United States
Department of
Agriculture

Animal and Plant
Health Inspection
Service

April 8, 2012

Version 1

Weed Risk Assessment for *Hakea gibbosa* (Sm.) Cav. (Proteaceae) – Rock hakea

Flowers and leaves of *Hakea gibbosa* (source: John Tann, http://www.flickr.com/photos/31031835@N08/5946090124/).

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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.

Hakea gibbosa **(Sm.) Cav. – Rock hakea**

Species Information

Family: Proteaceae

Initiation: On July 26, 2011, APHIS published a notice in the Federal Register announcing that *Hakea gibbosa* has been proposed for listing in APHIS' Not Authorized Pending Pest Risk Analysis (NAPPRA) (APHIS, 2011). Plants in the NAPPRA category are potential quarantine pests that cannot be imported until they have been evaluated with a weed risk assessment and found to be Low Risk or enterable. The PERAL Weed Team initiated this assessment to evaluate the risk potential of *H. gibbosa*.

Foreign distribution: This species is native to New South Wales in Australia (NGRP, 2012). It was introduced to the United Kingdom in the late 1800s, but is not known to have escaped (Anonymous, 2007). It has naturalized in New Zealand and South Africa (CABI, 2012; Howell and Sawyer, 2006; NGRP, 2012) and beyond its native range in Australia (Randall, 2007).

U.S. distribution & status: *Hakea gibbosa* has been cultivated in the United States since at least 1917 (Bailey, 1917), but only to a very limited extent. Online searches at two different "plant finder" databases did not identify any nurseries carrying it. Furthermore, a California nursery specializing in Australian native plants lists 27 other species of *Hakea* available for retail, but not *H. gibbosa* (O'Connell, 2012). We found one specimen at the University of California Botanical Garden (UCBG, 2012). *Hakea gibbosa* is not known to have naturalized in the United States (NGRP, 2012).

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. *Hakea gibbosa* analysis

Establishment/Spread Potential In South Africa and New Zealand, *H. gibbosa* is a fast-spreading species (Fugler, 1982; Reed, 1977; Weber, 2003). The following traits are believed to have contributed to its invasiveness in South Africa: forms dense thickets, maintains a long-term aerial seed bank in serotinous[2] cones, and produces viable seeds that are readily dispersed by wind (Richardson et al., 1987). Release from natural predators in its native range also probably contributed to its ability to establish and spread (Gordon and Fourie, 2011). We had a low amount of uncertainty for this risk element.
Risk score = 7 Uncertainty index = 0.11

Impact Potential In natural systems, dense stands of *H. gibbosa* change community structure, and suppress native species (Richardson et al., 1987; van Wilgen et al., 2008; Weber, 2003; Wells et al., 1986). They may also reduce water availability, and increase fire intensity (CABI, 2012). *Hakea gibbosa* is an extremely prickly shrub, and dense infestations restrict access to invaded mountainous areas valued for recreation and tourism (CABI, 2012; Fugler, 1982; Wells et al., 1986). It also reduces the grazing potential of wild lands and threatens wild cut flower production systems (CABI, 2012; van Wilgen et al., 2008). In natural and disturbed systems, *H. gibbosa* is subject to control efforts in New Zealand (Beever, 1988) and in South Africa (Fugler, 1982; Gordon and Fourie, 2011), where it is a prohibited species (CABI, 2012; Henderson, 2001; Macdonald et al., 2003). We had greater than average uncertainty here due to broad comments in the literature about the impacts of *Hakea* species.
Risk score = 3.3 Uncertainty index = 0.21

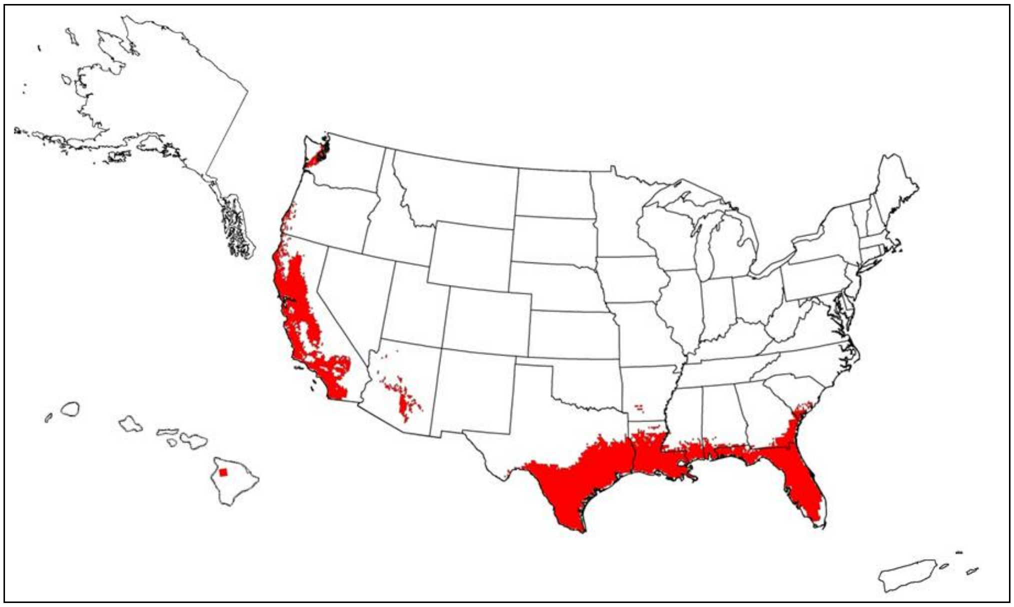
Geographic Potential Based on three climatic variables, we estimate that about 8 percent of the United States is suitable for the establishment of *H. gibbosa* (Fig. 1). This predicted distribution is based on the species' known distribution elsewhere in the world and includes point-referenced localities and areas of occurrence. The map for *H. gibbosa* represents the joint distribution of Plant Hardiness Zones 9-11, areas with 10-70 inches of annual precipitation, and the following Köppen-Geiger climate classes: steppe, mediterranean, humid subtropical, and marine west coast.

The area estimated likely represents a conservative estimate as it uses three climatic variables to estimate the area of the United States that is suitable for establishment of the species. Other environmental variables, such as soil and habitat type, may further limit the areas in which this species is likely to establish.

Entry Potential We did not assess *H. gibbosa*'s entry potential because this species is already present in the United States, where it is cultivated to a very limited extent (Bailey, 1917; UCBG, 2012).

[2] Serotinous cones are pine cones that are retained on the tree and do not open to release their seeds until either fire or some other cause kills the tree.

Figure 1. Predicted distribution of *H. gibbosa* 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) = 37.8%
P(Minor Invader) = 57.5%
P(Non-Invader) = 4.7%

Risk Result = Evaluate Further
Secondary Screening = High Risk

Figure 2. *Hakea gibbosa* 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.

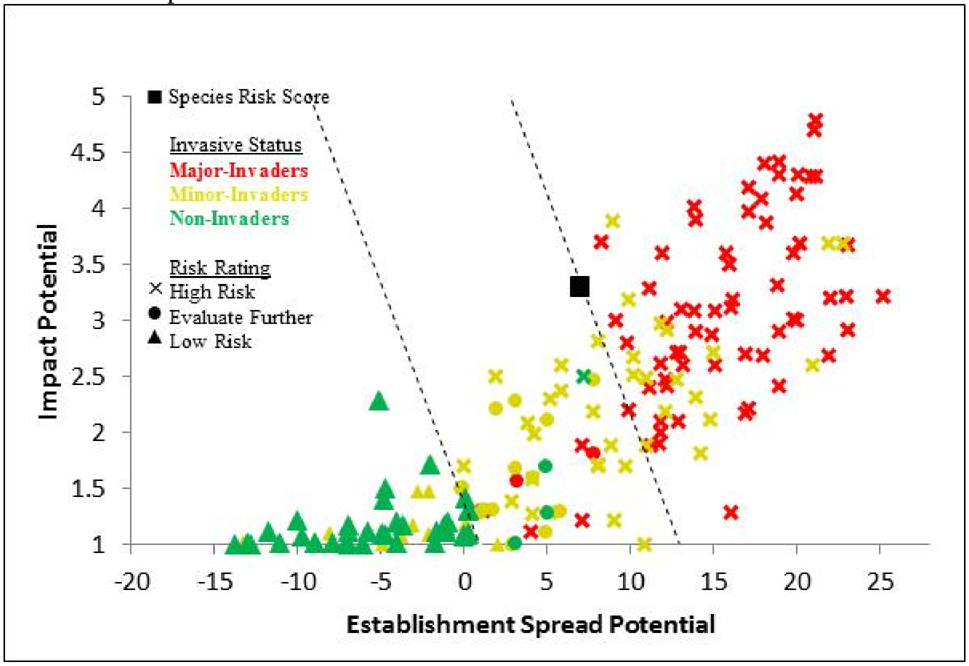
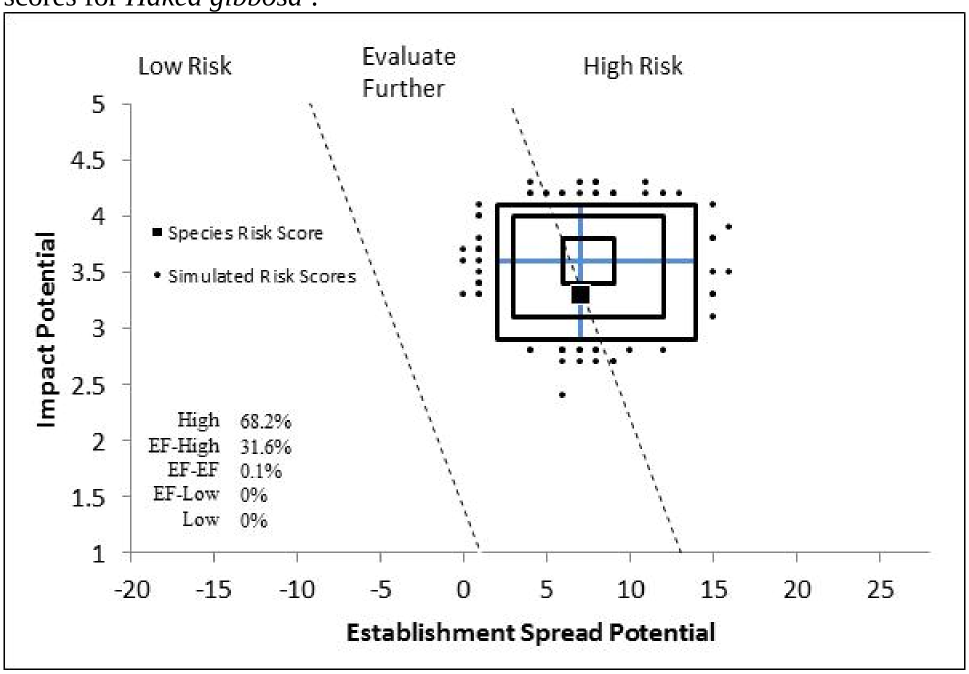


Figure 3. Monte Carlo simulation results (N=5,000) for uncertainty around the risk scores for *Hakea gibbosa*[a].



[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 *H. gibbosa* is High Risk after secondary screening (Fig. 2). Our uncertainty simulation supported this conclusion because nearly all of the simulated risk scores resulted in an outcome of High Risk (Fig. 3). The authors of two independent weed risk assessments also concluded that this species poses a relatively high risk potential (Parker et al., 2007; Tucker and Richardson, 1995). *Hakea gibbosa* is considered an invasive species in South Africa and New Zealand, where it is being controlled (Beever, 1988; Fugler, 1982; Gordon and Fourie, 2011). Its primary impact is to natural areas where it reduces species diversity, changes community structure, and restricts access (CABI, 2012; Richardson et al., 1987; Weber, 2003; Wells et al., 1986). Dense stands may also reduce water availability in catchment systems that are important for wildlife and municipalities (see discussion in Appendix A). *Hakea gibbosa* is targeted for control under the Working for Water program of South Africa (CABI, 2012).

Given its risk potential and long history in the United States (Bailey, 1917), it is puzzling that *H. gibbosa* has not yet become naturalized, particularly in the Mediterranean climate of California. Some possible explanations for this include: 1) limited cultivation has limited its opportunity to escape; 2) U.S. seed predators have prevented escape; or 3) where grown, the fire regime has not allowed naturalization. Without additional data on how environmental conditions in the United States are interacting with the species' biology to determine its invasive potential, it is difficult to speculate beyond this.

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Appendix A. Weed risk assessment for *Hakea gibbosa* (Sm.) Cav. (Proteaceae). The following information was obtained from the species' risk assessment, which was conducted using Microsoft Excel. The information shown in this appendix was modified to fit on the page. The original Excel file, the full questions, and the guidance to answer the questions are available upon request.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ESTABLISHMENT/SPREAD POTENTIAL			
ES-1 (Status/invasiveness outside its native range)	f - negl	5	Native to New South Wales, Australia (NGRP, 2012). Introduced in the United Kingdom in the late 1800s, but not known to have escaped (Anonymous, 2007). Naturalized in New Zealand and South Africa (CABI, 2012; Howell and Sawyer, 2006; NGRP, 2012) and beyond its native range in Australia (Randall, 2007). Invades mountain fynbos (Groves and Di Castri, 1991; Henderson, 2001; Richardson et al., 1997). Invasive in New Zealand and southern Africa; in this reference "invasive" refers to a spreading species (Weber, 2003). Fast-spreading species in South Africa (Fugler, 1982; Reed, 1977). Both alternate choices for the Monte Carlo simulation are "e."
ES-2 (Is the species highly domesticated)	n - low	0	Although this species is cultivated (e.g., for firewood, hedging) (Anonymous, 2007; Bailey and Bailey, 1976; Henderson, 2001), there is no evidence it has been bred to reduce or eliminate traits associated with weed potential.
ES-3 (Weedy congeners)	y - negl	1	*Hakea sericea* is a major weed in South Africa (Holm et al., 1979; Nel et al., 2004). Several *Hakea* species are described as displacing species, forming dense thickets, and changing habitat structure (Weber, 2003; Wells et al., 1986). *Hakea sericea* reduces water availability (Le Maitre, 1996, 2004).
ES-4 (Shade tolerant at some stage of its life cycle)	? - max		Unknown. In its native range in Australia, this species occurs in "exposed sandstone ridges, and sometimes heath and dry sclerophyll forests on the central coast of New South Wales, around Sydney" (Anonymous, 2007). This suggests that it is probably well adapted to growing in open habitats. It is also reported as "intolerant of shade" (NZ PCN, 2010). However, another source indicates it is shade tolerant (Weber, 2003). It is best grown in open sunny sites, but will tolerate "a fair degree of shade" (Anonymous, 2007). Because the evidence is conflicting, answering "unknown."
ES-5 (Climbing or smothering growth form)	n - negl	0	The plant is a shrub or tree growing to 4 meters high (Henderson, 2001; Weber, 2003).
ES-6 (Forms dense thickets)	y - negl	2	Forms dense thickets (CABI, 2012; Fugler, 1982; Richardson et al., 1987; Weber, 2003).
ES-7 (Aquatic)	n - negl	0	Is a terrestrial plant species (van Wilgen et al., 2008).
ES-8 (Grass)	n - negl	0	Not a grass; species is in the Proteaceae family (Henderson, 2001; NGRP, 2012).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	No evidence. The Proteaceae is not a plant family known to contain nitrogen-fixing species (Martin and Dowd, 1990).
ES-10 (Does it produce viable seeds or spores)	y - negl	1	Reproduces via seeds entirely (CABI, 2012; Wells et al., 1986).
ES-11 (Self-compatible or apomictic)	? - max	0	Unknown. "Proteaceous species are commonly considered to be primarily outcrossing and many, including *H. carinata*, have protandrous flowers that should enhance outcrossing. *H. carinata* has been shown, however, to be capable of self fertilisation," and in this study populations were substantially selfing (Starr and Carthew, 1998). *Hakea erinacea* is self-

Question ID	Answer - Uncertainty	Score	Notes (and references)
			compatible, while *H. cristata* strongly preferred non-self-pollen (Lamont et al., 1998).
ES-12 (Requires special pollinators)	n - mod	0	This species is most likely pollinated by honey bees in New Zealand (Butz Huryn and Moller, 1995). The congeners *H. erinacea* and *H. cristata* are visited by honeybees and other flying insects (Lamont et al., 1998).
ES-13 (Minimum generation time)	c - negl	0	The plant is a perennial (Wells et al., 1986). Juvenile period is two years (Richardson et al., 1987). *Hakea gibbosa* produces fruit at a much younger age than *H. suaveolens* which produces at about six years; these authors recommend resurvey for recruitment after nine months of felling for *H. gibbosa* as opposed to the three years used for *H. suaveolens* (Fugler, 1982), which suggests that plants begin reproducing by their third year. Since it is unlikely that *H. gibbosa* would begin reproducing in its first year, both alternate choices for the Monte Carlo simulation were "d."
ES-14 (Prolific reproduction)	n - low	-1	Fruit of *H. gibbosa* contain two seeds each (Henderson, 2001). Copious seed production (CABI, 2012). Produces less seeds than *H. sericea* but devotes 70 percent of its resources to reproductive and ancillary organs (Richardson et al., 1987). Seed loads on *H. gibbosa* are about 25 percent of that on *H. sericea* in South Africa (cited in Gordon, 1993). Seeds have relatively lower viability/germinability than *H. sericea* (Gordon and Fourie, 2011); however, the article does not provide any data. Thus, because *H. sericea* does not have prolific reproduction (evidence follows), and because *H. gibbosa*'s fertility is reported to be less than that of *H. sericea*, *H. gibbosa* seems unlikely to produce more than 1000 seeds per square meter per year. **Evidence for *H. sericea***: seed densities of up to 7500 per square meter have been reported in the ash after fire in South Africa (cited in Kluge and Neser, 1991). In New Zealand, one study found follicle densities to be up to 260 per square meter (520 seeds per square meter) (Williams, 1992). These estimates of seed production account for reproduction across an individual's entire life as this species retains seeds in woody follicles until the tree dies in a fire (CABI, 2012; Richardson et al., 1997; Richardson et al., 1987). Median estimates of fire return intervals for several fynbos habitats in South Africa range between 10-13 years (van Wilgen et al., 2010). Thus, assuming *H. sericea* begins reproducing at three years, it has about 7-10 years of seed production before it has a 50 percent cumulative chance of encountering a returning fire. Under this timeframe and assuming 7500 seeds per square meter, then seed production estimates range from 750 to 1071 per year per square meter. However, since 7500 is an upper limit (i.e., "up to") and other estimates of annual seed production are lower, *H. sericea* seems unlikely to produce more than 1000 seeds per square meter per year under most situations.
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - high	1	This species is cultivated for hedging (Anonymous, 2007; Bailey and Bailey, 1976; Henderson, 2001). Because hedges are pruned periodically, and because seed-bearing follicles are retained in the canopy (Richardson et al., 1997), it seems likely that seeds will be spread when cuttings are discarded in local brush dumps or other refuse areas. CABI (2012) reports that it has

Question ID	Answer - Uncertainty	Score	Notes (and references)
			occasionally been dispersed by people collecting the fruit for dried flower arrangements and then disposing of fruit on waste piles; but this does not seem like a significant pathway as seeds would be shed indoors.
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	n - mod	-1	One reference said this is a seed contaminant (Wells et al., 1986); however, no other source supports this. Furthermore, as this is primarily a weed of wild vegetation (not agricultural areas) (CABI, 2012), it seems unlikely that it would contaminate most trade goods.
ES-17 (Number of natural dispersal vectors)	1	-2	For questions ES17a-ES17e: Fruit are wooden capsules 35 mm x 30 mm splitting into two equal halves, each with a single winged seed (CABI, 2012; Henderson, 2001). Seeds are about 10 mm by 8 mm (CABI, 2012).
ES-17a (Wind dispersal)	y - negl		Seeds are winged (Gunn and Ritchie, 1988; Weber, 2003). Winged seeds can disperse several kilometers (cited in CABI, 2012). *Hakea* are wind-dispersed (Groom, 2010).
ES-17b (Water dispersal)	n - low		No evidence; clearly adapted for wind dispersal. This species is relatively well known in South Africa.
ES-17c (Bird dispersal)	n - low		No evidence; clearly adapted for wind dispersal. This species is relatively well known in South Africa.
ES-17d (Animal external dispersal)	n - mod		No evidence. No structures to facilitate external dispersal (DEWR, 2012).
ES-17e (Animal internal dispersal)	n - mod		No evidence.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	y - negl	1	Seeds are stored in the canopy (Richardson et al., 1997). Serotinous seed bank (Tasker et al., 2011). Seeds are produced annually and stored in the canopy until a fire event releases them (CABI, 2012).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	n - low	-1	No evidence it regenerates from bases after fire (Richardson et al., 1987). *Hakea gibbosa* is killed by fires in the fynbos habitat of South Africa (Le Maitre, 1996). Given the amount of effort applied controlling this and other *Hakea* species in South Africa, this type of trait would likely have been reported in the control literature; consequently, we are using "low" uncertainty.
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - low	0	Not listed by Heap (2012). Some specific herbicides are recommended (CABI, 2012; Weber, 2003).
ES-21 (Number of cold hardiness zones suitable for its survival)	3	-1	
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 - low	0	No evidence.
Imp-G2 (Parasitic)	n - negl	0	No evidence. Not a member of a family containing parasitic plants (Heide-Jorgensen, 2008; Nickrent, 2009).
Impacts to Natural Systems			
Imp-N1 (Change ecosystem	? - max		Unknown. We found no specific evidence to support a "yes"

Question ID	Answer - Uncertainty	Score	Notes (and references)
processes and parameters that affect other species)			response for this species. A datasheet from the CABI Invasive Species Compendium states that dense stands of *H. gibbosa* reduce water availability and increase fire intensity (CABI, 2012); however, the datasheet does not provide an original reference for verification. Much of the primary literature supporting impacts to water and fire regime refer to the impacts of *Hakea* species in South Africa (e.g., Richardson et al., 1997). Although there are only three invasive *Hakea* species in South Africa (*H. sericea*, *H. gibbosa*, and *H. drupacea*), *H. sericea* is by far the most problematic and extensive species (Le Maitre et al., 2008), and most reports of impacts of *Hakea* species are probably referring to this species. Because the congener *H. sericea* reduces water availability (Le Maitre, 1996; Le Maitre et al., 2002) and changes some fuel properties that may affect natural systems (van Wilgen and Richardson, 1985), it seems reasonable that *H. gibbosa* may also have similar impacts. Without specific evidence for this species, we could not answer yes, and therefore answered unknown.
Imp-N2 (Change community structure)	y - low	0.2	Alters vegetation structure (Richardson et al., 1987).
Imp-N3 (Change community composition)	y - negl	0.2	Suppresses and replaces native vegetation (Weber, 2003; Wells et al., 1986). Crowds out native vegetation (CABI, 2012). Estimated to have a high impact on biodiversity (van Wilgen et al., 2008).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	y - negl	0.1	Based on the impacts to biodiversity described under Imp-N3, dense stands of this species are likely to threaten T&E species (CABI, 2012) in the United States. It is threatening the endangered *Euryops lasiocladus* (an aster) with extinction in South Africa (Helme and Raimondo, 2011).
Imp-N5 (Is it likely to affect any globally outstanding ecoregions)	y - high	0.1	Because it can change community structure, and possibly change ecosystem processes, this species is likely to affect globally outstanding ecoregions in the United States (Ricketts et al., 1999).
Imp-N6 (Weed status in natural systems)	c - negl	0.6	Flora and conservation weed in South Africa (Groves and Di Castri, 1991; Wells et al., 1986). Serious environmental weed (CABI, 2012). Invader of natural systems; control methods and herbicides are available (Weber, 2003). Various control options are described (CABI, 2012). Being hand-pulled in a park in New Zealand (Beever, 1988). Subject to biocontrol efforts in South Africa (Gordon and Fourie, 2011). *Hakea gibbosa* is controlled in mountain habitats by the Dept. of Forestry in South Africa (Fugler, 1982). *Hakea* species are best controlled in fynbos vegetation by cutting down all vegetation, waiting 12-18 months for the seeds to be released, then burning to kill seedlings and seeds, and survey afterwards to identify individuals that escaped the fire (Richardson et al., 1997). Both alternate choices for the Monte Carlo simulation are “b.”
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Impacts human property, processes, civilization, or safety)	? - max		There is no specific or direct evidence for this species. *Hakea* species are described as reducing water availability in catchments for municipal areas (Richardson et al., 1997). Because the congener *H. sericea* reduces water availability (Le Maitre, 1996; Le Maitre et al., 2002), it is possible, and probably

Question ID	Answer - Uncertainty	Score	Notes (and references)
			likely, this species is having a similar effect. But without specific and direct evidence, answering “unknown.”
Imp-A2 (Changes or limits recreational use of an area)	y - negl	0.1	Restricts access and vision (Wells et al., 1986). Dense stands of this prickly shrub restrict recreational access (CABI, 2012). Dense stands of *Hakea* (referring to *H. sericea*, *H. gibbosa*, and *H. suaveolens*) make access difficult or impossible (Fugler, 1982).
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	n - low	0	No evidence. This plant is widely planted as a hedge plant in South Africa (CABI, 2012). Consequently, using "low" uncertainty.
Imp-A4 (Weed status in anthropogenic systems)	c - low	0.4	Industrial (tourist) and hydrological weed in South Africa (Wells et al., 1986). "*H[akea] gibbosa* is one of the weeds targeted by the massive alien clearing campaign in South Africa ('Working for Water' programme) initiated in 1996 to eradicate invasive species from all water catchments, rivers, wet lands and other water resources" (CABI, 2012). Both alternate answers for the Monte Carlo simulation are "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	y - low	0.4	Estimated to have a high impact (reducing grazing potential by 60 percent when very abundant) on the grazing potential of wild lands (van Wilgen et al., 2008). "*H[akea] gibbosa* is a threat to the wild flower industry in South Africa estimated to be worth approximately US$40 million per year. More than 75% of these flowers are harvested from areas where *H. gibbosa* is either present or threatening to invade" (CABI, 2012).
Imp-P2 (Lowers commodity value)	n - mod	0	No evidence.
Imp-P3 (Is it likely to impact trade)	n - mod	0	Declared category 1 weed in South Africa which means it is prohibited and must be controlled where it occurs (Henderson, 2001; Macdonald et al., 2003). Prohibited in South Africa (CABI, 2012). However, there is no evidence it is likely to follow a pathway in trade.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	? - max		Although *Hakea* species are reported to reduce water availability, it is unknown whether this species is having that impact. See discussion under Imp-N1.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - low	0	No evidence and well studied. It is not listed in Burrows and Tyrl (2001).
Imp-P6 (Weed status in production systems)	b - mod	0.2	Not a weed of crops, though it is found invading heaths and natural grasslands that are used for grazing (CABI, 2012). It is recognized as a threat to the wildflower industry of South Africa (CABI, 2012). It is classified as a principal weed of agriculture in South Africa (Holm et al., 1979). Though widely controlled in fynbos vegetation (see references under Imp-N6), there is no evidence of control in production systems. Alternate answers for the Monte Carlo simulation are "c" and "a."
GEOGRAPHIC POTENTIAL			Unless otherwise noted, references were from GBIF (2012). PT refers to geo-referenced occurrences with latitude/longitude coordinates. OCC refers to species occurrences at a localized or regional level, but without geo-referenced data points.
Plant cold hardiness zones			

Question ID	Answer - Uncertainty	Score	Notes (and references)
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 - negl	N/A	No evidence.
Geo-Z8 (Zone 8)	n - mod	N/A	No evidence.
Geo-Z9 (Zone 9)	y - negl	N/A	PT: New Zealand.
Geo-Z10 (Zone 10)	y - negl	N/A	PT: Australia, New Zealand.
Geo-Z11 (Zone 11)	y - high	N/A	OCC: South Africa (Henderson, 2001).
Geo-Z12 (Zone 12)	n - mod	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 - low	N/A	No evidence.
Geo-C3 (Steppe)	y - mod	N/A	OCC: South Africa.
Geo-C4 (Desert)	n - high	N/A	No evidence.
Geo-C5 (Mediterranean)	y - mod	N/A	OCC: South Africa (Henderson, 2001).
Geo-C6 (Humid subtropical)	y - negl	N/A	PT: Australia.
Geo-C7 (Marine west coast)	y - negl	N/A	PT: Australia, New Zealand.
Geo-C8 (Humid cont. warm sum.)	n - low	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 - mod	N/A	No evidence.
Geo-R2 (10-20 inches; 25-51 cm)	y - mod	N/A	OCC: South Africa (Henderson, 2001).
Geo-R3 (20-30 inches; 51-76 cm)	y - mod	N/A	OCC: South Africa (Henderson, 2001).
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	PT: Australia.
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	PT: Australia.
Geo-R6 (50-60 inches; 127-152 cm)	y - low	N/A	Answering “yes” because the species can obviously occur in wetter and drier rainfall bands.
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	PT: 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.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-R11 (100+ inches; 254+ cm))	n - negl	N/A	No evidence.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	Likely cultivated in the United States since at least 1917 (Bailey, 1917). Specimen grown at the University of California Botanical Garden (UCBG, 2012). However, not known to have naturalized in the United States (NGRP, 2012).
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	