NAME OF SPECIES: Centaurea solstitialis L. (1)	
Synonyms: N/A	
Common Name: Yellow star-thistle, St. Barnaby's thistle, (1). Golden star-thistle, yellow cockspur (7).	
A. CURRENT STATUS AND DISTRIBUTION	
I. In Wisconsin?	1. YES ☒ NO ☐
	2. Abundance: 3 recorded occurrences in WI (1).
	3. Geographic Range: One recorded occurrence in each of the southern counties of Crawford, Rock, Waukesha, and Kern (1).
	4. Habitat Invaded: Farm fields, weedy roadsides (1). Disturbed Areas ☒ Undisturbed Areas ☐
	5. Historical Status and Rate of Spread in Wisconsin: The first recorded occurrence is from 1958. (1)
	6. Proportion of potential range occupied: Probably <1% (MS)
II. Invasive in Similar Climate Zones	1. YES ☒ NO ☐ Where (include trends): Nationally, the weed is found in 23 of the 48 contiguous states, extending as far east as New York. It has also extended into Canada from British Columbia to Ontario. (6) Infestations of yellow star-thistle in the eastern 2/3 of the U.S. are sporadic and localized, but apparently populations fail to establish and persist on a year-to-year basis, possibly because of unfavorable growth conditions. (8) Unsure how future climate conditions will influence abundance.
III. Invasive in Similar Habitat Types	1. Upland ☒ Wetland ☐ Dune ☐ Prairie ☒ Aquatic ☐ Forest ☐ Grassland ☐ Bog ☐ Fen ☐ Swamp ☐ Marsh ☐ Lake ☐ Stream ☐ Other: Open, disturbed sites, grasslands, rangeland, open woodlands, fields, pastures, roadsides, waste places (7). Shrub steppe (11).
IV. Habitat Effected	1. Soil types favored or tolerated: Well-drained soils (2). Prefers soils with deep silt loam and loam w/few course sediments and well drained. (5) (6). Prefers to live in places that experience droughts in the summer (2). Temps above 30 C severely reduce seed germination (5). Shade reduces root growth (5). Plants can establish in poor soils including rocky and sandy soils. While it prefers deeper soils this doesn't limit its spread.
	2. Conservation significance of threatened habitats: Found in Death Valley National Park, Glen Canyon National Recreation Area, Redwood National Park, Sequoia and Kings Canyon National Parks, and Yosemite National Park (2). Threatens globally rare species, Lomatium cookei, in Oregon (6).
V. Native Habitat	1. List countries and native habitat types: Star-thistle is native to North Africa, temperate Asia/Eurasia (Balkan-Asia minor, the Middle East, south-central Europe), and the Mediterranean region of southern Europe. (2) Northern Africa: Algeria; Tunisia. Asia: Iran; Iraq; Lebanon; Syria; Turkey; Armenia; Azerbaijan; Georgia; Russian Federation - Ciscaucasia, Dagestan; Tajikistan; Turkmenistan. Europe: Ukraine; Albania; Bulgaria; Greece [incl. Crete]; Italy [incl. Sardinia, Sicily]; Yugoslavia; France [incl. Corsica]; Spain [incl. Baleares]. (9)

VI. Legal Classification	1. Listed by government entities? Noxious in AZ, CA, CO , ID, MT, NV, NM, ND, UT, WA. Regulated in OR, SD. (3).
	2. Illegal to sell? YES ☒ NO ☐ Notes: California, CO: A list noxious; ID: noxious; MT: category 3 noxious; NV: noxious; NM: ; ND; UT; WA. (3)
B. ESTABLISHMENT POTENTIAL AND LIFE HISTORY TRAITS	
I. Life History	1. Type of plant: Annual ☒ Biennial ☒ Monocarpic Perennial ☐ Herbaceous Perennial ☐ Vine ☐ Shrub ☐ Tree ☐
	2. Time to Maturity: 8 days from flower initiation to mature seed production (5). Over 90% of C. solstitialis seeds are germinable one week after seed dispersal. Maximum germination of seeds (nearly 100%) occurs when seeds are exposed to moisture, light and temperatures of 10, 15, or 20 Celsius. (13)
	3. Length of Seed Viability: Seed can survive for up to 10 years in the field, depending on environmental conditions (7). However, in other studies conducted in California, over 95% of the seed either emerged or were damaged two or three years after natural dispersal to the soil surface. This suggests that C. solstitialis seeds may be relatively short-lived under normal field conditions where seeds are predominantly dispersed on the soil surface. (6)
	4. Methods of Reproduction: Asexual ☐ Sexual ☒ Notes: Seed heads typically contain ~ 30-80 seeds. Seed head production is highly variable (1- 1000 heads per plant) and depends on a variety of factors, including soil moisture and competition. Most seeds are dispersed within 2 ft of parent plant, but move further due to human/animal carriers. Large plants can produce nearly 75,000 seeds. Infestations can produce 50-100 million seeds/acre. (2) (5)(7)
	5. Hybridization potential: N/A
II. Climate	1. Climate restrictions: Prefers to live in places that experience limited precipitation in summer (2). Temps above 30 C severely reduces seed germination (5). Shade reduces root growth (5). C. solstitialis is best adapted to open grasslands with average annual precipitation between 10 and 60 inches (25 to 150 cm) per year. It is generally associated with deep well-drained soils. Although populations can occur at elevations at high as 8,000 ft (2,400 m), most large infestations are found below 5,000 ft (1,500 m). (6). Shaded conditions reduce flower production and root growth. In some areas, flowering plants may be found year-round in areas not exposed to severe frost. (7)
	2. Effects of potential climate change: N/A

III. Dispersal Potential	1. Pathways - Please check all that apply: Unintentional: Bird ☒ Animal ☒ Vehicles/Human ☒ Wind ☒ Water ☐ Other: Spread in hay. Seeds fall near the parent plant or are dispersed to short distances with wind and to greater distances with human activities, animals, and soil movement (7). Seed is transported in large amounts by road maintenance equipment and on the undercarriage of vehicles. The movement of contaminated hay and uncertified seed are also important long distance transportation mechanisms. Once at a new location, seed is transported in lesser amounts and over short to medium distances by animals and humans when the seed adheres to clothing and to hair and fur. Birds also transport seed over great distances. (6) Intentional: Ornamental ☐ Forage/Erosion control ☐ Medicine/Food: ☐ Other:
	2. Distinguishing characteristics that aid in its survival and/or inhibit its control: Max germination of 100% can be reached if seeds get moisture, light and constant temps between 10 -20 C degrees (5). Continuous germination throughout spring rainy season (5). Taproots grow vigorously early in the season to soil depths of 1 m or more, giving plants access to deep soil moisture during the dry summer and early fall months. (7) Disturbances created by cultivation, poorly timed mowing, road building and maintenance, or overgrazing favor this rapid colonizer.(12)
IV. Ability to go Undetected	1. HIGH ☐ MEDIUM ☐ LOW ☒ Notes:
C. DAMAGE POTENTIAL	
I. Competitive Ability	1. Presence of Natural Enemies: Several biocontrol agents have been introduced from the Mediterranean region to control yellow star-thistle. Currently established in California are the yellow star-thistle bud weevil (Bangasternus orientalis), hairy weevil (Eustenopus villosus), flower weevil (Larinus curtus), gall fly (Urophora sirunaseva), peacock fly (Chaetorellia australis), and false peacock fly (Chaetorellia succinea). These insects have yet to provide significant reduction in yellow star-thistle populations in most areas. (7)
	2. Competition with native species: Invades a desert preserve in Oregon containing the threatened Lomatium cookei. Lomatium cookei currently ranked as a G1 in the NatureServe database in March 2004. Occasionally threatens endangered grassland species (e.g., Chlorogalum purpureum var. purpureum). (11)
	3. Rate of Spread: -changes in relative dominance over time: -change in acreage over time: HIGH(1-3 yrs) ☒ MEDIUM (4-6 yrs) ☐ LOW (7-10 yrs) ☐ Notes: Star-thistle's introduction in North America probably occurred sometime after 1849 as a seed contaminant in Chilean-

	grown alfalfa seed. By 1958, it was estimated to have invaded over 1 million acres (400,000 ha) of California. Over the past 40 years, C. solstitialis has spread exponentially to infest rangeland, native grasslands, orchards, vineyards, pastures, roadsides, and wasteland areas. Infestations reached nearly 8 million acres (3 million ha) in California by 1985. In 1989, it was estimated that C. solstitialis was expanding in rangelands by 7,000-20,000 acres/year (2800-8000 ha/yr) in the west. By 1994, the rate of spread was estimated to be twice as rapid. (6) Spread at a rate of ca. 6%/year (11).
II. Environmental Effects	1. Alteration of ecosystem/community composition? YES ☒ NO ☐ Notes: C. solstitialis infestations can reduce wildlife habitat and forage, displace native plants, and decrease native plant and animal diversity. Dense infestations not only displace native plants and animals, but also threaten natural ecosystems and nature reserves by fragmenting sensitive plant and animal habitat. (6) Knapweeds can reduce biomass production of neighboring plants as much as 90% and also can greatly reduce the species diversity of a site. (10) Threatens pacific northwest bunchgrasses and rare plants associated with them (11)
	2. Alteration of ecosystem/community structure? YES ☒ NO ☐ Notes: More uniform density in grassland layer. Displaces native plants and can form impenetrable stands. (11)
	3. Alteration of ecosystem/community functions and processes? YES ☒ NO ☐ Notes: C. solstitialis significantly depletes soil moisture reserves in annual grasslands in California and in perennial grasslands in Oregon. Heavy infestations of C. solstitialis in grasslands with loamy soils can use as much as 50% of annual stored soil moisture. In deep soils, C. solstitialis can significantly reduce soil moisture reserves to depths greater than six feet (1.8 m). (6) Utilizes deep soil moisture, often creating artificial drought conditions even after average precipitation years; Increased erosion from switch from perennial to annual system; negatively impacts or eliminates microbiotic crust layer (11).
	4. Allelopathic properties? YES ☐ NO ☐ Notes: It is unclear if allelopathy is a major competitive factor (10)
D. SOCIO-ECONOMIC Effects	
I. Positive aspects of the species to the economy/society:	Notes: N/A
II. Potential socio-economic effects of requiring controls: Positive: Negative:	Notes: N/A
III. Direct and indirect socio-economic effects of plant:	Notes: Seeds often contaminate grains and hay. Yellow star-thistle contains an unidentified compound that causes nigropallidal encephalomalacia or chewing disease in horses. The compound

	only affects horses and permanently damages the area of the brain that controls fine motor movements, including mouth and lip movements. Bees foraging on yellow star-thistle flowers produce a flavorful high quality honey. (7) Because of its high water usage, C. solstitialis threatens both human economic interests as well as native plant ecosystems. (6)
IV. Increased cost to sectors caused by the plant:	Notes: Millions of dollars in losses probably occur from interference with livestock grazing and forage harvesting procedures, and lower yield and forage quality of rangelands. Because of the spiny nature of C. solstitialis, livestock and wildlife avoid grazing in heavily infested areas. Thus, infestations can greatly increase the cost of managing livestock. It can also reduce land value and reduce access to recreational areas. C. solstitialis might also cause an annual economic loss of $16 to $56 million in water conservation costs in the Sacramento River watershed alone.(6)
V. Effects on human health:	Notes: N/A
VI. Potential socio-economic effects of restricting use: Positive: Negative:	Notes: N/A
E. CONTROL AND PREVENTION	
I. Costs of Prevention (including education; please be as specific as possible):	Notes: N/A
II. Responsiveness to prevention efforts:	Notes: Survey roadsides for the presence of this weed and immediately control new infestations to prevent seed production and its subsequent spread. It is important to control new infestations when they are small because spot eradication is least expensive and most effective at this time.(12)
III. Effective Control tactics:	Mechanical ☒ Biological ☒ Chemical ☒ Times and uses: Management techniques, such as grazing, mowing, burning, and cultivation, can prevent seed production and control infestations when employed over a period of 2-3 years or more, depending on the degree of infestation and other factors. These methods must be properly timed to be effective. High-intensity short-duration grazing by sheep, goats, or cattle should be implemented during the period when plants have developed flowering stems, but not spiny heads. Mowing is most effective when plants are cut below the height of the lowest branches and 2-5 % of the total population of seed heads is in bloom. Mowing too early usually reduces seed production, but doesn't eliminate it. Prescribed burns can provide control if implemented after annual plants have dried, but before yellow star-thistle seed is produced. Burning at other times may enhance yellow star-thistle survival. Repeated shallow cultivation throughout the germination period and prior to seed production can control plants in crop fields. To prevent re-infestation, vigilant monitoring and spot eradication may be required indefinitely. All star-thistles are highly susceptible to the herbicide cloppyralid. (7) There are herbicide resistant biotypes in the Southwest of the country.

	Effective late-season control strategies such as mowing, tillage, prescribed burning, or post emergence herbicides should be conducted after seasonal rainfall events are completed, but before viable seeds are produced. In addition, the use of pre-emergence herbicides applied from late fall to early spring should provide residual control extending beyond the rainy season.(5) Bio-controls, Eustenopus villosus and Chaetorellia succinea, have proven to be the most effective agents for yellow star-thistle seed suppression. These insects are becoming more widespread throughout California. However, they only suppress yellow star-thistle seed production by about 50%, so they should not be considered as the sole method of control. It is possible that a combination of herbicides and biocontrol will provide more sustainable control than either technique used alone. (12) Several herbicides are effective in controlling YST.
IV. Minimum Effort:	Notes: Due to the short longevity of the seedbank yellow star-thistle management programs may require only two to three years of effective control to dramatically reduce the soil seedbank and infestation. (5)
V. Costs of Control:	Notes: N/A
VI. Cost of prevention or control vs. Cost of allowing invasion to occur:	Notes: N/A
VII. Non-Target Effects of Control:	Notes: N/A
VIII. Efficacy of monitoring:	Notes: N/A
IX. Legal and landowner issues:	Notes: N/A

F. REFERENCES USED:

☐ UW Herbarium
☐ WI DNR
☐ TNC
☐ Native Plant Conservation Alliance
☐ IPANE
☐ USDA Plants

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Author(s), Draft number, and date completed: Ashlie Kollmansberger, Mariquita Sheehan, 2nd Draft. May 14, 2007

Reviewer(s) and date reviewed: M. Renz, Sept. 19, 2007. Jerry Doll, September 27, 2007.

Approved and Completed Date: