United States Department of Agriculture

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Animal and Plant Health Inspection Service

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Version 2

Weed Risk Assessment for *Dolichandra unguis-cati* (Bignoniaceae) – Cat's-claw

Left: Tree infested with *D. unguis-cati* (Source: University of Florida/IFAS Center for Aquatic and Invasive Plants; Bogatescu, 2013). Upper right: Individual vines climbing up a tree (Source: University of Florida/IFAS Center for Aquatic and Invasive Plants; Bogatescu, 2013). Bottom right: Fruit pods of a vine growing on trellis (Source: C. Lewis, Weedbusters, NZ; Lewis, 2013).

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Executive Summary

The result of the weed risk assessment for *Dolichandra unguis-cati* is High Risk of becoming weedy or invasive in the United States. *Dolichandra unguis-cati* is a climbing woody vine that can grow up to 15 meters long. It climbs using recurved hooks and adventitious roots, and it runs along the ground, rooting and producing subterranean tubers at each node. This species has become naturalized in numerous countries and readily invades forest and riparian habitats, savannas, roadsides, gardens, orchards, plantations, and other disturbed sites. *Dolichandra unguis-cati* is native to Puerto Rico and the U.S. Virgin Islands. It is currently naturalized in about 50 U.S. counties, primarily in Florida but also in Texas, Louisiana, Georgia, Hawaii, and South Carolina. It is recognized as invasive by many U.S. gardeners and is listed as a Category 1 exotic species by the Florida Exotic Pest Plant Council. The University of Florida Center for Aquatic and Invasive Plants recommends that it not be used in Florida landscapes. This species is not known to be regulated by any state, but state and county park managers in Florida are trying to eradicate it. Control strategies include mechanical and chemical approaches. It is sold in the United States by some wholesale and retail nurseries and is being promoted for use in xeric environments in the southwestern United States.

Dolichandra unguis-cati readily establishes and spreads, reproducing vegetatively and through seed. Seeds are both wind- and water-dispersed but do not appear to form a long-term seed bank. Prostrate vines root along their nodes and produce underground tubers, forming dense mats on the ground. Because both tubers and stem pieces can resprout, the species is very resilient to disturbance and control activities. In natural systems, *D. unguis-cati* smothers vegetation, prevents recruitment of native species, and kills large trees through shading and through physical damage from the weight of the vines. In urban environments, this species has similar impacts on ornamental trees and shrubs, and can attach and cause damage to walls, roofs, and other structures. It is also considered an agriculture weed of plantations and orchards. *Dolichandra unguis-cati* is regulated in Australia, New Zealand, and South Africa. We estimate that about 20 percent of the United States is suitable for the establishment of this species.

1. Plant Information and Background

SPECIES: *Dolichandra unguis-cati* (L.) L. G. Lohmann (NGRP, 2019)

FAMILY: Bignoniaceae

SYNONYMS: *Bignonia tweediana* Lindl., *B. unguis-cati* L., *Doxantha unguis-cati* (L.) Miers (NGRP, 2019); *Macfadyena unguis-cati* (L.) A. H. Gentry (NGRP, 2019; The Plant List, 2019). See The Plant List (2019) for additional synonyms.

COMMON NAMES: Cat's-claw, catclaw-creeper, catclaw-trumpet, funnel-creeper (NGRP, 2019).

BOTANICAL DESCRIPTION: *Dolichandra unguis-cati* is a climbing woody vine that can grow up to 15 meters long (Correll and Correll, 1982) and 6 cm in diameter (Dhileepan, 2012). Vines running along the ground will readily root along nodes. Leaves are typically opposite and bifoliate, although plants may also have simple or five-compound leaves (Boyne et al., 2013). Between each pair of leaflets is a three-forked tendril with recurved tips that can grab onto vegetation and artificial surfaces (Correll and Correll, 1982; Dhileepan, 2012). Flowers are solitary, yellow, and funnel-shaped (Correll and Correll, 1982). Fruit are bean-like, growing to lengths of 30 to 50 cm, and split to release numerous seeds with membranous wings (Correll and Correll, 1982). *Dolichandra unguis-cati* includes both diploid (2n=40) and polyploid (2n=80) individuals (Cordeiro et al., 2017). In Australia, the species has two forms that differ with respect to several growth and reproductive traits, which have likely affected their overall invasive potential (Buru et al., 2016a; Buru et al., 2016b; Buru et al., 2014).

INITIATION: In April 2012, the Australian Weeds Committee added this species and others to their list of Weeds of National Significance (AWC, 2013). On May 2, 2012, the PPQ Federal Noxious Weed policy manager requested that we review those species (Tasker, 2012), and the resulting weed risk assessments that were completed in 2013. On March 20, 2017, a Florida stakeholder noted that this species is problematic throughout Florida and asked how it could be listed as a Federal Noxious Weed (Brown, 2017). In this document, we update the original weed risk assessment to help PPQ policy managers determine whether this species should be listed as a U.S. Federal Noxious Weed.

WRA AREA[1]: United States and Territories.

FOREIGN DISTRIBUTION: *Dolichandra unguis-cati* is native to Mexico, Central America, and most of the Caribbean and South America (Acevedo-Rodríguez and Strong, 2012; NGRP, 2019). It has been sold as an ornamental in many countries with tropical or subtropical climates (Downey and Turnbull, 2007) and is naturalized in Australia, Bermuda, Cape Verde, India, Kenya, Mauritius, Micronesia, New Caledonia, New Zealand, Niue, Portugal, Réunion, Seychelles, South Africa, Swaziland, Tanzania, Uganda, and Vanuatu (Downey and Turnbull, 2007; Kairo et al., 2003; Kalidass and Murugan, 2016;

[1] The "WRA area" is the area in relation to which the weed risk assessment is conducted (definition modified from that for "PRA area") (IPPC, 2017).

NGRP, 2019). It is considered a weed or a casual alien in China (Weber et al., 2008), Cuba (Acevedo-Rodríguez and Strong, 2012), India (Holm et al., 1991), and Portugal (DAISIE, 2013). *Dolichandra unguis-cati* is regulated in Australia, New Zealand, and South Africa (APHIS, 2019; ARC, 2019; DAF, 2016; MPI, 2012).

U.S. DISTRIBUTION AND STATUS: *Dolichandra unguis-cati* is native to Puerto Rico and the U.S. Virgin Islands (NGRP, 2019). It is naturalized in the United States, primarily in Florida, but also in Texas, Louisiana, Georgia, Hawaii, and South Carolina (Fig. 1) (EDDMapS, 2019; Kartesz, 2019; Wagner et al., 1999). It was cultivated in Hawaii as early as 1928 (Wagner et al., 1999) and probably introduced to the continental United States sometime after 1930 since it is not listed in Hortus (Bailey and Bailey, 1930), but it is listed in Hortus Third (Bailey and Bailey, 1976). *Dolichandra unguis-cati* was first recorded in the wild in Florida in 1957 (Ward, 2005). It is sold in the United States by Monrovia (2019), a large plant wholesale and distribution business, and by other nurseries (e.g., Univ. of Minn., 2019; Village Nurseries, 2019). Australian researchers, concerned about the resurgence of horticultural interest in this plant, noted that it is being promoted in the United States for desert and saline environments (Downey and Turnbull, 2007), which we verified (University of Arizona Master Gardeners Program, 2006). The weed and invasive potential of this species is recognized by many U.S. gardeners, who advise others not to plant it (Dave's Garden, 2019). *Dolichandra unguis-cati* is listed as a Category 1 species by the Florida Exotic Pest Plant Council (FLEPPC, 2017) and is considered invasive in Texas (TIPPC, 2015). The University of Florida Center for Aquatic and Invasive Plants recommends that it not be used in Florida landscapes (UF-IFAS, 2019), and state and county park managers in Florida are trying to eradicate *D. unguis-cati* where possible (Bard, 2013; Maguire, 2013). Control strategies include mechanical removal of small plants, which must ensure that all tubers are removed, and chemical approaches (CABI, 2018).

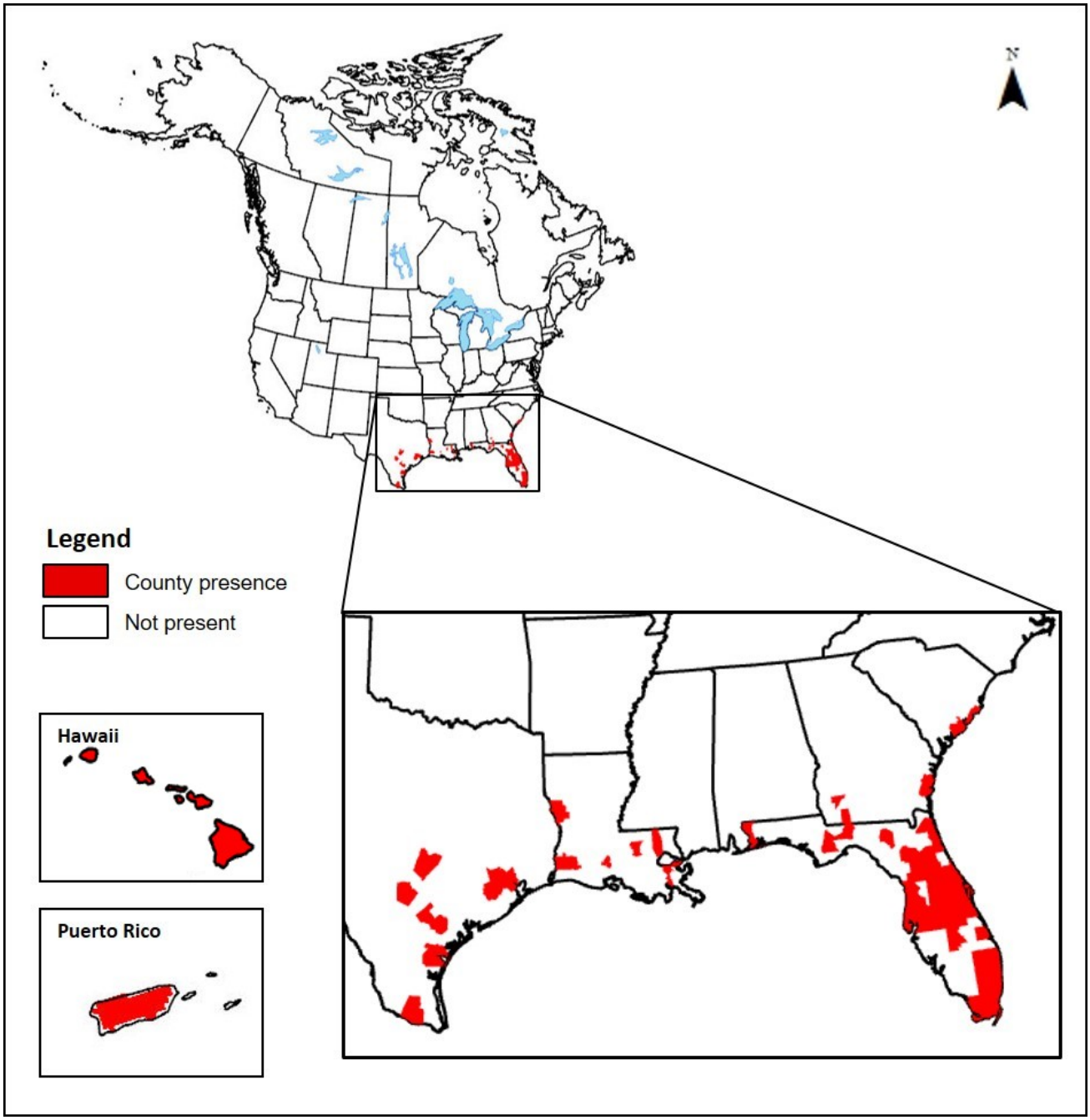

Figure 1. Known naturalized distribution of *Dolichandra unguis-cati* in the United States and Canada. The records shown here were obtained primarily from other species distribution databases (EDDMapS, 2019; SEINet, 2019) and were not independently verified by PERAL. Map insets for Hawaii and Puerto Rico are not to scale.

2. Analysis

ESTABLISHMENT/SPREAD POTENTIAL

Dolichandra unguis-cati is an invasive species that readily establishes and spreads. It is a woody vine that attaches to and climbs up its host using claw-like hooks and adventitious roots (Gentry, 1980; Wagner et al., 1999). It thrives in open, sunny habitats but can also grow in shady areas (Downey and Turnbull, 2007; Vivian-Smith and Panetta, 2004). This species is self-compatible and reproduces vegetatively and through seed (Vivian-Smith and Panetta, 2004). Seeds are both wind- and water-dispersed (Grice and Setter, 2003; Vivian-Smith and Panetta, 2004; Wright, 2009). *Dolichandra unguis-cati* has relatively long seedling and juvenile stages (Downey and Turnbull, 2007) and does not produce a long-term seed bank (Vivian-Smith and Panetta, 2004). Stems that are running along the ground root along their nodes and produce underground tubers, forming dense mats on the ground (Csurhes and Edwards, 1998; WMC, 2013). Because both tubers and stem pieces can resprout, the species is very resilient to disturbance and control activities (Dhileepan et al., 2013). In heavy infestations, tuber density may be as high as 938 per m^2 (Downey and Turnbull, 2007). We had very low uncertainty for this risk element.

Risk score = 14 Uncertainty index = 0.08

IMPACT POTENTIAL

Like other large invasive vines, *Dolichandra unguis-cati* poses a threat to entire natural ecosystems and can damage production systems. In natural systems it smothers vegetation, prevents recruitment of native species, and kills large trees through shading and through physical damage from the weight of the vines (Downey and Turnbull, 2007; King et al., 2011; Mulvaney, 1991; WMC, 2013; Grice and Setter, 2003). In urban environments, this species has similar impacts on ornamental trees and shrubs, and can attach and cause damage to walls, roofs, and other structures (Dave's Garden, 2019). Numerous gardeners have commented on its negative impacts and the difficulty of control. Those who rate it positively note that it needs to be planted away from other plants and should be contained through both regular pruning and use of root barriers (Dave's Garden, 2019). *Dolichandra unguis-cati* is considered an agricultural weed (Groves et al., 2005; Randall, 2007) and a "significant invader" of plantations and orchards (King et al., 2011). Although this species is likely to have similar effects on orchards and forest plantations as on natural areas, we found little evidence that it has done so. A variety of control strategies are used to manage this species, including biocontrol agents (King et al., 2011; Snow and Kunjithapatham, 2013). *Dolichandra unguis-cati* is regulated in Australia (Downey and Turnbull, 2007), New Zealand (MPI, 2012), and South Africa (McNeely, 2001; Nel et al., 2004). Because we found relatively little information about impacts and control activities in production systems, we had above-average uncertainty for this element.

Risk score = 3.4 Uncertainty index = 0.26

GEOGRAPHIC POTENTIAL

Based on three climatic variables, we estimate that about 20 percent of the United States is suitable for the establishment of *D. unguis-cati* (Fig. 2). This predicted distribution is based on its known distribution elsewhere in the world, using evidence from both point-referenced localities and general areas of occurrence. The map for *D. unguis-cati* represents the joint distribution of Plant Hardiness Zones 8 to 13, areas with 10 to over 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 only three climatic variables. Other environmental variables, such as soil and habitat type, may further limit the areas in which this species is likely to establish. Furthermore, we assumed that *D. unguis-cati* could occur in Plant Hardiness Zone 8 based on occurrence records (GBIF, 2019) and cultivation reports from this Zone (Dave's Garden, 2019), but it may only be able to establish in the warmer portions of this zone, thereby shifting the northern edge of its predicted distribution further south. *Dolichandra unguis-cati* is normally associated with forest and riparian habitats (King et al., 2011; Downey and Turnbull, 2007), but has also been reported in savannas (Downey and Turnbull, 2007) and along roadsides and other disturbed areas (Buru et al., 2016b).

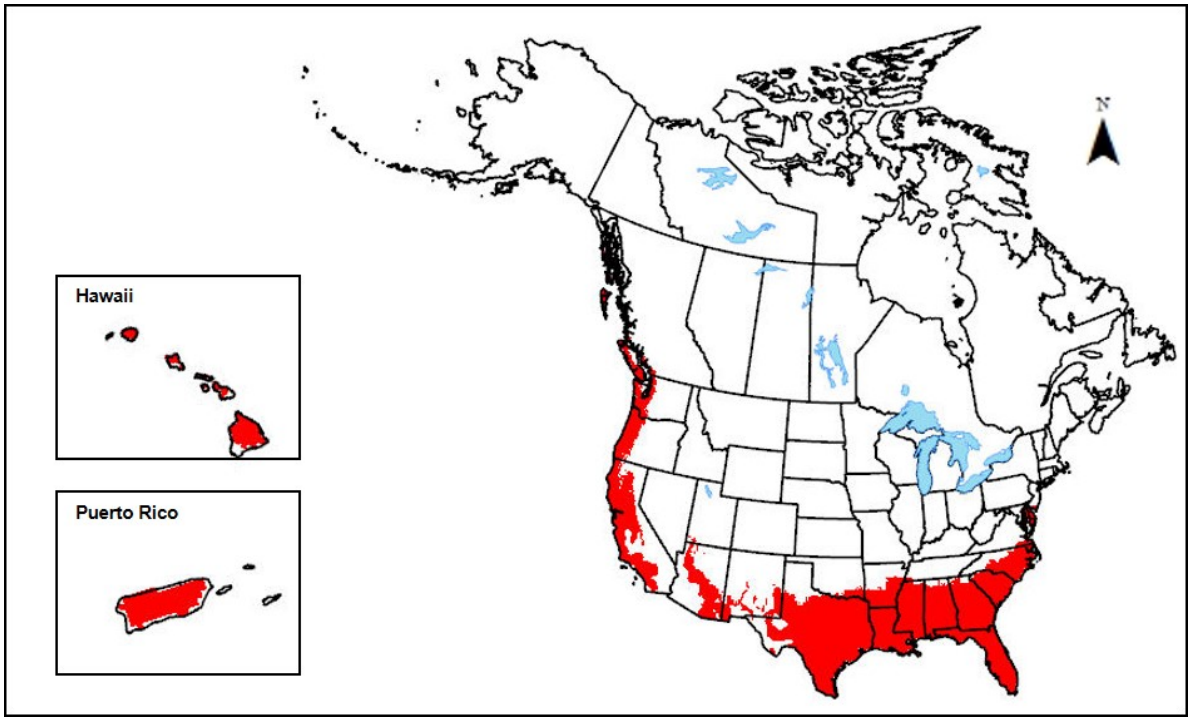

Figure 2. Potential geographic distribution of *D. unguis-cati* in the United States and Canada. Map insets for Hawaii and Puerto Rico are not to scale. For additional information on the PPQ climate-matching process for weeds see Magarey et al., (2017).

ENTRY POTENTIAL

We did not assess the entry potential of *D. unguis-cati* because this species is already present in the United States (Kartesz, 2019; Wagner et al., 1999).

3. Predictive Risk Model Results

Model Probabilities: P(Major Invader) = 77.0%
P(Minor Invader) = 22.1%
P(Non-Invader) = 0.9%
Risk Result = High Risk]
Risk Result after Secondary Screening =Not Applicable

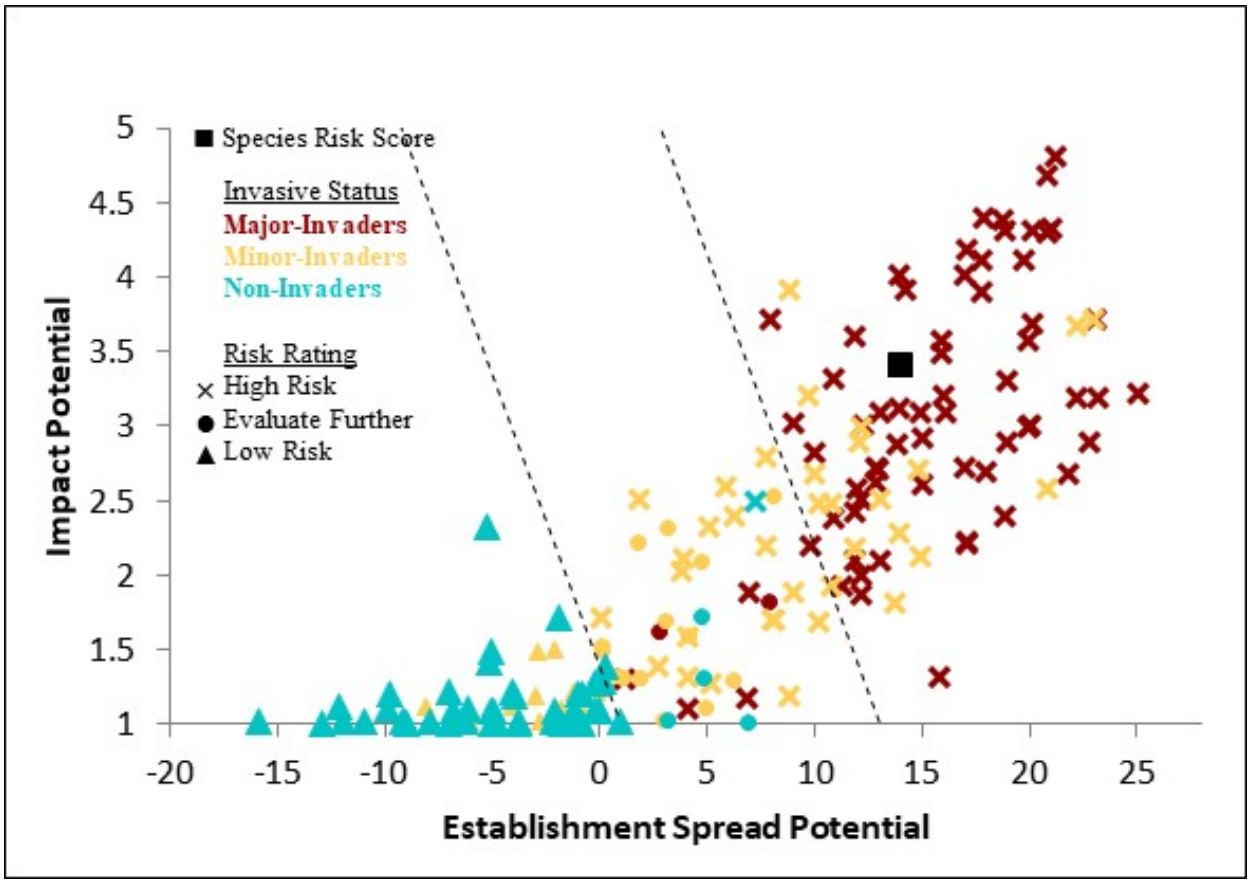

Figure 3. *Dolichandra unguis-cati* risk score (black box) relative to the risk scores of species used to develop and validate the PPQ WRA model (other symbols). See Appendix A for the complete assessment.

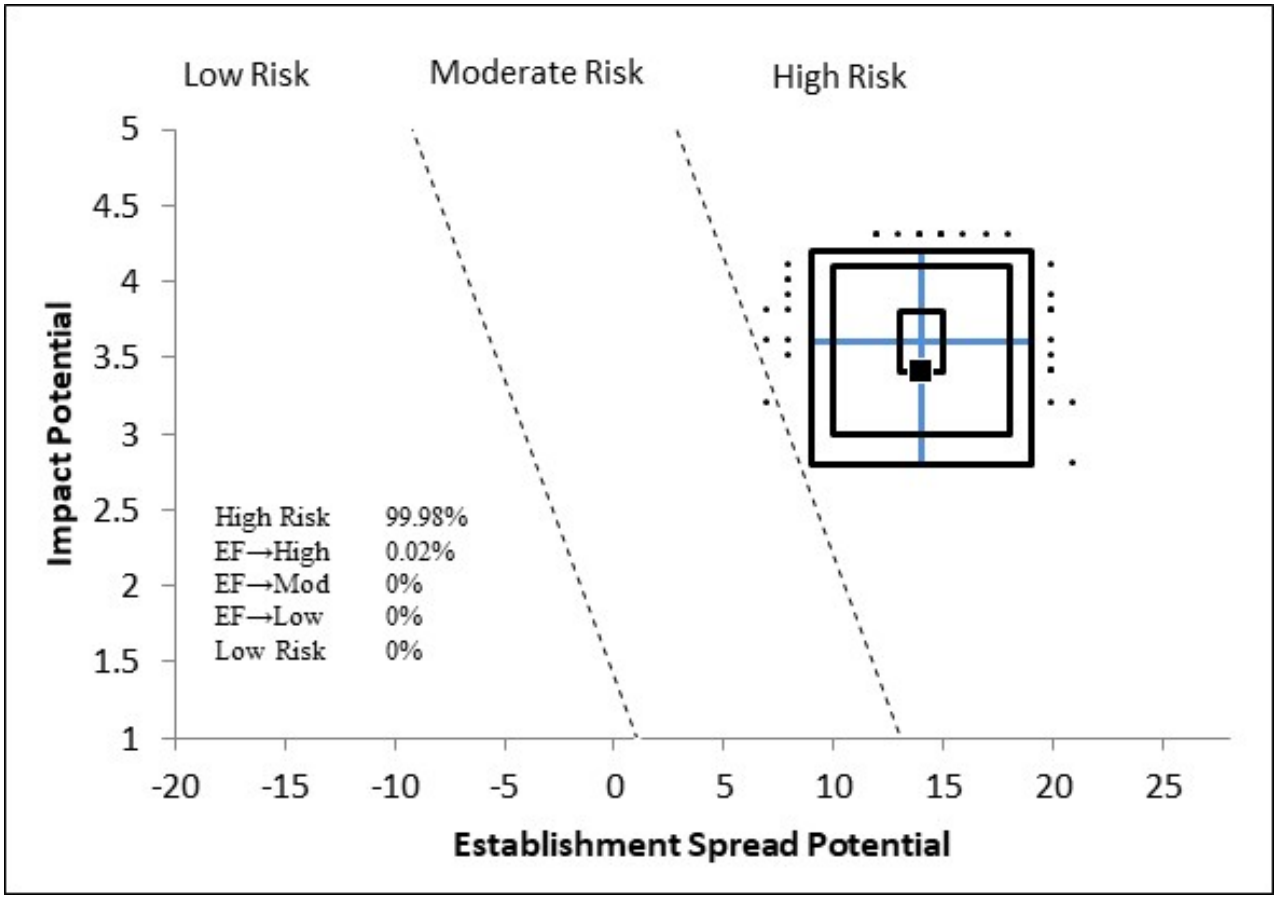

Figure 4. Model simulation results (N=5,000) for uncertainty around the risk score for *D. unguis-cati*. The blue "+" symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

4. Discussion

The result of the weed risk assessment for *Dolichandra unguis-cati* is High Risk (Fig. 3). Despite the uncertainty associated with our assessment, we are confident in our result because all but one of the simulated risk scores resulted in the same conclusion (Fig. 4). Furthermore, our result is consistent with those of two other weed risk assessments (UF-IFAS, 2015; University of Hawaii, 2013) and with the behavior of this species where it has been introduced (Downey and Turnbull, 2007). *Dolichandra unguis-cati* represents a significant threat to ecosystems because of its ability to smother vegetation and kill trees (Downey and Turnbull, 2007; Grice and Setter, 2003; Vivian-Smith and Panetta, 2004). Out of 340 invasive environmental weeds in New South Wales, Australia, *D. unguis-cati* ranked 11th for its threat to biodiversity and is recommended for control (Downey et al., 2010). This species is not recommended for planting in (UF-IFAS, 2019).This species' ability to root from cuttings and resprout from underground tubers makes *D. unguis-cati* particularly difficult to manage (Csurhes and Edwards, 1998; King et al., 2011).

5. Acknowledgements

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SUGGESTED CITATION

PPQ. 2019. Weed risk assessment for *Dolichandra unguis-cati* (L.) L. G. Lohmann (Bignoniaceae) – Cat's-claw. United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (PPQ), Raleigh, NC. 25 pp.

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Appendix A. Weed risk assessment for *Dolichandra unguis-cati* (L.) L. G. Lohmann (Bignoniaceae)

The following table includes the evidence and associated references used to evaluate the risk potential of this taxon. We also include the answer, uncertainty rating, and score for each question. The Excel file in which this assessment was conducted is available upon request.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ESTABLISHMENT/SPREAD POTENTIAL			
ES-1 [What is the taxon's establishment and spread status outside its native range? (a) Introduced elsewhere =>75 years ago but not escaped; (b) Introduced <75 years ago but not escaped; (c) Never moved beyond its native range; (d) Escaped/Casual; (e) Naturalized; (f) Invasive; (?) Unknown]	f - negl	5	*Dolichandra unguis-cati* is native to Mexico, Central America, and most of the Caribbean and South America (Acevedo-Rodríguez and Strong, 2012; NGRP, 2019). It has become naturalized in Australia, Bermuda, Cape Verde, India, Kenya, Mauritius, Micronesia, New Caledonia, New Zealand, Niue, Portugal, Réunion, Seychelles, South Africa, Swaziland, Tanzania, Uganda, and Vanuatu (Downey and Turnbull, 2007; Kairo et al., 2003; Kalidass and Murugan, 2016; NGRP, 2019). This species is considered invasive in the Bahamas (Kairo et al., 2003), India (Bhatt et al., 2012), New Caledonia (Soubeyran, 2008), and the United States (Florida) (UF-IFAS, 2019). It is common in Australia (Mulvaney, 1991) and is categorized as an invasive species, which are species that spread rapidly (Randall, 2007). *Dolichandra unguis-cati* is naturalized and spreading in South Africa (King et al., 2011). In New Zealand, it is considered a casual (Howell and Sawyer, 2006) and a naturalized alien (Landcare Research, 2013) and may become more widespread in the future (MPI, 2012). In the United States, it is naturalized in Florida, Texas, Louisiana, Georgia, Hawaii, and South Carolina (Kartesz, 2019; Wagner et al., 1999; Weakley, 2010), having escaped and spread from areas where it was cultivated (Langeland and Burks, 1998). Wagner et al. (1999) consider it "sparingly naturalized" in Hawaii, but Staples et al. (2000) report it as invasive. Alternate answers for the Monte Carlo simulation are both "e."
ES-2 (Is the species highly domesticated)	n - low	0	This species is cultivated (Bailey and Bailey, 1976; Neal, 1965; Wagner et al., 1999); however, we found no evidence that it has been highly domesticated or bred for traits associated with reduced weed risk.
ES-3 (Significant weedy congeners)	n - low	0	The genus contains about nine species native to the Neotropics (Mabberley, 2008; Wagner et al., 1999). No congeners have been reported as significant weeds (e.g., Randall, 2017).
ES-4 (Shade tolerant at some stage of its life cycle)	y - low	1	*Dolichandra unguis-cati* thrives in full sun to part shade (Kaufman and Kaufman, 2007; Langeland and Burks, 1998) but can also grow in shady environments (Downey and Turnbull, 2007; Vivian-Smith and Panetta, 2004).

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-5 (Plant a vine or scrambling plant, or forms tightly appressed basal rosettes)	y - negl	1	This species is a tropical liana (woody vine) growing up to 15 meters or more in length (Space and Flynn, 2002; Wagner et al., 1999). It adheres to trees with recurved hooks and adventitious roots (Weber, 2003).
ES-6 (Forms dense thickets, patches, or populations)	y - negl	2	This species forms dense mats on the ground (Buru et al., 2016b ; Csurhes and Edwards, 1998; Space and Flynn, 2002; Weber, 2003). It often roots at nodes (Wagner et al., 1999). Vines running on the ground root along nodes, which produce tubers, from which grow more stems, leading to dense ground mats (WMC, 2013). It reproduces from pieces and cuttings (Space and Flynn, 2002) and forms dense infestations in Australia (Vivian-Smith and Panetta, 2004).
ES-7 (Aquatic)	n - negl	0	This species is not an aquatic; it is a terrestrial, woody vine (Wagner et al., 1999; Weber, 2003).
ES-8 (Grass)	n - negl	0	It is not a grass; it is in the Bignoniaceae family (Wagner et al., 1999).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	We found no evidence that this species fixes nitrogen. Bignoniaceae is not one of the plant families known to contain nitrogen-fixing species (Martin and Dowd, 1990; Santi et al., 2013).
ES-10 (Does it produce viable seeds or spores)	y - negl	1	It reproduces by seed (Osunkoya et al., 2009; Vivian-Smith and Panetta, 2004; Weber, 2003; WMC, 2013).
ES-11 (Self-compatible or apomictic)	y - low	1	In one study, researchers found that some seeds had multiple embryos, which are produced through a type of apomixis (Buru et al., 2016a; Vivian-Smith and Panetta, 2004). Multiple seedlings from a single seed suggest that it is facultatively apomictic (Downey and Turnbull, 2007). "Plants are self-fertile, unlike most bignoniaceous lianes in N.Z. [New Zealand], so the sp. is more likely to occur wild" (Landcare Research, 2013). The congener *D. cynanchoides* has a mixed mating system in which some seeds are produced through self-pollination (Bianchi et al., 2005).
ES-12 (Requires specialist pollinators)	n - mod	0	We found no evidence that *D. unguis-cati* requires specialized pollinators. It is pollinated by anthophorid bees in Costa Rica (Downey and Turnbull, 2007). If plants can produce seeds through apomixis (Landcare Research, 2013), they may not require pollinators.
ES-13 [What is the taxon's minimum generation time? (a) less than a year with multiple generations per year; (b) 1 year, usually annuals; (c) 2 or 3 years; (d) more than 3 years; or (?) unknown]	d - high	-1	We found limited information on this species' generation time. Two sources note that the species has an extended seedling or juvenile period because plants invest energy developing underground storage tubers (Downey and Turnbull, 2007; Langeland and Burks, 1998). These tubers later produce climbing stems (WMC, 2013). For seed-based reproduction, this evidence suggests a minimum generation time of four years or more, choice "d." *Dolichandra unguis-cati* also reproduces vegetatively because tubers and stem fragments can give rise to new individuals (Dhileepan et al., 2013; King et al., 2011). Under normal circumstances, however, these structures are probably interconnected and function as

Question ID	Answer - Uncertainty	Score	Notes (and references)
			one very large plant, rather than as individual plants. Assuming that vegetative fragmentation is rare for woody vines, we predict that it would also require four or more years. One study concluded that reproduction from seeds is more important (Osunkoya et al., 2009). Alternate answers for the uncertainty simulation were "c" and "b."
ES-14 (Prolific seed producer)	y - high	1	*Dolichandra unguis-cati* produces inflorescences that typically have one to three flowers, though up to 15 flowers have been recorded (Downey and Turnbull, 2007). Seed pods contain an average of 90 winged seeds (King et al., 2011) and up to about 212 seeds (Downey and Turnbull, 2007; Osunkoya et al., 2009). A few sources report that the species has a high seed production rate (King et al., 2011; Langeland and Burks, 1998; WMC, 2013). An image from the New Zealand Weed Busters website shows a vine on a trellis with dozens of long seed pods within about a square meter (WMC, 2013). Depending on plant type, germination rates range between 31 percent and 70 percent (Buru et al., 2014; Vivian-Smith and Panetta, 2004). Assuming an average of 90 seeds per pod, plants would need to produce 15 to 35 pods per square meter to meet the threshold of 1000 viable seeds required by this question. Since a woody vine can extend vertically up into a canopy, these reproduction rates seem feasible. In one study, researchers measured deposition rates of 167 seeds per square meter per year directly underneath plant canopies (Downey and Turnbull, 2007); however, this may not be reflective of seed production rates, as some of the wind-dispersed seeds are expected to move beyond plant canopies. Based on the overall weight of the evidence, we answered yes, but with high uncertainty.
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - mod	1	Because this species is cultivated (Bailey and Bailey, 1976; Neal, 1965; Wagner et al., 1999) and because it can root from nodes, cuttings, and tubers (Dhileepan et al., 2013; King et al., 2011; Space and Flynn, 2002), it is likely to be spread unintentionally by people in yard waste. Notes on an herbarium record from Polk County, FL indicate that the plant sample was collected from a ruderal area around an old dumpsite at the edge of an orange grove (GBIF, 2019).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	n - mod	-1	We found no evidence that this species is dispersed in trade as either a contaminant or a hitchhiker (e.g., AQAS, 2019).
ES-17 (Number of natural dispersal vectors)	2	0	Propagule traits for ES-17a through ES-17e: Fruit capsules are 26-95 cm long and 1-2 cm in diameter (Wagner et al., 1999). Seeds are numerous, 1.0-3.5 cm long and 4.2-5.8 cm wide, with two membranous wings (Wagner et al., 1999; Acevedo-Rodriguez, 2005). *Dolichandra unguis-cati* has been placed in several genera, one typified as being primarily wind-dispersed

Question ID	Answer - Uncertainty	Score	Notes (and references)
			(*Doxantha*) and another as being primarily water-dispersed (*Macfadyena*) (Gentry, 1973). Gentry (1980) also reports that the Bignoniaceae have undergone several adaptive shifts from wind to water dispersal.
ES-17a (Wind dispersal)	y - negl		This species is wind-dispersed (Csurhes and Edwards, 1998; Kaufman and Kaufman, 2007; Staples et al., 2000; Weber, 2003; WMC, 2013; Wright, 2009).
ES-17b (Water dispersal)	y - negl		This species has been reported to be water-dispersed (Kaufman and Kaufman, 2007; Weber, 2003; Wright, 2009). Given the dispersal ecology of the family, the reports for both wind and water dispersal in the literature, and the fact that this species grows along riparian corridors in Australian rainforests (Downey and Turnbull, 2007; Grice and Setter, 2003; Vivian-Smith and Panetta, 2004), we are assuming that its light, winged seeds are dispersed by both wind and water. Seeds can float in water for up to 54 days, with 50 percent still floating after 36 days (Downey and Turnbull, 2007). Germination is not affected by immersion in water (Downey and Turnbull, 2007).
ES-17c (Bird dispersal)	n - low		We found no evidence. Given the morphology of the fruit and seed, bird dispersal does not seem likely.
ES-17d (Animal external dispersal)	n - mod		We found no evidence.
ES-17e (Animal internal dispersal)	n - low		We found no evidence. Given the lack of obvious rewards for frugivores, this type of dispersal seems unlikely.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	n - low	-1	In one study, researchers determined that very few seeds were viable after having been buried a year, and none germinated in their second season. They concluded that this species does not form a long-term seed bank (Vivian-Smith and Panetta, 2004).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	y - negl	1	*Dolichandra unguis-cati* tolerates mutilation, as each section is often rooted at the nodes (Wagner et al., 1999). Control is difficult because it has tuberous roots and reproduces from pieces and cuttings (Kaufman and Kaufman, 2007; King et al., 2011; Space and Flynn, 2002). It is also difficult to control because it can resprout from underground tubers that are 20-40 cm in length (Dhileepan et al., 2013; Vivian-Smith and Panetta, 2004; Weber, 2003). It resprouts after fire (Downey and Turnbull, 2007).
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - negl	0	We found no evidence that this species is resistant to herbicides, nor is it listed in Heap (2019). A detailed review of control strategies, including several different herbicide formulations and strategies, did not note any herbicide resistance (Downey and Turnbull, 2007).
ES-21 (Number of cold hardiness zones suitable for its survival)	6	0	
ES-22 (Number of climate types suitable for its survival)	6	2	

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-23 (Number of precipitation bands suitable for its survival)	10	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - low	0	We found no evidence, and this species is relatively well studied, particularly in Australia (e.g., Downey and Turnbull, 2007).
Imp-G2 (Parasitic)	n - negl	0	We found no evidence that this species is parasitic. The Bignoniaceae is not a plant family known to contain parasitic plant species (Heide-Jorgensen, 2008; Nickrent, 2016).
Impacts to Natural Systems			
Imp-N1 (Changes ecosystem processes and parameters that affect other species)	y - mod	0.4	*Dolichandra unguis-cati* destabilizes banks in riverine systems (Downey and Turnbull, 2007). It is also reported to affect stream health and water quality in highly-invaded areas (Downey and Turnbull, 2007), but this has not been verified. Mulvaney (1991) states that because it smothers canopies of remnant forests, it disrupts ecosystem photosynthesis and productivity in these habitats. This species may also change soil fertility and nutrient cycling (Perrett et al., 2012). Because some of this evidence is not very strong, we used moderate uncertainty.
Imp-N2 (Changes habitat structure)	y - negl	0.2	Because the weight and shading of vines eventually kill host trees, leading to canopy collapse (Vivian-Smith and Panetta, 2004), *D. unguis-cati* changes the structure of invaded forest habitats. Grice and Setter (2003) report that "[t]he vines reduced healthy rainforests to a stand of vine-draped poles within one to two decades." This species smothers all layers of a forest (Csurhes and Edwards, 1998; Grice and Setter, 2003). In mature infestations, tuber density can be as high as 1000 per square meter to within 30 cm of the soil surface, and individual tubers have been found as deep as 1 meter (Downey and Turnbull, 2007; Osunkoya et al., 2009).
Imp-N3 (Changes species diversity)	y - negl	0.2	Dense mats of *D. unguis-cati* prevent the recruitment of native species (Downey and Turnbull, 2007; King et al., 2011; WMC, 2013). As a smothering vine species (MPI, 2012), it outcompetes forest understory plants and kills "host" trees because of its weight and shading effect (Weber, 2003; Csurhes and Edwards, 1998; Downey and Turnbull, 2007). *Dolichandra unguis-cati* has become the dominant ground cover in undisturbed hardwood forests by Lake George in Florida (Langeland and Burks, 1998).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species?)	y - negl	0.1	In Australia, this species is affecting one plant and one animal species listed as Threatened under the New South Wales Threatened Species Conservation Act of 1995 (Coutts-Smith and Downey, 2006). It is also damaging roosts of threatened flying foxes (Downey and Turnbull, 2007), but these types of animals do not occur in the

Question ID	Answer - Uncertainty	Score	Notes (and references)
			United States. Given the other impacts listed above, it is likely to affect Threatened and Endangered species in the United States.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions?)	y - negl	0.1	*Dolichandra unguis-cati* threatens riparian and rainforest communities in subtropical and tropical habitats in Australia (Csurhes and Edwards, 1998; Downey and Turnbull, 2007), including lowland rainforest communities, which are endangered in New South Wales (Downey and Turnbull, 2007). It can dominate entire landscapes in Australia (Osunkoya et al., 2009). This species is likely to affect several globally outstanding ecoregions in the United States, particularly those in the southeastern and western United States (Ricketts et al., 1999).
Imp-N6 [What is the taxon's weed status in natural systems? (a) Taxon not a weed; (b) taxon a weed but no evidence of control; (c) taxon a weed and evidence of control efforts]	c - negl	0.6	*Dolichandra unguis-cati* is a weed in Florida (Kaufman and Kaufman, 2007), Reunion (Tassin et al., 2006), and South Africa (Henderson, 2001). It is considered one of the most destructive weeds of rainforests in Australia (Grice and Setter, 2003; Groves et al., 2005). Seedlings and small plants can be dug out, but the tubers must be removed carefully because they can resprout (Weber, 2003; WMC, 2013). Five biological control agents have been released in South Africa (King et al., 2011) and Australia (Snow and Kunjithapatham, 2013). It is listed as a Category 1 weed under the Conservation of Agricultural Resources Act of South Africa and must be controlled (Nel et al., 2004). Detailed control strategies are described elsewhere (Downey and Turnbull, 2007). Alternate answers for the Monte Carlo simulation were both "b."
Impact to Anthropogenic Systems (e.g., cities, suburbs, roadways)			
Imp-A1 (Negatively impacts personal property, human safety, or public infrastructure)	y - negl	0.1	Leaves have a claw-tipped tendril that allows the plant to climb on walls and buildings (King et al., 2011; Neal, 1965; Weber, 2003). "The ability of cat's claw creeper to grow over most surfaces can cause serious damage in urban settings, as the tendrils and aerial roots which anchor the plant are also capable of lifting roof tiles and cladding. In addition, the weight of vines can crack walls and break fences. Consequently, the removal of cat's claw creepers can also damage such surfaces since the tendrils and aerial roots bind tightly to them" (Downey and Turnbull, 2007). *Dolichandra unguis-cati* is also problematic for power companies and railways as it often grows up utility poles, weighing them down, and causing localized power interruptions (Downey and Turnbull, 2007). Several home gardeners have reported that the claws and roots will damage the walls on their homes and their roof shingles, and in some cases plants will grow into their homes (Dave's Garden, 2019).
Imp-A2 (Changes or limits recreational use of an area)	n - mod	0	We found no evidence.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-A3 (Affects desirable and ornamental plants, and vegetation)	y - negl	0.1	Several home gardeners have noted that this species damages desirable ornamentals (Dave's Garden, 2019). For example, one gardener from Florida said that it "almost destroyed my parents [*sic*] 70 year old heirloom garden in north Florida! It smothered 60 year old camellias, azaleas, trees, etc." (Dave's Garden, 2019).
Imp-A4 [What is the taxon's weed status in anthropogenic systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	c - negl	0.4	*Dolichandra unguis-cati* is a weed of urban spaces and roadsides (Buru et al., 2016b; Henderson, 2001; King et al., 2011). Twenty out of 33 home gardeners described this species as a pest plant (Dave's Garden, 2019). In South Africa, it is regulated and must be controlled (Nel et al., 2004). Ornamental plantings sometimes lead to infestations that must be controlled (Ward, 2005). Home gardeners have had to remove it because of its damage to home structures and to other plants (Dave's Garden, 2019). One person had to dig up their ligustrum hedge in order to remove the tubers of this vine (Dave's Garden, 2019). Alternate answers for the Monte Carlo simulation are both "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	? - max		One study reports that *D. unguis-cati* poses a serious risk for forestry operations as it can stress and kill trees (Downey and Turnbull, 2007). Although Imp-P6 documents some evidence that it is present in plantations and orchards, we found no evidence that it reduces yield in production systems. Consequently, we answered unknown.
Imp-P2 (Lowers commodity value)	? - max		One study reports that it poses a serious risk for forestry operations because it is difficult to control (Downey and Turnbull, 2007). Although Imp-P6 documents some evidence that it is present in plantations and orchards, we did not find any evidence that it lowers the value of agricultural or forest products. Consequently, we answered unknown.
Imp-P3 (Is it likely to impact trade?)	n - mod	0	*Dolichandra unguis-cati* is prohibited in South Africa (ARC, 2019; McNeely, 2001), and banned from sale, distribution, and propagation throughout New Zealand (APHIS, 2019; MPI, 2012). Its sale and movement are also regulated in Queensland, Western Australia, and New South Wales (DAF, 2016; Dhileepan, 2012; Downey and Turnbull, 2007). Because we found no evidence that it is likely to contaminate commodities in trade (e.g., AQAS, 2019), however, we answered no.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - low	0	We found no evidence.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - low	0	We found no evidence. It is palatable to cattle (Downey and Turnbull, 2007). It is not known to be toxic to goats, but nor is it known to be eaten by them (Simmonds et al., 2000).

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-P6 [What is the taxon's weed status in production systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	b - high	0.2	*Dolichandra unguis-cati* is considered an agricultural weed (Groves et al., 2005; Randall, 2007), as it can invade plantations and orchards (Henderson, 2001; King et al., 2011). Downey and Turnbull (2007) state that it is mainly an environmental weed in Australia (Downey and Turnbull, 2007). It is listed as a Category 1 weed under the Conservation of Agricultural Resources Act of South Africa and must be controlled in all systems (Nel et al., 2004). The herbicide silvex has been used to control it in Florida citrus (Ryan, 1969). Other than these references, we did not find any additional information on impacts or control in production systems. Because the evidence is weak and anecdotal, and because one source said it is primarily an environmental weed, we answered "b" with high uncertainty. Alternate answers for the uncertainty simulation were "c" and "a."
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically referenced points obtained from the Global Biodiversity Information Facility (GBIF, 2019).
Plant hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence that it occurs in this Plant Hardiness Zone.
Geo-Z2 (Zone 2)	n - negl	N/A	We found no evidence.
Geo-Z3 (Zone 3)	n - negl	N/A	We found no evidence.
Geo-Z4 (Zone 4)	n - negl	N/A	We found no evidence.
Geo-Z5 (Zone 5)	n - negl	N/A	We found no evidence.
Geo-Z6 (Zone 6)	n - negl	N/A	We found no evidence.
Geo-Z7 (Zone 7)	n - high	N/A	We found three points in Mexico, one in Bolivia, and a few in Argentina, all in mountainous regions. Due to mapping error in regions where Plant Hardiness Zones change quickly over short distances, we answered no with high uncertainty.
Geo-Z8 (Zone 8)	y - mod	N/A	We found some points in Australia and Argentina, one in Ecuador, a few in Bolivia, and one in South Africa, all in mountainous regions. The plant is hardy to Zone 8 (Dave's Garden, 2019).
Geo-Z9 (Zone 9)	y - negl	N/A	Many points in South Africa and Argentina. It is recommended for this Zone (Page and Olds, 2001). It survives temperatures as low as 20 °F (University of Arizona Master Gardeners Program, 2006). The species is hardy to Zone 9 (Page and Olds, 2001).
Geo-Z10 (Zone 10)	y - negl	N/A	Australia and New Zealand. It withstands a few degrees of frost (Bailey and Bailey, 1976; King et al., 2011). Recommended for this Zone (Page and Olds, 2001).
Geo-Z11 (Zone 11)	y - negl	N/A	Australia, South Africa, and Mexico.
Geo-Z12 (Zone 12)	y - negl	N/A	Brazil, Bolivia, and Mexico.
Geo-Z13 (Zone 13)	y - negl	N/A	French Guiana, Peru, and Brazil.
Köppen -Geiger climate classes			

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-C1 (Tropical rainforest)	y - negl	N/A	Bolivia, Brazil, Colombia, Panama, and Peru.
Geo-C2 (Tropical savanna)	y - negl	N/A	Bolivia, Brazil, Honduras, Mexico, and Venezuela.
Geo-C3 (Steppe)	y - low	N/A	Some points in Mexico. A few in Australia and Bolivia. Two points in Colombia and one in Peru.
Geo-C4 (Desert)	n - high	N/A	A few points in Mexico, but these are close to steppe habitats. This species is reported to be drought-tolerant and able to grow in desert-like conditions (Downey and Turnbull, 2007). We answered no with high uncertainty, however, because we did not consider this to be sufficient evidence, particularly without evidence of xerophytic adaptations.
Geo-C5 (Mediterranean)	y - mod	N/A	A few points in France, Italy, and Spain. Two points in South Africa. One point each in Ecuador and Colombia. Because some of these records may be based on cultivated plants, we used moderate uncertainty instead of low.
Geo-C6 (Humid subtropical)	y - negl	N/A	Australia, Argentina, Brazil, Paraguay, and the United States (Florida and Texas).
Geo-C7 (Marine west coast)	y - negl	N/A	Australia, Argentina, Brazil, and New Zealand. Some points in Bolivia, Colombia, Ecuador, and Peru.
Geo-C8 (Humid cont. warm sum.)	n - mod	N/A	We found no evidence it occurs in this climate class.
Geo-C9 (Humid cont. cool sum.)	n - negl	N/A	We found no evidence.
Geo-C10 (Subarctic)	n - negl	N/A	We found no evidence.
Geo-C11 (Tundra)	n - negl	N/A	We found no evidence.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	n - high	N/A	Points at the tip of Baja California and elsewhere in Mexico, but these are in areas that are intermixed or very near the next precipitation band. Based on the general biology and morphology of this species (Downey and Turnbull, 2007), and potential mapping issues for such a small region, we did not think it likely to be present in such extreme conditions.
Geo-R2 (10-20 inches; 25-51 cm)	y - low	N/A	Some points in Mexico. A few in Australia, South Africa, and Spain.
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	Brazil, Mexico, and Paraguay. A few points in France and Italy.
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	Argentina, Australia, Brazil, and the United States (Texas).
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	This species is widely distributed in regions of Mexico, Brazil, and Central America that include this precipitation band.
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	This species is widely distributed in regions of Mexico, Brazil, and Central America that include this precipitation band.
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	This species is widely distributed in regions of Mexico, Brazil, and Central America that include this precipitation band.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	This species is widely distributed in regions of Mexico, Brazil, and Central America that include this precipitation band.
Geo-R9 (80-90 inches; 203-229 cm)	y - negl	N/A	This species is widely distributed in regions of Mexico, Brazil, and Central America that include this precipitation band.
Geo-R10 (90-100 inches; 229-254 cm)	y - negl	N/A	This species is widely distributed in regions of Mexico, Brazil, and Central America that include this precipitation band.
Geo-R11 (100+ inches; 254+ cm)	y - negl	N/A	This species is widely distributed in regions of Mexico, Brazil, and Central America that include this precipitation band.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	This plant is naturalized in the United States (Kartesz, 2019).
Ent-2 (Plant proposed for entry, or entry is imminent)	-	N/A	
Ent-3 [Human value & cultivation/trade status: (a) Neither cultivated or positively valued; (b) Not cultivated, but positively valued or potentially beneficial; (c) Cultivated, but no evidence of trade or resale; (d) Commercially cultivated or other evidence of trade or resale]	d - negl	N/A	This species is cultivated (Page and Olds, 2001). It was introduced to Australia as an ornamental (Auld and Medd, 1987) as early as 1865 (Downey and Turnbull, 2007) and is one of the ten most serious invasive species currently for sale in Australia (Groves et al., 2005). It has been imported illegally into New Zealand (Williams et al., 2001).
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	