the complete assessment.

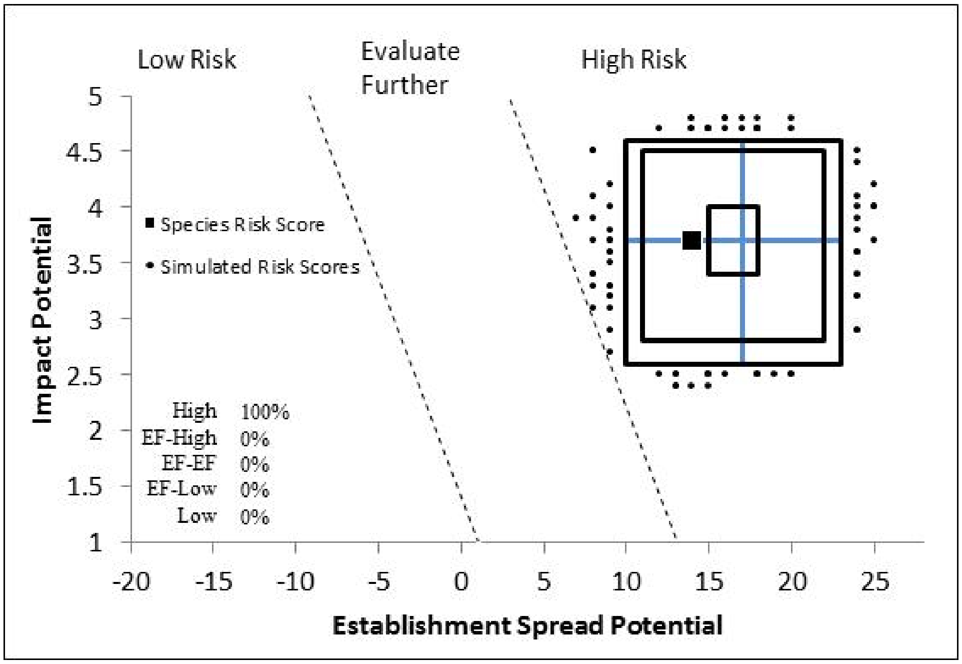

Figure 3. Model simulation results (N=5,000) for uncertainty around the risk score for *Luziola subintegra*. The blue "+" symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

3. Discussion

The result of the weed risk assessment for *L. subintegra* is High Risk (Fig. 2). Despite the relatively high level of uncertainty associated with the assessment, the uncertainty simulation corroborated that rating (Fig. 3). *Luziola subintegra* has already demonstrated its invasive potential in southern Florida, where over a period of a few years it spread across 3,000 acres of a lake shore (Bodle, 2009). Of particular concern is that it harms natural, agricultural, and anthropogenic systems. We believe that this risk assessment describes its current impacts on natural and agricultural systems adequately. This species is associated with irrigation canals in Costa Rica (Rojas and Agüero, 1996). *Luziola subintegra* may pose a significant risk to the water management system in South Florida, because it is well suited to a variety of aquatic habitats including lakes, ponds, savannas and rice fields (Martínez-y-Pérez et al., 2008). Because southern Florida has an extensive network of canals, this species is very likely to spread into the state's canal system, which delivers drinking water to municipalities and regulates storm water surge.

4. Literature Cited

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.

Antigua, G. 1993. Integrated weed management of rice in Cuba. Pages 129-135 *in*

J. L. Armenta Soto, ed. Proceedings of a monitoring tour and workshop on integrated pest management of rice in the Caribbean, held in Guyana and Trinidad & Tobago, October 7-11, 1991. Centro Internacional de Agricultura Tropical (CIAT), Cali; Colombia.

Anzalone, A., M. Balaguer, and I. Dorante. 1998. Malezas de importancia económica en el cultivo de arroz inundado en el estado Portuguesa [Abstract].Jornadas de Investigación del Decanato de Agronomía de la Universidad Centroccidental Lisandro Alvarado, Barquisimeto, Venezuela.

APHIS. 2014. Phytosanitary Certificate Issuance & Tracking System (PCIT). United States Department of Agriculture, Animal and Plant Health Inspection Service (APHIS). https://pcit.aphis.usda.gov/pcit/faces/index.jsp. (Archived at PERAL).

Bodle, M. J. 2009. *Luziola subintegra*. Personal communication to A. L. Koop on December 16, 2009, from Michael Bodle, South Florida Water Management District.

Bodle, M. J. 2012. Incoming! New plants find their ways into Florida. South Florida Water Management District, West Palm Beach, FL. 33 pp.

Castrillo, W. A., M. Acevedo, G. Torrealba, D. Medina, and W. Martinez. 2005. Malezas en zonas arroceras de Venezuela. INIA Divulga 5:1-3.

Cayon, S. G., and D. Aristizabal. 1990. *Luziola subintegra* Sw. and its control. / Paja blanca (*Luziola subintegra* Sw.) y su control [Abstract]. Arroz 39(366):31-36.

Faegri, K., and L. Van der Pijl. 1979. The Principles of Pollination Ecology. Pergamon Press, Oxford. 244 pp.

Ferriter, A., D. Thayer, M. Bodle, and B. Doren. 2009. Chapter 9: The status of nonindigenous species in the South Florida environment. Pages 9.1-9.37 *in* Anonymous, (ed.). South Florida Environmental Report. South Florida Water Management District, West Palm Beach, FL.

Fischer, A. 1997. Manejo integrado de malezas del arroz. Pages 31-50 *in* A. Pantoja, A. Fischer, F. Correa-Victoria, L. R. Sanint, and A. Ramirez, (eds.). Manejo Integrado de Plagas en Arroz, Centro Internacional de Agricultura Tropical.

FLEPPC. 2013. Florida Exotic Pest Plant Council's 2013 list of invasive plant species. Florida Exotic Pest Plant Council (FLEPPC), U.S.A. 2 pp.

GBIF. 2009. GBIF, Online Database. Global Biodiversity Information Facility (GBIF). http://data.gbif.org/welcome.htm. (Archived at PERAL).

Heap, I. 2014. The international survey of herbicide resistant weeds. Weed Science Society of America. www.weedscience.com. (Archived at PERAL).

Holm, L. G., J. V. Pancho, J. P. Herberger, and D. L. Plucknett. 1979. A Geographical Atlas of World Weeds. Krieger Publishing Company, Malabar, FL. 391 pp.

Hutchinson, J., and K. Langeland. 2012. Seed bank regeneration in Tropical American watergrass (*Luziola subintegra*). Center for Aquatic and Invasive Plants, Institute of Food and Agricultural Services, University of Florida Gainesville, Fl. 13 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.

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.
Kunzer, J. M., and M. J. Bodle. 2008. *Luziola subintegra* (Poaceae: Oryzea), new to Florida and the United States. Journal of the Botanical Research Institute of Texas 2(1):633-636.
Leon, B., and K. R. Young. 1996. Aquatic plants of Peru: Diversity, distribution and conservation. Biodiversity and Conservation 5:1169-1190.
Marnotte, P., and L. Téoulet. 2004. Nuisibilité de l'enherbement sur le polder rizicole de Mana en Guyane [Weed competition on the Mana Rice-Growing polder, French Guiana] [Abstract]. Pages 8-10 *in* Dix-neuvième conférence du COLUMA. Journées internationales sur la lutte contre les mauvaises herbes, Dijon, France.
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.
Martínez-y-Pérez, J. L., T. Mejía-Saulés, and V. Sosa. 2008. A taxonomic revision of *Luziola* (Poaceae: Oryzeae). Systematic Botany 33(4):702-718.
Martinez-y-Perez, J. L., V. Sosa, and T. Mejia-Saules. 2006. Species delimitation in the *Luziola peruviana* (Poaceae) complex. Brittonia 58(4):362-375.
NGRP. 2014. 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.
Nicora, E. G. 1993. Notes on South American grasses [Abstract]. Hickenia (Boletin del Darwinion) 2(17-23):85-92.
Piepenbring, M., and P. Stein. 2000. Morphology and ecology of fruit release of *Luziola subintegra* (Poaceae). Beitraege zur Biologie der Pflanzen 72(2):253-264.
Poonai, P. 1960. Weed control in rice fields [Abstract]. Fmrs' Leafl. Brit. Guiana Dep. Agric. 12(3):5.
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.
Rojas, M., and R. Agüero. 1996. Malezas asociadas a canales de riego y terrenos colindantes de arroz anegado en Finca El Cerrito, Guanacaste, Costa Rica. Agronomia Mesoamericana 7(1):9-19.
Santos, S. A., C. Costa, G. da Silva e Souza, A. Pott, J. M. Alvarez, and S. R. Machado. 2002. Composição botânica da dieta de bovinos em pastagem nativa na sub-região da Nhecolândia, Pantanal [Botanical composition of cattle diet on rangelands in the Pantanal wetland, Brazil]. Revista Brasileira de Zootecnia 31(4):1648-1662.
SFWMD. 2014. Plant treated report for *Luziola subintegra* for the period: 01 Jul 2006 to 30 Jan 2014. South Florida Water Management District (SFWMD), West Palm Beach, FL. 1 pp.
Tascon, E., and A. Fischer. 1997. Malezas especificas y guia de manejo. Pages 99-116 *in* A. Pantoja, A. Fischer, F. Correa-Victoria, L. R. Sanint, and A. Ramirez, (eds.). Manejo Integrado de Plagas en Arroz, Centro Internacional de Agricultura Tropical.

Weakley, A. S. 2008. Flora of the Carolinas, Virginia, Georgia, northern Florida, and Surrounding Areas (working draft). University of North Carolina Herbarium, Chapel Hill, NC, U.S.A. 924 pp.

Wunderlin, R. P., and P. F. Hansen. 2009. Atlas of Florida Vascular Plants. University of South Florida, Department of Biology, Institute for Systematic Botany. http://florida.plantatlas.usf.edu/Default.aspx. (Archived at PERAL).

Wunderlin, R. P., and P. F. Hansen. 2014. Atlas of Florida Vascular Plants. University of South Florida, Department of Biology, Institute for Systematic Botany. http://florida.plantatlas.usf.edu/Default.aspx. (Archived at PERAL).

Zomlefer, W. B. 1994. Guide to Flowering Plant Families. The University of North Carolina Press, Chapel Hill, NC, U.S.A. 430 pp.

Appendix A. Weed risk assessment for *Luziola subintegra* Swallen (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 - low	5	The U.S. population of *Luziola subintegra* is the first population known from outside its native range (Martínez-y-Pérez et al., 2008). This species established a breeding population in a relatively remote area of Florida, and rapidly expanded its population over a two-year period (Bodle, 2009). A second population was later discovered further south near Everglades National Park (Bodle, 2009; Wunderlin and Hansen, 2014). Alternate answers for the Monte Carlo simulation were both "e."
ES-2 (Is the species highly domesticated)	n - low	0	We found no evidence that it has been domesticated or bred for any purpose.
ES-3 (Weedy congeners)	y - negl	1	*Luziola spruceana* is a principal weed in Surinam (Holm et al., 1979). It is a significant weed of rice in British Guiana (Poonai, 1960) and Cuba (Antigua, 1993). *Luziola pittieri* (a synonym of *L. peruviana*) is considered a significant weed of rice in Venezuela, possibly because it is very tolerant of herbicides (Castrillo et al., 2005).
ES-4 (Shade tolerant at some stage of its life cycle)	n - mod	0	We found no evidence. It is unlikely to be shade tolerant as it grows in open, sunny habitats, such as wetlands and lake borders (Kunzer and Bodle, 2008; Martínez-y-Pérez et al., 2008).
ES-5 (Climbing or smothering growth form)	n - low	0	*Luziola subintegra* is neither a vine nor a rosette plant. It is a floating or emergent plant of small ponds and rivers (Martínez-y-Pérez et al., 2008; Martinez-y-Perez et al., 2006).
ES-6 (Forms dense thickets)	y - low	2	In Lake Okeechobee, it forms dense mats that are impenetrable, except by airboat (Bodle, 2009, 2012).
ES-7 (Aquatic)	y - negl	1	Stoloniferous perennial, emergent, floating, mat-forming aquatic or prostrate-creeping terrestrial (Kunzer and Bodle, 2008). Three other *Luziola* species that occur in the southeastern United States are either aquatics or grow in wet places (Weakley, 2008). *Luziola subintegra* can float in small ponds due to spongy leaf sheaths (Martínez-y-Pérez et al., 2008). An obligate aquatic plant in Peru growing in Amazonian River floodplains (Leon and Young, 1996).
ES-8 (Grass)	y - negl	1	This taxon is a grass (Wunderlin and Hansen, 2014).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	This taxon is not a woody plant. Additionally, we found no evidence that this species fixes nitrogen. This species is not a member of a plant family known to contain nitrogen-fixing species (Martin and Dowd, 1990).
ES-10 (Does it produce viable seeds or spores)	y - negl	1	Reproduces by seed (Cayon and Aristizabal, 1990). Seeds can germinate right away, but they can also remain viable, if kept moist, for at least 10 months (seed study still ongoing) (Bodle, 2009).
ES-11 (Self-compatible or apomictic)	? - max	0	Unknown.
ES-12 (Requires special pollinators)	n - negl	0	Grasses are generally wind-pollinated (Faegri and Van der Pijl, 1979; Zomlefer, 1994). In *L. subintegra*, the staminate inflorescence is positioned above the feminine inflorescence

Question ID	Answer - Uncertainty	Score	Notes (and references)
			(Martínez-y-Pérez et al., 2008) (as in corn), which is consistent with wind pollination.
ES-13 (Minimum generation time)	b - high	1	Unknown; however, as a stoloniferous, herbaceous species with a population that rapidly expanded in Florida, it is highly unlikely to be four or more years. Because it reproduces vegetatively and is herbaceous, we expect the minimum generation time is likely one year. Consequently, we answered "b" with high uncertainty. Alternate answers for the Monte Carlo simulation were "c" and "a."
ES-14 (Prolific reproduction)	n - low	-1	Plants produce about 20-30 seeds per panicle, with a maximum of about 100-200 seeds per square meter (in the United States; Bodle, 2009).
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - low	1	*Luziola subintegra* plants are easily confused and transplanted with rice plants (Tascon and Fischer, 1997). A secondary colony of *L. subintegra* was found in a disturbed area of Miami-Dade County. Mike Bodle believes that it was likely transported there as a contaminant on contractor equipment; this contractor works in both areas where the plant is established (Bodle, 2009).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	?-max	-1	Unknown. Because plants are easily confused and transplanted with rice plants (Tascon and Fischer, 1997), they may follow as contaminants in rice seedlings or seed lots.
ES-17 (Number of natural dispersal vectors)	1	-2	Fruit and seed description for ES-17a through ES-17e: "Caryopses (achenes) with a hard, brittle pericarp, minutely longitudinally striate, asymmetrically ovoid, to 2 mm long, with a persistent style base" (Kunzer and Bodle, 2008).
ES-17a (Wind dispersal)	n - low		We found no evidence of wind dispersal. Given that the species has adaptations to draw the female panicles into the water (Piepenbring and Stein, 2000), it seems unlikely seeds are wind dispersed.
ES-17b (Water dispersal)	y - negl		The species has adaptations to draw the female panicles into the water; many aquatic plants do this (Piepenbring and Stein, 2000). Although this paper does not explicitly state that seeds are water dispersed, this is a reasonable explanation for this behavior. Furthermore, *L. subintegra* forms floating mats in small ponds and lakes (Bodle, 2009; Martínez-y-Pérez et al., 2008), which may likely break away and colonize new areas. This species colonized a section of the Caloosahatchee River when the Army Corp of Engineers opened water gates that drain Lake Okeechobee (Bodle, 2009).
ES-17c (Bird dispersal)	? - max		We found no evidence, but answered unknown because seeds may be consumed by waterfowl or stick to their feathers.
ES-17d (Animal external dispersal)	? - max		We found no evidence, but answered unknown because seeds may stick to animal fur.
ES-17e (Animal internal dispersal)	n - mod		We found no evidence.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	y - negl	1	Results from an experimental study showed that seeds remained viable after 2.5 years under flooded conditions with a germination rate of 69 percent (Hutchinson and Langeland, 2012). Based on reductions in seed viability over this time, the study concluded that seed may remain viable in flooded conditions for 6.5 years (Hutchinson and Langeland, 2012). "Seed viability was reduced by 51% for dry, ambient stored

Question ID	Answer - Uncertainty	Score	Notes (and references)
			seeds compared to seeds under flooded conditions for seeds 30.0 months. This indicates that it may take approximately 2 years to exhaust the seed bank of this species under dry conditions provided no new seedlings are allowed to reach maturity and produce seeds" (Hutchinson and Langeland, 2012).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	? - max	0	Unknown. Because this species is stoloniferous and roots from nodes (Kunzer and Bodle, 2008), it is likely to respond well to mutilation by regrowing from cut fragments.
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - mod	0	We found no evidence of herbicide resistance. This species is not listed by Heap (2014). Herbicide treatments are fairly effective, except in some cases it does not appear to translocate down the rhizome all the way (Bodle, 2009). However, Mike Bodle with the South Florida Water Management district is concerned plants may develop herbicide resistance because they have been using the same herbicide to control this plant over the last few years (Bodle, 2009).
ES-21 (Number of cold hardiness zones suitable for its survival)	4	0	
ES-22 (Number of climate types suitable for its survival)	4	2	
ES-23 (Number of precipitation bands suitable for its survival)	9	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - low	0	We found no evidence based on a review at the genus and species level. Furthermore, it seems unlikely that an aquatic plant would evolve allelopathy.
Imp-G2 (Parasitic)	n - negl	0	No evidence from botanical description at either the species or genus level (Martínez-y-Pérez et al., 2008), and it does not belong to a family known to contain parasitic species (e.g., Nickrent, 2009).
Impacts to Natural Systems			
Imp-N1 (Change ecosystem processes and parameters that affect other species)	n - high	0	We found no evidence.
Imp-N2 (Change community structure)	y - low	0.2	Forms dense mats that alter habitat structure (Kunzer and Bodle, 2008).
Imp-N3 (Change community composition)	y - negl	0.2	Forms populations that are monocultures (Kunzer and Bodle, 2008). Excludes native species (Bodle, 2009).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	y - low	0.1	Given this species' ability to form dense mats and monocultures (see evidence under Imp-N3 and ES-6), and that it invades natural areas, it is likely to affect Threatened and Endangered species. In a phone conversation, Mike Bodle with the South Florida Water Management District said *L. subintegra* may take over some habitats of the Okeechobee gourd (*Cucurbita okeechobeensis*) during high water events. It also has the potential to overwhelm foraging areas for the snail kite (*Rostrhamus sociablis*) and wood stork (*Mycteria americana*) (Bodle, 2009).
Imp-N5 (Is it likely to affect any	y - low	0.1	This species has invaded Fisheating Bay in Lake Okeechobee,

Question ID	Answer - Uncertainty	Score	Notes (and references)
globally outstanding ecoregions)			which is part of a globally outstanding ecoregion (Ricketts et al., 1999). Given the impacts described under Imp-N3, Imp-N2, and ES-6, it is likely to have a significant impact in the Lake Okeechobee ecosystem.
Imp-N6 (Weed status in natural systems)	c - negl	0.6	An environmental weed in Florida, it is being controlled with state funds by the South Florida Water Management District (Bodle, 2009, 2012; Kunzer and Bodle, 2008). Since the species' discovery, the district has spent $631,000 managing it (SFWMD, 2014). 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)	? - max		Unknown. This species should be able to colonize canals in south Florida (Bodle, 2009). This would restrict and impede the flow of water, which is important for consumption and flood control.
Imp-A2 (Changes or limits recreational use of an area)	y - low	0.1	Due to the thick mat of leaves and stems, *L. subintegra* restricts recreational access to habitats; only airboats can move over these colonies (Bodle, 2009).
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	n - high	0	We found no evidence.
Imp-A4 (Weed status in anthropogenic systems)	b - high	0.1	Because it reduces access and may impede water flow in canals, it is considered an anthropogenic weed (Bodle, 2009). Alternate answers for the Monte Carlo simulation were "c" and "a."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	y - high	0.4	*Luziola subintegra* can dominate rice paddies when rice seed is planted directly in drained paddies (Fischer, 1997); although this reference did not say it reduces rice yield, we are interpreting dominate ("predominar" in the reference) to indicate that. *Luziola subintegra* is a principal weed of rice, and among other rice weeds, reduces rice yield from 30 to 70 percent (Marnotte and Téoulet, 2004). We used high uncertainty, because the reference (abstract only) on yield loss refers to a group of weeds and not specifically *L. subintegra*
Imp-P2 (Lowers commodity value)	y - high	0.2	*Luziola subintegra*, among other weeds, increases control costs in cultivated rice in Venezuela (Anzalone et al., 1998). Using high uncertainty, because this reference (abstract only) refers to a group of weeds and not specifically *L. subintegra*.
Imp-P3 (Is it likely to impact trade)	n - high	0	No *Luziola* species appears to be listed as a quarantine pest by other countries (APHIS, 2014).
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	y - low	0.1	Impedes the flow of water to irrigated rice fields and increases the evapotranspiration of water which is valuable for rice production (Fischer, 1997). Associated with irrigation canals (and/or rice fields) in Costa Rica (Rojas and Agüero, 1996).
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - low	0	Not described as toxic in a study examining cattle preference for different feed (Santos et al., 2002).
Imp-P6 (Weed status in production systems)	c - high	0.6	Considered as a weed in tropical rice plantations (Fischer, 1997). Listed as a principal weed of rice in Venezuela (Castrillo et al., 2005). *Luziola* spp. is listed along with *Murdania nudiflora* as two species difficult to control (Fischer, 1997). Using high uncertainty because it is not

Question ID	Answer - Uncertainty	Score	Notes (and references)
			absolutely clear which *Luziola* species are under control. *Luziola peruviana*, also a significant weed of rice, is controlled in rice paddies (Castrillo et al., 2005). 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, 2009).
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 - negl	N/A	We found no evidence that it occurs in this zone.
Geo-Z6 (Zone 6)	n - negl	N/A	We found no evidence that it occurs in this zone.
Geo-Z7 (Zone 7)	n - negl	N/A	We found no evidence that it occurs in this zone.
Geo-Z8 (Zone 8)	n - negl	N/A	We found no evidence that it occurs in this zone.
Geo-Z9 (Zone 9)	y - high	N/A	We found no direct evidence. However, we answered yes with high uncertainty because submersed aquatic plants will be insulated from extreme minimum temperatures.
Geo-Z10 (Zone 10)	y - negl	N/A	Argentina and the United States (FL). In Argentina (Nicora, 1993).
Geo-Z11 (Zone 11)	y - negl	N/A	Bolivia, Brazil, Honduras, Mexico.
Geo-Z12 (Zone 12)	y - negl	N/A	Ecuador and Peru.
Geo-Z13 (Zone 13)	y - negl	N/A	Brazil, Ecuador, and Venezuela.
Köppen -Geiger climate classes			
Geo-C1 (Tropical rainforest)	y - negl	N/A	Bolivia, Honduras, and Peru.
Geo-C2 (Tropical savanna)	y - negl	N/A	Bolivia, Brazil, and Mexico.
Geo-C3 (Steppe)	y - low	N/A	Ecuador.
Geo-C4 (Desert)	n - low	N/A	We found no evidence that it occurs in this climate class.
Geo-C5 (Mediterranean)	n - mod	N/A	We found no evidence that it occurs in this climate class.
Geo-C6 (Humid subtropical)	y - negl	N/A	Mexico and the United States (FL).
Geo-C7 (Marine west coast)	n - high	N/A	One point near this climate class in Mexico.
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 - mod	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.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence that it occurs in this climate class.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	n - negl	N/A	We found no evidence it occurs in this band.
Geo-R2 (10-20 inches; 25-51 cm)	y - high	N/A	Two points in Ecuador.
Geo-R3 (20-30 inches; 51-76 cm)	y - low	N/A	Bolivia.
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	Argentina and Bolivia.
Geo-R5 (40-50 inches; 102-127 cm)	y - low	N/A	One point near this edge in Brazil.
Geo-R6 (50-60 inches; 127-152	y - negl	N/A	Brazil, Mexico, and Venezuela.

Question ID	Answer - Uncertainty	Score	Notes (and references)
cm)			
Geo-R7 (60-70 inches; 152-178 cm)	y - low	N/A	One point near this edge in Nicaragua.
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	El Salvador, French Guiana, Mexico, and the United States (FL).
Geo-R9 (80-90 inches; 203-229 cm)	y - negl	N/A	French Guiana and Mexico.
Geo-R10 (90-100 inches; 229-254 cm)	y - negl	N/A	French Guiana, Honduras, and Mexico.
Geo-R11 (100+ inches; 254+ cm))	y - negl	N/A	Costa Rica and Panama.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	Recently discovered in Florida (Wunderlin and Hansen, 2009).
Ent-2 (Plant proposed for entry, or entry is imminent)	-	N/A	
Ent-3 (Human value & cultivation/trade status)	-	N/A	
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	