United States Department of Agriculture

Weed Risk Assessment for *Cestrum laevigatum* Schltdl. (Solanaceae) – Inkberry

United States Department of Agriculture

Animal and Plant Health Inspection Service

August 5, 2013

Version 1

Left: *Cestrum laevigatum* flowers. Right: *Cestrum laevigatum* fruit (source: WESSA, 2006).

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.

***Cestrum laevigatum* Schltdl.– Inkberry**
Species Family: Solanaceae
Information Synonyms: *Cestrum axillare* Vell. (from Reed, 1977).
Initiation: On November 25, 2011, Al Tasker (PPQ, National Weeds Program Coordinator) asked the PERAL Weed Team to evaluate *Cestrum laevigatum* for potential listing as a Federal Noxious Weed (Tasker, 2011). This species has been added to the Not Authorized Pending Pest Risk Analysis (NAPPRA) list of regulated species (APHIS, 2013b).
Foreign distribution: This species is native to South America (NGRP, 2013; Weber, 2003). It has been introduced to South Africa (Henderson, 2001; Wells and Stirton, 1982), Swaziland (Wells and Stirton, 1982), Kenya, Tanzania, and Uganda (Lusweti et al., 2011).
U.S. distribution and status: This species is not present in the United States (Bailey and Bailey, 1976; Kartesz, 2013).
WRA area[1]: Entire United States, including territories.

[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).

1. *Cestrum laevigatum* analysis

Establishment/ Spread Potential

In South Africa, *Cestrum laevigatum* has spread into natural grasslands, forests, riparian habitats, and coastal dunes (Cowling et al., 1997; Henderson, 2001; Wells et al., 1986). *Cestrum laevigatum* grows as a shrub or tree and can form dense thickets (Fourie, 2011; Weber, 2003). It produces dark berries that are dispersed by birds (Foster et al., 1986; Weber, 2003). We had greater than average uncertainty for this risk element due to the lack of biological information available for this species.

Risk score = 10 Uncertainty index = 0.25

Impact Potential

Cestrum laevigatum is a Declared Weed in South Africa, which means this plant is prohibited in South Africa and must be controlled or eradicated where possible (Macdonald et al., 2003). *Cestrum laevigatum* invades natural areas (Cowling et al., 1997; Henderson, 2001; Wells et al., 1986) and forms dense stands that displace and prevent the regeneration of native species (Weber, 2003; Wells et al., 1986). This plant is also controlled in agricultural pasture land because it is highly toxic to livestock, causing liver damage to cattle, sheep, goats, and bison that can result in death (Falcao and Alencastro, 1974; Peixoto et al., 2000; van der Lugt et al., 1991). *Cestrum laevigatum* is generally considered desirable as an ornamental and as a hedge in urban and suburban settings (Henderson, 2001; van der Lugt et al., 1991), but dense patches can restrict access to recreational areas (de Lange and Poulter, 2004; Wells et al., 1986). We had greater than average uncertainty for this risk element due to the limited information available on this species.

Risk score = 3.4 Uncertainty index = 0.20

Geographic Potential

Based on three climatic variables, we estimate that about 20 percent of the United States is suitable for the establishment of *Cestrum laevigatum* (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 *Cestrum laevigatum* represents the joint distribution of Plant Hardiness Zones 8-13, areas with 10-100+ inches of annual precipitation, and the following Köppen-Geiger climate classes: tropical rainforest, tropical savanna, steppe, Mediterranean, humid subtropical, and marine west coast.

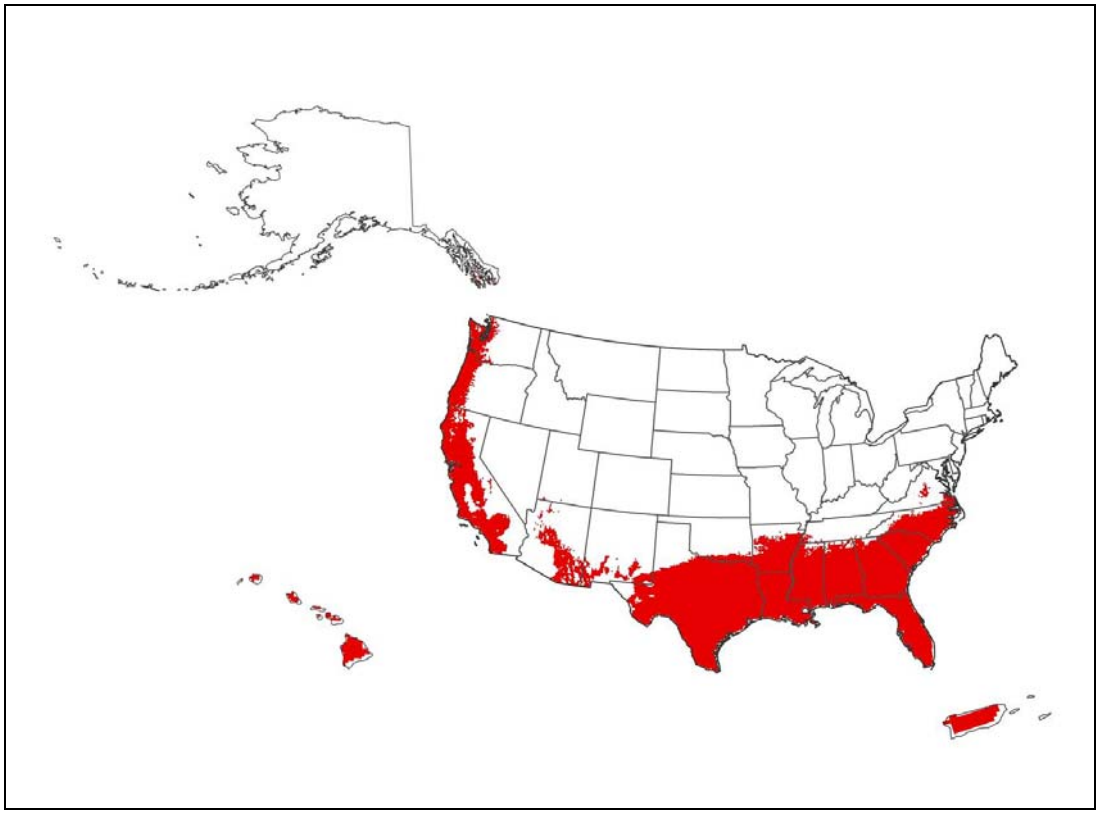
The area estimated likely represents a conservative estimate as it only uses three climatic variables. Other environmental variables, such as soil and habitat type, may further limit the areas in which this species is likely to establish.

Entry Potential

Cestrum laevigatum is not known to occur in the United States (Bailey and Bailey, 1976; Kartesz, 2013) and does not appear to be readily available for sale in retail stores or online. It has several characteristics that horticulturalists and pharmacologists would find desirable, however, so commercial potential exists. *Cestrum laevigatum* was brought into South Africa as an ornamental and as a plant for hedges (Henderson, 2001; van der Lugt et al., 1991). The leaves are used in traditional medicine as a treatment for malaria and fevers (de Madureira et al.,

2002), and the extract from *C. laevigatum* leaves and flowers has been shown to inhibit the growth of several phytopathogenic fungi (Mdee et al., 2009). Additionally, dried *C. laevigatum* leaves are smoked by the Mapuche of southern Chile as a substitute for cannabis (Pennacchio et al., 2010).
Risk score = 0.25 Uncertainty index = 0.13

Figure 1. Predicted distribution of *Cestrum laevigatum* 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) = 56.6%
P(Minor Invader) = 41.1%
P(Non-Invader) = 2.3%
Risk Result = High Risk
Secondary Screening = Not Applicable

Figure 2. *Cestrum laevigatum* 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.

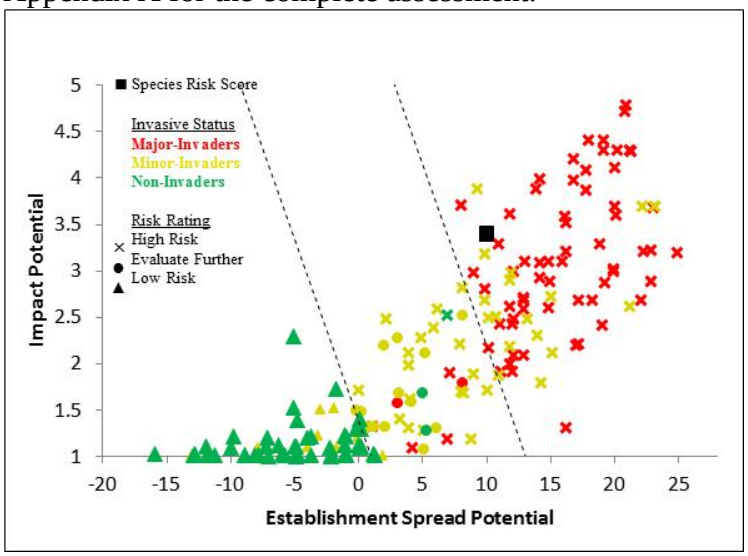
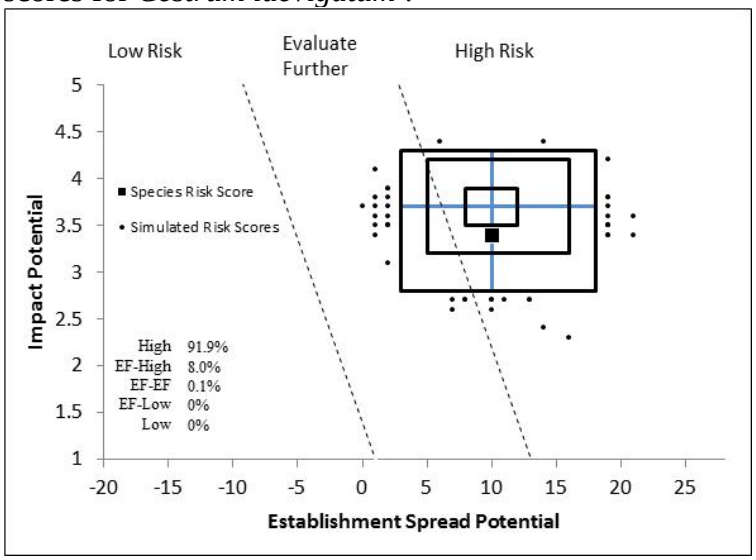


Figure 3. Monte Carlo simulation results (N=5,000) for uncertainty around the risk scores for *Cestrum laevigatum*[a].



[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 *Cestrum laevigatum* is High Risk. We had a high amount of uncertainty associated with this risk assessment (Fig. 3) due to the limited information available on this species, but our result seems statistically robust because over 98 percent of the simulated risk scores gave outcomes of High Risk. *Cestrum laevigatum* had an impact score comparable to that of other known major invaders (Fig. 2), because this species this plant is toxic to livestock and considered a weed and controlled in agricultural and natural systems (Kluge and Erasmus, 1991; Macdonald et al., 2003; van der Lugt et al., 1991; Weber, 2003; Wells et al., 1986).

Cestrum laevigatum is not known to occur in the United States (Kartesz, 2013; Parker et al., 2007) and does not appear to be readily available for sale online. However, this plant has many desirable properties and could be intentionally introduced into the United States as an ornamental (Henderson, 2001; van der Lugt et al., 1991), for medicinal uses (de Madureira et al., 2002; Mdee et al., 2009), or for research (Pennacchio et al., 2010).

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.

APHIS. 2013a. Phytosanitary Certificate Issurance & Tracking System (PCIT). United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS). https://pcit.aphis.usda.gov/pcit/faces/index.jsp. (Archived at PERAL).

APHIS. 2013b. Plants for planting whose importation is not authorized pending pest risk analysis: Notice of addition of taxa of plants for planting to list of taxa whose importation is Not Authorized Pending Pest Risk Analysis. Federal Register 78(75):31172–31210. Available at http://www.gpo.gov/fdsys/.

ARC. 2011. Southern Africa Plant Invaders Atlas (SAPIA) News. Agriculture Research Council (ARC). Last accessed June 28, 2011, http://www.arc.agric.za/home.asp?pid=1&toolid=2&sec=1001.

Bailey, L. H., and E. Z. Bailey. 1976. Hortus Third: A concise dictionary of plants cultivated in the United States and Canada. Macmillan, London, United Kingdom. 1290 pp.

Biosecurity New Zealand. 1999. Importing countries phytosanitary requirements: Republic of South Africa, Wellington, New Zealand. 128 pp.

Botha, C. J., and E. Venter. 2002. Plants poisonous to livestock Southern Africa (CD-ROM). University of Pretoria, Veterinary Science, Department of Paraclinical Sciences, Section Pharmacology and Toxicology, Pretoria, South Africa. Available at http://repository.up.ac.za/handle/2263/8477.

Cowling, R. M., D. M. Richardson, and S. M. Pierce (eds.). 1997. Vegetation of

Southern Africa. Cambridge University Press, Cambridge, U.K. 615 pp.
DAFF. 2013. Green cestrum. *Cestrum parqui*. Factsheet P15. Department of Agriculture, Fisheries and Forestry (DAFF), State of Queensland Department of Agriculture, Queensland, Australia.
de Lange, H., and T. Poulter. 2004. The effect of alien plant species on the riparian zone water management. Pages 43-44 *in* 8th Yellowfish Working Group Conference. Federation of Southern African Flyfishers, Le Paradise Resort, Badplaas, South Africa. May 13-15, 2004.
de Madureira, M. d. C., A. P. Martins, M. Gomes, J. Paiva, A. P. da Cunha, and V. do Rosário. 2002. Antimalarial activity of medicinal plants used in traditional medicine in S. Tomé and Príncipe islands. Journal of Ethnopharmacology 81:23-29.
Falcao, W. F. d. A., and F. M. M. R. Alencastro. 1974. Anatomia e morfologia da especie *Cestrum laevigatum* Schlechtd. (Solanaceae). Brasil Florest 17:65-72.
Foster, R. B., J. B. Arce, and T. S. Wachter. 1986. Dispersal and the sequential plant communities in Amazonian Peru floodplain. Tasks for Vegetation Science 15:357-370.
Fourie, A. 2011. Preliminary attempts to identify pathogens as biological control agents against *Cestrum* species (Solanaceae) in South Africa. African Entomology 19(2):278-281.
GBIF. 2013. Data Portal. Global Biodiversity Information Facility (GBIF). Last accessed May 1, 2013, http://data.gbif.org/welcome.htm.
Grainger, M. J., and R. J. van Aarde. 2012. The role of canopy gaps in the regeneration of coastal dune forest. African Journal of Ecology 51:11-20.
Heap, I. 2013. The International Survey of Herbicide Resistant Weeds Last accessed May 6, 2013, www.weedscience.org.
Heide-Jørgensen, H. S. 2008. Parasitic flowering plants. Brill Publishers, Leiden, The Netherlands. 442 pp.
Henderson, L. 2001. Alien weeds and invasive plants: a complete guide to declared weeds and invaders in South Africa. Agricultural Research Council, South Africa. 300 pp.
Holm, L. G., J. V. Pancho, J. P. Herberger, and D. L. Plucknett. 1991. A Geographical Atlas of World Weeds. John Wiley and Sons, New York, New York. 391 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.
Jose, S., H. P. Singh, D. R. Batish, and R. K. Kohli. 2013. Invasive Plant Ecology. CRC Press, Boca Raton, Florida. 282 pp.
Kartesz, J. T. 2013. North American Plant Atlas [maps generated from Kartesz, J.T. 2010. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP). (in press)]. The Biota of North America Program, Chapel Hill, N.C. http://www.bonap.org/MapSwitchboard.html. (Archived at PERAL).

Kluge, R. L., and D. J. Erasmus. 1991. An approach towards promoting progress with the control of woody alien invasive plants in Natal. South African Forestry Journal 157(1):86-90.

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.

Lopes, K. P., V. C. de Souza, L. A. de Andrade, G. V. Dornelas, and R. d. L. A. Bruno. 2006. Estudo do banco de sementes em povoamentos florestais puros e em uma capoeira de Floresta Ombrófila Aberta, no município de Areia, PB, Brasil. Acta Botanica Brasilica 20(1):105-113.

Lusweti, A., E. Wabuyele, P. Ssegawa, and J. Mauremootoo. 2011. *Cestrum laevigatum* (Inkberry). BioNET-EAFRINET. Last accessed May 31, 2013, http://keys.lucidcentral.org/keys/v3/eafrinet/weeds/key/weeds/Media/Html/Cestrum_laevigatum_(Inkberry).htm.

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.

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.

Mdee, L. K., P. Masoko, and J. N. Eloff. 2009. The activity of extracts of seven common invasive plant species on fungal phytopathogens. South African Journal of Botany 75(2):375-379.

Monro, A. K. 2012. Eight new species of *Cestrum* (Solanaceae) from Mesoamerica. PhytoKeys (8):49-82.

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, U.S.A. Last accessed June 12, 2009, http://www.parasiticplants.siu.edu/ListParasites.html.

Parker, C., B. P. Caton, and L. Fowler. 2007. Ranking Nonindigenous Weed Species by Their Potential to Invade the United States. Weed Science 55:386-397.

Peixoto, P. V., L. C. Brust, M. D. Duarte, T. N. Franca, V. C. Duarte, and C. S. Barros. 2000. *Cestrum laevigatum* poisoning in goats in southeastern Brazil. Veterinary and Human Toxicology 42(1):13-14.

Pennacchio, M., L. Jefferson, K. H. Medard, and E. Welch. 2010. Uses and abuses of plant-derived smoke: Its ethnobotany as hallucinogen, perfume, incense, and medicine. Oxford University Press, Oxford, United Kingdom. 264 pp.

Randall, R. P. 2012. A global compendium of weeds. 2nd edition. Department of Agriculture and Food, Western Australia, South Perth, Australia. 1119 pp.

Reed, C. F. 1977. Economically Important Foreign Weeds. Pages 746 *in* Agriculture Handbook No. 498. Agricultural Research Service, United

States Department of Agriculture., U.S.A.
Ricketts, T. H., E. Dinerstein, D. M. Olson, and C. J. Loucks. 1999. Terrestrial ecoregions of North America: A conservation assessment. Island Press, Washington, D. C. 485 pp.
Rodrigues, R. R., S. V. Martins, and L. A. F. Matthes. 2005. Post-fire regeneration in a semideciduous mesophytic forest, south-eastern Brazil. *in* A. R. Burk, (ed.). New research on forest ecosystems. Nova Science Publishers Inc, Hauppauge, New York.
Tasker, A. 2011. Emailing: NAPPRA pest plant CPHST review Nov 2011_v2b avt WRA Req. Personal communication to A. L. Koop on November 25, 2011, from Al Tasker (PPQ, National Weeds Program Coordinator).
van der Lugt, J. J., P. W. Nel, and J. P. Kitching. 1991. The pathology of *Cestrum laevigatum* (Schlechtd.) poisoning in cattle. The Onderstepoort Journal of Veterinary Research 58(3):211-221.
van Eck, H., C. Ham, and G. van Wyk. 1997. Survey of indigenous tree uses and preferences in the Eastern Cape Province. Southern African Forestry Journal 180:61-64.
van Wilgen, B. W., B. Reyers, D. C. Le Maitre, D. M. Richardson, and L. Schonegevel. 2008. A biome-scale assessment of the impact of invasive alien plants on ecosystem services in South Africa. Journal of Environmental Management 89(4):336-349.
Weber, E. 2003. Invasive Plant Species of the World: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK. 548 pp.
Wells, M. J., A. A. Balsinhas, H. Joffe, V. M. Englebrecht, G. Harding, and C. H. Stirton. 1986. A catalogue of problem plants in southern Africa. Memoirs of the Botanical Survey of South Africa No. 53. Botanical Research Institute, Pretoria, South Africa. 658 pp.
Wells, M. J., and C. H. Stirton. 1982. Weed problems of South African pastures. Geobotany 2:429-434.
WESSA. 2006. *Cestrum laevigatum*. Alien Invader Plants. Wildlife and Environment Society of South Africa (WESSA). Last accessed June 24, 2013, http://www.oocities.org/wessaaliens/species/inkberry.htm.
WSSA. 2012. *Cestrum laevigatum*. Weed Science Society of America (WSSA). 6 pp.

Appendix A. Weed risk assessment for *Cestrum laevigatum* Schltdl. (Solanaceae). 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	Native to South America (NGRP, 2013; Weber, 2003). Has spread into natural grasslands in South Africa (Wells and Stirton, 1982). "It has spread rapidly in South Africa and is now a proclaimed weed" (van der Lugt et al., 1991). "Fast-growing species of the forest fringe" in South Africa that invades the forest biome (Cowling et al., 1997). "[E]xtremely abundant" in Port St Johns, South Africa (ARC, 2011). "*Cestrum laevigatum* is invasive in parts of Kenya and it has been introduced to Tanzania and Uganda" (Lusweti et al., 2011). "Naturalized in South Africa and Swaziland" (WSSA, 2012). Alternate choices for the Monte Carlo simulation are both "e."
ES-2 (Is the species highly domesticated)	n - mod	0	No evidence. *Cestrum laevigatum* is cultivated (Randall, 2012) but we found no evidence that breeding programs exist for this species.
ES-3 (Weedy congeners)	y - low	1	Holm et al. (1991) lists *Cestrum parqui* as a principal weed in Argentina (Holm et al., 1991). *Cestrum parqui* is being managed with herbicides in Australia because this plant is toxic to livestock (DAFF, 2013).
ES-4 (Shade tolerant at some stage of its life cycle)	n - mod	0	Grainger and van Aarde (2012) studied the species composition of canopy gaps and coastal dune forest, and found *C. laevigatum* growing mainly in canopy gaps (Grainger and van Aarde, 2012). Grows along forest edges, at the base of rocky slopes (Falcao and Alencastro, 1974), and in pastures (Reed, 1977). "[G]rows in coastal forests and thickets" (Fourie, 2011). Grows only in canopy gaps and along forest margins (Jose et al., 2013). "[G]rows as an under-storey" plant in forests (Botha and Venter, 2002). Because this evidence indicates that *C. laevigatum* grows mainly in sunny environments, we answered no but with moderate uncertainty.
ES-5 (Climbing or smothering growth form)	n - negl	0	*Cestrum laevigatum* is a shrub or tree in the family Solanaceae (Cowling et al., 1997; Falcao and Alencastro, 1974; NGRP, 2013).
ES-6 (Forms dense thickets)	y - low	2	"The plant forms dense stands" (Weber, 2003). "[C]apable of forming dense stands" (Fourie, 2011).
ES-7 (Aquatic)	n - negl	0	Terrestrial shrub or tree in the family Solanaceae (Cowling et al., 1997; Falcao and Alencastro, 1974; NGRP, 2013).
ES-8 (Grass)	n - negl	0	Not a grass; plant is a shrub in the family Solanaceae (Falcao and Alencastro, 1974; NGRP, 2013).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	Woody plant (Cowling et al., 1997) in the family Solanaceae, which is not known to contain nitrogen-fixing species (Martin and Dowd, 1990).
ES-10 (Does it produce viable seeds or spores)	y - negl	1	Produces seeds (Cowling et al., 1997). Reproduces by seed (Lusweti et al., 2011; Wells et al., 1986).
ES-11 (Self-compatible or apomictic)	? - max	0	Unknown.
ES-12 (Requires special pollinators)	n - mod	0	"The genus *Cestrum* (Solanaceae) includes ca. 150 species...of moth, butterfly and hummingbird pollinated small trees, shrubs, vines and robust herbs" (Monro, 2012). We answered no based

			on this evidence, but with high uncertainty because this is genus-level information.
ES-13 (Minimum generation time)	c - mod	0	Flowers from April to October, and bears fruit from June to November (Reed, 1977). Listed as a perennial plant (Cowling et al., 1997). The related species *C. parqui* is also a shrub and produces flowers after two years (DAFF, 2013). Based on this evidence, we answered "c" but with moderate uncertainty. The alternate answers for the Monte Carlo simulation are both "d."
ES-14 (Prolific reproduction)	? - max	0	Unknown. Each fruit normally contains 6 seeds (Botha and Venter, 2002).
ES-15 (Propagules likely to be dispersed unintentionally by people)	? - max	0	Unknown for *C. laevigatum*. The related species *C. parqui* can be moved to new areas when root pieces are relocated during cultivation or roadside grading (DAFF, 2013).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	n - mod	-1	No evidence.
ES-17 (Number of natural dispersal vectors)	1	-2	Fruit and seed description used to answer ES-17a through ES-17e: "Fruit: A succulent purple black berry, 1 cm in diameter, which normally contains 6 seeds" (Botha and Venter, 2002). "Seeds oblong, 4-6 mm. long and wide, 3 mm. thick, rounded dorsally with network of reticulations overlaid with semi-transparent coating, giving an extremely ridged and wrinkled appearance" (Reed, 1977).
ES-17a (Wind dispersal)	n - negl		No evidence and highly unlikely. Seeds are produced in berries (Botha and Venter, 2002) and have no adaptations for wind dispersal. Furthermore, they are relatively large.
ES-17b (Water dispersal)	? - max		*Cestrum laevigatum* "grows near rivers or watercourses" (Botha and Venter, 2002). The related species *C. parqui* also produces seeds in berries, and its seeds are spread by water movement (DAFF, 2013). Thus, it seems likely that the seeds of *C. laevigatum* could also be moved by water, but we answered unknown because this evidence is based on congeneric information.
ES-17c (Bird dispersal)	y - negl		Dispersed by birds (Cowling et al., 1997). The genus *Cestrum* is listed as bird-dispersed (Foster et al., 1986). "Seeds are dispersed by birds" (Weber, 2003).
ES-17d (Animal external dispersal)	n - low		We found no evidence. Seeds are produced in berries (Botha and Venter, 2002) and have no obvious method of attaching to animals.
ES-17e (Animal internal dispersal)	yes - high		The genus *Cestrum* spp. is listed under "Bird Dispersal (also taken by mammals)" by Foster et al. (1986). We found no other evidence that mammals eat the fruit so we used high uncertainty.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	yes - high	1	Seeds of the related species *C. parqui* "remain dormant in the soil for many years" (DAFF, 2013). *Cestrum laevigatum* seeds were found in the top 5 cm of soil of a forest seed bank in Brazil (Lopes et al., 2006). We answered yes but with high uncertainty because it is based on congeneric information.
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	? - max	0	The related species *C. parqui* regrows from cut root pieces (DAFF, 2013). *Cestrum laevigatum* is able to vegetatively reproduce through coppicing (Cowling et al., 1997) and was listed as a pioneer species growing in a forest fragment degraded by fire (Rodrigues et al., 2005). We answered unknown because this evidence is mainly based on congeneric information about *C. parqui*.

ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - mod	0	We found no evidence. Managed with herbicides (Kluge and Erasmus, 1991; Weber, 2003). Not listed by Heap (2013).
ES-21 (Number of cold hardiness zones suitable for its survival)	6	0	
ES-22 (Number of climate types suitable for its survival)	6	2	
ES-23 (Number of precipitation bands suitable for its survival)	10	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - mod	0	We found no evidence. Extract from *C. laevigatum* leaves and flowers has been shown to inhibit the growth of several phytopathogenic fungi (Mdee et al., 2009) but we found no information about *C. laevigatum* having any allelopathic properties on plants.
Imp-G2 (Parasitic)	n - negl	0	We found no evidence. Plant is a shrub or tree in the family Solanaceae (Falcao and Alencastro, 1974; NGRP, 2013) and the Solanaceae is not one of the families known to contain parasitic plant species (Heide-Jørgensen, 2008; Nickrent, 2009).
Impacts to Natural Systems			
Imp-N1 (Change ecosystem processes and parameters that affect other species)	? - max		"Little is known on the ecology of this species as an invasive plant" (Weber, 2003). Wells et al. (1986) and Henderson (2001) list this species as a transformer, but do not describe how *C. laevigatum* transforms ecosystems, so we answered unknown.
Imp-N2 (Change community structure)	? - max		*Cestrum laevigatum* forms dense stands that prevent the regeneration of native shrubs and trees (Fourie, 2011; Weber, 2003), but we found no information about this plant changing community structure. Thus, we answered unknown.
Imp-N3 (Change community composition)	y - negl	0.2	"[F]orms dense stands that shade out native plant species and prevent the natural regeneration of shrubs and trees" (Weber, 2003). Van Wilgen et al. (2008) rated *C. laevigatum* as having a moderate impact on biodiversity in South African ecosystems (van Wilgen et al., 2008). Replaces indigenous vegetation (Wells et al., 1986).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	y - mod	0.1	*Cestrum laevigatum* invades many different natural systems, including forests, savanna, grasslands, riparian habitats, and coastal dunes (Henderson, 2001; Weber, 2003) and "forms dense stands that shade out native plant species and prevent the natural regeneration of shrubs and trees" (Weber, 2003). Thus, it seems likely that *C. laevigatum* could impact Threatened and Endangered plant species in the United States.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions)	y - high	0.1	Invades forest, savanna, grassland, riparian habitats, plantations, and coastal dunes (Henderson, 2001; Weber, 2003). Van Wilgen et al. (2008) listed *C. laevigatum* as threatening the savanna biome in South Africa (van Wilgen et al., 2008). Based on this information and the geographic potential of this species (see below), *C. laevigatum* could be a threat to globally outstanding ecoregions in the United States such as the Californian coasts and chaparral lands (Ricketts et al., 1999).
Imp-N6 (Weed status in natural systems)	c - negl	0.6	*Cestrum laevigatum* is a Declared Weed in South Africa (Biosecurity New Zealand, 1999), which means this plant is prohibited in South Africa and must be controlled or eradicated

			where possible (Macdonald et al., 2003). Controlled manually and with herbicides (Weber, 2003). Research is being done to find potential biological control agents against *C. laevigatum* (Fourie, 2011). The 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)	n - mod	0	We found no evidence.
Imp-A2 (Changes or limits recreational use of an area)	y - low	0.1	De Lange and Poulter (2004) list *C. laevigatum* as an invasive plant species that interferes with fly-fishing angling. Listed as obstructing access by Wells et al. (1986).
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	n - mod	0	We found no evidence.
Imp-A4 (Weed status in anthropogenic systems)	a - low	0	Not considered to be a weed in urban and suburban areas. The plant is cultivated as an ornamental and used as a hedge plant (Henderson, 2001) Considered to be a valuable plant by indigenous people in South Africa, who use the plant for firewood (Jose et al., 2013; van Eck et al., 1997). The alternate answers for the Monte Carlo simulation are both "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	y - low	0.4	*Cestrum laevigatum* reduces farm yields by killing livestock; *C. laevigatum* poisoning has caused the deaths of cows in Brazil and is the cause of Chase Valley disease in cows in South Africa (van der Lugt et al., 1991). This plant has also killed goats on a farm in Brazil (Peixoto et al., 2000).
Imp-P2 (Lowers commodity value)	y - low	0.2	Van Wilgen et al. (2008) listed *C. laevigatum* as having a very high impact on land grazing potential.
Imp-P3 (Is it likely to impact trade)	n - mod	0	Prohibited entry into South Africa (Biosecurity New Zealand, 1999). Listed as a harmful organism by Namibia, New Zealand, and South Africa (APHIS, 2013a). However, *C. laevigatum* does not appear to follow any trade pathways, so we answered no with moderate uncertainty.
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)	y - negl	0.1	Highly toxic to cattle, sheep, and goats, causing staggering, muscle tremors, sunken eyes, and death (Falcao and Alencastro, 1974). Poisonous to cattle (Reed, 1977). Causes liver damage in cattle, resulting in animal death. Previous studies demonstrated that this plant is also toxic to sheep and goats, but not to horses, pigs, rabbits, fowl, and guinea pigs (van der Lugt et al., 1991). Toxic to buffalo (Peixoto et al., 2000).
Imp-P6 (Weed status in production systems)	c - low	0.6	Controlled with herbicides in pastureland in South Africa (Kluge and Erasmus, 1991; Wells et al., 1986). Considered a weed in its native range of Brazil and Peru (Reed, 1977). The alternate answers for the Monte Carlo simulation are both "b."
GEOGRAPHIC POTENTIAL			Below, p.s. refers to Point Source data (i.e., geo-referenced data points) and occur. refers to occurrence-only data (i.e., presence in a region).
Plant cold hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence.

Geo-Z2 (Zone 2)	n - negl	N/A	We found no evidence.
Geo-Z3 (Zone 3)	n - negl	N/A	We found no evidence.
Geo-Z4 (Zone 4)	n - negl	N/A	We found no evidence.
Geo-Z5 (Zone 5)	n - low	N/A	We found no evidence.
Geo-Z6 (Zone 6)	n - mod	N/A	We found no evidence.
Geo-Z7 (Zone 7)	n - high	N/A	We found no evidence.
Geo-Z8 (Zone 8)	y - negl	N/A	South Africa (GBIF, 2013, p.s.).
Geo-Z9 (Zone 9)	y - negl	N/A	South Africa (GBIF, 2013, p.s.).
Geo-Z10 (Zone 10)	y - negl	N/A	Border of Zambia and Zimbabwe (GBIF, 2013, p.s.) and Brazil (Falcao and Alencastro, 1974, occur.).
Geo-Z11 (Zone 11)	y - negl	N/A	Paraguay and Brazil (GBIF, 2013, p.s.).
Geo-Z12 (Zone 12)	y - negl	N/A	Brazil (Falcao and Alencastro, 1974, occur.; GBIF, 2013, p.s.).
Geo-Z13 (Zone 13)	y - mod	N/A	Brazil (Falcao and Alencastro, 1974, occur.).
Köppen-Geiger climate classes			
Geo-C1 (Tropical rainforest)	y - low	N/A	Brazil (GBIF, 2013, p.s.).
Geo-C2 (Tropical savanna)	y - low	N/A	Brazil (GBIF, 2013, p.s.).
Geo-C3 (Steppe)	y - negl	N/A	South Africa and Brazil (GBIF, 2013, p.s.).
Geo-C4 (Desert)	n - low	N/A	We found no evidence.
Geo-C5 (Mediterranean)	y - low	N/A	South Africa (GBIF, 2013, p.s.).
Geo-C6 (Humid subtropical)	y - negl	N/A	Paraguay (GBIF, 2013, p.s.).
Geo-C7 (Marine west coast)	y - negl	N/A	Peru and South Africa (GBIF, 2013, p.s.).
Geo-C8 (Humid cont. warm sum.)	n - mod	N/A	We found no evidence.
Geo-C9 (Humid cont. cool sum.)	n - low	N/A	We found no evidence.
Geo-C10 (Subarctic)	n - negl	N/A	We found no evidence.
Geo-C11 (Tundra)	n - negl	N/A	We found no evidence.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	n - mod	N/A	We found no evidence.
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	South Africa (GBIF, 2013, p.s.).
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	South Africa and Brazil (GBIF, 2013, p.s.).
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	South Africa (GBIF, 2013, p.s.).
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	Brazil (GBIF, 2013, p.s.).
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	Paraguay (GBIF, 2013, p.s.).
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	Brazil (GBIF, 2013, p.s.).
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	Brazil (GBIF, 2013, p.s.).
Geo-R9 (80-90 inches; 203-229 cm)	y - mod	N/A	We answered yes because this plant has been found in areas receiving 70-80" of rainfall and over 100" of rainfall. Thus, *C. laevigatum* is also likely to grow in areas that receive 80-90" of rainfall.
Geo-R10 (90-100 inches; 229-254 cm)	y - mod	N/A	We answered yes because this plant has been found in areas receiving 70-80" of rainfall and over 100" of rainfall. Thus, *C.*

			laevigatum is also likely to grow in areas that receive 90-100" of rainfall.
Geo-R11 (100+ inches; 254+ cm))	y - mod	N/A	Peru (GBIF, 2013, p.s.).
ENTRY POTENTIAL			
Ent-1 (Plant already here)	n - low	0	We found no evidence of *C. laevigatum* being present in the United States. Parker et al. (2007) list it as not cultivated in the United States. It is not listed by Kartesz (2013) or by Bailey and Bailey Bailey and Bailey, 1976.
Ent-2 (Plant proposed for entry, or entry is imminent)	n - mod	0	We found no evidence.
Ent-3 (Human value & cultivation/trade status)	c - low	0.25	"[I]ntroduced into southern Africa as evergreen ornamental shrubs, hedges and sometimes as windbreaks in gardens" (van der Lugt et al., 1991). Cultivated as an ornamental and used as a hedge (Henderson, 2001). The leaves are used in traditional medicine as a treatment for malaria and fevers in the Gulf of Guinea (de Madureira et al., 2002). Extract from *C. laevigatum* leaves and flowers has been shown to inhibit the growth of several phytopathogenic fungi species (Mdee et al., 2009). The Mapuche of southern Chile smoke dried *C. laevigatum* leaves as a substitute for cannabis to induce hallucinogenic visions (Pennacchio et al., 2010). Listed as cultivated by Randall (2012). However, we did not find any online sources offering this plant for sale, so we answered "c."
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	n - mod		We found no evidence. *Cestrum laevigatum* is present in South America and South Africa (GBIF, 2013; NGRP, 2013).
Ent-4b (Contaminant of plant propagative material (except seeds))	n - mod	0	We found no evidence.
Ent-4c (Contaminant of seeds for planting)	n - mod	0	We found no evidence.
Ent-4d (Contaminant of ballast water)	n - mod	0	We found no evidence.
Ent-4e (Contaminant of aquarium plants or other aquarium products)	n - mod	0	We found no evidence.
Ent-4f (Contaminant of landscape products)	n - mod	0	We found no evidence.
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	? - max		Unknown for *C. laevigatum*. The related species *C. parqui* can be moved to new areas when root pieces are relocated during cultivation or roadside grading (DAFF, 2013).
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	n - mod	0	We found no evidence.
Ent-4i (Contaminant of some other pathway)	a - mod	0	We found no evidence of this *C. laevigatum* contaminating other pathways.
Ent-5 (Likely to enter through natural dispersal)	n - mod	0	We found no evidence.