Weed Risk Assessment for *Mikania micrantha* Kunth. (Asteraceae) – Mile-a-minute

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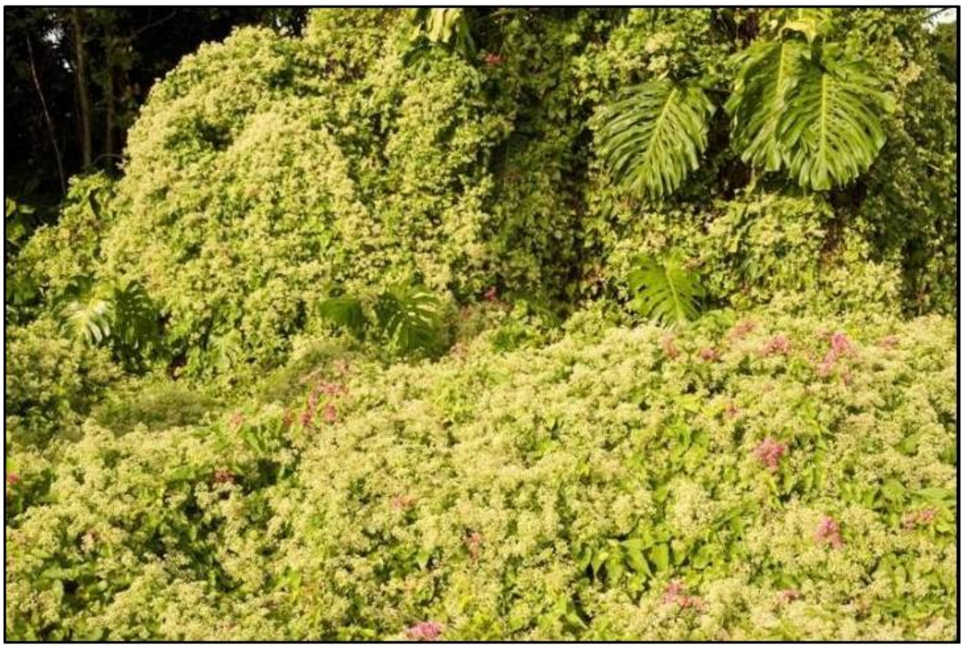

A patch of *Mikania micrantha* in Homestead, Florida (source: Keith Bradley, Institute for Regional Conservation).

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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

***Mikania micrantha* Kunth. – Mile-a-minute**

Family: Asteraceae

Initiation: *Mikania micrantha* was recently detected in the Homestead region of southern Florida (Sellers and Langeland, 2009). The PPQ Eastern Region program manager for weeds asked the Plant Epidemiology and Risk Analysis Laboratory to complete a weed risk assessment on this species.

Foreign distribution: *Mikania micrantha* is native to Mexico, Central America, South America, and the Caribbean (Acevedo-Rodriguez, 2005; Boggan et al., 1997). It is naturalized in Australia, and in many countries in tropical Asia, the West Indies, the Pacific Islands (CABI, 2010; NGRP, 2012). Because this species is difficult to distinguish from two other species of *Mikania*, which are also weeds, some of the older literature is confounded (CABI, 2010).

U.S. distribution and status: This species is native to and locally common in Puerto Rico (Acevedo-Rodriguez, 2005; NRCS, 2010). Some references list it as an exotic in Hawaii (e.g., Weber, 2003), but it is not listed in a flora for the state (Wagner et al., 1999). It is an invasive exotic in Guam (Sherley, 2000) and was recently detected in Miami-Dade County, Florida (Sellers and Langeland, 2009). After completing some delimiting surveys, Florida has decided to take official action against it by eradicating it where possible and placing infected nurseries under quarantine (Derksen et al., 2010). *Mikania micrantha* is listed as a Federal Noxious Weed in the United States and a state noxious weed in ten states (NRCS, 2010).

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

[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. *Mikania micrantha* analysis

Establishment/Spread Potential *Mikania micrantha* has already demonstrated an ability to establish and spread elsewhere in the world (CABI, 2010). The small, plumose seeds readily contaminate agricultural products, seeds, clothing, and equipment (Tiwari et al., 2005). Other traits that have contributed to its success as an invader include prolific reproduction (Zhang et al., 2004), a short generation time (Mini and Abraham, 2005), tolerance to mutilation (Tiwari et al., 2005), and a wide adaptive potential (GBIF, 2012). Mature infestations are difficult to eradicate because it can regenerate from small stem fragments (Tiwari et al., 2005). Uncertainty was low due to the abundance and quality of literature available for this species.
Risk score = 20 Uncertainty index = 0.09

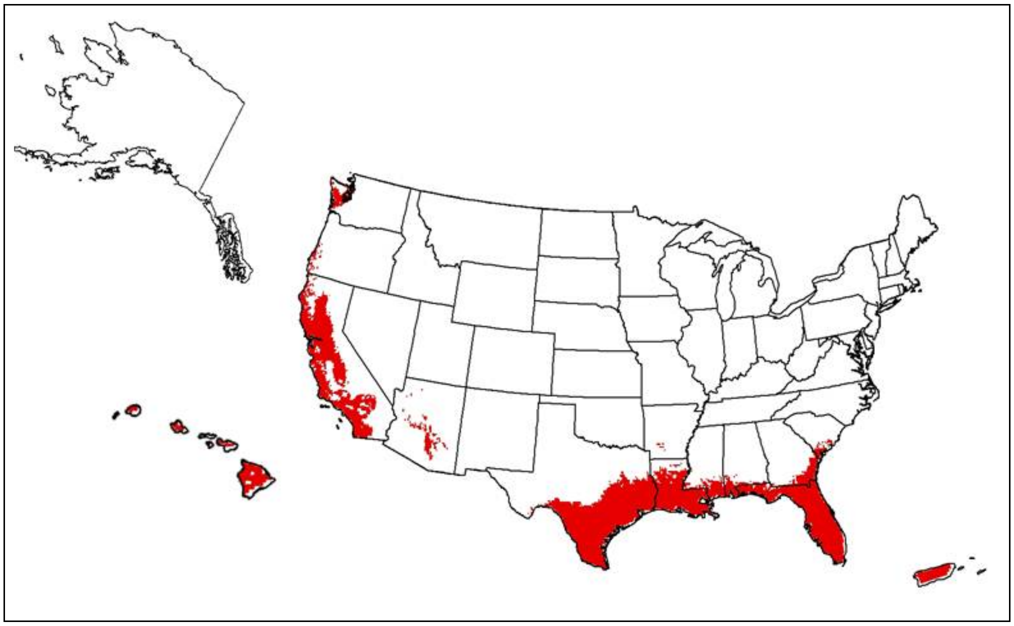
Impact Potential *Mikania micrantha* scored highly in this risk element because it impacts both natural and production systems. As a vine it climbs over other vegetation blocking sunlight, smothering forests, and preventing forest tree regeneration (Tiwari et al., 2005). It suppresses the underlying vegetation (Grice and Setter, 2003). In natural ecosystems it reduces biodiversity and changes nutrient cycling (Chen et al., 2009; Soubeyran, 2008). In agriculture, it reduces yield in plantations (Yang et al., 2005) and increases costs of control (CABI, 2010). Heavy infestations in coconut plantations in Samoa caused farmers to abandon plantations (ISSG, 2010). Finally, *M. micrantha* is considered an urban weed (ISSG, 2010; Waterhouse, 1997; Zhang et al., 2004). As above, uncertainty was low for this risk element.
Risk score = 4.3 Uncertainty index = 0.10

Geographic Potential *Mikania micrantha* is a tropical species, native to Central America, South America, and the Caribbean. Based on three climatic variables, we estimate that about eight percent of the United States is suitable for the establishment of *M. micrantha* (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 *M. micrantha* represents the joint distribution of Plant Hardiness Zones 9-13, areas with 10-100+ inches of annual precipitation, and the following Köppen-Geiger climate classes: tropical rainforest, tropical savanna, steppe, mediterranean, humid subtropical, and marine west coast.

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. For example, even though *M. micrantha* can grow in regions with 10-30 inches of annual precipitation, it may be restricted to wet habitats such as lake shores or river corridors.

Entry Potential We did not assess entry potential for *M. micrantha* because this species is native to Puerto Rico (Acevedo-Rodriguez, 2005; NRCS, 2010) and recently established in southern Florida (Derksen et al., 2010).

Figure 1. Predicted distribution of *Mikania micrantha* 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) = 95.9%
P(Minor Invader) = 3.9%
P(Non-Invader) = 0.1%

Risk Result = High Risk
Secondary Screening = Not Applicable

Figure 2. *Mikania micrantha* 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.

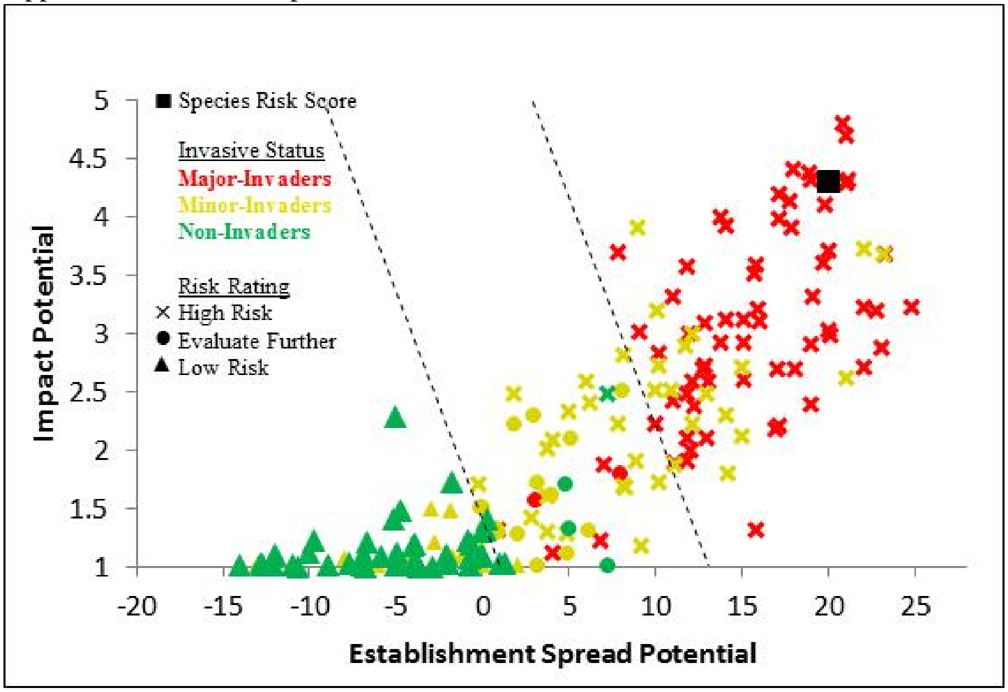
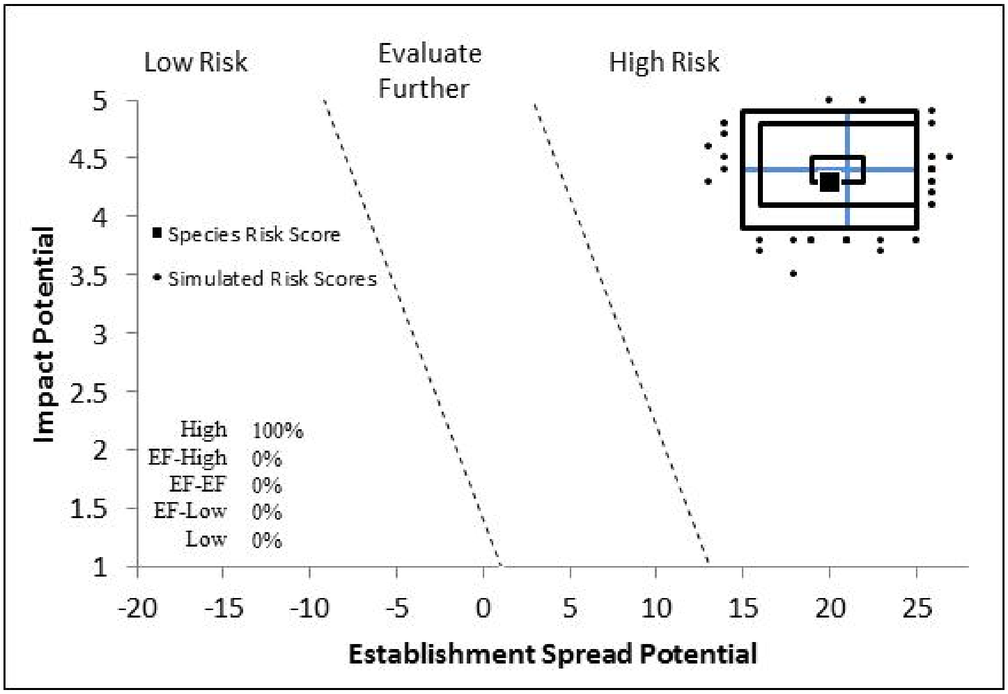


Figure 3. Monte Carlo simulation results (N=5,000) for uncertainty around the risk scores for *Mikania micrantha*[a].



[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 *M. micrantha* is High Risk. Relative to the 204 species used to develop and validate the PPQ weed risk assessment model, *M. micrantha* had one of the highest risk scores (Figs. 2 and 3). This species is considered one of the world's worst weeds (Holm et al., 1977). It grows quickly: up to about 47 cm of growth per week (Zhang et al., 2004). Management may be difficult due to its prolific reproduction and ability to root at the nodes of stem fragments (Tiwari et al., 2005). Although *M. micrantha* likely established in southern Florida through either intentional or unintentional human-mediated dispersal, it is possible for species native to the Caribbean to extend their range naturally into the United States. Indeed, the flora of southern Florida derives in part from the Caribbean (Long and Lakela, 1976). Given the proximity of Florida to this species' native range, some natural pests of the species may already exist in the United States.

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Appendix A. Weed risk assessment for *M. micrantha* Kunth. (Asteraceae). 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	Naturalized in tropical Asia, Hawaii, Mascarenes, Melanesia, Polynesia, and the West Indies (NGRP, 2012). Naturalized in Australia (Randall, 2007). Naturalized in India, and possibly invasive (Drake et al., 1989). One of the worst invaders among many Pacific Islands (including Rarotonga, Fiji, Palau, Guam, Niue, American Samoa, Samoa, Tonga, Vanuatu, Wallis & Futuna) (Sherley, 2000; Space and Flynn, 2002; Space et al., 2003). Invasive in China, having spread to an area very quickly (Yan et al., 2001; Zhang et al., 2004). Invasive in many Asian countries (CABI, 2010). "*Mikania micrantha* is a neotropical fast growing vine that has become a major weed in SE Asia and the Pacific during the latter part of the 20th century. It is still extending its range…" (CABI, 2010). Both alternate choices for the Monte Carlo simulation are "e."
ES-2 (Is the species highly domesticated)	n - low	0	No evidence.
ES-3 (Weedy congeners)	y - negl	1	*Mikania cordata* is a serious weed of plantation crops in many parts of the world, perhaps worse than *M. micrantha* (Holm et al., 1977). *Mikania congesta* is a principal weed in Malaysia (Holm et al., 1979). *Mikania scandens* is considered a serious weed in several countries (Holm et al., 1979).
ES-4 (Shade tolerant at some stage of its life cycle)	n - mod	0	Intolerant of heavy shade; colonizes gaps (ISSG, 2010; Tiwari et al., 2005). Occurs in sun and shade (Fournet and Hammerton, 1991; Raju, 1998). Occurs in sun and shade, but grows must profusely in sunny environments (Zhang et al., 2004). Has a high light compensation point which suggests it is a heliophyllic species; it performs best in sunny sites but it can tolerate shady ones (Zhang et al., 2004). This same reference says that increasing understory shade can make conditions unsuitable for it (Zhang et al., 2004). Greenhouse studies showed it does much better in full sun than under low irradiance (Zhang and Wen, 2009). Seed germination experiments indicate that light is very important for seed germination and plant growth (Yang et al., 2005). From these references, it is clear that it performs better in sun, but it isn't entirely clear that some stage isn't shade tolerant. Answering "no," but with "mod" uncertainty.
ES-5 (Climbing or smothering growth form)	y - negl	1	Twining perennial vine (Tiwari et al., 2005). Herbaceous twining vine obtaining lengths up to 10 meters (Acevedo-Rodriguez, 2005). Vine (CABI, 2010).
ES-6 (Forms dense thickets)	y - negl	2	"Forms dense tangled infestations in pastures, plantations and disturbed forests" (Grice and Setter, 2003). Forms dense thickets by the numerous intermingled stems and stolons (Weber, 2003). Dense vine blankets prevent native seeds from reaching the soil surface (Yadav, 2010).

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-7 (Aquatic)	n - negl	0	Terrestrial vine found in damp, lowland clearings or open areas (CABI, 2010). Not an aquatic species.
ES-8 (Grass)	n - negl	0	Species is not a grass. It is in the Asteraceae (NGRP, 2012).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	No evidence. Asteraceae is not known to fix nitrogen (Martin and Dowd, 1990).
ES-10 (Does it produce viable seeds or spores)	y - negl	1	Reproduces by seed (Tiwari et al., 2005). Seed germination as high as 96 percent. Can produce up to 170,000 seeds per square meter (Zhang et al., 2004).
ES-11 (Self-compatible or apomictic)	n - high	-1	Mostly self-incompatible (Hong et al., 2007). This species is a secondary pollen presenter, which is a strategy to promote outcrossing (Hong et al., 2008). However, it is not possible to completely rule out self-pollination (Hong et al., 2008).
ES-12 (Requires special pollinators)	n - mod	0	No evidence, and unlikely. *Mikania micrantha* is insect pollinated (Hong et al., 2008). A variety of different pollinator types visit *Mikania aurticifolia* (Cerana, 2004).
ES-13 (Minimum generation time)	b - low	1	Seeds germinating in April will begin flowering in October, with seeds maturing in 9-12 days after flowers open (Mini and Abraham, 2005). Thus, at the very least this species can behave as an annual, producing one generation per year. Alternate choices for the Monte Carlo simulation are "c" and "a."
ES-14 (Prolific reproduction)	y - negl	1	A single plant can produce over 40,000 seeds (Tiwari et al., 2005) and cover over 25 square meters (ISSG, 2010). This is about 1600 seeds per square meter. Seeds germinate readily (Raju, 1998). Control is difficult due to high output of viable seeds (ISSG, 2010). Seeds are produced 15-17 days after flower buds develop (CABI, 2010). Seed germination is as high as 96 percent. It can produce up to 170,000 seeds per square meter (Zhang et al., 2004). Flower biomass can make up to 38-42 percent of aboveground biomass (Zhang et al., 2004).
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - negl	1	"Small seeds or stem fragments may easily be contaminated with agriculture, horticulture, forestry and pasture seeds" (Tiwari et al., 2005). The pappus helps the seed attach to clothing (Csurhes and Edwards, 1998). Seeds may be moved by vehicles and equipment (CABI, 2010). Intercepted as a contaminant on a truck coming from Mexico (CABI, 2010).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	y - mod	2	Contaminant in a shipment of medicinal herbs from Mexico (CABI, 2010). "Small seeds or stem fragments may easily be contaminated with agriculture, horticulture, forestry and pasture seeds" (Tiwari et al., 2005). Using moderate uncertainty as we don't know how often this occurs.
ES-17 (Number of natural dispersal vectors)	3	2	The following description applies to questions ES-17a through ES-17e: Seeds are achenes with a silky pappus (Tiwari et al., 2005).
ES-17a (Wind dispersal)	y - negl		Seeds with a pappus; they are wind dispersed (Tiwari et al., 2005). Wind-dispersed (Wright, 2009).
ES-17b (Water dispersal)	y - negl		Species occurs in wetlands and low vegetation near lakes (Tiwari et al., 2005; Weber, 2003). Occurs along rivers and streams in India (Raju, 1998) and in its native range (Yang et al., 2005). *Mikania cordata* is reported to have spread quickly in Mauritius via stem fragments in streams and rivers (Csurhes and Edwards, 1998). Seeds dispersed by water (CABI, 2010).

Question ID	Answer - Uncertainty	Score	Notes (and references)
			The pappus helps seeds remain afloat in water and therefore aid in dispersal via water (Yang et al., 2005). New infestations found along streams in Australia (Brooks et al., 2008).
ES-17c (Bird dispersal)	n - mod		No evidence.
ES-17d (Animal external dispersal)	y - negl		The pappus facilitates dispersal on animals by helping the seeds attach to fur (Csurhes and Edwards, 1998; ISSG, 2010). Seeds dispersed by animals (Tiwari et al., 2005). Dispersed by livestock (Tiwari et al., 2005; assuming they mean externally).
ES-17e (Animal internal dispersal)	n - mod		No evidence it is consumed by animals and dispersed in this fashion.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	? - max	0	Unknown because the evidence is not clear and somewhat conflicting. One study reports that *Mikania* seeds can remain viable in the soil for up to seven years (pers. comm. in Brooks et al., 2008). However, another study reports that seeds don't last for more than a year (Mini and Abraham, 2005). An abstract from a foreign paper on soil seed banks of *M. micrantha* does not clarify if the paper examined long-term seed viability (Zhang et al., 2005).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	y - negl	1	It roots at nodes (Csurhes and Edwards, 1998; Tiwari et al., 2005). Burning is not recommended because it is deep-rooted and can easily regenerate. Mature infestations are difficult to eradicate because small stem fragments can regenerate the plant (Tiwari et al., 2005). Increased allocation to seeds in burned sites (Drake et al., 1989). Species is adapted to periodic disturbance (Drake et al., 1989). Regenerates with vigor after cutting (Raju, 1998).
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - low	0	No evidence of herbicide resistance (Heap, 2010). Seems like some plants are tolerant to some herbicides, particularly large plants (Tiwari et al., 2005), but herbicides are recommended for control (Raju, 1998; Weber, 2003). Various herbicides are used (CABI, 2010).
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)	9	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	y - negl	0.1	Several studies and data sheets have reported that *M. micrantha* produces allelopathic chemicals that inhibit the growth of other plants (ISSG, 2010; Tiwari et al., 2005; Wu et al., 2010; Zhao and Peng, 2009), and that this has helped its invasion in China (Xie et al., 2010). It is often difficult to determine whether a plant is truly allelopathic because most allelopathy studies are lab-based, where they subject test plants to artificial concentrations of plant extracts. However, in the case of *M. micrantha*, one author examined allelopathy under field conditions and using soil from directly underneath *M. micrantha* plants. This author showed that soil and plant extracts of *Mikania micrantha* inhibited radish seed germination, radicle length, and shoot length (Chen et al.,

Question ID	Answer - Uncertainty	Score	Notes (and references)
			2009). The author concluded that "allelopathic chemicals from *Mikania micrantha* not only affect other plants, but also soil nutrient properties." Based on the anecdotal evidence from numerous other studies and the outcomes from Chen's field study, there is little doubt this species is allelopathic.
Imp-G2 (Parasitic)	n - negl	0	No evidence. Family is not known to contain parasitic plants (e.g., Heide-Jorgensen, 2008; Nickrent, 2009; Walker, 2010).
Impacts to Natural Systems			
Imp-N1 (Change ecosystem processes and parameters that affect other species)	y - low	0.4	Soil samples from underneath *M. micrantha* had higher carbon (C), nitrogen (N), and ammonia than in open sites nearby. *Mikania micrantha* extracts increased soil C, N, and soil nitrification, possibly through allelopathy (Chen et al., 2009). Produces an excessive amount of litter during the first few years (CABI, 2010). Interferes with forest regeneration (Tiwari et al., 2005). Spreads quickly after natural disturbances such as fires and other disturbances and prevents natural forest regeneration because it smothers the vegetation (Weber, 2003).
Imp-N2 (Change community structure)	y - negl	0.2	Climbs over other vegetation blocking sunlight, smothering forests, and preventing forest tree regeneration (Tiwari et al., 2005). Suppresses underlying vegetation (Grice and Setter, 2003). Blocks sun and kills trees (Yan et al., 2001). Dominates large areas (Yan et al., 2001)..
Imp-N3 (Change community composition)	y - negl	0.2	Kills plants it smothers (Tiwari et al., 2005). Threatens biodiversity in French Polynesia (Soubeyran, 2008). A major threat to local biodiversity (CABI, 2010). In aquatic environments, it can grow over floating or emergent vegetation from the sides and kill it (e.g., water hyacinth; Zhang et al., 2004). Periodic cutting of *M. micrantha* from plots originally dominated by it (80 percent cover) increased biomass and diversity of native species (Lian et al., 2006).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	y - mod	0.1	In a comparative study between *M. micrantha* and the native *M. cordata* (in Taiwan), data suggest that the exotic could replace the native species (Hsu and Chiang, 2003). Threatens macaque monkeys on an island of China (Yan et al., 2001). This species invades natural communities, particularly those that are disturbed. It is likely to affect T&E species that also require disturbance or those that live in open, moist, and edge habitats.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions)	y - low	0.1	This is a tropical/subtropical species that has recently been detected in southern Florida (Sellers and Langeland, 2009). There are several globally outstanding ecoregions in Florida that are suitable for its survival (Ricketts et al., 1999).
Imp-N6 (Weed status in natural systems)	c - negl	0.6	A significant weed in forests, scrublands, wetlands in Nepal (Tiwari et al., 2005). In Nepal, volunteer groups remove vegetation from wildlife preserves and they replant with native species (Tiwari et al., 2005). Environmental weed in Australia (Randall, 2007). Can be a weed in secondary succession in India. Biocontrol options are being developed in parts of the world (ISSG, 2010; Tiwari et al., 2005). Significant weed of natural forests in Pacific islands (Sherley, 2000). Subject to eradication campaigns in Palau (Space et al., 2003). A study on the efficacy of periodic cutting on native species diversity

Question ID	Answer - Uncertainty	Score	Notes (and references)
			was undertaken (Lian et al., 2006). Weed of natural communities in Nepal and is being managed (Sapkota, 2007). Both alternate choices for the Monte Carlo simulation were "b."
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Impacts human property, processes, civilization, or safety)	n - high	0	Climbs over walls and fences (ISSG, 2010), but we found no evidence concerning these types of impacts. It restrains development of the main species in mangrove wetlands (from the abstract it is unclear which species these may be and what is meant by restrained) (Zhang and Zhang, 2008); mangroves are important barriers to storms and help protect coastal human settlements. Without clear and direct evidence, answering “no” with “high” uncertainty.
Imp-A2 (Changes or limits recreational use of an area)	n - high	0	There is no evidence of this impact, but we would expect that vine tangles could interfere with hiking, hunting, and river access.
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	? - max	0	Unknown. This species is a garden and lawn weed (Waterhouse, 1997; Zhang et al., 2004). It is found in vegetable plots and plant hedges (Feng et al., 2002). Thus, based on its impacts in natural and production systems, you would expect for it outcompete desirable plants in urban areas. However, we found no such evidence. Consequently, answering unknown.
Imp-A4 (Weed status in anthropogenic systems)	b - mod	0.1	Occurs in disturbed areas in its native range (Acevedo-Rodriguez, 2005). Weed of gardens (Waterhouse, 1997) and lawns (Zhang et al., 2004). Climbs over walls and fences (ISSG, 2010). Invasive in roadsides and disturbed areas (CABI, 2010; Space and Flynn, 2002). Serious weed in urban areas (CABI, 2010). Found in vegetable plots and plant hedges (Feng et al., 2002). Definitely a weed in urban/suburban settings, but no specific evidence that it is being controlled in these types of systems (hence “mod” uncertainty). Alternate choices for the Monte Carlo simulation are both "c."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	y - negl	0.4	Infests bananas, sugarcane, and root crops in the Lesser Antilles (Fournet and Hammerton, 1991). Weed of upland rice in Indonesia and India (Galinato et al., 1999). In tea, coffee, and cardamom plantations, and plantation crop nurseries in India (Raju, 1998). Has killed large breadfruit trees (ISSG, 2010). "While it does not grow well in rice paddies, it can encroach from the edges to smother the crop" (ISSG, 2010). Suppresses growth of bamboos in plantations and even kills them (CABI, 2010). "The species causes substantial yield losses in agroforestry systems, in tea, oil palm, rubber, teak, and sal (*Shorea robusta*) plantations, as well as in many crops including bamboo, reed, plantains and pineapples" (Yang et al., 2005). There are economic losses associated with this species, but from the abstract it is not clear in what kind of system (Zhong et al., 2004). Reduces growth and productivity in teak plantations (Muraleedharan and Anitha, 2000). Complete eradication is important for normal growth in young oil palm plantations (Mangoensoekarjo, 1978).

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-P2 (Lowers commodity value)	y - negl	0.2	Has caused abandonment of coconut plantations in Samoa (ISSG, 2010). Reduces profit from tea plantations by up to 30 percent due to control costs (ISSG, 2010). Makes harvesting of non-wood products such as bamboos difficult (ISSG, 2010). "The annual cost of controlling *M. micrantha* was estimated at US$9.8 million for rubber, oil palm and cocoa crops in Malaysia" (CABI, 2010). Makes planting more difficult in teak plantations; increases maintenance in teak plantations (Muraleedharan and Anitha, 2000).
Imp-P3 (Is it likely to impact trade)	y - low	0.2	Banned from sale in Queensland, Australia (Csurhes and Edwards, 1998). Quarantine pest in Australia and subject to eradication program in Queensland (Brooks et al., 2008). Managed by the Chinese government (although unsure if it qualifies as a quarantine pest; Zhang et al., 2004). "Small seeds or stem fragments may easily be contaminated with agriculture, horticulture, forestry and pasture seeds" (Tiwari et al., 2005).
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - high	0	No evidence from the extensive literature on this species. Using "high" uncertainty because this species favors moist environments (Yadav, 2010).
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	y - high	0.1	Sometimes used as fodder for goats and pigs (Tiwari et al., 2005). In Nepal, cattle that feed around patches of this often suffer from liver fluke. This is attributed to the high densities of snails, which are an intermediary host and live in *Mikania* patches (Tiwari et al., 2005). Cattle and goats eat it during times of famine (Raju, 1999). In parts of India, fed to cattle during the summer when availability of grass is low, but "*Mikania* is known to cause hepatotoxicity and liver damage in dairy cattle" (APFISN, No Date). Answering "yes" because it appears that for some animals, at some times or concentrations, it is either directly toxic, or is associated with animal pests.
Imp-P6 (Weed status in production systems)	c - negl	0.6	Farmers manually control vines as they come onto their fields in Nepal (Tiwari et al., 2005). Controlled in a variety of ways in different plantations (CABI, 2010). Controlled in oil palm plantations (Mangoensoekarjo, 1978). Serious agricultural weed (Holm et al., 1979), but not found in cropped lands (Raju, 1998). Weed of nurseries (Zhang et al., 2004). Affects 75 percent of teak plantations in one part of India (ISSG, 2010). Agricultural weed in Australia (Randall, 2007). Occurs in pastures in its native range (Acevedo-Rodriguez, 2005). Weed in shifting agriculture (Drake et al., 1989). Considered a weed in Mexico where it is native, but the reference does not indicate in what kinds of systems (Villasenor Rios and Espinosa Garcia, 1998). Weed in fallow lands and croplands in Nepal (Tiwari et al., 2005). Relatively important weed of plantations and fruit trees (Waterhouse, 1997). Considered a major weed of citrus and other plantation trees in Southeast Asia, but also in tomatoes in Malaysia (Waterhouse, 1993). Both alternate choices for the Monte Carlo simulation were "b."

Question ID	Answer - Uncertainty	Score	Notes (and references)
GEOGRAPHIC POTENTIAL			
Plant cold hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	In Guangdong Province in China, had spread to most areas south of latitude 24˚N (Zhang et al., 2004). Experiments showed it can grow through the winter in areas 26-28˚N latitude (Zhang et al., 2004).
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 - mod	N/A	No evidence.
Geo-Z8 (Zone 8)	n - high	N/A	In a couple of places it occurred just on the edge of this zone in Peru and Bolivia (GBIF, 2012).
Geo-Z9 (Zone 9)	y - low	N/A	Point data - Ecuador, Mexico (GBIF, 2012).
Geo-Z10 (Zone 10)	y - negl	N/A	Point data - Peru, Colombia, Mexico (GBIF, 2012).
Geo-Z11 (Zone 11)	y - negl	N/A	Point data - Ecuador, Peru (GBIF, 2012).
Geo-Z12 (Zone 12)	y - negl	N/A	Point data - Ecuador, Peru (GBIF, 2012).
Geo-Z13 (Zone 13)	y - negl	N/A	Point data - Brazil, French Guiana, Panama (GBIF, 2012).
Köppen-Geiger climate classes			
Geo-C1 (Tropical rainforest)	y - negl	N/A	Point data - Ecuador, Brazil (GBIF, 2012).
Geo-C2 (Tropical savanna)	y - negl	N/A	Point data - Brazil, Mexico (GBIF, 2012).
Geo-C3 (Steppe)	y - mod	N/A	Point data - Ecuador (GBIF, 2012). But no evidence it occurs in similar habitats elsewhere.
Geo-C4 (Desert)	n - negl	N/A	No evidence.
Geo-C5 (Mediterranean)	y - mod	N/A	Point data - Ecuador (GBIF, 2012). But no evidence it occurs in similar habitats elsewhere.
Geo-C6 (Humid subtropical)	y - negl	N/A	Point data - Mexico, Paraguay (GBIF, 2012).
Geo-C7 (Marine west coast)	y - low	N/A	Point data - Peru, Mexico Colombia (GBIF, 2012).
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)	n - low	N/A	No evidence.
Geo-R2 (10-20 inches; 25-51 cm)	y - high	N/A	Point data - A few points appear in this band in Argentina (GBIF, 2012).
Geo-R3 (20-30 inches; 51-76 cm)	y - mod	N/A	Point data - Brazil, Peru, Bolivia (GBIF, 2012).
Geo-R4 (30-40 inches; 76-102 cm)	y - mod	N/A	Point data - Brazil, Bolivia (GBIF, 2012).
Geo-R5 (40-50 inches; 102-127 cm)	y - low	N/A	Point data - Brazil, Paraguay (GBIF, 2012).
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	Point data - Brazil (GBIF, 2012). They tend to be confined to tropical and subtropical regions receiving more than 1500 mm (59 inches) rainfall per year (Csurhes and Edwards, 1998).

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	Point data - Brazil (GBIF, 2012). Occurs at sites receiving greater than 1700 mm (66 inches) annual precipitation (Fournet and Hammerton, 1991).
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	Point data - Honduras (GBIF, 2012).
Geo-R9 (80-90 inches; 203-229 cm)	y - negl	N/A	Point data - Nicaragua, Guatemala (GBIF, 2012).
Geo-R10 (90-100 inches; 229-254 cm)	y - negl	N/A	Point data - Nicaragua, Guatemala (GBIF, 2012).
Geo-R11 (100+ inches; 254+ cm)	y - negl	N/A	Point data - Colombia, Peru, Ecuador (GBIF, 2012).
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	Native to and locally common in Puerto Rico (Acevedo-Rodriguez, 2005; NRCS, 2010). Some references list it as an exotic present in Hawaii (e.g., Weber, 2003), but it is not listed in a flora for the state (Wagner et al., 1999). It was detected in Miami-Dade County, Florida in late 2009 (Sellers and Langeland, 2009). Present as an invasive exotic in Guam (Sherley, 2000).
Ent-2 (Plant proposed for entry, or entry is imminent)	-	N/A	
Ent-3 (Human value & cultivation/trade status)	-	N/A	Some species of *Mikania* are cultivated as ornamentals or cover crops (Csurhes and Edwards, 1998). Recently detected as an ornamental at a nursery in Australia (Csurhes and Edwards, 1998). Used as a natural remedy for some ailments in Mexico (Standley, 1930). Introduced to India after World War II to hide airfields (ISSG, 2010). Introduced for soil conservation in Taiwan in the 1970s (CABI, 2010). May have been introduced into Australia as a medicinal plant (Brooks et al., 2008).
Ent-4 (Entry as a contaminant)			"Small seeds or stem fragments may easily be contaminated with agriculture, horticulture, forestry and pasture seeds" (Tiwari et al., 2005).
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	Noted growing in nursery pots in Florida (Derksen et al., 2010).
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	Seeds dispersed by vehicles (Tiwari et al., 2005). Intercepted by USDA as a contaminant on a truck coming from Mexico (CABI, 2010). May have been introduced into Australia as packing material for palm seeds (Brooks et al., 2008).

Question ID	Answer - Uncertainty	Score	Notes (and references)
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	-	N/A	Some species of *Mikania* are fed to cattle, resulting in the spread of uneaten stems (Csurhes and Edwards, 1998). Intercepted as a contaminant of medicinal herbs from Mexico (CABI, 2010).
Ent-4i (Contaminant of some other pathway)	-	N/A	Seeds moved by livestock (assuming the authors meant externally; Tiwari et al., 2005). Seeds attach to human clothing (Csurhes and Edwards, 1998).
Ent-5 (Likely to enter through natural dispersal)	-	N/A	Seeds are wind dispersed and probably entered Nepal from India in this fashion (Tiwari et al., 2005).