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Population Viability Assessment for Hill's thistle (Cirsium hillii (Canby) Fernald)

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POPULATION VIABILITY ASSESSMENT FOR HILL'S THISTLE (CIRSIUM HILLII (CANBY) FERNALD)

SCIENTIFIC NAME: Cirsium hillii (Canby) Fernald

COMMON NAME: Hill's thistle, prairie thistle, pasture thistle, small prairie thistle, hollow-rooted thistle

FAMILY: Asteraceae

SYNONYMS: Cirsium pumilum (Nuttall) Sprengel subsp. hillii (Canby) Moore & Frankton; Cirsium pumilum (Nuttall) Sprengel var. hillii (Canby) Boivin

USFS REGION 9 STATUS: Sensitive Species

USFW STATUS: None

ILLINOIS STATUS: Threatened Species

GLOBAL AND STATE RANK: G3N3

RANGE: This species can be found in Ontario, Pennsylvania, Ohio, Michigan, Indiana, Illinois, Wisconsin, Iowa, Minnesota, and possibly in South Dakota (Gleason and Cronquist, 1991; Moore and Frankton, 1966) (figure 1). In Illinois, this species can be found in 36 counties: Adams, Cass, Champaign, Christian, Coles, Cook, DeKalb, DuPage, Fulton, Greene, Grundy, Hancock, Henry, Iroquois, Kane, Kankakee, Knox, Lake, Lee, Logan, McDonough, McHenry, Macoupin, Madison, Mason, Menard, Montgomery, Morgan, Peoria, Putnam, Sangamon, Schuyler, Scott, Stark, Will, and Winnebago (figure 2).

PHYSIOGRAPHIC DISTRIBUTION: Cirsium hillii can be found in the Southwestern Great Lakes Moraines Section and Ozark Highlands Section of the Eastern Broadleaf Forest Continental Province (Key et al., 1995). Based upon the Natural Divisions of Illinois (Schwegman et al., 1973), this species can be found in the Rock River Hill County Division, Northeastern Morainal Division, Grand Prairie Division, Upper Mississippi River and Illinois Bottomlands Division (Mississippi River Section), Illinois River and Mississippi River Sand Division, Western Forest-Prairie Division, Middle Mississippi Border Division, and Wisconsin Driftless Division (Eric Ulaszek per. comm.).

HABITAT: This species can be found in dry-mesic prairies, hill prairies, sand prairies, savannas, open woods, and alvar communities. Plants associated with Cirsium hillii in prairies are: Amorpha canescens, Arenaria stricta, Asclepias viridiflora, Aster sericeus, Bouteloua curtipendula, Dalea purpurea, Gentiana puberula, Lithospermum incisum,

Pedicularis canadensis, Schizachyrium scoparium, Silphium terebinthinaceum, Solidago nemoralis, Sporobolus heterolepis, and Zizia aptera (Swink and Wilhelm, 1994).

SPECIES DESCRIPTION: Short-lived perennial 25-60 cm tall with a deep taproot (hollow rooted). Stem simple or with one to two short branches near the top. Leaves mostly basal. Alternate lanceolate leaves, serrate lobed with fine marginal spines (3-6 mm long), and pinnate venation. Inflorescence a bright rose-pink terminal flower head (1-4) with hundreds of flowers (Kenneth Robertson per. comm.). Fruit is an achene. As an adult Cirsium hillii is a very distinct species however during the seedling and rosette stages it can be confused with Cirsium vulgaris.

LIFE HISTORY: Both sexual and asexual reproduction can be found in Cirsium hillii. Cirsium hillii blooms from June to August. Seeds will germinate forming a vegetative plant having a rosette with purplish prickly leaves. Potentially, Cirsium hillii can be in this vegetative stage for several years (Kenneth Robertson per. comm.) and eventually it will bolt producing a flowering shoot with 1-4 flower heads. After Cirsium hillii blooms it will set fruit and normally it will die. At this point no information is available regarding the breeding system of the species. However, Voss and Eifert (1978) suggest that butterflies are potential pollinators. In the case of asexual reproduction, Cirsium hillii can produce a basal rosettes from adventitious buds along the lateral roots or sometimes plants that have bolted may produce lateral shoots before dying (after blooming) (Ostlie and Bender, 1990).

Although Cirsium hillii has high seed production (Kenneth Robertson per. comm.), seed germination has been suggested to be low (10-20% in greenhouse experiment) (Ostlie and Bender, 1990). Several seed treatments (e.g. moist stratification at 40 °F for two months followed by sowing or surface sowing with warm stratification followed by cold stratification) have been suggested to enhance germination (Ostlie and Bender, 1990). Because of the low seed germination it is possible that seeds have low viability or a light requirement. Besides the above treatments, it has been suggested that fire, mowing, or minor soil disturbances are needed for seed germination (Ostlie and Bender, 1990; TNC-BioSources, 1999)

Seeds are dispersed by wind. Mature heads break off and blow away scattering the seeds (Ostlie and Bender, 1990). Also, Voss and Eifert (1978) suggest that goldfinches can eat and disperse the seeds.

Currently there are 48 populations or state records of Cirsium hillii in Illinois (Illinois Natural Heritage Database, 1999). Based upon the Illinois Natural Heritage Database (1999) populations can range from 1 to > 100 individuals. For example, in a study on Site M in 1994 (Cass County)(Robertson et al. 1995), a total of 23 populations were found at the site and population counts were done for 18 populations. From these 18 populations, a total of 690 plants (287 flowering and 403 rosettes) were found. Populations ranged from >100 (58 flowering and 87 rosettes), 50-100, 10-50 and <10 individuals.

NATURAL AND HUMAN LAND USE THREATS: Because of land use practices and the association of this species with prairies, concern regarding the decline of Cirsium hillii in the region is evident. The main threat to this species is the loss of habitat as a

consequence of development, agriculture, and excessive grazing. Herbicide application has destroyed many populations as a consequence of misidentification of the species with other non-native Cirsium species (TNC-BioSources, 1999) and other species such as Carduus nutans (Steven R. Hill per. comm.). An additional threat to Cirsium hillii is vegetation encroachment by native and non-native species.

VIABILITY: To maintain minimum viable populations of Cirsium hillii throughout its habitat range, protection, management, and restoration of habitat should be provided as much as possible. A minimum viable population is defined as a population size likely to give a population a 95% probability of surviving over a 100 year period (Menges, 1992). To insure viability:

1. It is vital that the size of the existing populations of Cirsium hillii be maintained or increased to insure the persistence of this species in the region. Also, it is necessary that local seed sources are available for future reintroductions of the species to other areas. The only way to accomplish such a task is by protecting the already existing seed sources (i.e. populations) available in the region.

2. The creation and maintenance of a metapopulation for Cirsium hillii is crucial for the persistence of the species in the region. A metapopulation is as an assemblage of populations existing in a balance between extinction and colonization, the boundaries of which can be a site or a geographical region (Husband and Barrett, 1996; Levins 1969, 1970). The populations that will form this metapopulation should be large because they can have a better opportunity of persistence than small populations (Hanski et al., 1996). Hanski et al. (1996) have suggested, based upon models, that a metapopulation should consist of a minimum of 15-20 well connected populations. However, Hanski et al. (1996) point out that if this cannot be achieved, the few remaining populations and habitats should be protected and other management techniques should be used to allow the persistence of these populations. Also, based upon models, populations should be >200 individuals to avoid demographical and environmental stochasticity (Menges, 1992). This number can be higher or lower depending upon the species. In the case of Cirsium hillii, Ostlie and Bender (1990) determined that the population size should be 200 or more individuals.

The existing population of Cirsium hillii in the region potentially can go extinct as a consequence of low recruitment, stochastic event, etc. By developing several populations (i.e. metapopulation) this situation may be prevented. Also, by having a metapopulation, other interactions that will impact the overall viability of Cirsium hillii in the region, such as pollinator interactions, genetic structure, gene flow within and between populations, and seed dispersal, can be maintained.

3. Protection of existing and newly discovered populations in the region should be attempted. Protection of these populations also implies protection of their habitat.

MANAGEMENT: To maintain minimum viable populations of Cirsium hillii throughout its habitat range, specific management practices will be needed to insure the persistence of the species.

1. To maintain and increase the existing populations of Cirsium hillii, specific practices should be followed:

a. Management practices such as prescribed burns, grazing, mowing, and removal of vegetation (e.g. woody, noxious weeds, etc.) should be used to avoid encroachment in existing habitat. These management practices should be conducted during the early spring or late fall to avoid any impact on the reproduction of the species. Ostlie and Bender (1990) suggest that fire may have a negative impact on the long-term survival of individual plants. Kenneth Robertson (per. comm.) suggests that grazing may benefit Cirsium hillii by creating disturbances that will expose the soil, allowing seedlings to establish. In addition to these management practices, an Integrated Pest Management Plan such as the one developed by Carroll and White (1997) can be used to control exotic species.

b. Tiles should not be broken to prevent changes in the hydrology of the site (existing habitat) that may impair reproduction, recruitment, and establishment of individuals.

c. Activities that increase the likelihood of noxious weed introduction or cause trampling (e.g. humans or animals) of the plants should be avoided or minimized.

d. Development of trails in areas where Cirsium hillii is found should be avoided or minimized to prevent negative impacts to the populations, especially seedlings.

e. Collection of Cirsium hillii should only be allowed for scientific reasons and only by permit.

2. To develop and maintain a metapopulation of Cirsium hillii, attempts should be made to restore or reintroduce the species in areas that were historically mesic prairie (i.e. dry-mesic prairie). This includes the improvement of areas that have mesic prairie and the reconstruction of areas that have lost the mesic prairie plant matrix. Part of this restoration and reconstruction will include the reintroduction of Cirsium hillii in the appropriate habitat (i.e. dry-mesic prairie). Potential habitat that can be used are sites that have soils found in mesic prairie. The following is a list of soils found in mesic prairie (Laatsch and Loebach, 1997; Eric Ulaszek per. comm.): Brenton silt loam (soil depth 1.5-3.0 ft. over outwash), Channahon silt loam (soil depth 10-25" bedrock), Elliot silt loam (soil depth less than 2.0 ft. over till), LaHogue loam (soil depth 40-60" over sand), Proctor silt loam (soil depth 1.5-3.0 ft. over outwash), and Warsaw silt loam (soil depth 2.0-3.5 ft. over gravel drift).

To maintain and increase these populations of Cirsium hillii, the following practices should be considered in addition to those measures outlined under 1 of this section:

a. To enhance the genetic diversity of the populations, seeds should be collected from nearby populations (e.g. 50-100 miles from the site) to develop seedlings, rootstock, etc.

b. Seed sowing should be used to develop populations in the proper areas.

c. For the successful establishment of Cirsium hillii, development of bare soil areas may be needed for germination and seedling establishment.

d. Monitoring and evaluation should be conducted for any restored or reintroduced populations. In the event that a restored or reintroduced population is unsuccessful, a site's potential for a second reintroduction or restoration attempt should be reevaluated. This may require additional research.

3. In the case that additional populations of Cirsium hillii are found in the region, they should be marked and protected from any potential damage and the above practices for maintenance and enhancement of these populations should be followed. Their habitat should also be protected.

MONITORING: In natural populations, regular counts of individuals (i.e. flowering, non-flowering, and rosettes) should be done to determine population status. Transects and quadrats should be used to determine the size of a population in a large area. Hand counts can be done if a population is small (less than 100 individuals). In restorations, sampling should be done as above to detect increases or decreases in the population. If no significant changes are detected, reevaluation of restoration techniques and management practices should be done to enhance the population.

RESEARCH NEEDS: Immediate research needs for Cirsium hillii that will help in the establishment and management of the species are:

1. Collect information on several aspects of natural history such as specific habitat requirements, in particular seedling establishment, soil depth needs, pH, soil texture, etc. for the species. This will allow a better understanding of how and where the species can be reintroduced.

2. Determine several aspects of the reproductive biology such as breeding system and pollinators. This information may help us understand if reproductive factors associated with the species may be the limiting factor in the persistence of populations in an area or in the reintroduction of the species to an area.

3. Determine if the species is rhizomatous and the implications that this may have in sexual reproduction (e.g. seed production, seed viability, etc.).

4. Collect demographic and population size information. This information is needed to determine the population structure and population changes (i.e. increases or decreases) of the species. With this information, specific recommendations can be made if the population is declining or only seedlings are found.

5. Develop a Population Viability Analysis. A PVA identifies the threats faced by a species and can evaluate the likelihood that the species will persist for a given time into the future. To develop a PVA, field studies, data analysis, modeling, assessment of extinction risks, sensitivity analysis, and monitoring, among other things, are needed.

6. Determine the impact of different management (e.g. grazing, fire) and recreational activities. It is important to determine the best management practice(s) to improve the habitat for the species. Also, it is important to determine which recreational activities are compatible with the species. This will prevent any risks to the species and its habitat.

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c) Personal communications

Kenneth Robertson. Illinois Natural History Survey-Center for Biodiversity. 607 East Peabody Drive. Champaign, Illinois 61820. Phone number: 217-244-2171.

Eric Ulaszek. U.S. Forest Service. Midewin National Tallgrass Prairie. 30071 South State Route 53. Wilmington, Illinois 60481. Phone number: 815-432-6370.

Figure 1) Distribution of Cirsium hillii in the United States of America (www.itis.usda.gov/plantproj/plants/cgi_bin/fr_enter.cgi?earl=fr_qurymenu).

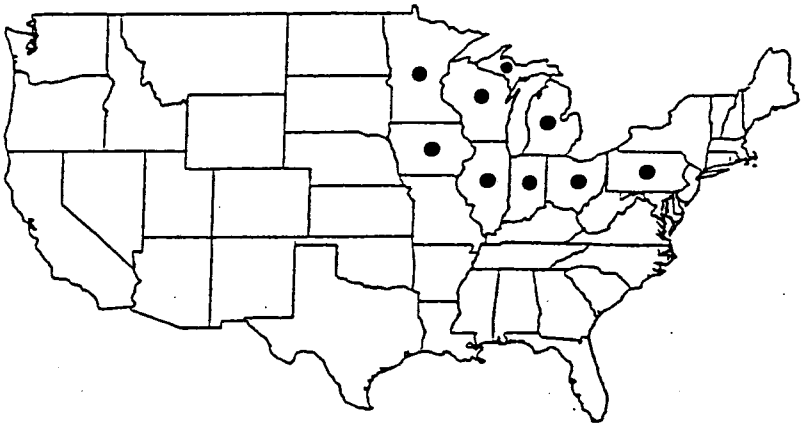

Figure 2) Distribution of Cirsium hillii in Illinois (Illinois Natural Heritage Database, 1999; Mohlenbrock and Ladd, 1978; and www.fs.fed.us/ne/delaware/ilpin/C.htm).