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***CASTILLEJA LEVISECTA*, A Threatened South Puget Sound Prairie Species
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Abstract

Castilleja levisecta (Golden paintbrush), is a multi-stemmed perennial in the figwort or *Scrophulariaceae* family. An endemic to the Pacific Northwest, it inhabits low elevation prairies and grasslands within the Puget Trough region, and is typically associated with *Festuca idahoensis* or *F. rubra*. *C. levisecta* is easily identified by its showy inflorescences consisting of whorls of conspicuous golden-yellow leaf bract surrounding less-conspicuous greenish flowers. Plants emerge in early March and flower from April to July. Bumblebees are most frequently observed foraging on the flowers of *C. levisecta*, and are suspected of being a primary pollinator. Seed production is rather prolific, and cold stratification is required for germination.

Like many species within the family *Scrophulariaceae*, and particularly within the genus *Castilleja*, *C. levisecta* is considered to be a facultative root parasite. Greenhouse experiments have indicated that *C. levisecta* does not require a host to survive and flower. Little is currently known about its host preference or specificity. Demographic studies suggest that high levels of regression, low recruitment rates, and relatively high mortality in juveniles may contribute to the spatial and temporal variation within populations of *C. levisecta*.

Historical records and collections indicate that *C. levisecta* once occurred as far south as the Willamette Valley in Oregon and north onto Vancouver Island, British Columbia. *C. levisecta* is currently believed to have been extirpated in Oregon. Twelve known remaining populations of various sizes are distributed in Thurston County, Whidbey Island and the San Juan Islands in Washington, and two islands outside of Victoria in British Columbia. The single largest and healthiest population occurs within the South Puget Sound Prairie Landscape.

C. levisecta has been on the Washington Natural Heritage Program's list of endangered species since 1981. The U. W. Fish and Wildlife Service proposed to list *C. levisecta* as a threatened species under the federal Endangered Species Act in May, 1994. A 1995 moratorium on listing delayed the publication of a final rule, which was eventually resubmitted in July, 1996. To date, the final ruling on *Castilleja levisecta* is still awaited.

The conversion of habitat to agricultural, residential, and other uses is a primary cause of the decline in the number of populations of *C. levisecta*. Threats to the extant populations include loss of suitable habitat, the invasion of grassland habitat by native and non-native species, herbivory, trampling, and collecting by humans. The few remaining populations

of *Castilleja levisecta* in the Pacific Northwest region are isolated, fragmented, and most are quite small. As such, they are vulnerable to extirpation from random, stochastic events, and are individually and collectively critical for the long term survival of this species.

Introduction

Castilleja levisecta (golden paintbrush), is a multi-stemmed perennial in the Scrophulariaceae or figwort family. An endemic to the Pacific Northwest, it inhabits low elevation open grasslands and prairies within the Puget Trough region. It is typically associated with *Festuca idahoensis* or *F. rubra*, and a variety of other vascular plants, depending upon the site location.

C. levisecta has been considered to be endangered in the state of Washington since the first endangered species list was published by the Washington Natural Heritage Program in 1981 (Washington Natural Heritage Program 1981, 1994). Habitat loss and habitat degradation have primarily been responsible for the extirpation of a number of populations of *C. levisecta* historically, and continue to pose threats to the extant populations. Although it has been proposed for listing as a threatened species by the U.S. Fish and Wildlife Service (1994), a 1995 moratorium on listing delayed the publication of a final rule. The final rule was resubmitted in July 1996 following the lifting of the moratorium.

History and Distribution

Historically *C. levisecta* had been reported from over 30 sites in the Puget Trough region of Western Washington and British Columbia, and had occurred as far south as the Willamette Valley in Oregon (Hitchcock and Cronquist 1973).

Early collections include one taken near Mill Plain Washington in 1800 and in Victoria, British Columbia in 1875. Today *C. levisecta* is believed to be extinct in Oregon. Twelve extant populations ranging in size from 5 to over 10,000 individuals occur in Thurston, Island, and San Juan counties in Washington, and near Victoria in British Columbia (Washington Natural Heritage Program, personal communication). The single largest and presumably healthiest population occurs within the South Puget Sound Prairie Landscape within the boundaries of the Rocky Prairie Natural Area Preserve. The approximately 15 hectare preserve is managed by the Washington State Department of Natural Resources.

Current knowledge of *Castilleja levisecta* comes from the collective field work and research of a number of individuals. Early reports were based on fieldwork that began in 1980, (e.g., Sheehan and Sprague 1984, Evans et al. 1984). A 1995 report by the Washington Natural Heritage Program serves to summarize what is currently known about this species based on past reports and research conducted since 1990 (Gamon 1995). A demographic monitoring study conducted from 1991 to 1994 provided information about the population dynamics and biology of *C. levisecta* at Rocky Prairie (Wentworth 1994). The population at Rocky Prairie has been and continues to be the subject of much monitoring and research due to the size and high quality of the

population at this site. Monitoring and habitat restoration efforts are currently underway at Rocky Prairie and at several other sites.

Population Biology

Castilleja levisecta is easily identified by its showy inflorescences consisting of whorls of conspicuous golden-yellow leaf bracts surrounding less-conspicuous greenish flowers (Figure 1). Plants emerge in early March and flower from April to July, with peak flowering occurring in mid-to late May. Plants are typically multi-stemmed with 5 to 15 unbranched stems. Non-flowering stems range in height from less than 4 cm. to 22 cm., with a mean height of 6 cm. Small, non-flowering plants and seedlings are rather inconspicuous (Wentworth, personal observation). Inflorescences, or flowering stems, can reach 33 cm. in height with a mean of 18.5 cm. (Wentworth 1994).

Flowering plants have been observed to have as many as 8 inflorescences with a mean of 2 inflorescences per plant. The hermaphroditic flowers produce fruits containing numerous (>150), seeds. The seeds of *C. levisecta* are less than 1 mm. long, are covered by a reticulating membrane, and do not appear to have any particular dispersal mechanisms. Cold stratification is required for germination. Germination in outdoor artificial seedbanks was found to be 8-12% within the first year and 2% in the second year. Germination under laboratory conditions was 47% in the first year and 13% in the second year. No germination occurred in the third year in either outdoor or indoor trials (Wentworth unpublished data). Removal of the seed coat does not

appear to affect germination (Gamon 1995).

Many species of *Castilleja* appear to be adapted to cross pollination (Kuijt 1969). Bumblebees have been frequently observed foraging on the flowers of *C. levisecta* (Evans et al. 1984, Wentworth, personal observation), and are suspected of being a primary pollinator. Results from pollinator exclusion experiments suggest that fruit set is almost 5 times greater in open pollinated (unbagged) flowers than in bagged flowers (Wentworth, unpublished data).

Like many species within the family Scrophulariaceae, and particularly within the *Castilleja* genus, *C. levisecta* is considered to be a facultative root parasite (Heckard 1962, Kuijt 1969). Greenhouse experiments have indicated that *C. levisecta* does not require a host to survive and flower. Plants appear to produce haustoria when grown in pots with potential host species, as well as in control pots without hosts (Wentworth, unpublished data). Furthermore, the presence alone of haustoria does not necessarily indicate functional parasitism (Kuijt, personal communication). Little else is currently known about its host preference or host specificity.

In a three year demographic monitoring study conducted from 1991-1994 at Rocky Prairie, Wentworth (1994) followed the fates of over 800 *C. levisecta* individuals within 2 study plots. Plants were mapped, tagged and classified into 4 life history stages based on a combination of size and reproductive maturity. Regression, or the ability of an individual to regress for

example, from a larger, reproductive stage to a smaller non-reproductive stage, and vegetative dormancy, were two of the more surprising and confounding demographic transitions observed. Regression was greater than growth in many cases, particularly in the large reproductive stage. Population viability analyses indicated spatial and temporal variation between study populations in terms of stage specific demographic patterns and overall population growth rates. High levels of regression, low recruitment rates, and relatively high mortality in juveniles may contribute to the spatial and temporal variation within populations of *C. levisecta* (Wentworth 1994).

Conservation

The conversion of habitat to agricultural, residential, and other uses has been the primary cause of the decline in the number of populations of *C. levisecta*. *C. levisecta* is not a successful competitor and it can not survive under a closed canopy. Threats to the extant populations include loss of suitable habitat due to the invasion of grassland habitat by both native and non-native species such as *Pseudotsuga menziesii* (Douglas fir), *Pteridium aquilinum* (bracken fern), *Rubus ursinus* (Pacific blackberry), *Symphoricarpos albus* (snowberry), *Cytisus scoparius* (Scots broom), and *Cirsium* spp. (thistle). Trampling and collecting by humans may threaten populations to a lesser degree. Although herbivory does not appear to pose a significant threat to the large population at Rocky Prairie, herbivory by deer, rabbits or other mammals could potentially have a severe impact on the smaller populations.

Management efforts for the conservation of this species should continue to include long term monitoring and the restoration of existing habitats. Studies to obtain knowledge about recruitment rates, degree of parasitism, host preferences, minimum viable population size, and additional knowledge about the species population biology are needed to provide a basis for sound conservation and management strategies.

Additional research is needed to determine the effects of interspecific competition and to examine the response of *C. levisecta* to vegetation management treatments such as controlled burning, clipping and herbicide application. The relatively few remaining populations of *C. levisecta* in the Pacific Northwest region are isolated, fragmented, and most are quite small. In addition to the more obvious threats mentioned above, the remaining populations are also vulnerable to extirpation from random, stochastic events. Recolonization following catastrophic events is less likely in small, isolated populations and reduced genetic variability minimizes the chances for a species to adapt to environmental changes (Shaffer 1981). As such, all remaining populations are individually and collectively critical for the long term survival of this species.

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