Weed Risk Assessment for *Hakea salicifolia* (Vent.) B. L. Burtt. (Proteaceae) – Finger hakea

United States Department of Agriculture

Animal and Plant Health Inspection Service

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Version 1

Left: Habit of *H. salicifolia*. Right: Leaves and follicles of *H. salicifolia* (source of both images: Trevor James, http://www.nzflora.info/Index.html).

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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 salicifolia* (Vent.) B. L. Burtt. – Finger hakea**

Species Information

Family: Proteaceae

Initiation: On November 25, 2011, Al Tasker (PPQ, National Weeds Program Coordinator) asked the PERAL Weed Team to evaluate *Hakea salicifolia* for potential listing as a Federal Noxious Weed.

Foreign distribution: *Hakea salicifolia* is native to Australia in New South Wales and Queensland (NGRP, 2012). It has been introduced to Spain (Dana et al., 2002) and is naturalized in Portugal, New Zealand, South Africa, Swaziland, and elsewhere in Australia (Howell and Sawyer, 2006; NGRP, 2012; Randall, 2007; Ross and Walsh, 2003; SNTC, 2012; Teixeira et al., 2008).

U.S. distribution and status: This species is listed for retail in Ventura, California, by a nursery specializing in Australian plants (O'Connell, 2012). We do not know when it was first introduced to the United States for cultivation, but if the "*Hakea saligna*" listed in *Hortus* (Bailey and Bailey, 1930) is a synonym of *H. salicifolia* (ANBG, 2012), then this species has been in the United States since at least 1930. It appears to be rarely cultivated here and is not known to have naturalized in the United States (Kartesz, 2012).

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

1. *Hakea salicifolia* analysis

Establishment/Spread Potential *Hakea salicifolia* is a large shrub or small tree that can form dense populations (Williams, 1992). It produces wind-dispersed seeds that are released from an aerial seed bank after fire, but some are also released continuously from the canopy (Richardson et

[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).

al., 1987; Williams, 1992). Because *H. salicifolia* is cultivated as a hedge plant (Anonymous, 2008; Marchante et al., 2005), some seeds may likely be dispersed unintentionally by people discarding yard waste. In New Zealand, it spread across several thousand acres in a national park (McQueen, 1993; Williams, 1992). In Portugal, it is one of the most invasive and aggressive species (Marchante et al., 2005). Yet, in South Africa, where other invasive *Hakea* species exist, *H. salicifolia* has not become a significant invader (Richardson et al., 1987). *Hakea salicifolia* does not possess any other traits that suggest a high capacity for establishment and spread, and it earned a moderate score here because of its behavior elsewhere. We had an average amount of uncertainty associated with this risk element.
Risk score = 5 Uncertainty index = 0.13

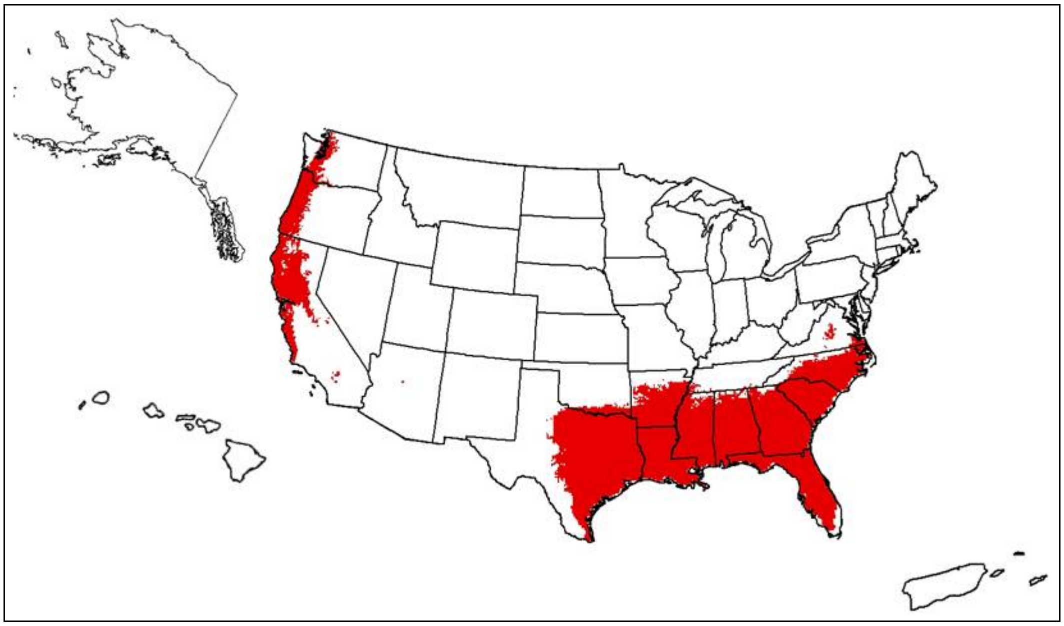
Impact Potential We found little evidence of harm caused by *H. salicifolia*. In Australia it replaces native vegetation in invaded areas (The University of Queensland, 2012), and it is an environmental weed in New Zealand (The University of Queensland, 2012) which is being controlled in some (but not all) places (Wotherspoon and Wotherspoon, 2002). Although it can convert open scrubland into closed scrub thickets, most populations of *H. salicifolia* in a New Zealand national park are being replaced by native plants, and for that reason it is not being controlled (Williams, 1992). We had an average level of uncertainty with this risk element.
Risk score = 2.1 Uncertainty index = 0.14

Geographic Potential Based on three climatic variables, we estimate that about 15.7 percent of the United States is suitable for the establishment of *H. salicifolia* (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. salicifolia* represents the joint distribution of Plant Hardiness Zones 8-11, areas with 20-70 inches of annual precipitation, and the following Köppen-Geiger climate classes: mediterranean, humid subtropical, and marine west coast. We are uncertain about whether or not *H. salicifolia* can survive in hardiness zone 8. We answered "yes" in the assessment (Appendix A) because it occurred on the edge of this zone in a few places in Australia and New Zealand (GBIF, 2012), and because a gardening forum indicated it was hardy to zone 8 (DavesGarden, 2012).

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. Also, *H. salicifolia* is likely to only be able to survive in the warmer regions of zone 8.

Entry Potential We did not assess *H. salicifolia*'s entry potential because this species is already present in the United States (O'Connell, 2012).

Figure 1. Predicted distribution of *Hakea salicifolia* 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) = 15.5%
P(Minor Invader) = 70.3%
P(Non-Invader) = 14.1%

Risk Result = Evaluate Further

Secondary Screening = High Risk

Figure 2. *Hakea salicifolia* 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.

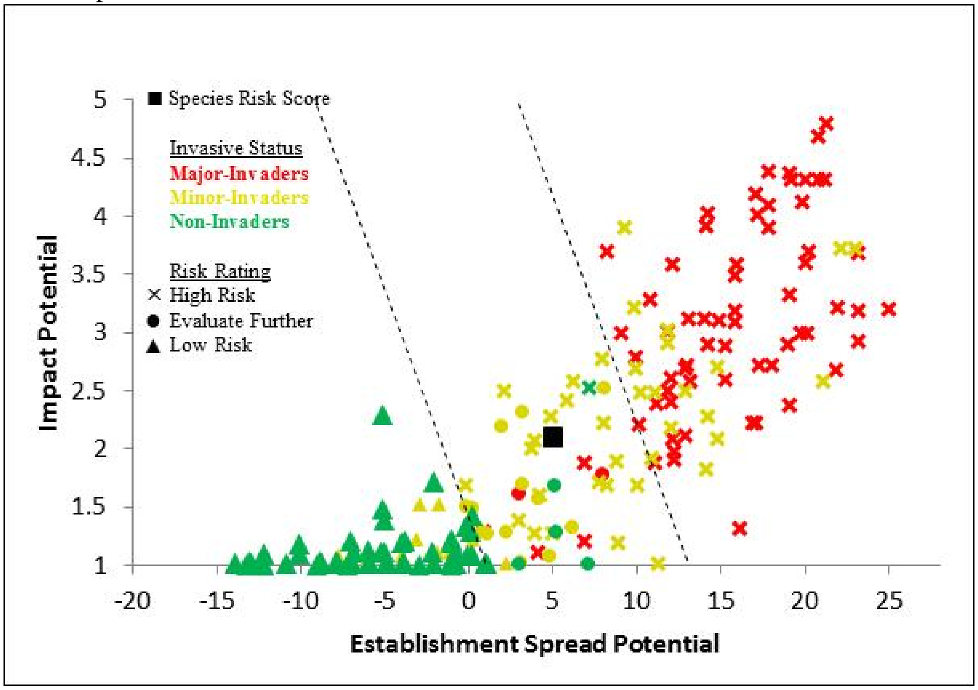
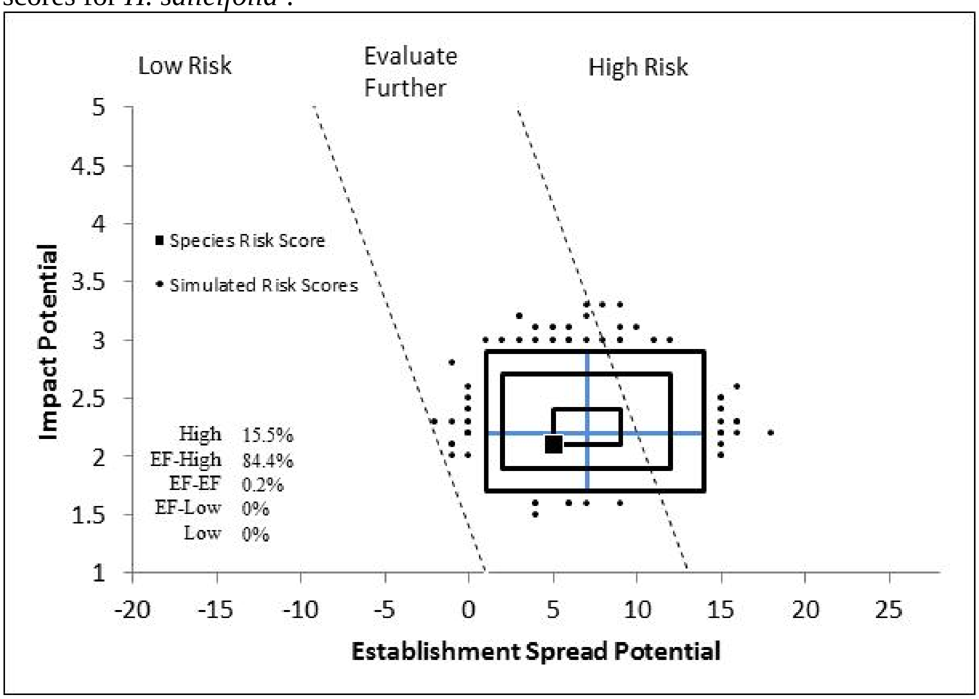


Figure 3. Monte Carlo simulation results (N=5,000) for uncertainty around the risk scores for *H. salicifolia*[a].



[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. salicifolia* was "Evaluate Further" (Fig. 2) but because this species has demonstrated an ability to be invasive elsewhere (naturalized and spreading), our secondary screening tool gave a final determination of "High Risk." Evaluations with four other weed risk assessment systems have resulted in similar conclusions. Analysis with the Parker system (Parker et al., 2007) and the Weber and Gut system (Andreu and Vila 2010) resulted in moderate risk scores, while analysis with the Tucker and Richardson system for South Africa (Tucker and Richardson, 1995) and the Australian WRA for Hawaii (University of Hawaii, 2012) resulted in high risk scores. In our uncertainty simulation, 84.4 percent of the simulated risk scores initially resulted in determinations of "Evaluate Further" and were later classified as "High Risk" following secondary screening (Fig. 3).

Given its risk rating and potentially long history in the United States (see *H. saligna* in Bailey and Bailey, 1930), it is puzzling that *H. salicifolia* has not yet naturalized in the United States, particularly in the mediterranean climate of California. Some possible explanations include the following: 1) minor cultivation has limited its opportunities to escape; 2) seed predators here 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.

4. Literature Cited

7 U.S.C. § 1581-1610. 1939. The Federal Seed Act, Title 7 United States Code § 1581-1610.

7 U.S.C. § 7701-7786. 2000. Plant Protection Act, Title 7 United States Code § 7701-7786.

ANBG. 2012. Australian Plant Names Index (online database). Australian National Botanic Gardens (ANBG). http://www.anbg.gov.au/cpbr/databases/apni-search-full.html. (Archived at PERAL).

Andreu, J., and M. Vila 2010. Risk analysis of potential invasive plants in Spain. Journal for Nature Conservation 18(1):34-44.

Anonymous. 2008. Weeds and invasive plants in the Karoo and Garden Route. Southern Africa Plant Invaders Atlas 9:2-2. Last accessed June 28, 2011, http://www.arc.agric.za/home.asp?pid=1&toolid=2&sec=1001.

Bailey, L. H., and E. Z. Bailey. 1930. Hortus: A Concise Dictionary of Gardening, General Horticulture and Cultivated Plants in North America. The MacMillan Company, New York. 352 pp.

Burrows, G. E., and Tyrl. 2001. Toxic Plants of North America. Iowa State University Press, Ames, IA. 1342 pp.

Butz Huryn, V. M., and H. Moller. 1995. An assessment of the contribution of honey bees (*Apis mellifera*) to weed reproduction in New Zealand protected natural areas. New Zealand Journal of Ecology 19(2):111-122.

Dana, E. D., M. Sanz-Elorza, and E. Sobrino. 2002. Plant invaders in Spain (checklist): The unwanted citizens. University of Almeria, Department of Plant Biology and Ecology. Last accessed http://www.ual.es/personal/edana/alienplants/.

DavesGarden. 2012. Plant files database. Dave's Garden.

http://davesgarden.com/guides/pf/go/1764/. (Archived at PERAL).
EPPO. 2006. Invasive plant species in Portugal: An overview. European and Mediterranean Plant Protection Organization (EPPO). Last accessed December 17, 2012, http://gd3.eppo.int/reporting.php/article973.
GBIF. 2012. GBIF, Online Database. Global Biodiversity Information Facility (GBIF). http://data.gbif.org/welcome.htm. (Archived at PERAL).
Groom, P. K. 2010. Implications of terminal velocity and wing loading on hakea (Proteaceae) seed dispersal [Abstract]. Journal of the Royal Society of Western Australia 93(4):175-179.
Groves, R. H., R. Boden, and W. M. Lonsdale. 2005. Jumping the garden fence: Invasive garden plants in Australia and their environmental and agricultural impacts. CSIRO, Australia. 173 pp.
Heap, I. 2012. The international survey of herbicide resistant weeds. Weed Science Society of America. www.weedscience.com. (Archived at PERAL).
Heide-Jorgensen, H. S. 2008. Parasitic Flowering Plants. Brill, Leiden, The Netherlands. 438 pp.
Henderson, L. 2001. Alien weeds and invasive plants: A complete guide to declared weeds and invaders in South Africa. Agricultural Research Council, South Africa. 300 pp.
Holm, L. G., J. V. Pancho, J. P. Herberger, and D. L. Plucknett. 1979. A Geographical Atlas of World Weeds. Krieger Publishing Company, Malabar, FL. 391 pp.
Howell, C. J., and J. W. D. Sawyer. 2006. New Zealand naturalised vascular plant checklist. New Zealand Plant Conservation Network, Wellington, New Zealand. 60 pp.
IPPC. 2012. International Standards for Phytosanitary Measures No. 5: Glossary of Phytosanitary Terms. Food and Agriculture Organization of the United Nations, Secretariat of the International Plant Protection Convention (IPPC), Rome, Italy.
Kartesz, J. 2012. The Biota of North America Program (BONAP). North American Plant Atlas. http://www.bonap.org/MapSwitchboard.html. (Archived at PERAL).
Koop, A., L. Fowler, L. Newton, and B. Caton. 2012. Development and validation of a weed screening tool for the United States. Biological Invasions 14(2):273-294.
Lamont, B. B., J. M. Olesen, and P. J. Briffa. 1998. Seed production, pollinator attractants and breeding system in relation to fire response - Are there reproductive syndromes among co-occurring proteaceous shrubs? Australian Journal of Botany 46(3-4):377-385.
Le Maitre, D. C., W. Thuiller, and L. Schonegevel. 2008. Developing an approach to defining the potential distributions of invasive plant species: A case study of *Hakea* species in South Africa. Global Ecology and Biogeography 17(5):569-584.
Macdonald, I. A. W., J. K. Reaser, C. Bright, L. E. Neville, G. W. Howard, S. J. Murphy, and G. Preston. 2003. Invasive alien species in southern Africa: National reports & directory of resources. The Global Invasive Species Programme, Cape Town, South Africa. 125 pp.
Marchante, H., E. Marchante, and H. Freitas. 2005. Invasive plant species in Portugal: an overview. Pages 99-103 *in* S. Brunel, (ed.). International Workshop on Invasive Plants in Mediterranean Type Regions of the World. Council of Europe Publishing, Mèze, France.

Martin, P. G., and J. M. Dowd. 1990. A protein sequence study of the dicotyledons and its relevance to the evolution of the legumes and nitrogen fixation. Australian Systematic Botany 3:91-100.

Mast, A. R., E. F. Milton, E. H. Jones, R. M. Barker, W. R. Barker, and P. H. Weston. 2012. Time-calibrated phylogeny of the woody Australian genus *Hakea* (Proteaceae) supports multiple origins of insect-pollination among bird-pollinated ancestors. American Journal of Botany 99(3):472-487.

McQueen, D. R. 1993. A review of interaction between naturalised woody plants and indigenous vegetation in New Zealand. Tuatara 32:32-56.

Nel, J. L., D. M. Richardson, M. Rouget, T. N. Mgidi, N. Mdzeke, D. C. Le Maitre, B. W. L. S. van Wilgen, L. Henderson, and S. Neser. 2004. A proposed classification of invasive alien plant species in South Africa: Towards prioritizing species and areas for management action. South African Journal of Science 100:53-64.

NGRP. 2012. Germplasm Resources Information Network (GRIN). United States Department of Agriculture, Agricultural Research Service, National Genetic Resources Program (NGRP). http://www.ars-grin.gov/cgi-bin/npgs/html/index.pl?language=en. (Archived at PERAL).

Nickrent, D. 2009. Parasitic plant classification. Southern Illinois University Carbondale, Carbondale, IL. Last accessed June 12, 2009, http://www.parasiticplants.siu.edu/ListParasites.html.

O'Connell, J. 2012. Nursery catalogue. Australian Native Plants Nursery. Last accessed December 14, 2012, http://www.australianplants.com/default.aspx.

Parker, C., B. P. Caton, and L. Fowler. 2007. Ranking nonindigenous weed species by their potential to invade the United States. Weed Science 55:386-397.

Randall, J. M. 2007. The Introduced Flora of Australia and its Weed Status. CRC for Australian Weed Management, Department of Agriculture and Food, Western Australia, Australia. 528 pp.

Richardson, D. M., B. W. V. Wilgen, and D. T. Mitchell. 1987. Aspects of the reproductive ecology of four Australian *Hakea* species (Proteaceae) in South Africa. Oecologia 71(3):345-354.

Richardson, F. J., R. G. Richardson, and R. C. H. Shepherd. 2006. Weeds of the South-east: An Identification Guide for Australia. R. G. and F.J. Richardson,, Meredith, Victoria, Australia. 438 pp.

Ricketts, T. H., E. Dinerstein, D. M. Olson, C. J. Loucks, W. Elchbaum, D. DellaSala, K. Kavanagh, P. Hedao, P. T. Hurley, K. M. Carney, R. Abell, and S. Walters. 1999. Terrestrial Ecoregions of North America: A Conservation Assessment. Island Press, Washington D.C. 485 pp.

Ross, J. H., and N. G. Walsh. 2003. A Census of the Vascular Plants of Victoria (7th edition). National Herbarium of Victoria, Royal Botanic Gardens, South Yarra, Victoria, Australia. 280 pp.

SNTC. 2012. Swaziland's alien plants database (online database). Swaziland National Trust Commission (SNTC). (Archived at PERAL).

Starr, G. J., and S. M. Carthew. 1998. Genetic differentiation in isolated populations of *Hakea carinata* (Proteaceae). Australian Journal of Botany 46(5-6):671-682.

Teixeira, G., A. Monteiro, and C. Pepo. 2008. Leaf morphoanatomy in *Hakea sericeae* and *H. salicifolia*. Microscopy and Microanalysis 14(SUPPL. 3):109-110.

The University of Queensland. 2012. Weeds of Australia (Online Database).

Queensland Government. http://keyserver.lucidcentral.org/weeds/data/03030800-0b07-490a-8d04-0605030c0f01/media/Html/Index.htm. (Archived at PERAL).

Tucker, A. O., A. J. Redford, J. Scher, and M. D. Trice. 2010. Dried Botanical ID. Delaware State University, Identification Technology Program; United States Department of Agriculture, Center for Plant Health Science and Technology, Fort Collins, CO. Last accessed December 17, 2012, http://idtools.org/id/dried_botanical.

Tucker, K. C., and D. M. Richardson. 1995. An expert system for screening potetially invasive alien plants in South African fynbos. Journal of Environmental Management 44:309-338.

University of Hawaii. 2012. Hawai‘i Pacific Weed Risk Assessment. University of Hawaii. Last accessed December 5, 2012, https://sites.google.com/site/weedriskassessment/home.

Weber, E. 2003. Invasive Plant Species of the World: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK. 548 pp.

Wells, M. J., V. M. Balsinhas, H. Joffe, V. M. Engelbrecht, G. Harding, and C. H. Stirton. 1986. A Catalogue of Problem Plants in Southern Africa Incorporating The National Weed List of South Africa. Memoirs of the Botanical Survey of South Africa 53.

Williams, P. A. 1992. *Hakea salicifolia*: Biology and role in succession in Abel Tasman National Park, New Zealand. Journal - Royal Society of New Zealand 22(1):1-18.

Wotherspoon, S. H., and J. A. Wotherspoon. 2002. The evolution and execution of a plan for invasive weed eradication and control on an island, Rangitoto Island, Hauraki Gulf, New Zealand. Pages 381-388 *in* C. R. Veitch and M. N. Clout, (eds.). Turning the Tide: The Eradication of Invasive Species. IUCN SSC Invasive Species Specialist Group., Gland, Switzerland, and Cambridge, UK.

Appendix A. Weed risk assessment for *Hakea salicifolia* (Vent.) B. L. Burtt. (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 eastern Australia in New South Wales and Queensland (NGRP, 2012). Introduced to Spain (Dana et al., 2002). Naturalized in Portugal, New Zealand, South Africa, Swaziland, southern Europe, and elsewhere in Australia (Howell and Sawyer, 2006; NGRP, 2012; Randall, 2007; Ross and Walsh, 2003; SNTC, 2012; Teixeira et al., 2008). Used extensively as a hedge plant in South Africa, but shows no evidence of spreading into natural vegetation (Richardson et al., 1987). Naturalized in Victoria and South Australia, Australia (Groves et al., 2005; The University of Queensland, 2012). Invasive in northern Australia and New Zealand; the term "invasive" implies spread in this reference (Weber, 2003). Spreading by seed, but the source is not clear if it is from established plants or from naturalized populations (Anonymous, 2008). One of the most invasive and aggressive invasive species in Portugal (Marchante et al., 2005). Spreading, or at least historically has spread, in a national park in New Zealand to cover several thousand acres (McQueen, 1993; Williams, 1992). Both alternate choices for the Monte Carlo simulation were "e."
ES-2 (Is the species highly domesticated)	n - low	0	Although this species is cultivated, there is no evidence it has been domesticated to reduce weed traits. Cultivated in Australia (Groves et al., 2005). Commonly planted ornamental, windbreak, and hedge tree (Anonymous, 2008; Marchante et al., 2005). Introduced as a hedge plant to New Zealand (Williams, 1992). The cultivar 'Gold Medal' is available in the United States, along with the regular species (O'Connell, 2012).
ES-3 (Weedy congeners)	y - negl	1	*Hakea sericea* and *H. gibbosa* are major weeds 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 - high	0	Light-dependent species that relies on canopy disturbance to establish (Weber, 2003). Populations do not regenerate under closed-canopy conditions; however, seedlings are reported to be shade tolerant (Williams, 1992). Although shade tolerance of seedlings supports an answer of "yes" based on the question-specific guidance, answering "no" based on the comments that this species requires canopy disturbance to regenerate. Using "high" uncertainty because it is not clear whether the shade tolerance of seedlings is due to inherent tolerance or lingering reserves in the cotyledons.
ES-5 (Climbing or smothering growth form)	n - negl	0	Erect shrub growing to 4-6 meters tall (Richardson et al., 2006; Weber, 2003; Williams, 1992).
ES-6 (Forms dense thickets)	y - low	2	Forms dense stands (Weber, 2003). In a New Zealand national park, "*H. salicifolia* now forms dense pure stands" with up to 0.8 stems per square meter (Williams, 1992). In a study comparing

Question ID	Answer - Uncertainty	Score	Notes (and references)
			four species of exotic *Hakea* in South Africa, the authors found that this species does not form dense thickets in South Africa (Richardson et al., 1987). Answering "yes" based on its behavior in New Zealand, where climatic conditions may be more suitable for its survival (Williams, 1992).
ES-7 (Aquatic)	n - negl	0	Species is a terrestrial shrub (Richardson et al., 2006; Weber, 2003; Williams, 1992), not an aquatic.
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	Regenerates from seed in naturalized populations (Williams, 1992). Because this information came from a detailed community/population study of this species, using "negl" uncertainty.
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-compatible, while *H. cristata* strongly preferred non-self-pollen (Lamont et al., 1998).
ES-12 (Requires special pollinators)	n - low	0	Insect pollinated (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)	d - low	-1	Juvenile period is four years (Richardson et al., 1987). Both alternate answers for the Monte Carlo simulation are "c."
ES-14 (Prolific reproduction)	n - low	-1	Like other *Hakea* species, *H. salicifolia* retains fruit (follicles) in the canopy until it is killed by a fire. In dense stands, where plants are typically single-stemmed, trees have a canopy width of about 2-4 meters, while in isolated individuals canopies measure up to 6 meters in width (Williams, 1992). In more open sites, individuals are multi-stemmed and branches arch outwards forming a dome (Williams, 1992). "Bushes commonly have about 1,000 follicles by the time they reach 5-10 cm stem diameter at perhaps 10 years, and 13,000 at 15-20 cm diameter at perhaps 30 years" (Williams, 1992). Assuming plants begin reproducing at four years of age, then plants produce from 166 to 500 follicles per year per square meter. Because each follicle has 2 seeds Weber, 2003), then this estimate represents 332 to 1000 seeds per year per square meter. However, this does not account for the size of the canopy, which is more than 1 square meter. Thus, it seems unlikely that *H. salicifolia* has prolific reproduction. Other data: This species does not produce as much seed as *H. sericea* (Richardson et al., 1987). Seed viability is 100 perfect in young follicles and 92 percent in old follicles (Williams, 1992). Dense stands with up to 0.8 stems per square meter support up to 500-600 closed follicles per square meter, where follicles contain two seeds each (Williams, 1992), but this represents production over the plants life time.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - high	1	This species is cultivated as a hedge and windbreak tree (Anonymous, 2008; Marchante et al., 2005). Because hedges are pruned periodically, and because seed-bearing follicles are retained in the canopy (Williams, 1992), seeds will likely be spread as cuttings are discarded in local brush dumps or other refuse areas.
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	n - high	-1	Seed pods of *H. salicifolia* are used in potpourri material (Tucker et al., 2010), but it is unknown whether seeds remain viable after the addition of dyes and fragrances. Because it does not seem likely that most potpourri will be disposed outside in compost after use, and because it seems unlikely seeds would contaminate any other pathway, answering "no" with "high" uncertainty. A
ES-17 (Number of natural dispersal vectors)	1	-2	For questions ES17a-ES17e: Fruits are tardily dehiscent, woody follicles of about 3 cm length opening with two valves; each fruit contains two winged seeds of 15-20 mm length and 5-7 mm width (Weber, 2003)
ES-17a (Wind dispersal)	y - negl		This species has winged seeds that facilitate dispersal by wind (Richardson et al., 1987). Winged seeds are "presumably dispersed by wind" (Williams, 1992). *Hakea* species are wind-dispersed (Groom, 2010).
ES-17b (Water dispersal)	n - low		No evidence; this species is clearly adapted for wind dispersal.
ES-17c (Bird dispersal)	n - mod		No evidence.
ES-17d (Animal external dispersal)	n - mod		No evidence.
ES-17e (Animal internal dispersal)	n - mod		No evidence.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	y - negl	1	Some seeds are released from the canopy over time, but most are retained in a serotinous seed bank (Richardson et al., 1987; Williams, 1992). "It does not require fire to release seed from its fruits (follicles) and appears to like moist sites. In its native Australia it grows in wet sclerophyll forest and edges of rainforest—similar habitats are abundantly available" (Anonymous, 2008). No soil seed bank detected (Williams, 1992).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	n - mod	-1	May regenerate some from stem bases after fire (Richardson et al., 1987), but there is no indication or evidence that it regenerates significantly more so than most other plant species. Canopy stored seeds are killed in fire (Richardson et al., 1987).
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - low	0	No evidence and not listed by Heap (2012). Herbicide applications to cut stumps are recommended (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)	3	0	
ES-23 (Number of precipitation bands suitable for its survival)	5	0	
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)	n - low	0	Evidence from a national park in New Zealand suggests that this species does not alter ecosystem properties or processes; in most sites it appears to be succumbing to natural succession dynamics (Williams, 1992). In New Zealand, it does not appear to have affected the fire regime (Williams, 1992).
Imp-N2 (Change community structure)	y - mod	0.2	Aerial photographs from several time periods show it is invading open scrub sites in a New Zealand national park and is creating a closed scrub community (Williams, 1992). We consider a change from an open to closed community to be a change in the structure of a habitat.
Imp-N3 (Change community composition)	y - low	0.2	Reduces species richness and eliminates natural vegetation (Weber, 2003). Infestations replace native vegetation in areas where it is exotic in Australia (The University of Queensland, 2012).
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	y - mod	0.1	Because this species impacts native species in Australia (The University of Queensland, 2012) and can invade natural systems (Williams, 1992), it is likely to affect threatened and endangered species in the United States.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions)	n - high	0	In a New Zealand national park, "*H. salicifolia* now forms dense pure stands" with up to 0.8 stems per square meter (Williams, 1992). In all but the habitats with the thinnest soils, it is being replaced by native vegetation (Williams, 1992). This species has the potential to establish in U.S. systems recognized to be globally outstanding ecoregions (Ricketts et al., 1999). However, its behavior in New Zealand indicates most native vegetation is replacing it (Williams, 1992). Furthermore, in South Africa, where other *Hakea* species have become invasive and caused harm, this species has not been problematic or spread to any great extent (Le Maitre et al., 2008; Richardson et al., 1987).
Imp-N6 (Weed status in natural systems)	c - low	0.6	Natural areas weed in Australia (Randall, 2007). Invades sand dunes in Portugal (Marchante et al., 2005). Significant environmental weed in Victoria, Australia (Groves et al., 2005). Control strategies are provided (Weber, 2003). Being controlled to zero adult density on a New Zealand island managed for biotic diversity (Wotherspoon and Wotherspoon, 2002). In some sites in a New Zealand park, it seems it is being replaced by native species through natural succession, but in open woodland and low scrub it is still invading and should probably be controlled in case a fire increases its dominance further; currently it is not being controlled in the park (Williams, 1992). Alternate answers for the Monte Carlo simulation are both "b."
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Impacts human property, processes, civilization, or safety)	n - mod	0	No evidence.
Imp-A2 (Changes or limits recreational use of an area)	n - mod	0	No evidence.
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and	n - mod	0	No evidence.

Question ID	Answer - Uncertainty	Score	Notes (and references)
vegetation)			
Imp-A4 (Weed status in anthropogenic systems)	a - high	0	In Australia, it is only regarded as an environmental weed (The University of Queensland, 2012). Invades disturbed lands in Portugal, but not specifically described as a weed (Marchante et al., 2005). Alternate answers for the Monte Carlo simulation are "b" and "c."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	n - mod	0	No evidence.
Imp-P2 (Lowers commodity value)	n - mod	0	No evidence.
Imp-P3 (Is it likely to impact trade)	n - mod	0	Proposed for legislation in South Africa (Macdonald et al., 2003). Regulated in Portugal (EPPO, 2006). But no evidence it is likely to a trade pathway.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - mod	0	No evidence.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - low	0	No evidence (Burrows and Tyrl, 2001).
Imp-P6 (Weed status in production systems)	a - low	0	No evidence it is considered a production system weed. Both alternate answers for the Monte Carlo simulation are "b."
GEOGRAPHIC POTENTIAL			Unless indicated otherwise, all determinations were based on geo-referenced occurrences from GBIF (2012).
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 - negl	N/A	No evidence.
Geo-Z8 (Zone 8)	y - high	N/A	A few points on edge in Australia and New Zealand. Hardy to zone 8 (DavesGarden, 2012).
Geo-Z9 (Zone 9)	y - negl	N/A	Australia. Hardy to zone 9 (DavesGarden, 2012).
Geo-Z10 (Zone 10)	y - negl	N/A	Australia.
Geo-Z11 (Zone 11)	y - negl	N/A	South Africa.
Geo-Z12 (Zone 12)	n - high	N/A	No evidence.
Geo-Z13 (Zone 13)	n - negl	N/A	No evidence.
Köppen-Geiger climate classes			
Geo-C1 (Tropical rainforest)	n - negl	N/A	No evidence.
Geo-C2 (Tropical savanna)	n - negl	N/A	No evidence.
Geo-C3 (Steppe)	n - high	N/A	One point on the edge in Australia.
Geo-C4 (Desert)	n - negl	N/A	No evidence.
Geo-C5 (Mediterranean)	y - negl	N/A	South Africa, Portugal.
Geo-C6 (Humid subtropical)	y - negl	N/A	South Africa, Australia.
Geo-C7 (Marine west coast)	y - negl	N/A	South Africa, Australia.
Geo-C8 (Humid cont. warm sum.)	n - negl	N/A	No evidence.

Question ID	Answer - Uncertainty	Score	Notes (and references)
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 - negl	N/A	No evidence.
Geo-R2 (10-20 inches; 25-51 cm)	n - high	N/A	One point on the edge in Australia.
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	South Africa, Australia.
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	South Africa, Swaziland, Australia.
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	Portugal, Australia.
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	New Zealand. Receiving 1380 mm of annual precipitation in Abel Tasman National Park in New Zealand (Williams, 1992).
Geo-R7 (60-70 inches; 152-178 cm)	y - negl	N/A	New Zealand.
Geo-R8 (70-80 inches; 178-203 cm)	n - high	N/A	No evidence.
Geo-R9 (80-90 inches; 203-229 cm)	n - negl	N/A	No evidence.
Geo-R10 (90-100 inches; 229-254 cm)	n - negl	N/A	No evidence.
Geo-R11 (100+ inches; 254+ cm))	n - negl	N/A	No evidence.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	Species is being grown and sold in Ventura California by a nursery specializing in Australian plants (O'Connell, 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	-	N/A	

Question ID	**Answer - Uncertainty**	**Score**	**Notes (and references)**
landscape products)			
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	Seed pods are used in potpourri (Tucker et al., 2010).
Ent-4i (Contaminant of some other pathway)	-	N/A	
Ent-5 (Likely to enter through natural dispersal)	-	N/A	