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Weed Risk Assessment for *Ligustrum sinense* Lour. (Oleaceae) – Chinese privet

Infestation of *L. sinense* (source: John D. Byrd, Mississippi State University, 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.

***Ligustrum sinense* Lour. – Chinese privet**

Species Information Family: Oleaceae

Initiation: On June 26, 2012, Ken Langeland, Professor at the University of Florida's Center for Aquatic and Invasive Plants, asked about the availability of a weed risk assessment for *Ligustrum sinense* because he wants to propose that the state of Florida list it as a state noxious weed (Langeland, 2012b). Based on that request, the PERAL Weed Team initiated this assessment.

Foreign distribution: *Ligustrum sinense* is native to southeastern Asia in China, Laos, and Vietnam (NGRP, 2012). It has been introduced to numerous other countries including Argentina, Australia, Honduras, Mexico, New Zealand, and South Africa (GBIF, 2012; NGRP, 2012).

U.S. distribution and status: *Ligustrum sinense* is widely distributed throughout the southeastern United States and Atlantic coastal states, ranging from Massachusetts south to Florida and then west to Texas and Oklahoma (Kartesz, 2012). Together with *L. vulgare* (European privet), *L. sinense* covers about 2.7 million acres in U.S. forests (Miller et al., 2008). In southern states, it is "found about everywhere that birds fly" (Dirr, 1998). It was first introduced into the United States as an ornamental in 1852 (Dirr, 1998) and first naturalized at least in the early 1900s (Greene and Blossey, 2012; NRCS, 2000). Between the 1950s and 1970s, it became widely naturalized (Zhang et al., 2008). Although this species is not a state noxious weed in any U.S. state (Kartesz, 2012), it is considered a major threat in the southeastern United States (Miller et al., 2008; Sutter et al., 2011) and is on invasive plant lists of every southeastern state (Maddox et al., 2010). *Ligustrum sinense* is managed at a local level in the United States (e.g., Osland et al., 2009; Sutter et al., 2011).

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

1. *Ligustrum sinense* analysis

Establishment/Spread Potential *Ligustrum sinense* can readily establish and spread (Csurhes and Edwards, 1998; IABIN, 2008; Swarbrick and Timmins, 1999), but particularly in the southeastern United States where it covers millions of acres in U.S. forests (Miller et al., 2008). This species forms dense populations (Smith, 2008; WMC, 2012), is shade-adapted (Dirr, 1998), produces thousands of fruit (Westoby et al., 1983), is dispersed by birds (Swarbrick and Timmins, 1999), and readily resprouts after damage (Swarbrick and Timmins, 1999). Besides producing seeds, it also reproduces through root suckering (Loewer, 2001), allowing a single colonist to form a new population. Several other *Ligustrum* species are significant weeds (Miller, 2003; Miller et al., 2008; Randall, 2007; Swarbrick and Timmins, 1999). Uncertainty was low for this risk element.
Risk score = 14 Uncertainty index = 0.10

Impact Potential *Ligustrum sinense* is primarily an environmental and anthropogenic weed. Its dense populations exclude native plant and animal species (Greene and Blossey, 2012; Ulyshen et al., 2010), and change the structure of forest understories (Smith, 2008). Furthermore, it is threatening several Threatened and Endangered species (e.g., *Ribes echinellum* in Florida and *Helianthus schweinitzii* in the Carolinas; Coutts-Smith and Downey, 2006; Langeland and Burks, 1998; NRCS, 2000; Sutter et al., 2011). This species also hinders recreational access in bottomland forests (Hanula et al., 2009). In urban landscapes, *L. sinense* is a nuisance because of its rapid growth, offensive and allergenic floral scent, and root suckering ability, and gets mostly negative comments on an online gardening website (DavesGarden, 2012). Natural resource managers and homeowners are trying to keep this species under control (DavesGarden, 2012; Sutter et al., 2011; Veitch and Clout, 2002). Potential biocontrol agents have been sought (Zhang et al., 2008). This risk element had an average amount of uncertainty.
Risk score = 3.3 Uncertainty index = 0.19

Geographic Potential Based on three climatic variables, we estimate that about 50 percent of the United States is suitable for the establishment of *L. sinense* (Fig. 1). This 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 *L. sinense* represents the joint distribution of Plant Hardiness Zones 6-12, areas with 10-100+ inches of annual precipitation, and the following climate classes: tropical rainforest, tropical savanna, steppe, mediterranean, humid subtropical, marine west coast, humid continental warm summers, and humid continental cool summers.

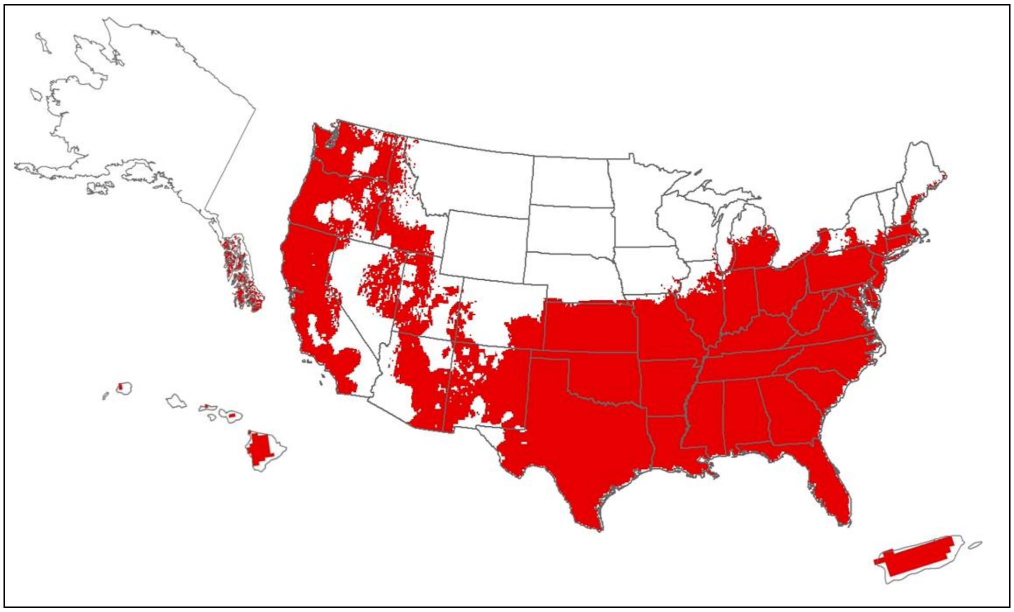
The area estimated in Fig. 1 likely represents a conservative estimate as it only uses three climatic variables. Because Plant Hardiness Zone 6 may only be partially suitable for *L. sinense* (Dirr, 1998), it may not occur as far north as indicated (Fig. 1). Other environmental variables, such as soil and habitat type, may further limit

[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).

the areas in which this species is likely to establish. *Ligustrum sinense* is found in bottomlands, moist woods, stream edges, and disturbed sites (Smith, 2008). It prefers low wet areas, but it also invades some upland systems (Langeland and Burks, 1998; Smith, 2008).

Entry Potential We did not assess entry potential because this species is already present in the United States (Greene and Blossey, 2012; NRCS, 2000; Zhang et al., 2008).

Figure 1. Predicted distribution of *Ligustrum sinense* 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) = 75.9%
P(Minor Invader) = 23.1%
P(Non-Invader) = 0.9%

Risk Result = High Risk

Secondary Screening = N/A

Figure 2. *Ligustrum sinense* 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.

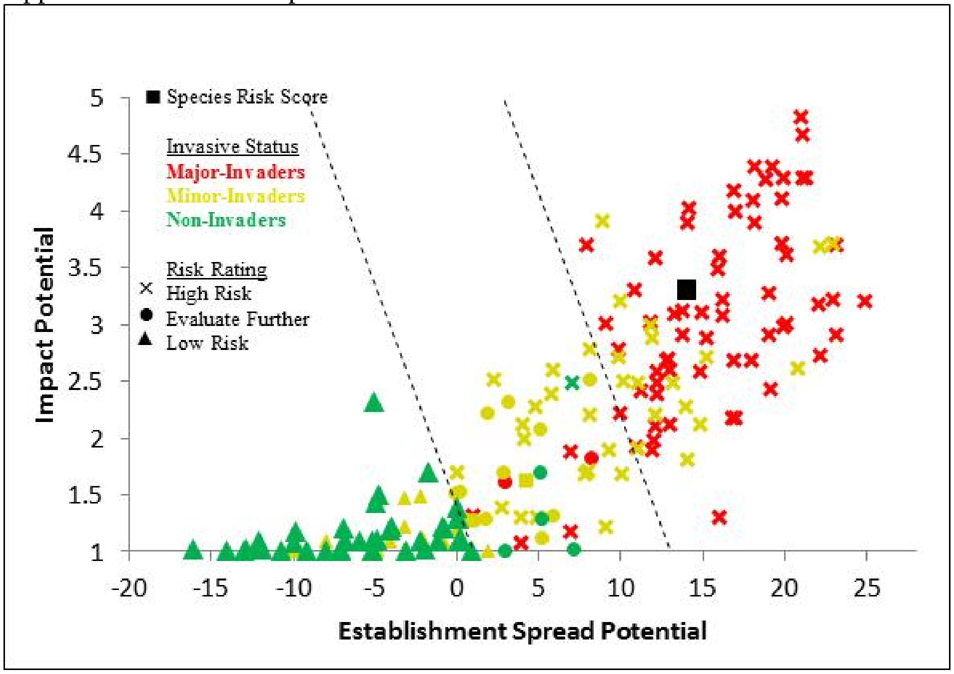
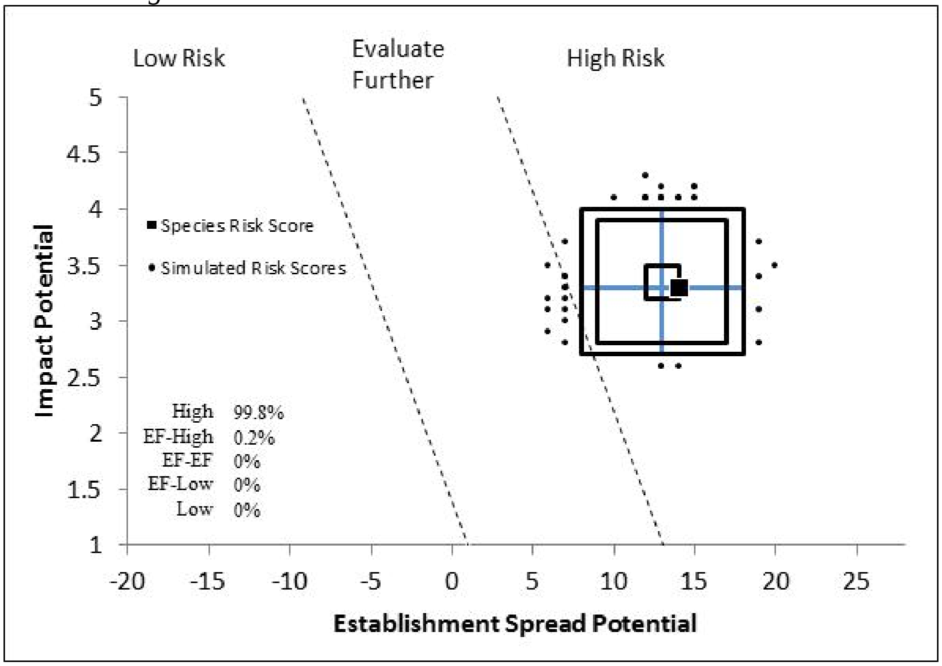


Figure 3. Monte Carlo simulation results (N=5,000) for uncertainty around the risk scores for *Ligustrum sinense*[a].



[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 *L. sinense* is High Risk (Fig. 2). Because nearly all of the simulated risk scores (99.7 percent) gave a result of high risk, we are confident this risk rating is accurate (Fig. 3).

Ligustrum sinense is widely distributed in the southeastern United States (Kartesz, 2012; Miller et al., 2008) and is likely reaching the limits of its potential distribution. Despite the numerous impacts associated with this species, it is still available in the nursery trade (Wirth et al., 2004). Dirr (1998) notes that the invasive wild form is generally not available in commerce, but the cultivar 'Variegatum,' which has leaves bordered in gray to creamy white, is available. This cultivar readily reverts back to the green form and becomes invasive.

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.

Auld, B. A., and R. W. Medd. 1987. Weeds: An Illustrated Botanical Guide to the Weeds of Australia. Inkata Press, Melbourne, Australia. 255 pp.

Brown, C. E., and S. R. Pezeshki. 2000. A study on waterlogging as a potential tool to control *Ligustrum sinense* populations in western Tennessee. Wetlands 20(3):429-437.

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

Corlett, R. T. 1996. Characteristics of vertebrate-dispersed fruits in Hong Kong. Journal of Tropical Ecology 12(6):819-833.

Coutts-Smith, A. J., and P. O. Downey. 2006. Impact of weeds on threatened biodiversity in New South Wales. CRC for Australian Weed Management, Adelaide, Australia. 98 pp.

Csurhes, S., and R. Edwards. 1998. Potential environmental weeds in Australia: Candidate species for preventative control. Queensland Department of Natural Resources, Australia. 202 pp.

DavesGarden. 2012. Plant files database. Dave's Garden. http://davesgarden.com/guides/pf/go/1764/. (Archived at PERAL).

Dirr, M. A. 1998. Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses (5th ed.). Stipes Publishing, Champaign, IL. 1187 pp.

Downey, P. O., T. J. Scanlon, and J. R. Hosking. 2010. Prioritizing weed species based on their threat and ability to impact on biodiversity: A case study from New South Wales. Plant Protection Quarterly 25(3):111-126.

GBIF. 2012. GBIF, Online Database. Global Biodiversity Information Facility (GBIF). http://data.gbif.org/welcome.htm. (Archived at PERAL).

Greene, B., and B. Blossey. 2012. Lost in the weeds: *Ligustrum sinense* reduces native plant growth and survival. Biological Invasions 14(1):139-150.

Grice, A. C., and M. J. Setter (eds.). 2003. Weeds of Rainforests and Associated Ecosystems. Cooperative Research Centre for Tropical Rainforest Ecology and Management. Rainforest CRC, Cairns, Australia. 116 pp.

Groves, R. H., R. Boden, and W. M. Lonsdale. 2005. Jumping the garden fence:

Invasive garden plants in Australia and their environmental and agricultural impacts. CSIRO, Australia. 173 pp.

Hanula, J. L., S. Horn, and J. W. Taylor. 2009. Chinese privet (*Ligustrum sinense*) removal and its effect on native plant communities of riparian forests. Invasive Plant Science and Management 2(4):292-300.

Harrington, T. B., and J. H. Miller. 2005. Effects of application rate, timing, and formulation of glyphosate and triclopyr on control of Chinese privet (*Ligustrum sinense*). Weed Technology 19(1):47-54.

Heap, I. 2012. 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.

Howell, C. J., and J. W. D. Sawyer. 2006. New Zealand naturalised vascular plant checklist. New Zealand Plant Conservation Network, Wellington, New Zealand. 60 pp.

IABIN. 2008. Base de Datos de Invasiones Biologicas en Argentina. Inter-American Biodiversity Information Network (IABIN). http://www.uns.edu.ar/inbiar/busca_especies.asp. (Archived at PERAL).

IPPC. 2012. International standards for phytosanitary measures: Glossary of phytosanitary terms (ISPM#5). Secretariat of the International Plant Protection Convention (IPPC), Food and Agriculture Organization of the United Nations, Rome. 38 pp.

Kartesz, J. 2012. The Biota of North America Program (BONAP). North American Plant Atlas. http://www.bonap.org/MapSwitchboard.html. (Archived at PERAL).

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.

Langeland, K. A. 2012a. Is *Ligustrum sinense* really dispersed by mammals? Personal communication to A. L. Koop on August 22, 2012, from Ken Langeland, Professor and Extension Specialist at the University of Florida, Center for Aquatic and Invasive Plants.

Langeland, K. A. 2012b. Request for four weed risk assessments. Personal communication to A. L. Koop on June 26, 2012, from Ken Langeland, Professor and Extension Specialist at the University of Florida, Center for Aquatic and Invasive Plants.

Langeland, K. A., and K. C. Burks. 1998. Identification and Biology of Non-native Plants in Florida's Natural Areas. University of Florida, Gainesville, Florida. 165 pp.

Langeland, K. A., and R. K. Stocker. 2001. Control of non-native plants in natural areas of Florida (SP 242). University of Florida, Institute of Food and Agricultural Sciences, Gainesville, FL. 34 pp.

Lavergne, C., J.-C. Rameau, and J. Figier. 1999. The invasive woody weed *Ligustrum robustum* subsp. *walkeri* threatens native forests on La Réunion. Biological Invasions 1(4):377-392.

Liogier, H. A., and L. F. Martorell. 2000. Flora of Puerto Rico and adjacent islands: a systematic synopsis (2nd ed.). Editorial de la Universidad the Puerto Rico, San Juan, Puerto Rico. 382 pp.

Loewer, P. 2001. Solving Weed Problems. The Lyons Press, Guilford, CT. 282 pp.

Mabberley, D. J. 2008. Mabberley's Plant-Book: A Portable Dictionary of Plants, their Classification and Uses (3rd edition). Cambridge University Press,

New York. 1021 pp.
Macdonald, I. A. W., J. K. Reaser, C. Bright, L. E. Neville, G. W. Howard, S. J. Murphy, and G. Preston. 2003. Invasive alien species in southern Africa: National reports & directory of resources. The Global Invasive species Programme, Cape Town, South Africa. 125 pp.
Maddox, V., J. Byrd Jr, and B. Serviss. 2010. Identification and control of invasive privets (*Ligustrum* spp.) in the middle Southern United States. Invasive Plant Science and Management 3(4):482-488.
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.
Merriam, R. W., and E. Feil. 2002. The potential impact of an introduced shrub on native plant diversity and forest regeneration. Biological Invasions 4(4):369-373.
Miller, J. H. 2003. Nonnative invasive plants of southern forests (General Technical Report SRS-62). United States Department of Agriculture, Forest Service, Southern Research Station, Asheville, NC. 93 pp.
Miller, J. H., E. B. Chambliss, and C. M. Oswalt. 2008. Maps of occupation and estimates of acres covered by nonnative invasive plants in southern forests using SRS FIA data posted on March 15, 2008. United States Department of Agriculture, Forest Service. Last accessed August 15, 2012, http://www.invasive.org/fiamaps/.
Mitchell, J. D., B. G. Lockaby, and E. F. Brantley. 2011. Influence of Chinese privet (*Ligustrum sinense*) on decomposition and nutrient availability in riparian forests. Invasive Plant Science and Management 4(4):437-447.
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.
NGRP. 2012. 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. 2000. Plant guide: Chinese privet *Ligustrum sinense* Lour. United States Department of Agriculture, National Resource Conservation Service (NRCS), Baton Rouge, LA. 6 pp.
Osland, M. J., J. W. Pahl, and C. J. Richardson. 2009. Native bamboo [*Arundinaria gigantea* (Walter) Muhl., Poaceae] establishment and growth after the removal of an invasive non-native shrub (*Ligustrum sinense* Lour., Oleaceae): Implications for restoration. Castanea 74(3):247-258.
Panetta, F. D. 2000. Fates of fruits and seeds of *Ligustrum lucidum* W.T. Ait. and *L. sinense* Lour. maintained under natural rainfall or irrigation. Australian Journal of Botany 48(6):701-706.
Randall, J. M. 2007. The Introduced Flora of Australia and its Weed Status. CRC for Australian Weed Management, Department of Agriculture and Food, Western Australia, Australia. 528 pp.
Randall, J. M., and J. Marinelli (eds.). 1996. Invasive Plants: Weeds of the Global Garden. Brooklyn Botanic Garden, Brooklyn, NY. 111 pp.

Randall, R. P. 2012. A Global Compendium of Weeds, 2nd edition. Department of Agriculture and Food, Western Australia, Perth, Australia. 1107 pp.

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.

Simmonds, H., P. Holst, and C. Bourke. 2000. The palatability, and potential toxicity of Australian weeds to goats. Rural Industries Research and Development Corporation, Australia. 156 pp.

Smith, C. 2008. Invasive plants of North Carolina. North Carolina Department of Transportation, NC. 189 pp.

Stromayer, K. A. K., R. J. Warren, A. S. Johnson, P. E. Hale, C. L. Rogers, and C. L. Tucker. 1998. Chinese privet and the feeding ecology of white-tailed deer: The role of an exotic plant. Journal of Wildlife Management 62(4):1321-1329.

Strong, C. M., D. R. Brown, and P. C. Stouffer. 2005. Frugivory by Wintering hermit thrush In Louisiana. Southeastern Naturalist 4(4):627-638.

Sutter, R. D., T. E. Govus, R. L. Smyth, C. Nordman, M. Pyne, and T. Hogan. 2011. Monitoring change in a central U.S. calcareous glade: Resampling transects established in 1993. Natural Areas Journal 31(2):163-172.

Swarbrick, and S. Timmins. 1999. The biology of Australian weeds 36. *Ligustrum lucidum* Aiton and *Ligustrum sinense* Lour. Plant Protection Quarterly 14:122-130.

Ulyshen, M. D., S. Horn, and J. L. Hanula. 2010. Response of beetles (Coleoptera) at three heights to the experimental removal of an invasive shrub, Chinese privet (*Ligustrum sinense*), from floodplain forests. Biological Invasions 12(6):1573-1579.

Veitch, C. R., and M. N. Clout. 2002. Turning the Tide: The Eradication of Invasive Species (Proceedings of the International Conference on Eradication of Island Invasives): Occasional Paper of the IUCN Species Survival Commission No. 27. The World Conservation Union (IUCN), SSC Invasive Species Specialist Group. 414 pp.

Vidra, R. L., T. H. Shear, and M. S. Jon. 2007. Effects of vegetation removal on native understory recovery in an exotic-rich urban forest. Journal of the Torrey Botanical Society 134(3):410-419.

Ward, R. W. 2002. Extent and dispersal rates of Chinese privet (*Ligustrum sinense*) invasion on the Upper Oconee River floodplain, North Georgia [Abstract]. Southeastern Geographer 42(1):29-48.

Weber, E. 2003. Invasive Plant Species of the World: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK. 548 pp.

Westoby, M., J. Dalby, and L. Adams-Acton. 1983. Fruit production by two sepcies of privet, *Ligustrum sinense* Lour. and *L. lucidum* W. T. Ait. Australian Weeds 2(127-129).

White, E., N. Tucker, N. Meyers, and J. Wilson. 2004. Seed dispersal to revegetated isolated rainforest patches in North Queensland. Forest Ecology and Management 192(2-3):409-426.

Williams, P. A., B. J. Karl, P. Bannister, and W. G. Lee. 2000. Small mammals as potential seed dispersers in New Zealand. Austral Ecology 25:523-532.

Wirth, F. F., K. J. Davis, and S. B. Wilson. 2004. Florida nursery sales and economic impacts of 14 potentially invasive landscape plant species. Journal of Environmental Horticulture 22(1):12-16.

WMC. 2012. Weedbusters detailed information sheet: *Ligustrum sinense*. The Weedbusters Management Committee (WMC). Last accessed Augst 14, 2012, http://www.weedbusters.co.nz/weed_info/detail.asp?WeedID=86.

Zhang, Y. Z., J. L. Hanula, and J. H. Sun. 2008. Survey for potential insect biological control agents of *Ligustrum sinense* (Scrophulariales: Oleaceae) in China. The Florida Entomologist 91(3):372-382.

Zheng, H., Y. Wu, J. Ding, D. Binion, W. Fu, and R. Reardon. 2006. Invasive Plants of Asian Origin Established in the United States and Their Natural Enemies, Volumne 1 (2nd ed.). United States Department of Agriculture, Forest Service, Morgantown, WV. 147 pp.

Appendix A. Weed risk assessment for *Ligustrum sinense* Lour. (Oleaceae). The following information was obtained from the species' risk assessment, which was conducted using Microsoft Excel. The information shown in this appendix was modified to fit on the page. The original Excel file, the full questions, and the guidance to answer the questions are available upon request.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ESTABLISHMENT/SPREAD POTENTIAL			
ES-1 (Status/invasiveness outside its native range)	f - negl	5	*Ligustrum sinense* is native to SE Asia in China, Laos, and Vietnam (NGRP, 2012). It was introduced in 1852 to the United States and was noted as naturalizing as early as 1933 (Dirr, 1998). Since then it has spread throughout the southeastern United States and is now widely recognized as invasive (Dirr, 1998; Langeland and Burks, 1998), including in Hawaii (Motooka et al., 2003). Naturalized in New Zealand (Howell and Sawyer, 2006), South Africa, the United States (NGRP, 2012), Puerto Rico (Liogier and Martorell, 2000), and Argentina (IABIN, 2008). Invasive weed that is spreading in Australia (Coutts-Smith and Downey, 2006; Randall, 2007; White et al., 2004). Widely naturalized and spreading in Australia and New Zealand (Csurhes and Edwards, 1998; Swarbrick and Timmins, 1999). Alternate choices for the Monte Carlo simulation were both "e".
ES-2 (Is the species highly domesticated)	n - low	0	Widely cultivated as a hedge or specimen plant (Groves et al., 2005; Smith, 2008; Zhang et al., 2008), and for other purposes in China (Zhang et al., 2008). Several cultivars selected for variegation and growth form are available (Dirr, 1998). No evidence, however, that it has been bred for reduced weed potential.
ES-3 (Weedy congeners)	y - negl	1	*Ligustrum japonicum*, *L. lucidum*, *L. ovalifolium*, and *L. vulgare* are significant weeds or invasive plants (Miller, 2003; Miller et al., 2008; Randall, 2007; Swarbrick and Timmins, 1999).
ES-4 (Shade tolerant at some stage of its life cycle)	y - negl	1	It thrives in heavy shade and full sun (Dirr, 1998). Forest pioneer establishing in disturbed areas (Weber, 2003). Shade tolerant (Greene and Blossey, 2012; Miller, 2003). "Often becoming locally abundant, even in deep shade" (Langeland and Burks, 1998).
ES-5 (Climbing or smothering growth form)	n - negl	0	Not a vine. Species is a deciduous shrub or small tree, to 2-4 meters tall (Dirr, 1998; Zheng et al., 2006).
ES-6 (Forms dense thickets)	y - negl	2	Forms dense, impenetrable thickets (Loewer, 2001; Smith, 2008; Weber, 2003; WMC, 2012).
ES-7 (Aquatic)	n - negl	0	Plant is a terrestrial shrub (Swarbrick and Timmins, 1999). May not tolerate flooding (Ward, 2002).
ES-8 (Grass)	n - negl	0	Not a grass, plant in the Oleaceae family (NGRP, 2012).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	No evidence in the literature for this widely studied species. Plants in the Oleaceae family (NGRP, 2012) are not known to fix nitrogen (Martin and Dowd, 1990).
ES-10 (Does it produce viable seeds or spores)	y - negl	1	Produces abundant fruit (Langeland and Burks, 1998). Spreads by seeds (and suckers) (Loewer, 2001). Propagates through seeds (Swarbrick and Timmins, 1999; WMC, 2012).
ES-11 (Self-compatible or apomictic)	? - max	0	Unknown. One author reports that self-compatibility is relatively rare among the Oleaceae (references in Lavergne et al., 1999); however, because this statement is taxonomically broad,

Question ID	Answer - Uncertainty	Score	Notes (and references)
			answering unknown.
ES-12 (Requires special pollinators)	n - mod	0	No evidence. Pollination is presumably by medium-sized insects such as flies and beetles; flower scent is very heavy (Swarbrick and Timmins, 1999). Given that this species does not show any evidence of limited fruit set where it has been introduced, it seems unlikely to require a specialized pollinator.
ES-13 (Minimum generation time)	c - high	0	Unknown. Short-lived but continuously replaced (WMC, 2012). There is no information on the minimum generation time of this species. However, as a shrub to small tree it is highly unlikely to have multiple generations per year or complete its lifecycle in one year. Because rapid growth rates are reported for garden settings (DavesGarden, 2012), it seems more likely that its minimum generation time will be two or more years. Consequently answering "c" but with "high" uncertainty since it could be greater than three years. The alternate answers for the Monte Carlo simulation were both "d".
ES-14 (Prolific reproduction)	y - high	1	Prolific reproducer (Greene and Blossey, 2012; Weber, 2003). An average square meter of canopy produces 1,300 fruit, but this includes all size classes (Westoby et al., 1983). Fruit production ranges from a little more than 800 per square meter for the smaller plants to about 2400 square meter for the large ones (Westoby et al., 1983). Typically, fruit contain 1 seed per fruit, but up to 3 have been found (Swarbrick and Timmins, 1999). About 75 percent of seeds are viable (Swarbrick and Timmins, 1999). 1,300 × 0.75 seed viability results in 975 viable seeds per square meter, which is 25 from the threshold. However, given that the 1,300 estimate includes values from smaller sized individuals that may not represent fully grown reproductive adults, answering "yes" but with "high" uncertainty. Furthermore, this estimate was based on stems and not necessarily a mature population that has reached the carrying capacity of the environment.
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - low	1	Seed is spread by vegetation dumping and soil removal (WMC, 2012).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	n - low	-1	No evidence. Does not seem likely given that this species is primarily an invader of natural areas.
ES-17 (Number of natural dispersal vectors)	2	0	Evidence for ES-17a through ES-17e: Subglobose black fruits are 5-8 mm in diameter and appear September to December (Weber, 2003; Zheng et al., 2006).
ES-17a (Wind dispersal)	n - negl		No evidence. Fruit (as described above) are too large for wind dispersal, and are clearly adapted for dispersal by vertebrates.
ES-17b (Water dispersal)	y - mod		This species is clearly adapted for dispersal by birds (references in ES-17c). However, because it invades bottomland and floodplain forests (Brown and Pezeshki, 2000; Ward, 2002), we should also consider water as a potential dispersal agent. Fruit of *L. sinense* can float for up to two weeks (Greene and Blossey, 2012). One author reports that it is dispersed by floodwaters (Langeland and Stocker, 2001). Answering "yes" but with "mod" uncertainty without additional information indicating that water dispersal is an important vector for dispersal.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-17c (Bird dispersal)	y - negl		Bird-dispersed (Coutts-Smith and Downey, 2006; Smith, 2008; Swarbrick and Timmins, 1999; White et al., 2004). In a study on frugivory of hermit thrushes (*Catharus guttatus*), the authors found seeds of *L. sinense* in 27 percent of the collected fecal samples (Strong et al., 2005). Privet seeds are also often regurgitated (Strong et al., 2005).
ES-17d (Animal external dispersal)	n - negl		No evidence. There is no evidence that fruit are adapted for external dispersal on animals. Because this species is very well studied and described using “negl” uncertainty.
ES-17e (Animal internal dispersal)	n - mod		There was no strong evidence supporting dispersal via this vector. In a study of the characteristics of vertebrate-dispersed fruits, the author reported that *L. sinense* is only dispersed by birds (Corlett, 1996). If animals consume the fruit, they will likely destroy the seeds during mastication or gut passage (Williams et al., 2000). In one park in the southeastern United States, fruit of *L. sinense* represented 11 percent of the diet of deer (*Odocoileus virginianus*) during the fall (Stromayer et al., 1998); however, the authors did not indicate if the seeds were destroyed during ingestion. Evidence supporting mammal-dispersed seeds (Langeland and Stocker, 2001; and citation in Harrington and Miller, 2005) was not from the primary literature and may have been assuming seeds are dispersed after animals consume fruit. A personal communication (Langeland, 2012a) from the author of one of these sources indicated that the information in that reference was incorrect, and that *L. sinense* is not dispersed by mammals. Thus, based on the weight of the evidence, we are assuming animals do not disperse seeds of this species.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	n - low	-1	Experimental field data indicate that most seeds stored in the soil lose viability within a year; only 0.28 percent were still viable at 12 months, and none at 18 and 24 months (Panetta, 2000). Seeds of *L. sinense* lost viability after storage for one year under dry, laboratory conditions, while some seeds of the congener *L. lucidum* could germinate after that time (Swarbrick and Timmins, 1999). Another report mentions that *L. sinense* has a "huge seedbank" (NRCS, 2000), but it does not clarify whether these are seeds that have persisted for more than one year in the soil.
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	y - negl	1	Suckers from roots after damage (Weber, 2003). Untreated stumps resprout quickly (WMC, 2012). Repeated mowing and burning does not affect it significantly (references in Zhang et al., 2008). One of its stress-tolerant features is its ability to tolerate serious stem damage (Swarbrick and Timmins, 1999). Frequently suckers from surface roots (DavesGarden, 2012).
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - negl	0	In several studies that have evaluated the effectiveness of herbicide treatments or in published descriptions of control strategies, herbicide resistance has not been mentioned (Hanula et al., 2009; Harrington and Miller, 2005; NRCS, 2000; Swarbrick and Timmins, 1999). Not listed in Heap's database of herbicide-resistant species (2012).
ES-21 (Number of cold hardiness zones suitable for its survival)	7	0	
ES-22 (Number of climate types	8	2	

Question ID	Answer - Uncertainty	Score	Notes (and references)
suitable for its survival)			
ES-23 (Number of precipitation bands suitable for its survival)	10	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - low	0	There is no evidence of allelopathy. Seeds of *L. sinense* and *L. lucidum* germinate readily under parent canopies (Swarbrick and Timmins, 1999). Because this species is well studied, using “low” uncertainty.
Imp-G2 (Parasitic)	n - negl	0	Species is in the Oleaceae family (NGRP, 2012), which is not known to contain parasitic plants (Heide-Jorgensen, 2008; Nickrent, 2009).
Impacts to Natural Systems			
Imp-N1 (Change ecosystem processes and parameters that affect other species)	y - high	0.4	From a study on litter decomposition and nutrient availability, the authors found that increasing amounts of leaves of *L. sinense* in the litter increased the decomposition rate of litter and nitrogen mineralization in the soil (Mitchell et al., 2011). The authors conclude that "C and N dynamics in Piedmont riparian forests were significantly influenced in direct proportion to the amount of privet present in the understory" (Mitchell et al., 2011). This may explain differences in the understory community of beetles between invaded and uninvaded forests (Ulyshen et al., 2010). It negatively impacts forest regeneration by inhibiting forest tree seedling recruitment (Hanula et al., 2009; Merriam and Feil, 2002), most likely because of its dense cover. Answering "yes" but with "high" uncertainty because it is not clear how abiotic changes in soil C and N affect other species.
Imp-N2 (Change community structure)	y - negl	0.2	Alters community structure (Smith, 2008). Displaces native shrub layer (Weber, 2003). Often forms monotypic stands (Hanula et al., 2009).
Imp-N3 (Change community composition)	y - negl	0.2	In a study dedicated to determining the impact of this species on community composition in floodplain forests, the authors found that as cover of *L. sinense* increased, herbaceous plant height and cover, native plant abundance, and species richness decreased (Greene and Blossey, 2012). In the same study, a transplant experiment showed that native plant seedling growth and survival were lower underneath a canopy of *L. sinense* than away from it (Greene and Blossey, 2012). *Ligustrum sinense* shades out the understory, altering native species composition (Smith, 2008). Dominates young forest plantations and regrowth in Queensland subtropics (Grice and Setter, 2003). Displaces native seedlings and shrubs in New Zealand and Australia (Swarbrick and Timmins, 1999; WMC, 2012).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	y - negl	0.1	This species is one of the 20 most commonly identified weeds threatening endangered biodiversity in Australia (Coutts-Smith and Downey, 2006). Threatening to displace the endangered *Ribes echinellum* in Florida (Langeland and Burks, 1998) and *Helianthus schweinitzii* in the Carolinas (NRCS, 2000). Encroaching on other rare species in the United States (Sutter et al., 2011).
Imp-N5 (Is it likely to affect any	y - low	0.1	Contributing to woody species encroachment in glade

Question ID	Answer - Uncertainty	Score	Notes (and references)
globally outstanding ecoregions)			communities of Tennessee, which contain many unique and endemic species (Sutter et al., 2011). Poses a threat to riparian vegetation (cited in Csurhes and Edwards, 1998). Due to its ability to successfully compete with and displace native vegetation, it poses a threat to entire ecosystems (NRCS, 2000). This species is invading several globally recognized ecoregions in the southeastern United States (Ricketts et al., 1999).
Imp-N6 (Weed status in natural systems)	c - negl	0.6	Major environmental weed in Australia and the United States (Groves et al., 2005; Miller, 2003). Of several hundred species prioritized for control in Australia (based on impact and spread potential), *L. sinense* ranked 9th on the list (Downey et al., 2010). Weed of natural areas; mechanical and chemical control strategies described (Motooka et al., 2003; Smith, 2008). Effect of different control strategies on resulting forest composition have been evaluated in U.S. forests (Hanula et al., 2009). Controlled in natural areas of New Zealand and the United States (Sutter et al., 2011; Veitch and Clout, 2002). Studies for potential biocontrol have been conducted (Zhang et al., 2008). Alternate answers for the Monte Carlo simulation are both "b".
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Impacts human property, processes, civilization, or safety)	y - high	0.1	Not much evidence. One gardener complained that the fruit clogged her gutters (DavesGarden, 2012). Another complained that the abundant purple fruit left stains in the concrete that could not be fully removed by pressure washing (DavesGarden, 2012). Using “high” uncertainty because the evidence is weak.
Imp-A2 (Changes or limits recreational use of an area)	y - low	0.1	Anecdotal comment: Removal of *L. sinense* from heavily invaded riparian forests improves the recreational value of these forests because it opens the understory up to allow people easy access to streamsides (Hanula et al., 2009).
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	n - high	0	Not much evidence. One gardener complained that it killed her grass (DavesGarden, 2012).
Imp-A4 (Weed status in anthropogenic systems)	c - negl	0.4	Particularly troublesome in urban bushland in Sydney, Australia (Auld and Medd, 1987). Weed of fence lines and roadsides (Csurhes and Edwards, 1998; Randall and Marinelli, 1996). The scent of *Ligustrum* flowers is offensive to some due to the presence of trimethylamines (a fishy smell; Mabberley, 2008). Specific management plans for urban areas have been developed and funding set aside to control it (Swarbrick and Timmins, 1999). The effect of removing this species (and three other invaders) from an urban forest was evaluated in one study (Vidra et al., 2007), supporting the idea this species is managed in urban areas (Vidra et al., 2007). From a garden forum of this species 21 posts were negative, 7 were neutral, and 5 were positive. Overall, gardeners complained about this species’ invasiveness, impacts (including allergies), and difficulty in control (DavesGarden, 2012). 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)	n - mod	0	No evidence.
Imp-P2 (Lowers commodity	? - max		Trimethylamines in *Ligustrum* taint honey of bees that feed on it

Question ID	Answer - Uncertainty	Score	Notes (and references)
value)			(Mabberley, 2008), but this was an anecdotal comment.
Imp-P3 (Is it likely to impact trade)	n - mod	0	Regulated in Australia (Randall, 2007). Regulated in South Africa as a category 3: may no longer be planted (Macdonald et al., 2003). However, there is no evidence this species is likely to be a pathway contaminant.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - mod	0	No evidence.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	y - mod	0.1	Reports of toxicity of *Ligustrum* are not common and there are very few experimental data (Burrows and Tyrl, 2001). Opinions on toxicity seem to be mixed (see discussion in Swarbrick and Timmins, 1999). Overall, the genus appears to be toxic if ingested, causing mild to severe digestive disturbance. In some cases, it has also had possible cardiotoxic effects as well, as several species of animals (cows, horses, and rabbits) have died (Burrows and Tyrl, 2001). *Ligustrum sinense* is not very palatable, but it appears to have low risk of toxicity to goats (Simmonds et al., 2000). In the United States, it is browsed by deer (Burrows and Tyrl, 2001; Miller, 2003) and is an important Fall and Winter food source (Stromayer et al., 1998). Although not considered in this question about animal toxicity, one child died a few hours after eating *Ligustrum* berries in Russia (Burrows and Tyrl, 2001).
Imp-P6 (Weed status in production systems)	a - mod	0	Reported to invade agricultural land and pastures (Ward, 2002), but no evidence it is considered a weed there or grows directly with crops or other valuable species. No strong evidence it is considered an agricultural weed (Randall, 2012). Alternate answers for the Monte Carlo simulation are both "b".
GEOGRAPHIC POTENTIAL			Unless stated otherwise, the evidence cited below represents point source data (latitude/longitude coordinates) from GBIF (2012).
Plant cold hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	No evidence.
Geo-Z2 (Zone 2)	n - negl	N/A	No evidence.
Geo-Z3 (Zone 3)	n - negl	N/A	No evidence.
Geo-Z4 (Zone 4)	n - negl	N/A	No evidence.
Geo-Z5 (Zone 5)	n - low	N/A	No evidence.
Geo-Z6 (Zone 6)	y - high	N/A	U.S. (MA, CT); Hardy to zone 7 (and somewhat 6) (Dirr, 1998).
Geo-Z7 (Zone 7)	y - negl	N/A	U.S. (CT, RI, VA, KY, TN); hardy to zone 7 (and somewhat 6) (Dirr, 1998).
Geo-Z8 (Zone 8)	y - negl	N/A	U.S. (AR, MS, AL, GA, SC, NC, OR), Australia.
Geo-Z9 (Zone 9)	y - negl	N/A	Costa Rica, Argentina.
Geo-Z10 (Zone 10)	y - negl	N/A	Costa Rica, Panama.
Geo-Z11 (Zone 11)	y - negl	N/A	Costa Rica, Taiwan.
Geo-Z12 (Zone 12)	y - low	N/A	Costa Rica, Panama
Geo-Z13 (Zone 13)	n - negl	N/A	No evidence.
Köppen-Geiger climate classes			
Geo-C1 (Tropical rainforest)	y - negl	N/A	Costa Rica, Panama.
Geo-C2 (Tropical savanna)	y - negl	N/A	Costa Rica, Taiwan, Vietnam.
Geo-C3 (Steppe)	y - negl	N/A	U.S. (CA), China.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-C4 (Desert)	n - low	N/A	No evidence.
Geo-C5 (Mediterranean)	y - negl	N/A	U.S. (WA, OR).
Geo-C6 (Humid subtropical)	y - negl	N/A	U.S. (TX, AR, LA, MS, TN, VA, GA, SC, NC, …), Argentina, South Africa, Taiwan, Australia.
Geo-C7 (Marine west coast)	y - negl	N/A	U.S. (NC-Appalachians), South Africa, China, Australia, New Zealand.
Geo-C8 (Humid cont. warm sum.)	y - negl	N/A	U.S. (KY, VA, MA, RI).
Geo-C9 (Humid cont. cool sum.)	y - negl	N/A	U.S. (VA, CT, MA).
Geo-C10 (Subarctic)	n - low	N/A	No evidence.
Geo-C11 (Tundra)	n - negl	N/A	No evidence.
Geo-C12 (Icecap)	n - negl	N/A	No evidence.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	n - low	N/A	No evidence.
Geo-R2 (10-20 inches; 25-51 cm)	y - low	N/A	U.S. (CA).
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	U.S. (TX), South Africa, Australia.
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	U.S. (TX), South Africa, Australia.
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	U.S. (MA, CT,RI, VA, NC, SC, …), Australia.
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	U.S. (AL, TN, MS, GA, FL, …), Australia, New Zealand.
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	U.S. (LA, MS), Argentina, New Caledonia, New Zealand.
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	Vietnam, Taiwan.
Geo-R9 (80-90 inches; 203-229 cm)	y - negl	N/A	Taiwan.
Geo-R10 (90-100 inches; 229-254 cm)	y - low	N/A	Suitable area above and below this precipitation band.
Geo-R11 (100+ inches; 254+ cm))	y - negl	N/A	Costa Rica, Panama/
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	Widely naturalized in the southeastern United States (Miller, 2003).
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	

Question ID	**Answer - Uncertainty**	**Score**	**Notes (and references)**
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	