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Weed Risk Assessment For *Carthamus oxyacantha* (Asteraceae) – Wild safflower

Carthamus oxyacantha (Photo by Nasser Halaweh, creative commons license; iNaturalist, 2020)

AGENCY CONTACT
Plant Epidemiology and Risk Analysis Laboratory
Science and Technology
Plant Protection and Quarantine
Animal and Plant Health Inspection Service
United States Department of Agriculture
1730 Varsity Drive, Suite 300
Raleigh, NC 2760

Executive Summary

The result of the weed risk assessment for *Carthamus oxyacantha* is Moderate Risk of becoming weedy or invasive in the United States. *Carthamus oxyacantha* is an annual herb that can grow up to 1.5 m tall. In the 1970s, it was found growing outside a spice plant in Monterey County, CA but it has since been eradicated and is not present in the United States. It has not spread outside its native range. It is a Federal Noxious Weed and is regulated in Florida. It is self-compatible and reproduces only by seed. In its native range, it is a weed of grains and legumes. It reduces crop yield, and its sharp spines interfere with harvesting. Several of its congeners are also weeds, although *C. tinctorius* is the safflower species cultivated for its oil. We estimate that 10 to 43 percent of the United States is suitable for the establishment of *C. oxyacantha*. While it could potentially enter the United States as a seed contaminant or on vehicles, we have high uncertainty for both pathways.

Plant Information and Background

PLANT SPECIES: *Carthamus oxyacantha* M. Bieb. (Asteraceae) (NPGS, 2020)

SYNONYMS: *Carthamus flavescens* Willd. (NPGS, 2020), *C. oxyacanthus* M. Bieb. (Kartesz, 2015; NRCS, 2020)

COMMON NAMES: Wild safflower (NPGS, 2020), jeweled distaff thistle (NRCS, 2020).

BOTANICAL DESCRIPTION: *Carthamus oxyacantha* is an annual herb up to 1.5 m tall. It has sharp spines on the leaves and yellow flower heads, which are 1-1.5 inches across (Flowers of India, 2016). It grows in sandy soil in hot, dry areas (Tanveer et al., 2012) and on dry, open plains and mountains (Ahmad et al., 2010).

INITIATION: PPQ received a permit request for *C. oxyacantha* for use in breeding with cultivated safflower, *C. tinctorius*. Although that request was later voided, we developed this analysis to characterize the risk potential of *C. oxyacantha* and determine whether it should be delisted as a Federal Noxious Weed. A similar analysis was done for *C. tinctorius*.

WRA AREA[1]: United States and Territories

FOREIGN DISTRIBUTION: *Carthamus oxyacantha* is native from Iran southeast through India and as far north as Kazakhstan (NPGS, 2020). Tanveer et al. (2012) also describe it as native to tropical South Africa, but we found no other evidence of its presence in that country. It is not established outside of its native range (NPGS, 2020). It is used as a source of edible oil and animal feed, and the young leaves may be eaten by people (Tanveer et al., 2012). It is also used medicinally (Schori and Showalter, 2011) and could be a source of biodiesel fuel (Azam et al., 2010). We found no evidence, however, that it is cultivated for any of these purposes.

U.S. DISTRIBUTION AND STATUS: *Carthamus oxyacantha* was formerly present in Monterey County, CA near a spice plant, but the location was paved over, so the species has been eradicated (CDFA, 2017; Kartesz, 2015; Kelch, 2020). McPherson et al. (2004) list it as present in Florida and Oregon, but we were unable to verify that information. We found no evidence of sale in any nurseries (Plant Information Online, 2020) and no indication of interest on gardening forums (Dave's Garden, 2020; GardenWeb, 2020). It is a Federal Noxious Weed (7 CFR § 360, 2010) that was listed in 1976 (APHIS, 1976); it is regulated in Florida and South Carolina (NPB, 2020).

[1] The “WRA area” is the area in relation to which the weed risk assessment is conducted (definition modified from that for “PRA area”) (IPPC, 2017).

Analysis

ESTABLISHMENT/SPREAD POTENTIAL: *Carthamus oxyacantha* is a weed in its native range (Ahmadi et al., 2016) but is not established anywhere as an exotic (Al Fadal and Al-Fredan, 2015; NPGS, 2020). It is a self-compatible annual (McPherson et al., 2004) that reproduces only by seed (CDFA, 2017). It is dispersed primarily by wind (Khalid and Shad, 1990) and possibly externally on animals (CDFA, 2017). Several of its congeners are also significant weeds (Ash et al., 2010; Bowles et al., 2010; Imrie and Knowles, 1970; Vilatersana et al., 2007). We have very high uncertainty for this risk element.

Risk score = 7.0 Uncertainty index = 0.31

IMPACT POTENTIAL: *Carthamus oxyacantha* is a weed of agricultural systems, including wheat, barley, corn, chickpea, and lentil (Ahmadi et al., 2016; Chaturvedi et al., 2014; Khan et al., 2004; Tanveer et al., 2012). It contributes to yield loss in wheat (Hussain et al., 2012), chickpea (Khan et al., 2004), and field pea (Tewari et al., 2008) and the spines interfere with crop harvesting (Khan et al., 2011; Khan et al., 2004). It appears to compete with wheat for water (Khalid, 1988). We have very low uncertainty for this risk element due to the abundance of literature referring to its agricultural impact.

Risk score = 2.2 Uncertainty index = 0.06

GEOGRAPHIC POTENTIAL: Using the PPQ climate-matching model for weeds (Magarey et al., 2017), we estimate that about 10 to 43 percent of the United States is suitable for the establishment of *C. oxyacantha*. (Fig. 1). The larger area represents the joint distribution of Plant Hardiness Zones 5-11; areas with 0-40 inches of annual precipitation; and the following Köppen-Geiger climate classes: steppe, desert, Mediterranean, humid subtropical, marine west coast, humid continental warm summer, and humid continental cool summer. (See Appendix). The area of the United States shown to be climatically suitable was determined using only these variables. Other factors such as soil, hydrology, disturbance regime, and species interactions may alter the areas in which this species is likely to establish. In its native range, it grows in sandy soil in hot, dry areas (Tanveer et al., 2012); on dry, open plains and mountains (Ahmad et al., 2010); and as a weed of various grains and legumes (Ahmadi et al., 2016; Chaturvedi et al., 2014; Khan et al., 2004; Tanveer et al., 2012).

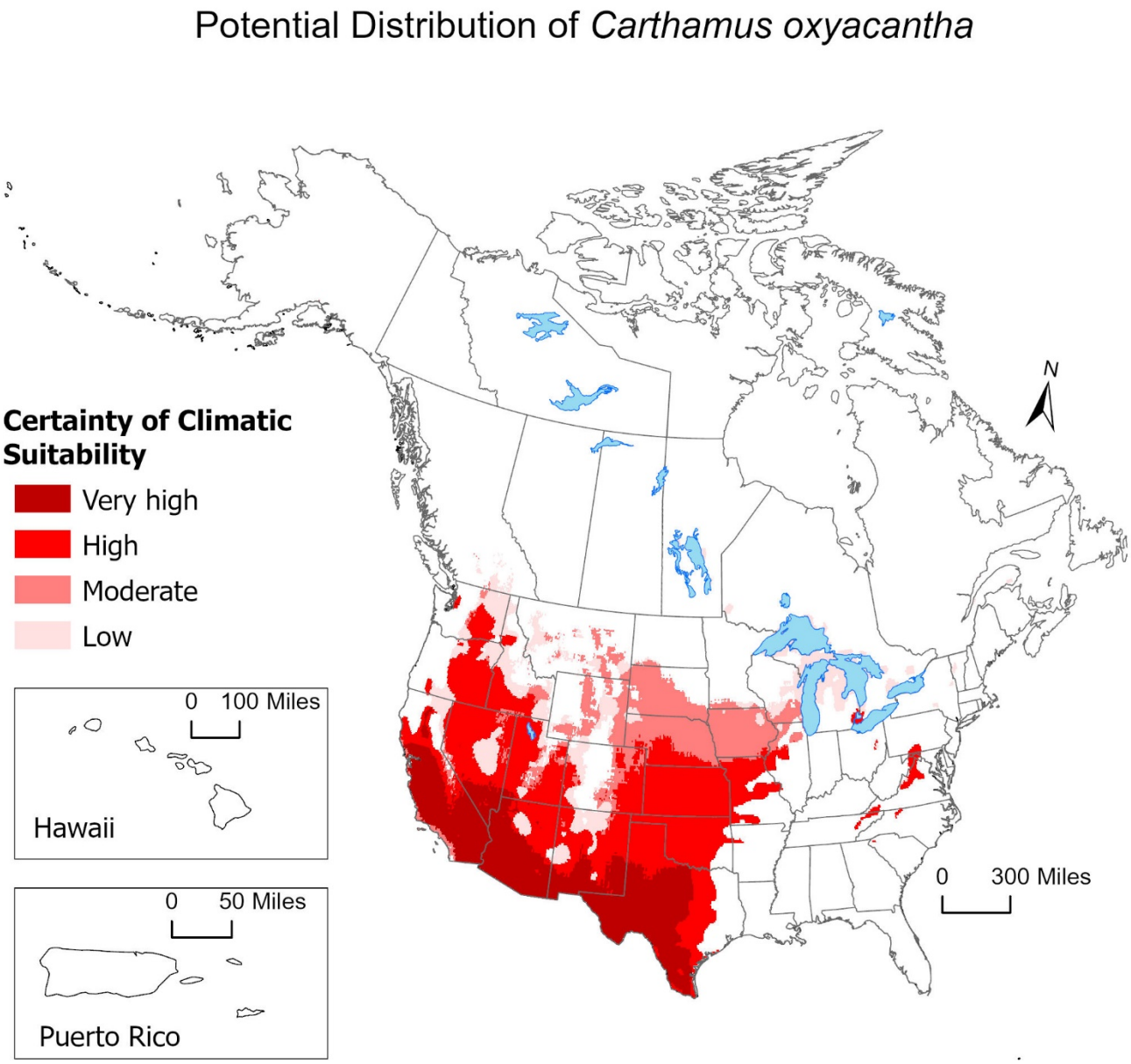

Figure 1. Potential distribution of *Carthamus oxyacantha* in the United States. Climatic suitability was determined using the APHIS-PPQ climate matching tool for invasive plants (Magarey et al., 2017). The known distribution of *C. oxyacantha* was based on distribution records from online databases and other sources (see text).

ENTRY POTENTIAL: PPQ received a request for a permit to bring *C. oxyacantha* into the United States for breeding with cultivated safflower; this is the most likely method of entry. The species could potentially also enter as a seed contaminant (AQAS, 2020) or as a hitchhiker on vehicles (CDFA, 2017).

Risk score = 0.09 Uncertainty index = 0.06

Risk Model Results

Model Probabilities: P(Major Invader) = 23.8%
P(Minor Invader) = 67.3%
P(Non-Invader) = 8.8%
Risk Result = Evaluate Further
Risk Result after Secondary Screening = Moderate Risk

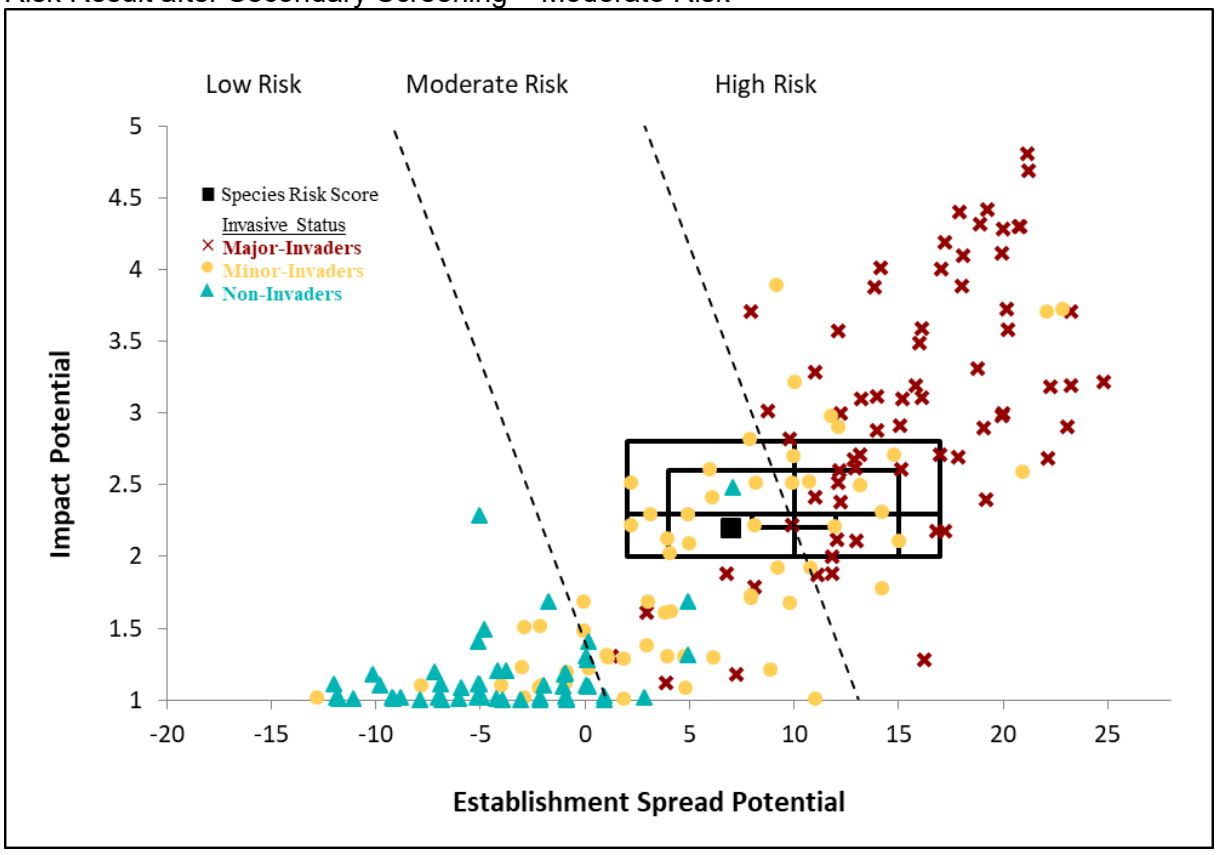

Figure 2. Risk and uncertainty results for *Carthamus oxyacantha*. The risk score for this species (solid black symbol) is plotted relative to the risk scores of the species used to develop and validate the PPQ WRA model (Koop et al., 2012). The results from the uncertainty analysis are plotted around the risk score for *C. oxyacantha*. The smallest, black box contains 50 percent of the simulated risk scores, the second 95 percent, and the largest 99 percent. The black vertical and horizontal lines in the middle of the boxes represent the medians of the simulated risk scores (N=5000). Note the 50th percentile box in this assessment collapsed into a line on the median Impact value of 2.3; it ranges from 10 to 14 on the ES risk element. For additional information on the uncertainty analysis used, see Caton et al. (2018)

Discussion

The result of the weed risk assessment for *Carthamus oxyacantha* is Moderate Risk of becoming weedy or invasive in the United States. It is well-documented as an agricultural weed, but we have more uncertainty about its ability to establish and spread. The only verifiable record that we found from outside of its native range was in Monterey County, CA, and it has been eradicated from that site (Kelch, 2020).

PPQ received a permit request to bring *C. oxyacantha* into the United States for breeding with cultivated safflower. Chloroplast DNA indicates that *C. oxyacantha* was the wild progenitor of *C. tinctorius* var. *tinctorius*, one variety of cultivated safflower (Sehgal et al., 2008); the species are closely related. They can form viable hybrids (Ashri and Knowles, 1960), and the oil characteristics are similar between *C. oxyacantha* and *C. tinctorius*; thus, *C. oxyacantha* could possibly serve as a source of stress resistance genes without decreasing oil quality (Saeidi et al., 2008). If *C. oxyacantha* or its hybrids were to escape, however, they could acquire genes for herbicide resistance from interbreeding with transgenic safflower (McPherson et al., 2004). In Pakistan and India, cultivated safflower is harvested at the same time of year that *C. oxyacantha* starts to bloom; thus, natural hybridization is unlikely there (Ashri and Knowles, 1960). We do not know, however, whether the reproductive periods for the two species would overlap if *C. oxyacantha* were to become established in the United States.

Suggested Citation

PPQ. 2020. Weed risk assessment for *Carthamus oxyacantha* M. Bieb. (Asteraceae) – Wild safflower. United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (PPQ), Raleigh, NC. 19 pp.

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Appendix. Weed risk assessment for *Carthamus oxyacantha* M. Bieb. (Asteraceae)

The following table includes the evidence and associated references used to evaluate the risk potential of this taxon. We also include the answer, uncertainty rating, and score for each question.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ESTABLISHMENT/SPREAD POTENTIAL			
ES-1 [What is the taxon's establishment and spread status outside its native range? (a) Introduced elsewhere =>75 years ago but not escaped; (b) Introduced <75 years ago but not escaped; (c) Never moved beyond its native range; (d) Escaped/Casual; (e) Naturalized; (f) Invasive; (?) Unknown]	c - high	0	*Carthamus oxyacantha* is native from Iran, southeast through India and as far north as Kazakhstan (NPGS, 2020). Tanveer et al. (2012) describe it as native to South Africa, but we found no other evidence of this. According to current databases (EDDMapS, 2020; Kartesz, 2015; NRCS, 2020), it was present in Monterey County, CA, but it has in fact been eradicated from the single location in the state (Kelch, 2020). McPherson et al. (2004) list it as present in Florida and Oregon, but we could not verify this. We found no other information about *C. oxyacantha* spreading outside of its native range. As a result, we do not consider it to have a tendency to escape. Our alternate answers for the uncertainty simulation were "d" and "b."
ES-2 (Is the species highly domesticated)	n - negl	0	*Carthamus oxyacantha* is the wild progenitor of cultivated safflower (Sehgal et al., 2008) and may be a source of genetic material for breeding (Saeidi et al., 2008), but it is not cultivated as a crop.
ES-3 (Significant weedy congeners)	y - negl	1	The genus *Carthamus* includes 55 species (Mabberley, 2008). *Carthamus lanatus* and *C. leucocaulos* are important weeds in Australia (Ash et al., 2010; Bowles et al., 2010}); *C. flavescens* is a weed in Turkey, Syria, Lebanon, and Iraq (Imrie and Knowles, 1970); and *C. creticus* and *C. turkestanicus* are noxious weeds in the Mediterranean region (Bowles et al., 2010; Vilatersana et al., 2007). California regulates *C. lanatus*, *C. creticus*, and *C. leucocaulos* as state noxious weeds (CDFA, 2020).
ES-4 (Shade tolerant at some stage of its life cycle)	n - mod	1	We found no information, but since *C. oxyacantha* is a plant of hot, dry places, it is likely to be under full sun and not shade-tolerant.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-5 (Plant a vine or scrambling plant, or forms tightly appressed basal rosettes)	n - high	0	*Carthamus* spp. are described as having a rosette phase (Arslan, 2018); however, botanical descriptions of *C. oxyacantha* (Ahmad et al., 2010; Reed, 1977) did not describe the leaves as rosette-forming, suggesting that the rosette phase may not be significant. Our uncertainty is high because of the lack of information.
ES-6 (Forms dense thickets, patches, or populations)	n - low	0	We found no evidence of dense populations.
ES-7 (Aquatic)	n - negl	0	It is a terrestrial herb (Flowers of India, 2016).
ES-8 (Grass)	n - negl	0	It is in the family Asteraceae (NPGS, 2020) and thus, it is not a grass.
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	We found no evidence that this species fixes nitrogen. Furthermore, it is not a member of a plant family that is known to contain nitrogen fixing species (Santi et al., 2013).
ES-10 (Does it produce viable seeds or spores)	y - negl	1	Kheradnam and Bassiri (1978) found that it produced viable seed.
ES-11 (Self-compatible or apomictic)	y - negl	1	Khider (1969) describes the species as both self-compatible and outcrossing. Al Fadal and Al-Fredan (2015) report that it is primarily self-pollinated but outcrosses about ten percent of the time.
ES-12 (Requires specialist pollinators)	n - low	0	*Carthamus oxyacantha* can be pollinated by insects but is typically self-pollinated (Al Fadal and Al-Fredan, 2015). Since it can self-pollinate and specific insect pollinators are not mentioned, it most likely does not require specialist pollinators.
ES-13 [What is the taxon's minimum generation time? (a) less than a year with multiple generations per year; (b) 1 year, usually annuals; (c) 2 or 3 years; (d) more than 3 years; or (?) unknown]	b - negl	1	*Carthamus oxyacantha* is an annual (McPherson et al., 2004; Tanveer et al., 2012). We found no evidence that it can produce more than one generation per year or that it takes longer than a year to grow and set seed. Our answers for the uncertainty simulation were both "a."

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-14 (Prolific seed producer)	? - max	0	Kheradnam and Bassiri (1978) found that each plant produced an average of 150 flowering heads, with 11 seeds per head, though only 60 percent of heads were fertile. About 54 percent of seeds germinated, so the total average would be about 890 viable seeds per plant. Khan et al. (2005) found an average density of 74 weeds /m^2 in untreated wheat fields and listed eight major weed species, including *C. oxyacantha*, but we do not know how many were *C. oxyacantha*, so we cannot determine the number of plants/m^2. Al Fadal and Al-Fredan (2015) observed up to 530 seeds per plant and made no reference to viability.
ES-15 (Propagules likely to be dispersed unintentionally by people)	? - max	0	The California Department of Food and Agriculture assessment indicates that the heads can be dispersed by human activity and on vehicles (CDFA, 2017), but they do no cite any sources and we found no direct evidence. Although the seeds are small, they do not appear to have any adaptations for sticking to clothing or vehicles (Scher et al., 2015).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	y - mod	2	*Carthamus oxyacantha* seed has been intercepted at U.S. ports of entry 20 times since 2010, typically in baggage as a contaminant of other seeds (AQAS, 2020). The California Department of Food and Agriculture assessment states that the heads can be contaminants of agriculture products (CDFA, 2017), but no direct evidence is provided.
ES-17 (Number of natural dispersal vectors)	1	-2	The fruits are pale, shiny, brown-splotched achenes with a tapered shape, 3-5.5 mm long, 2.25 mm wide, and 1.5 mm thick. They develop with a pappus, but it falls off early and is rarely seen (Reed, 1977).
ES-17a (Wind dispersal)	y - low		The dry plants and heads are blown by the wind, which disperses the seeds (CDFA, 2017; Khalid and Shad, 1990).
ES-17b (Water dispersal)	n - mod		The achenes do not have any particular adaptations for water dispersal, and the species is found primarily in dry areas (Ahmad et al., 2010); thus, water dispersal is unlikely.
ES-17c (Bird dispersal)	? - max		Unknown. The blue rock pigeon (*Columba livia*) feeds on the species (Batool et al., 2019), but we found no evidence of the birds dispersing the seeds.
ES-17d (Animal external dispersal)	? - max		The California Department of Food and Agriculture assessment indicates that the

Question ID	Answer - Uncertainty	Score	Notes (and references)
			heads can be dispersed by animals (CDFA, 2017), but they do not cite any sources, and we found no direct evidence.
ES-17e (Animal internal dispersal)	n - high		We found no evidence for this dispersal method, and the plant does not produce a fleshy fruit that would likely be eaten.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	y - mod	1	Hussain et al. (2017) found 140 seeds/m^2 in a soil sieving experiment but no seedlings in a seedling emergence experiment. Heydari et al. (2014) found *C. oxyacantha* seeds in the seed banks of forest sites where human activity had been abandoned, but they found no aboveground plants, so we do not know if those seeds were viable. In the undisturbed forest, they found aboveground plants, but no seeds in the seed bank. In a study of weed seeds in wheat fields, Ahmad et al. (2018) recorded 740 *C. oxyacantha* seeds/m^2 before cultivation, 130/m^2 before sowing, and 1200/m^2 after harvest. Bassiri and Rouhani (1976) found that year-old seeds did not lose viability and that scarification did not significantly increase the germination rate. We have moderate uncertainty since we have evidence of seeds persisting in the soil and of being viable for over a year but not evidence of soil seed banks allowing for long-term persistence of the weed.
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	? - max	0	Unknown. We found no information on the response of the species to physical disturbance.
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	y - mod	1	*Carthamus oxyacantha* is not listed in the International Herbicide-Resistant Weed Database (Heap, 2020). It could, however, hybridize with transgenic cultivated safflower and acquire genes for herbicide resistance (Mayerhofer et al., 2011; McPherson et al., 2004)
ES-21 (Number of cold hardiness zones suitable for its survival)	7	0	
ES-22 (Number of climate types suitable for its survival)	7	2	
ES-23 (Number of precipitation bands suitable for its survival)	4	-1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - low	0	We found no evidence of allelopathy for this species.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-G2 (Parasitic)	n - negl	0	*Carthamus oxyacantha* is not reported to be parasitic and is not in a family known to include parasitic species (Heide-Jorgensen, 2008).
Impacts to Natural Systems			
Imp-N1 (Changes ecosystem processes and parameters that affect other species)	n - low	0	We found no evidence of this impact.
Imp-N2 (Changes habitat structure)	n - low	0	We found no evidence of this impact.
Imp-N3 (Changes species diversity)	n - low	0	We found no evidence of this impact.
Imp-N4 (Is it likely to affect federal Threatened and Endangered species?)	n - low	0	*Carthamus oxyacantha* is primarily an agricultural weed and unlikely to affect endangered or threatened species.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions?)	n - low	0	*Carthamus oxyacantha* is primarily an agricultural weed and unlikely to affect globally significant ecoregions.
Imp-N6 [What is the taxon's weed status in natural systems? (a) Taxon not a weed; (b) taxon a weed but no evidence of control; (c) taxon a weed and evidence of control efforts]	a - low	0	We found no evidence that *C. oxyacantha* is a weed of natural areas. Our alternate answers for the uncertainty simulation were both "b."
Impact to Anthropogenic Systems (e.g., cities, suburbs, roadways)			
Imp-A1 (Negatively impacts personal property, human safety, or public infrastructure)	n - low	0	We found no evidence of this impact.
Imp-A2 (Changes or limits recreational use of an area)	n - low	0	We found no evidence of this impact.
Imp-A3 (Affects desirable and ornamental plants, and vegetation)	n - low	0	We found no evidence of this impact.
Imp-A4 [What is the taxon's weed status in anthropogenic systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	a - low	0	We found no evidence that *C. oxyacantha* is a weed of anthropogenic systems. Our alternate answers for the uncertainty simulation were both "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	y - negl	0.4	Sixty percent of respondents in Peshawar, Pakistan listed it as a major weed of wheat, and 91 percent reported yield loss due to major weeds (Hussain et al., 2012). The plant encourages lodging of wheat, making it difficult to harvest, and in some areas of Lakki Marwat, Pakistan, *C. oxyacantha* and *Alhajii maurorum* covered 80 percent of the crop area (Khan et al., 2011). It reduces yield in chickpea and cereals and interferes with harvesting (Khan et al., 2004). Treating field pea with metribuzin to control *C. oxyacantha* increased yield by 57 percent (Tewari et al., 2008).

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-P2 (Lowers commodity value)	n - mod	0	We found no evidence of this impact.
Imp-P3 (Is it likely to impact trade?)	y - mod	0.2	*Carthamus oxyacantha* is listed as a harmful organism by Colombia, Honduras, and Mexico (PCIT, 2020). It may occasionally be an agricultural contaminant (CDFA, 2017). We have moderate uncertainty because we have little evidence of the species being moved as a contaminant.
Imp-P4 (Reduces the quality or availability of irrigation, or strongly competes with plants for water)	? - max	0	Unknown. Khalid (1988) recorded a high moisture content in *C. oxyacantha* from wheat fields during the stage at which wheat is particularly sensitive to soil moisture and surmised that the weed deprives the crop of water. We do not, however, have enough information about the water use of *C. oxyacantha* compared to that of wheat or about water availability to say whether the weed actually deprives the wheat crop of water.
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - low	0	Livestock will not eat the plant because of its sharp spines (Flowers of India, 2016), but we found no evidence that it is toxic. It is not listed in the Cornell University database of plants toxic to livestock (Cornell CALS, 2020).
Imp-P6 [What is the taxon's weed status in production systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	c - negl	0.6	It is a weed of wheat, barley, corn, chickpea, and lentil (Ahmadi et al., 2016; Chaturvedi et al., 2014; Khan et al., 2004; Tanveer et al., 2012). It was one of the dominant weeds of broad bean targeted by a weed suppression experiment in Iraq (Alsaadawi et al., 2013) and of wheat targeted by an experiment in Pakistan (Hassan et al., 2008). Das et al. (2000) tested 26 different herbicide regimes for the control of *C. oxyacantha*. Our alternate answers for the uncertainty simulation were both "b."
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically referenced points obtained from the Global Biodiversity Information Facility (GBIF Secretariat, 2019).
Plant hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence of presence in this zone.
Geo-Z2 (Zone 2)	n - negl	N/A	1 point in Afghanistan, away from other points.
Geo-Z3 (Zone 3)	n - negl	N/A	We found no evidence of presence in this zone.
Geo-Z4 (Zone 4)	n - negl	N/A	We found no evidence of presence in this zone.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-Z5 (Zone 5)	y - mod	N/A	1 point in Afghanistan, Iran, and Turkey.
Geo-Z6 (Zone 6)	y - low	N/A	3 points in Iran, 2 in Armenia and Afghanistan, 1 in Pakistan and Turkey.
Geo-Z7 (Zone 7)	y - low	N/A	3 points in Afghanistan, 2 in Iran, 1 in Georgia and Turkey.
Geo-Z8 (Zone 8)	y - negl	N/A	6 points in Iran, 5 in Afghanistan, 2 in Azerbaijan, 1 in Turkey.
Geo-Z9 (Zone 9)	y - negl	N/A	Few points in Pakistan; 4 in Afghanistan; 1 in Kuwait, Iraq, and Iran.
Geo-Z10 (Zone 10)	y - negl	N/A	Some points in Pakistan and 1 in India, Iran, and Iraq.
Geo-Z11 (Zone 11)	y - mod	N/A	2 points in Pakistan near the border with Zone 10, 1 in India.
Geo-Z12 (Zone 12)	n - negl	N/A	We found no evidence of presence in this zone.
Geo-Z13 (Zone 13)	n - negl	N/A	We found no evidence of presence in this zone.
Köppen -Geiger climate classes			
Geo-C1 (Tropical rainforest)	n - negl	N/A	We found no evidence of presence in this climate class.
Geo-C2 (Tropical savanna)	n - mod	N/A	1 point in India, very far away from all other points. Without more evidence, we assumed that this band is most likely not suitable for the species.
Geo-C3 (Steppe)	y - negl	N/A	Few points in Pakistan and Afghanistan, 7 in Iraq, 2 in Armenia, 2 in Azerbaijan.
Geo-C4 (Desert)	y - negl	N/A	Many points in Pakistan, 5 in Afghanistan, 3 in Iran, 1 in Iraq and Kuwait.
Geo-C5 (Mediterranean)	y - negl	N/A	3 points in Pakistan, 2 in Iran, 1 in Afghanistan, Iraq, and Turkey.
Geo-C6 (Humid subtropical)	y - negl	N/A	Some points in Pakistan, 1 in Georgia and India.
Geo-C7 (Marine west coast)	y - low	N/A	4 points in Pakistan.
Geo-C8 (Humid cont. warm sum.)	y - low	N/A	3 points in Turkey, 2 in Iran, 1 in Pakistan
Geo-C9 (Humid cont. cool sum.)	y - high	N/A	1 point in Turkey in the same general area as the others.
Geo-C10 (Subarctic)	n - negl	N/A	We found no evidence of presence in this climate class.
Geo-C11 (Tundra)	n - negl	N/A	We found no evidence of presence in this climate class.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence of presence in this climate class.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	y - negl	N/A	Many points in Pakistan, 7 in Afghanistan, 3 in Iran, 1 in Iraq and Kuwait.
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	8 points in Pakistan and Afghanistan, 5 in Iran, 2 in Armenia, 1 in Turkey and Azerbaijan.
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	Many points in Pakistan, 4 in Iran, 2 in Afghanistan, 1 in India.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-R4 (30-40 inches; 76-102 cm)	y - low	N/A	6 points in Pakistan, 1 in Afghanistan, Iran, and Turkey.
Geo-R5 (40-50 inches; 102-127 cm)	n - high	N/A	1 point in Turkey, Iran, and India. These points are all very close to drier sites and are in mountains, which can result in spatial error in the map data. Thus, we assumed that this band is most likely not suitable for the species.
Geo-R6 (50-60 inches; 127-152 cm)	n - high	N/A	2 points in Turkey, 1 in Georgia. These points are all very close to drier sites and are in mountains, which can result in spatial error in the map data. Thus, we assumed that this band is most likely not suitable for the species.
Geo-R7 (60-70 inches; 152-178 cm)	n - negl	N/A	We found no evidence of presence in areas receiving more than 60 inches of annual precipitation.
Geo-R8 (70-80 inches; 178-203 cm)	n - negl	N/A	See notes for Geo-R7.
Geo-R9 (80-90 inches; 203-229 cm)	n - negl	N/A	See notes for Geo-R7.
Geo-R10 (90-100 inches; 229-254 cm)	n - negl	N/A	See notes for Geo-R7.
Geo-R11 (100+ inches; 254+ cm)	n - negl	N/A	See notes for Geo-R7.
ENTRY POTENTIAL			
Ent-1 (Plant already here)	n - low	0	The species has been eradicated from California (Kelch, 2020). One reference lists it as present in Florida and Oregon (McPherson et al., 2004), but we were not able to verify this.
Ent-2 (Plant proposed for entry, or entry is imminent)	n - negl	0	PPQ received a permit request to acquire *C. oxyacantha* plants for breeding with cultivated safflower. The species is not, however, proposed for continual trade; thus, we answered no.
Ent-3 [Human value & cultivation/trade status: (a) Neither cultivated or positively valued; (b) Not cultivated, but positively valued or potentially beneficial; (c) Cultivated, but no evidence of trade or resale; (d) Commercially cultivated or other evidence of trade or resale]	b - low	0.05	*Carthamus oxyacantha* is used as a source of edible oil and animal feed, and the young leaves may be eaten by people (Tanveer et al., 2012). It is also used medicinally (Schori and Showalter, 2011) and could be a source of biodiesel fuel (Azam et al., 2010). We found no evidence, however, that it is cultivated for any of these purposes.
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	n - low		It is native from the Middle East through India and is not present outside its native range (NPGS, 2020).
Ent-4b (Contaminant of plant propagative material (except seeds))	n - low	0	We found no evidence.
Ent-4c (Contaminant of seeds for planting)	y - high	0.04	*Carthamus oxyacantha* seed has been intercepted at U.S. ports of entry 20 times since 2010, typically in baggage as a contaminant of other seeds (AQAS, 2020). It was also detected near a spice plant in

Question ID	Answer - Uncertainty	Score	Notes (and references)
			California, although it is no longer present at that location (CDFA, 2017).
Ent-4d (Contaminant of ballast water)	n - low	0	We found no evidence. *Carthamus oxyacantha* is a weed of hot, dry environments (Tanveer et al., 2012) and so is unlikely to grow particularly near coastlines.
Ent-4e (Contaminant of aquarium plants or other aquarium products)	n - negl	0	*Carthamus oxyacantha* is a terrestrial plant found in hot, dry environments (Tanveer et al., 2012) and is very unlikely to contaminate aquarium products.
Ent-4f (Contaminant of landscape products)	n - low	0	We found no evidence.
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	? - max	0	Unknown. We found no evidence. A California Department of Agriculture assessment indicated that the heads can be dispersed on vehicles but did not provide a specific citation (CDFA, 2017). Therefore, we answered unknown since we found no additional evidence.
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	n - low	0	We found no evidence.
Ent-4i (Contaminant of some other pathway)	a - low	0	We found no evidence.
Ent-5 (Likely to enter through natural dispersal)	n - negl	0	The species is not present in Canada, Mexico, or the Caribbean (NPGS, 2020) and has no mechanism for natural dispersal from its native range to the United States.