Weed Risk Assessment for *Rumex sagittatus* Thunb. (Polygonaceae) – Climbing dock

United States Department of Agriculture

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Version 1

Left: An infestation of fruiting *Rumex sagittatus* plants in Wanganui, New Zealand (photographer: Colin C. Ogle; NZ PCN, 2013; Ogle, 2013). Right: Infructescence in species' native range in Zimbabwe (photographer: Bart Wursten; Hyde, 2013).

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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.

***Rumex sagittatus* Thunb. – Climbing dock**

Species Information

Family: Polygonaceae

Synonyms: *Acetosa sagittata* (Thunb.) L. A. S. Johnson & B. G. Briggs; *Rumex scandens* Burch. [Löve and Kapoor, 1967; NGRP, 2013; The Plant List, 2013].

Initiation: On November 25, 2011, Al Tasker (PPQ, National Weeds Program Coordinator) asked the PERAL Weed Team to evaluate *Rumex sagittatus* for potential listing as a Federal Noxious Weed (Tasker, 2011). This species has been listed under APHIS' Not Authorized Pending Pest Risk Analysis (NAPPRA) regulations as a pest plant (APHIS, 2013).

Foreign distribution: Native to Botswana, Lesotho, Namibia, Malawi, Mozambique, South Africa, Swaziland, Zambia, and Zimbabwe (APD, 2013; Hyde et al., 2013a; Hyde et al., 2013b; NGRP, 2013). This species is widely naturalized in subcoastal regions of Australia from southern Queensland through southeastern South Australia, and is present in Perth and Tasmania (The University of Queensland, 2013).

U.S. distribution and status: We have found no evidence that this species is naturalized or currently cultivated in the United States (e.g., Backyard Gardener, 2013; Bailey and Bailey, 1930; Dave's Garden, 2013; Page and Olds, 2001). A report on Mediterranean invasive plant species reached a similar conclusion for California (Cal-IPC, 2008). One report exists of a donation of plant material to the Michigan Department of Agriculture in 1878 (p. 146, Baird, 1878), but it is unclear if this species is still present in the United States.

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

[1] "WRA area" is the area in relation to which the weed risk assessment is conducted [definition modified from that for "PRA area" (IPPC, 2012).

1. *Rumex sagittatus* analysis

Establishment/Spread Potential

Rumex sagittatus is a scrambling, vine-like perennial that is naturalized in Australia and New Zealand and is spreading (Heyligers and Adams, 2004; Williams et al., 1998). It has a rapid growth rate (Weedbusters, 2013) and can likely produce a new generation within two to three years after germination (see ES-13 in Appendix A). It produces an abundance of seeds (Williams et al., 1998) that are dispersed by wind and water (The University of Queensland, 2013; Weedbusters, 2013). Underground storage tubers greatly increase its resilience to drought, fire, and management (Heyligers and Adams, 2004; Reidy et al., 2005; Thomson and Leishman, 2005; Weedbusters, 2013) and contribute to unintentional dispersal through soil movement and vegetation dumping (The University of Queensland, 2013; Weber, 2003; Weedbusters, 2013). We had an average amount of uncertainty with this risk element.
Risk score = 12 Uncertainty index = 0.20

Impact Potential

Rumex sagittatus appears to be primarily a weed of natural areas, where it smothers herbs and shrubs, reduces native species richness, and prevents regeneration (Reidy et al., 2005; Weber, 2003; Weedbusters, 2013), particularly after disturbance (Heyligers and Adams, 2004). *Rumex sagittatus* forms a vine "blanket" that alters plant community structure (The University of Queensland, 2013). In New South Wales, it threatens endangered taxa (Coutts-Smith and Downey, 2006; The University of Queensland, 2013) and could do so in the United States as well. *Rumex sagittatus* is subject to control in natural systems (Smith and Patterson, 1978; Timmins and Braithwaite, 2002; Timmins and Mackenzie, 1995). It is a weed of wastelands and gardens (APD, 2013; Auld and Medd, 1987; The University of Queensland, 2013), but it is not clear if it is being actively managed in production systems, or urban/suburban settings. It is a weed of production systems in southern Africa because of potential toxicity to livestock (Wells et al., 1986). In an Australian model prioritizing 340 invasive weeds for management, this species ranked 22nd, posing a very high threat to biodiversity (Downey et al., 2010). This contrasts with observations from New Zealand that this species has not yet had a major impact (Williams et al., 1998), but that may be because it is a relatively new weed that is still spreading in New Zealand (Williams et al., 1998). We had an average amount of uncertainty with this risk element.
Risk score = 2.5 Uncertainty index = 0.19

Geographic Potential

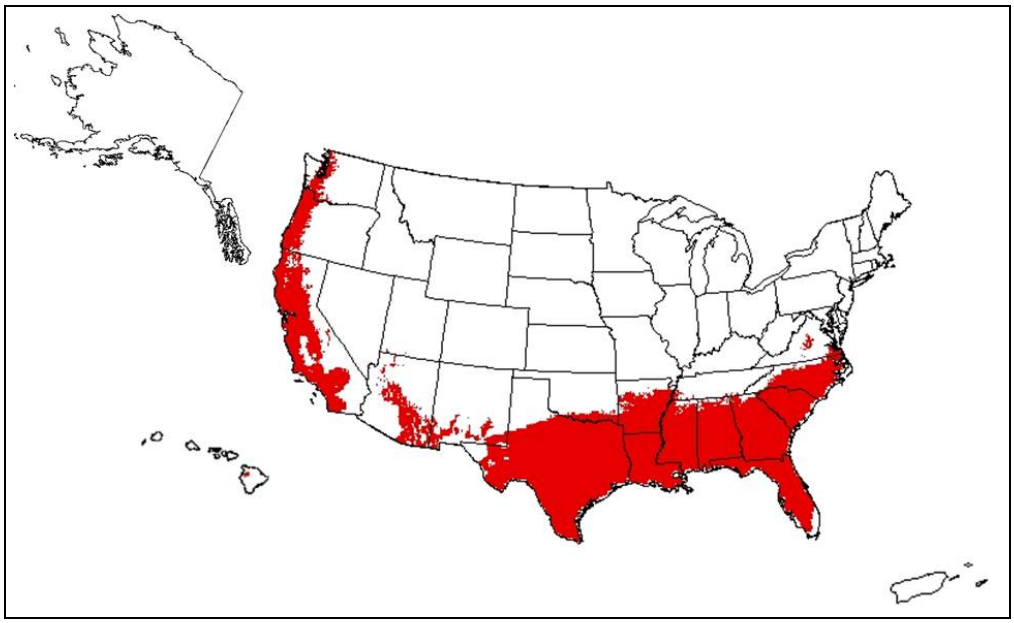
Based on three climatic variables, we estimate that about 20 percent of the United States is suitable for the establishment of *R. sagittatus* (Fig. 1). This predicted distribution is based on the species' known distribution elsewhere in the world and includes point-referenced localities and areas of reported occurrence. The map for *R. sagittatus* represents the joint distribution of Plant Hardiness Zones 8-11, areas with 10-70 inches of annual precipitation, and the following Köppen-Geiger climate classes: steppe, Mediterranean, humid subtropical, and marine west coast. In southern Africa there were a couple of point-sourced occurrences (GBIF, 2013) in dry (0-10 inches), desert-like conditions. However, because these appeared to be inconsistent with the rest of the species' distribution and general morphological traits, we considered these occurrences doubtful and did not include them in our predictive mapping.

The area estimated likely represents a conservative estimate as it only uses three

climatic variables. Other environmental variables, such as soil and habitat type, may further limit the areas in which this species is likely to establish. *Rumex sagittatus* occurs in a broad range of habitats: coastal bluffs, dry forests, dunes, forests, grasslands, riparian areas, river valleys, and stony hills (APD, 2013; The University of Queensland, 2013; Weber, 2003; Williams et al., 1998).

Entry Potential *Rumex sagittatus* is likely to be introduced to the United States intentionally because it is positively valued elsewhere. In Africa, it is used in traditional medicine and thus may be of interest to western medicine (Brown, 1921; Jäger et al., 1996). Categorized as a garden escape (Coutts-Smith and Downey, 2006), it was likely introduced into Australia for horticulture, probably because of the bright display of pink infructescences. Although currently out of stock, one South African retailer offers *R. sagittatus* seeds for sale on the internet (Anonymous, 2013). We found no evidence suggesting it is likely to enter the United States as a hitchhiker or trade contaminant.
Risk score = 0.5 Uncertainty index = 0.11

Figure 1. Predicted distribution of *Rumex sagittatus* 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) = 54.9%
P(Minor Invader) = 42.7%
P(Non-Invader) = 2.4%
Risk Result = High Risk
Secondary Screening = Not Applicable

Figure 2. *Rumex sagittatus* 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.

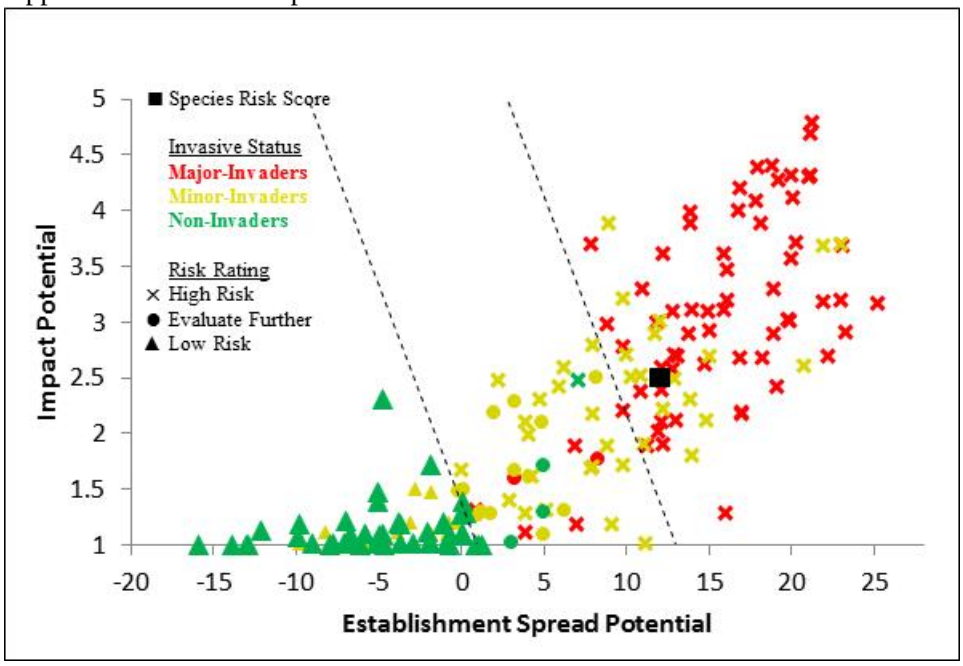
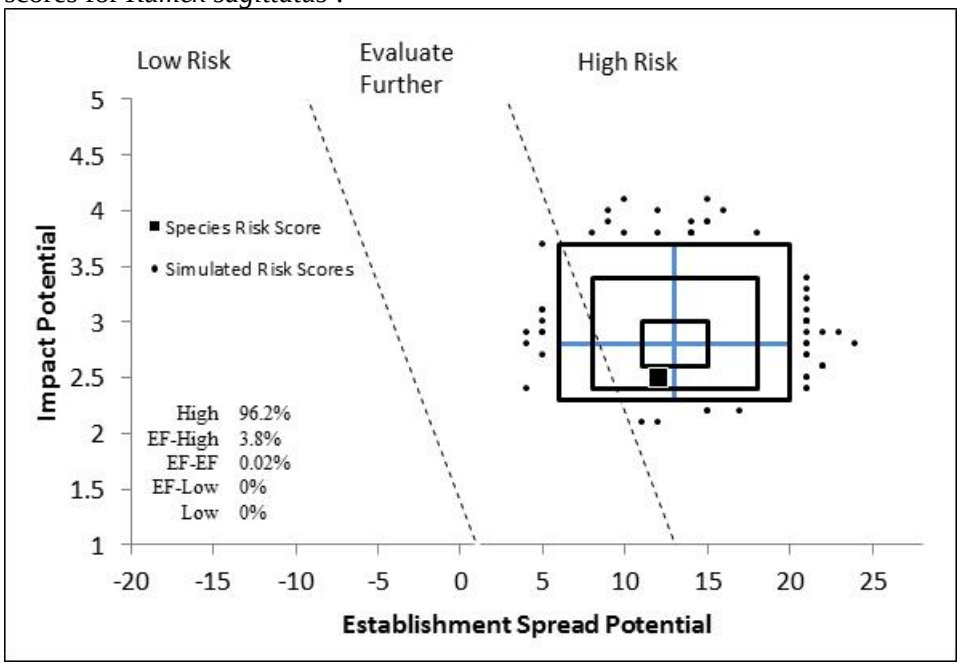


Figure 3. Monte Carlo simulation results (N=5,000) for uncertainty around the risk scores for *Rumex sagittatus*[a].



[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 *R. sagittatus* is High Risk (Fig. 2). Our analysis indicates that this species has a high likelihood of naturalizing and becoming invasive if it is introduced to the United States. Limited biological information and conflicting information in existing evidence contributed to our uncertainty. Despite that, we are confident in our conclusion of High Risk because of the preponderance of High Risk outcomes in the uncertainty analysis (Fig. 3). Our results are consistent with that of another predictive WRA model that found that *R. sagittatus* was highly likely to become a weed (Scott and Panetta, 1993).

We found no evidence that *R. sagittatus* is currently present in the United States. Our analysis of entry potential suggests that this species is reasonably likely to be intentionally introduced in the future for medicinal research or cultivation as an ornamental. If it escapes and establishes, it will likely be difficult to control (Erskine et al., 2002) because of its high reproductive output, resilience, and entangling habit.

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Appendix A. Weed risk assessment for *Rumex sagittatus* Thunb. (Polygonaceae). The following information came from the original risk assessment, which is available upon request (full responses and all guidance). We modified the information to fit on the page.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ESTABLISHMENT/SPREAD POTENTIAL			
ES-1 (Status/invasiveness outside its native range)	f - negl	5	Native to Botswana, Lesotho, Namibia, Malawi, Mozambique, South Africa, Swaziland, Zambia, and Zimbabwe (APD, 2013; Hyde et al., 2013a; Hyde et al., 2013b; NGRP, 2013). Widely naturalized in Australia, suggesting species has historically spread (The University of Queensland, 2013). Spreading in New Zealand (Williams et al., 1998). Spreading on an Australian island set aside for conservation (Heyligers and Adams, 2004). It is believed it will continue to spread in Australia (The University of Queensland, 2013). Alternate answers for the Monte Carlo simulation are both "e."
ES-2 (Is the species highly domesticated)	n - low	0	Listed as a garden escape in Australia (Coutts-Smith and Downey, 2006), suggesting it is or at least was cultivated there. Not deliberately cultivated in Australia anymore, though occasionally it appears in retail due to its colorful fruit (The University of Queensland, 2013). There is no evidence it has been bred for traits associated with reduced weed potential.
ES-3 (Weedy congeners)	y - negl	1	*Rumex crispus* and *R. obtusifolius* are important weeds in America and Europe (Auld and Medd, 1987). Some members of the genus are toxic to farm animals (Burrows and Tyrl, 2001). Several species are considered serious and principal weeds in multiple countries (Holm et al., 1979). *Rumex acetosella* is a serious weed of cereals, pasture, other crops, and nurseries throughout the world (Holm et al., 1997). *Rumex crispus* is a significant weed of pastures because it is largely unpalatable (CABI, 2013).
ES-4 (Shade tolerant at some stage of its life cycle)	y - high	1	Although shade tolerant, grows more vigorously in sun (Weber, 2003). "Intolerant of shade" (Weedbusters, 2013). Seedlings appear to prefer open conditions (Williams et al., 1998). Occurs on rocks in shade in Africa (APD, 2013). Because it appears to grow in shade, at least under some conditions, answering yes, but with high uncertainty.
ES-5 (Climbing or smothering growth form)	y - negl	1	A prostrate, ascending, or climbing perennial herb (Auld and Medd, 1987). A climbing or scrambling herb reaching up to 3 meters high, with stems trailing on the ground or climbing over supporting vegetation (Weber, 2003; Weedbusters, 2013). Vigorous perennial climber (Richardson et al., 2006).
ES-6 (Forms dense thickets)	n - high	0	This species is present as widely spaced individual plants (Williams et al., 1998). In Australia and New Zealand, it forms thick mats on the ground (NZ PCN, 2013; The University of Queensland, 2013), but it is not clear if this is one large sprawling plant or several individuals. Consequently, answering no based on the explicit evidence from the first reference, but raising uncertainty to high.
ES-7 (Aquatic)	n - negl	0	A terrestrial herb (Auld and Medd, 1987; Richardson et al., 2006).
ES-8 (Grass)	n - negl	0	Plant is not a grass; it is in the Polygonaceae family (NGRP, 2013; Richardson et al., 2006).

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	The Polygonaceae is not a family known to contain nitrogen-fixing species (Martin and Dowd, 1990). Furthermore, this species is herbaceous.
ES-10 (Does it produce viable seeds or spores)	y - negl	1	Produces viable seeds (Williams et al., 1998). Spreads by seeds (Weber, 2003).
ES-11 (Self-compatible or apomictic)	? - max	0	Unknown. Flowers bisexual or functionally female (Morris, 2009; The University of Queensland, 2013). Plants gynodioecious (female plants and male/female plants) (Navajas-Pérez et al., 2005). Dioecious or monoecious perennial (NZ PCN, 2013).
ES-12 (Requires special pollinators)	? - max		Unknown. Flowers of the closely related *Rumex vesicarius* are wind-pollinated (Schatral and Osborne, 2006). Because we do not know whether wind-pollination is common among other members of the genus, we are answering unknown.
ES-13 (Minimum generation time)	c - high	0	Perennial herb (Auld and Medd, 1987; Richardson et al., 2006). Spreads by tubers and seeds (Weber, 2003). Germinating seeds take about three years before the plants become "visible" in native vegetation (Williams et al., 1998). Based on the available information, this species likely reproduces within its second or third year. Alternate answers for the Monte Carlo simulation are "b" and "d."
ES-14 (Prolific reproduction)	y - high	1	There are no quantitative data related to seed production; however, a few anecdotal comments suggest the plant reproduces prolifically (see evidence that follows). Thus, based on these comments and on images (The University of Queensland, 2013) of plants with heavy fruit production, answering yes but with high uncertainty. Specific evidence: Produces large masses of capsules (Richardson et al., 2006; Weedbusters, 2013). Depending on when seeds are collected, 40-80 percent of the seeds are viable (Williams et al., 1998). Prolific seeder (The University of Queensland, 2013).
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - negl	1	Tubers spread by soil movement and vegetation dumping (The University of Queensland, 2013; Weber, 2003; Weedbusters, 2013).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	n - mod	-1	No evidence. Because this species does not appear to be a significant weed of production systems, it seems unlikely to contaminate a trade pathway.
ES-17 (Number of natural dispersal vectors)	2	0	For questions ES17a-ES17e: Fruit is winged (Morris, 2009). Light brown seeds are 3 mm in length (Morris, 2009; Weber, 2003). Fruit of the genus *Acetosa* (synonym of *Rumex*) is a three-angled nut enclosed by the persistent balloon-like flower segments (Richardson et al., 2006). "The fruit is a small nut surrounded by three papery wings (i.e. valves) 4-7 mm long and 6-10 mm across that have conspicuous veins. These fruit are initially green in color but usually turn bright pinkish-red or purplish as they mature (particularly near their margins) and are often mistaken for the flowers of this species. The fruit finally turn pale brown in color when they reach full maturity, usually during summer, and are dispersed from the plant in late summer and autumn" (The University of Queensland, 2013).
ES-17a (Wind dispersal)	y - negl		Perianth with papery wings (Auld and Medd, 1987). Seeds dispersed by wind (Heyligers and Adams, 2004; The

Question ID	Answer - Uncertainty	Score	Notes (and references)
			University of Queensland, 2013; Weber, 2003; Weedbusters, 2013).
ES-17b (Water dispersal)	y - low		Seeds and tubers dispersed by water (Weedbusters, 2013). The papery fruit floats on water and the rhizomes/tubers may disperse downstream if they become dislodged during floods (The University of Queensland, 2013). Because the fruit readily float on the papery wings, and because it occurs, in addition to other habitat types, in moist gullies and riparian areas (The University of Queensland, 2013), answering yes.
ES-17c (Bird dispersal)	n - mod		No evidence.
ES-17d (Animal external dispersal)	n - mod		No evidence.
ES-17e (Animal internal dispersal)	n - mod		No evidence.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	n - high	-1	Rapid germination of seeds suggests that a long-term seed bank would not be formed (Williams et al., 1998).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	y - negl	1	Control is difficult due to the many tubers that dislodge easily (Weber, 2003). Tolerates damp or dry conditions, dying back to the tuber (Weedbusters, 2013). Tubers, and rhizomes occasionally, usually resprout after herbicide application and fragment if missed when digging (Weedbusters, 2013). Resprouts after fire (Heyligers and Adams, 2004; Reidy et al., 2005; Thomson and Leishman, 2005).
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	? - max		Plants are susceptible to herbicides, but they sometimes resprout (Smith and Patterson, 1978; Williams et al., 1998). "Appears resistant to Glyphosate" (Erskine et al., 2002). However, the Weed Science Society of America does not list any species of *Rumex* as herbicide-resistant. *Rumex crispus* and *R. obtusifolius* can hybridize (Auld and Medd, 1987). Because the reference by Erskine is not definitive, answering unknown.
ES-21 (Number of cold hardiness zones suitable for its survival)	4	0	
ES-22 (Number of climate types suitable for its survival)	4	2	
ES-23 (Number of precipitation bands suitable for its survival)	6	0	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - mod	0	No evidence.
Imp-G2 (Parasitic)	n - negl	0	Plant is in the Polygonaceae family (NGRP, 2013), which is not known to contain any parasitic species (Heide-Jorgensen, 2008; Nickrent, 2009).
Impacts to Natural Systems			
Imp-N1 (Change ecosystem processes and parameters that affect other species)	n - mod	0	No evidence.
Imp-N2 (Change community structure)	y - low	0.2	Forms mats on the ground surface that interfere with native species regeneration (The University of Queensland, 2013). Readily forms a vine tangle in vegetation (see image in NZ

Question ID	Answer - Uncertainty	Score	Notes (and references)
			PCN, 2013). Because this species can dominate the herbaceous layer and low shrub layer (see additional references under Imp-N3), answering yes.
Imp-N3 (Change community composition)	y - negl	0.2	Completely smothers herbs and shrubs, preventing any regeneration and reducing native species richness (Weber, 2003). Quickly scrambles over most plants to about 3 meters high (Weedbusters, 2013). Replaces low canopy and prevents regeneration (Weedbusters, 2013). When not controlled, it can dominate a site (Reidy et al., 2005). Dominates vegetation after disturbance (Heyligers and Adams, 2004).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	y - negl	0.1	In a model prioritizing 340 invasive weeds, this species was identified to pose a very high threat to biodiversity ranking 22nd in the list (Downey et al., 2010). It threatens the New South Wales, Threatened *Allocasuarine portuensis* (Coutts-Smith and Downey, 2006; The University of Queensland, 2013).
Imp-N5 (Is it likely to affect any globally outstanding ecoregions)	? - max		A group of vines and scramblers, including *R. sagittatus*, were identified as a group to represent a key threatening process to biodiversity (Hughes, 2006). Because Hughes (2006) did not identify the specific impacts of *R. sagittatus*, and because we found no evidence of impacts to ecosystem processes, answering unknown.
Imp-N6 (Weed status in natural systems)	c - negl	0.6	Invades dunes (Weedbusters, 2013; Williams et al., 1998). A weed of the natural environment in Australia (Randall, 2007) and New Zealand (Howell, 2008). Significant environmental weed in natural areas in Australia (Groves et al., 2005; Smith and Patterson, 1978). Controlled in conservation areas in New Zealand (Timmins and Braithwaite, 2002; Timmins and Mackenzie, 1995). Specific control strategies are described (Weber, 2003; Weedbusters, 2013), but the references don't distinguish between natural and anthropogenic areas. Recommended for control in Tasmania (Morris, 1969). Studies in New Zealand and Australian natural areas have been conducted to see how *R. sagittatus* and the surrounding vegetation respond to herbicide applications (Smith and Patterson, 1978; Williams et al., 1998). Alternate answers for the Monte Carlo simulation are both "b."
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Impacts human property, processes, civilization, or safety)	n - high	0	No specific evidence. Because this plant is viewed as a garden weed, using high uncertainty for Imp-A1 through Imp-A3.
Imp-A2 (Changes or limits recreational use of an area)	n - high	0	No specific evidence.
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	n - high	0	No specific evidence.
Imp-A4 (Weed status in anthropogenic systems)	b - high	0.4	Occurs in wasteland and roadsides (Weedbusters, 2013). Minor wasteland weed (Auld and Medd, 1987). Major weed of gardens and urban bushland in southeastern Australia (The University of Queensland, 2013). Garden weed in Africa (APD, 2013). Naturalized in urban Auckland, New Zealand (Esler and Astridge, 1987). Specific control strategies are described (Weber, 2003; Weedbusters, 2013), but the

Question ID	Answer - Uncertainty	Score	Notes (and references)
			references don't distinguish between natural and anthropogenic areas. A vegetation management plan for a one-kilometer section of beach in an Australian city mentions that this species is difficult to control and recommends herbicide trials be done with Metasulfuron; they also recommend that plants should be hand-pulled along with their tubers (Erskine et al., 2002). However, from satellite imagery, this section of beach appears to correspond to a wild or natural area, which disqualifies it from consideration in this subelement. Ultimately, we did not find strong evidence that this species is being managed in anthropogenic areas. Answering "b" but using high uncertainty. Alternate answers for the Monte Carlo simulation were "c" and "a."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	n - mod	0	No evidence.
Imp-P2 (Lowers commodity value)	n - mod	0	No evidence.
Imp-P3 (Is it likely to impact trade)	n - mod	0	Regulated in New South Wales (Parsons and Cuthbertson, 2001) locally (The University of Queensland, 2013). Prohibited from sale and distribution in certain municipalities (The University of Queensland, 2013). Because there is no evidence this species is likely to follow a pathway, answering no.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - mod	0	No evidence.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	y - high	0.1	Health concern for sheep and goats in South Africa (Wells et al., 1986). *Rumex sagittatus* is toxic (Randall, 2012). No known risk of toxicity to goats in Australia but highly palatable to them (Simmonds et al., 2000). We did not find any other information on *R. sagittatus*. Some species of *Rumex* are known to be toxic to animals and humans, and yet some are consumed with no adverse effects (Burrows and Tyrl, 2001).
Imp-P6 (Weed status in production systems)	b - low	0.2	Agricultural weed in Australia (Randall, 2007). Considered an agricultural weed in South Africa (Wells et al., 1986). Alternate answers for the Monte Carlo simulation were "a" and "c."
GEOGRAPHIC POTENTIAL			Unless otherwise noted, all evidence below represents point-occurrences obtained from GBIF (2013) or a generalized distribution in the southeastern corner of the state of South Australia, Australia (Barker et al., 2005).
Plant cold hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	No evidence.
Geo-Z2 (Zone 2)	n - negl	N/A	No evidence.
Geo-Z3 (Zone 3)	n - negl	N/A	No evidence.
Geo-Z4 (Zone 4)	n - negl	N/A	No evidence.
Geo-Z5 (Zone 5)	n - negl	N/A	No evidence.
Geo-Z6 (Zone 6)	n - negl	N/A	No evidence.
Geo-Z7 (Zone 7)	n - high	N/A	One point in Lesotho. Answering no because this could either

Question ID	Answer - Uncertainty	Score	Notes (and references)
			be a misidentification, or a plant growing in a protected microhabitat.
Geo-Z8 (Zone 8)	y - negl	N/A	Lesotho, South Africa, and New Zealand.
Geo-Z9 (Zone 9)	y - negl	N/A	Australia, South Africa, and New Zealand.
Geo-Z10 (Zone 10)	y - negl	N/A	Australia and South Africa.
Geo-Z11 (Zone 11)	y - negl	N/A	South Africa.
Geo-Z12 (Zone 12)	n - high	N/A	No evidence.
Geo-Z13 (Zone 13)	n - negl	N/A	No evidence.
Köppen-Geiger climate classes			
Geo-C1 (Tropical rainforest)	n - negl	N/A	No evidence.
Geo-C2 (Tropical savanna)	n - negl	N/A	No evidence.
Geo-C3 (Steppe)	y - high	N/A	Two points in Namibia, five points near or on edge in South Africa.
Geo-C4 (Desert)	n - high	N/A	Two points in Desert. Answering no because none of the literature I read indicated this plant grew in desert like conditions.
Geo-C5 (Mediterranean)	y - negl	N/A	Australia and South Africa.
Geo-C6 (Humid subtropical)	y - negl	N/A	Australia and South Africa.
Geo-C7 (Marine west coast)	y - negl	N/A	Australia and New Zealand.
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 - high	N/A	Four points in South Africa, and one in Namibia. Answering no because growth in these dry, desert-like conditions is not consistent with the species' overall distribution.
Geo-R2 (10-20 inches; 25-51 cm)	y - high	N/A	Three points in South Africa, and one in Namibia.
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	South Africa, and one point in Australia.
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	Australia, and South Africa.
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	Australia, and New Zealand.
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	New Zealand.
Geo-R7 (60-70 inches; 152-178 cm)	y - low	N/A	New Zealand.
Geo-R8 (70-80 inches; 178-203 cm)	n - mod	N/A	No evidence.
Geo-R9 (80-90 inches; 203-229 cm)	n - negl	N/A	No evidence.
Geo-R10 (90-100 inches; 229-254 cm)	n - negl	N/A	No evidence.
Geo-R11 (100+ inches; 254+ cm))	n - negl	N/A	No evidence.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ENTRY POTENTIAL			
Ent-1 (Plant already here)	n - high	0	The only evidence we have come across indicating this plant is in the United States, is a report of a donation of plant material to the Michigan Department of Agriculture in 1878 (p. 146, Baird, 1878). Because this was the only evidence, we answered no and proceeded with this analysis.
Ent-2 (Plant proposed for entry, or entry is imminent)	n - low	0	No evidence.
Ent-3 (Human value & cultivation/trade status)	d - low	0.5	Used in traditional Zulu medicine and of interest to western researchers (Jäger et al., 1996). Used by the Zulu tribe in Africa to dispel evil spirits (Anonymous, 2013). Used to treat dysentery in Nairobi (Brown, 1921). A garden escape in Australia (Coutts-Smith and Downey, 2006), suggesting it is or at least was cultivated there. Seeds available online (Anonymous, 2013). Occasionally appears in retail in Australia due to its colorful fruit (The University of Queensland, 2013).
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	n - mod		No evidence.
Ent-4b (Contaminant of plant propagative material (except seeds))	n - mod	0	No evidence.
Ent-4c (Contaminant of seeds for planting)	n - mod	0	No evidence.
Ent-4d (Contaminant of ballast water)	n - mod	0	No evidence.
Ent-4e (Contaminant of aquarium plants or other aquarium products)	n - mod	0	No evidence.
Ent-4f (Contaminant of landscape products)	n - mod	0	No evidence.
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	n - mod	0	No evidence.
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	n - low	0	No evidence, and seems unlikely.
Ent-4i (Contaminant of some other pathway)	? - mod		Unknown.
Ent-5 (Likely to enter through natural dispersal)	n - mod	0	No evidence.