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Population Viability Assessment for Goldenseal (Hydrastis canadensis L.)

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POPULATION VIABILITY ASSESSMENT FOR GOLDENSEAL (HYDRASTIS CANADENSIS L.)

SCIENTIFIC NAME: Hydrastis canadensis L.

COMMON NAME: Goldenseal, ground raspberry, orange root, yellow root, yellow puccoon, Indian dye, eye root, jaundice root, eyebalm, tumeric root, hydrastis.

FAMILY: Ranunculaceae

SYNONYMS: None

USFS REGION 9 STATUS: Sensitive Species

USFW STATUS: None

ILLINOIS STATUS: None

GLOBAL AND STATE RANK: G4

RANGE: Northeastern United States from southern New York through southwestern Ontario as far west to Minnesota, south to Georgia, Missouri and Mississippi, and east to Kentucky and the Carolinas. The largest populations of Hydrastis canadensis have been found in Ohio, Indiana, Kentucky, and West Virginia (res.agr.ca/lond/pmrc/study/newcrops/goldseal.html) (figure 1). In Illinois, this species can be found in 61 counties: Adams, Alexander, Brown, Calhoun, Cass, Champaign, Coles, Cook, DeKalb, DuPage, Edgar, Fulton, Gallantin, Greene, Grundy, Hancock, Hardin, Henry, Iroquois, Jackson, Jefferson, Jersey, Johnson, Kane, Kankakee, Knox, Lee, Logan, McLean, Macon, Macoupin, Madison, Marion, Massac, Menard, Monroe, Morgan, Ogle, Peoria, Perry, Pike, Pope, Pulaski, Randolph, Richland, St. Clair, Saline, Sangamon, Schuyler, Scott, Shelby, Stark, Tazewell, Union, Vermilion, Wabash, Washington, Will, Williamson, Winnebago, and Woodford (figure 2).

PHYSIOGRAPHIC DISTRIBUTION: Hydrastis canadensis can be found in the Southwestern Great Lakes Moraines Section, Ozark Highlands Section, Upper Gulf Plain Section, Central Till Plains (Oak-Hickory) Section, North Central U.S. Driftless and Escarpment Section, and Interior Low Plateau-Shawnee Hill Section of the Eastern Broadleaf Forest Continental Province and in the Central Till Plains Section and Central Dissected Till Plains Section of the Prairie Parkland Temperate Province (Key et al., 1995). Based upon the Natural Divisions of Illinois (Schwegman et al., 1973), Hydrastis canadensis can be found in all Natural Divisions, but not all sections (Eric Ulaszek per. comm.).

HABITAT: Hydrastis canadensis can be found in moist rich soil with good drainage and a pH of 5.5 to 6.5 in deciduous forest (upland forest and wet-mesic forest) and woodland understories with approximately 40 to 80% shade (www.ncpmh.org.html). Plants associated with Hydrastis canadensis in mesic forest and woodland are: Acer saccharum, Actaea pachypoda, Allium tricoccum, Anemonella thalictroides, Arisaema triphyllum, Asarum canadense, Botrychium virginianum, Caulophyllum thalictroides, Dentaria laciniata, Geranium maculatum, Hepatica acutiloba, Hydrophyllum virginianum, Phlox divaricata, Tilia americana, Trillium flexipes, Trillium recurvatum, Uvularia grandiflora, and Viola pubescens (Swink and Wilhelm, 1994).

SPECIES DESCRIPTION: Long-lived perennial herb, 20-50 cm tall. Yellow rhizome 1/2 to 3/4 inch thick and covered with slender yellow rootlets. Hairy stems arising from buds on the rhizome. One basal leaf and 2 alternate cauline leaves near the top. Leaves palmate with a doubly serrate lobed (5 to 7) margin. Small solitary flower with three white sepals and greenish-white stamens arising from the base of the second or uppermost leaf. Fruit a red berry with 10 to 30 dark shinny seeds.

LIFE HISTORY: Both sexual and asexual reproduction are present in Hydrastis canadensis. This species blooms from April to May. The sepals fall as soon as the flower expands. Several aspects of the reproductive biology of the species, including the breeding system, have not been studied. However, it has been shown that seed production is low (White, 1991; res.agr.ca/lond/pmrc/study/newcrops/goldseal.html). Asexual reproduction is via rhizomes and is the primary form of propagation (White, 1991). Rhizomes increase in size to a certain point then break up separating the plants.

Hydrastis canadensis seeds may require cool and moist stratification for germination (res.agr./lond/pmrc/study/newcrops/goldseal.html) or a warm stratification followed by cold stratification (Baskin and Baskin, 1998). The seeds of H. canadensis have characteristics of both deep simple epicotyl and deep simple morphophysiological dormancy (MPD) (Baskin and Baskin, 1998). Seeds are similar to those of deep simple MPD because embryo growth is during autumn, but unlike seeds with deep simple MPD because the seed coat splits open during autumn. These seeds also share a radical growth beyond the limits of the seed coat with deep simple epicotyl MPD species, but differ from those species in that the radical remains covered by the endosperm until spring.

Fruits of Hydrastis canadensis mature in mid to late July and seeds (i.e. fruits) are dispersed during the fall potentially by animals, most likely bird species because of the red fruits (Eichenberger and Parker, 1976).

Limited information is available regarding the size of unharvested populations of Hydrastis canadensis because of the intense harvesting to which they are subjected. In general, wild populations of Hydrastis canadensis are small and individuals are clumped due to its vegetative reproduction and seed dispersal pattern (Eichenberger and Parker, 1976). Eichenberger and Parker (1976) found that populations can have less than 25 to more than 100 individuals per clump. Clumps found at the interior of a forest (i.e. oak-hickory) had more individuals than edge clumps (Eichenberger and Parker, 1976). This can be interpreted as a reflection of the partial shade requirement, 40 to 80%, of the species. In cultivation, growers place 32 plants per square yard to produce 2 lb. of dry root after three years of growth (b-and-t-world-seeds.com/goldroot.htm).

NATURAL AND HUMAN LAND USE THREATS: The biggest threat to Hydrastis canadensis is the intense destructive rhizome harvesting that the populations endure as a consequence of its supposed medical use. Because of its slow growth and low seed production, harvesting of wild population has resulted in the decimation of these populations. Other threats associated with Hydrastis canadensis are land use practices such as habitat loss as a consequence of logging, development, agriculture, and grazing. Natural threats are minimal. For example, herbivory is minimal on Hydrastis canadensis because of the presence of alkaloids in all part of the plant (Gagnon, 1999).

VIABILITY: To maintain minimum viable populations of Hydrastis canadensis 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 Hydrastis canadensis 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 Hydrastis canadensis 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.

The existing population of Hydrastis canadensis in the region potentially can go extinct as a consequence of illegal harvesting, 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 Hydrastis canadensis 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 Hydrastis canadensis throughout its habitat range, specific management practices will be needed to insure the persistence of the species.

1. To maintain and increase the existing population of Hydrastis canadensis, specific practices should be followed:

a. To successfully maintain and increase the existing Hydrastis canadensis populations, harvesting should not be allowed. Violation of this recommendation should result in a penalty.

b. Management practices such as removal of noxious weeds should be used to avoid encroachment in existing habitat. These management practices should be conducted to provide the conditions for Hydrastis canadensis to grow. Hydrastis canadensis grows in wooded areas with 40 to 80% shade (www.ncpmh.org.html). 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.

c. Removal of woody material is not recommended because it can provide a source of organic materials for the development of rich soils.

d. 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.

e. Development of trails in areas where Hydrastis canadensis is found should be avoided or minimized to prevent negative impacts to the populations.

f. Collection of Hydrastis canadensis should only be allowed for scientific reasons and only by permit.

2. To develop and maintain a metapopulation of Hydrastis canadensis, attempts should be made to restore or reintroduce this species in areas that were historically mesic upland forest and mesic woodland. This includes the improvement of areas that have mesic upland forest and mesic woodland. Part of this restoration will include the reintroduction of Hydrastis canadensis in the appropriate habitat.

To maintain and increase these populations of Hydrastis canadensis, 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 and rootstock.

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

c. For the successful establishment of Hydrastis canadensis individuals, planting should be done in areas of 40 to 80% shade.

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 Hydrastis canadensis 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. seedlings, juveniles, flowering adults, and non-flowering adults) 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 restored areas, sampling should be done as above to detect increases or decreases in the population. If no significant changes are detected, reevaluation of seeding techniques and management practices should be done to enhance the population. For a detail monitoring protocol for Hydrastis canadensis see Gagnon (1999).

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

1. 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.

2. 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.

3. Determine the genetic diversity, genetic population structure, and gene flow of Hydrastis canadensis. This information can be used to avoid outcrossing or inbreeding depression problems particularly in small populations.

4. 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.

5. Determine the impact of a harvesting program if harvesting is allowed in the future. It is important to determine if populations can be harvested or how a supplemental growing program can be used to avoid the harvesting of natural populations.

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www.ncpmh.org.html

c) Personal communication

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

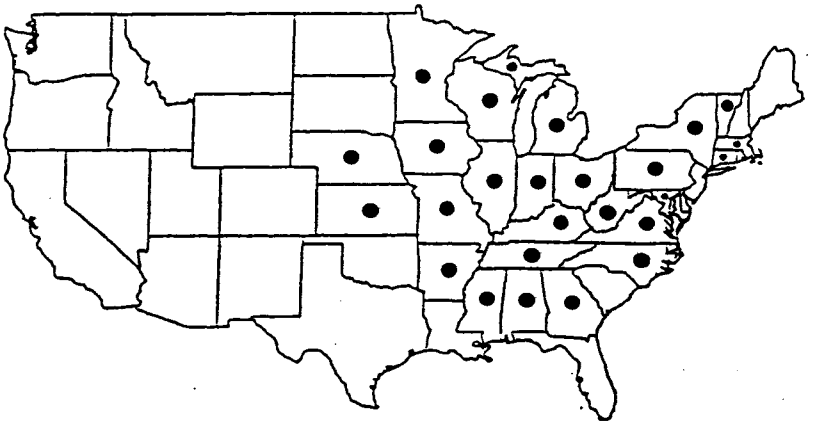

Figure 2) Distribution of Hydrastis canadensis in Illinois (Mohlenbrock and Ladd, 1978 and www.fs.fed.us/ne/delaware/ilpin/H.htm).