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Weed Risk Assessment for *Cordia curassavica* (Jacq.) Roem. & Schult. (Boraginaceae) – Black sage

Inflorescence of *Cordia curassavica* (source: Marcia Stephani, http://en.wikipedia.org/wiki/File:Cordia_curassavica_1.jpg).

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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.

Species Information

***Cordia curassavica* (Jacq.) Roem. & Schult. – Black sage**

Family: Boraginaceae

Synonyms: *Varronia curassavica* Jacq., [Acevedo-Rodríguez and Strong, 2012; NGRP, 2013]; *Cordia macrostachya* (Jacq.) Roem. & Schult [NGRP, 2013].

Initiation: On November 25, 2011, Al Tasker (PPQ, National Weeds Program Coordinator) asked the PERAL Weed Team to evaluate *Cordia curassavica* for potential listing as a Federal Noxious Weed (Tasker, 2011). This species has been proposed for listing under APHIS' Not Authorized Pending Pest Risk Analysis (NAPPRA) regulations (APHIS, 2011).

Foreign distribution: This species is native from southern Mexico throughout Central America and the Caribbean, and most of South America (Acevedo-Rodríguez and Strong, 2012; Boggan et al., 1997; NGRP, 2013). It has naturalized in Christmas Island, Indonesia, Malaysia, Mauritius, and Singapore (NGRP, 2013).

U.S. distribution and status: In 2010, it was detected in the United States for the first time in Broward County, Florida, where it is escaping or possibly naturalized (Wunderlin et al., 2010). It is not known to occur anywhere else in the United States.

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. *Cordia curassavica* analysis

Establishment/Spread Potential *Cordia curassavica* has a demonstrated ability to establish and rapidly spread. After introduction, this species rapidly spread through Mauritius, Malaysia, and Sri Lanka (Dassanayake and Fosberg, 1991; Simmonds, 1980; Ung et al., 1979; Williams, 1948, 1961). Williams (1948). Researchers attribute its success in Mauritius partially to climatic suitability, dispersal by birds, and lack of natural enemies. This species forms dense populations (Fowler et al., 2000; Greathead, 2003; Ung et al., 1979), resists mutilation (Ung et al., 1979; Williams, 1961), and rapidly regrows after herbicide application (Ung et al., 1979). By one report it reproduces prolifically (Wiehe, 1946 cited in Williams, 1961) but two other sources indicate it does not produce many seeds (Simmonds, 1951; Ung et al., 1979) relative to a threshold of 1,000 seeds per square meter. We had an average amount of uncertainty for this risk element.
Risk score = 11 Uncertainty index = 0.19

Impact Potential Although this species may displace native species (Greathead, 2003) and is considered an urban weed (Dassanayake and Fosberg, 1991; Simmonds, 1980), it seems to primarily affect production systems, such as sugarcane plantations in Mauritius (Maulik, 1947). In a Malaysian coconut plantation, it retards the growth of young trees (Simmonds, 1980; Ung et al., 1979). High population density of this large shrub can hinder access to plantation trees (Ung et al., 1979). Several biological control agents were introduced and effectively controlled this species in Malaysia and Mauritius (Callan, 1948; Simmonds, 1951, 1980). Due to the limited amount of literature on this species, we had relatively high uncertainty for this risk element.
Risk score = 2.9 Uncertainty index = 0.26

Geographic Potential Based on three climatic variables, we estimate that about 8 percent of the United States is suitable for the establishment of *C. curassavica* (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 *C. curassavica* represents the joint distribution of Plant Hardiness Zones 9-13, areas with 0-100+ inches of annual precipitation, and the following Köppen-Geiger climate classes: tropical rainforest, tropical savanna, steppe, desert, humid subtropical, and marine west coast. We had high uncertainty regarding whether this species could survive in Plant Hardiness Zone 9 since the few points we saw for this zone occurred just within the border. Those populations may occur in somewhat sheltered microhabitats in this zone. If zone 9 is indeed too cold for this species' establishment, then only about 1 percent of the United States would be suitable for *C. curassavica*.

The area estimated likely represents a conservative estimate as it uses three climatic variables to estimate the area of the United States that is suitable for establishment of the species. Other environmental variables, such as soil and habitat type, may further limit the areas in which this species is likely to establish. *Cordia curassavica* occurs in damp to dry thickets, from sea level to 1,300 meters altitude (de Oliveira et al., 2007; Matuda, 1950; Reed, 1977), but it may not compete well above about 500 meters (Williams, 1948). In its native range, it primarily occurs in successional habitats (Opler et al., 1975).

Entry Potential We did not assess the entry potential of *C. curassavica* because it is already present in the United States (see above).

Figure 1. Predicted distribution of *Cordia curassavica* 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) = 55.0%
P(Minor Invader) = 42.6%
P(Non-Invader) = 2.4%

Risk Result = High Risk

Secondary Screening = Not Applicable

Figure 2. *Cordia curassavica* 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.

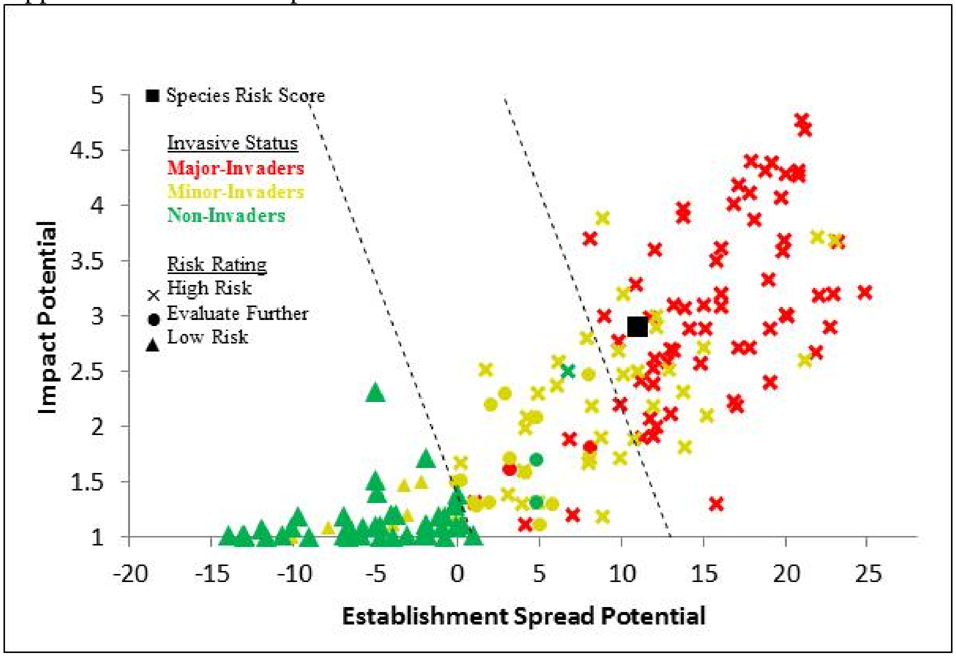
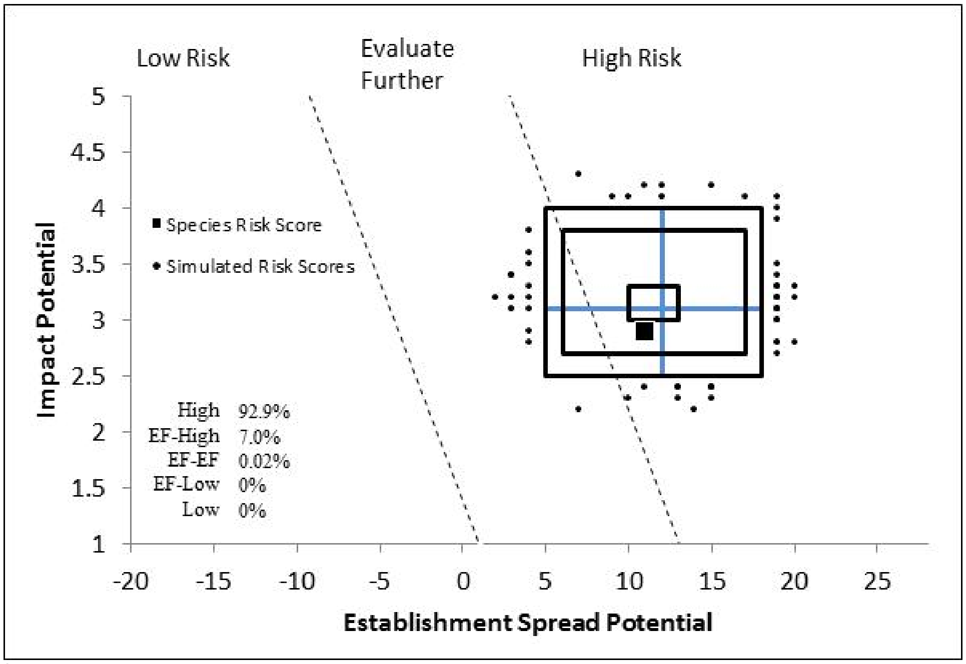


Figure 3. Monte Carlo simulation results (N=5,000) for uncertainty around the risk scores for *Cordia curassavica*[a].



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

3. Discussion

The result of the weed risk assessment for *C. curassavica* is High Risk (Fig. 2). This species has naturalized and spread in Christmas Island, Malaysia, Mauritius, and Sri Lanka (Dassanayake and Fosberg, 1991; Simmonds, 1980; Swarbrick, 1997; Ung et al., 1979). It forms dense, impenetrable thickets in disturbed and agricultural areas (Fowler et al., 2000; Greathead, 2003; Swarbrick, 1997). In one case it rendered a 2000-ha coconut plantation unproductive because it overtopped the young trees (see photo in Ung et al., 1979). Two biocontrol agents introduced to Mauritius to control the species have been so successful that the plant is no longer considered a weed (Fowler et al., 2000). Overall, our analysis had moderate to high uncertainty, particularly due to the lack of recent scientific evidence. However, the uncertainty simulation indicated that the conclusion of High Risk was robust (Fig. 3).

Cordia curassavica has been collected from one disturbed site in the United States (Wunderlin et al., 2010). It is not clear from this report how abundant the species is or whether it can be considered to be truly naturalized. This species is cultivated as a medicinal plant in Central and South America (Albuquerque et al., 2012; Hernandez et al., 2007; Mussi-Dias et al., 2012), so someone may have introduced it to southern Florida. Still, we found no evidence that *C. curassavica* is commercially cultivated in the United States. Our analysis found that it is highly likely to become invasive in the United States, although it may undergo a lag phase prior to invasion as it has elsewhere (e.g., Malaysia; Simmonds, 1980). Because this species can hybridize with certain members of the genus Cordia (those in section *Varronia*) (Dassanayake and Fosberg, 1991), it may threaten the Florida native *Cordia globosa*.

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Appendix A. Weed risk assessment for *Cordia curassavica* (Jacq.) Roem. & Schult. (Boraginaceae). 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	Native to Central America, the Caribbean, and tropical South America (NGRP, 2013). It has naturalized in Indonesia, Madagascar, Malaysia, Mauritius, and Singapore (Dassanayake and Fosberg, 1991; Kull et al., 2012; NGRP, 2013). Introduced to Malaysia in 1897 into a botanical garden and by 1954 had rapidly spread across peninsular Malaysia, and continues to spread (Simmonds, 1980; Ung et al., 1979). It rapidly spread throughout Mauritius (Williams, 1948). A report that it is "widely established as a common weed" in Sri Lanka (Dassanayake and Fosberg, 1991) suggests it has readily spread. Naturalized on Christmas Island and widespread (Swarbrick and Hart, 2001). "*Cordia curassavica* is now abundant around the Townships and other highly disturbed places throughout the Dog's Head area and is becoming increasingly common elsewhere around the island, especially in previous rehabilitation areas and along roadsides" (Swarbrick, 1997). Alternate answers for the Monte Carlo simulation are both "e."
ES-2 (Is the species highly domesticated)	n - low	0	Cultivated as a medicinal plant in Brazil (Albuquerque et al., 2012; Mussi-Dias et al., 2012). Used in traditional Mexican medicine (Hernandez et al., 2007). However, we found no evidence that it has been bred for reduced weed potential.
ES-3 (Weedy congeners)	y - low	1	*Cordia boissieri* is a principal weed in Mexico (Holm et al., 1979). Several other species of *Cordia* are listed as weeds in Randall (2012), but in particular is *C. alliodora*, which is known to or suspected of causing significant ecological change in the Galapagos Islands (Tye, 2001). *Cordia alliodora* is a significant weed in Mexico (Puerto, n.d.). *Cordia collococca* is listed as an economically important weed, but its impacts are not described (Reed, 1977).
ES-4 (Shade tolerant at some stage of its life cycle)	n - low	0	Shade-intolerant species (Green et al., 2004). In Costa Rica, "*Cordia curassavica* occurs in well-drained, frequently rocky, xeric habitats associated with broken dry forest, or at forest margins." (Opler et al., 1975). For Christmas Island, management recommendations include using rainforest canopy tree species to overtop and shade it out (Swarbrick and Hart, 2001). Seeds germinate in well-lit disturbed areas (U.S. Forest Service, 2013). Together this evidence indicates this is a light-adapted species.
ES-5 (Climbing or smothering growth form)	n - negl	0	Plant is a multi-stemmed shrub growing to three meters tall (Reed, 1977; Swarbrick, 1997), not a vine.
ES-6 (Forms dense thickets)	y - negl	2	Developed dense thickets in Mauritius (Fowler et al., 2000; Greathead, 2003). Occurs in an almost solid stand of 2000 hectares in Malaysia in a coconut plantation (Simmonds, 1980; Ung et al., 1979).
ES-7 (Aquatic)	n - negl	0	Plant is a 1-1.5 meter tall shrub (Albuquerque et al., 2012;

			Reed, 1977). Grows up to 3 meters tall in Malaysia (Ung et al., 1979).
ES-8 (Grass)	n - negl	0	Plant is not a grass; it is in the Boraginaceae family (NGRP, 2013).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	Plant is in the Boraginaceae (NGRP, 2013), which is not one of the families known to contain nitrogen-fixing species (Martin and Dowd, 1990).
ES-10 (Does it produce viable seeds or spores)	y - negl	1	Reproduces through seeds only (Albuquerque et al., 2012; Williams, 1948).
ES-11 (Self-compatible or apomictic)	n - low	-1	This species is heterostylous (Opler et al., 1975; Taisma and Varela, 2005). A pollination experiment showed that self-pollination produced no pollen tubes at the style (Taisma and Varela, 2005). Except for *C. alliodora*, all *Cordia* species are either heterostylous with associated self-incompatibility or are dioecious (Opler et al., 1975).
ES-12 (Requires special pollinators)	n - negl	0	*Cordia curassavica* uses nectar to attract pollinators (Opler et al., 1975). Cream-colored flowers attract numerous butterflies, wasps, bees, and flies, many of which are effective pollinators (Opler et al., 1975). In a detailed study of the reproductive biology of eight *Cordia* species, no specialized pollinators were described. Using "negl" uncertainty because this was a detailed study (Opler et al., 1975).
ES-13 (Minimum generation time)	c - high	0	Plant is a perennial shrub (Albuquerque et al., 2012). It is unlikely that a shrub germinating from seed would be producing flowers within its first year. One source states that plants that are “probably two years old” produce flowers (Callan, 1948). Consequently answering "c," but with "high" uncertainty. The alternate answers for the Monte Carlo simulation are "d" and "b."
ES-14 (Prolific reproduction)	n - high	-1	Fruit contain one seed (U.S. Forest Service, 2013); also see drawing in Ung et. al. (1979). "Weiche (1946) after investigating the ecology of *C. macrostachya* [synonym of *C. curassavica*] in Trinidad and in Mauritius, concluded that the invading power of the plant in the latter country was due to a profuse production of viable fruits, and that this in turn was due to the plant's comparative freedom from injurious insects" (Williams, 1961). The cited author then estimated that one acre of scrub was producing 134 million viable seed annually (Williams, 1961), which is about 33,111 seeds per square meter. However, this estimate seems unusually high for a shrub producing fleshy berries. Without being able to see the original document, we have little confidence in this report. From a simulated herbivory experiment, a potted control bush that was about 3 feet high and 2 feet in diameter had 575 buds, flowers and fruit at the peak of its reproductive period, which is approximately 492 units per square meter (Simmonds, 1951). An estimate from Malaysia indicates 750 seeds per square meter (Ung et al., 1979). These last two estimates seem much more reasonable and suggest the rate is likely to be less than the threshold of 1,000 per square meter.
ES-15 (Propagules likely to be dispersed unintentionally by people)	? - max	0	Unknown.
ES-16 (Propagules likely to	y - high	2	Accidentally introduced into Mauritius in a consignment of

disperse in trade as contaminants or hitchhikers)			sugarcane (Maulik, 1947; Simmonds, 1949); but the details of this are lacking. It seems unlikely that this species would follow a commercial pathway; however, without additional information, answering "y" but with high uncertainty.
ES-17 (Number of natural dispersal vectors)	1	-2	For ES17a-ES17e: Seeds are 4.5-5 x 3.5 mm (Reed, 1977). Has red-colored, fleshy fruit with thin testas (Opler et al., 1975). Red-colored fruit (5 mm across) have one seed each (Swarbrick, 1997).
ES-17a (Wind dispersal)	n - negl		No evidence, and highly unlikely given the size of the fruit and their obvious adaptation for frugivory (Reed, 1977; Swarbrick, 1997).
ES-17b (Water dispersal)	n - mod		No evidence.
ES-17c (Bird dispersal)	y - negl		Fruits are bird dispersed (Dassanayake and Fosberg, 1991; Opler et al., 1975). Using "negl" uncertainty because this was a detailed study comparing the reproductive and life history features of several *Cordia* species (Opler et al., 1975). Several bird species consume fruit and pass seeds unharmed (Williams, 1948).
ES-17d (Animal external dispersal)	n - low		No evidence of mechanisms to allow attachment to animals. Fruit appear to be adapted for frugivory.
ES-17e (Animal internal dispersal)	? - max		No evidence, but it may be possible that some animal species may consume the fruit and disperse the seeds elsewhere. Fruit of *Cordia bicolor*, which measure 8 mm in length (Wehncke and Dalling, 2005), are dispersed by various mammal species (Beckman and Muller-Landau, 2007).
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	? - max	0	The viability of seeds in the soil is unknown (Swarbrick, 1997).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	y - low	1	"*Cordia* bushes are very tolerant to mechanical injury and uprooting is normally necessary to kill them" (Williams, 1961). They regenerate rapidly, and abundant foliage can be seen only one month following slashing (Ung et al., 1979).
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - mod	0	Not listed by Heap (2013). Appears to be somewhat tolerant of some herbicides applied in Malaysia as it still regenerates (Ung et al., 1979); however, this does not seem to be evidence of resistance as the plants are regenerating after herbicide damage.
ES-21 (Number of cold hardiness zones suitable for its survival)	5	0	
ES-22 (Number of climate types suitable for its survival)	6	2	
ES-23 (Number of precipitation bands suitable for its survival)	11	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - mod	0	No evidence.
Imp-G2 (Parasitic)	n - negl	0	Plant is in the Boraginaceae family (NGRP, 2013), which is not a family 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)	n - mod	0	No evidence.

Imp-N2 (Change community structure)	n - mod	0	No evidence.
Imp-N3 (Change community composition)	y - low	0.2	Prior to biocontrol, dense thickets displaced native vegetation on Mauritius (Greathead, 2003). Crowds out other vegetation (U.S. Forest Service, 2013).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	y - mod	0.1	Based on this species' ability to displace native vegetation, it seems likely it could affect T&E species in the United States.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions)	? - max		Unknown. The only evidence of impact to natural systems is that this species displaces native vegetation. In disturbed and production areas it is more problematic. Because of its impacts in these systems, there seems to be a potential to impact entire ecoregions, but without additional evidence we are answering this question as "unknown."
Imp-N6 (Weed status in natural systems)	a - high	0	It is not clear whether *C. curassavica* is considered a weed of natural areas. Biological control agents have been used to control this species, with success, in Malaysia, Mauritius, and Sri Lanka (Denoth et al., 2002; Radosevich et al., 2007). Biocontrol agents were introduced in 1947 and 1949 to control it on Mauritius (Greathead, 2003). But based on the literature, it seems this was motivated by impacts to agricultural systems, and not natural ones. Plant is of conservation concern on Christmas Island (Swarbrick, 1997), but it is not clear if this can be interpreted to mean a weed of natural areas. Answering "a," but with "high" uncertainty because of the lack of clarity on this issue. Alternate answers for the Monte Carlo simulation are "b" and "c."
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Impacts human property, processes, civilization, or safety)	n - mod	0	No evidence.
Imp-A2 (Changes or limits recreational use of an area)	? - max		Unknown. There is no evidence of this impact in recreational areas. However, because it makes passage through coconut plantations very difficult (Ung et al., 1979), it is possible it may have a similar effect in recreational areas. One author states it used to form an almost impenetrable undergrowth in Mauritius (Wiehe, 1960), but the author didn't clarify in which kinds of environments.
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	y - mod	0.1	"Interferes in rehabilitation" (i.e., the reforestation) of mine sites on Christmas Island (Swarbrick, 1997).
Imp-A4 (Weed status in anthropogenic systems)	b - high	0.1	It is a peri-urban weed (Simmonds, 1980). Common around townships on Christmas Island (Swarbrick, 1997). Roadside weed in Sri Lanka (Dassanayake and Fosberg, 1991). Common weed along roadsides and other heavily disturbed urban areas on Christmas Island (Swarbrick and Hart, 2001). Recommended for control at mine sites on Christmas Island (Swarbrick, 1997). Because a recommendation of control is not the same as evidence of control, and because we could not acquire the entire original document, answering "b" but with "high" uncertainty. Both alternate answers for the Monte Carlo simulation are "c."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product	y - low	0.4	Competes for nutrients and sunlight in a young coconut

yield)			plantation, inhibiting normal crop growth (Simmonds, 1980; Ung et al., 1979). Rendered a 2000-ha coconut plantation in Malaysia unproductive (see photo in Ung et al., 1979).
Imp-P2 (Lowers commodity value)	y - low	0.2	Prior to biological control, dense thickets displaced pasture vegetation on Mauritius (Greathead, 2003). Grows so densely that passage through coconut plantations is nearly impossible and only the tips of 5-10 year old coconut fronds can be seen (Ung et al., 1979).
Imp-P3 (Is it likely to impact trade)	y - high	0.2	This species is associated with agriculture, and there has been one documented instance of introduction with sugarcane (Maulik, 1947; Simmonds, 1949), but this may be a rare case. *Cordia curassavica* is regulated by the government of India (APHIS, 2013). Consequently answering "y" but with "high" uncertainty.
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)	n - mod	0	No evidence.
Imp-P6 (Weed status in production systems)	c - negl	0.6	A principal weed in Trinidad, where it is native (Holm et al., 1979). A weed in sugarcane plantations in Mauritius (Maulik, 1947). A weed of aloe-growing areas in Mauritius (Williams, 1961). An agricultural weed in a young coconut plantation in Malaysia (Simmonds, 1980). The Malaysian Dept. of Agriculture in 1977 evaluated mechanical slashing followed by herbicide application, but found that this was not practical (Simmonds, 1980). They then looked to a biocontrol program which was effective in Mauritius (Simmonds, 1980). Both alternate answers for the Monte Carlo simulation are "b."
GEOGRAPHIC POTENTIAL			Unless otherwise noted, all evidence below represents point-occurrences obtained from GBIF (2013).
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 - negl	N/A	No Evidence.
Geo-Z6 (Zone 6)	n - negl	N/A	No Evidence.
Geo-Z7 (Zone 7)	n - negl	N/A	No Evidence.
Geo-Z8 (Zone 8)	n - negl	N/A	No Evidence.
Geo-Z9 (Zone 9)	y - high	N/A	Some points in Mexico.
Geo-Z10 (Zone 10)	y - negl	N/A	Argentina, Mexico.
Geo-Z11 (Zone 11)	y - negl	N/A	Mexico, Brazil.
Geo-Z12 (Zone 12)	y - negl	N/A	Mexico.
Geo-Z13 (Zone 13)	y - negl	N/A	Suriname, French Guiana.
Köppen-Geiger climate classes			
Geo-C1 (Tropical rainforest)	y - negl	N/A	Brazil, Guyana, French Guiana.
Geo-C2 (Tropical savanna)	y - negl	N/A	Thailand, Mexico, Brazil.
Geo-C3 (Steppe)	y - low	N/A	A few points in Brazil, Bolivia, and Mexico.
Geo-C4 (Desert)	y - mod	N/A	A few points in Mexico.
Geo-C5 (Mediterranean)	n - low	N/A	No evidence.

Geo-C6 (Humid subtropical)	y - negl	N/A	Brazil, Argentina. The United States (Broward County, Florida) (Wunderlin et al., 2010).
Geo-C7 (Marine west coast)	y - high	N/A	A couple of points in Mexico, Colombia.
Geo-C8 (Humid cont. warm sum.)	n - negl	N/A	No evidence.
Geo-C9 (Humid cont. cool sum.)	n - negl	N/A	No evidence.
Geo-C10 (Subarctic)	n - negl	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)	y - mod	N/A	A few points in Mexico. The locality info from GBIF indicates it is occurring in wet habitats such as streams and drainages.
Geo-R2 (10-20 inches; 25-51 cm)	y - low	N/A	A few points in Mexico. The locality info from GBIF indicates it is occurring in wet habitats such as streams and drainages. Lagunillas semiarid enclave of Venezuelan Andes which receives 450-500 mm annual precipitation (Larrea-Alcázar and Soriano, 2008).
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	Brazil. Lagunillas semiarid enclave of Venezuelan Andes which receives 450-500 mm annual precipitation (Larrea-Alcázar and Soriano, 2008).
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	Brazil, Venezuela, Mexico.
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	Brazil.
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	Brazil.
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	Brazil.
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	Mexico.
Geo-R9 (80-90 inches; 203-229 cm)	y - negl	N/A	Mexico.
Geo-R10 (90-100 inches; 229-254 cm)	y - negl	N/A	Surinam.
Geo-R11 (100+ inches; 254+ cm))	y - negl	N/A	French Guiana, Guyana.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - low	1	Reported as naturalized in an urban park in Broward County, Florida (Wunderlin et al., 2010).
Ent-2 (Plant proposed for entry, or entry is imminent)	-	N/A	
Ent-3 (Human value & cultivation/trade status)	-	N/A	Cultivated as a medicinal plant in Brazil (Albuquerque et al., 2012; Mussi-Dias et al., 2012) with anti-inflammatory action (Moura and Grazia, 2011). Used as a medicinal plant by traditional healers in eastern Nicaragua (Coe et al., 2012). Composition of its essential oils have been examined (de Oliveira et al., 2007).
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	