Management Plan for an Alkali Sink and Its Endangered Plant *Cordylanthus palmatus*

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ABSTRACT / *Cordylanthus palmatus* is a hemiparasitic annual of the family Scrophulariaceae. It is on both the federal and state lists of endangered species. Only four widely separated populations remain, all of them in alkali sinks, where the plant thrives in saline-sodic soils. The largest population is at Springtown, Alameda County, California. This article reports on efforts to develop a management plan for both the plant and the alkali sink ecosystem. The plan is based on: (1) characterization of hydrology, soils and geomorphology of the site; (2) characterization of the land use impacts to the site; (3) analysis of plant distribution in relation to gradients of elevation and soil chemistry; (4) studies on water potential and water stress in *Cordylanthus palmatus* and associated species. On the basis of this plan, both the State of California and private groups are cooperating to create, restore, and manage a preserve in the Springtown Alkali Sink.

The Springtown Alkali Sink on the northeast side of the Livermore Valley in Alameda County, California, USA, is a complex mosaic of vernal pools, mounds, and alkali scalds, supporting a significant remnant of alkali sink scrub vegetation. This vegetation type, which formerly covered large areas of the Sacramento and San Joaquin valleys, has been largely destroyed by agricultural and urban development. At Springtown, the alkali sink scrub community includes the largest of the four remaining populations of the palmate-bracted bird's-beak (*Cordylanthus palmatus*).

The Springtown Alkali Sink is unique seasonal wetland of considerable ecological significance. It is located in eastern Alameda County, about 3.5 mi northeast of downtown Livermore (Figure 1). Parts of the alkali sink were developed in recent decades for residential subdivisions and a golf course or were disturbed by off-road vehicles or earth-moving equipment. Much of the remaining alkali sink areas are proposed for future development. In 1982, an endangered plant—*Cordylanthus palmatus*—was discovered on the site. The presence of this state and federally listed endangered plant and the designation of parts of the area as wetlands have placed constraints on future development of the area.

The bird's-beak genus, *Cordylanthus*, is indigenous to western North America and is represented by approximately 32 species. It is related to Indian paintbrush (*Castilleja*) and to owl's clover (*Orthocarpus*). *Cordylanthus palmatus* (Ferris) MacBride, known as palmate-bracted bird's-beak or Ferris' bird's-beak, belongs to a morphologically and ecologically distinct group of species in the subgenus *Hemistegia*. All species within the subgenus occur in saline and alkaline habitats.

*Cordylanthus palmatus* is a low, highly branched herbaceous annual, 10–30 cm high. The leaves are gray-green, hairy, and lie close to the stem (Figure 2). The plant has glands that enable it to secrete salt, and mature plants are often encrusted with salt crystals. All members of the genus *Cordylanthus* are hemiparasitic, that is, able to parasitize the roots of other plants. *Cordylanthus palmatus* was added to the federal list of endangered species in 1983 and the state list of endangered plants in 1984.

The historic range of *Cordylanthus palmatus* included at least ten scattered locations in the San Joaquin and Sacramento valleys, in Fresno, Madera, San Joaquin, Yolo, and Colusa counties. It now occurs in only four populations within the historic range: in

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116 a. Coats and others

Figure 1. Historic and remaining sites where *Cordylanthus palmatus* has been found.

Colusa, Yolo, Alameda, and Fresno counties. The Alameda County site, at Springtown, is by far the most important of these due to its large size and relatively high habitat quality.

This study was undertaken in order to: (1) determine the extent of the existing population of *Cordylanthus* on the site; (2) determine the environmental factors that are critical to the long-term viability of the alkali sink ecosystem and the endangered plant population; (3) identify habitat that must be preserved to ensure the survival of the remaining *Cordylanthus* population; and (4) develop management recommendations for the alkali sink ecosystem. The specific steps involved in this study are: (1) mapping the distribution of *Cordylanthus* on the site, at a scale of 1:2400; (2) characterizing the soils, hydrology, and land-use history of the site; (3) characterizing the physiological ecology of *Cordylanthus palmatus* and relating its ecological requirements to the environment of the site; and (4) developing a management plan that specifies allowable use intensity zones and a monitoring program for the site.

Although concern for one endangered plant provided the impetus for this study, the Springtown Alkali Sink is more than a habitat for *Cordylanthus*. Rather, it is a complex mosaic that includes streams, vernal pools, alkali scalds, and annual grasslands with a unique assemblage of plants and animals. The proper approach to protecting *Cordylanthus* on the site is to maintain a viable alkali sink wetland ecosystem.

Description of Study Area

Geomorphology, Soils, and Hydrology

The Springtown Alkali Sink formed on the gently sloping alluvial valley floor, where a fault has occluded groundwater movement and altered the course of Altamont Creek. Erosion of the marine shale and sandstone that comprise the Altamont uplands northeast of the sink has contributed both fine-grained sediment and dissolved salt, especially sodium chloride, to the sink (State of California 1974, Herd 1977). Mean annual potential evapotranspiration is about 57 ins, far greater than the mean annual precipitation of only 14 in. With such a large moisture deficit, soluble salts could be expected to accumulate in any closed or poorly drained basin.

The hydrologic system of the Springtown Alkali Sink can be subdivided into three zones. In zone I, the Altamont uplands, rainfall generates surface runoff or shallow subsurface flow, which moves rapidly to well-defined intermittent and ephemeral stream channels. These channels deliver runoff to zone II, the recharge zone at the base of the hills. Here, much of the surface runoff infiltrates into loam and sandy loam soils, and the stream channels become poorly defined. Shallow groundwater reaches the sink through layers of sandy alluvium interbedded with clay and silt. During intense or prolonged storms, surface runoff reaches the alkali sink (zone III) directly. Altamont Creek, which traverses the sink, occasionally overflows its banks, although recent channelization for flood control has reduced the frequency of overbank flooding.

Even in dry years, the water table in the alkali sink lies near the surface. In June 1988, the second of two dry years, it was within 2–4 ft of the surface in lower areas of the sink. The high water table allows both moisture and salts to move upward by capillary action, contributing to saline–sodic conditions at the soil surface and setting the stage for soil saturation and the formation of vernal pools. Figure 3 shows the portions of the study area in the Alkali Sink that met the US Army Corps of Engineers's criteria for designation as a wetland.

Acting together since the close of the Pleistocene, the factors of climate, topography, parent material, and living organisms have led to the development in the sink of saline–sodic soils (Natrixeralfs). The Soil Conservation Service recognizes two soil series in the