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Weed Risk Assessment for *Ardisia crenata* Sims (Myrsinaceae) – Coralberry ardisia

Left: A population of *A. crenata* in Earleton, FL (Alachua Co) near Lake Santa Fe (source: Jeff Hutchinson; provided by the University of Florida, Center for Aquatic and Invasive Plants). Right: Habit of *A. crenata* showing fruit produced during the previous year and developing flowers of the current year (source: Chris Evans, River to River CWMA, Bugwood.org).

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.

***Ardisia crenata* Sims – Coralberry ardisia**

Species Information

Family: Myrsinaceae

Initiation: On June 26, 2012, Ken Langeland, Professor at the University of Florida’s Center for Aquatic and Invasive Plants, asked if a weed risk assessment for *Ardisia crenata* was available, because he wanted to propose that the State of Florida list it as a state noxious weed (Langeland, 2012). Based on that request, the PERAL Weed Team initiated this assessment.

Foreign distribution: Native from Japan through southeast Asia, including China, India, Japan, Malaysia, Myanmar, South Korea, Taiwan, the Philippines, Thailand, and Vietnam (NGRP, 2012; Ohwi, 1984). Introduced to and naturalized in the Cook Islands (Space and Flynn, 2002), New Zealand (Heenan, 2002; Howell and Sawyer, 2006), Mauritius (Lorence and Sussman, 1986), the Seychelles (NGRP, 2012), Australia (Csurhes and Edwards, 1998; Randall, 2007), Madagascar (Kull et al., 2012), Réunion (Soubeyran, 2008), and South Africa (Macdonald et al., 2003; Nel et al., 2004).

U.S. distribution and status: *Ardisia crenata* is naturalized in AL, FL, GA, HI, LA, and TX (Kartesz, 2012; NRCS, 2012; UG, 2012). In Florida it is well distributed, occurring from central to northern Florida, and is under control by the Florida Department of Environmental Protection (Meisenburg, 2007). It may be controlled locally by other agencies in Florida and elsewhere, but we did not evaluate this. In other southeastern U.S. states, it is only present in a few counties each (UG, 2012). This species has also been introduced to Puerto Rico (Acevedo-Rodríguez and Strong, 2012), but its status there is unclear.

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. *Ardisia crenata* analysis

Establishment/Spread Potential *Ardisia crenata* has escaped and naturalized in several countries, including the United States (Heenan, 2002; Howell and Sawyer, 2006; Kull et al., 2012; Randall, 2007; Soubeyran, 2008). In the United States, it readily escapes from cultivation, and establishes and spreads in natural systems (Dozier, 1999; Kitajima et al., 2006). This species can grow in shade, form dense populations, and self-pollinate (Kitajima et al., 2006; Lorence and Sussman, 1986; Mu et al., 2010; Singhurst et al., 1997). Some bird species consume and disperse the fruit (Meisenburg, 2007; Space and Flynn, 2002; Staples et al., 2000), and although mammals may also disperse seeds, they may not consume it very often or move them very far (Meisenburg, 2007). Plants readily resprout after significant damage to aboveground stems (Dozier, 1999). Uncertainty was low due to the availability of several ecological studies.
Risk score = 12 Uncertainty index = 0.05

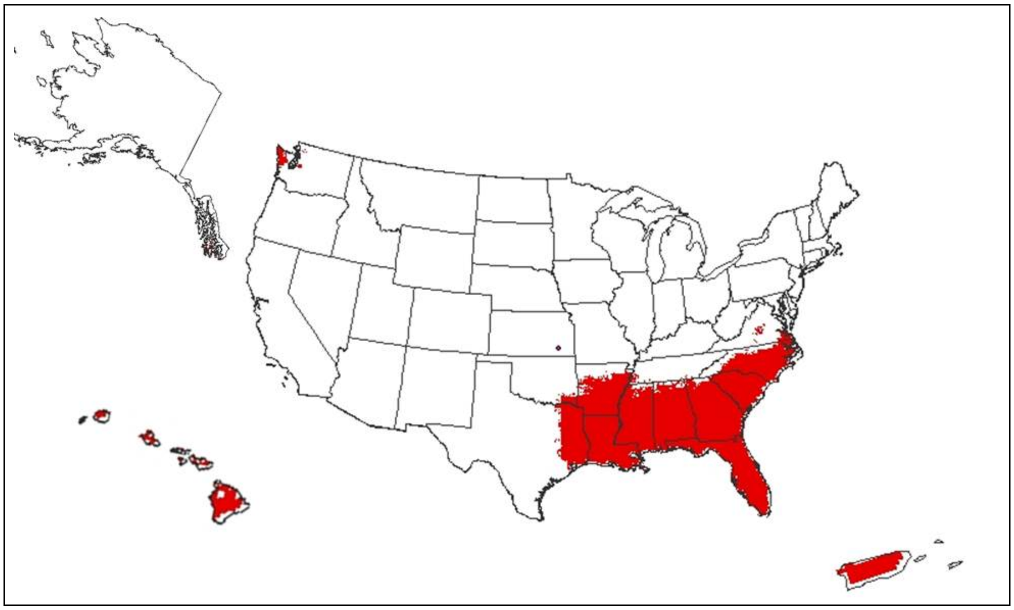
Impact Potential *Ardisia crenata* primarily causes problems in natural systems where dense populations of up to 300 stems per square meter form (Kitajima et al., 2006). Canopy cover of *A. crenata* is negatively associated with native species coverage and diversity (Fox and Kitajima, 2001). Dense, nearly monospecific populations alter the structure of the forest understory and alter forest regeneration (Dozier, 1999). In the United States, *A. crenata* canopies are fuller than in its native range in Japan (Kitajima et al., 2006), reducing understory light by an additional 70 percent. Fuller canopies increase the species' ability to compete with native species (Dozier, 1999). Mechanical and chemical strategies are available to control *A. crenata* (Hutchinson et al., 2011; Langeland and Stocker, 2001; Weber, 2003). It is being managed by the Florida Department of Environmental Protection (Meisenburg, 2007) and is a prohibited plant in South Africa (Macdonald et al., 2003; Nel et al., 2004). One source categorized *A. crenata* as an agricultural weed (Randall, 2007), but we found no other information to support this. We had low uncertainty for this risk element.
Risk score = 2.8 Uncertainty index = 0.12

Geographic Potential We estimate that about 11 percent of the United States is suitable for the establishment of *A. crenata* (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 (GBIF, 2012; Mu et al., 2010; Niu et al., 2012). The map represents the joint distribution of Plant Hardiness Zones 8-13, areas with 40-100+ inches of annual precipitation, and the following Köppen-Geiger climate classes: tropical rainforest, tropical savanna, humid subtropical, and marine west coast. A few dozen points were clustered in or southwest of Tokyo, Japan (hardiness zone 7), but given this species' cold sensitivity and the heat island effect associated with large cities, we assumed that it cannot generally live in this hardiness zone. The coldest suitable zone reported for this species is zone 8 (DavesGarden, 2012; Page and Olds, 2001).

The estimated distribution likely represents a conservative estimate, as it uses only three climatic variables. Other environmental variables, such as soil and habitat type, will further limit the areas in which this species is likely to establish. *Ardisia* *crenata* thrives in acidic soils of suburban, urban, and natural woodlands (FNA Editorial Committee, 2009). It invades forest margins and understories, and riverbanks in swamp forests (Agriculture Research Council, 2009). Though not shown, *A. crenata* may be able to establish in warm microclimates of some zone 7 cities.

Entry Potential We did not assess *Ardisia crenata*'s entry potential because this species is already present in the United States (Kartesz, 2012; NRCS, 2012).

Figure 1. Predicted distribution of *Ardisia crenata* 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) = 59.3%
P(Minor Invader) = 38.6%
P(Non-Invader) = 2.0%

Risk Result = High Risk
Secondary Screening = Not Applicable

Figure 2. *Ardisia crenata* 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.

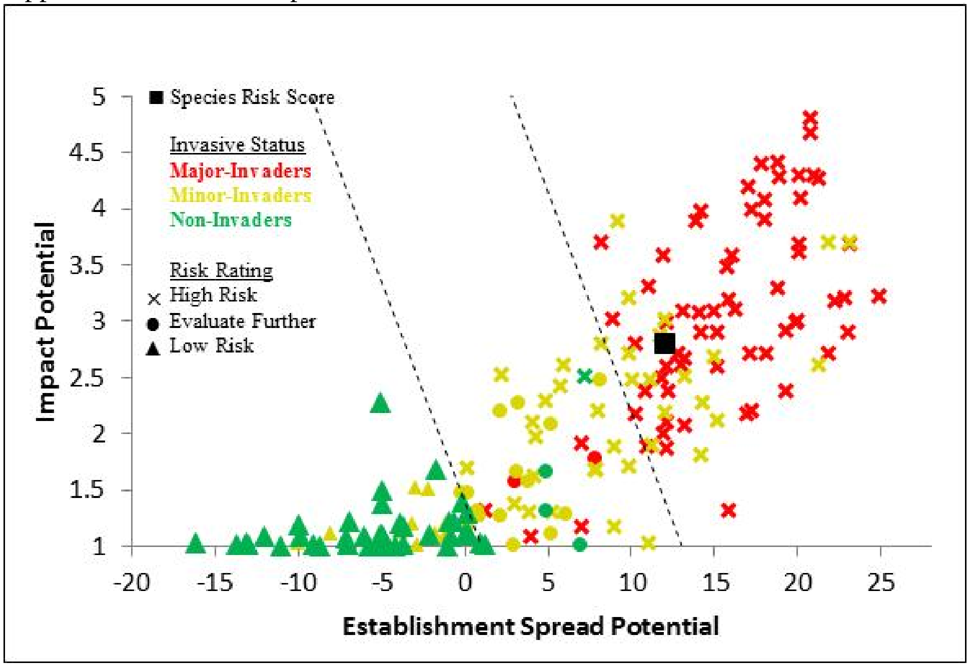
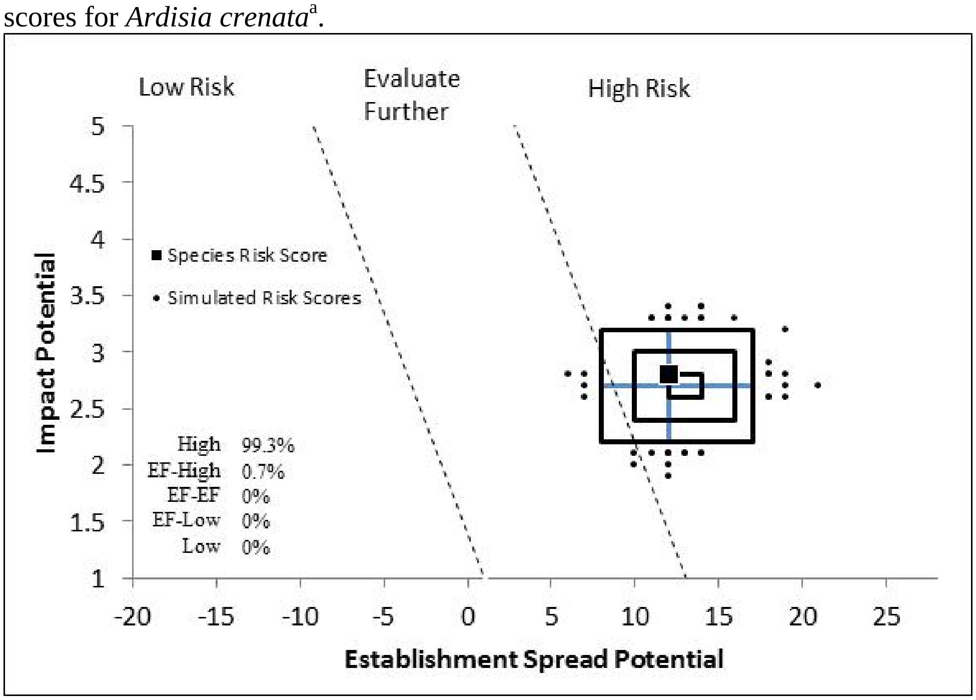


Figure 3. Monte Carlo simulation results (N=5,000) for uncertainty around the risk scores for *Ardisia crenata*[a].



[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 *A. crenata* is High Risk (Fig. 2). Because we found several ecological studies on this species, our uncertainty for both risk elements was low. The Monte Carlo simulation of the impact of uncertainty demonstrates that the model result was robust (Fig. 3). Furthermore, three other weed risk assessments of this species have also concluded it is medium-high to high risk (IFAS, 2011; Nishida et al., 2009; UH, 2012).

Ardisia crenata is capable of establishing and spreading in undisturbed forests due to its high shade tolerance (Lorence and Sussman, 1986). Because it does not produce a seed bank, *A. crenata* may be somewhat easier to manage in natural areas than plants which do develop long-term seed banks (Fox and Kitajima, 2001). Its conspicuous bright red berries further contribute to ease of control. The main challenge for managers, however, is that this widely cultivated species may often reinvade natural areas from ornamental plantings. *Ardisia crenata* has been cultivated in Florida since at least 1900 (Meisenburg, 2007), and is sold in national home improvement stores (Koop, personal observation). Florida growers reported yearly sales of over $100,000 in 2004 (Wirth et al., 2004). Cultivars introduced into the United States may be more invasive and damaging than the wild type due to selection by horticulturalists for a fuller plant canopy, more fruit, and greater storage of carbohydrates in roots (Kitajima et al., 2006).

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Appendix A. Weed risk assessment for *A. crenata* Sims (Myrsinaceae). 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	Although the invasive status of this species varies from country to country, the literature indicates this species is capable of naturalizing and spreading, as it has in the United States. Evidence: Introduced and cultivated in the Cook Islands (Space and Flynn, 2002). Introduced to Puerto Rico but it is unclear if it has naturalized there (Acevedo-Rodríguez and Strong, 2012). Casual/escaping in New Zealand in 1996 (Heenan, 2002; Howell and Sawyer, 2006). Naturalized in the Seychelles (NGRP, 2012), Australia (Csurhes and Edwards, 1998; Randall, 2007), and Madagascar (Kull et al., 2012). Invasive in La Réunion (Soubeyran, 2008). Described as not invasive in the Flora of North America (FNA Editorial Committee, 2009), but other authors report it as invasive in the United States. Invasive in Florida (Dozier, 1999; Kaufman and Kaufman, 2007; Kitajima et al., 2006). Invasive in southern forests (Miller, 2003), but the author doesn't really describe his terminology. Invades woodlands in South Africa (Agriculture Research Council, 2009; Henderson, 2001). Species is described from a 1940s reference of the vegetation of Mauritius as having penetrated every forest on the island, even those not disturbed by human activity (Lorence and Sussman, 1986). Both alternate answers for the Monte Carlo simulation were "e".
ES-2 (Is the species highly domesticated)	n - negl	0	*Ardisia crenata* is an ornamental plant (NGRP, 2012) and is cultivated in Florida (Wirth et al., 2004). Cultivars have been selected for different-colored fruit and for higher fecundity (Csurhes and Edwards, 1998; Kitajima et al., 2006). There is no evidence that cultivation has reduced weed or invasive potential; in fact, it may have increased it (Kitajima et al., 2006).
ES-3 (Weedy congeners)	y - negl	1	Several species of *Ardisia* are considered weeds (Randall, 2007). Of these, *Ardisia elliptica* is a significant weed due to its rapid spread, dense stands, and impact on native species diversity (Koop, 2003; Randall and Marinelli, 1996).
ES-4 (Shade tolerant at some stage of its life cycle)	y - negl	1	*Ardisia crenata* is shade tolerant (Lorence and Sussman, 1986; Singhurst et al., 1997). It grows in woodlands, forest margins and understories, and riverbanks in swamp forests (Agriculture Research Council, 2009; FNA Editorial Committee, 2009). In its native range, it grows in dark damp places (Tassin et al., 2006). Light levels above 5 percent of full sun decrease seedling biomass, relative growth rate, and survival (Dozier, 1999).
ES-5 (Climbing or smothering growth form)	n - negl	0	Species is not a vine or with a smothering basal rosette. Species is a 1-1.5 meter tall woody shrub (FNA Editorial Committee, 2009).
ES-6 (Forms dense thickets)	y - low	2	Forms dense thickets in wet forests in Mauritius; average density is 21 seedlings per square meter (Lorence and Sussman, 1986). May reach densities of 100 plants per square meter (Langeland and Burks, 1998). Up to 300 stems per square meter (Kitajima et al., 2006).

Question ID	**Answer - Uncertainty**	**Score**	**Notes (and references)**
ES-7 (Aquatic)	n - negl	0	Species is a terrestrial shrub (FNA Editorial Committee, 2009).
ES-8 (Grass)	n - negl	0	Not a grass; species is in the Myrsinaceae family (NGRP, 2012).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	No evidence. This woody species is in the Myrsinaceae family (NGRP, 2012), which is not one of the families known to fix nitrogen (Martin and Dowd, 1990).
ES-10 (Does it produce viable seeds or spores)	y - negl	1	Produces viable seeds (Chimera and Drake, 2010; Csurhes and Edwards, 1998; Langeland and Burks, 1998). Reproduces from seeds in the wild (Kitajima et al., 2006).
ES-11 (Self-compatible or apomictic)	y - low	1	Plants are self-compatible and have a mixed mating system; the inbreeding coefficient is quite high (Mu et al., 2010). Plants are self-compatible and have low allelic diversity in Korean populations (Chung Pyo et al., 2000). Bag pollination experiments indicate that *A. crenata* var. *bicolor* is self-compatible (Zhao et al., 2006), but others say that self-pollination is not well understood right now (Roh et al., 2006). The weight of the evidence indicates plants are self-compatible. Other *Ardisia* species are self-compatible and have a mixed mating system (Pascarella, 1997).
ES-12 (Requires special pollinators)	n - mod	0	Bees and flies visit flowers and are considered to be pollinators (Chung Pyo et al., 2000). No other evidence is available. Because this plant appears to readily fruit where it is established, it seems unlikely that it requires a specialized pollinator. Therefore answering "no" with "mod" uncertainty.
ES-13 (Minimum generation time)	c - low	0	Produces seed within two years (Langeland and Burks, 1998). It takes about four years for seedlings to flower and produce berries (Roh et al., 2006). Generation time for *Ardisia crenata* var. *bicolor* is 3 years (Zhao et al., 2006). Under greenhouse conditions, the generation time is 2-3 years (Fox and Kitajima, 2001). Although slow-growing, under ideal conditions it may reach reproductive age within two years (Odenwald and Turner, 1987 in Dozier, 1999), but an average estimate is about 3 years (Chimera and Drake, 2010). Based on the available evidence, we estimate the minimum generation time to be 2-3 years.
ES-14 (Prolific reproduction)	n - high	0	Unknown. Flowers have an average fruit set rate of 89 percent (Dozier, 1999). Healthy adults contain about 30 to 225 (mean = 129) fruit per plant (personal communication cited in Dozier, 1999). Terminal inflorescences are 5-18+ flowered (FNA Editorial Committee, 2009). Average density is 21 seedlings per square meter in Mauritius (Lorence and Sussman, 1986). Seed germination rates of about 80-99 percent (Chimera and Drake, 2010; Dozier, 1999). Personal communication with an expert on A. crenata believes (based on observation and not data) that on average seed production is less than the threshold of 1000 per square meter, however, there may be some patches that produce more than this amount (Meisenburg, 2012). Based on the evidence, answering “no” but with “high” uncertainty.
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - mod	0	This species is cultivated (Wirth et al., 2004). Naturalized populations are found in forested lots in urban areas near residences with ornamental plantings of *A. crenata* (Meisenburg, 2007). The congener *A. elliptica* became established in Everglades National Park when plants bearing mature fruit were discarded at the Park’s brush dump site (Koop, 2003). Thus, it is likely that at least some naturalized populations of *A. crenata*

Question ID	Answer - Uncertainty	Score	Notes (and references)
			were established due to improper disposal of yard waste containing reproductive material (Meisenburg, 2007).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	n - low	-1	There is no evidence this species disperses in trade as a contaminant. It seems unlikely this would occur given this plant is a forest understory herb, with fruit that are red drupes about 6-8 mm in diameter (Agriculture Research Council, 2009; FNA Editorial Committee, 2009).
ES-17 (Number of natural dispersal vectors)	2	0	For questions ES-17a - 17e: Fruits are one-seeded, red drupes 6-8 mm in diameter (Agriculture Research Council, 2009; FNA Editorial Committee, 2009).
ES-17a (Wind dispersal)	n - negl		Based on the botanical description of the fruit above, the fruit are too large and not adapted for wind dispersal (fruit are large and spherical).
ES-17b (Water dispersal)	n - mod		No evidence. Whole ripe fruit float, which may help spread seed locally during heavy rains (Dozier, 1999). However, because this evidence is speculative, because fruits appear to be adapted for animal dispersal, and because seeds with intact fruit pulp don't germinate as readily (Chimera and Drake, 2010), water dispersal seems unlikely to be an effective dispersal strategy.
ES-17c (Bird dispersal)	y - negl		Bird dispersed (Meisenburg, 2007; Space and Flynn, 2002; Staples et al., 2000). Dispersed by mockingbirds and cedar waxwings in Florida (Langeland and Burks, 1998).
ES-17d (Animal external dispersal)	n - low		No evidence. Based on the botanical description above, there is no evidence fruit are adapted for this dispersal mechanism.
ES-17e (Animal internal dispersal)	y - low		Dispersed by raccoons (Dozier, 1999; Hutchinson et al., 2011). Some animals consume seeds and later regurgitate them (Dozier, 1999). An isolated population in a preserve probably originated from a rare long-distance dispersal event via a vertebrate (Kitajima et al., 2006). However, mammal dispersal may not be that frequent, as fruits are more adapted to dispersal by birds than other animals (Meisenburg, 2007). Other *Ardisia* species, including *A. elliptica* in Florida, are dispersed by small mammals (Koop, 2003; Wright, 2009). Seeds of *Ardisia seiboldii* are dispersed by macaque monkeys in Japan; fruit are hoarded in cheek-pouches and later seeds are spit out (Yumoto et al., 1998).
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	n - negl	-1	<u>Soil seed banks</u>: Seed burial studies indicate it is very unlikely seeds persist in the soil for long periods of time (Fox and Kitajima, 2001). If seeds of *A. crenata* dry out for more than a few weeks, they die (Aekyung et al., 2003). Seeds are sensitive to desiccation and lose viability as they lose moisture; there is no evidence of a dormancy mechanism (Fox and Kitajima, 2001). The congener *A. elliptica* does not possess seed dormancy (Koop, 2004). <u>Aerial seed bank</u>: Fruit of *A. crenata* are long-lasting, remaining on the stems for 10 months to almost a year, and sometimes overlapping with the next cohort of fruit (Dozier, 1999; Kitajima et al., 2006; Meisenburg, 2007). In Hong Kong, unbagged fruit persist for an average of 41 days, bagged fruit longer, and bagged damaged fruit for 161 days (Tang et al., 2005). Fruiting plants in dense patches of *Ardisia crenata* lose fruit at slower rates (Meisenburg, 2007). Because fruit of *A. crenata* generally don't persist for more than a year, and because of this species' sensitivity to moisture loss in seed and other data,

Question ID	Answer - Uncertainty	Score	Notes (and references)
			answering "no". Using "negl" uncertainty because seed survival was directly measured with burial experiments.
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	y - negl	1	Very tolerant of aboveground tissue damage (Dozier, 1999) and resprouts vigorously after cutting and fire (Langeland and Burks, 1998). This species shows one of the highest rates of carbohydrate storage in the roots among a set of tropical species; this may have been due to artificial selection for cold resistant growth forms in Japan (Kitajima et al., 2006). "An unfortunate and unintended consequence of the high resprouting ability of the Florida ecotype is the difficulty of eradication; *A. crenata* recovers easily from repeated mowing and above-ground removal by resprouting from the stem base within a year (KK unpublished data)" (Kitajima et al., 2006).
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - low	0	No evidence and not listed in Heap (2012). Furthermore, a variety of herbicides are effective at reducing plant cover (Hutchinson et al., 2011).
ES-21 (Number of cold hardiness zones suitable for its survival)	6	0	
ES-22 (Number of climate types suitable for its survival)	4	2	
ES-23 (Number of precipitation bands suitable for its survival)	7	0	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - mod	0	No evidence.
Imp-G2 (Parasitic)	n - negl	0	No evidence. Plant is in the Myrsinaceae family (NGRP, 2012), which is not one of the families 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 - low	0.4	This shade-adapted species has a very low light compensation point and reduces forest understory light by an additional 70%, which effectively excludes all other species (Dozier, 1999; Langeland and Burks, 1998). Suppresses forest regeneration (Dozier, 1999).
Imp-N2 (Change community structure)	y - mod	0.2	Forms nearly monodominant strata (Bray et al., 2003; Dozier, 1999). Based on the guidelines, this is enough evidence to support a "yes"; however, using "mod" uncertainty without additional evidence.
Imp-N3 (Change community composition)	y - negl	0.2	Associated with reduced native species diversity in the understory, and small native groundcover plants are displaced (Langeland and Burks, 1998). Cover of *A. crenata* is negatively associated with native species diversity and cover (Fox and Kitajima, 2001). Colonies have "completely dominated the shrub-undershrub layers" where they were initially discovered in Texas (Singhurst et al., 1997). Suppresses native understory diversity and richness (Bray et al., 2003).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	y - low	0.1	Given the impacts to natural systems described in Imp-N1, Imp-N2, and Imp-N3, this species is likely to affect Threatened and Endangered species.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions)	y - high	0.1	Given the impacts to natural systems described above in N1-N3, particularly its ability to reduce forest understory light levels, and because this species is establishing in globally outstanding

Question ID	Answer - Uncertainty	Score	Notes (and references)
			ecoregions (Ricketts et al., 1999), it may affect entire ecoregions. However, without additional supporting evidence, using “high” uncertainty.
Imp-N6 (Weed status in natural systems)	c - negl	0.6	Natural areas weed in Australia (Randall, 2007). Emerging weed in South Africa (Agriculture Research Council, 2009). Recommended for eradication on the Cook Islands (Space and Flynn, 2002). Prohibited and must be controlled in South Africa (Macdonald et al., 2003; Nel et al., 2004). Environmental weed in Australia but may not warrant control (Groves et al., 2005). Manual and chemical means for control are described (Langeland and Stocker, 2001; Weber, 2003). In Florida, herbicide trials have been conducted (Hutchinson et al., 2011). The Florida Department of Environmental Protection is managing it (Meisenburg, 2007). Alternate answers for the Monte Carlo simulation were both “b”.
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Impacts human property, processes, civilization, or safety)	n - low	0	No evidence.
Imp-A2 (Changes or limits recreational use of an area)	n - low	0	No evidence.
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	n - low	0	No evidence.
Imp-A4 (Weed status in anthropogenic systems)	a - low	0	Although some gardeners recognize this as a weed (DavesGarden, 2012), there is no evidence it is considered a weed in anthropogenic areas. This species is a valuable ornamental species that is appreciated for its showy red fruits that contrast with deep green foliage around Christmas time (Meisenburg, 2007; Wirth et al., 2004). 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 - low	0	No evidence. Because there is no strong evidence of this species being problematic in production systems, using low uncertainty for this subsection. Also, note that because this species does not do well in sunny environments (Dozier, 1999), it is unlikely to be problematic in open production systems.
Imp-P2 (Lowers commodity value)	n - low	0	No evidence.
Imp-P3 (Is it likely to impact trade)	n - low	0	No evidence. Although it is prohibited and must be controlled in South Africa (Macdonald et al., 2003; Nel et al., 2004), there is no evidence it would follow a pathway as a contaminant.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - low	0	No evidence.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - mod	0	There is no evidence that *Ardisia* is toxic, but it was suspected as the causal agent of cattle death in two separate incidences (Burrows and Tyrl, 2001). Consequently, answering "n" but with "mod" uncertainty. Note that the congeners *A. seiboldii* and *A. japonica* are consumed by deer (*Cervus nippon*) in Japan (Jayasekara and Takatsuki, 2000; Tsujino and Yumoto, 2004).
Imp-P6 (Weed status in production	b - high	0.2	Listed as an agricultural weed in Australia (Randall, 2007),

Question ID	Answer - Uncertainty	Score	Notes (and references)
systems)			however, we found no other evidence indicating this plant is problematic in agricultural/production systems. Consequently, using "high" uncertainty. Both alternate answers for the Monte Carlo simulation were “a”.
GEOGRAPHIC POTENITAL			Unless indicated otherwise, all determinations below were based on latitude/longitude points obtained from the Global Biodiversity Information Facility (GBIF, 2012) and two other sources (Mu et al., 2010; Niu et al., 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 - negl	N/A	No evidence.
Geo-Z6 (Zone 6)	n - mod	N/A	One point on edge in Japan. The coldest zone this species is reported suitable for is zone 8 (DavesGarden, 2012; Page and Olds, 2001).
Geo-Z7 (Zone 7)	n - high	N/A	There were a few dozen points clustered in or southwest of Tokyo Japan, but given this plant’s cold sensitivity and the heat island effect of major cities, we are assuming that it cannot generally live in this hardiness zone. The coldest zone this species is reported suitable for is zone 8 (DavesGarden, 2012; Page and Olds, 2001).
Geo-Z8 (Zone 8)	y - low	N/A	China and the United States (LA) (1 point).
Geo-Z9 (Zone 9)	y - negl	N/A	China and the United States (FL, LA).
Geo-Z10 (Zone 10)	y - negl	N/A	Australia and China.
Geo-Z11 (Zone 11)	y - negl	N/A	Laos and Thailand.
Geo-Z12 (Zone 12)	y - negl	N/A	Madagascar and Tanzania.
Geo-Z13 (Zone 13)	y - negl	N/A	Malaysia and the United States (HI).
Köppen-Geiger climate classes			
Geo-C1 (Tropical rainforest)	y - negl	N/A	Malaysia.
Geo-C2 (Tropical savanna)	y - negl	N/A	The United States (HI) and Thailand.
Geo-C3 (Steppe)	n - negl	N/A	No evidence.
Geo-C4 (Desert)	n - negl	N/A	No evidence.
Geo-C5 (Mediterranean)	n - mod	N/A	No evidence.
Geo-C6 (Humid subtropical)	y - negl	N/A	The United States and China.
Geo-C7 (Marine west coast)	y - negl	N/A	China and New Zealand (Heenan, 2002; Howell and Sawyer, 2006).
Geo-C8 (Humid cont. warm sum.)	n - mod	N/A	No evidence.
Geo-C9 (Humid cont. cool sum.)	n - high	N/A	Few points outside of this climate class in Japan.
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)	n - negl	N/A	No evidence.
Geo-R2 (10-20 inches; 25-51 cm)	n - negl	N/A	No evidence.
Geo-R3 (20-30 inches; 51-76 cm)	n - negl	N/A	No evidence.
Geo-R4 (30-40 inches; 76-102 cm)	n - mod	N/A	No evidence.
Geo-R5 (40-50 inches; 102-127	y - negl	N/A	China.

Question ID	Answer - Uncertainty	Score	Notes (and references)
cm)			
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	China and the United States (FL). Grows in a Florida in areas receiving 133 cm of precipitation per year (Kitajima et al., 2006).
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	China, and United States (LA).
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	China.
Geo-R9 (80-90 inches; 203-229 cm)	y - negl	N/A	Malaysia, Laos, Taiwan.
Geo-R10 (90-100 inches; 229-254 cm)	y - negl	N/A	Malaysia.
Geo-R11 (100+ inches; 254+ cm))	y - negl	N/A	Malaysia. Grows in a region of Japan where precipitation reaches 307 cm per year (Kitajima et al., 2006).
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	*Ardisia crenata* is naturalized in AL, FL, GA, HI, LA, and TX (Kartesz, 2012; NRCS, 2012).
Ent-2 (Plant proposed for entry, or entry is imminent)	-	N/A	
Ent-3 (Human value & cultivation/trade status)	-	N/A	The genus *Ardisia* has many species with interesting pharmaceutical properties; numerous species, including *A. crenata*, have been used in traditional medicine (Kobayashi and de Mejía, 2005).
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	