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Animal and Plant
Health Inspection
Service

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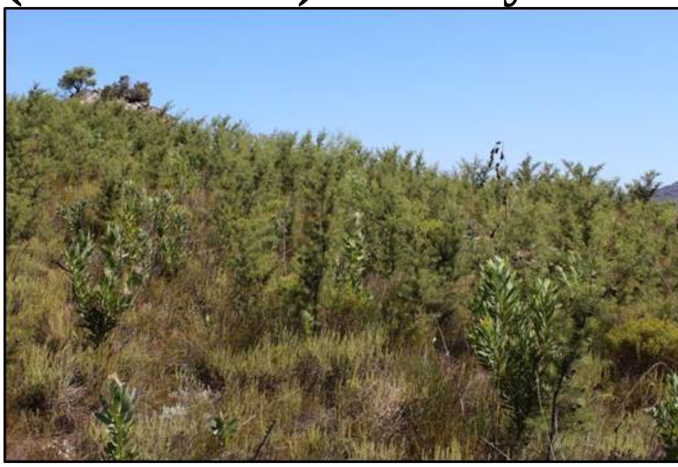
Version 2

Weed Risk Assessment for *Hakea sericea* Schrad. & J. C. Wendl. (Proteaceae) – Bushy needlewood




Left: A young population of *H. sericea* in South Africa (source: http://www.ispot.org.za/).
Right: Leaves, flowers, and follicles of *H. sericea* (source: Anonymous, 2011).

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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 sericea* Schrad. & J. C. Wendl. – Bushy needlewood**

Species Information

Family: Proteaceae

Initiation: On April 25, 2011, Al Tasker (USDA-APHIS-PPQ National Weeds Program Coordinator) identified *Hakea sericea* as a species of potential phytosanitary significance for the United States (Tasker, 2011) because it was listed in an article titled "Emerging invasive alien plants for the Mediterranean basin" (Brunel et al., 2010). The PERAL Weed Team initiated this risk assessment to evaluate the risk potential of *H. sericea* in the United States.

Foreign distribution: *Hakea sericea* is native to eastern Australia (NGRP, 2012). It has naturalized in South Africa, Portugal, Spain, France, and New Zealand, and beyond its native range in Australia (Anonymous, 2011; NGRP, 2012; Pulgar Sañudo, 2006; Richardson et al., 1997; Williams, 1992).

U.S. distribution and status: *Hakea sericea* is cultivated in the United States as an ornamental (Bailey and Bailey, 1976; Cal-IPC, 2008; Donaldson et al., 1983; FAO, 2003), but only rarely (DiTomaso, 2011). It is not listed in the *Manual of Woody Landscape Plants* (Dirr, 1998), nor are there any homeowner comments under its page in the popular Dave's Garden website (DavesGarden, 2011). In a search of Backyard Gardener's "Plant Finder" database (Backyard Gardener, 2011), we found no nurseries selling it. *Hakea sericea* has been in the United States since at least 1930 (Bailey and Bailey, 1930), and is not known to have naturalized (Kartesz, 2012; NRCS, 2012; UC, 2011).

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 sericea* analysis

Establishment/Spread Potential *Hakea sericea* has escaped, naturalized, and spread in natural and disturbed areas in Portugal, Spain, South Africa, and New Zealand (Fried, 2010; Marchante et al., 2005; Pulgar Sañudo, 2006; Richardson et al., 1997; Sousa et al., 2004; Tomson, 1922; Williams, 1992). It is particularly invasive in fynbos communities (a type of mediterranean-like plant community) in South Africa, where it spread soon after introduction (Esler et al., 2009). Several species traits have contributed to rapid spread in South Africa: an aerial seed bank (serotiny), effective wind dispersal, formation of dense stands (Richardson et al., 1987), and the fire regime in fynbos communities, which eliminates competing species and stimulates the release of thousands of seeds stored in the plant canopy (van Wilgen et al., 2010). Experts also believe that release from seed predators in its native range has increased the invasive potential of *H. sericea* in South Africa (Kluge and Neser, 1991; Le Maitre et al., 2008). Uncertainty was low for this risk element due to an abundance of information.

Risk score = 9 Uncertainty index = 0.10

Impact Potential *Hakea sericea* is primarily a threat to natural communities. In fynbos vegetation in South Africa, it excludes native species, changes community structure, alters fire regime, disrupts vegetation success, and reduces surface water runoff (CABI, 2012; Le Maitre et al., 2002; van Wilgen and Richardson, 1985; Williams, 1992). In wild lands suitable for agricultural productivity, *H. sericea* replaces wildflowers important for the cut flower industry (CABI, 2012), and reduces grazing potential because its needle-like leaves are unpalatable (van Wilgen et al., 2008; Wells et al., 1986). It is targeted for control by the South African Working for Water campaign because it reduces runoff in mountain catchments (CABI, 2012; Forsyth et al., 2012). Several biological control agents have been introduced into South Arica to manage *H. sericea* (Kluge and Neser, 1991). We had a moderate amount of uncertainty for this element.

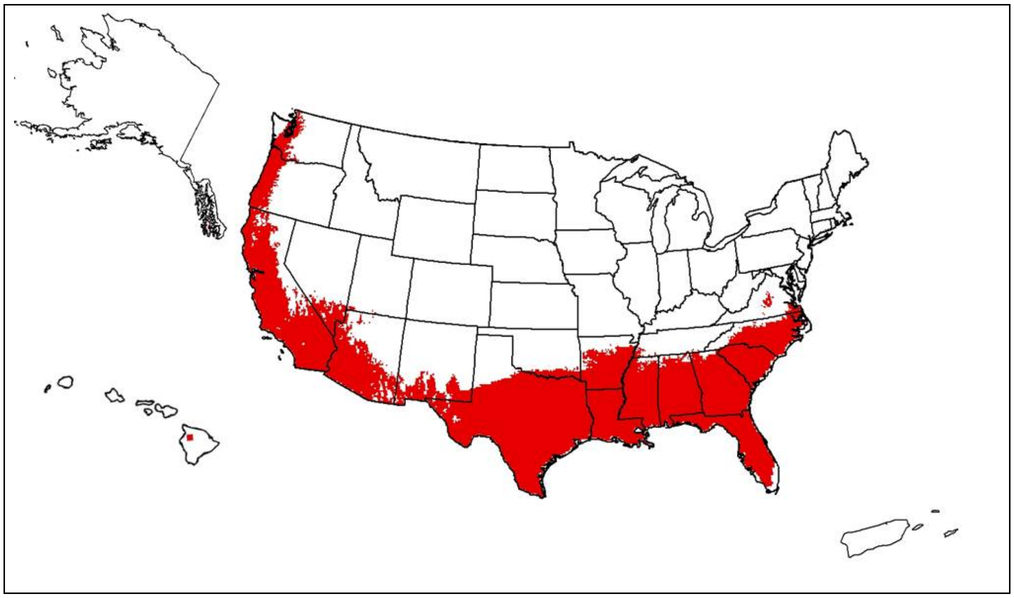
Risk score = 3.8 Uncertainty index = 0.21

Geographic Potential Based on three climatic variables, we estimate that about 23 percent of the United States is suitable for the establishment of *H. sericea* (Fig. 1). This predicted distribution is based on the species' known distribution elsewhere in the world and includes point-referenced localities and other areas of occurrence. The map for *H. sericea* represents the joint distribution of Plant Hardiness Zones 8-11, areas with 0-80 inches of annual precipitation, and the following Köppen-Geiger climate classes: steppe, desert, mediterranean, humid subtropical, and marine west coast. In our analysis we found one geo-referenced occurrence for a naturalized population in desert habitat in South Australia (Anonymous, 2011). This also corresponded to the only point that supported survival in 0-10 inches of annual precipitation. Although only one point supported survival in this climate, we still answered "yes" for these climate layers because the data point appeared to be legitimate. Because we found no other occurrences in desert-like habitats, that occurrence is most likely in a protected microhabitat, rather than desert *per se*

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. Fire in particular appears to be important in determining the distribution of this species, as it depends on periodic fires for recruitment (van Wilgen et al., 2010).

Entry Potential *Hakea sericea* is already present in the United States, where it is cultivated as an ornamental (Bailey and Bailey, 1976; Cal-IPC, 2008; Donaldson et al., 1983; FAO, 2003). We did not need to assess its entry potential.

Figure 1. Predicted distribution of *H. sericea* 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) = 56.8%
P(Minor Invader) = 41.0%
P(Non-Invader) = 2.3%

Risk Result = High Risk
Secondary Screening = Not Applicable

Figure 2. *Hakea sericea* 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.

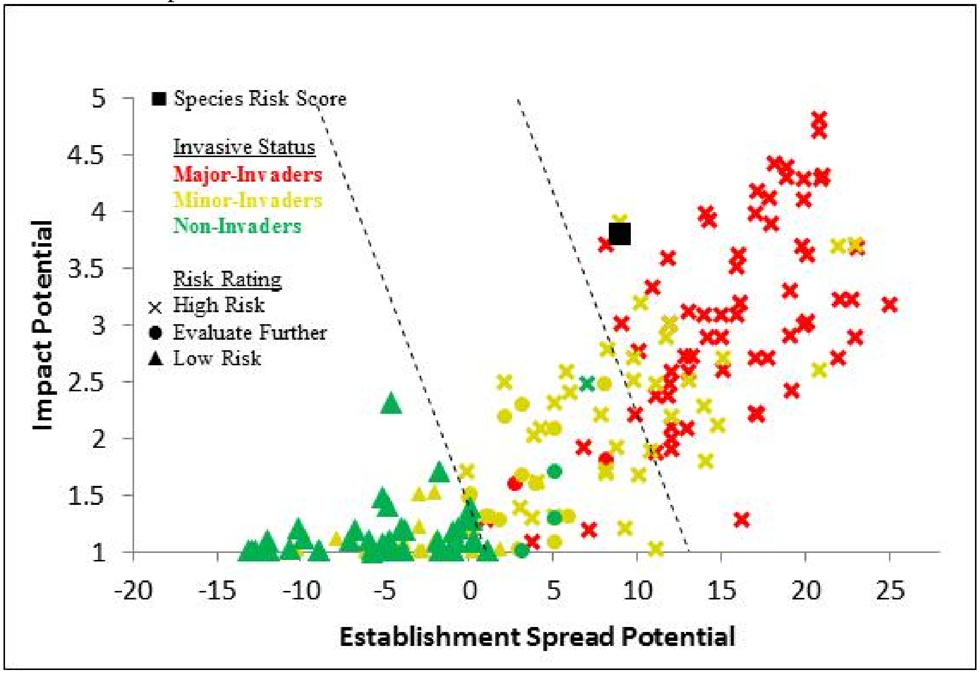
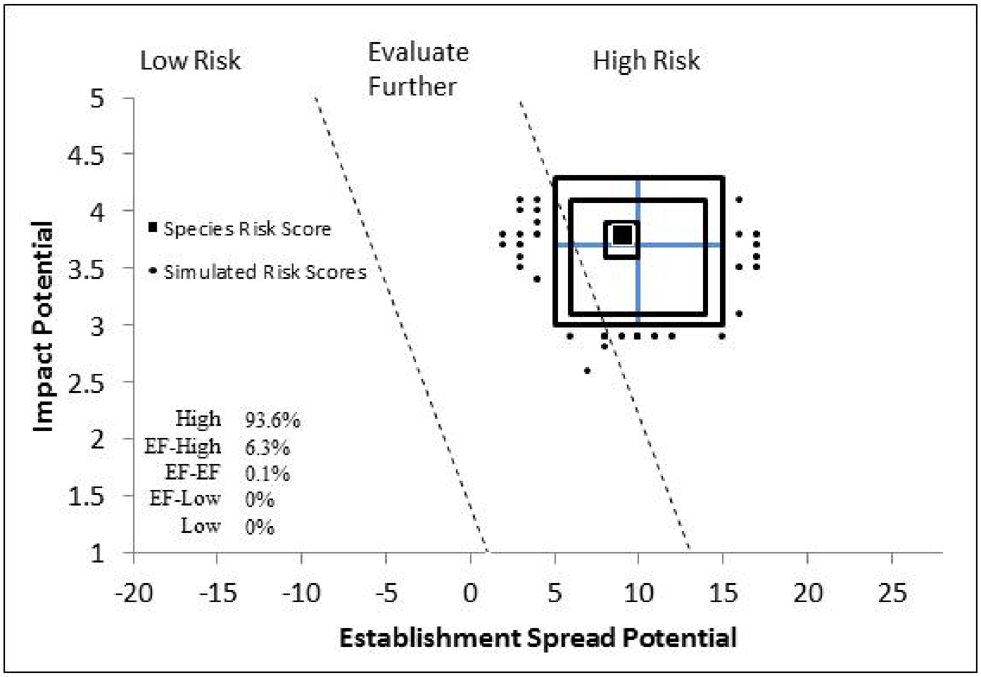


Figure 3. Monte Carlo simulation results (N=5,000) for uncertainty around the risk scores for *Hakea sericea*[a].



[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. sericea* is High Risk (Fig. 2). Our conclusion seems statistically robust based on the results of the uncertainty simulation (Fig. 3). Other evaluations of the risk potential of this species have led to similar conclusions (Parker et al., 2007; Tucker and Richardson, 1995). *Hakea sericea* has demonstrated its ability to invade and negatively impact mediterranean climates elsewhere in the world (e.g., South Africa, Portugal, and New Zealand) (Fried, 2010; Marchante et al., 2005; Pulgar Sañudo, 2006; Richardson et al., 1997; Sousa et al., 2004; Tomson, 1922; Williams, 1992). Two biological control agents introduced to South Africa have reduced seed production by 95 percent, and may have halted its spread in South Africa (Moran and Hoffmann, 2012). The effectiveness of biocontrol programs in South Africa (Esler et al., 2009) suggests that part of its ability to invade there was release from herbivores in its native range (Kluge and Neser, 1991).

Given its risk potential and long history in the United States (see *H. acicularis* in Bailey and Bailey, 1930), it is puzzling that *H. sericea* has not yet naturalized in the United States, particularly in California's mediterranean climate. Some possible explanations for this include the following: 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 been conducive for naturalization. Without additional data on how U.S. environmental conditions 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 sericea* Schrad. & J. C. Wendl. (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 Australia in New South Wales and southeastern Queensland (NGRP, 2012). Naturalized in New Zealand, South Africa, France, Spain, Portugal, and elsewhere in Australia (CABI, 2012; Fried, 2010; Howell and Sawyer, 2006; NGRP, 2012; Randall, 2007; Ross and Walsh, 2003). "Invasive" in Portugal and Spain, where individuals are appearing in isolated pristine areas, particularly after fire (Fried, 2010; Marchante et al., 2005; Pulgar Sañudo, 2006; Sousa et al., 2004). Escaping in New Zealand from hedge plantings (Cheeseman, 1906). It rapidly spread in New Zealand in the early 1900s (Tomson, 1922; Williams, 1992). Spreading from naturalized populations in South African fynbos, to form satellite colonies, particularly after fire (Richardson et al., 1997). One of the most pervasive invaders in South African fynbos (CABI, 2012; Groves and Di Castri, 1991). Both alternate answers for the Monte Carlo simulation were "e."
ES-2 (Is the species highly domesticated)	n - low	0	Although this species is cultivated for shelter, shade, ornament (Henderson, 2001), land reclamation (CABI, 2012), hedging, sand binding, and firewood (CABI, 2012), there is no evidence that it has been domesticated in any way to reduce weed potential.
ES-3 (Weedy congeners)	y - negl	1	*Hakea gibbosa* is a principal weed in South Africa (Holm et al., 1979; Nel et al., 2004). Several *Hakea* species are described as displacing species, forming dense thickets, reducing water availability, and changing habitat structure (Weber, 2003; Wells et al., 1986).
ES-4 (Shade tolerant at some stage of its life cycle)	n - low	0	Plant grows in sun and semi-shade (PFAF, 2011). Plants grow in fynbos vegetation in South Africa, which is an open, dry habitat (Richardson et al., 1987). Leaves are needle-like (Richardson et al., 2006), which indicates an adaption to reduce water loss. Community succession dynamics in New Zealand forests indicate that the plant is unable to recruit in shade (Williams, 1992).
ES-5 (Climbing or smothering growth form)	n - negl	0	Shrub or tree growing to five meters high (Henderson, 2001; Weber, 2003).
ES-6 (Forms dense thickets)	y - negl	2	Forms dense thickets (Fugler, 1982; Gordon, 1993b; Richardson et al., 1987; Weber, 2003). Forms dense, impenetrable thickets of up to 0.89 stems per square meter (cited in Kluge and Neser, 1991).
ES-7 (Aquatic)	n - negl	0	Plant is not an aquatic; it is a shrub or tree (Henderson, 2001; Weber, 2003).
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. Not in a plant family known to fix nitrogen (Martin and Dowd, 1990).
ES-10 (Does it produce viable seeds or spores)	y - negl	1	Reproduces via seeds (Le Maitre et al., 2008; Wells et al., 1986).
ES-11 (Self-compatible or apomictic)	? - max	0	Unknown for *H. sericea*. "Proteaceous species are commonly considered to be primarily outcrossing and many, including *H. carinata*, have protandrous flowers that should enhance

Question ID	Answer - Uncertainty	Score	Notes (and references)
			outcrossing. *H. carinata* has been shown, however, to be capable of self fertilization," and in this study populations were substantially selfing (Starr and Carthew, 1998). *Hakea erinacea* is self-compatible, while *H. cristata* strongly preferred non-self-pollen (Lamont et al., 1998)
ES-12 (Requires special pollinators)	n - low	0	Insect pollinated (EPPO, 2011; Mast et al., 2012). 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	Perennial (Wells et al., 1986). The juvenile stage is two years (CABI, 2012; Richardson et al., 1987). Le Maitre et al. (2008) have quantitative data showing reproduction starts in the third year. Seedlings recolonizing burnt areas take several years before they can produce fruit (CABI, 2012). In Australia, the plant begins to produce follicles at 4-6 years of age, and in New Zealand, when it is about 1 meter tall (Williams, 1992). Based on the quantitative data from one study alone, using "negl". Both alternate answers for the Monte Carlo simulation were "d."
ES-14 (Prolific reproduction)	n - high	-1	Seed production in South Africa is far more prolific than in its native range, probably due to the absence of seed predators (cited in CABI, 2012). 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 3 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, it does not seem likely that under most situations *H. sericea* will be producing more than 1000 seeds per square meter per year.
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - high	1	This species is cultivated for hedging (CABI, 2012). Because hedges are pruned periodically, and because seed-bearing follicles are retained in the canopy (CABI, 2012; Richardson et al., 1997), seeds will likely be spread when cuttings are discarded in local brush dumps or other refuse areas. The plant has occasionally been dispersed by people collecting the fruit for dried flower arrangements and then disposing of fruit on waste piles (CABI, 2012), but this does not seem to be 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.

Question ID	**Answer - Uncertainty**	**Score**	**Notes (and references)**
ES-17 (Number of natural dispersal vectors)	1	-2	For questions ES17a-ES17e: Fruit are wooden capsules (20-25 mm by 25-30 mm) splitting into equal halves, each with a winged seed (Henderson, 2001). Each seed is 8 mm in length and 5 mm in width and has a membranous wing of length 15 mm and width 10 mm (Gordon, 1993b).
ES-17a (Wind dispersal)	y - negl		Seeds are winged (Gordon, 1993b; Gunn and Ritchie, 1988; Weber, 2003). Wind disperses seeds over several kilometers (Richardson et al., 1997). Seeds are dispersed long distances by wind, forming the nucleus of new invasions (CABI, 2012). Seeds are dispersed well by wind (Richardson et al., 1987). *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.
ES-17c (Bird dispersal)	n - low		No evidence. Clearly adapted for wind dispersal. This species is relatively well known.
ES-17d (Animal external dispersal)	n - low		No evidence. No structures to facilitate external dispersal. Not known to be dispersed in this fashion (Gordon, 1993a).
ES-17e (Animal internal dispersal)	n - low		No evidence. Not known to be dispersed by animals (Gordon, 1993a).
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	y - negl	1	High seed longevity in the canopy, where seeds are only released after fire or death of the plant (Gordon, 1993b). Seeds are produced annually and stored in the canopy (CABI, 2012; Richardson et al., 1997). Plants are serotinous, forming an aerial seed bank that is only released after death of the parent (Richardson et al., 1987).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	n - low	-1	Does not resprout after fire; instead it depends on recruitment from seeds (Richardson et al., 1997). No evidence it regenerates from stem bases after fire (Richardson et al., 1987). As a serotinous species, it essentially reproduces right after a fire clears competing vegetation by releasing all of its seeds at once (Richardson et al., 1987; van Wilgen and Richardson, 1985). Spreads rapidly after fire (Sousa et al., 2004). In this regard, the population benefits from fires; however, how seeds respond to fire is not considered under this question. Given the amount of effort applied controlling this and other *Hakea* species in South Africa, this type of trait would most 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	No evidence. Not listed by Heap (2011). Furthermore, a variety of herbicides are available for its control (CABI, 2012; Weber, 2003).
ES-21 (Number of cold hardiness zones suitable for its survival)	4	0	
ES-22 (Number of climate types suitable for its survival)	5	2	
ES-23 (Number of precipitation bands suitable for its survival)	8	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - low	0	No evidence.

Question ID	Answer - Uncertainty	Score	Notes (and references)
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 processes and parameters that affect other species)	y - low	0.4	Several sources claim that this species reduces surface water resources of the landscape (CABI, 2012; van Wilgen et al., 2008; Weber, 2003) and that reduced water availability will affect aquatic biota (Richardson et al., 1997). However, these sources don't provide specific evidence that *H. sericea* reduces water availability. These claims appear to be based on the results of a simulation study that showed how dense infestations of woody species reduce water yield from catchment systems from 30 to 70 percent (Le Maitre, 1996). The simulation model was based on reductions in surface water runoff from fynbos vegetation afforested with *Pinus radiata*. The authors used data on biomass density and water runoff from these stands to parameterize their model (Le Maitre, 1996). Thus, although there is no specific data for *H. sericea*, based on this simulation, it is very likely that dense stands formed by this species are reducing surface water runoff. In a later study, the authors report specific estimates of the amount of water reduced by populations/stands of *H. sericea* using the same model (Le Maitre et al., 2002). *Hakea sericea* increases fuel load in the understory, and lowers foliage moisture content (CABI, 2012), but nonetheless may not support fire as well as natural fynbos vegetation (van Wilgen and Richardson, 1985). In more extreme events, if fires do develop in areas dominated by *H. sericea*, fire intensity will be much higher (van Wilgen and Richardson, 1985). *Hakea sericea* disrupts vegetation succession in New Zealand (Williams, 1992). Even though there is much uncertainty regarding each of the impacts described here, because of the number of sources involved and the multiple ways that *H. sericea* may be impacting ecosystem processes, answering "yes" but with "low" uncertainty.
Imp-N2 (Change community structure)	y - low	0.2	Alters vegetation structure (Richardson et al., 1987; van Wilgen and Richardson, 1985).
Imp-N3 (Change community composition)	y - negl	0.2	Replaces native vegetation (Wells et al., 1986). Reduces native species diversity and affects wildlife (Weber, 2003). Has reduced native species richness in fynbos (cited in 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 - low	0.1	Based on its impacts to individual species and entire ecosystems (described in Imp-N1 through Imp-N3), this species is likely to affect T/E species in the United States.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions)	y - mod	0.1	Based on its impacts to individual species and entire ecosystems described in Imp-N1 through Imp-N3), this species is likely to affect entire ecosystems. *Hakea sericea* invades mediterranean ecosystems (CABI, 2011), which are considered globally outstanding in California (Ricketts et al., 1999)
Imp-N6 (Weed status in natural systems)	c - negl	0.6	Flora and conservation weed (Forsyth et al., 2012; Randall, 2007; Richardson et al., 1997; Wells et al., 1986). Controlled in natural systems in South Africa (Fugler, 1982; Richardson et al., 1997) using a variety of techniques: manually, prescribed fire, and biocontrol (Esler et al., 2009; Richardson et al., 1987). Six biological control agents have been used to control this species in

Question ID	Answer - Uncertainty	Score	Notes (and references)
			South Africa (Gordon, 1993b; Moran and Hoffmann, 2012). *Hakea* species are best controlled in fynbos vegetation by cutting down all vegetation, waiting 12-18 months for the seeds to be released, and then burning to kill seedlings and seeds and surveying afterwards to identify individuals that escaped the fire (Richardson et al., 1997). Being hand-pulled in a park in New Zealand natural areas (Beever, 1988). Being controlled to zero adult density on a New Zealand island managed for biotic diversity (Wotherspoon and Wotherspoon, 2002). Alternate answers for the Monte Carlo simulation were both "b."
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Impacts human property, processes, civilization, or safety)	y - low	0.1	Simulation studies indicate it significantly increases water loss in catchments that supply water to municipal areas (Le Maitre et al., 2002). *Hakea* species reduce water availability in catchments for municipal areas (Richardson et al., 1997; Wells et al., 1986). Reduces access for firefighters (van Wilgen and Richardson, 1985). Despite multiple references, using "low" uncertainty because it is difficult to determine how much *H. sericea* alone is contributing to this impact.
Imp-A2 (Changes or limits recreational use of an area)	y - negl	0.1	Obstructs access and vision (van Wilgen and Richardson, 1985; Wells et al., 1986). Has prickly, needle-like leaves that are 1 mm thick and restrict access to mountains (CABI, 2012). "Reduces the aesthetic, recreational and scientific value of the indigenous plant communities" (cited in Kluge and Neser, 1991).
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	n - low	0	No evidence. Because this species is relatively well known and documented, using "low" uncertainty.
Imp-A4 (Weed status in anthropogenic systems)	c - high	0.4	Ruderal, industrial (tourist) weed (Wells et al., 1986). One of the weeds targeted for removal under the working for water program of South Africa (CABI, 2012). While it is clear this species is considered an anthropogenic weed and is controlled for its impact on water availability, the importance of these impacts relative to those in natural systems in motivating control is not clear. For this reason using high uncertainty. Both alternate answers for the Monte Carlo simulation were "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	y - mod	0.4	Replaces preferred vegetation (grass) and is unpalatable (Wells et al., 1986). Leaves are unpalatable (CABI, 2012). "*H[akea] sericea* poses a threat to the US$40 million industry exporting ornamental *Protea* spp. from South Africa" because it replaces wildflowers important for the cut flower industry (CABI, 2012). 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). Because most of this evidence appears anecdotal, using "mod" uncertainty, despite the number of references.
Imp-P2 (Lowers commodity value)	n - high	0	No evidence.
Imp-P3 (Is it likely to impact trade)	n - mod	0	Declared category 1 weed in South Africa; category 1 weeds are prohibited and must be controlled and eradicated whenever possible (Henderson, 2001; Macdonald et al., 2003). However, no evidence that it can follow a pathway, other than as an

Question ID	Answer - Uncertainty	Score	Notes (and references)
			intentionally introduced plant.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	? - max		Unknown. This plant "significantly increases water loss" (Wells et al., 1986) in fynbos vegetation, and reduces runoff in mountain catchments (Le Maitre, 1996; Le Maitre et al., 2002). It may have these impacts in agricultural areas or catchments supplying water to these areas, but so far there is no evidence of this.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - low	0	No evidence (Burrows and Tyrl, 2001) and well studied.
Imp-P6 (Weed status in production systems)	b - high	0.2	A few sources indicate or suggest this is a weed of pasture (Wells et al., 1986) or agriculture (Holm et al., 1979; Randall, 2007). One source states it is controlled in South African rangelands using integrated control strategies (Haysom and Murphy, 2003); however, these authors do not define what they consider to be rangelands. *Hakea sericea* invades fynbos, which is of little agricultural value, except for the cut flower industry (Kluge and Neser, 1991). This species primarily impacts natural systems, human access, and water availability (CABI, 2011). Answering "b" but with “high” uncertainty as there is no other evidence indicating this species is a production system weed. Alternate answers for the Monte Carlo simulation are "a" and "c."
GEOGRAPHIC POTENTIAL			
Plant cold hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	No evidence.
Geo-Z2 (Zone 2)	n - negl	N/A	No evidence.
Geo-Z3 (Zone 3)	n - negl	N/A	No evidence.
Geo-Z4 (Zone 4)	n - negl	N/A	No evidence.
Geo-Z5 (Zone 5)	n - negl	N/A	No evidence.
Geo-Z6 (Zone 6)	n - negl	N/A	No evidence.
Geo-Z7 (Zone 7)	n - low	N/A	No evidence.
Geo-Z8 (Zone 8)	y - low	N/A	Point data: Australia capital territory, Portugal (GBIF, 2012).
Geo-Z9 (Zone 9)	y - negl	N/A	Point data: Australia, New Zealand, Portugal (GBIF, 2012), South Africa (Henderson, 2001). Suitable for cultivation in this zone (Page and Olds, 2001). The mean minimum temperature of the coldest month of where it occurs is -1 to 7 ˚C (Anonymous, 2011).
Geo-Z10 (Zone 10)	y - negl	N/A	Point data: Australia, New Zealand, Portugal (GBIF, 2012), South Africa (Henderson, 2001). Suitable for cultivation in this zone (Page and Olds, 2001).
Geo-Z11 (Zone 11)	y - low	N/A	Point data: South Africa (a few points; Henderson, 2001). Suitable for cultivation in this zone (DavesGarden, 2011).
Geo-Z12 (Zone 12)	n - low	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 - negl	N/A	Point data: South Africa (Henderson, 2001).
Geo-C4 (Desert)	y - high	N/A	Point data: Australia (1 pt., Anonymous, 2011).
Geo-C5 (Mediterranean)	y - negl	N/A	Point data: Australia (Anonymous, 2011), Portugal (GBIF, 2012), France (EPPO, 2011), South Africa (Henderson, 2001). Reported

Question ID	Answer - Uncertainty	Score	Notes (and references)
			to occur in this climate based on a biocontrol study (Gordon, 1993b).
Geo-C6 (Humid subtropical)	y - low	N/A	Point data: Australia (GBIF, 2012), South Africa (Henderson, 2001).
Geo-C7 (Marine west coast)	y - negl	N/A	Point data: Australia (GBIF, 2012), New Zealand (GBIF, 2012), South Africa (Henderson, 2001).
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)	y - mod	N/A	Point data: Australia (1 pt. on edge; Anonymous, 2011). Lower annual limit of 200 mm for rainfall (CABI, 2011).
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	Point data: Australia (GBIF, 2012), South Africa (Henderson, 2001).
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	Point data: Australia (GBIF, 2012), Portugal (GBIF, 2012), South Africa (Henderson, 2001). Mean annual rainfall 65-250cm (Anonymous, 2011).
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	Point data: Australia, Portugal (GBIF, 2012).
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	Point data: Australia, New Zealand, Portugal (GBIF, 2012).
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	Point data: New Zealand (GBIF, 2012).
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	Point data: New Zealand (GBIF, 2012). Occurs in South Africa in areas receiving 1700 mm rainfall annually (Gordon, 1993b).
Geo-R8 (70-80 inches; 178-203 cm)	y - mod	N/A	Point data: New Zealand (2 pts. near) (GBIF, 2012)
Geo-R9 (80-90 inches; 203-229 cm)	n - high	N/A	No evidence. Answering no because there are no reports that it grows in these areas.
Geo-R10 (90-100 inches; 229-254 cm)	n - high	N/A	No evidence. Answering no because there are no reports that it grows in these areas, other than two references that state it grows in areas receiving a mean annual rainfall in this range (Anonymous, 2011; CABI, 2011).
Geo-R11 (100+ inches; 254+ cm)	n - high	N/A	No evidence. Answering no because there are no reports that it grows in these areas, other than CABI (2011).states an upper annual limit of 3000 mm for rainfall.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	Species cultivated in the United States (Bailey and Bailey, 1976; Cal-IPC, 2008; Donaldson et al., 1983; FAO, 2003); however, it is not known to what extent. It is probably not widely cultivated as it is not listed by Dave's Garden (2011) or Dirr (1998). No nurseries were found selling it in a search of Backyard Gardener's "Plant Finder" database (Backyard Gardener, 2011). This species has been in the United States since at least 1930 (Bailey and Bailey, 1930) and is not known to have naturalized (Kartesz, 2012; NRCS, 2012; UC, 2011).
Ent-2 (Plant proposed for entry, or entry is imminent)	-	N/A	

Question ID	Answer - Uncertainty	Score	Notes (and references)
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	