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Version 1

Weed Risk Assessment for *Dittrichia graveolens* (L.) Greuter (Asteraceae) – Stinkwort

Left: Small patch of D. graveolens in a field in California. Right: Flower heads and mature fruit (note, image number is 5374501) (source of both images: Joseph M. DiTomaso, University of California - Davis, Bugwood.org)

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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.

***Dittrichia graveolens* (L.) Greuter – Stinkwort**

Species Information

Family: Asteraceae

Synonyms: *Inula graveolens* (L.) Desf.; *Cupularia graveolens* (L.) Godr. & Gren.; *Erigeron graveolens* L.; (The Plant List, 2013). In the literature, this species often appears as *Inula graveolens*.

Initiation: On August 19, 2013, Hilda Diaz-Soltera, USDA Senior Invasive Species Coordinator, forwarded to APHIS a report that *Dittrichia graveolens* is spreading and posing a threat in California (Diaz-Soltero, 2013). We initiated this WRA to characterize this species' risk potential.

Foreign distribution: This species is native to southern Europe (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, France, Greece, Italy, Macedonia, Montenegro, Portugal, Serbia, Spain), northern Africa (Algeria, Libya, Morocco, and Tunisia), central Asia (Afghanistan, Cyprus, Iran, Israel, Jordan, Lebanon, Pakistan, Syria, Turkey), and tropical Asia (India) (NGRP, 2013). It has naturalized in Australia, Austria, Belgium, the Czech Republic, Egypt, Germany, the Netherlands, New Zealand, Slovenia, South Africa, Switzerland, and the United Kingdom (NGRP, 2013). It has likely been introduced into other areas.

U.S. distribution and status: *Dittrichia graveolens* is naturalized in the United States, particularly in California, where it is spreading along highways (DiTomaso, 2004). This species was first reported as a weed in Santa Clara County, California in 1984 and spread to 36 of 58 California counties by 2012 (Brownsey et al., 2013). Most of these occurrences are along the coast and in the north Central Valley (Kartesz, 2013). *Dittrichia graveolens* is also known to occur in one or two counties in each of the following states: Connecticut, New Jersey, New York, and South Carolina (Kartesz, 2013). Plants in South Carolina are located at a wool-processing mill (Nesom, 2004). Given the large number of occurrences of other Australian weeds at this site, this population was probably introduced from wool imports from Australia (Nesom, 2004). *Dittrichia graveolens* primarily occurs in disturbed areas, but concern exists that it will spread into rangelands and undisturbed areas such as grasslands and riparian corridors (Brownsey, 2013). It is already present in some conservation areas, but only in disturbed sites (Univ. of California, 2013).

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

1. *Dittrichia graveolens* analysis

Establishment/Spread Potential *Dittrichia graveolens* is an invasive annual herb that produces up to 71,000 seeds per plant (Brownsey, 2013). Since it was first discovered in California in 1984, it has spread rapidly through the state, particularly along highways (DiTomaso, 2004). This species is dispersed by wind and water (Parsons and Cuthbertson, 2001), and the barbs on the seed's pappus help it to attach to animal fur (Randall, 1999) and possibly feathers (Brownsey et al., 2013). *Dittrichia graveolens* contaminates vehicles and equipment (Moerkerk, 2006). It can also move in trade on hides and wool (Nesom, 2004; Parsons and Cuthbertson, 2001). Plants pulled out of the ground during the flowering stage may still be able to mature seed (Parsons and Cuthbertson, 2001). We had less than average uncertainty for this risk element.

Risk score = 20 Uncertainty index =0.14

Impact Potential *Dittrichia graveolens* is primarily a weed of disturbed lands, rangelands, and pastures. It produces aromatic oils that make it unpalatable to livestock (Philbey and Morton, 2000). Furthermore, because of the barbs on the pappus of the seeds, it leads to enteritis and other gastrointestinal disease in livestock (Schneider and du Plessis, 1980). Significant stock losses have been reported when animals have been forced to graze upon *D. graveolens* (Auld and Medd, 1987); 20 percent of a herd of sheep died after grazing on this species in Australia (Philbey and Morton, 2000). The oils in the plant also taint the meat and milk of animals that consume the plants (Auld and Medd, 1987; Everist, 1957; Parsons and Cuthbertson, 2001). Some people are allergic and develop severe dermatitis after contacting *D. graveolens* plants (Parsons and Cuthbertson, 2001; Thong et al., 2008). Thirty years after introduction to South Australia, *D. graveolens* was one of the worst weeds of cereals but it is no longer important because of a general increase in soil fertility (Parsons and Cuthbertson, 2001). *Dittrichia graveolens* is a declared noxious weed in Australia (DPI, 2013), and is under an eradication program in Queensland (Parsons and Cuthbertson, 2001). We had an average amount of uncertainty for this risk element.

Risk score = 3.2 Uncertainty index = 0.19

Geographic Potential Based on three climatic variables, we estimate that about 63 percent of the United States is suitable for the establishment of *D. graveolens* (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 *D. graveolens* represents the joint distribution of Plant Hardiness Zones 6-11, areas with 90 inches or less of annual precipitation, and the following Köppen-Geiger

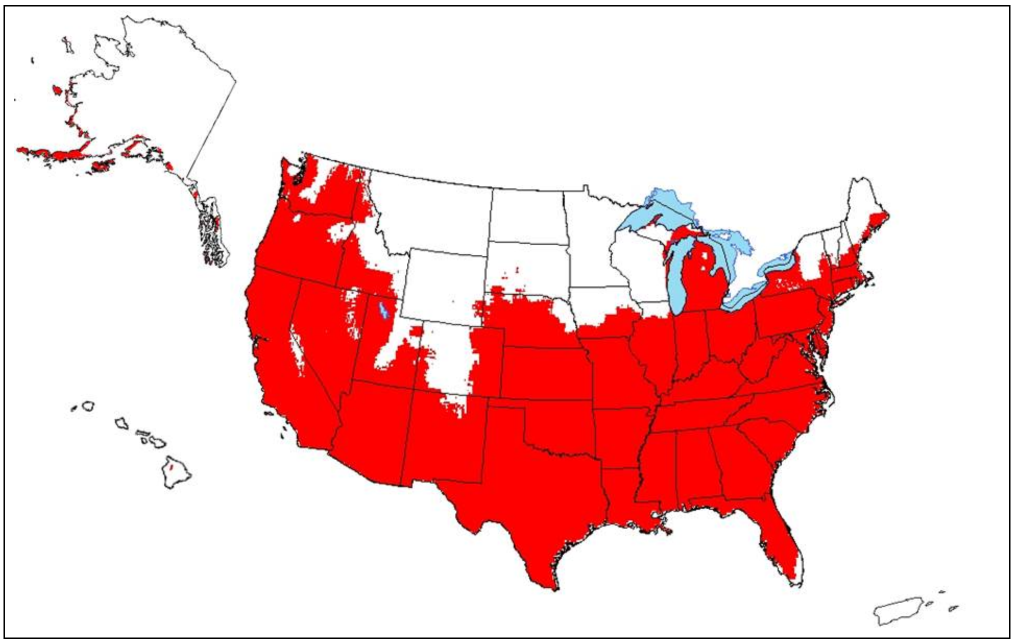
[1] "WRA area" is the area in relation to which the weed risk assessment is conducted [definition modified from that for "PRA area" (IPPC, 2012).

climate classes: steppe, desert, Mediterranean, humid subtropical, marine west coast, humid continental warm summers, humid continental cool summers, and subarctic.

The area estimated likely represents a conservative estimate as it only uses three climatic variables. Other environmental variables, such as soil and habitat type, may further limit the areas in which this species is likely to establish. *Dittrichia graveolens* primarily occurs in open habitats such as pastures, roadsides, fields, riparian woodlands, levees, washes (e.g., dry creek beds), waste ground, orchards, vernal pools, margins of tidal marshes, and other disturbed areas (Boulos, 2002; Brownsey et al., 2013; DiTomaso, 2004; DiTomaso and Healy, 2007; Qaiser and Abid, 2005).

Entry Potential We did not assess the entry potential of *Dittrichia graveolens* because this species is already present in the United States (Brownsey et al., 2013; Kartesz, 2013).

Figure 1. Predicted distribution of *Dittrichia graveolens* 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) = 92.4%
P(Minor Invader) = 7.3%
P(Non-Invader) = 0.2%

Risk Result = High Risk
Secondary Screening = Not Applicable

Figure 2. *Dittrichia graveolens* 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.

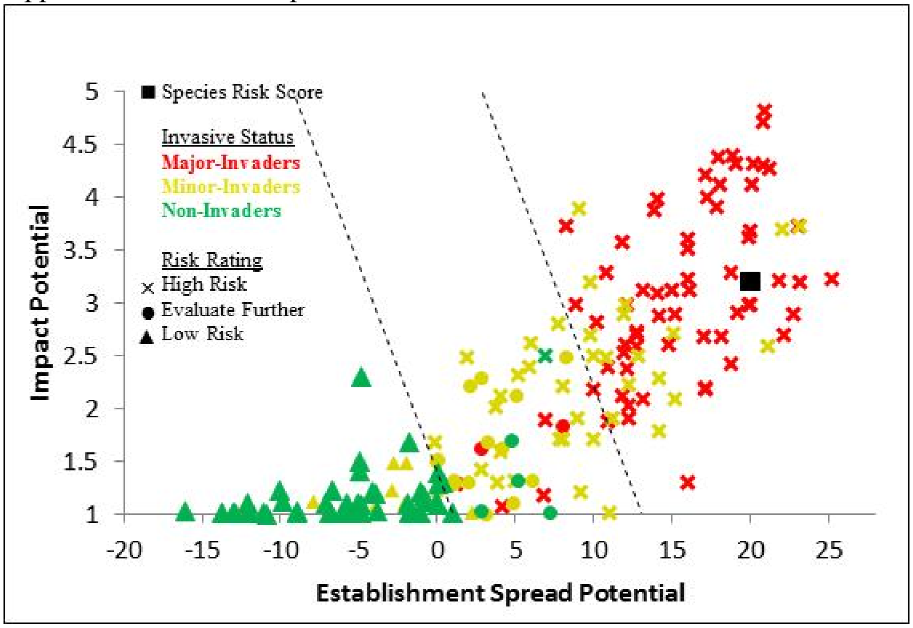
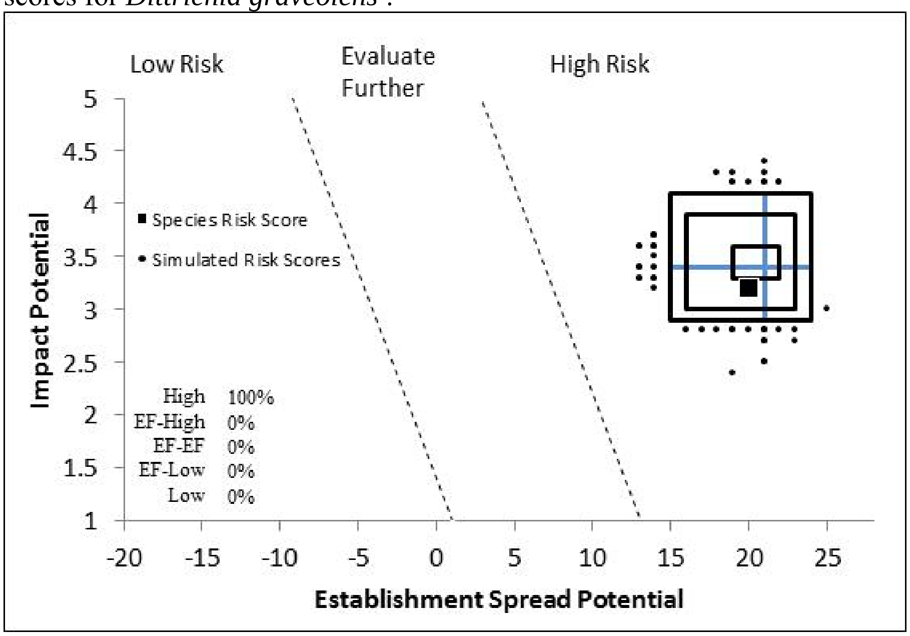


Figure 3. Monte Carlo simulation results (N=5,000) for uncertainty around the risk scores for *Dittrichia graveolens*[a].



[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 *D. graveolens* is High Risk (Fig. 2), which is supported by the results of our uncertainty analysis (Fig. 3). An analysis with the Australian weed risk assessment system resulted in a similar conclusion (Pheloung, 1995). Our assessment indicates *D. graveolens* is a highly invasive plant, a fact that is readily confirmed by its rapid spread in Australia (Parsons and Cuthbertson, 2001; Schomburgk, 1879) and in the United States in California (Brownsey et al., 2013). Its rate of spread in California over the last 18 years has concerned resource managers (Brownsey et al., 2013). A demographic analysis showed that the primary factor driving this species' invasion is its high fertility, that is the number of seeds are produced, germinate, and contribute to the next generation (Brownsey, 2013). For new populations where density-dependent mortality is not a significant factor, population growth rates are likely to be very high (Brownsey, 2013).

The ability of *D. graveolens* to invade undisturbed wildlands and rangelands is not very clear. Research done in the United States showed it develops its taproot several weeks later than other species with similar life histories, suggesting it may not be very competitive under drier conditions (Brownsey, 2013). In wetter environments where a deep taproot is not necessary (wetland) or where superior competitors are eliminated (overgrazed pastures), this species may become problematic (Brownsey et al., 2013). In Australia, though, *D. graveolens* is a significant weed of rangelands, as it withstands drought better than most other plants (Parsons and Cuthbertson, 2001).

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Appendix A. Weed risk assessment for *Dittrichia graveolens* (L.) Greuter (Asteraceae). The following information came from the original risk assessment, which is available upon request (full responses and all guidance). We modified the information to fit on the page.

Question ID	**Answer - Uncertainty**	**Score**	**Notes (and references)**
ESTABLISHMENT/SPREAD POTENTIAL			
ES-1 (Status/invasiveness outside its native range)	f - negl	5	This species is native to southern Europe, northern Africa, central Asia, and India (NGRP, 2013). It is a casual alien in Belgium, where it was introduced by horticulture (Verloove, 2006). Introduced to South Africa three centuries ago (Bamuamba et al., 2008) and now appears to be naturalized (GBIF, 2013). Recently recorded as naturalized in Egypt (Boulos, 2002). Introduced recently to Slovenia and Austria and spreading fast along highways (Frajman and Kaligarič, 2009). Naturalized in New Zealand (Howell and Sawyer, 2006). Rapidly spreading species in the United States in California (Brownsey et al., 2013; Cal-IPC, 2006; Hrusa et al., 2002). In Australia, it rapidly spread from the 1860s through the 1890s (Parsons and Cuthbertson, 2001). Alternate answers for the Monte Carlo simulation were both "e."
ES-2 (Is the species highly domesticated)	n - negl	0	This species is reported as cultivated (Randall, 2012), most likely for its use in natural/herbal medicines (Abu-Dahab and Afifi, 2007; Bamuamba et al., 2008; Parsons and Cuthbertson, 2001; Pieroni et al., 2006). We found no evidence it has been domesticated or bred for traits associated with reduced weed potential.
ES-3 (Weedy congeners)	n - mod	0	There are two species in the genus. The other species, *Dittrichia viscosa*, is also considered a weed (Hanf, 1983; Randall, 2007; Randall, 2012), but we found no evidence it is considered a significant weed.
ES-4 (Shade tolerant at some stage of its life cycle)	n - negl	0	*Dittrichia viscosa* is found in open, unshaded areas in Australia (Parsons and Cuthbertson, 2001). Greenhouse studies have shown that growth is dramatically decreased under lower light levels (Brownsey et al., 2013).
ES-5 (Climbing or smothering growth form)	n - negl	0	An herb 20-40 cm tall, profusely branching from the base (Brownsey et al., 2013; Hanf, 1983).
ES-6 (Forms dense thickets)	y - negl	2	"Forming dense masses on levee[s]" in a California natural area (Hrusa et al., 2002). Forms dense patches in Australia (Parsons and Cuthbertson, 2001). Can form dense infestations in disturbed sites and along highways (DiTomaso, 2004). Forms dense stands in overgrazed pastures in California (Brownsey et al., 2013). Forms dense stands in its native range during the dry season (Öztürk and Mert, 1983).
ES-7 (Aquatic)	n - negl	0	Species is a terrestrial herb (Parsons and Cuthbertson, 2001; Stace, 2010).
ES-8 (Grass)	n - negl	0	Species is not a grass; rather, it is an herb in the Asteraceae (Stace, 2010).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	Species is not woody; rather, it is an annual herb (Stace, 2010). Asteraceae species are not known to fix nitrogen (Martin and Dowd, 1990).

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-10 (Does it produce viable seeds or spores)	y - negl	1	Reproduces by seed (Brownsey et al., 2013; Parsons and Cuthbertson, 2001). Seed germination is limited by soil moisture and not temperature or light (Brownsey et al., 2013). Seed viability of freshly collected seeds is 90 percent (Brownsey et al., 2013).
ES-11 (Self-compatible or apomictic)	? - max	0	Unknown.
ES-12 (Requires special pollinators)	? - max		Unknown.
ES-13 (Minimum generation time)	b - negl	1	The life cycle of this annual herb (Hanf, 1983; Parsons and Cuthbertson, 2001) is described in Brownsey et al. (2013). Seeds germinate in the spring and plants senesce after seed production in the fall (Parsons and Cuthbertson, 2001). Alternate answers for the Monte Carlo simulation were both "a."
ES-14 (Prolific reproduction)	y - negl	1	Prolific seed bearer (Schomburgk, 1879 cited in Kloot, 1980). Ninety percent of freshly collected seeds are viable (Brownsey et al., 2013). From a population demographic study where fertility and life history transition rates were estimated, mean seed production per plant was estimated to be about 71,000 [based on a population with a mean density of 3.2 plants per square meter] (Brownsey, 2013). Taking into account not only seed viability, but also germination and survival to adulthood, and assuming no density-dependent mortality, one plant could produce up to 14,493 adults in the next generation (Brownsey, 2013).
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - negl	1	It is spreading along roadways in California from the San Francisco area into the Central Valley (Hrusa et al., 2002). Seeds attach to clothing and bags, and moves in sand and gravel for road construction (Parsons and Cuthbertson, 2001). Contaminates vehicles and equipment (Moerkerk, 2006), and likely spreading that way in California (Brownsey et al., 2013).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	y - negl	2	Seeds attach to hides and wool (Parsons and Cuthbertson, 2001). Species is present in a waste area around a wool-combing facility in South Carolina, where it was probably introduced on wool from Australia (Nesom, 2004). Described as a wool-alien (Clement and Foster, 1994). Probably introduced to Australia as a contaminant of wheat seeds from Germany (Schomburgk, 1879 cited in Kloot, 1980).
ES-17 (Number of natural dispersal vectors)	3	2	Fruit and seed descriptions for ES-17a through ES-17e: Seeds approximately 2 mm long with about 30 pappus bristles (Hanf, 1983). Pappus of numerous barbed bristles that are 3-4 mm long (Parsons and Cuthbertson, 2001).
ES-17a (Wind dispersal)	y - negl		The pappus aids in wind dispersal (Parsons and Cuthbertson, 2001). Wind dispersed (Schomburgk, 1879 cited in Kloot, 1980). Likely spread by wind (Brownsey et al., 2013).
ES-17b (Water dispersal)	y - high		The pappus aids in water dispersal (Parsons and Cuthbertson, 2001). A Victoria weed risk assessment also noted water dispersal (DPI, 2013), but it cited the former reference by Parson and Cuthbertson (2001). Because the pappus likely helps the seeds float, we answered yes but with high uncertainty.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-17c (Bird dispersal)	? - max		Likely spreads on bird feathers (Brownsey et al., 2013), but because that author was speculating, we answered unknown.
ES-17d (Animal external dispersal)	y - negl		Reported as a wool alien (Stace, 2010). Likely spreads on the fur of animals (Brownsey et al., 2013). Barbs on the pappus hairs allow seeds to attach to hair and skin (Randall, 1999).
ES-17e (Animal internal dispersal)	? - max		Unknown. Rangeland animals consume seeds (Philbey and Morton, 2000), but it is not known if seeds remain viable after excretion.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	y - negl	1	Based on a field planting experiment, 2.5 percent of the seeds planted during the fall and winter of 2010-2011 germinated over one year later (Brownsey, 2013). Seeds are short-lived and probably don't survive more than three years (Parsons and Cuthbertson, 2001). Based on some seed traits, seed longevity in the soil should be relatively short, two to three years (Brownsey et al., 2013). Because evidence exists that they persist for more than a year, we answered yes.
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	y - mod	1	Forms a taproot with numerous laterals, plus plants pulled at the flowering stage continue to develop and mature seed (Parsons and Cuthbertson, 2001). For that reason the authors suggested burning pulled plants. We believe this is evidence for tolerating mutilation/cultivation..
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	n - low	0	We found no evidence. Not listed by Heap (2013). Because this species is so well known in production and disturbed systems, we used low uncertainty.
ES-21 (Number of cold hardiness zones suitable for its survival)	6	0	
ES-22 (Number of climate types suitable for its survival)	8	2	
ES-23 (Number of precipitation bands suitable for its survival)	9	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	y - high	0.1	A laboratory experiment tested four different concentrations of aqueous extracts of root, stem, and flower tissues, and two different concentrations of each of three organic solvents. This study found some allelopathic effects on the germination and radicle growth of four different test species (Omezzine et al., 2011). Answering yes because this study used a variety of extracts and test species. However, using high uncertainty because it is not clear whether these effects are realized under field conditions.
Imp-G2 (Parasitic)	n - negl	0	We found no evidence. This plant family is not known to contain parasitic plants (Heide-Jorgensen, 2008; Nickrent, 2009). Thus, we answered no.
Impacts to Natural Systems			
Imp-N1 (Change ecosystem processes and parameters that affect other species)	n - mod	0	We found no evidence. Impacts to wildlife and natural ecosystems have not been reported in the United States because this is a relatively new invader in California (Brownsey et al., 2013).
Imp-N2 (Change community structure)	n - mod	0	We found no evidence.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-N3 (Change community composition)	? - max		Unknown. Compared to species with similar phenology, *D. graveolens* develops taproots later in the season, which indicates it may not be as competitive as other species with similar life histories that develop them earlier (Brownsey, 2013). *Dittrichia graveolens* poses a threat to rangeland biodiversity (Martin et al., 2006). We considered that evidence here because some rangelands can be considered as both natural and production systems. Still, it is not clear if this species can invade undisturbed areas (including rangelands; Brownsey, 2013; Brownsey et al., 2013) and reduce biodiversity in these areas, so we answered unknown.
Imp-N4 (Is it likely to affect federal Threatened and Endangered species)	? - max		Unknown.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions)	n - mod	0	We found no evidence.
Imp-N6 (Weed status in natural systems)	b - mod	0.2	Present in some conservation areas in California (Univ. of California, 2013), including in gravel bars alongside streams and creek banks (Hrusa et al., 2002). This species invades grasslands and riparian scrub in California (Cal-IPC, 2006), and is a natural areas weed in Australia (Randall, 2007). Although present in natural areas, *D. graveolens* is primarily a disturbance and agricultural weed (Brownsey, 2013; Parsons and Cuthbertson, 2001). We found no evidence that it is being managed in natural systems. Alternate answers for the Monte Carlo simulation were "a" and "c."
Impact to Anthropogenic Systems (cities, suburbs, roadways)			
Imp-A1 (Impacts human property, processes, civilization, or safety)	n - mod	0	We found no evidence.
Imp-A2 (Changes or limits recreational use of an area)	? - max		Foul smelling (Hrusa et al., 2002). Smelling unpleasantly of camphor (Hanf, 1983). The epithet "graveolens" is Latin for foul-smelling (Parsons and Cuthbertson, 2001). Leaves and stems are covered with hairs that exude a sticky, strong-smelling oil (Parsons and Cuthbertson, 2001). Some people might object to and avoid the smell of this species (Esler, 1988). Dogs are known to vomit when working in dense patches, probably from ingesting or inhaling the bristles (Parsons and Cuthbertson, 2001). This species is clearly foul smelling and toxic to animals (see Imp-P5), but because we found no direct evidence that it restricts recreational use of areas, we answered unknown.
Imp-A3 (Outcompetes, replaces, or otherwise affects desirable plants and vegetation)	n - mod	0	We found no evidence.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-A4 (Weed status in anthropogenic systems)	c - negl	0.4	Species is present along roadsides, in empty lots, and in disturbed areas in California (Univ. of California, 2013), and very similar behavior in Australia (Parsons and Cuthbertson, 2001). Being controlled along roadsides in Australia (Kay, 1981). In California it is primarily a weed of roadsides and highly disturbed areas, and different control strategies are being tested (Brownsey et al., 2013). Treated by the California Department of Transportation along roadsides (Ortiz, 2013). Alternate answers for the Monte Carlo simulation were both "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	y - low	0.4	Significant livestock losses due to intestinal damage from the sharp bristles have been reported when animals have been forced to graze upon this species (Auld and Medd, 1987). Twenty percent of a herd of sheep died after grazing on this species (Philbey and Morton, 2000).
Imp-P2 (Lowers commodity value)	y - negl	0.2	Because of the aromatic oils, grazing animals only eat the plants when they are young; they avoid eating older plants (Parsons and Cuthbertson, 2001; Simmonds et al., 2000). Sheep will only eat it when nothing else is available (Philbey and Morton, 2000). Infested paddocks provide no grazing value (Parsons and Cuthbertson, 2001). "The pasture land taken possession of by it become valueless, as the weed cannot be extirpated without heavy cost" (Schomburgk, 1879 cited in Kloot, 1980). The oil taints the meat and milk of animals forced to graze on the plant (Auld and Medd, 1987; Everist, 1957; Parsons and Cuthbertson, 2001). Aromatic oils can discolor wool (Randall, 1999).
Imp-P3 (Is it likely to impact trade)	y - low	0.2	Because this species is regulated elsewhere (DPI, 2013; Randall, 2007) and because it has been shown to follow trade pathways (see evidence under ES-16), we answered yes.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	n - mod	0	We found no evidence.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	y - negl	0.1	Causes enteritis in sheep (Schneider and du Plessis, 1980). "Sheep eat the flower heads at times and serious losses have been attributed to the plant, not because of any toxin, but because of irritation and puncturing of the stomach, intestine or bowel lining by the barbed pappus hairs. It seems that this damage allows the absorption of toxins produced by enterotoxaemia bacteria and the animal may die of pulpy kidney disease. Death may be sudden" (Parsons and Cuthbertson, 2001). The bristles of the pappus become embedded in the villi of the small intestine of sheep, causing an inflammatory response and secondary infections (Philbey and Morton, 2000). "Contact dermatitis, tainting of milk and meat and exacerbation of carbon tetrachloride toxicity have been attributed to exposure to *D. graveolens*" (Philbey and Morton, 2000). "Formerly a rather frequent wool-alien in fields" in the United Kingdom (Stace, 2010). Although this species is not inherently toxic, because of the animal disease it indirectly causes, answering yes.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-P6 (Weed status in production systems)	c - negl	0.6	Present in a pasture in California (Hrusa et al., 2002). Naturalized in palm groves and orchards in Egypt (Boulos, 2002). Weed of dry fallow and arable land in Europe (Hanf, 1983). Weed of agricultural areas in Australia (Randall, 2007). A weed occurring over broad areas of grazing land (Parsons and Cuthbertson, 2001). Major weed of rangeland in South Australia, but not so much row crops (Schomburgk, 1879 cited in Kloot, 1980). Weed of cereals in South Africa (Parsons and Cuthbertson, 2001). Growing interspersed with wheat in South Africa (Schneider and du Plessis, 1980). Thirty years after introduction to South Australia, it was recognized as one of the worst weeds of cereals; however, it is no longer an important agricultural weed because of a general increase in soil fertility (Parsons and Cuthbertson, 2001). It is under an eradication program in Queensland (Parsons and Cuthbertson, 2001); although we are assuming this is due to this species' impacts in agricultural systems. Various control strategies for pasture are described (Parsons and Cuthbertson, 2001). Controlled in Queensland (Everist, 1957). Alternate answers for the Monte Carlo simulation were both "b."
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically referenced points obtained from the Global Biodiversity Information Facility (GBIF, 2013).
Plant cold hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence it occurs in this zone.
Geo-Z2 (Zone 2)	n - negl	N/A	We found no evidence it occurs in this zone.
Geo-Z3 (Zone 3)	n - negl	N/A	We found no evidence it occurs in this zone.
Geo-Z4 (Zone 4)	n - negl	N/A	We found no evidence it occurs in this zone.
Geo-Z5 (Zone 5)	n - high	N/A	A few points in Austria near Zone 6. These particular plants may have been growing in sheltered locations; thus, answering no with high uncertainty.
Geo-Z6 (Zone 6)	y - negl	N/A	Austria. Points in Slovenia (Frajman and Kaligarič, 2009).
Geo-Z7 (Zone 7)	y - negl	N/A	Austria and Germany. Points in Slovenia (Frajman and Kaligarič, 2009).
Geo-Z8 (Zone 8)	y - negl	N/A	Australia, France, and Spain.
Geo-Z9 (Zone 9)	y - negl	N/A	Australia, Portugal, Spain, and the United States (CA).
Geo-Z10 (Zone 10)	y - negl	N/A	Australia and the United States (CA).
Geo-Z11 (Zone 11)	y - negl	N/A	Australia.
Geo-Z12 (Zone 12)	n - high	N/A	Several geo-referenced points exist for Tanzania; however, none of the locality fields for these records indicate they are in this country (GBIF, 2013). Given that we found no other evidence that this species occurs in Tanzania, or in tropical environments in general, we answered no.
Geo-Z13 (Zone 13)	n - low	N/A	We found no evidence it occurs in this zone.
Köppen-Geiger climate classes			
Geo-C1 (Tropical rainforest)	n - negl	N/A	We found no evidence it occurs in this climate class.
Geo-C2 (Tropical savanna)	n - low	N/A	We found no evidence it occurs in this climate class.
Geo-C3 (Steppe)	y - negl	N/A	Australia, South Africa, Spain, and the United States (CA).
Geo-C4 (Desert)	y - mod	N/A	Australia. Collected near Burg El-Arab circa 50 km west of Alexandria, Egypt (Boulos, 2002).

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-C5 (Mediterranean)	y - negl	N/A	Australia, Portugal, South Africa, Spain, and the United States (CA). Native of the Mediterranean region (Parsons and Cuthbertson, 2001).
Geo-C6 (Humid subtropical)	y - negl	N/A	Australia.
Geo-C7 (Marine west coast)	y - negl	N/A	Australia, France, New Zealand, and Germany.
Geo-C8 (Humid cont. warm sum.)	y - low	N/A	Regional occurrence in the United States (CT, NJ, NY) (Kartesz, 2013).
Geo-C9 (Humid cont. cool sum.)	y - negl	N/A	Austria and Germany.
Geo-C10 (Subarctic)	y - low	N/A	Points running along a major highway in Slovenia that traverses this climate type (Frajman and Kaligarič, 2009). Two points in France, but these are in a mountainous region near Marine West Coast (GBIF, 2013).
Geo-C11 (Tundra)	n - low	N/A	We found no evidence it occurs in this climate class.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence it occurs in this climate class.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	y - negl	N/A	A couple of points in the southwestern United States (CA), one point in South Africa, several in Spain, and about two dozen in Australia (near the next higher band).
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	Australia, South Africa, and the United States (CA). Found in Australia in areas with 300-500 mm rainfall, and withstands drought better than most other plants (Parsons and Cuthbertson, 2001).
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	Australia, South Africa, and the United States (CA).
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	Australia and the United States (CA).
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	Australia, France, Portugal, and Spain. Regional occurrence in the United States (CT, NJ, NY) (Kartesz, 2013).
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	Austria, France, Germany, and Spain. Regional occurrence in the United States (CT, NJ, NY) (Kartesz, 2013).
Geo-R7 (60-70 inches; 152-178 cm)	y - low	N/A	Austria and Germany. Slovenia (Frajman and Kaligarič, 2009).
Geo-R8 (70-80 inches; 178-203 cm)	y - low	N/A	Germany and Slovenia (Frajman and Kaligarič, 2009).
Geo-R9 (80-90 inches; 203-229 cm)	y - mod	N/A	A few points in a high elevation area in Germany.
Geo-R10 (90-100 inches; 229-254 cm)	n - high	N/A	We found no evidence it occurs in this precipitation band.
Geo-R11 (100+ inches; 254+ cm))	n - negl	N/A	We found no evidence it occurs in this precipitation band.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	y - negl	1	Present in the United States (Brownsey et al., 2013; Kartesz, 2013).
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)			

Question ID	Answer - Uncertainty	Score	Notes (and references)
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	The congener *D. viscosa* was collected as a ballast weed in the late 1800s in Florida, but it does not appear to have naturalized in the United States (Weakley, 2010).
Ent-5 (Likely to enter through natural dispersal)	-	N/A	