Taxon: Silybum marianum (L.) Gaertn. **Family:** Asteraceae

Common Name(s): blessed milk thistle
bull thistle
gundagai thistle
holy thistle
lady's thistle
milk thistle
variegated artichoke
variegated thistle

Synonym(s): Carduus marianus L.
Mariana mariana (L.) Hill.

Assessor: Chuck Chimera **Status:** Assessor Approved **End Date:** 9 Sep 2018

WRA Score: 20.5 **Designation:** H(HPWRA) **Rating:** High Risk

Keywords: Biennial Herb, Spiny, Dense Thickets, Self-Fertile, Wind-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)	Intermediate
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	n=0, y = 2*multiplier (see Appendix 2)	y
305	Congeneric weed	n=0, y = 1*multiplier (see Appendix 2)	n
401	Produces spines, thorns or burrs	y=1, n=0	y
402	Allelopathic	y=1, n=0	n
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals	y=1, n=-1	n

Qsn #	Question	Answer Option	Answer
405	Toxic to animals		
406	Host for recognized pests and pathogens	y=1, n=0	n
407	Causes allergies or is otherwise toxic to humans	y=1, n=0	n
408	Creates a fire hazard in natural ecosystems		
409	Is a shade tolerant plant at some stage of its life cycle	y=1, n=0	n
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		
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	y
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	y
801	Prolific seed production (>1000/m2)	y=1, n=-1	y
802	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1	y
803	Well controlled by herbicides	y=-1, n=1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire		
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)		

Supporting Data:

Qsn #	Question	Answer
101	**Is the species highly domesticated?**	**n**
	Source(s)	**Notes**
	DiTomaso, J. 2007. Weeds of California and Other Western States. 2 Volumes. UCANR Publications, Oakland, CA	"Blessed milkthistle has been used medicinally for at least 2000 years" [with no apparent loss in weediness]

102	**Has the species become naturalized where grown?**	
	Source(s)	**Notes**
	WRA Specialist. 2018. Personal Communication	NA

103	**Does the species have weedy races?**	
	Source(s)	**Notes**
	WRA Specialist. 2018. 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, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 7 Sep 2018]	"Native Africa MACARONESIA: Portugal [Madeira Islands] NORTHERN AFRICA: Algeria, Egypt, Libya, Morocco, Tunisia Asia-Temperate WESTERN ASIA: Afghanistan, Cyprus, Egypt, [Sinai] Iran, Iraq, Israel, Jordan, Lebanon, Syria, Turkey CAUCASUS: Armenia, Azerbaijan, Russian Federation-Ciscaucasia [Ciscaucasia] SIBERIA: Russian Federation [Kurgan] MIDDLE ASIA: Tajikistan, Turkmenistan, Uzbekistan Asia-Tropical INDIAN SUBCONTINENT: India, [Himachal Pradesh, Jammu and Kashmir, Uttar Pradesh] Pakistan Europe SOUTHEASTERN EUROPE: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece (incl. Crete), Italy (incl. Sardinia, Sicily), Macedonia, Montenegro SOUTHWESTERN EUROPE: France (incl. Crosica), Portugal, Spain (incl. Baleares)"
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Variegated thistle originated in the Mediterranean region, Asia Minor and the Soviet Union. It has now spread to most temperate areas of the world and is considered an important weed in many of them."

202	**Quality of climate match data**	**Intermediate**

Qsn #	Question	Answer
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 7 Sep 2018]	

203	Broad climate suitability (environmental versatility)	y
	Source(s)	**Notes**
	Missouri Botanical Garden. (2018). Silybum marianum. http://www.missouribotanicalgarden.org. [Accessed 7 Sep 2018]	"Zone: 5 to 10"
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 7 Sep 2018]	Native & naturalized range extends from temperate to tropical regions

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	**Notes**
	Maui Invasive Species Committee. (2018). Blessed Milk Thistle (Silybum marianum). http://mauiinvasive.org/blessed-milk-thistle/. [Accessed 7 Sep 2018]	"Maui – Only known from a naturalized population in the Makawao area of Maui. MISC is working to eradicate the populations. Rarely cultivated as an ornamental, blessed milk thistle is more commonly grown for its medicinal properties. If you see this plant anywhere on Maui, please report it."
	Brandes, D. and Fritzsch, K. (2002). Alien plants of Fuerteventura, Canary Islands. http://www.maltawildplants.com/ASTR/Docs/ASTSQ/Canary_Aliens.pdf. [Accessed 7 Sep 2018]	"Small daily and yearly temperature deviations as well as no frost are characteristics of a marginal tropical climate" [naturalized in Canary Islands, subtropical]
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 7 Sep 2018]	Native & naturalize range includes regions with tropical climates (e.g. Asia-Tropical, Africa, & Southern America]

205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Variegated thistle originated in the Mediterranean region, Asia Minor and the Soviet Union. It has now spread to most temperate areas of the world and is considered an important weed in many of them. Variegated thistle is common in the western United States in pastures and neglected areas, and on channel banks. It is a common weed in sheep areas of New Zealand and is regarded as weedy in South Arica, South America (Argentina and Brazil) and Afghanistan, and within its native range throughout Europe and Tunisia, Israel, Jordan and Iraq. "

301	Naturalized beyond native range	y

Qsn #	Question	Answer
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 7 Sep 2018]	"Naturalized Africa MACARONESIA: Portugal, [Azores] Spain [Canary Islands] NORTHEAST TROPICAL AFRICA: Eritrea, Ethiopia EAST TROPICAL AFRICA: Kenya SOUTHERN AFRICA: South Africa [Eastern Cape, Gauteng] Australasia AUSTRALIA: Australia NEW ZEALAND: New Zealand Europe NORTHERN EUROPE: Denmark, Ireland, Norway, Sweden, United Kingdom MIDDLE EUROPE: Austria, Belgium EASTERN EUROPE: Belarus, Lithuania, Moldova, Russian Federation-European part, [European part] Ukraine (incl. Krym) SOUTHEASTERN EUROPE: Romania, Slovenia Northern America EASTERN CANADA: Canada [New Brunswick, Nova Scotia, Ontario, Quebec] WESTERN CANADA: Canada [Alberta, British Columbia, Saskatchewan] NORTHEASTERN U.S.A.: United States [Connecticut, Indiana, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Vermont, West Virginia] NORTHWESTERN U.S.A.: United States [Oregon, Washington] SOUTHEASTERN U.S.A.: United States [Alabama, Arkansas, Louisiana, Mississippi, North Carolina, Tennessee, Virginia] SOUTH-CENTRAL U.S.A.: United States [New Mexico, Texas] SOUTHWESTERN U.S.A.: United States [Arizona, California, Nevada] NORTHERN MEXICO: Mexico [Baja Norte] Southern America BRAZIL: Brazil [Parana, Rio Grande do Sul, Santa Catarina] WESTERN SOUTH AMERICA: Ecuador, Peru SOUTHERN SOUTH AMERICA: Argentina, Chile, Uruguay"
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Variegated thistle originated in the Mediterranean region, Asia Minor and the Soviet Union. It has now spread to most temperate areas of the world and is considered an important weed in many of them. Variegated thistle is common in the western United States in pastures and neglected areas, and on channel banks. It is a common weed in sheep areas of New Zealand and is regarded as weedy in South Africa, South America (Argentina and Brazil) and Afghanistan, and within its native range throughout Europe and Tunisia, Israel, Jordan and Iraq. "
	Maui Invasive Species Committee. (2018). Blessed Milk Thistle (Silybum marianum). http://mauiinvasive.org/blessed-milk-thistle/. [Accessed 7 Sep 2018]	[Recent MISC reports indicate Silybum may be eradicated or not present at former sites following active control measures] "Maui– Only known from a naturalized population in the Makawao area of Maui. MISC is working to eradicate the populations."

302	**Garden/amenity/disturbance weed**	

Qsn #	Question	Answer
	Source(s)	**Notes**
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	"In his observations of the species in southeast Australia, Parsons (1973) usually found it on soils of alluvial or volcanic origin, on the soils of river flats and in places where N was plentiful. In agriculture and forest lands it was found wherever soil was disturbed, on fire lanes of ranges and forests, on farm roads, around animal camps and yards and near rabbit warrens. Grasslands become susceptible to invasions by the species if dry weather in late summer and autumn results in breaks in the cover so that thistle seedlings become established." [a disturbance adapted weed of agriculture and natural settings, already scored for question 3.04]

303	Agricultural/forestry/horticultural weed	y
	Source(s)	**Notes**
	DiTomaso, J. 2007. Weeds of California and Other Western States. 2 Volumes. UCANR Publications, Oakland, CA	"Blessed milkthistle is a state-listed noxious weed in Oregon (class B) and Washington (class A) and is a government-listed noxious weed in much of southern Australia."
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	"In New Zealand, this species is a serious weed in open pastures and waste places, but particularly in coastal areas. Unconsolidated sands and light, stony soils that dry out badly in summer are likely to have good stands of S. marianum. Glue and Matthews (1957) found it to be the largest and fastest growing of all the common thistles in the country."
	Young, J. A., Evans, R. A., & Hawkes, R. B. (1978). Milk thistle (Silybum marianum) seed germination. Weed Science, 26(4), 395-398	"The Mediterranean climate of California has provided a suitable environment for many alien species (9), but milk thistle is relatively unique in that it rapidly spread through the central valleys of California during the 1940's (10). Spreading in a short time to dominate a discontinuous habitat is a remarkable demonstration of adaptation for colonizing. The agricultural environment that was invaded had been dominated by alien annual weeds for 150 yr. For a species without vegetative propagation to invade a community of annuals underscores the competitive advantage of its germination characteristics."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Weed of: Cereals, Cotton, Orchards & Plantations, Pastures, Sunflowers"

304	Environmental weed	y
	Source(s)	**Notes**
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	"The Pampas region of South America is the site of one of the world's most important grasslands. These grasslands were invaded by S. marianum and by Cynara cardunculus, often called "cardoon." The two species, introduced from Eurasia, grow to great size in the Pampas and in favorable seasons may form an almost impenetrable plant cover over large areas (Darwin 1839, Hudson 1918). Even today, at several places in the world where infestations have gotten out of control, it is not uncommon to travel and farm and range roads with thickets of S. marianum towering to 3 to 4 m in height on either side. "

Qsn #	Question	Answer
	Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"This plant occurs frequently in disturbed sites and is invasive because the large rosettes shade out native plants and form extensive patches that crowd out native vegetation and impede wildlife."

305	Congeneric weed	n
	Source(s)	**Notes**
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No other Silybum species are documented as weeds

401	Produces spines, thorns or burrs	y
	Source(s)	**Notes**
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Stout herb, stems glabrous to slightly pubescent, hollow or containing pith, ribbed, 90-250 cm tall. Leaves with variegated appearance on upper surface, shiny, deeply divided, spiny, margins wavy. Rosette leaves up to 60 cm long, stem leaves smaller."

402	Allelopathic	n
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Variegate thistle is very competitive in pastures and, when well established, eliminates most other plants, including other thistle species by shading and competition for moisture and nutrients" [not allelopathy]
	Gabay, R., Plitmann, U., & Danin, A. (1994). Factors affecting the dominance of Silybum marianum L. (Asteraceae) in its specific habitats. Flora, 189(3), 201-206	"We found no experimental evidence for effective allelopathic influence of S. marianum on the germination of other species. Thus, its dominance in the nests is probably not due to allelopathy but rather to other adaptive traits advantageous in competition, such as fast growth and a rapid gain of biomass, as observed in this study."

403	Parasitic	n
	Source(s)	**Notes**
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Stout herb, stems glabrous to slightly pubescent, hollow or containing pith, ribbed, 90-250 cm tall." [Asteraceae]

404	Unpalatable to grazing animals	n
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Goats readily eat the flower heads, and they have been used successfully by a number of landholders to reduce seed production which eventually has an effect on thistle populations."

Qsn #	Question	Answer
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	"poisoning of livestock as the result of feeding on S. marianum is not a special case of toxicity but instead is a routine problem that arises wherever animals are forced to or allowed to graze on species, sometimes crops, that accumulate high levels of nitrate. Stock animals normally have little interest in this formidable plant because of the tough, sharp spines on leaves and flowerheads. They will eat when the plant has been cut and wilted, or when it is standing after being sprayed with a hormone-like herbicide. At times of plant die-off in late summer and autumn, animals may be seed feeding on senescent leaves. If nitrogen is plentiful in the soil and the nitrate is high in the plant tissues the animals can be harmed. For the farmer who is uninformed of this there is a danger, and for those who appreciate the problem there is a dilemma, for if a range has a scattering of S. marianum or if his animals may suddenly break into dense patches of the thistle, there is a continuing decision that needs to be made about the quantity they should be allowed to ingest. In Australia, it is reported that the field cases of nitrate poisoning are very often in hungry livestock or among animals that are under the stress of mustering... "

405	Toxic to animals	
	Source(s)	**Notes**
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	"On occasion it is very high in nitrates and can be very toxic to stock animals…poisoning of livestock as the result of feeding on S. marianum is not a special case of toxicity but instead is a routine problem that arises wherever animals are forced to or allowed to graze on species, sometimes crops, that accumulate high levels of nitrate. Stock animals normally have little interest in this formidable plant because of the tough, sharp spines on leaves and flowerheads. They will eat when the plant has been cut and wilted, or when it is standing after being sprayed with a hormone-like herbicide. At times of plant die-off in late summer and autumn, animals may be seed feeding on senescent leaves. If nitrogen is plentiful in the soil and the nitrate is high in the plant tissues the animals can be harmed. For the farmer who is uninformed of this there is a danger, and for those who appreciate the problem there is a dilemma, for if a range has a scattering of S. marianum or if his animals may suddenly break into dense patches of the thistle, there is a continuing decision that needs to be made about the quantity they should be allowed to ingest. In Australia, it is reported that the field cases of nitrate poisoning are very often in hungry livestock or among animals that are under the stress of mustering" [Potentially indirectly toxic. Nitrogen is not a toxin but management issue]

406	Host for recognized pests and pathogens	n
	Source(s)	**Notes**
	Missouri Botanical Garden. (2018). Silybum marianum. http://www.missouribotanicalgarden.org. [Accessed 7 Sep 2018]	"Problems - No serious insect or disease problems. Watch for slugs and snails. Caterpillars may chew on the foliage."

Qsn #	Question	Answer
	Berner, D. K., Paxson, L. K., Bruckart, W. L., Luster, D. G., Mcmahon, M., & Michael, J. L. (2002). First report of Silybum marianum as a host of Puccinia punctiformis. Plant Disease, 86(11), 1271	"Silybum marianum (L.) Gaertn. (milk thistle) is a problematic invasive weed in the western United States. The rust fungus, Puccinia punctiformis (F. Strauss) Rohl., is found throughout the world as a pathogen of Cirsium arvense (L.) Scop. (Canadian thistle). Recently, plants of S. marianum grown from surface-disinfested seeds in our quarantine greenhouse were parasitized by a rust. Apparently, an isolate of P. punctiformis collected from C. arvense in Turkey that was present in the greenhouse had spread to adjacent S. marianum plants and caused infection without applying any artificial dew period. Ribosomal internal transcribed spacer region sequences from fungal spore DNA isolated from the two hosts were identical. Initial signs on S. marianum were abundant, fragrant spermogonia on large leaves. These signs occur on secondary shoots of C. arvense and are indicative of systemic fungal infection (1). As the fungus infection developed on S. marianum, uredinia and urediniospores were produced. Sori on older leaves also produced teliospores. Urediniospores from infected leaves were harvested and sprayed uniformly on eight 17-day-old plants of S. marianum grown in isolation from P. punctiformis. The spore suspension consisted of 4 mg urediniospores suspended in 40 ml distilled water. Inoculated plants were incubated for 18 h in a dew chamber at 20°C in the dark and transferred to a greenhouse (20 to 25°C, 30 to 50% relative humidity, and natural light). After 13 days, uredia with urediniospores developed on four of the plants. Using the same procedure, inoculations were repeated on plants of S. marianum and S. eburneum Coss. & Durieu (the only other species described in the genus) with urediniospores of a domestic isolate of the fungus from C. arvense in Maryland. Of 51 inoculated plants of S. marianum, 23 became infected and produced uredinia. None of the 12 inoculated plants of S. eburneum showed symptoms of infection. In nature, C. arvense and S. marianum occupy different ecological areas. C. arvense is found predominately in humid temperate habitats, while S. marianum is found in habitats with a dry Mediterranean climate. Life cycles of each host are also different. C. arvense is a perennial that emerges in spring and dies back in winter, while S. marianum is a winter annual that emerges in fall and dies in late spring. Because of the differences in life cycles combined with the different geographical distribution, P. punctiformis from C. arvense may rarely encounter susceptible S. marianum plants in the field. Since fungal spores can be produced routinely on artificially inoculated plants, there might be potential to use P. punctiformis for biological control of S. marianum. To our knowledge, this is the first report of S. marianum as a host for P. punctiformis."
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	Not listed as an important alternate hose for plant pathogens. Most mentions of pathogens deal with prospective biocontrol agents.

407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	**Notes**

Qsn #	Question	Answer
	DiTomaso, J. 2007. Weeds of California and Other Western States. 2 Volumes. UCANR Publications, Oakland, CA	"Seeds contain silybin, a compound that stimulates liver tissue growth and is used as an antidote for poisoning by the death cap mushroom [Amanita phalloides]. Blessed milkthistle has been used medicinally for at least 2000 years. The young foliage, with prickles removed, is sometimes consumed as a salad green or cooked vegetable."
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	"Young shoots can be boiled and eaten like cabbage and young leaves can be added to salads, the seeds can be used as a coffee substitute"

408	Creates a fire hazard in natural ecosystems	
	Source(s)	**Notes**
	Knapp, J. (2010). Catalina Island's invasive plant management program, with an emphasis on invasion and protection of oak ecosystems. Pp. 35-46 in Oak ecosystem restoration on Catalina Island, California. Catalina Island Conservancy, Avalon, CA	"Table 3. Invasive plant species and known or suspected impacts to oak ecosystems … Silybum marianum … Alters understory and fire regime, and competes with native species"
	Lambert, A. M., D'Antonio, C., & Dudley, T. L. (2010). Invasive species and fire in California ecosystems. Fremontia, 38(2-3), 29-36	[Potential ladder fuel] [Table 1 … thistles … Carduus spp., Cirsium spp., Cynara cardunculus, Silybum marianum … Could be ladder fuels in open woodlands; disturbed soils"

409	Is a shade tolerant plant at some stage of its life cycle	n
	Source(s)	**Notes**
	Plants for a Future. (2018). Silybum marianum. https://pfaf.org/user/Plant.aspx?LatinName=Silybum+marianum. [Accessed 7 Sep 2018]	"It cannot grow in the shade. It prefers dry or moist soil."
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Shading discourages thistle seedlings by reducing their root growth and, therefore, their capacity to survive in competition with deep-rooted perennial species."

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y
	Source(s)	**Notes**
	Missouri Botanical Garden. (2018). Silybum marianum. http://www.missouribotanicalgarden.org. [Accessed 7 Sep 2018]	"Grow in average, moderately fertile, well-drained soils in full sun. Tolerates poor soils."
	Karkanis, A., Bilalis, D., & Efthimiadou, A. (2011). Cultivation of milk thistle (Silybum marianum L. Gaertn.), a medicinal weed. Industrial Crops and Products, 34(1), 825-830	"Milk thistle is grown successfully on a range of soil types, from sandy soils to much heavier clay soils." … "Milk thistle is grown successfully on a range of soil types, from sandy soils to much heavier clay soils. Milk thistle is tolerant to a wide range of pH, but grows well in soils with a pH of 5.5–7.6 (Andrzejewska et al., 2011; Haban et al., 2009; Hadi et al., 2008) with adequate nutrient supply and salinity of 15 dS m−1, and produced seeds rich in actives substances."

411	Climbing or smothering growth habit	n

Qsn #	Question	Answer
	Source(s)	**Notes**
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Stout herb, stems glabrous to slightly pubescent, hollow or containing pith, ribbed, 90-250 cm tall."

412	Forms dense thickets	y
	Source(s)	**Notes**
	Mooney, H. A., & Hobbs, R. J. (2000). Invasive Species in a Changing World. Island Press. Washington, D.C.	"Charles Darwin (1898) provided one of the first and certainly one of the most vivid descriptions of a plant invasion at its zenith, the dominance of Silybum marianum (variegated thistle) in the Argentinean pampas by 1833. In recounting his overland journey from Bahia Blanca to Buenos Aires, he noted that "very many (probably several hundred) square miles are covered by one mass of these prickly plants, and are impenetrable to man or beast. Over the undulating plains, where these great beds occur, nothing else can now live."
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Under suitable conditions the weed forms nearly monospecific stands covering large areas."

501	Aquatic	n
	Source(s)	**Notes**
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	[Terrestrial] "Grassland, pastures, coastal scrub and dunes, riparian habitats, disturbed sites."

502	Grass	n
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 7 Sep 2018]	Family: Asteraceae (alt.Compositae) Subfamily: Carduoideae Tribe: Cardueae Subtribe: Carduinae

503	Nitrogen fixing woody plant	n
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 7 Sep 2018]	Family: Asteraceae (alt.Compositae) Subfamily: Carduoideae Tribe: Cardueae Subtribe: Carduinae

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	**Notes**

Qsn #	Question	Answer
	Karkanis, A., Bilalis, D., & Efthimiadou, A. (2011). Cultivation of milk thistle (Silybum marianum L. Gaertn.), a medicinal weed. Industrial Crops and Products, 34(1), 825-830	"Milk thistle plants develop a strong root system and thus can be cultivated in light soils with periodic water deficits."
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	"S. marianum can propagate only by seeds, some of which may persist in the field as long as 10 yr."

601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	**Notes**
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	"It is a common weed in sheep areas of New Zealand and is regarded as weedy in South Africa, South America (Argentina and Brazil) and Afghanistan, and within its native range throughout Europe and Tunisia, Israel, Jordan and Iraq." [No evidence. Widespread native & introduced range]

602	Produces viable seed	y
	Source(s)	**Notes**
	Karkanis, A., Bilalis, D., & Efthimiadou, A. (2011). Cultivation of milk thistle (Silybum marianum L. Gaertn.), a medicinal weed. Industrial Crops and Products, 34(1), 825-830	"Milk thistle is directly seeded in soils. Optimum germination occurs at 2–15 ◦C (Young et al., 1978). Ghavani and Ramin (2007) reported that the percentage of germination at 15 ◦C was higher than at 25 and 35 ◦C. Young et al. (1978) also observed that one month after harvest, milk thistle seeds had after-ripening requirements related to germination temperature that limited germination to 10–20 ◦C temperatures. Generally, the higher the incubation temperature during germination, the longer the after-ripening requirement (up to a maximum of 5 months). Andrzejewska et al. (2011) reported that the germinability of seeds was, depending on the year, from 65 to 75%. Therefore, in practice, 25–35% more sowing material was required. Seed is small (40–60 seeds per gram). The recommended sowing depth is 1–1.5 cm. Andrzejewska et al. (2011) reported a sowing depth of 3 cm. Sowing occurs in autumn and spring depending on environment conditions (rainfall and temperature). Therefore, in moderate climates sowing occurs in spring. In addition, in warm climates sowing occurs in autumn (Table 1)."
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	"S. marianum can propagate only by seeds, some of which may persist in the field as long as 10 yr."
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Seeds black or brown, smooth, mottled, 6-8 mm long."

Qsn #	Question	Answer
603	**Hybridizes naturally**	
	Source(s)	**Notes**
	Kadereit, J.W. & Jeffrey, C. (eds.). 2010. The Families and genera of vascular plants. Volume VIII. Flowering Plants. Eudicots: Asterales. Springer-Verlag, Berlin, Heidelberg, New York	[Unknown] "Silybum … Two or three species, Mediterranean region, introduced elsewhere."

604	**Self-compatible or apomictic**	**y**
	Source(s)	**Notes**
	Keasar, T., Gerchman, Y., & Lev-Yadun, S. (2016). A seven-year study of flower-color polymorphism in a Mediterranean annual plant. Basic and Applied Ecology, 17(8), 741-750	"S. marianum is a spiny annual ruderal weedof Mediterranean origin … Its protandrous, self-compatible flowers are arranged in flower heads that remainopen for 2–3 weeks. … Inflorescences covered with insect exclusion nets produced 30%more seeds than inflorescences that were not caged. This suggests that S. marianum can self-pollinate spontaneously, and that insect herbivores may substantially reduce seed set."
	Karkanis, A., Bilalis, D., & Efthimiadou, A. (2011). Cultivation of milk thistle (Silybum marianum L. Gaertn.), a medicinal weed. Industrial Crops and Products, 34(1), 825-830	"Since the outcrossing rate on average is only about 2%, Silybum is predominantly a self-pollinator (Hetz et al., 1995)."

605	**Requires specialist pollinators**	**n**
	Source(s)	**Notes**
	Keasar, T., Gerchman, Y., & Lev-Yadun, S. (2016). A seven-year study of flower-color polymorphism in a Mediterranean annual plant. Basic and Applied Ecology, 17(8), 741-750	"Most of the visitors were honeybees, but solitary bees, wasps and beetles were also recorded."
	Thorp, R. W., Wenner, A. M., & Barthell, J. F. (2000). Pollen and nectar resource overlap among bees on Santa Cruz Island. In Proceedings of the Fifth California Islands Symposium (Browne et al., eds) (pp. 261-267)	"Reduction in seed set after removal of honey bees may not occur as predicted for some other exotic weeds since they are also frequently visited by diverse guilds of native bees. Examples may include Asteraceae: Centaurea solstitialis, Cichorium intybus L., and Silybum marianum (L.) Gaertn.;"
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"The plant is of some value to the honey industry because the flowers provide a useful source of pollen in early summer."

606	**Reproduction by vegetative fragmentation**	**n**
	Source(s)	**Notes**
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	"S. marianum can propagate only by seeds, some of which may persist in the field as long as 10 yr."

Qsn #	Question	Answer
607	**Minimum generative time (years)**	**1**
	Source(s)	**Notes**
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	"S. marianum is an erect annual or biennial to 3 m or more, commonly 1 to 2 m"

701	**Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)**	**y**
	Source(s)	**Notes**
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"It reproduces by seeds, which are dispersed mainly by wind but also in mud attaching to animals and machinery."

702	**Propagules dispersed intentionally by people**	**y**
	Source(s)	**Notes**
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	"The weed is spread by natural means, by transport vehicles, including farm equipment, by animals, with movement of hay, in mud and water, by accident on sacks and other articles of commerce, and sometimes with intent to use the species for folk remedies or other medical purposes."

703	**Propagules likely to disperse as a produce contaminant**	**y**
	Source(s)	**Notes**
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	"In 1851, in Australia, this species was subject of the first legislation against noxious weeds in that country…In Tasmania, it is found in feed grains offered to stock animals and in low-grade, uncertified cropseed supplies. Here it is one of the species whose seeds are "prohibited" in the standards for certified pasture seed."

704	**Propagules adapted to wind dispersal**	**y**
	Source(s)	**Notes**
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"It reproduces by seeds, which are dispersed mainly by wind but also in mud attaching to animals and machinery."
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	"seeds and pappus may vary in size, and where latter is large enough the seed may be carried some distance by the wind…The seeds are large and have a small pappus, so that many are found within a few meteres of the parent plant, thus giving rise to dense local stands (2)Seeds probably disperse only short distances with wind"

Qsn #	Question	Answer
705	**Propagules water dispersed**	**y**
	Source(s)	**Notes**
	Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Seeds are dispersed by attaching to animals, by water and in mud."

706	**Propagules bird dispersed**	**n**
	Source(s)	**Notes**
	Bruzzese, E. (1996). Ecology of Cirsium vulgate and Silybum marianum in relation to biological control. Plant Protection Quarterly, 11, 245-249	"Variegated thistle seeds are large and palatable and are eaten by birds and rodents. Evidence of this was observed at all sites. In spite of these losses, large seed banks were maintained at all sites." [Birds and rodents are seed predators, not dispersers, although some seeds might be dispersed by seed caching birds or rodents]

707	**Propagules dispersed by other animals (externally)**	**y**
	Source(s)	**Notes**
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"It reproduces by seeds, which are dispersed mainly by wind but also in mud attaching to animals and machinery."

708	**Propagules survive passage through the gut**	**y**
	Source(s)	**Notes**
	Bruzzese, E. (1996). Ecology of Cirsium vulgate and Silybum marianum in relation to biological control. Plant Protection Quarterly, 11, 245-249	"Variegated thistle seeds are large and palatable and are eaten by birds and rodents. Evidence of this was observed at all sites. In spite of these losses, large seed banks were maintained at all sites." [birds and rodents are seed predators, not dispersers]
	Harrington, K. C., Beskow, W. B., & Hodgson, J. (2011). Recovery and viability of seeds ingested by goats. New Zealand Plant Protection 64: 75-80	[A very small percentage of seeds may remain viable after ingestion by goats] "The percentage of viable seeds ingested that remained viable when excreted ranged from 25.7% for broad-leaved dock to 0.5% for variegated thistle (Silybum marianum). A large proportion of recovered seeds was excreted within 24 h of ingestion, and all seeds had passed through the goats within 72 h."
	Fazelian, S., Kohyani, P. T., & Shirmardi, H. A. (2014). Endozoochorous seed dispersal of plant species in semi-steppe rangelands. International Journal of Advanced Biological and Biomedical Research, 2(2), 473-486	[Seeds survive after passage through cattle, sheep & goats] "The results showed for Silybum marianum species, there was a significant difference between the cattle treatment with sheep and goats treatments. Germination percent in cattle treatment higher than other animal treatments and equal with 4/16 percent." … "Species Salvia officinalis, Conium maculatom, Cynara scolymus, Silybum marianum and Plantago lanceolata, germinated in all four treatments (3 animal treatments and one control treatment), that the percentage of germination for this species, in cattle treatment more than two other animals treatments, and germination percentage in control treatment is more than germination of each animal treatments."

801	**Prolific seed production (>1000/m2)**	**y**

Qsn #	Question	Answer
	Source(s)	**Notes**
	Young, J. A., Evans, R. A., & Hawkes, R. B. (1978). Milk thistle (Silybum marianum) seed germination. Weed Science, 26(4), 395-398	"Precise figures on seed pro- production for milk thistle are not available. We do know that seeds average 0.02 g in weight, about 50 seeds are produced per terminal head, and 10 to 50 heads are produced per plant. From this we can calculate 10 to 50 g of seed produced per plant. With a conservative average density of 2 plants/mi2 theoretical seed production reaches 100 to 500 kg/ha."
	Bruzzese, E. (1996). Ecology of Cirsium vulgate and Silybum marianum in relation to biological control. Plant Protection Quarterly, 11, 245-249	"Seed banks ranged from 2111 to 6058 seeds m-2."

802	**Evidence that a persistent propagule bank is formed (>1 yr)**	**y**
	Source(s)	**Notes**
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Seeds may remain viable in the soil for at least 9 years."

803	**Well controlled by herbicides**	**y**
	Source(s)	**Notes**
	Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Chemical control is most effective at the seedling and rosette stages. An effective herbicide is 2,4-D ester. Planting desirable species suppresses seedling establishment of this plant. "
	Parsons, W.T. & Cuthbertson, E.G. 2001. Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Variegated thistle is susceptible to several herbicides. It is most readily killed in the seedling and rosette stages, becoming more resistant as plants mature. Herbicides containing 2,4-D or MCPA are effective, but in New Zealand, MCPA is generally preferred. Because seeds germinate over several months and autumn spraying kills only those plants which have emerged, a further spraying is necessary to kill those germinating in later winter-early spring. "

804	**Tolerates, or benefits from, mutilation, cultivation, or fire**	
	Source(s)	**Notes**
	DiTomaso, J. 2007. Weeds of California and Other Western States. 2 Volumes. UCANR Publications, Oakland, CA	"Cultivation can control seedlings. Mowing mature plants before flowers open can help control stands. Burning can encourage seed germination and establishment" [Seeds stimulated by fire, but is suppressed by cultivation and mowing]

Qsn #	Question	Answer
805	**Effective natural enemies present locally (e.g. introduced biocontrol agents)**	
	Source(s)	**Notes**
	DiTomaso, J. 2007. Weeds of California and Other Western States. 2 Volumes. UCANR Publications, Oakland, CA	"The seedhead weevil (Rhinocyllus conicus) was released in 1971 in southern California as a biocontrol agent for blessed milkthistle, but control has been poor to date. In addition, the weevil attacks several native thistle species." [Probably no natural enemies in Hawaii, but unknown at this point]

Summary of Risk Traits:

High Risk / Undesirable Traits
• Broad climate suitability (5+ hardiness zones & broad natural & introduced ranges)
• Naturalized in regions with tropical climates
• Naturalizing on Maui (prior to control by Maui Invasive Species Committee); widely naturalized elsewhere
• A disturbance-adapted agricultural & environmental weed
• Spiny
• May be high in nitrates & potentially toxic to grazing animals
• Tolerates many soil types
• Forms dense thickets that exclude other vegetation
• Reproduces by seeds
• Self-fertile
• Can reach maturity in 1-2 years
• Seeds dispersed by wind, water, in mud stuck to animals & machinery, as a contaminant & intentionally by people
• Prolific seed production
• Seeds remain viable for at least 9 years

Low Risk Traits
• Palatable to browsing/grazing animals
• Requires full sun (shade limits ability to spread)
• Not reported to spread vegetatively
• Herbicides provide effective control