United States Department of Agriculture

Weed Risk Assessment for *Acanthospermum hispidum* DC. (Asteraceae) – Bristly starbur

United States Department of Agriculture

Animal and Plant Health Inspection Service

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Version 1

Left: Patch of *Acanthospermum hispidum* (source: J.M. Garg, wikimedia.org). Right middle: *Acanthospermum hispidum* seeds (source: S. Hurst, USDA NRCS PLANTS database). Right bottom: Close-up of *A. hispidum* (source: B.T. Wursten, www.zimbabweflora.co.zw).

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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.

Acanthospermum hispidum DC. – Bristly starbur

Species Information

Family: Asteraceae

Synonyms: None (NGRP, 2014).

Common names: Star burr, bristly starbur, goat's head, Texas cockspur (Holm et al., 1997).

Botanical description: *Acanthospermum hispidum* is an herbaceous or subherbaceous annual plant, with stems erect, 20 to 60 cm tall (Holm et al., 1997). It is often found in agricultural settings and may spread along waterways and nearby floodplains, and invade rangelands (Anon.-Queensland, 2011).

Initiation: APHIS received a market access request from South Africa for corn seeds for planting in the United States (DAFF, 2012). During the development of that commodity risk analysis, *A. hispidum* was identified as a weed of potential concern to the United States. The PPQ Weeds Cross Functional Working Group requested PERAL evaluate this species with a weed risk assessment.

Foreign distribution: This species is native to Central America (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua), South America (Argentina, Bolivia, Brazil, Colombia, French Guiana, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela) and the Caribbean (Dominican Republic) (NGRP, 2014). It is also native to Puerto Rico and the Virgin

Islands (Acevedo-Rodríguez and Strong, 2012). It is naturalized in Africa (e.g., Cape Verde, Ethiopia, Kenya, Tanzania, Uganda, Sierra Leone, Angola, Botswana, South Africa, Madagascar, Mauritius, Reunion), Asia (e.g., Yemen, China, India, Nepal, Sri Lanka), Australia, and some islands of the Caribbean (e.g., Antigua and Barbuda, Dominica, British Virgin Islands (NGRP, 2014). It is also established in southern Ontario (Bradley, 2013).

U.S. distribution and status: *Acanthospermum hispidum* is native to Puerto Rico (above) and is thought to have been introduced into Florida in ship ballast in the 1800s (Hall et al., 2004). Although primarily distributed in Florida, it has also established or been reported in Alabama, Florida, Georgia, Hawaii, New Jersey, Oregon, South Carolina and Virginia (Hall et al., 2004; Weakley, 2010; NGRP, 2014; NRCS, 2014). It has caused problems for corn, peanut, and soybean farmers in Alabama, southern Georgia, and northern Florida (Hall et al., 2004), but is not under official control in those states (Dixon, 2014; Kauffman, 2014). It is a state noxious weed in Hawaii (ARS, 2014).

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

1. *Acanthospermum hispidum* analysis

Establishment/Spread Potential

Acanthospermum hispidum is a known invader in multiple countries and continues to spread into warm regions. It forms dense patches (Parsons and Cuthbertson, 2001), is self-compatible (Holm et al., 1997; Santos, 1983), and produces a persistent propagule bank (Holm et al., 1997; Ivens, 1967). Its fruit is a cluster of achenes covered with hooked spines that easily stick to clothes, objects, and the fur of passing animals. Additionally, its propagules disperse in trade as contaminants and hitchhikers (Auld and Medd, 1987; Parsons and Cuthbertson, 2001). We had very low uncertainty for this risk element.

Risk score = 18 Uncertainty index = 0.05

Impact Potential

This taxon is a weed particularly of agricultural systems, but also natural systems. It reduces yields (Walker et al., 1989, in Holm et al., 1997), competes with crops for water and nutrients, impedes harvesting (Parsons and Cuthbertson, 2001), and is toxic to animals (Holm et al., 1997). *Acanthospermum hispidum* is a wool contaminant, reducing the value of the wool and injuring the animals (Parsons and Cuthbertson, 2001). It is allelopathic (Leela, 1985) and changes community composition in natural areas (Anon.-Queensland, 2011). We had high uncertainty for this risk element.

Risk score = 3.1 Uncertainty index = 0.20

[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).

Geographic Potential Based on three climatic variables, we estimate that 84.5 percent of the United States is suitable for the establishment of *A. hispidum* (Fig. 1). We based this on the species' known distribution elsewhere in the world; it includes point-referenced localities and areas of occurrence. The map for *A. hispidum* represents the joint distribution of Plant Hardiness Zones 4-13, areas with mean annual precipitation from near 0 inches up to 100 and greater inches, and the following Köppen-Geiger climate classes: tropical rainforest, tropical savannah, steppe, desert, humid subtropical, marine west coast, humid continental warm summers, and humid continental cool summers. Because *A. hispidum* is an annual plant and agricultural weed, it may be associated with irrigated areas in drier zones.

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.

Entry Potential We did not assess the entry potential of *A. hispidum* because it is already present in the United States (Weakley, 2010).

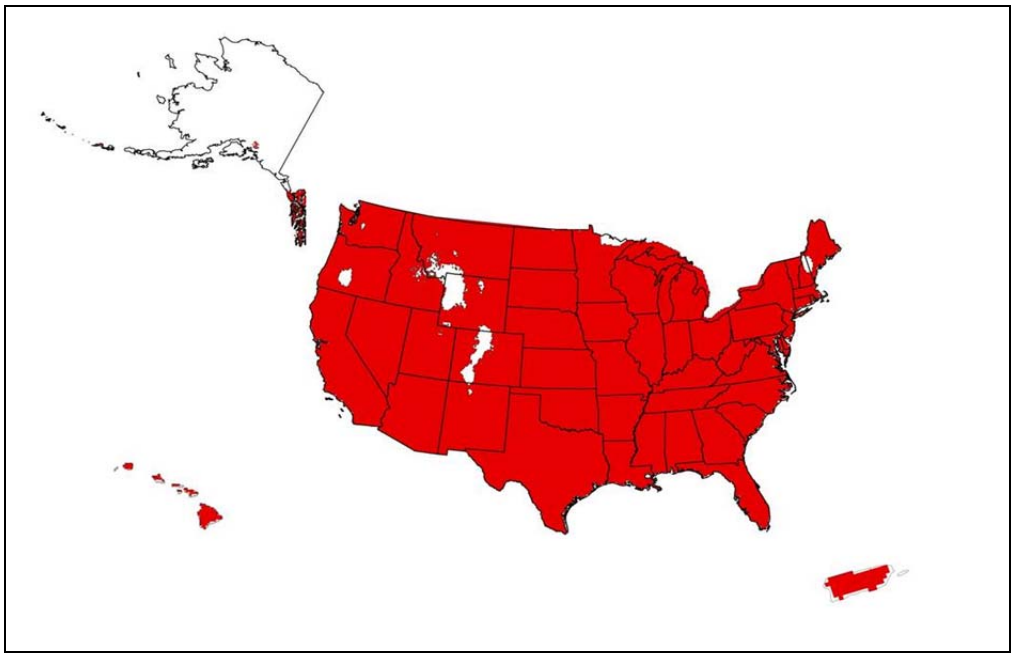

Figure 1. Predicted distribution of *Acanthospermum hispidum* in the United States. Map insets for Alaska, Hawaii, and Puerto Rico are not to scale.

2. Results and Conclusion

Model Probabilities: P(Major Invader) = 87.8%
P(Minor Invader) = 11.8%
P(Non-Invader) = 0.4%

Risk Result = High Risk
Secondary Screening = Not Applicable

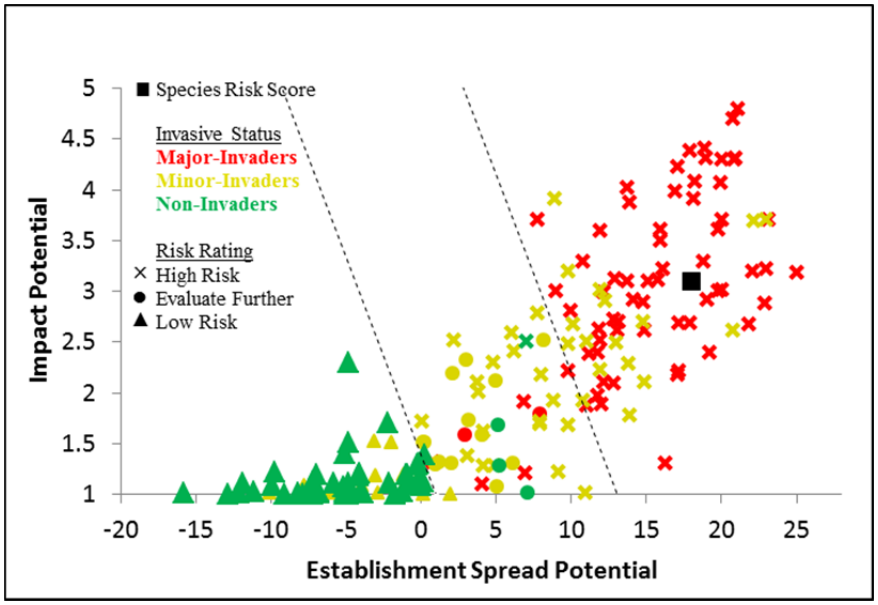

Figure 2. *Acanthospermum hispidum* risk score (black box) relative to the risk scores of species used to develop and validate the PPQ WRA model (other symbols). See Appendix A for the complete assessment.

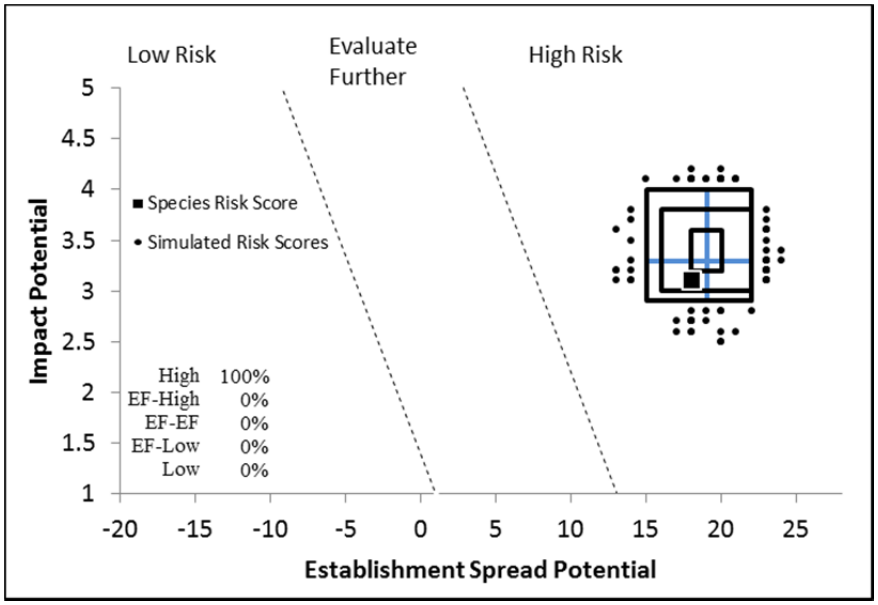

Figure 3. Model simulation results (N=5,000) for uncertainty around the risk score for *Acanthospermum hispidum*. The blue "+" symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

3. Discussion

The result of the weed risk assessment for *A. hispidum* is High Risk. Its bristly seeds stick to clothes, animals, and other objects, so it can be easily spread, and is a troublesome wool and hay contaminant (Holm et al., 1997). This taxon is an agricultural weed of 25 crops in nearly 40 countries (Holm et al., 1997), and a strong competitor for resources that also impedes harvesting (Parsons and Cuthbertson, 2001). Affected crops include peanuts, beans, pineapple, sugarcane, sunflowers, vegetables, cotton, orchards, pastures, rice, soybeans, barley and wheat. In the southern United States, *A. hispidum* is a weed of cotton and soybeans (Hall et al., 2004). It can also be a host for several important plant diseases, including *Verticillium albo-atrum* and tomato leaf curl (Holm et al., 1997). More recently, it is well controlled by herbicides in southern peanut fields (Kauffman, 2014). It can change community compositions in pastures and along waterways and floodplains (Anon.-Queensland, 2011). *Acanthospermum hispidum* is not under official control in the southern United States (Corban, 2014; Dixon, 2014; Kauffman, 2014).

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Appendix A. Weed risk assessment for *Acanthospermum hispidum* DC. (Asteraceae). 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 tropical America but now occurring in nearly 40 countries (Holm et al., 1997). This species is present in Alabama, southern Georgia, northern Florida, and appears to be spreading southward in Florida (Hall et al., 2004). Introduced and naturalized in the United States (OR, VA, SC, GA, AL, FL, NJ, NY (NRCS, 2014) and NC (Baker et al., 2005) and in Canada (southern Ontario) (Bradley, 2013). Native to Puerto Rico and the U.S. Virgin Islands (NRCS, 2014). Considered a noxious weed in Australia (Mito and Uesugi, 2004). Introduced to Queensland, Australia late in the 19th century, naturalized by 1906, and now spread to all parts of Queensland except the lower south-western interior and to northern New South Wales, the Northern Territory and tropical Western Australia (Parsons and Cuthbertson, 2001). Widespread in the hotter areas of Kenya and Tanzania extending from 0-1700 m and spreading (Terry and Michieka, 1987). Considered an invasive alien in Uttar Pradesh (Khanna, 2009). Invasive in Madagascar (Kull et al., 2012). Invasive alien in Zimbabwe (Maroyi, 2012). Alternate answers for this question are both ‘e’.
ES-2 (Is the species highly domesticated)	n - low	0	We found no evidence that this taxon has been domesticated, nor does it appear to be widely cultivated.
ES-3 (Weedy congeners)	n - mod	0	The genus *Acanthospermum* has eight species (Mabberley, 2008). Other *Acanthospermum* species are reportedly common weeds, but none appear to be significant weeds. *Acanthospermum australe* is reported as a weed of wasteland on the central and north coast of New South Wales in Australia (Auld and Medd, 1987). It is also reported as a wool casual alien in the United Kingdom, as is *A. glabratum* (Clement and Foster, 2000). *Acanthospermum australe* is listed as a common weed of agriculture in four countries and as a weed of agriculture in another four (Holm et al., 1997).
ES-4 (Shade tolerant at some stage of its life cycle)	n - mod	0	*Acanthospermum hispidum* is sensitive to shade (reduced dry matter production and reduced seed production), although it can grow in shaded areas (Shetty et al., 1982, in Holm et al., 1997). Plant height is not appreciably changed by shade; leaf area increases and leaf thickness is reduced (Murthy and Rao, 1978 in Holm et al., 1997). Advice for control in pastures includes taking advantage of its shade sensitivity and including species that provide a dense surface cover (Parsons and Cuthbertson, 2001).
ES-5 (Climbing or smothering growth form)	n - negl	0	*Acanthospermum hispidum* is an herbaceous or subherbaceous annual plant, stems erect 20 to 60 cm tall (Holm et al., 1997).
ES-6 (Forms dense thickets)	y - low	2	It forms dense patches, reduces the area available for grazing (Parsons and Cuthbertson, 2001).

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-7 (Aquatic)	n - negl	0	*Acanthospermum hispidum* is a terrestrial plant (Holm et al. 1997).
ES-8 (Grass)	n - negl	0	This taxon is not a grass; it is in the family Asteraceae (Holm et al., 1997).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	*Acanthospermum hispidum* is an herbaceous or subherbaceous annual plant (Holm et al., 1997), not a woody plant. Additionally, we found no evidence of nitrogen fixation.
ES-10 (Does it produce viable seeds or spores)	y - negl	1	Viability of seeds increases through the growing season (from 63 to 88 percent) (Holm et al., 1997).
ES-11 (Self-compatible or apomictic)	y - negl	1	The flowers are mainly wind-pollinated and seem to have high levels of self-pollination, since self-compatibility has already been shown to occur in this species (Santos, 1983 in Santos and Stubblebine, 1987). Pollination occurs primarily by wind and self-pollination is common (Holm et al., 1997).
ES-12 (Requires special pollinators)	n - negl	0	Pollination occurs primarily by wind (Holm et al., 1997).
ES-13 (Minimum generation time)	b - mod	1	*Acanthospermum hispidum* is an annual herb; its life cycle lasts about 120 days (Santos and Stubblebine, 1987). Seeds germinate in spring or early summer rains (Parsons and Cuthbertson, 2001). If temperatures are conducive to growth, seed dormancy can be broken by incubation in the dark for 10-30 days (Chakraborty et al., 2012). Alternate answers for the Monte Carlo simulation are a and c.
ES-14 (Prolific reproduction)	y - negl	1	The species seeds prolifically, averaging over 2000 seeds per plant (Parsons and Cuthbertson, 2001). Pure stands can produce over 10,000 kg/ha of seed that contain nearly one billion seeds (Schwerzel, 1970, in Holm et al., 1997). In India, pure stands of *A. hispidum* had 310,000 plants/ha (31 plants/m^2) and nearly all produced seed (Holm et al., 1997). This weed produces seeds prolifically and continues to grow until frost (Baker et al., 2005). In Alabama, natural populations of *A. hispidum* in a heavily infested area can average 60 to 80 seedlings per m^2 when left undisturbed (Walker et al. 1989). A study of *A. hispidum* competition with peanut allowed 8 to 64 weeds per 7.5 m row (approx. 1 to 9 plants per m^2) and natural infestations averaged approximately 5 plants per m^2 (Walker et al. 1989). At 2000 seeds per plant and 5 plants per m^2, this far exceeds the 5000 seeds per m^2 criteria for prolific reproduction.
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - negl	1	Bristly seeds cling to clothing and other objects, and can be readily transported to other areas (Holm et al., 1997). This taxon is thought to have been introduced into Florida in the 1800s in ship ballast (Hall et al., 2004).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	y - negl	2	A troublesome wool contaminant in Australia (Auld and Medd, 1987). Regular contaminant in chaff and hay from the northern parts of Australia (Parsons and Cuthbertson, 2001).
ES-17 (Number of natural dispersal vectors)	2	0	Fruit and seed description for ES-17a through ES-17e: Fruit a star-shaped cluster of 5 to 10 (usually 8) flat, thick, triangular achenes about 6 mm long, 3 mm wide at apex, covered with numerous stiff, short, hooked spines with

Question ID	Answer - Uncertainty	Score	Notes (and references)
			much longer horn-like, straight or curved spines at the apex, straw colored to yellowish-brown (Holm et al., 1997).
ES-17a (Wind dispersal)	n - negl		Fruit adapted to animal dispersal rather than wind dispersal (see Holm et al., 1997).
ES-17b (Water dispersal)	y - low		The burrs float readily and may travel long distances along streams, especially in time of flood, germinating as the water recedes (Parsons and Cuthbertson, 2001). Seeds dispersed by water, particularly during floods (Anon.-Queensland, 2011).
ES-17c (Bird dispersal)	? - max		We found no evidence of bird dispersal; however, clingy seeds may attach to bird feathers as they do to animal fur.
ES-17d (Animal external dispersal)	y - negl		Bristly seeds cling to animals (Holm et al., 1997).
ES-17e (Animal internal dispersal)	n - low		This taxon is toxic to animals (Ali and Adam 1978a, b; Lemonica and Alvarenga 1994) and we found no evidence of animals consuming it.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	y - negl	1	Eighty percent of the seed retains viability after burial for one year and some viability is maintained after three years at a depth of 24 cm (Holm et al., 1997). Seed germinates irregularly over a long period and can remain dormant for several years (Ivens, 1967).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	n - negl	-1	We found no evidence that it tolerates mutilation or fire, and control recommendations include deep plowing of seeds (to a depth greater than 7.5 cm) to help reduce occurrence of the weed (Hall et al., 2004).
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - low	0	Control methods include the use of chemical herbicides. "Good control can be obtained by pre-emergence treatment with 2,4-D. Young seedlings are also susceptible to 2,4-D, MCPA and other growth-regulating type herbicides" (Ivens, 1967). Chemical control can be very effective (Parsons and Cuthbertson, 2001).
ES-21 (Number of cold hardiness zones suitable for its survival)	10	0	
ES-22 (Number of climate types suitable for its survival)	8	2	
ES-23 (Number of precipitation bands suitable for its survival)	11	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	y - mod	0.1	Both seeds and leaves contain phenolic acids that are allelopathic to other plants (Chakraborty et al., 2012). Leachates from intact seeds and leaves inhibit germination and root and shoot growth of several crops (Leela, 1985).
Imp-G2 (Parasitic)	n - negl	0	We found no evidence this species is parasitic. Asteraceae has no known parasitic species (Nickrent, 2013).
Impacts to Natural Systems			
Imp-N1 (Change ecosystem processes and parameters that affect other species)	n - low	0	We found no evidence that this taxon alters ecosystem processes.
Imp-N2 (Change community structure)	n - low	0	We found no evidence that this taxon changes community structure.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-N3 (Change community composition)	y - low	0.2	Invades native rangeland pastures and outcompetes more desirable native species, particularly along waterways and on nearby floodplains; negatively affects biodiversity (Anon.-Queensland, 2011).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	? - max		We found no evidence of its affecting threatened and endangered species, but it is an environmental weed in some areas with the capacity to outcompete other species (Anon.-Queensland, 2011). *Acanthospermum hispidum* is a common weed of creek flats and sandy soils in northern New South Wales, Queensland and Northern Territory (Auld and Medd, 1987).
Imp-N5 (Is it likely to affect any globally outstanding ecoregions)	n - mod	0	We found no evidence that it would affect globally outstanding ecoregions.
Imp-N6 (Weed status in natural systems)	b - high	0.2	A weed of the environment in Australia (Randall, 2007). Very common in alluvial soils along waterways, and on floodplains in rangelands and natural areas in these regions (Anon.-Queensland, 2011). Listed as a priority environmental weed in two of Australia's Natural Resource Management regions (Anon.-Queensland, 2011). Although it is listed as a priority environmental weed in Australia, we did not find any specific evidence of control nor any specific evidence of environmental impacts. Therefore, answering b with high uncertainty. The alternate answers for the Monte Carlo simulation are both c.
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Impacts human property, processes, civilization, or safety)	n - low	0	We found no evidence of such impacts.
Imp-A2 (Changes or limits recreational use of an area)	n - low	0	We found no evidence of recreational use being impacted by this taxon.
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	? - max		We found no specific evidence of *A. hispidum* outcompeting garden/urban plants, but it can outcompete other plants and is reported as a garden weed (see Imp-A4).
Imp-A4 (Weed status in anthropogenic systems)	b - high	0.4	A book on U.S. weeds advises home gardeners to remove this plant by hand hoeing and mechanical cultivation (Lorenzi and Jeffery, 1987). However, because this was the only source recommending control, and because we found no evidence of impacts above, we answered b with high uncertainty. Our 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)	y - negl	0.4	Peanut seed yields decrease linearly as the time of *A. hispidum* interference increases; interference for 13 weeks reduced peanut forage biomass by 54 percent (Walker et al., 1989 in Holm et al. 1997). In Florida, 0 to 60 plants of star burr (*A. hispidum*) per 9 meters of crop row reduced peanut yield from 5.06 to 1.44 ton per hectare (Parsons and Cuthbertson, 2001). It reduces the area available for grazing (Parsons and Cuthbertson, 2001).
Imp-P2 (Lowers commodity value)	y - negl	0.2	A troublesome wool contaminant in Australia (Auld and Medd, 1987). Burrs are objectionable in the hair of animals

Question ID	Answer - Uncertainty	Score	Notes (and references)
			(Ivens, 1967). Burrs tangled in wool cannot be removed mechanically, which reduces the value of the clip (Parsons and Cuthbertson, 2001). The burrs can also injure animals by penetrating the hooves and causing infection, resulting in lameness (Parsons and Cuthbertson, 2001).
Imp-P3 (Is it likely to impact trade)	y - negl	0.2	It cannot be present in hay sold within Australia, and imported products contaminated with *A. hispidum* must be quarantined (Anon.-Australia, 1982, in Holm et al. 1997).
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - high	0.1	Star burr (*A. hispidum*) is a serious competitor with several crops, particularly sugarcane in Argentina, Brazil, India and Mauritius, and cotton and soybeans in Africa, Bolivia, and the United States (Parsons and Cuthbertson, 2001). Besides competing for water and nutrients, it also impedes harvesting (Parsons and Cuthbertson, 2001). Because this is the only evidence for strongly competing with other plants for water, we answered no with high uncertainty.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	y - low	0.1	Laboratory studies have proven that *A. hispidum* is toxic to animals when consumed on a daily basis (Ali and Adam, 1978). Cattle and other animals avoid the plant, possibly because of plant resins or because of the hairy or thorny stems (Holm et al., 1997).
Imp-P6 (Weed status in production systems)	c - negl	0.6	Nearly 40 countries report *A. hispidum* as a weed problem in 25 crops, including peanuts, beans, pineapple, sugarcane, sunflowers, vegetables, cotton, orchards, pastures, rice, soybeans, barley and wheat, and others (Holm et al., 1997). Once introduced it can become a serious crop menace; it is widespread and serious weed in India, very competitive and widespread in Brazil, and one of the most aggressive weeds in Zimbabwe (Holm et al., 1997). It is listed as a serious weed of agriculture in 7 countries and a principal weed of agriculture in 4 countries, including the United States (Holm et al., 1997). It is controlled in Africa with herbicides and cultural control strategies (Ivens, 1967). Controlled in croplands in the United States (Lorenzi and Jeffery, 1987). Extension publications offer advice on chemical controls in peanuts and cotton in the southern United States (Hall et al., 2004). Alternate answers for the Monte Carlo simulation are both b.
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically-referenced points obtained from the Global Biodiversity Information Facility (GBIF, 2014).
Plant cold hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence that it occurs in this zone.
Geo-Z2 (Zone 2)	n - negl	N/A	We found no evidence that it occurs in this zone.
Geo-Z3 (Zone 3)	n - negl	N/A	We found no evidence that it occurs in this zone.
Geo-Z4 (Zone 4)	y – mod	N/A	Southern Ontario, Canada (Bradley, 2013).
Geo-Z5 (Zone 5)	y - low	N/A	Southern Ontario, Canada (Bradley, 2013) and the United States (New York) (NRCS, 2014).
Geo-Z6 (Zone 6)	y - negl	N/A	Southern Ontario, Canada (Bradley, 2013) and the United States (New York) (NRCS, 2014).
Geo-Z7 (Zone 7)	y - negl	N/A	Southern Ontario, Canada (Bradley, 2013) and the United States (New Jersey, Virginia) (NRCS, 2014), and North

Question ID	Answer - Uncertainty	Score	Notes (and references)
			Carolina (Baker et al. 2005).
Geo-Z8 (Zone 8)	y - negl	N/A	The United States (Alabama, Georgia, South Carolina, Virginia) (NRCS 2014), and North Carolina (Baker et al. 2005).
Geo-Z9 (Zone 9)	y - negl	N/A	The United States (Alabama, Georgia), and Florida (NRCS, 2014).
Geo-Z10 (Zone 10)	y - negl	N/A	Colombia, Paraguay, Argentina, Namibia, and Botswana.
Geo-Z11 (Zone 11)	y - negl	N/A	Honduras, Bolivia, Brazil, Mali, and Burkina Faso.
Geo-Z12 (Zone 12)	y - negl	N/A	Nicaragua, Venezuela, Brazil, Ghana, and Cote d'Ivoire.
Geo-Z13 (Zone 13)	y - negl	N/A	El Salvador, Venezuela, Puerto Rico, Brazil, Ghana, and Cote d'Ivoire.
Köppen -Geiger climate classes			
Geo-C1 (Tropical rainforest)	y - negl	N/A	Colombia, the Dominican Republic, Guyana, and Brazil.
Geo-C2 (Tropical savanna)	y - negl	N/A	Honduras, Nicaragua, Venezuela, Bolivia, Brazil, Ghana, and Cote d'Ivoire.
Geo-C3 (Steppe)	y - negl	N/A	Brazil, Argentina, Mali, Burkina Faso, Namibia, and Botswana.
Geo-C4 (Desert)	y - negl	N/A	South Africa and Australia.
Geo-C5 (Mediterranean)	n - low	N/A	We found no evidence that it occurs in this climate class.
Geo-C6 (Humid subtropical)	y - negl	N/A	The United States (AL, GA), Argentina, Paraguay, and South Africa.
Geo-C7 (Marine west coast)	y - negl	N/A	Colombia, Argentina, and Peru, Bolivia.
Geo-C8 (Humid cont. warm sum.)	y - negl	N/A	Southern Ontario, Canada (Bradley, 2013) and the United States (New Jersey) (NRCS, 2014).
Geo-C9 (Humid cont. cool sum.)	y - negl	N/A	Southern Ontario, Canada (Bradley, 2013) and the United States (New Jersey and Oregon) (NRCS, 2014).
Geo-C10 (Subarctic)	n - negl	N/A	We found no evidence that it occurs in this climate class.
Geo-C11 (Tundra)	n - negl	N/A	We found no evidence that it occurs in this climate class.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence that it occurs in this climate class.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	y - negl	N/A	Colombia, Peru, Mali, Burkina Faso, and Namibia.
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	Bolivia, Argentina, Burkina Faso, and South Africa.
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	Nicaragua, Honduras, Puerto Rico, Paraguay, and Argentina.
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	Argentina, Paraguay, Ghana, and South Africa.
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	Argentina, Ghana, and Benin.
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	The United States (Alabama and Georgia), Nicaragua, and the Dominican Republic.
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	The United States (Alabama and Georgia) and Nicaragua.
Geo-R8 (70-80 inches; 178-203 cm)	y - negl	N/A	Nicaragua and Honduras.
Geo-R9 (80-90 inches; 203-229 cm)	y - negl	N/A	Ghana and Togo.
Geo-R10 (90-100 inches; 229-254 cm)	y - low	N/A	We found no direct evidence; however, it is likely to grow in areas with 90-100 inches of precipitation given that we found evidence that it grows in areas receiving more than 100 inches of precipitation.
Geo-R11 (100+ inches; 254+ cm))	y - negl	N/A	The Dominican Republic and Colombia.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	First reported from SC in 1997 (Hill and Horn, 1997); in FL, GA, SC, and VA (Weakley, 2010); reported also in OR, NY, NJ (NRCS, 2014) and NC (Baker et al., 2005).
Ent-2 (Plant proposed for entry, or entry is imminent)	-	N/A	
Ent-3 (Human value & cultivation/trade status)	-	N/A	
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	