

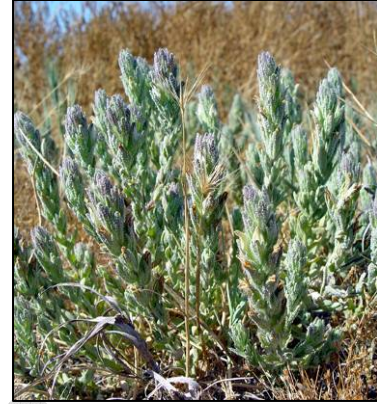
Palmate-Bracted Bird's-Beak

(*Cordylanthus palmatus*)

Legal Status

Federal: Endangered.

State: Endangered.



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Global and State Conservation Status: G1S1.1: Global Rank, G1 = Critically Imperiled: At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors; State Rank, S1 = Critically Imperiled: Critically imperiled in the state because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state; State ranks in California often also contain a threat designation attached to the S-rank., S1.1 = Very threatened.

CNPS List: 1B.1;1B: Rare, threatened, or endangered in California and elsewhere. 0.1: Seriously endangered in California.

Recovery Plan: Recovery Plan for Upland Species of the San Joaquin Valley, California (USFWS 1998).

Species Description and Life History

Palmate-bracted bird's-beak is a winter germinating, 10- to 30-cm (4- to 12-in) tall, highly branched, herbaceous annual plant in the snapdragon family (Scrophulariaceae) (Calflora 2008; Chuang and Heckard 1973, 1993). It belongs to the morphologically and ecologically distinct subgenus *Hemistegia* (Chuang and Heckard 1973). All members of *Hemistegia* develop mucilage containing cells in their leaf tissue, are covered with glandular salt-excreting hairs, and grow in saline soils (Chuang and Heckard 1986). Furthermore, all members of the genus are hemiparasitic and can obtain water and nutrients from the roots of other plants (Chuang and Heckard 1971).

Adult plants begin flowering in late May and continue flowering as late as October (L.C. Lee and Associates, and Center for Conservation Biology 2002). While palmate-bracted bird's-beak has a mixed mating system, it requires an insect pollinator to transfer pollen between its male and female reproductive structures in order to set viable seed. The primary pollinators at the Springtown population, near Livermore, Alameda County, are bumblebees (*Bombus vosnesenskii* and *B. californicus*) early in the season and small native bees (*Halictus tripartitus*, *Lasioglossum* [*Dialectus*], and *Lasioglossum* [*Evyllaesus*]) later in the season (L.C. Lee and Associates 2002, Saul-Gershenz 2004). No

pollinator studies have been conducted for any other populations. Pollinators are critically important for seed set. A study at the Springtown site found that *Lasioglossum* native bee species, which nest in bare soil areas adjacent to palmate-bracted bird's-beak plants, were particularly important, as 96 percent of the bees visiting palmate-bracted bird's-beak from June through July were of this genus (L.C. Lee and Associates 2002, Saul-Gershenz 2004). Those same species of small native bees also utilized nectar and pollen from common spikeweed (L.C. Lee and Associates 2002). Studies of the important pollinators of crop plants in Yolo County have found that populations of these same species of bees require bare ground and rodent burrows for nest sites and that the intensification of agriculture is eliminating their nesting habitat (Kremen 2001, Kremen *et al.* 2002a, Kremen *et al.* 2002b, Kremen *et al.* 2004). Additionally a shortage of pollinators has been reported in California as a result, at least partly, from the infestation of honeybees with the parasitic mite, *Varroa destructor* (Sousa 2005).

The timing of palmate-bracted bird's-beak seed germination has not been studied, but Fleishman *et al.* (1994) stated that the seed germinates in January and February. Observations that the seed can float for up to 3 weeks (Showers 1990) and that individuals are less densely aggregated during years of overland flows than during years of no overland flows (Showers 1988) also suggest that germination occurs during the winter months. Germination of previously buried seed may also be an important factor in the distribution and density of individuals in a population. While no studies have been conducted to determine the germination characteristics of seed under field conditions, seeds can remain viable for at least 3 years under laboratory conditions (Center for Conservation Biology 1994).

Habitat Requirements and Ecology

This species is restricted to seasonally-flooded, saline-alkali soils in lowland plains and basins at elevations of less than 155 meters (500 feet) (USFWS 1998). Small differences in soil topography are critical for seedling establishment, as seedlings establish on banks and sides of raised irrigation ditches and on small berms in areas subject to overland flows (Showers 1988). Extensive soil tests across mound and swale topography at the Springtown population have shown that soil salt concentrations are generally highest in the bottoms of swales and lowest on the tops of mounds (Coats *et al.* 1988, 1989, 1993). At Springtown, palmate-bracted bird's-beak was found to occur primarily on soils with intermediate salt content along the sides of the swales. The authors concluded that it was generally excluded from the scalds in the swales due to high soil salt content, and it was excluded from the tops of the mounds due to competition from exotic annual grasses (Coats *et al.* 1988, 1989, 1993). The descriptions of the Woodland population suggest that it also occurs on the sides of small topographic features and that the plants are shaded by dense populations of exotic annual grasses (Foothill Associates 2002, Showers 1988).

The extant population in Yolo County is located southeast of the City of Woodland in a heavily human-impacted area of what historically was alkaline sink vegetation occurring on along both sides of Willow Slough and above the Yolo Basin (U. S. Bureau of Soils 1909a, 1909b, Mann *et al.* 1911). The hydrology, salts, and clay soils that created and

maintained the alkaline sink vegetation were deposited when floodwaters from Putah Creek flowed northward from the area near the city of Davis and emptied into Willow Slough. That flow was supplemented when the combined floodwaters of Putah Creek, Cache Creek, and all of the drainages of the Blue Ridge filled the Cache/Putah Basin, drained eastward through a gap in the Plainfield Ridge, and flowed into the Yolo Basin through Willow Slough (Graymer *et al.* 2002).

Laguna de Santos Callé, as Willow Slough was previously known, was a unique perennial stream (Eliason 1850, Anonymous 1870) that during the dry season originated from a series of pond-like springs approximately 9 miles southwest of Woodland on the eastern edge of the Plainfield Ridge. As the slough approached the area of Merritt, south of Woodland, it transformed into a 2.5-mile-long, gravel bottomed, linear lake, with an average width of 150 ft and a maximum depth of 75 ft. Approximately 1 mile east of County Road 103, the stream flowing from the lake branched as it dropped over the edge of the alluvial deposits into the Yolo Basin, where it flowed another 2.5 miles northeastward until it emptied into a tule marsh. This perennial stream would have created a very shallow saline water table along Willow Slough that is comparable to the water table along Altamont Creek, which created and maintained the alkaline sink at Springtown. Recent studies show a localized trough in the underlying Tehama formation under this section of Willow Slough and a localized area of shallow groundwater (Wood Rodgers 2004, Lunderoff and Scalmanini 2004). Large floods from Cache Creek and Putah Creek have flowed through Willow Slough as recently as 1942, but gravel mining in Cache Creek, dam building on both Cache and Putah Creeks, and the construction of the Willow Slough Bypass have drastically altered the hydrology, salt budgets, and clay deposition patterns in the area of the alkali sink vegetation. Aerial photographs show that all of the alkaline sink vegetation was either converted into rice fields or ditched for drainage, except for a single pool-meadow complex immediately along Willow Slough (USDA 1952). That pool has been disked multiple times (Showers 1990, 1996). Given the intensity and extent of the agricultural impacts to the entire alkali sink area and the irreversible changes in hydrology, the area where palmate-bracted birds-beak does not currently support alkali sink vegetation and it would be very difficult to replicate the natural hydrological regimes that would allow that type of vegetation to be successfully restored in the area. However, the historic aerial photographs show that the disked pool meadow complex did receive extensive amounts of supplemental summer water through ditches draining the upstream rice fields, so it may be possible to restore the appropriate hydrology artificially.

Monitoring studies have documented that populations of palmate-bracted bird's-beak experience significant mortality between early spring and early summer, and then low mortality rates through September (Center for Conservation Biology 1992, Fleishman *et al.* 1994, Cypher 1998). A positive correlation between high mortality rates and high seedling densities has been demonstrated at some research locations. However, because these data were obtained from field surveys where seedling density was not manipulated, density-independent causes of seedling mortality cannot be ruled out. Alternative explanations for high mortality rates include lack of appropriate hosts, drought stress, and competition with introduced annual grasses. Finally, there are no data describing the soil

moisture requirements of palmate-bracted bird's-beak during the period of maximum mortality in spring, but studies have found that plants grow where they have access to adequate levels of soil moisture during the summer rainless period.

According to current data on the species, only perennial plants, such as saltgrass (*Distichlis spicata*), Mojave red sage (*Kochia californica*), and Torrey seepweed (*Suada moquinii*), are assumed to function as appropriate host plants for palmate-bracted bird's-beak (Coats *et al.* 1988, Cypher 1998, EIP Associates 1998). However, in a greenhouse host-preference experiment, Chuang and Heckard (1971) observed that palmate-bracted bird's-beak was vigorous and produced many flowers when grown with common sunflower (*Helianthus annuus*), which is a summer-flowering annual. This finding suggests that common spikeweed, a summer- and fall-flowering annual plant in the same plant family as common sunflower, and which is closely associated with palmate-bracted bird's-beak in its natural habitat, may be a suitable host. Because the roots of older perennials become increasingly lignified (woody) and resistant to parasitism, age and spatial distribution of the roots may also contribute to the suitability of a potential host plant for palmate-bracted bird's-beak parasitism (see Marvier and Smith 1997).

Species Distribution and Population Trends

Distribution

Palmate-bracted bird's-beak is endemic to the west side of the Sacramento Valley, the north side of the Sacramento NWR Complex, the San Joaquin Valley, and the Springtown area of the Livermore Valley. This species is currently known to exist at six locations outside Yolo County: Delevan National Wildlife Refuge (NWR), Sacramento NWR (established from seed collected at the Delevan NWR), Colusa NWR, the Springtown area, western Madera County, and the combined Alkali Sink Ecological Reserve and Mendota Wildlife Management Area (USFWS 1998).

Very little information exists concerning the historical distribution of palmate-bracted bird's-beak in Yolo County prior to extensive habitat conversion. The two documented locations in Yolo consist of an extirpated population that was located northeast of the city of Woodland and an extant population located southeast of Woodland (CNDDDB 2004, Crampton 1979). Within the last 25 years, the species has been observed in areas adjacent to the Woodland population in an alkali playa/meadow (Crampton 1979) and on Pescadero silty clay, saline-alkali, and Willows clay soil types (Showers 1988, 1996; EIP Associates 1998; Foothill Associates 2002).

Individuals in the existing Woodland population are generally found on small topographic features such as old irrigation checks, banks of shallow ditches, and along the shoreline of a pond. The entire population is limited to Pescadero silty clay, saline-alkali, and Willows clay soil types (Andrews 1970; Showers 1988, 1996; EIP Associates 1998).

Population Trends

Little is known about regional population trends of palmate-bracted bird's-beak. The conversion of land to farming and development is resulting in declines because of the destruction of extensive areas of potential habitat in the Sacramento and San Joaquin Valleys (USFWS 1998). However, populations are known to fluctuate. For instance, populations of palmate-bracted bird's-beak in the central San Joaquin Valley, in areas such as Mendota, have fluctuated between 0 and 800 flowering individuals from 1987 to 1993 (Fleishman *et al.* 2001).

The Colusa, Delevan, and Springtown populations appear to be robust with large populations of between 10,000 and 100,000 flowering individuals in 1991 and 1992, while the Mendota population is small and has fluctuated between 0 and 800 flowering individuals from 1987 to 1993 (Fleishman *et al.* 2001). Between 1983 and 1990, the Woodland population was restricted to a single property that is known as the City of Woodland Preserve. The size of this population ranged from 200 to 1,400 flowering individuals (EIP Associates 1990). In 1996 and 1998, special-status species surveys of the area discovered additional individuals on the adjoining Woodland Regional Park, Brauner, and Maupin properties (Showers 1996, EIP Associates 1998).

Threats to the Species and Other Conservation Issues

Natural threats to palmate-bracted bird's-beak populations include potential lack of appropriate hosts and pollinators, and competition with introduced annual grasses such as annual ryegrass (Dawson *et al.* 2007). A number of specific threats to the species were identified in the 1998 recovery plan but only urban expansion, altered hydrology, and limited genetic variation were identified as threats to the Woodland population (USFWS 1998). More recently, the Woodland site has been extensively invaded by annual ryegrass which poses a severe threat to the species at this site (M. Showers, pers. comm.)

Finally, as previously mentioned, studies of the important pollinators of crop plants in Yolo County have found that intensification of agriculture is eliminating the nesting habitat of native bees, upon which the palmate-bracted bird's-beak depends for pollination (Kremen *et al.* 2001, 2002a, 2002b, 2004). Additionally a shortage of pollinators has been reported in California as a result, at least partly, from the infestation of honeybees with the parasitic mite, *Varroa destructor* (Sousa 2005).

Research should be directed on invasive species control (such as research by Wingo-Tussing and Schierenbeck and grazing/burning studies on annual grass control at the Sacramento NWR), native pollinator habitat requirements, potential host plants, and techniques for establishing the appropriate hydrological regime which could be partially based on an analysis of how water was managed on the rice fields up stream of the disked pool/meadow complex.

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