

<b>Taxon:</b> <i>Emex spinosa</i> (L.) Campd.	<b>Family:</b> Polygonaceae
<b>Common Name(s):</b> devil's-thorn lesser-jack little-jack spiny emex	<b>Synonym(s):</b> Centopodium spinosum (L.) Burch. Rumex glaber Forssk. Rumex spinosus L. Vibo spinosa (L.) Medik.

<b>Assessor:</b> Chuck Chimera	<b>Status:</b> Assessor Approved	<b>End Date:</b> 1 Jul 2020
<b>WRA Score:</b> 12.0	<b>Designation:</b> H(Hawai'i)	<b>Rating:</b> High Risk

**Keywords:** Weedy Annual, Disturbance-Adapted, Spiny Achenes, Self-Compatible, Animal-Dispersed

Qsn #	Question	Answer Option	Answer
101	Is the species highly domesticated?	y=-3, n=0	n
102	Has the species become naturalized where grown?		
103	Does the species have weedy races?		
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	(0-low; 1-intermediate; 2-high) (See Appendix 2)	Intermediate
202	Quality of climate match data	(0-low; 1-intermediate; 2-high) (See Appendix 2)	High
203	Broad climate suitability (environmental versatility)	y=1, n=0	y
204	Native or naturalized in regions with tropical or subtropical climates	y=1, n=0	y
205	Does the species have a history of repeated introductions outside its natural range?	y=-2, ?=-1, n=0	y
301	Naturalized beyond native range	y = 1*multiplier (see Appendix 2), n= question 205	y
302	Garden/amenity/disturbance weed		
303	Agricultural/forestry/horticultural weed	n=0, y = 2*multiplier (see Appendix 2)	y
304	Environmental weed		
305	Congeneric weed	n=0, y = 1*multiplier (see Appendix 2)	y
401	Produces spines, thorns or burrs	y=1, n=0	n
402	Allelopathic	y=1, n=0	y
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals		
405	Toxic to animals		
406	Host for recognized pests and pathogens		
407	Causes allergies or is otherwise toxic to humans	y=1, n=0	n
408	Creates a fire hazard in natural ecosystems	y=1, n=0	n

Qsn #	Question	Answer Option	Answer
409	Is a shade tolerant plant at some stage of its life cycle		
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y=1, n=0	y
411	Climbing or smothering growth habit	y=1, n=0	n
412	Forms dense thickets	y=1, n=0	y
501	Aquatic	y=5, n=0	n
502	Grass	y=1, n=0	n
503	Nitrogen fixing woody plant	y=1, n=0	n
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	y=1, n=0	n
601	Evidence of substantial reproductive failure in native habitat	y=1, n=0	n
602	Produces viable seed	y=1, n=-1	y
603	Hybridizes naturally	y=1, n=-1	y
604	Self-compatible or apomictic	y=1, n=-1	y
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	n
607	Minimum generative time (years)	1 year = 1, 2 or 3 years = 0, 4+ years = -1	1
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y=1, n=-1	y
702	Propagules dispersed intentionally by people	y=1, n=-1	n
703	Propagules likely to disperse as a produce contaminant	y=1, n=-1	y
704	Propagules adapted to wind dispersal	y=1, n=-1	y
705	Propagules water dispersed	y=1, n=-1	y
706	Propagules bird dispersed	y=1, n=-1	n
707	Propagules dispersed by other animals (externally)	y=1, n=-1	y
708	Propagules survive passage through the gut	y=1, n=-1	n
801	Prolific seed production (>1000/m <sup>2</sup> )	y=1, n=-1	y
802	Evidence that a persistent propagule bank is formed (>1 yr)		
803	Well controlled by herbicides	y=-1, n=1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire	y=1, n=-1	n
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	y=-1, n=1	y

**Supporting Data:**

Qsn #	Question	Answer
101	Is the species highly domesticated?	n
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[No history or evidence of domestication] "Native to the Mediterranean region; in Hawai'i naturalized in open, dry to mesic, disturbed habitats, 150-1,950 m, on O'ahu, Moloka'i, Maui, and Hawai'i."

102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. (2020). Personal Communication	NA

103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. (2020). Personal Communication	NA

201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	Intermediate
	Source(s)	Notes
	USDA, Agricultural Research Service, National Plant Germplasm System. (2020). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. <a href="https://npgsweb.ars-grin.gov/">https://npgsweb.ars-grin.gov/</a> . [Accessed 29 Jun 2020]	"Native Africa NORTHERN AFRICA: Algeria (n.), Egypt, Libya, Morocco, Tunisia Asia-Temperate ARABIAN PENINSULA: Kuwait, Saudi Arabia WESTERN ASIA: Cyprus, Israel, Jordan, Lebanon, Turkey (w.) Europe SOUTHEASTERN EUROPE: Greece (incl. Crete), Italy (incl. Sardinia, Sicily) SOUTHWESTERN EUROPE: France, [Corse] Portugal, Spain (incl. Balears)"

202	Quality of climate match data	High
	Source(s)	Notes
	USDA, Agricultural Research Service, National Plant Germplasm System. (2020). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. <a href="https://npgsweb.ars-grin.gov/">https://npgsweb.ars-grin.gov/</a> . [Accessed 30 Jun 2020]	

203	Broad climate suitability (environmental versatility)	y
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Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	Haselwood, E.L., Motter, G.G., & Hirano, R.T. (eds.). 1983. Handbook of Hawaiian Weeds. University of Hawaii Press, Honolulu, HI	[Broad elevation range, demonstrating environmental versatility] "Found in dry regions from sea level to 5,000 feet. A weed in pastures, rangelands, and cultivated areas."
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Broad elevation range, demonstrating environmental versatility] "Native to the Mediterranean region; in Hawai'i naturalized in open, dry to mesic, disturbed habitats, 150-1,950 m, on O'ahu, Moloka'i, Maui, and Hawai'i."

<b>204</b>	<b>Native or naturalized in regions with tropical or subtropical climates</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Native to the Mediterranean region; in Hawai'i naturalized in open, dry to mesic, disturbed habitats, 150-1,950 m, on O'ahu, Moloka'i, Maui, and Hawai'i. First collected on Moloka'i in 1928 (Degener 18174, BISH)."

<b>205</b>	<b>Does the species have a history of repeated introductions outside its natural range?</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	"Where introduced, <i>E. spinosa</i> is present in many countries and whilst it is a common weed in Kenya (Agnew, 1974) it has only ever become a serious weed in the Hawaiian Islands (Holm et al., 1979). Kosinova (1974) states that it has been found only once in Sudan, and has a very limited distribution in Australia (Gilbey 1974; Pheloung et al., 1996). Siddiqi (1973) reports <i>E. spinosa</i> as being a weed in north-west Pakistan but notes that it is not common, and it is reported as rare in India (Varma et al., 1984)."

<b>301</b>	<b>Naturalized beyond native range</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Native to the Mediterranean region; in Hawai'i naturalized in open, dry to mesic, disturbed habitats, 150-1,950 m, on O'ahu, Moloka'i, Maui, and Hawai'i. First collected on Moloka'i in 1928 (Degener 18174, BISH)."
	CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	"Where introduced, <i>E. spinosa</i> is present in many countries and whilst it is a common weed in Kenya (Agnew, 1974) it has only ever become a serious weed in the Hawaiian Islands (Holm et al., 1979). Kosinova (1974) states that it has been found only once in Sudan, and has a very limited distribution in Australia (Gilbey 1974; Pheloung et al., 1996). Siddiqi (1973) reports <i>E. spinosa</i> as being a weed in north-west Pakistan but notes that it is not common, and it is reported as rare in India (Varma et al., 1984)."

<b>302</b>	<b>Garden/amenity/disturbance weed</b>	
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Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	Scott, J. K., & Yeoh, P. B. (2004). <i>Emex spinosa</i> (L.) Campd.: a predicted weed threat that has not lived up to expectations?. Pp. 501-504 in Weed management: balancing people, planet, profit. 14th Australian Weeds Conference, Wagga Wagga, New South Wales, Australia, 6-9 Sep 2004: Weed Society of New South Wales	[A weed of disturbed areas that may impact agriculture] "Excluding its native habitat and Australia, <i>E. spinosa</i> occupies highly disturbed areas and is reported as occurring along roads, railways and areas of cereal cultivation in upland Kenya (Graham 1958) along field borders and in waste sandy places in West Pakistan (Siddiqi 1973), and along the edge of drains in India (Varma et al. 1984)."
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[A weed of disturbed sites that impacts pastures and could affect restoration of dry to mesic disturbed sites] "in Hawai'i naturalized in open, dry to mesic, disturbed habitats, 150-1,950 m"

303	Agricultural/forestry/horticultural weed	y
	<b>Source(s)</b>	<b>Notes</b>
	Haselwood, E.L., Motter, G.G., & Hirano, R.T. (eds.). 1983. Handbook of Hawaiian Weeds. University of Hawaii Press, Honolulu, HI	"Found in dry regions from sea level to 5,000 feet. A weed in pastures, rangelands, and cultivated areas." ... "Declared noxious in Regulations 2 and NW 10 and for State land lenses. Grows rapidly during rains, crowding out plants. Dries up quickly."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Weed of: Cereals, Cotton, Orchards & Plantations, Pastures, Pome Fruits, Sunflowers, Vegetables"

304	Environmental weed	
	<b>Source(s)</b>	<b>Notes</b>
	Scott, J. K., & Yeoh, P. B. (2004). <i>Emex spinosa</i> (L.) Campd.: a predicted weed threat that has not lived up to expectations?. Pp. 501-504 in Weed management: balancing people, planet, profit. 14th Australian Weeds Conference, Wagga Wagga, New South Wales, Australia, 6-9 Sep 2004: Weed Society of New South Wales	"Over 25 years ago, <i>Emex spinosa</i> (L.) Campd. (Polygonaceae), a plant of Mediterranean and west Asian origin, was predicted to out-compete its widespread congener, <i>Emex australis</i> Steinh., to become an even more serious weed problem across southern Australia. This prediction was based on field and glasshouse studies of plant competition which showed <i>E. spinosa</i> was more aggressive than <i>E. australis</i> with a faster growth rate and higher seed production. Today, <i>E. spinosa</i> continues to be only found in isolated patches in the northern grains growing region and adjacent pastoral region in Western Australia as well as scattered populations in eastern Australia. This paper explores the possible reasons why this species has not become more of a problem, including the impact of genetic barriers, the impact of pathogens and insects, and farming practices that may have suppressed the invasion potential of this species."
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Could impact restoration of dry to mesic disturbed sites] "in Hawai'i naturalized in open, dry to mesic, disturbed habitats, 150-1,950 m"
	Motooka, P., Castro, L., Nelson, D., Nagai, G. & Ching, L. 2003. Weeds of Hawaii's Pastures and Natural Areas: An Identification and Management Guide. CTAHR, UH Manoa, Honolulu, HI	[May impact natural areas, but primarily a weed of pastures and disturbed sites] "Environmental impact: Spiny fruits can cause painful injuries so are a nuisance in pastures, roadsides, and natural areas."

Qsn #	Question	Answer
	CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc	[No concrete detrimental impacts to the natural environment are reported] "in Hawaii, uncontrolled <i>Emex</i> form dense mats of vegetation that shade out and displace useful plants. They then dry up during early summer to leave hillsides devoid of living vegetation and subject to sheet erosion (Goeden, 1978)." ... "In the Santa Monica Mountains, USA, <i>E. spinosa</i> is present in Point Muga State Park (Chester et al., 2002) but the impact of the weed on biodiversity is not documented."

305	Congeneric weed	y
	Source(s)	Notes
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	" <i>Emex australis</i> ... Weed of: Cereals, Grapevines, Pastures, Pome Fruits"

401	Produces spines, thorns or burrs	n
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Spine-tipped fruits] "Annual herbs 3-8 dm tall; stems decumbent to ascending. Leaves ovate to nearly deltate, 5-42 cm long, 1.1-12 cm wide, glabrous, petioles 2-29 cm long. Staminate flowers in terminal and axillary, pedunculate clusters, tepals narrowly oblong-oblongeolate, ca. 1.5-2 mm long; pistillate flowers axillary, sessile, outer tepals ca. 4-6 mm long in fruit, tipped with divergent spines, inner ones erect, 5-6 mm long. Nuts pale brown, glossy, ca. 4 mm long"

402	Allelopathic	y
	Source(s)	Notes
	Khan, R., et al. (2012). Bioherbicidal activity of some winter weeds against some crops. Pakistan Journal of Weed Science Research, 18(4): 561-569	[Extracts may inhibit germination of sunflower seeds] "The study aims at investigating the allelopathic effects of twelve weed species including <i>Anagallis arvensis</i> , <i>Plantago lanceolata</i> , <i>Medicago polymorpha</i> , <i>Ammi visnaga</i> , <i>Phragmites australis</i> , <i>Silybum marianum</i> , <i>Emex spinosa</i> , <i>Malcolmia africana</i> , <i>Calendula arvensis</i> , <i>Rumex crispus</i> , <i>Fumaria indica</i> and <i>Cirsium arvense</i> on seed germination, seed inhibition, seed germination time, seed germination index and seed vigor index of the test crops (wheat, maize and sunflower). A laboratory experiment was laid out in a completely randomized design in March 2010 in the Department of Weed Science, The University of Agriculture, Peshawar, Pakistan. <i>Rumex crispus</i> inhibited the seed germination up to 80% and 70% in both wheat and sunflower, respectively while the seed of maize showed high tolerance against all extracts except <i>Fumaria indica</i> extract that inhibited the maize seed germination up to 40%. In the present study, sunflower proved more susceptible to all extracts and maize was more tolerant to the phytotoxicity of all the weeds."

403	Parasitic	n
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Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Annual herbs 3-8 dm tall; stems decumbent to ascending." [Polygonaceae. No evidence]

404	Unpalatable to grazing animals	
	<b>Source(s)</b>	<b>Notes</b>
	Hanelt, P. (ed.). 2001. Mansfeld's Encyclopedia of Agricultural and Horticultural Crops (except Ornamentals), Volume 1. Springer-Verlag, Berlin, Heidelberg, New York	"Cultivated in England in the 17th cent. as a vegetable, in Libya still today consumed cooked as vegetable." [Palatable to people]
	Hanson, H. C. (1952). Grazing land problems, Molokai Island, Territory of Hawaii. Rangeland Ecology & Management, 5(4), 230-242	[In contrast to other grazing land species, which are characterized with forage values from excellent, good, fair and poor, <i>Emex spinosa</i> is classified as a pest, with no apparent forage value. Probably unpalatable] "Table 2 ... <i>Emex spinosa</i> - relative forage value = Pest]
	Panetta, F. D., & Randall, R. P. (1993). <i>Emex australis</i> and the competitive hierarchy of a grazed annual pasture. The Journal of Applied Ecology, 30(2): 373-379	[Related species grazed by animals] "Emex seedlings were not grazed until they reached the three true leaf stage. Thereafter, individual plants escaped defoliation for short periods only; approximately 80% of the sampled population suffered some degree of defoliation during the period spanning 4-8 weeks after emergence. Less than 5% of the population escaped defoliation over the entire experimental period."

405	Toxic to animals	
	<b>Source(s)</b>	<b>Notes</b>
	McKenzie, R. (2020). Australia's Poisonous Plants, Fungi and Cyanobacteria: A Guide to Species of Medical and Veterinary Importance. CSIRO Publishing, Clayton South, VIC	[Unknown. Related species may be toxic to animals] " <i>Emex spinosa</i> (lesser jack, little jack) can occur together with <i>E. australis</i> in some areas of Australia (New South Wales, South Australia), but its toxin content is unrecorded." ... " <i>E. australis</i> ... Toxins: Soluble oxalates. 6% total and 2% soluble oxalate have been found in dry matter. Toxic parts of the plant: Leaves Animals affected: Ruminants. Sheep are the most likely victims."

406	Host for recognized pests and pathogens	
	<b>Source(s)</b>	<b>Notes</b>

Qsn #	Question	Answer
	<p>CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a></p>	<p>[Unknown. Impacts to agriculture generally pertain to direct competition with crops, or impacts on pastures] "Surveys for insects associated with <i>E. spinosa</i> have been made in Morocco, Portugal (Krauss, 1963) and Israel (Scott and Shivas, 1990). Other insects, the weevils <i>Coniocleonus excoriatus</i>, <i>Lixus cribricollis</i>, <i>Perapion neofallax</i>, and <i>Perapion violaceum</i>, the aphid <i>Dysaphis emicis</i>, and the coreid bug <i>Haploprocta sulcicornis</i> are commonly found on plants in its indigenous range and have been proposed for assessment as biological control agents (Scott and Yeoh, 1996). Many of these species also include <i>Rumex</i> as host plants. Pathogens reported from <i>E. spinosa</i> from its indigenous range include <i>Cercospora tripolitana</i> (Hasan, 1979), and <i>Peronospora rumicis</i> (Viennot-Bourgin, 1969). There have been no studies of natural enemies in the introduced range. The weevils <i>Lixus cribricollis</i> (Julien et al., 1982) and <i>Apion miniatum</i> (Yeoh et al., 2002) are the only species from <i>E. spinosa</i> assessed and released in Australia as biological control agents. In the late 1980s and early 1990s, farmers in Australia reported <i>E. australis</i> plants with distorted leaves that developed a yellow chlorosis and died before setting viable seed. These symptoms were referred to as "doublegee decline" but were later found to be caused by an aphid, <i>Brachycaudus rumexicolens</i>, thought to be native to North America and an insect that was not intentionally introduced into Australia (Berlandier and Scott, 1993; Scott et al., 1994). <i>Brachycaudus rumexicolens</i> has a widespread distribution within Australia and its predicted distribution range (Scott and Yeoh, 1999) overlaps with the known distribution range for <i>E. spinosa</i> (Marshall and Weiss, 1982). Under laboratory conditions, <i>B. rumexicolens</i> readily attacks both <i>E. spinosa</i> and <i>E. australis</i> (Scott and Yeoh, 1998) and although there are no published data on its impact on naturalized populations of <i>E. spinosa</i>, it can cause a 30% reduction in seed weight of <i>E. australis</i> plants growing in pasture and a 80% reduction in seed number in <i>E. australis</i> plants grown in a glasshouse (Yeoh and Scott, 1996). There are also records of <i>B. rumexicolens</i> occurring in Portugal, Spain, Italy, Turkey and the Canary Islands (Berlandier and Scott, 1993) where the aphid was usually collected from <i>Rumex</i> spp. It should, however, also be affecting <i>E. spinosa</i> populations in all these Mediterranean countries as again, the predicted distribution range of the aphid (Scott and Yeoh, 1999) overlaps the known distribution of <i>E. spinosa</i> (Jalas and Suominen, 1979) in this region."</p>

407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	Notes
	<p>Hanelt, P. (ed.). 2001. <i>Mansfeld's Encyclopedia of Agricultural and Horticultural Crops (except Ornamentals)</i>, Volume 1. Springer-Verlag, Berlin, Heidelberg, New York</p>	<p>"Cultivated in England in the 17th cent. as a vegetable, in Libya still today consumed cooked as vegetable." [No evidence]</p>
	<p>Quattrocchi, U. 2012. <i>CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology</i>. CRC Press, Boca Raton, FL</p>	<p>"<i>Emex spinosa</i> ... For stomach and intestinal complaints, dyspepsia." [Used medicinally]</p>



Qsn #	Question	Answer
408	Creates a fire hazard in natural ecosystems	n
	Source(s)	Notes
	CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc	[Increased fire risk not listed among detrimental impacts] "In Hawaii, uncontrolled <i>Emex</i> form dense mats of vegetation that shade out and displace useful plants. They then dry up during early summer to leave hillsides devoid of living vegetation and subject to sheet erosion (Goeden, 1978)."

409	Is a shade tolerant plant at some stage of its life cycle	
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"naturalized in open, dry to mesic, disturbed habitats" [Occurs in high light environments, suggesting it may be shade intolerant]

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y
	Source(s)	Notes
	CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc	"Soil reaction acid alkaline neutral Soil texture heavy light medium Special soil tolerances infertile"

411	Climbing or smothering growth habit	n
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Annual herbs 3-8 dm tall; stems decumbent to ascending."

412	Forms dense thickets	y
	Source(s)	Notes
	Haselwood, E.L., Motter, G.G., & Hirano, R.T. (eds.). 1983. Handbook of Hawaiian Weeds. University of Hawaii Press, Honolulu, HI	"Declared noxious in Regulations 2 and NW 10 and for State land lenses. Grows rapidly during rains, crowding out plants. Dries up quickly."

Qsn #	Question	Answer
501	<b>Aquatic</b>	n
	<b>Source(s)</b>	<b>Notes</b>
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Terrestrial] "in Hawai'i naturalized in open, dry to mesic, disturbed habitats, 150-1,950 m"

502	<b>Grass</b>	n
	<b>Source(s)</b>	<b>Notes</b>
	USDA, Agricultural Research Service, National Plant Germplasm System. (2020). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. <a href="https://npgsweb.ars-grin.gov/">https://npgsweb.ars-grin.gov/</a> . [Accessed 30 Jun 2020]	Family: Polygonaceae Subfamily: Polygonoideae Tribe: Rumiceae

503	<b>Nitrogen fixing woody plant</b>	n
	<b>Source(s)</b>	<b>Notes</b>
	USDA, Agricultural Research Service, National Plant Germplasm System. (2020). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. <a href="https://npgsweb.ars-grin.gov/">https://npgsweb.ars-grin.gov/</a> . [Accessed 30 Jun 2020]	Family: Polygonaceae Subfamily: Polygonoideae Tribe: Rumiceae

504	<b>Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)</b>	n
	<b>Source(s)</b>	<b>Notes</b>
	CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	"The plant develops a long and thick taproot." [No bulbs, corms or tubers. Annual plant]

Qsn #	Question	Answer
601	<b>Evidence of substantial reproductive failure in native habitat</b>	<b>n</b>
	<b>Source(s)</b>	<b>Notes</b>
	CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	[No evidence] "E. spinosa is native to islands of, and countries bordering the Mediterranean. Jalas and Suominen (1979) mapped the regions in southern Europe where E. spinosa has been recorded showing it to be widely distributed on the mainland along the coastal regions of Portugal, Spain, and Greece. It is also common on the islands within the Mediterranean Sea with records shown for the Balearic Islands, Sardinia, Corsica, Sicily, Malta and Crete. However, there is a noticeable absence of records on the mainland coast from France all the way east to Albania, the exception being a couple of records on the eastern coast of Italy (around Bari). In Jalas and Suominen (1979), the only depicted locations that are non-coastal are on the Tagus River, Spain, where it has been located several hundred kilometres inland. Kosinova (1974) found E. spinosa distribution was restricted to the cultivated lands in Egypt and was one of only a few Mediterranean weeds to penetrate to the southern Egyptian regions near Nubia."

602	<b>Produces viable seed</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Ortiz, P. L., Berjano, R., Talavera, M., & Arista, M. (2009). The role of resources and architecture in modeling floral variability for the monoecious amphicarpic <i>Emex spinosa</i> (Polygonaceae). <i>American Journal of Botany</i> , 96(11), 2062-2073	" <i>Emex spinosa</i> is a self-compatible colonizing species with extraordinarily high fecundity (100% fruit set in natural populations)."

603	<b>Hybridizes naturally</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	"The chromosome number (based upon Australian populations) is 2n=20 (Putievsky et al., 1980) and is the same as both Australian and Portuguese populations of <i>E. spinosa</i> (Putievsky et al., 1980; Queiros, 1983). In Australia, where both species co-exist, the plants readily hybridize, with hybrids growing more vigorously than either parent but are completely sterile when self-pollinated (Putievsky et al., 1980)."

Qsn #	Question	Answer
604	<b>Self-compatible or apomictic</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Ortiz, P. L., Berjano, R., Talavera, M., & Arista, M. (2009). The role of resources and architecture in modeling floral variability for the monoecious amphicarpic <i>Emex spinosa</i> (Polygonaceae). <i>American Journal of Botany</i> , 96(11), 2062-2073	" <i>Emex spinosa</i> is a self-compatible colonizing species with extraordinarily high fecundity (100% fruit set in natural populations)."
	CABI. (2020). <i>Invasive Species Compendium</i> . Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	"The small (circa 2 mm), inconspicuous green flowers have predominantly separate sexes but are self-compatible and from these a hard wooden achene (fruit) with three spines (=modified lobes of the perianth) develops."

605	<b>Requires specialist pollinators</b>	<b>n</b>
	<b>Source(s)</b>	<b>Notes</b>
	Ortiz, P. L., Berjano, R., Talavera, M., & Arista, M. (2009). The role of resources and architecture in modeling floral variability for the monoecious amphicarpic <i>Emex spinosa</i> (Polygonaceae). <i>American Journal of Botany</i> , 96(11), 2062-2073	[Wind-pollinated] " <i>Emex spinosa</i> (L.) Campd. (Polygonaceae), an annual wind-pollinated herb that presents diverse sources of flower variability. <i>Emex spinosa</i> is a monoecious species that produces both female and male flowers that differ in primary and secondary sex characteristics (Luceño,1990)."

606	<b>Reproduction by vegetative fragmentation</b>	<b>n</b>
	<b>Source(s)</b>	<b>Notes</b>
	CABI. (2020). <i>Invasive Species Compendium</i> . Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	" <i>E. spinosa</i> is an autumn-winter germinating annual that can only reproduce by seed."

607	<b>Minimum generative time (years)</b>	<b>1</b>
	<b>Source(s)</b>	<b>Notes</b>
	Fullaway, D. T. (1957). Importations of natural enemies of the weed, <i>Emex spinosa</i> Campd. <i>Proceedings, Hawaiian Entomological Society</i> , 16: 359-360	" <i>Emex</i> , being an annual, comes up from seed in the ground after the first rains in October and by January or February has attained sufficient size to be noticeable in a pasture."

701	<b>Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Haselwood, E.L., Motter, G.G., & Hirano, R.T. (eds.). 1983. <i>Handbook of Hawaiian Weeds</i> . University of Hawaii Press, Honolulu, HI	"Propagation: By seed. Burs with hard, sharp spines are dispersed by animals and even automobile tires."

Qsn #	Question	Answer
	CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc	"The spiny achenes also facilitate the spread of the seed via human activity and the early Portuguese explorers accidentally transported them across the world, including Brazil, on their travels (Steinheil, 1838). There have been at least four separate introductions of <i>E. spinosa</i> into Australia (Marshall and Weiss, 1982). The achenes readily adhere to objects such as shoes and the tyres of vehicles such as cars, aircraft and machinery. As Gilbey (1974) points out, the spines of <i>E. spinosa</i> are shorter and less robust than those of <i>E. australis</i> , which may explain the slower rates of spread of <i>E. spinosa</i> within Australia. Although the <i>E. spinosa</i> achenes are less likely than <i>E. australis</i> achenes to impale and then remain attached to broad, flat rubber surfaces such as the soles of shoes, their smaller size allows them to wedge between the treads of shoes and tyres. From the patterns of infestations, Weiss and Julien (1975) suspect vehicles transported <i>E. spinosa</i> achenes around within the dried fruit production area of Merbein, Victoria, Australia and achenes from both <i>E. australis</i> and <i>E. spinosa</i> are stated to be disseminated by cars in Hawaii (Goeden, 1978)."

702	Propagules dispersed intentionally by people	n
	Source(s)	Notes
	CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc	"Although <i>E. spinosa</i> has limited beneficial characteristics, it is unlikely to have been intentionally introduced anywhere because of the obnoxious, spiny achenes with their resilient properties that makes controlling the species difficult."

703	Propagules likely to disperse as a produce contaminant	y
	Source(s)	Notes
	CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc	"As the spread of <i>E. spinosa</i> infestations across Western Australia follow the old stock routes, Gilbey (1974) suspected <i>E. spinosa</i> was introduced as a contaminant of fodder. <i>E. spinosa</i> seeds contaminate grain produce (Gilbey, 1974; Weiss and Julien, 1975) and limits exist on the maximum contamination levels allowed with cereal crops in Australia (Bowran, 1996; Fromm, 1996) and Morocco (WANA, 2001). In Hawaii, <i>E. spinosa</i> was thought to have been accidentally introduced with grass seed (Fullaway, 1958)."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Major Pathway/s: Contaminant, Crop, Herbal, Ornamental, Pasture"
	Fullaway, D. T. (1957). Importations of natural enemies of the weed, <i>Emex spinosa</i> Campd. Proceedings, Hawaiian Entomological Society, 16: 359-360	"The polygonaceous weedy herb, <i>Emex spinosa</i> Cam pd., is supposed to have been introduced unintentionally many years ago with grass seed from Australia."

704	Propagules adapted to wind dispersal	y
	Source(s)	Notes
	van Rheede van Oudtshoorn, K. & van Rooyen, M.W. 1999 Dispersal Biology of Desert Plants. Springer, Berlin, Heidelberg, New York	"The antitelechorous subterranean, synaptospermic propagules which germinate in situ on the maternal plant are smooth and larger than the aerial telechoric ones, which are spiny and are dispersed by wind, floods or animals."

Qsn #	Question	Answer
	CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc	"The large smooth and heavy subterranean achenes of <i>E. spinosa</i> are unlikely to move away from their site of origin; however, the aerial achenes are designed specifically for dissemination. Ripe aerial achenes detach from the parental plant either as separate units or in clusters on broken bits of the dead branch. As they are small and light, they are readily dispersed by strong winds or water and very few germinate in the immediate vicinity of their mother plant (Evenari et al., 1977)."

705	Propagules water dispersed	y
	Source(s)	Notes
	Weiss, P. (1980). Germination, Reproduction and Interference in the Amphicarpic Annual <i>Emex spinosa</i> (L.) Campd. <i>Oecologia</i> , 45(2), 244-251	"The aerial achenes are however adapted for dispersal, since they are small, spiny and float easily in water."

706	Propagules bird dispersed	n
	Source(s)	Notes
	CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc	[No evidence. No fleshy-fruited] " <i>E. spinosa</i> has hard thorny achenes that lie on the ground so that one thorn is always pointing upwards. The spines are slightly reflexed so that they can also hook onto passing objects and the erect habit of the plant would encourage dissemination by this method. Fullaway (1958) notes that in Hawaii, cattle dispersed <i>E. spinosa</i> achenes that attached to their feet. Within the desert habitats of Israel, Evenari et al. (1977) observed various animals spreading the aerial achenes."

707	Propagules dispersed by other animals (externally)	y
	Source(s)	Notes
	Haselwood, E.L., Motter, G.G., & Hirano, R.T. (eds.). 1983. Handbook of Hawaiian Weeds. University of Hawaii Press, Honolulu, HI	"Propagation: By seed. Burs with hard, sharp spines ore dispersed by animals and even automobile tires."

708	Propagules survive passage through the gut	n
	Source(s)	Notes
	Haselwood, E.L., Motter, G.G., & Hirano, R.T. (eds.). 1983. Handbook of Hawaiian Weeds. University of Hawaii Press, Honolulu, HI	"Propagation: By seed. Burs with hard, sharp spines ore dispersed by animals and even automobile tires." [Possibly, if consumed, but primarily externally dispersed]

801	Prolific seed production (>1000/m2)	y
	Source(s)	Notes

Qsn #	Question	Answer
	CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	"Individuals growing under poor field conditions (or in a short growing season) produce only a few seed (<10) at the crown, but the same plant is capable of producing over 1000 seeds given favourable conditions (Evenari et al., 1977; Weiss, 1980), with Putievsky et al. (1980) recording an average of 1188 seeds per plant. Seeds from <i>Emex</i> spp. have a lengthy but compulsory after-ripening period (Hagon and Simmons, 1978) so that when early rains occur some seed produced in the previous season are not yet at a suitable physiological state for germination. This makes control of <i>Emex</i> more difficult as new waves of seedlings may emerge with each subsequent major rainfall events throughout the season (Weiss, 1981). The presence of a proportion of achenes with long-term innate dormancy also results in a seed bank that can persist for years (Evenari et al., 1977; Weiss, 1980; 1990)."
	Fullaway, D. T. (1957). Importations of natural enemies of the weed, <i>Emex spinosa</i> Campd. Proceedings, Hawaiian Entomological Society, 16: 359-360	"Its presence in our pastures was duly reported by economic botanists, and since it is a heavy seeder and produces its seed in a spiny bur which cattle pick up on their feet and spread"

802	Evidence that a persistent propagule bank is formed (>1 yr)	
	Source(s)	Notes
	CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a>	[Probably yes based on longevity of <i>E. australis</i> seeds] "The achenes of <i>E. spinosa</i> are known to remain viable in the soil for many years and showed almost no mortality when stored in cardboard boxes at room temperatures for 7 years (Evenari et al., 1977); however, most studies on the persistence of viable <i>Emex</i> seed within the seed bank address <i>E. australis</i> and not <i>E. spinosa</i> . In Australia, where both species coexist, the degree of dormancy varies with the collection site, but the achenes from <i>E. spinosa</i> always have the higher rate of dormancy (Hagon, 1977). As <i>E. australis</i> seeds at some Australian sites are known to remain dormant within the soil for more than 8 years (Gilbey, 1996), this can be expected to also be possible for <i>E. spinosa</i> seeds."

803	Well controlled by herbicides	y
	Source(s)	Notes
	Motooka, P., Castro, L., Nelson, D., Nagai, G. & Ching, L. 2003. Weeds of Hawaii's Pastures and Natural Areas: An Identification and Management Guide. CTAHR, UH Manoa, Honolulu, HI	"Management: Sanitation is important in preventing the spread of spiny emex. The spiny fruits stick to soles of shoes and to vehicle tires. Very sensitive to dicamba; 0.25 lb/acre sufficient to kill all treated plants."

Qsn #	Question	Answer
	<p>CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. <a href="http://www.cabi.org/isc">www.cabi.org/isc</a></p>	<p>"Members of the Polygonaceae (including <i>Emex</i> spp.) are highly susceptible to dicamba, and it has proved effective in Hawaii (Motooka, 2002). To overcome the problems in using knapsack sprayers for herbicide application, a 'drizzle' method has been developed in which concentrated droplets of herbicides are squirted as a fine jet stream from up to 5 m away from the target weed which breaks up into large, sparsely distributed droplets that then drizzle onto the plant. By utilizing the drizzle method rather than conventional methods, labour requirements are reduced by 83-98%. Dicamba is registered for the control of <i>E. spinosa</i> within pastures, forests and non-cropping situations in Hawaii using this drizzle method (Motooka et al., 2002) and herbicide trials using this method gave &gt;86% control even with unfavourable spraying conditions (Motooka, 2002) and the drizzle method is also to apply the non-specific herbicides glyphosate and hexazinone." ... "ischof (1978) makes a general comment that <i>E. spinosa</i> within the Mediterranean region can be controlled with MCPA or 2,4-D. In Jordan, however, Turk and Tawaha (2003) noted that "in hot, dry areas 2,4-D application is not recommended for wheat and barley because (of its) negative effect on yield and yield components" reporting decreases in yields of &gt;22% for wheat and &gt;8% for barley whereas hand weeding increased yields. In Morocco, metribuzin and pendimethalin are the authorized herbicides for <i>E. spinosa</i> control in tomato crops (Rzozzi, 1999). In Libya, control of <i>E. spinosa</i> and other broadleaved weeds in sugar beet growing on irrigated sandy soils, pyrazon and lenacil are used (Siwicki, 1967) which are also widely used as a pre-emergent herbicide for the control of annual broadleaf weeds in beet crops throughout Europe (Thomson, 1989). However, so as to avoid crop damage, lower rates of application are recommended for use on sandy soils (Siwicki, 1967; Thomson, 1989). In Israel, the selective pre-emergent herbicide oxadiazon was effective for control of <i>E. spinosa</i>, other broadleaved weeds and grasses in transplanted Chinese cabbage (Lifshitz et al., 1987b), and pronamide alone, or in combination with oxadiazon, in transplanted iceberg lettuce (Lifshitz et al., 1987a). In Egypt, <i>E. spinosa</i> other annual broadleaved weeds are controlled by linuron or diuron, or for total control of all annual weeds, mixed with pendimethalin (Ibrahim et al., 1988)."</p>

804	Tolerates, or benefits from, mutilation, cultivation, or fire	n
	Source(s)	Notes



Qsn #	Question	Answer
	<p>CABI. (2020). Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc</p>	<p>[Regenerates by seed] "E. spinosa only reproduces by seed, is polygamo-monoecious (Zohary, 1966) and self compatible. " ... "Hand hoeing was the common practice used for controlling weeds, including E. spinosa, in crops such as sesame in Egypt, however growers are now switching to herbicides because they are cheaper and more effective (Ibrahim, 1988). In rainfed cereal crops in Jordan, increases of &gt;7% for wheat and &gt;4% for barley were observed following hand weeding of E. spinosa (Turk and Tawaha, 2003), and supplemented tillage as a weed control method, but again hand weeding is no longer economical. In Hawaii, prior to the introduction and establishment of the biological agent P. antiquum, small infestations of E. spinosa were hand weeded. Cultivation can stimulate the germination of Emex spp. achenes by burying those resting on the soil surface or by bringing deeply buried achenes closer to the surface where aeration, light and fluctuating temperatures can break seed dormancy (Hagon and Simmons, 1978; Weiss, 1980). Emex seedlings can then be killed by either a herbicide or a follow-up cultivation (Pearce, 1973). In general, weed control by cultivation is usually more effective in years with early rather than late autumn rains as most have already germinated, but there is a limit as to how late crop planting can be delayed before insufficient soil moisture at the end of the growing season will reduce crop yields (Turk and Tawaha, 2003)."</p>

805	<p><b>Effective natural enemies present locally (e.g. introduced biocontrol agents)</b></p>	<p><b>y</b></p>
	<p><b>Source(s)</b></p> <p>Markin, G.P., Lai, P. &amp; Funasaki, G.Y. (1992). Status of biological control of weeds in Hawaii and implications for managing ecosystems. Pp. 466-482 in Stone, C.P., Smith, C.W. &amp; Tunison, J.T. (eds.). Alien Plant Invasions in Native Ecosystems of Hawaii: Management and Research. Cooperative National Park Resources Studies Unit, University of Hawaii, Honolulu</p>	<p><b>Notes</b></p> <p>"Two very successful weed programs in Hawai'i have been against two annuals, the puncture vine (<i>Tribulus terrestris</i>) and the spiny emex (<i>Emex spinosa</i>) (Markin et al., this volume)." ... "Table 1. Introduction of insects and diseases for the biological control of weeds in Hawai'i.*" [<i>Emex spinosa</i> (L.) Campdera and <i>E. australis</i> Steinhell - Very successful control of both plants by the same insect"</p>

**Summary of Risk Traits:**

## High Risk / Undesirable Traits

- Elevation range exceeds 1000 m, demonstrating environmental versatility
- Grows in tropical climates
- Naturalized on Oahu, Molokai, Maui, and Hawaii (Hawaiian Islands), Australia, and elsewhere
- A disturbance-adapted that impacts agriculture and potentially the natural environment
- Other *Emex* species are invasive
- Spine-tipped achenes
- Allelopathic
- Tolerates many soil types
- Capable of forming dense cover in disturbed habitats
- Reproduces by seeds
- Hybridizes with *Emex australis*
- Self-compatible
- Reaches maturity in one growing season (annual)
- Seeds dispersed by sticking to animals and vehicles, by wind, water and as a seed contaminant
- Prolific seed production
- Might form a persistent seed bank (based on traits of related taxon)

## Low Risk Traits

- Thrives in open, disturbed habitats (may be shade intolerant)
- Not reported to spread vegetatively
- Herbicides and mechanical methods have provided effective control
- Biocontrol agents have been introduced into the Hawaiian Islands