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Version 1

Weed Risk Assessment for *Alectra vogelii* Benth. (Orobanchaceae) – Yellow witchweed

Alectra vogelii inflorescence (source: Lytton John Musselman, Old Dominion University, Bugwood.org).

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Executive Summary

The result of the weed risk assessment for *Alectra vogelii* is High Risk of becoming weedy or invasive in the United States. *Alectra vogelii* is an annual parasitic herb with a wide host range, and it attacks economically important leguminous crops such as *Glycine max* (soybean), *Vigna unguiculata* (cowpea), *Cicer arietinum* (chickpea), and *Arachis hypogaea* (peanut) in Africa. It is not known to have been introduced outside the continent, but it may be introduced into new areas in forage and possibly in crop seed. *Alectra vogelii* is not known to occur in the United States and is not cultivated anywhere. Because they are parasitic weeds, members of the genus *Alectra* are regulated in the United States as Federal Noxious Weeds and under 7 CFR 360. A single *A. vogelii* plant can produce up to 600,000 tiny, wind-dispersed seeds that remain viable for more than 10 years. Infestations of *A. vogelii* cause significant crop stunting and yield losses due to competition for nutrients. Symptoms of parasitism by *A. vogelii* include stunting, wilting, chlorosis, and reduced flower and legume production. Heavy infestations of *A. vogelii* in *V. unguiculata* often cause total yield losses. Chemical and manual controls are insufficient to manage *A. vogelii* infestations, so farmers also use parasite-resistant legume varieties. Approximately 23 percent of the United States is estimated to be suitable for the establishment of this species. *Alectra vogelii* is unlikely to be imported accidentally in most commodities. In Africa, however, it has been transported to uninfested areas in contaminated forage. Although we found no evidence that *A. vogelii* is a contaminant of seed for planting, its congener *A. picta* is thought to have been introduced in Ethiopia via contaminated seed, and plants in the related parasitic genus *Striga* are dispersed in crop seed in Africa. Because *Striga* spp. and *A. vogelii* often grow in the same fields, it is possible that *A. vogelii* may contaminate these agricultural products as well.

1. Plant Information and Background

SPECIES: *Alectra vogelii* Benth. (NGRP, 2018).

FAMILY: Orobanchaceae

SYNONYMS: *Alectra angustifolia* Engl., *A. merkeri* Engl., *A. scharensis* Engl. (NGRP, 2018).

COMMON NAMES: Yellow witchweed (CABI, 2019).

BOTANICAL DESCRIPTION: *Alectra vogelii* is a parasitic annual herb that grows mainly in legume crops in Africa (Mwaipopo, 2014; Visser, 1978). It is an erect herb that grows to 50 cm in height (Mwaipopo, 2014). For a full botanical description see Mwaipopo (2014).

Alectra vogelii has a wide host range (Parker and Riches, 1993) but typically parasitizes legumes, including *Glycine max* (soybean), *Vigna unguiculata* (cowpea), *Vigna subterranea* (Bambara groundnut), *Vigna radiata* (mung bean), *Cicer arietinum* (chickpea), *Arachis hypogaea* (peanut), and *Phaseolus* spp. (bean) (Visser, 1978; Parker and Riches, 1993), as well as *Helianthus annuus* (sunflower) (Visser, 1978), *Acanthospermum hispidum* (hispid starbur), *Polydora poskeana*, *Euphorbia* spp. (spurge), and *Hibiscus* spp. (rosemallow) (Mwaipopo, 2014). It has been observed in *Zea mays* (corn) and *Sorghum* spp. fields, but it is not known whether these species are true hosts (Visser, 1978). Parker and Riches (1993) note that infestations of non-legume hosts typically occur on fallow cropland. Additional hosts are listed by Parker and Riches (1993).

INITIATION: The USDA Cooperative Agricultural Pest Survey Program requested a weed risk assessment of *A. vogelii* to determine whether to continue listing this species on their Priority Pest List.

WRA AREA[1]: United States and Territories.

FOREIGN DISTRIBUTION: *Alectra vogelii* is found in Africa (Alonge et al., 2001; Visser, 1978). It is thought to be native to Angola, Botswana, Republic of the Congo, Ghana, Guinea, Kenya, Malawi, Mali, Namibia, Nigeria, South Africa, Swaziland, Tanzania, Uganda, Democratic Republic of the Congo (Zaire), Zambia, and Zimbabwe (NGRP, 2018). It has also been reported in Ethiopia (Mohamed et al., 2006), Mozambique, and Sierra Leone (Visser, 1978). The true native range of this species in Africa is unclear (Mwaipopo, 2014; Parker, 2012; Visser, 1978). Parker (2012) suggests that infestations in Ethiopia resulted from a recent chance introduction. We found no evidence that it has been introduced outside of Africa. It is not known to be cultivated anywhere, as it is a parasitic pest of crops. *Alectra vogelii* is regulated in trade in Honduras, and the genus *Alectra* is regulated in trade in Egypt, Israel, and South Korea (USDA PCIT, 2019).

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[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).

U.S. DISTRIBUTION AND STATUS: *Alectra vogelii* is not known to be naturalized (Kartesz, 2017; NRCS, 2018) or cultivated (Dave's Garden, 2019; University of Minnesota, 2018) in the United States. The genus *Alectra* is listed as a Federal Noxious Weed (NRCS, 2018) and is regulated as a parasitic plant under 7 CFR 360 (2011).

2. Analysis

ESTABLISHMENT/SPREAD POTENTIAL

Alectra vogelii is a common agricultural weed in Africa, but its biology is not well studied, and its natural host range and true native range are not known (Mwaipopo, 2014; Parker, 2012; Visser, 1978). For these reasons, we had very high uncertainty for this risk element. Its establishment and spread risk score, however, is high (Fig. 2), because it produces up to 600,000 seeds per plant (Visser, 1978), its seed is extremely small and remains viable for more than 10 years (Mwaipopo, 2014; Visser, 1978) (Mwaipopo, 2014; Visser, 1978), it is spread in livestock forage (Berner et al., 1994), and it is likely to be spread in contaminated crop seed, on agricultural equipment and vehicles, and in mud on livestock (Parker and Riches, 1993; Visser, 1978).

Risk score = 16.0 Uncertainty index = 0.24

IMPACT POTENTIAL

Alectra vogelii is a well-documented and serious annual parasitic weed of legume crops in Africa. It infests economically important crops, including *Glycine max* (soybean), *Vigna unguiculata* (cowpea, black-eyed pea), *Vigna subterranea* (Bambara groundnut), *Vigna radiata* (mung bean), *Cicer arietinum* (chickpea), and *Arachis hypogaea* (peanut) (Mwaipopo, 2014; Rank et al., 2004; Parker and Riches, 1993). Symptoms of *A. vogelii* infestation include stunting, wilting, chlorosis, and reduced flower and fruit set (Singh and Emechebe, 1997). Heavy infestations of cowpea often cause total yield loss (Mwaipopo, 2014). Nearly 90 million acres of soybean and 33 thousand acres of black-eyed pea were cultivated in the United States in 2018 (USDA NASS, 2018). We had low uncertainty for this risk element because its impacts and host preferences in agricultural systems are well known. *Alectra vogelii* has not been observed to significantly impact non-legume hosts (Mwaipopo, 2014; Parker, 2012; Visser, 1978). Its hosts in natural areas are unknown, and most infestations on non-legume hosts occur in fallow cropland (Parker and Riches, 1993). Thus, its known impacts in natural and anthropogenic areas are negligible. These observations reduced the risk score (Fig. 2) of this species despite its significant impacts to legume crop systems in Africa.

Risk score = 2.5 Uncertainty index = 0.06

GEOGRAPHIC POTENTIAL

Based on three climatic variables, we estimate that about 23 percent of the United States is suitable for the establishment of *A. vogelii* (Fig. 1). This predicted distribution is based on the known distribution of the species elsewhere in the world, using evidence from both point-referenced localities and general areas of occurrence. The map for *A. vogelii* represents the joint distribution of Plant Hardiness Zones 8-12, areas with 0-70 inches of annual precipitation, and the following Köppen-Geiger climate classes: tropical savanna, steppe, desert, Mediterranean, humid subtropical, and marine west coast.

The area of the United States shown to be climatically suitable (Fig. 1) for species establishment was estimated using only three climatic variables. Other variables, such as soil and habitat type, novel climatic conditions, or plant genotypes, may alter the areas in which this species is likely to establish. *Alectra vogelii* occurs in cropland in several climate types across Africa. Because it is a parasite of numerous crops, particularly legumes, it is not likely to be limited by host availability.

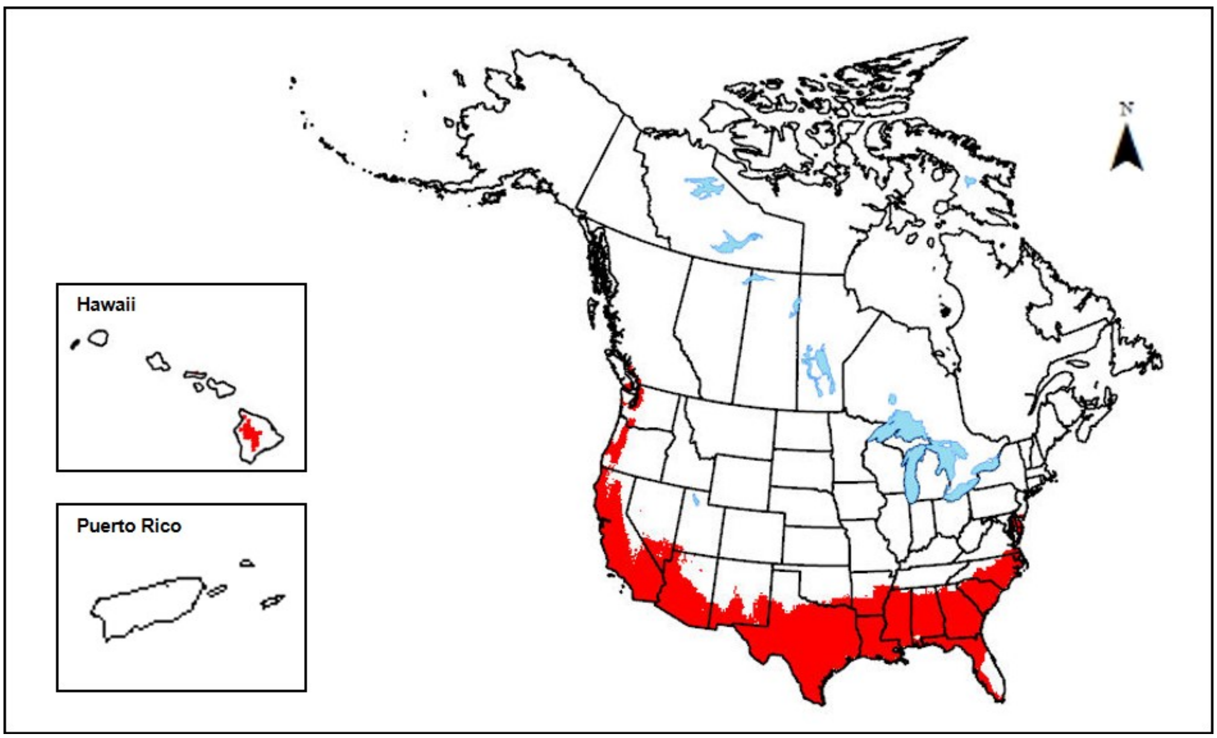

Figure 1. Potential geographic distribution of *Alectra vogelii* in the United States and Canada. Map insets for Hawaii and Puerto Rico are not to scale. For additional on PPQ's climate-matching process, see Magarey et al. (2017).

ENTRY POTENTIAL

The risk score for this risk element is low because *A. vogelii* is unlikely to be imported accidentally in most commodities. In Africa, however, it has been transported to uninfested areas in contaminated forage (Berner et al., 1994). We found no direct evidence that *A. vogelii* is a contaminant of seed for planting. The congener *A. picta*, however, was likely introduced into Ethiopia with contaminated seed (Parker and Riches, 1993), and plants in the related parasitic genus *Striga* are dispersed in crop seed in Africa. *Striga* spp. and *A. vogelii* often grow together in crop fields, so it is likely that *A. vogelii* could be dispersed in crop seed as well (Berner et al., 1994).

Risk score = 0.07 Uncertainty index = 0.06

3. Predictive Risk Model Results

Model Probabilities: P(Major Invader) = 75.8%
P(Minor Invader) = 23.2%
P(Non-Invader) = 1.0%
Risk Result = High Risk
Risk Result after Secondary Screening = Not applicable

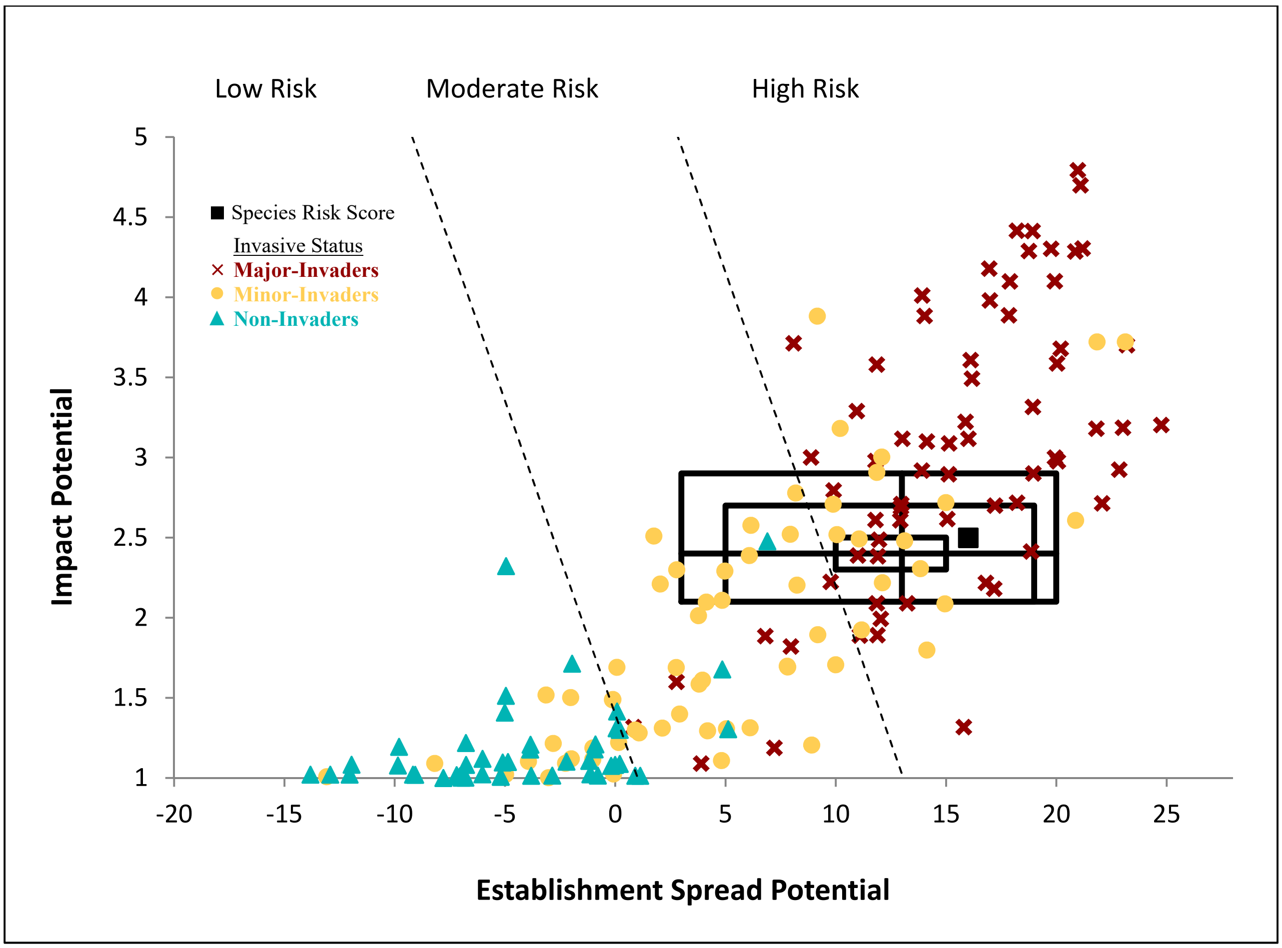

Figure 2. Risk and uncertainty results for *Alectra vogelii*. The species' risk score (solid black symbol) is plotted relative to the risk scores of the species used to develop and validate the PPQ WRA model (Koop et al., 2012). The results from the uncertainty analysis are plotted around the risk score for *Alectra vogelii*. The smallest, black box contains 50 percent of the simulated risk scores, the second 95

percent, and the largest 99 percent. The black vertical and horizontal lines in the middle of the boxes represent the medians of the simulated risk scores (N=5000). For additional information on the uncertainty analysis used, see Caton et al. (2018).

4. Discussion

The result of the weed risk assessment for *Alectra vogelii* is High Risk of becoming weedy or invasive in the United States. The establishment and spread risk score for *A. vogelii* is high due to its prolific seed production and the possibility of seed dispersal by wind, vehicles, and livestock forage. Its impacts are well documented on legume crops in Africa, but it has not been observed to affect other systems. Little is known about its natural host range and native range, and the lack of information raises the level of uncertainty of its potential impacts in natural systems. Overall, the risk score and level of uncertainty for its impact potential in the United States are low because of the lack of information about its effect on other systems. However, *Alectra vogelii* causes significant crop stunting and yield losses in legumes due to competition for nutrients (Mwaipopo, 2014; Rank et al., 2004). It is not known to have been introduced outside of Africa, but it may be introduced into new areas in forage and possibly in seed (Berner et al., 1994). Chemical and manual controls are insufficient to eliminate *A. vogelii* infestations, and farmers also use parasite-resistant legume varieties (Alonge et al., 2001; Mwaipopo, 2014) and crop rotation. *Alectra vogelii* is not known to occur in the United States and is not cultivated anywhere. Because they are parasitic plants, members of the genus *Alectra* are regulated in the United States as Federal Noxious Weeds (NRCS, 2018) and under 7 CFR 360 (2011).

5. Acknowledgements

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SUGGESTED CITATION

PPQ. 2019. Weed risk assessment for *Alectra vogelii* Benth. (Orobanchaceae) – Yellow witchweed. United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (PPQ), Raleigh, NC. 18 pp.

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Appendix A. Weed risk assessment for *Alectra vogelii* Benth. (Orobanchaceae)

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]	e - high	2	*Alectra vogelii* is native to Kenya, Tanzania, Uganda, Republic of Congo, Democratic Republic of the Congo (Zaire), Ghana, Guinea, Mali, Nigeria, Angola, Malawi, Zambia, Zimbabwe, Botswana, Namibia, South Africa, and Swaziland (NGRP, 2018). It has been reported in Ethiopia (Mohamed et al., 2006), Mozambique, and Sierra Leone (Visser, 1978). We answered "e" with high uncertainty because its true native range in Africa is unclear. Parker (2012) suggests that initial infestations in Ethiopia resulted from a recent chance introduction. We found no evidence that it has been introduced outside of Africa. Alternate answers for the Monte Carlo simulation were "b" and "c."
ES-2 (Is the species highly domesticated)	n - negl	0	This species is a parasitic weed and has not been cultivated or selectively bred for any purpose.
ES-3 (Significant weedy congeners)	y - low	1	*Alectra fluminensis* is an important weed of sugar cane in tropical and subtropical South America, and *A. picta* infests cowpea and peanut in Ethiopia and Cameroon (Mohamed et al., 2006; Riches et al., 1992).
ES-4 (Shade tolerant at some stage of its life cycle)	y - mod	1	*Alectra vogelii* is a holoparasite as a seedling, then a hemiparasite once its aerial parts emerge and begin photosynthesizing (Mwaipopo, 2014; Salako, 1984; Visser et al., 1977). We used moderate uncertainty because this species is a weed of crops and is only known to occur in cropland (Mwaipopo, 2014; Salako, 1984; Visser et al., 1977). Its ability to grow without light may only be due to its parasitism of host plants.
ES-5 (Plant a vine or scrambling plant, or forms tightly appressed basal rosettes)	n - negl	0	*Alectra vogelii* is an erect herb that does not form rosettes (Mwaipopo, 2014).
ES-6 (Forms dense thickets, patches, or populations)	n - mod	0	*Alectra vogelii* can reproduce in huge numbers and become so profuse that it causes total yield loss in crops (Alonge et al., 2001), but we answered no with moderate uncertainty because we found no evidence that this occurs

Question ID	Answer - Uncertainty	Score	Notes (and references)
			due to its growth habit, as *A. vogelii* is a slender, erect herbaceous plant (Mwaipopo, 2014).
ES-7 (Aquatic)	n - negl	0	*Alectra vogelii* is a terrestrial herb found mainly in legume crops (Mwaipopo, 2014; Visser, 1978).
ES-8 (Grass)	n - negl	0	*Alectra vogelii* is not a grass; it is in the Orobanchaceae (NGRP, 2018).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	*Alectra vogelii* is a parasitic annual herbaceous weed in the Orobanchaceae (NGRP, 2018). It parasitizes legume crops (Kabambe et al., 2008; Visser et al., 1977), and we found no evidence that it can fix nitrogen.
ES-10 (Does it produce viable seeds or spores)	y - negl	1	*Alectra vogelii* is an annual species that produces up to 600,000 seeds per plant (Visser, 1978) and is only known to reproduce via seed.
ES-11 (Self-compatible or apomictic)	y - mod	1	We found no information regarding the fertilization mechanism of *A. vogelii*, but one source states that *Alectra* spp. can self-pollinate after flowers are visited by flying insects that release "pollen clouds" (Heide-Jorgensen, 2008).
ES-12 (Requires specialist pollinators)	n - low	0	*Alectra vogelii* is pollinated by flies and bees of several genera (Parker and Riches, 1993). Other members of the genus *Alectra* are also visited by flies and bees (Heide-Jorgensen, 2008).
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]	b - mod	1	*Alectra vogelii* is an annual species (Mwaipopo, 2014) and likely completes its life cycle in one year. We answered "b" with moderate uncertainty because we found no definitive information regarding its life history. Fresh seed can germinate immediately, but the plant can take three months to emerge after germination (Visser, 1978). Alternate answers for the Monte Carlo simulation were "a" and "c".
ES-14 (Prolific seed producer)	y - negl	1	Seed capsules of *A. vogelii* contain up to 3000 seeds each, and plants may produce approximately 200 capsules per plant, resulting in up to 600,000 seeds per plant (Visser, 1978).
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - high	1	We found no direct evidence of *A. vogelii* seed dispersal by human activity. We answered yes with high uncertainty, however, because its seed is extremely small (0.25 mm), and it is likely that agricultural equipment and vehicles could carry seed to uninfested fields (Visser, 1978; Parker and Riches, 1993). In 1994, PPQ employees intercepted seeds of an unidentified

Question ID	Answer - Uncertainty	Score	Notes (and references)
			species of *Alectra* in seed for consumption in passenger baggage (AQAS, 2019).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	y - high	2	In Africa, seed of *A. vogelii* is dispersed in cowpea forage for livestock (Berner et al., 1994). Its seeds are very small and do not mimic those of legume crops (Visser, 1978). The seed of the similar genus *Striga* is dispersed in grain crop seed (Berner et al., 1994), however, and Parker and Riches (1993) state that *A. picta* infestations in Ethiopia probably originated from contaminated seed. It is possible that transport in contaminated seed may occur with *A. vogelii* seed as well.
ES-17 (Number of natural dispersal vectors)	3	2	Fruit and seed description for questions ES-17a through ES17e: *Alectra vogelii* fruit is an ovoid capsule 5-6 mm in length (Mwaipopo, 2014) and containing up to 3000 seeds. Seed is 0.25 mm in length (Visser, 1978; Parker and Riches, 1993).
ES-17a (Wind dispersal)	y - low		Seed of *A. vogelii* is tiny, approximately 0.25 mm in length, and is thought to be wind-dispersed (Visser, 1978; Parker and Riches, 1993).
ES-17b (Water dispersal)	y - mod		*Alectra vogelii* is a weed of upland crops in Africa (Mwaipopo, 2014). Seed is buoyant and can be dispersed short distances in water (Parker and Riches, 1993).
ES-17c (Bird dispersal)	n - low		We found no evidence suggesting that the seed of *A. vogelii* is dispersed by birds.
ES-17d (Animal external dispersal)	y - mod		Seed of *A. vogelii* is dispersed externally in mud on hooves (Parker and Riches, 1993).
ES-17e (Animal internal dispersal)	n - high		Seed of *A. vogelii* is tiny (Visser, 1978), and the fruit does not appear to be fleshy or attractive to animals. We answered no with high uncertainty because similar parasitic weeds in the genus *Striga*, with which *A. vogelii* is often found, have been shown to be internally dispersed short distances by livestock, and it is possible that *A. vogelii* seed could be dispersed similarly (Berner et al., 1994).
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	y - negl	1	Seed of this species can remain viable in soil for more than ten years (Mwaipopo, 2014; Visser, 1978).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	? - max	0	*Alectra vogelii* continuously produces aerial shoots from roots (Salako, 1984). Eradication is difficult with either chemical or mechanical weed control of *A. vogelii*, as the weed can remain alive and produce seed after host plants have been harvested (Visser, 1978). We answered unknown because it is not clear

Question ID	Answer - Uncertainty	Score	Notes (and references)
			whether cultivation encourages shoot or seed production.
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - low	0	This species is a common and long-standing crop weed in Africa. We found no evidence that it has developed herbicide resistance (Heap, 2013; Mwaipopo, 2014; Salako, 1984; Visser, 1978).
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)	7	0	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - mod	0	We found no evidence that *A. vogelii* is allelopathic.
Imp-G2 (Parasitic)	y - negl	0.1	*Alectra vogelii* is a parasite with a large host range (Parker and Riches, 1993). It causes yield losses in legume crops such as peas, dry beans, and peanuts. It has also been observed on sunflowers, *Sorghum* spp., *Euphorbia* spp., and *Hibiscus* spp. (Kabambe et al., 2008; Mwaipopo, 2014; Visser, 1978). Parker and Riches (1993), however, state that most infestations of alternate hosts are found on fallow or cleared cropland.
Impacts to Natural Systems			
Imp-N1 (Changes ecosystem processes and parameters that affect other species)	n - low	0	We found no evidence that *A. vogelii* impacts ecosystem processes. It is a weed of crops and is not known to be a weed of natural vegetation (Mwaipopo, 2014). Consequently, we used low uncertainty throughout this risk sub-element.
Imp-N2 (Changes habitat structure)	n - low	0	We found no evidence that *A. vogelii* changes habitat structure.
Imp-N3 (Changes species diversity)	n - low	0	We found no evidence that *A. vogelii* impacts species diversity.
Imp-N4 (Is it likely to affect federal Threatened and Endangered species?)	n - low	0	We found no evidence that *A. vogelii* might threaten protected species.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions?)	n - low	0	We found no evidence that *A. vogelii* might affect any natural systems.
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]	a - low	0	*Alectra vogelii* is a weed of crops and is not known to be a weed of natural systems (Mwaipopo, 2014). Alternate answers for the Monte Carlo simulation were both "b."
Impact to Anthropogenic Systems (e.g., cities, suburbs, roadways)			

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-A1 (Negatively impacts personal property, human safety, or public infrastructure)	n - low	0	*Alectra vogelii* is a weed of crops and is not known to be a weed outside of agricultural systems (Mwaipopo, 2014).
Imp-A2 (Changes or limits recreational use of an area)	n - low	0	*Alectra vogelii* is a weed of crops and is not known to be a weed outside of agricultural systems (Mwaipopo, 2014). As a small herbaceous plant (Mwaipopo, 2014), it is unlikely to limit recreational use of an area.
Imp-A3 (Affects desirable and ornamental plants, and vegetation)	n - low	0	*Alectra vogelii* is a weed of crops and is not known to be a weed outside of agricultural systems (Mwaipopo, 2014).
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]	a - low	0	*Alectra vogelii* is a weed of crops and is not known to be a weed outside of agricultural systems (Mwaipopo, 2014). Alternate answers for the Monte Carlo simulation were both "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	y - negl	0.4	Infestation by *A. vogelii* causes stunting, reduced fruit set (Singh and Emechebe, 1997), and yield losses in legume crops (Alonge et al., 2001; Kabambe et al., 2008; Mohamed et al., 2006; Mwaipopo, 2014). It can cause total yield loss in cowpea (including black-eyed pea) (Alonge et al., 2001; Mwaipopo, 2014). In Nigeria, it has caused total yield loss in soybean (Parker and Riches, 1993).
Imp-P2 (Lowers commodity value)	y - mod		*Alectra vogelii* infestation causes damage to cowpea crops. To control it, farmers use herbicides and resistant cultivars (Mwaipopo, 2014; Visser, 1978), resulting in reduced commodity values.
Imp-P3 (Is it likely to impact trade?)	y - high	0.2	Although we found no direct evidence that *A. vogelii* impacts trade, the genus *Alectra* is listed as a U.S. Federal Noxious Weed (NRCS, 2018), and it is regulated in trade in Honduras, Egypt, Israel, and South Korea (USDA PCIT, 2019). Because it may move in trade (see evidence under ES-16), it is likely to impact trade. The similar species *Striga asiatica* was introduced into the United States and became an important quarantine pest (Berner et al., 1994). For these reasons, we answered yes with high uncertainty.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - mod	0	We found no evidence that *A. vogelii* competes with crops for water.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - mod	0	We found no evidence that *A. vogelii* is toxic to animals.
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	c - negl	0.6	*Alectra vogelii* is a well-known weed of important leguminous crops in Africa (Visser, 1978; Alonge et al., 2001; Kabambe et al.,

Question ID	Answer - Uncertainty	Score	Notes (and references)
control; (c) Taxon a weed and evidence of control efforts]			2008). Physical and chemical control, crop rotation, and resistant cultivars, are widely used to manage this crop parasite (Alonge et al., 2001; Kabambe et al., 2008; Salako, 1984). The alternate answers for the Monte Carlo simulation were both "b."
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically referenced points obtained from the Global Biodiversity Information Facility (GBIF, 2018).
Plant Hardiness Zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence that the species occurs in this Zone.
Geo-Z2 (Zone 2)	n - negl	N/A	We found no evidence that the species occurs in this Zone.
Geo-Z3 (Zone 3)	n - negl	N/A	We found no evidence that the species occurs in this Zone.
Geo-Z4 (Zone 4)	n - negl	N/A	We found no evidence that the species occurs in this Zone.
Geo-Z5 (Zone 5)	n - negl	N/A	We found no evidence that the species occurs in this Zone.
Geo-Z6 (Zone 6)	n - negl	N/A	We found no evidence that the species occurs in this Zone.
Geo-Z7 (Zone 7)	n - low	N/A	No points found, but we used low uncertainty because a point has been recorded in Zone 8.
Geo-Z8 (Zone 8)	y - high	N/A	One point in South Africa. We used high uncertainty because only one point has been recorded in this Zone.
Geo-Z9 (Zone 9)	y - negl	N/A	Numerous points in South Africa.
Geo-Z10 (Zone 10)	y - negl	N/A	Two points in South Africa, one point in Malawi, one point in Kenya, one point in Angola, and one point in Zambia.
Geo-Z11 (Zone 11)	y - negl	N/A	Two points in Mozambique, one point in Tanzania, one point in Burundi, three points in Mali, and three points in Burkina Faso.
Geo-Z12 (Zone 12)	y - negl	N/A	Three points in Burkina Faso, two points in Nigeria, one point in Cameroon, one point in Democratic Republic of the Congo (DRC), and one point in Namibia.
Geo-Z13 (Zone 13)	n - high	N/A	We found no points in this zone; however, we used high uncertainty because this species is reported to occur in much of South Africa (Alonge et al., 2001), which includes this Zone.
Köppen -Geiger climate classes			
Geo-C1 (Tropical rainforest)	n - high	N/A	We found no points in this climate class but used high uncertainty because points have been recorded near this climate class.
Geo-C2 (Tropical savanna)	y - negl	N/A	One point in DRC, one point in Nigeria, one point in Benin, five points in Burkina Faso, and three points in Senegal.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-C3 (Steppe)	y - negl	N/A	Several points in South Africa, one point in Swaziland, two points in Botswana, two points in Tanzania, over 18 points in Burkina Faso, two points in Cameroon, and one point in Nigeria.
Geo-C4 (Desert)	y - high	N/A	One point in South Africa and one point in Namibia. We used high uncertainty because only two occurrences have been recorded in this climate class.
Geo-C5 (Mediterranean)	y - high	N/A	One point in Kenya. We used high uncertainty because only one point has been found in this climate class, and it occurs on the edge of the marine west coast class.
Geo-C6 (Humid subtropical)	y - negl	N/A	Many points in South Africa and one point in Zambia.
Geo-C7 (Marine west coast)	y - negl	N/A	Four points in South Africa, one point in DRC, one point in Angola, and one point in Malawi.
Geo-C8 (Humid cont. warm sum.)	n - negl	N/A	We found no evidence that the species occurs in this climate class.
Geo-C9 (Humid cont. cool sum.)	n - negl	N/A	We found no evidence that the species occurs in this climate class.
Geo-C10 (Subarctic)	n - negl	N/A	We found no evidence that the species occurs in this climate class.
Geo-C11 (Tundra)	n - negl	N/A	We found no evidence that the species occurs in this climate class.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence that the species occurs in this climate class.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	y - negl	N/A	Four points in South Africa and two points in Botswana.
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	Several points in South Africa, one point in Tanzania, and one point in Ethiopia.
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	Three points in South Africa, two points in Mozambique, one point in Tanzania, and two points in Burkina Faso.
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	One point in Mali, one point in Burkina Faso, one point in Benin, two points in Nigeria, and one point in Angola.
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	One point in Zambia and two points in Cameroon.
Geo-R6 (50-60 inches; 127-152 cm)	y - mod	N/A	One point in DRC. We used moderate uncertainty because only one occurrence was recorded in this precipitation band.
Geo-R7 (60-70 inches; 152-178 cm)	y - mod	N/A	One point in DRC. We used moderate uncertainty because only one occurrence was recorded in this precipitation band.
Geo-R8 (70-80 inches; 178-203 cm)	n - high	N/A	No points were recorded in this precipitation band, but we used high uncertainty because this species has a restricted distribution in Sierra Leone (Mwaipopo, 2014), which includes this precipitation band.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-R9 (80-90 inches; 203-229 cm)	n - low	N/A	We found no evidence that the species occurs in this precipitation band.
Geo-R10 (90-100 inches; 229-254 cm)	n - low	N/A	We found no evidence that the species occurs in this precipitation band.
Geo-R11 (100+ inches; 254+ cm)	n - low	N/A	We found no evidence that the species occurs in this precipitation band, and it seems unlikely that it would occur in regions that correspond to tropical rainforest.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	n - low	0	We found no evidence that *A. vogelii* is naturalized or cultivated in the United States (Dave's Garden, 2019; GardenWeb.com, 2018; NRCS, 2018).
Ent-2 (Plant proposed for entry, or entry is imminent)	n - negl	0	We found no evidence that *A. vogelii* would be purposefully introduced into the United States.
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]	a - low	0	We found no evidence that *A. vogelii* is cultivated, used medicinally, or of other benefit. This species is a parasitic plant (Kabambe et al., 2008; Visser et al., 1977).
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	n - low		We found no evidence that *A. vogelii* is present in these countries. It appears to be restricted to Africa (GBIF, 2018; Mohamed et al., 2006).
Ent-4b (Contaminant of plant propagative material (except seeds))	n - low	0	*Alectra vogelii* is parasitic on legume crop roots and spreads by seed only (Kabambe et al., 2008; Visser et al., 1977).
Ent-4c (Contaminant of seeds for planting)	y - high	0.04	We found no direct evidence that *A. vogelii* seed is spread in seeds for planting; however, we answered yes with high uncertainty because the congener *A. picta* is thought to have been introduced in Ethiopia via contaminated crop seed (Parker and Riches, 1993), and similar species in the genus *Striga* are dispersed in crop seed in Africa (Berner et al., 1994).
Ent-4d (Contaminant of ballast water)	n - mod	0	*Alectra vogelii* is parasitic on legume crop roots (Kabambe et al., 2008; Visser et al., 1977), and we found no evidence that it might contaminate ballast water. Its seed does float (Parker and Riches, 1993), however, and it is possible that it could be moved as a contaminant of fresh ballast water.
Ent-4e (Contaminant of aquarium plants or other aquarium products)	n - negl	0	*Alectra vogelii* is parasitic on legume crop roots in agricultural areas (Kabambe et al., 2008; Visser et al., 1977). We found no evidence that it occurs in or near water.
Ent-4f (Contaminant of landscape products)	n - low	0	We found no evidence that *A. vogelii* contaminates these products. It grows in

Question ID	Answer - Uncertainty	Score	Notes (and references)
			cropland, and non-cultivated natural hosts have not been observed (Visser, 1978).
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	n - mod	0	We found no evidence that *A. vogelii* contaminates these products. It is a weed of cropland (Visser, 1978)
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	y - mod	0	In 1994, PPQ employees intercepted seeds of an unidentified species of *Alectra* in seed for consumption in passenger baggage (AQAS, 2019). We found no other evidence that *A. vogelii* contaminates these products.
Ent-4i (Contaminant of some other pathway)	c - mod	0.02	*Alectra vogelii* seed is spread in cowpea forage in Africa (Berner et al., 1994). We used moderate uncertainty because we only found one source of information describing this pathway.
Ent-5 (Likely to enter through natural dispersal)	n - negl	0	We found no evidence that *A. vogelii* is present in North America. It is found in Africa (GBIF, 2018; Mohamed et al., 2006).