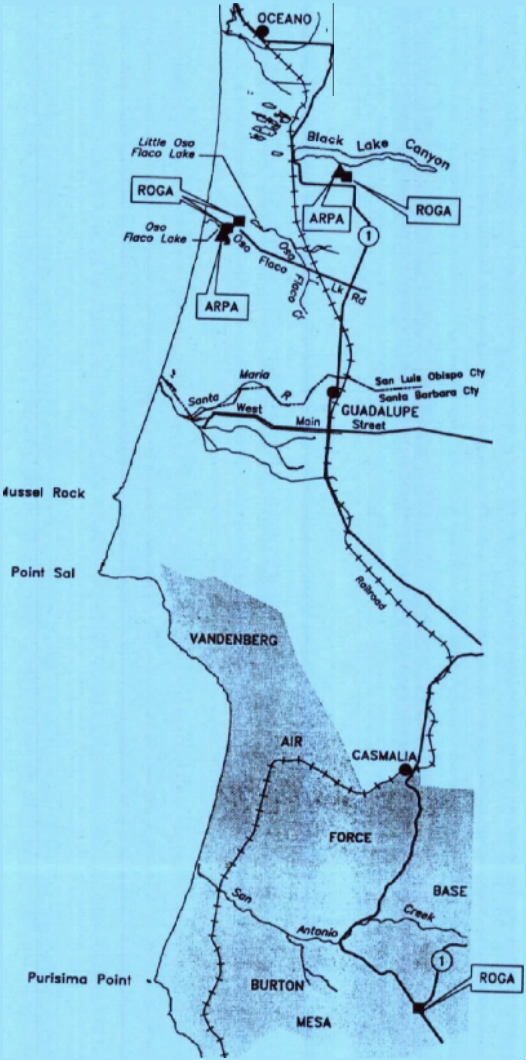
# Recovery Plan

## for Marsh Sandwort
*(Arenaria paludicolu)*
## andGambel'sWatercress
*(Rorippa gambelii )*



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# RECOVERY PLAN

FOR

# MARSH SANDWORT

# (*Arenaria paludicola*)

AND

# GAMBEL'S WATERCRESS

# (*Rorippa gambelii*)

Published by
U.S. Fish and Wildlife Service
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# LITERATURE CITATION

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# EXECUTIVE SUMMARY

**Current Status:** *Arenaria paludicola* and *Rorippa gambelii* are federally listed as endangered. Both have recently been collected in central or southern Mexico, but little is known of their status. In the United States, *Arenaria paludicola* is found in only two populations, one of fewer than 10 individuals in Black Lake Canyon; the other of more than 85 individuals at Oso Flaco Lake, San Luis Obispo County, California. Three populations of *Rorippa gambelii* are currently known in the United States — one with about 500 individuals in Black Lake Canyon near the *A. paludicola* population, one with about 300 individuals at Little Oso Flaco Lake, also in San Luis Obispo County, and a third population of approximately 100 plants on Vandenberg Air Force Base, Santa Barbara County.

**Habitat Requirements and Limiting Factors:** Both species occur in wetland areas with standing water or saturated acidic soils from sea level to 450 meters (1,480 feet). Both are threatened by encroaching native and alien vegetation associated with lowered water tables, agricultural and residential development, and off road vehicle use. In addition, the very low numbers of individuals and populations put these species at great risk of extinction due to random naturally occurring events.

**Recovery Objective:** Reclassify to threatened status.

**Reclassification Criteria:** These species can be considered for downlisting to threatened when:

1. New plants of each species are established so that there are at least 5 populations of at least 500 individuals each.
2. These populations occur in permanently protected habitats within the species' historical ranges.
3. The populations remain viable (self sustaining through natural reproduction and stable or increasing in size) for at least 5 years.

**Actions needed:**

1. Protect, maintain, and enhance species habitats
2. Monitor and document species populations and habitat characteristics
3. Conduct research on the ecology and biology of the species
4. Increase size of existing populations

5. Establish new populations within historical range
6. Evaluate progress and update management and recovery guidelines

**Recovery Costs, in thousands of dollars:**

| Year | Need 1 | Need 2 | Need 3 | Need 4 | Need 5 | Need 6 | Total |
|---|---|---|---|---|---|---|---|
| FY1 | 46.75 | 10.2 | 15.0 | 18.25 | 4.0 | 0 | 88.7 |
| FY2 | 41.25 | 11.2 | 13.0 | 14.25 | 4.0 | 0 | 80.45 |
| FY3 | 38.25 | 5.7 | 13.0 | 19.25 | * | 0 | 76.2 * |
| FY4 | 37.25 | 4.2 | 13.0 | 7.5 | * | 0 | 61.95* |
| FY5 | 42.25 | 4.2 | 13.0 | 1.5 | * | 0 | 60.95* |
| FY6 | 26.25 | 4.2 | 0 | 1.5 | * | 0 | 31.95* |
| FY7 | 26.25 | 4.2 | 0 | 1.5 | * | 4.0 | 35.95* |
| FY8 | 6.25 | 4.2 | 0 | 1.5 | * | 0 | 11.95* |
| FY9 | 6.25 | 4.2 | 0 | 1.5 | * | 0 | 11.95* |
| FY10 | 6.25 | 4.2 | 0 | 1.5 | * | 0 | 11.95* |
| Total | 277.5 | 56.5 | 67.0 | 68.25 | 8.0* | 4.0 | 481.25* |

* Some costs are yet to be determined

**Date of Downlisting:** If the proposed recovery actions are successful, downlisting from endangered to threatened might be possible by 2007. After five years, progress toward meeting the downlisting criteria should be evaluated, and a target date should be set.

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# I. INTRODUCTION

## A. BRIEF OVERVIEW

The final rule determining Federal endangered status for the plant species marsh sandwort (*Arenaria paludicola* Robinson) and Gambel's watercress (*Rorippa gambelii* (S. Watson) Rollins & Al-Shehbaz)) was published in the August 3, 1993, Federal Register (58 FR 41378). *Arenaria paludicola* has a recovery priority of 5; *Rorippa gambelii* has a recovery priority of 2. Recovery priorities for listed species range from 1 to 18, with 1 being the highest priority. A priority of 2 indicates a species facing a high degree of threat but also having a high potential for recovery; a priority of 5 indicates high threat and a low potential for recovery. In 1990, *Arenaria paludicola* and *Rorippa gambelii* were listed as endangered and threatened, respectively, by the State of California (Morey 1990; Wickenheiser and Morey 1990; Skinner and Pavlik 1994).

*Arenaria paludicola* is currently known from only two populations — one comprising fewer than 10 individuals in Black Lake Canyon, the other of more than 85 individuals at Oso Flaco Lake, both in San Luis Obispo County, California. Three populations of *Rorippa gambelii* are currently known — one with about 500 individuals in Black Lake Canyon near the *A. paludicola* population, one other with about 300 individuals at Little Oso Flaco Lake, also in San Luis Obispo County, and a third population of approximately 100 plants on Vandenberg Air Force Base, Santa Barbara County.

This recovery plan for the two species summarizes past and present knowledge concerning their range, habitat requirements and population ecology. Additionally, it discusses threats to their existence, as well as past and present research and conservation efforts directed at maintaining their survival. The plan delineates actions to be taken toward recovery of the two species.

This recovery plan is one of several being developed to conserve listed species of coastal California and their ecosystems (e.g. U.S. Fish and Wildlife Service 1997, 1998). The plans are intended to complement each other.

## B. TAXONOMY AND DESCRIPTION

### 1. *Arenaria paludicola*

Marsh sandwort (*Arenaria paludicola*) is a dicotyledonous plant belonging to the pink family (Caryophyllaceae). Pertinent synonyms for the scientific name are *Minuartia paludicola* House; *Alsinopsis paludicola* A. Heller; *Arenaria palustris* S. Watson not of Gay 1845; and *Alsine palustre* Kellogg.

The species first was described as *Alsine palustre* by Albert Kellogg in 1863, from specimens collected by Bolander near Fort Point (now within Golden Gate National Recreation Area), San Francisco, California. The plant was then "very abundant in swamps" in the area (Kellogg 1863). In 1876, Sereno Watson reassigned the species to the genus Arenaria. The resulting name, *Arenaria palustris*, inadvertently duplicated the name that Gay had published earlier, in 1845, for another species. This duplication of names was corrected by B.L. Robinson (1894), who substituted the currently used scientific name, *Arenaria paludicola.*

Based on the most recent description of the taxon in *The Jepson Manual* (Hartman 1993), the plant is a herbaceous green perennial often supported by surrounding vegetation, with angled or grooved stems, which are glabrous (without hair) except at the nodes (points of leaf attachment) (Figure 1, Figure 3). The trailing stems often root at the nodes, and can be up to 1 meter (3 feet) long. The opposite leaves of the plant are lanceolate (lance-shaped) and narrowly acute (sharp-pointed), with a solitary mid-vein. The species blooms from May to August. At Oso Flaco Lake, it was flowering with some green fruit in early June (John Chesnut, *in litt.* 1998). Flowers are small, white, and borne singly on long stalks arising from the leaf axils (point of leaf attachment to the stem); capsules (fruits) contain 15 to 20 seeds. The solitary axillary flower and smooth, angled stem distinguish this species from others in the genus. Hitchcock (1964) speculated that this plant was "very seldom collected, possibly because it is mistaken for sterile plants of *Galium aparine*," a common species. As reported by Bonilla (1992, *in litt.* 1998) from Zempoala Lakes in the state of Morelos in central Mexico, this species is an annual, flowering April to September and producing seeds from June to October.

2. *Rorippa gambelii*

Gambel's watercress (*Rorippa gambelii*), also a dicot, belongs to the mustard family (Brassicaceae). In 1876, it was described by S. Watson as *Cardamine gambelii* from specimens collected by Gambel in 1844 near Santa Barbara, California. This name was retained in later floras, although in 1933 O.E. Schulz placed the taxon in the genus *Nasturtium* (unrelated to the garden "nasturtium"). Al-Shehbaz and Rollins (1988) combined the two genera *Nasturtium* and *Rorippa*, based on the lack of consistency in features previously used to distinguish them, i.e., flower color, the presence of median nectaries (nectar-secreting glands), and seed coat pattern. They incorrectly spelled their new combination, as *Rorippa gambellii*. This incorrect spelling has been copied in several publications. The correct spelling, *Rorippa gambelii* (Dieter Wilken, Santa Barbara Botanic Garden, in litt. 1995), is used in this document. Based on recent work on genetic sequencing, this taxon will be moved back to the genus *Nasturtium* in late 1998 (Robert Price, University of Georgia, pers. comm. 1998).

As described in *The Jepson Manual* (Rollins 1993), *Rorippa gambelii* is a perennial rhizomatous (with creeping underground stems) branched herb that can grow up to 2 meters (6 feet) tall (this height is confirmed by John Chesnut [in litt. 1998] at Oso Flaco Lake). It roots at lower stem nodes, while the upper stem generally remains erect (Figure 2, Photo 2). It blooms from April to July, producing dense inflorescences (flower clusters) with white flowers; the lateral inflorescences may bloom through August. The inflorescences produce 15 to 30 fruits with about 10 to 30 seeds each (Price 1989). The plant has pinnate (feather-shaped) leaves with 7 to 13 uniform leaflets, which are angular and dentate (toothed) in the upper leaves. Small lobes are present at the base of the leaf stalk. Lower flower stalks often have bracts (specialized leaves), and pedicel (flower stalk) junctions with the main stem are flat. These characters separate this taxon from a look-alike, watercress (*Rorippa nasturtium-aquaticum*), whose three to seven lateral leaflets are entire or wavy-margined and smaller than the terminal leaflet; the leaflets are more lobed than angular in the upper leaves. The smaller flowers of *Rorippa nasturtium-aquaticum* are supported by pedicels without bracts or flat stem junctions. Moreover, the linear and narrower fruits of *Rorippa gambelii* have more finely reticulate (net-patterned) seeds, which are arranged in one row per chamber, versus two rows per chamber in *Rorippa nasturtium-aquaticum*.

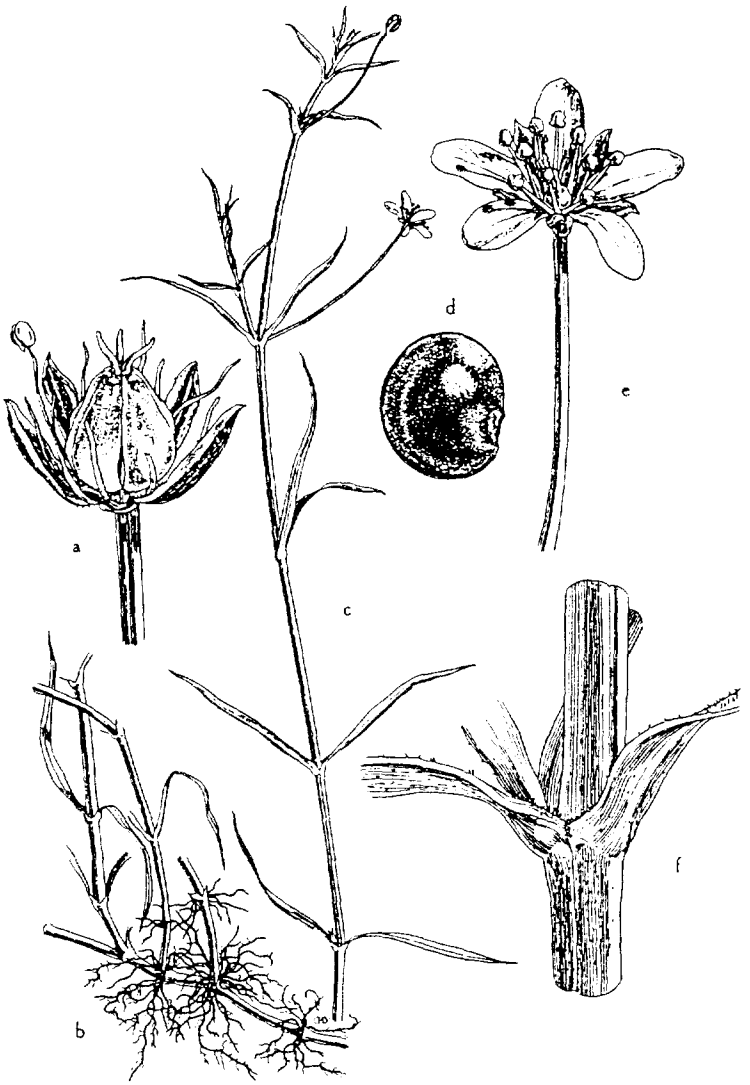


Fig. 226. *Arenaria paludicola*: *a*, calyx and mature capsule, × 6; *b*, habit, basal part of plant, showing roots at the nodes, × ½; *c*, habit, upper part of stem, showing flowers solitary in leaf axils, × ½; *d*, mature seed, globose, shiny, × 32; *e*, flower, × 3; *f*, connate leaf bases, × 8.

Figure 1. Illustration of *Arenaria paludicola* (from Mason 1957)

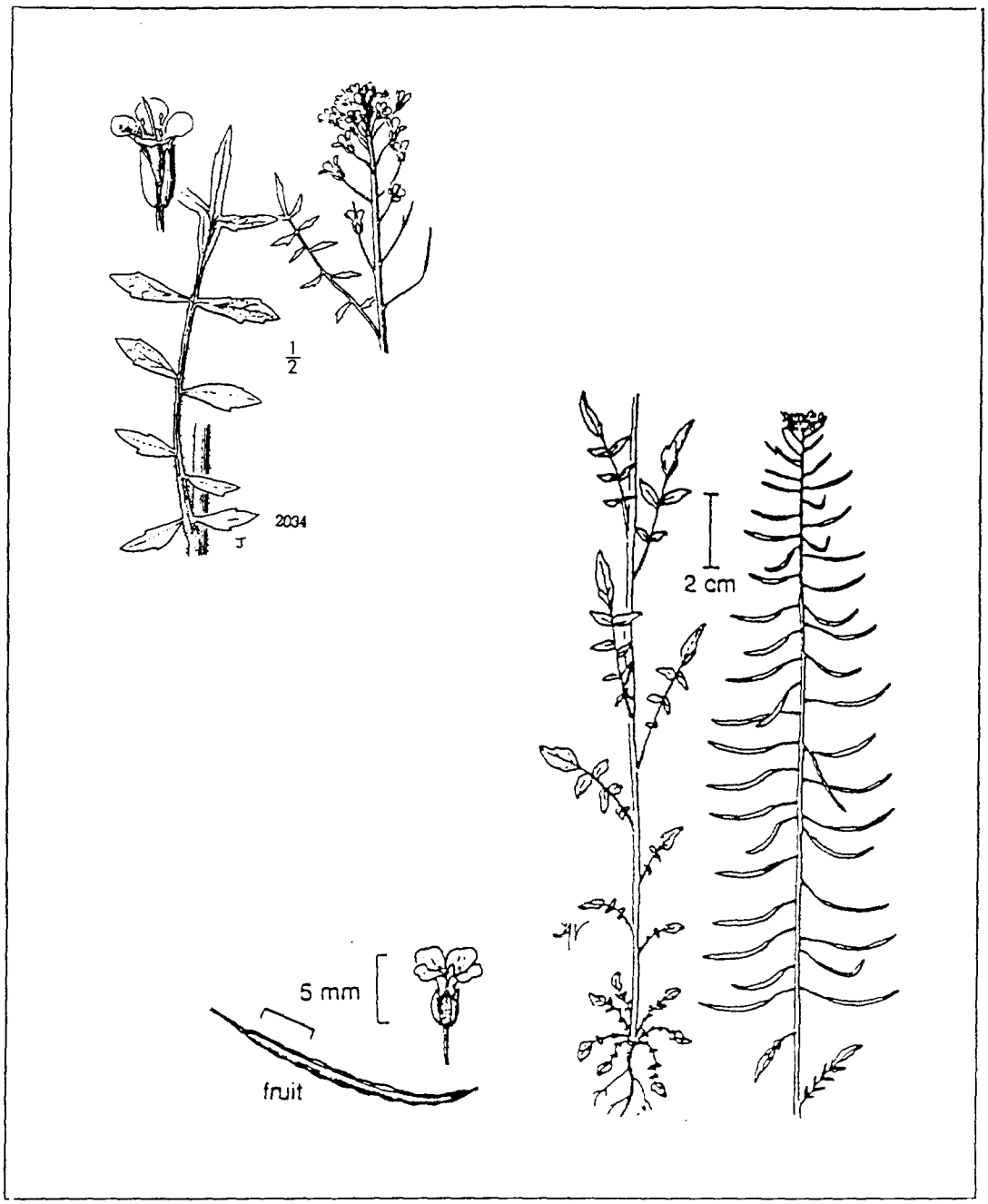


Figure 2. Illustration of *Rorippa gambelii* (top, from Abrams and Ferris 1940; bottom, from Hickman, ed. 1993).

Figure 3. Photos of *Arenaria paludicola* (top) and *Rorippa gambelii* (bottom). By Malcolm McLeod, from the of California Native Plant Society's rare plant slide collection.

## C. DISTRIBUTION

### 1. *Arenaria paludicola*

*Arenaria paludicola* was historically collected by botanists from scattered locations near the Pacific coast in southern and central California and Washington. In the past, this species may have been "more generally distributed, but rarely collected" as suggested by Abrams (1944), or it may have been restricted to a few widely separated locations (Table 1). California locations were recorded in 1899 in San Francisco and San Bernardino counties, in 1947 in Santa Cruz and San Luis Obispo counties, and in 1950 and 1964 in San Luis Obispo County. The southern range limit is given as Los Angeles County by Hitchcock (1964), and as the Santa Ana River (Orange County) by Hartman (1993). In a sequence of regional floras starting with Abrams and Ferris (1944), and continuing through Mason (1957), Munz and Keck (1968), Hoover (1970), Munz (1974), Smith (1976), and Hartman (1993), the earlier floras report the species as widespread within its historical range. Later floras report it as more localized and restricted, becoming "occasional," "scarce" in swamps and marshes, and most recently, "rare."

*Arenaria paludicola* was collected from "prairies" near Tacoma, Washington by Flett in 1896, but has evidently not been collected in Washington since then (Gamon 1991, Hitchcock 1964). Recent searches of sites where the species had been reported found no evidence of the plant. Gamon (1991) reports areas where this species might still exist include one or two wetlands in the Tacoma area in Washington. In 1990, the Washington State Natural Heritage Program listed *Arenaria paludicola* as Possibly Extirpated.

Only two of California's seven historical populations of *Arenaria paludicola* are known to exist today, near the southern San Luis Obispo County coast at Black Lake Canyon on the Nipomo Mesa and at Oso Flaco Lake further south (Figure 4). Here, freshwater marshes exist in a system of active to partly-stabilized sand dunes along an 8-kilometer (5-mile) stretch of coast from Oceano south to the Oso Flaco Lakes complex. Inland from the dune lakes complex, old Oceano sands deposited 40,000 years ago comprise the Nipomo Mesa, which is incised by the steep-walled Black Lake Canyon, whose bottom has patches of freshwater marsh that support both *Arenaria paludicola* and *Rorippa gambelii*. Even here, field surveys conducted in 1987 failed to find *Arenaria paludicola*

in some previously-reported locations, indicating that its populations may have declined recently (California Natural Diversity Data Base 1987).

*Arenaria paludicola* was first recorded at Black Lake Canyon by R.F. Hoover (1947). Later sightings were made in 1985 and 1992 (California Natural Diversity Data Base 1994). The population, recorded in 1985 as 1–10 plants in an area of less than 5 square meters (54 square feet), was not relocated in 1992; but some plants were found in a new location, about 90 meters (295 feet) downstream (Malcolm McLeod, Professor Emeritus, California Polytechnic State University, San Luis Obispo, pers. comm. 1994). This new occurrence was observed again in 1993, numbering about 10 individual stems (Tricia Waddell, University of California, Santa Barbara, pers. comm. 1994). Two stems were seen in July and August 1994; in August, the plants appeared to have been browsed (Parikh and Gale, pers. obs. 1994). In June 1996, only one plant remained.

John Chesnut (*in litt.* 1998) searched historic locations at Jack Lane and the shore of Oso Flaco Lake on May 18 and 19, 1998, but did not observe *Arenaria paludicola.* He noted that water levels were high at Jack Lake, and that while suitable habitat might be exposed after the water recedes, he believed the riparian willow community had expanded sufficiently to exclude habitat for this species. At Oso Flaco Lake in early June, he found *Arenaria paludicola* in two areas of *Sparganium* (bur-reed) and *Typha* (cattail) marsh with tussocks of *Carex cusickii* (a sedge) at the northwest shore of the lake. *Arenaria paludicola* is largely associated with sedge tussocks, growing in peat at the base of the tussock; Chesnut considers *Carex cusickii* the key component of *Arenaria paludicola* habitat. Other plants in the vicinity are *Mimulus guttatus* (monkeyflower), *Berula erecta* (cutleaf water-parsnip), *Hydrocotyle* spp., and *Epilobium ciliatum* (willow herb). All are common species.

During the public comment period on the draft plan, the Service received a report of *Arenaria paludicola* from Zempoala Lakes National Park, Morelos, Mexico, southwest of Mexico City (Langford *in litt.* 1998). Subsequently, Dr. Jaime R. Bonilla-Barbarosa of the Centro de Investigaciones Biológicas, Universidad de Morelos (*in litt.* 1998) provided details from his masters thesis (Bonilla 1992). *Arenaria paludicola* is native to edges and marshes of Zempoala Lake, where it is found with other emergent species such as *Bidens laevis* (bur-marigold), *Carex hermannii* (a sedge), *Glyceria striata* (fowl mannagrass),

and *Typha latifolia* (broad-leaved cattail). Dr. Bonilla reports the following physical data for the water and sediments where it grows:

| WATER | range | mean | units |
|---|---|---|---|
| Temperature | 10-21 | 15.75 | °C |
| pH | 5.8-8.3 | 6.73 | |
| Electric conductivity | 66-92 | 81.67 | micromhos/cm |
| Sodium | 0.25-0.77 | 0.48 | mEq/l |
| Potassium | 0.03-0.05 | 0.04 | mEq/l |
| Calcium | 0.02-0.17 | 0.10 | mEq/l |
| Magnesium | 0.01-1.45 | 0.51 | mEq/l |
| Bicarbonate | 0.9-2.16 | 1.32 | mEq/l |
| Chloride | 0.33-0.49 | 0.37 | mEq/l |
| Sulfate | 0.01-0.10 | 0.05 | mEq/l |
| Total phosphorus | 40-1390 | 205.83 | g/l |
| Total nitrogen | 130-1320 | 881.67 | g/l |
| SEDIMENT | | | |
| Texture | Clay, clay-sandy | | |
| pH | 5.4-6.7 | 6.2 | |

2. *Rorippa gambelii*

*Rorippa gambelii* was reported in the early 1900s from several wetland locations in southern California, from Los Angeles and San Bernardino counties southward. There was a disjunct population in the Valley of Mexico near Mexico City (Wickenheiser 1989). In 1947, a population was observed by R.F. Hoover in San Luis Obispo County near Small Twin Lake and Oceano Beach (California Natural Diversity Data Base 1994). These historical populations of *Rorippa gambelii* are extirpated. A population reported from San Diego County by Oberbauer (date unknown) may have been misidentified — the plants were possibly *Rorippa nasturtium-aquaticum* (Price 1989). Plants reported in Santa Barbara County occurred in a marsh dominated by sawgrass (*Cladium californicum*) in Barka Slough at Vandenberg Air Force Base (Dial 1980). They were not observed by Price in 1989 surveys, when he noted that the area had converted to willow woodland; additionally, Price reports that the 1980 record was not supported by a herbarium voucher. In California floras by Hoover (1970), Munz (1974), and Rollins

(1993), the distribution of *Rorippa gambelii* was termed, respectively, "locally common," "occasional, becoming scarcer," and finally, "rare."

*Rorippa gambelii* populations near Oso Flaco Lake.

| | 1989 (Price) | 1992 (McLeod, Keil) | 1993 (Waddell) | 1994 (Parikh, Gale) | 1998 (Chesnut) |
|---|---|---|---|---|---|
| Black Canyon Lake | 100 | 1,000 | 500 | 500 | not visited |
| Little Oso Flaco Lake | 300 | not relocated | 500 | 500? | site dredged |
| Oso Flaco Lake, S of causeway | 300 | not relocated | not relocated | not relocated | not relocated |
| Oso Flaco Lake, S of causeway (new site) | | | | | 68+ |
| Oso Flaco Lake, N of causeway | | | | | 400+ |
| Oso Flaco Lake, NW corner of lake | | | | | small number, with *Arenaria paludicola* |

In the 1980s, three small populations of *Rorippa gambelii* were reported at three sites within 4 miles (6 kilometers) of each other in San Luis Obispo County: Black Lake Canyon, Oso Flaco Lake, and Little Oso Flaco Lake. The three populations combined were estimated, in 1989, to have about 700 individual plants of *Rorippa gambelii*: 100 at Black Lake Canyon (seen by David Keil, California Polytechnic State University, San Luis Obispo, in 1988) and 300 at each of the two lakes (Price 1989). As of 1994, two of the populations were extant (Wickenheiser and Morey 1990; California Natural Diversity Data Base 1994).

In 1992, about 1,000 individuals were seen at Black Lake Canyon. The other populations were not relocated (M. McLeod, pers. comm. 1994; D. Keil, pers. comm. 1994). The Black Lake Canyon population was again observed in 1993, numbering about 500 individuals (T. Waddell, pers. comm. 1994); about the same number was seen in July

1994 (Parikh and Gale pers. obs. 1994). This population is approximately 200 meters (660 feet) downstream of the *Arenaria paludicola* plants.

Searches conducted in 1993 and 1994 failed to relocate the Oso Flaco Lake population (Mazer and Waddell 1994; Parikh and Gale, pers. obs., 1994). However, about 500 *Rorippa gambelii* plants were seen in shallow water at Little Oso Flaco Lake where Price had reported them in 1989 — in a drainage ditch next to agricultural fields along the north shore of the lake and west of this area along an extension that connects to the main part of the lake (Parikh and Gale, pers. obs. 1994). A May 1998 search by John Chesnut (independent botanical consultant, *in litt.* 1998) found no plants in Price's location southwest of the Oso Flaco causeway, but did find a large population north of the causeway. A visual estimate of population size was greater than 400 plants. A smaller population was on the east shore of the southern (larger) portion of the lake. Chesnut counted 68 plants here, but did not survey all of the potentially suitable habitat. Chesnut did not find *Rorippa gambelii* in any portion of Little Oso Flaco Lake. The site where *Rorippa gambelii* had been reported in 1989 was near a pump and filter station, and was dredged in spring 1998. Vegetation had not re-established at the time of Chesnut's visit.

A third population of *Rorippa gambelii* was discovered in 1996 by David Keil during the course of basewide surveys at Vandenberg Air Force Base (VAFB). Approximately 100 plants were found along a deep, slow-moving channel in a clearing between clumps of willow. The channel, which runs along the south side of the Purisima Hills, is part of the San Antonio Creek watershed on the northern half of the Base. The site is classified by the Base as "unimproved land." There are no known plans for use of the site at this time (Chris Gillespie, botanist, VAFB; pers. comm. 1997).

During the public comment period on the draft version of this plan, the Service was informed that several collections of *Rorippa gambelii* had been made in the 1980s from the State of Chiapas, Mexico (Robert Price, pers. comm. 1998). Donovan Bailey (graduate student, Cornell University; in litt. 1998) identified two herbarium sheets from the National Herbarium of Mexico as belonging to *Rorippa gambelii.* One was collected in 1985 in an altered pine forest near Tenejapa on the road to San Cristóbal de las Casas; the other was growing as an aquatic, 34 kilometers south of Ixtacomitán on the road to Tuxtla Gutierrez. There may be more specimens in Mexican herbaria.

## D. HABITAT REQUIREMENTS

Both *Arenaria paludicola* and *Rorippa gambelii* are found in freshwater marshes, and *Rorippa gambelii* additionally may occur in brackish marshes. The extant populations in California are in areas of Mediterranean climate, with cool wet winters and drier warmer summers; coastal fog is very common. The elevational range of both species is from sea level to about 450 meters (1,480 feet). Soils in their marshy habitats are saturated acidic bog soils, predominantly sandy with a high organic content. When the species were found in 1992, they occupied an area with some shallow standing water, about 5 centimeters (2 inches) deep, on level ground in the bottom of Black Lake Canyon (M. McLeod, pers. comm. 1994). Vegetation surrounding the plants at Black Lake Canyon includes emergent freshwater marsh species and some riparian woodland or wetland tree species, mainly arroyo willow (*Salix lasiolepis*) and California wax myrtle (*Myrica californica*). Eucalyptus (*Eucalyptus globulus*) trees planted in and around the canyon in the late 1800s form a dense canopy around the edges of the marshes, and some are invading the lower margins of the canyon. Shady or filtered light conditions in the canyon bottom may be inhibiting the growth of species such as *Arenaria paludicola* and *Rorippa gambelii*, but light requirements for their germination and survival are unknown. In the Black Lake Canyon location where *Arenaria paludicola* was found in 1994, soils were saturated, but no standing water was present. The undergrowth was dense. Associated plants included ferns, Pacific blackberry (*Rubus ursinus*), cattails (*Typha latifolia*), sedges (*Carex* spp.), California wax myrtle, hoary nettle (*Urtica dioica* ssp. *holosericea*), straggly gooseberry (*Ribes divaricatum* var. *pubiflorum*), fireweed (*Epilobium ciliatum*), American bulrush (*Scirpus americanus*), and honeysuckle (*Lonicera involucrata* var. *ledebourii*) (Figure 5). The stems of *Arenaria paludicola* were supported by Pacific reedgrass (*Calamagrostis nutkaensis*) (Mazer and Waddell 1994b).

*Rorippa gambelii* was found about 200 meters (660 feet) downstream of the *Arenaria paludicola* plants at Black Lake Canyon in dense vegetation just inside the marsh margin where ferns (present on drier ground) were absent. Soils were covered with heavy plant litter and were saturated, with no standing water, but with water about 15 centimeters (6 inches) below the soil surface. Associated species included giant burreed (*Sparganium eurycarpum*), nettles, Pacific blackberry, cattails, American bulrush, water-parsley (*Oenanthe sarmentosa*), and honeysuckle (Figure 5). Mazer and Waddell also found hoary nettle (Mazer and Waddell 1994b). *Rorippa gambelii* at Oso Flaco Lake was on

damp, dark, organic, soft, but not completely saturated soils under a canopy of willows, with little other competing vegetation, although some plants overtopped honeysuckle and Pacific blackberry shrubs. At another site on Oso Flaco Lake, the species was growing at the edge of a willow stand, between the willows and an American bulrush marsh, on fully saturated soil with some surface water. This soil was mucky, red tinted, and only slightly organic (Chesnut, *in litt.* 1998).

In the dune lakes habitats, *Rorippa gambelii* has been seen in areas partially disturbed by humans, for example, in patchy wetland habitat extending from the dune lakes (such as a drainage ditch adjacent to fields along the north shore of Little Oso Flaco Lake), or in clearings opened up by human disturbance (south of the causeway at Oso Flaco Lake). It is not known if *Arenaria paludicola* could survive such disturbances. Both species appear to be competing against other plants in the dense vegetation for water, nutrients, light, and space; their growth may be promoted by clearing some of the vegetation. Suitable habitat for both species does exist in other parts of Black Lake Canyon and the dune lakes, and it is possible that more populations could be found in future surveys. Undisturbed habitat for both species also could be present in groundwater-supported wetlands lying within dune swales on the San Antonio Terrace, a system of stabilized sand dunes in the northern part of nearby Vandenberg Air Force Base. *Rorippa gambelii* can occupy the margins of lakes or slow-moving streams, and probably requires a more permanent water source than *Arenaria paludicola*. Such habitat could be found in the San Antonio Creek drainage at Vandenberg Air Force Base (Price 1989).

## E. LIFE HISTORY

The California Department of Fish and Game sponsored a study by scientists from the Department of Biological Sciences at the University of California, Santa Barbara, to provide management and recovery recommendations for the two species (Mazer and Waddell 1994a and 1994b). The study investigated the two species' natural life cycles and ecological requirements, and evaluated the effectiveness of greenhouse propagation and controlled reintroduction. The study concentrated on *Rorippa gambelii* because the extremely small number of *Arenaria paludicola* individuals available for study from a single small population makes it a difficult species to examine and manipulate. At Black Lake Canyon, surveys were made for indicator plants for the two species' habitats. Field samples of soil were analyzed to examine characteristics of the substrates tolerated by the

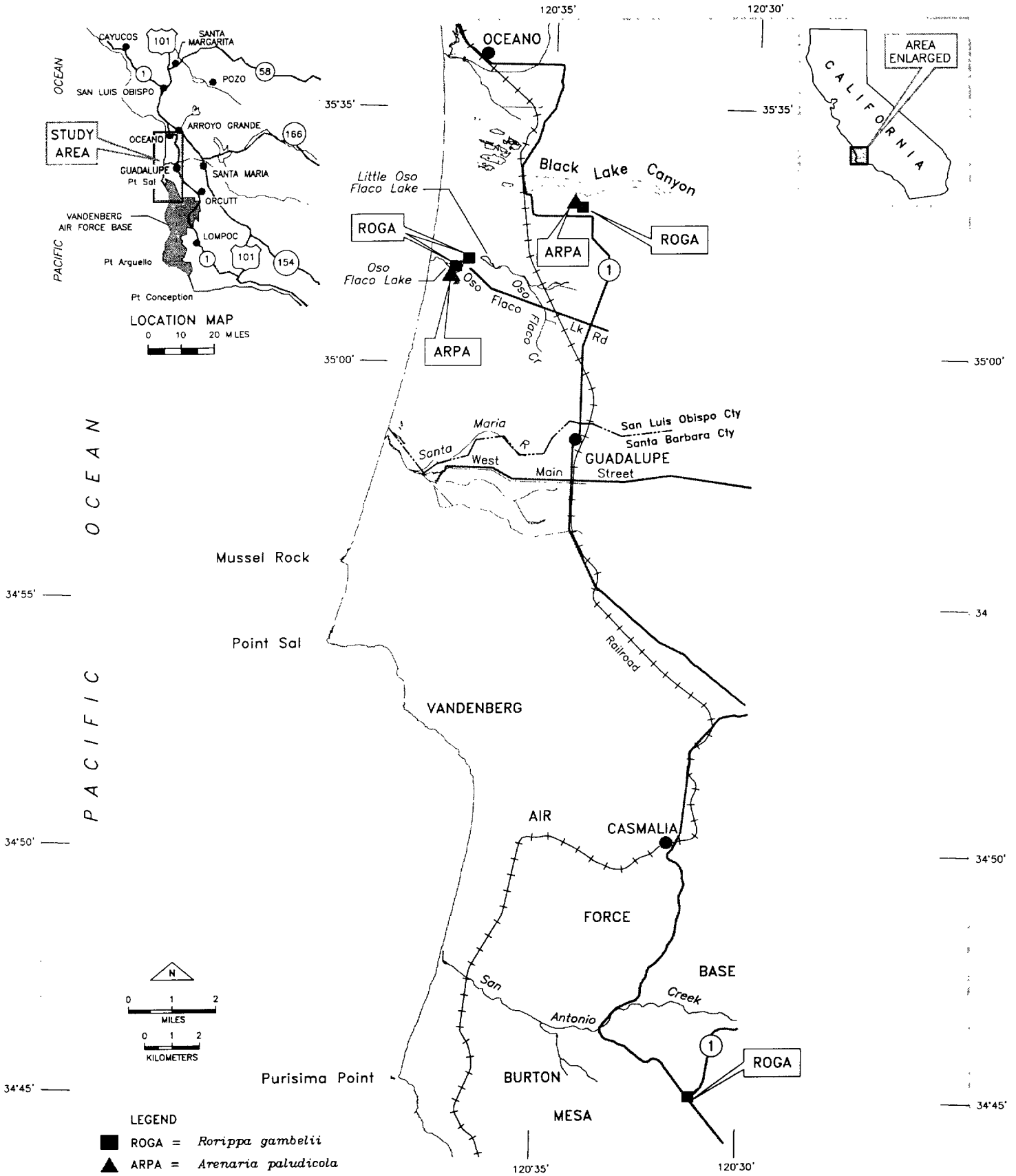


Figure 4. Distributions of *Arenaria paludicola* and *Rorippa gambelii*

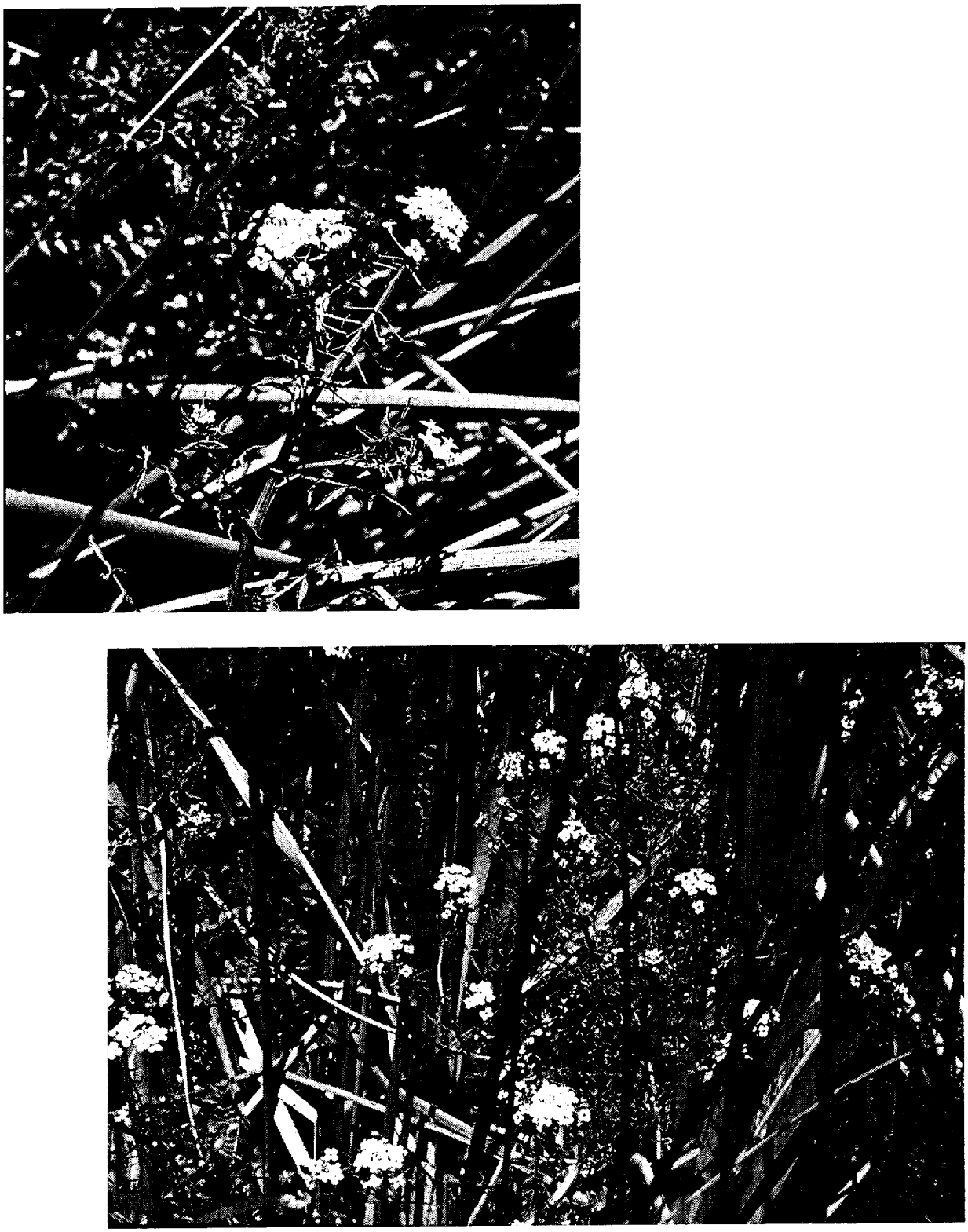

Figure 5. Habitat of *Arenaria paludicola* (top) and *Rorippa gambelii (bottom)*.
Photos by Robert Price, by permission of California Native Plant Society.

Figure 6. *Arenaria paludicola* habitat. Photo by Malcolm McLeod, by permission of California Native Plant Society.

Lake Canyon, surveys were made for indicator plants for the two species' habitats. Field samples of soil were analyzed to examine characteristics of the substrates tolerated by the endangered species. Data about population characteristics were collected on seedlings and juveniles, and natural processes contributing to pollination, fruit and seed production, and mortality also were examined. The data provide initial baseline information on the species' population growth, colonization, geographic range, and reproductive success. Because the study only covers two field seasons (1993 and 1994) and only one site, definitive conclusions on managing the two species cannot be drawn.

Mazer and Waddell (1994a and 1994b) observed that *Arenaria paludicola* flowered and fruited minimally in 1993 and 1994, with generally one or two flowers open at a time for pollination, although no pollinators were ever observed. Soil samples collected from the Black Lake Canyon field site had a viable seed bank. *Arenaria paludicola* germinated in the greenhouse under ambient light and temperature conditions in 25 percent of the soil samples, producing one or two seedlings per pot, while no seedlings emerged from samples subjected to a wet/vernalization treatment in a growth chamber. Currently, little else is known about the reproductive biology of *Arenaria paludicola* because information is lacking regarding its pollinators, seed germination and dispersal, and seedling recruitment. In addition to reproducing from seed, the species roots at the nodes, and cuttings have been used to propagate it fairly easily in potted soil (Bill Deneen, local resident, pers. comm. 1994; David Gurney, local resident, pers. comm. 1994; Susan Mazer, University of California, Santa Barbara, pers. comm. 1994). Plants have been grown successfully from cuttings; they flowered in 1993, and some plants flowered again in 1994 (D. Gurney, pers. comm. 1994 and B. Deneen, pers. comm. 1994).

Soil samples collected under the Black Lake Canyon population of *Rorippa gambelii* also had a viable seed bank which germinated in the greenhouse under ambient light and temperature conditions, with 75 percent of soil samples producing seedlings, and about 1 to 10 seedlings in each pot. Soil samples subjected to a wet/vernalization treatment rarely yielded seedlings. *Rorippa gambelii* seedlings started emerging in April, and flowered through an extended period from May to October, peaking in July (Mazer and Waddell 1994a and 1994b). Based on monitoring 49 seedlings in 10 quadrats, Mazer and Waddell (1994b) found that a high proportion (81.6 percent) survived to the end of the 3-month monitoring period. Mazer and Waddell (1994a) indicate that flowering phenology could be related to genetic or environmental factors, and may ensure that at least some

individual plants set fruit either early in drought years, when soils dry quickly, or later in more favorable rainfall years. Self-pollination appears occur in this species, based on the lack of pollinators seen in the field, as well as results of pollinator exclusion experiments.

Price (1989) observed that the dense inflorescences with many lateral flowers in *Rorippa gambelii* potentially could produce several thousand seeds per plant, although many of these seeds may not mature and be viable. He suggested that the species' localized distribution may be due to the lack of openings for growth among dense vegetation and the limited light conditions in the Black Lake Canyon marshes. Based on measurements made on 20 individuals, Mazer and Waddell (1994b) found fruit production ranged from 25 to 200 fruits per individual, averaging 85.8 fruits. The average seed production per fruit was 10.28 seeds, so the average plant produced 882 seeds.

## F. REASONS FOR LISTING AND CURRENT THREATS

Immediate threats to the survival of both *Arenaria paludicola* and *Rorippa gambelii* include habitat degradation or destruction and competition with exotic species for light, water, nutrients, and space. Other threats to the survival of the species may be related to biological and genetic factors and the occurrence of sudden disastrous events.

### 1. Habitat Degradation and Destruction

Wetland habitats (freshwater marshes and swamps), where both *Arenaria paludicola* and *Rorippa gambelii* are found, have been disappearing from the Pacific coast of North America at a rapid rate since the early part of the century. The conversion of wetland habitat to agriculture, ranching activities, and increased urbanization, and the use of off-road vehicles for recreation, have all eliminated or degraded habitat. Tables 1 and 2 summarize the status of historical sites for *Arenaria paludicola* and *Rorippa gambelii*. They indicate that the only historic site with potentially suitable habitat for both plants is in the dune lakes near Black Lake Canyon, except for the possibility that suitable habitat remains for *Arenaria paludicola* in wetlands near Tacoma, Washington

**a. Hydrology** — Black Lake Canyon is divided into a lower and an upper canyon, each supplied by a separate aquifer, separated by an impermeable layer. Aerial photos show

that the lower canyon, where *Arenaria paludicola* and *Rorippa gambelii* are found, was mainly open water with marshy margins in 1949; by 1956, 30 percent of the area was tree-covered, mainly with willows (Holland and McLeod 1992).

The lower canyon's groundwater table has been sinking steadily in the past few years, although the upper canyon shows a stable or rising groundwater table (David Chipping, California Native Plant Society, pers. comm. 1994). Reasons suggested for the drop in the lower canyon aquifer include water drawdown from wells, as well as water uptake and transpiration from the many introduced eucalyptus trees in this area. California's drought in the past decade also adversely affected the hydrology of the lower canyon. The upper canyon's rising or stable aquifer may be recharging through agricultural and golf course runoff, which may include pesticides and fertilizers. Agriculture is the major land use in the dune lakes region, particularly the area surrounding Little Oso Flaco Lake. Changes in agricultural activities may cause the water sources in such locations to fluctuate, rendering them unsuitable environments for the survival of the two species, especially *Rorippa gambelii.*

Increasing development and agricultural land use, in addition to changes in water levels at Black Lake Canyon and in the dune lakes, may degrade water quality. These activities may cause contaminants to enter water sources, although recent water quality testing by the Land Conservancy of San Luis Obispo County (LCSLO) suggested that concentrations of contaminants were not an issue (Ray Belknap, LCSLO, pers. comm. 1995). Degraded water quality could cause changes in nutrient composition in the soils underlying *Arenaria paludicola* and *Rorippa gambelii.* Additional water quality surveys are scheduled for Black Lake Canyon in 1998 to assess the suitability of specific locations for introductions of *Arenaria paludicola* and *Rorippa gambelii* (McEwen 1997).

Oso Flaco Lake levels historically fluctuated because the lake outlet (Oso Flaco Creek) was periodically opened using heavy equipment to alleviate potential flood damage to adjacent farmlands. In the five years up to 1998, a combination of factors resulted in higher water levels in the lake. The outlet has been artificially opened less frequently, and it has been partially blocked by encroaching dunes. The higher lake levels have inundated emergent marsh habitat previously found along the shoreline, and may not be as favorable for supporting *Arenaria paludicola* and *Rorippa gambelii.* (Jack Beigle, local naturalist, pers. comm. 1998).

**b. Soils** — Increased erosion from the steep sandy slopes of Black Lake Canyon, both from development on the canyon rim and from natural causes such as landslides, could result in increased sedimentation into bottom habitats. Sedimentation could degrade bottom wetland habitats for *Arenaria paludicola* and *Rorippa gambelii*.

A large part of the dune lakes area forms the Pismo Dunes State Vehicular Recreation Area owned by the California Department of Parks and Recreation. Past use of the dune lakes area by off-road vehicles caused the reduction in cover of stabilizing native vegetation. As a result, *Rorippa gambelii* habitat was, and continues to be, modified by sand encroachment from adjacent dunes at Oso Flaco Lake.

### 2. Competition

Conversion of pristine natural habitats to agriculture and increased urbanization have resulted in exotic plants encroaching on native vegetation. In Black Lake Canyon, eucalyptus trees and, to a lesser extent, veldtgrass (*Ehrharta calycina*), are almost certainly competing with native upland vegetation in canyon areas and causing hydrological changes in marshes (R. Belknap, pers. comm. 1995). Such changes probably are affecting the habitat of *Arenaria paludicola* and *Rorippa gambelii*. Only about one-third of the canyon area examined in the area's Enhancement Plan (prepared by The Land Conservancy of San Luis Obispo County in 1992) comprised native vegetation; the remainder is covered by eucalyptus, urbanized, or converted to agriculture. Both endangered species therefore have to compete for water, nutrients, light, and space with exotic species, as well as with densely growing native vegetation surrounding them.

### 3. Biological Factors

Currently, it is not known if the populations of these species suffer from a general lack of reproductive vigor, pollinator deficiencies, excessive inbreeding, or a loss of genetic diversity. These factors can result in lower tolerances to environmental fluctuations, and a corresponding restriction in range because of the reduced ability of the plants to colonize new sites. *Rorippa gambelii* may also be threatened by the presence of a thrips (Thysanoptera) species, which consumes much of the pollen (Mazer and Waddell 1994).

## 4. Natural and Human-Induced Disasters

Because populations of these species are extremely localized and the individual numbers of plants are small, any single natural or human-induced disaster could result in their extinction. Such events include fire, flood, pest attacks or other diseases, earthquakes, landslides, and, in an area such as the rim of Black Lake Canyon, development and construction, which could cause rapid erosion of steep slopes and subsequent sedimentation into the canyon bottom.

**Table 1. The Status of Historical Sites for *Arenaria paludicola***

| Historical sites | When plant was last seen | Suitable habitat remaining? | Status of historical habitat |
|---|---|---|---|
| **San Bernardino County** | | | |
| 1. Vicinity of San Bernardino, Santa Ana River | 1899 | No | Conversion to urbanization has occurred (extent of historical habitat unknown). |
| **San Luis Obispo County** | | | |
| 2. Jack Lake, west of Nipomo Mesa | 1964 | Maybe | Likely habitat may remain (lake is less than 1 acre). |
| 3. Near small Twin Lake, south of Arroyo Grande | 1947 | Maybe | Likely habitat may remain, though California Natural Diversity Database (CNDDB) (1994) indicates that development may have caused extirpation (lake is approximately 15 acres). |
| 4. Black Lake Canyon | 1995 | Yes | Extant population occurs here (population is less than 1 acre). Additional habitat along 0.5 mile of canyon bottom may be available as a result of habitat enhancement. |
| 5. Oso Flaco Lake | 1998 | Yes | Last previous report was in 1950 (lake is approximately 50 acres). |
| **Santa Cruz County** | | | |
| 6. Camp Evers near Scott Valley Junction | 1947 | No | Conversion to urbanization has occurred. By 1981, site was a trailer park. (extent of historical habitat unknown). |
| **San Francisco County** | | | |
| 7. Fort Point, Presidio Swamp, San Francisco | 1899 | No | Filled for expansion of Crissy Field<br>Note: this is the type locality. (Extent of historical habitat is unknown). |
| **Washington State** | | | |
| 8. From swamps near Tacoma | 1896 | Maybe | Likely habitat may remain (extent of likely habitat is unknown, but could be extensive). Note: no plants found in 1990 surveys |

**Table 2. The Status of Historical Sites for *Rorippa gambelii***

| Historical sites | When plant was last seen | Suitable habitat remaining? | Status of historical habitat |
|---|---|---|---|
| **San Bernardino County** | | | |
| 1. Urbita Hot Springs | 1935 | No | Swamp was drained in 1945. Site now consists of sand and cottonwoods (CNDDB 1994). (Extent of historical habitat unknown). |
| **San Luis Obispo County** | | | |
| 2. Near small Twin Lake s. of Arroyo Grande | 1947 | Maybe | Likely habitat may remain, though CNDDB (1994) indicates that development may have caused extirpation (lake is approximately 30 acres). |
| 3. Oso Flaco Lake | 1998 | Yes | Two populations discovered in spring 1998 (greater than 470 plants). A population was observed at another site on the lake in 1989 (population was less than 1 acre; lake is approximately 50 acres); not seen recently. |
| 4. Little Oso Flaco Lake | 1995 | Yes | Extant population in 1994, not relocated in 1998. (Population. was less than 1 acre; lake is approximately 30 acres) |
| 5. Black Lake Canyon | 1995 | Yes | Extant population currently occurs here (population is less than 1 acre; other pockets of likely habitat may occur in canyon) |
| **Santa Barbara County** | | | |
| 6. Near Santa Barbara | 1876 | No | Conversion to urbanization has occurred. Note: this is the type locality (extent of historical habitat unknown) |
| 7. Vandenberg Air Force Base | 1996 | Yes | Extant population occurs here |
| **Mexico** | | | |
| 8. Near Mexico City, Valley of Mexico | ?? | Doubtful | Conversion to urbanization is likely (extent of historical habitat unknown) |
| 9. Chiapas, SE of Tenejapa | 1985 | Unknown | Only information is from label on herbarium specimen. |
| 10. Chiapas, S of Ixtacomitán | 1984 | Unknown | Only information is from label on herbarium specimen. |

## G. CONSERVATION MEASURES

The final rule determining Federal endangered status for the plant species *Arenaria paludicola* and *Rorippa gambelii* was published in the August 3, 1993, Federal Register (58 FR 41378). As described in this rule, available conservation measures for listed species include the recognition that comes from being placed on the Federal list, which may promote conservation by various agencies, groups and individuals through resource allocation for research, protection, and recovery of the species. The Endangered Species Act authorizes the National Forest System and the Department of the Interior to acquire land to conserve endangered species. The Act requires that recovery actions be carried out for all listed species, initiated by the preparation of recovery plans. Federal agencies must ensure that activities they authorize avoid or minimize impacts; if a Federal action may affect a listed species, the responsible Federal agency must enter into formal consultation with the U.S. Fish and Wildlife Service. The trade prohibitions of the Endangered Species Act apply to *Arenaria paludicola* and *Rorippa gambelii*, so that among other things it is illegal to sell these plants in interstate commerce without a permit; to remove and reduce them to possession from areas under Federal jurisdiction; maliciously damage or destroy them on any area under Federal jurisdiction; or to remove, cut up, dig up, damage or destroy them on any other area in knowing violation of any State law or regulation or in the course of any violation of a State criminal trespass law.

The areas in which these species occur were not designated as critical habitats because the U.S. Fish and Wildlife Service found the designation was not prudent. The process of designating critical habitat requires the publication of precise descriptions and maps of the habitats, which could likely increase the threat to the species' survival from vandalism, collecting and take, or other damaging human activities.

In spite of the protection afforded by Federal, State, and local regulations, inadvertent "take" of these species could result from habitat modification or land use change by property owners. For example, under section 404 of the Clean Water Act, the U.S. Army Corps of Engineers regulates the discharge of fill into waters of the U.S. and wetlands. Many areas that may be developed in Black Lake Canyon and the dune lakes region, where wetland habitats could exist for *Arenaria paludicola* and *Rorippa gambelii,* are less than 10 acres (4 hectares) in size. For such areas, the Army Corps of Engineers could issue authorization to proceed under a "Nationwide" permit rather than an individual

permit. The section 404 regulations require the Army Corps of Engineers to solicit comments from the U.S. Fish and Wildlife Service on issuance of a Nationwide permit; however, protection of these sensitive habitats cannot be guaranteed by section 404 regulation. Additionally, if the project may affect proposed or listed species, the Army Corps of Engineers must initiate a formal consultation under section 7 of the Federal Endangered Species Act of 1973, as amended. However, because the Act does not prohibit "take" of listed plants as it does for listed animals, the U.S. Fish and Wildlife Service can require project modifications only if it finds that the proposed action is likely to jeopardize the continued existence of the species.

These two plants are protected by the State of California. In 1990, *Arenaria paludicola* and *Rorippa gambelii* were State-listed as endangered and threatened, respectively (Morey 1990; Wickenheiser and Morey 1990; Skinner and Pavlik 1994). State-listed species are protected under the California Endangered Species Act, the Native Plant Protection Act, and the California Environmental Quality Act. The Native Plant Protection Act requires permits for collecting, transporting or selling state-listed plants. Under the California Endangered Species Act, state-designated threatened and endangered plants and candidate species are protected from taking, except for scientific and management purposes, which require a permit or agreement from the California Department of Fish and Game. In addition, State agencies are required to consult formally with the California Department of Fish and Game on State projects that may affect listed threatened or endangered species or candidates. Under the California Environmental Quality Act, government agencies must consider environmental impacts of projects and avoid or mitigate them where possible. Where state-listed species may be adversely affected by a project, an Environmental Impact Report must be prepared to disclose impacts of the project and outline project alternatives. However, the lead agency may make a statement of overriding considerations and allow the development to adversely impact the species.

A degree of habitat protection for *Rorippa gambelii* has been provided by San Luis Obispo County's designation of the bottom and lower slopes of Black Lake Canyon as a Sensitive Resource Area. Further development is restricted and subject to more careful environmental review by the county. Development includes construction of new homes and the placement and operation of water wells. In 1986, property owners in the canyon were interested in relaxing the planning area standards and in reducing the boundaries of

the Sensitive Resource Area. In response to their request for changes, a Draft Environmental Impact Report was prepared, which reported significant adverse impacts from the proposed actions (McClelland Engineers, Inc. 1988). The request was subsequently dropped. A new amendment that would expand the Sensitive Resource Area boundary and increase erosion control on surrounding lands has been proposed by The Land Conservancy of San Luis Obispo County and was reviewed by the County Planning Department (R. Belknap, pers. comm. 1995). As of spring 1998, little further progress had been made (E. Wier, San Luis Obispo County Planning Department, pers. comm. 1998).

The two remaining populations of *Arenaria paludicola* and two of the three remaining populations of *Rorippa gambelii* in California are on lands controlled by State conservation agencies or private conservation organizations. During the environmental review process for the modification of the Sensitive Resource Area boundary and planning area standards for Black Lake Canyon, an Enhancement Plan for the canyon was prepared by the Land Conservancy of San Luis Obispo County (1992). The plan recommended the purchase of open space easements from willing sellers, especially in the part of the canyon with sensitive plant populations. Management strategies for sensitive canyon resources would then be developed in cooperation with property owners (LCSLO, 1992). Because of conflicting interests between property owners, the county, and other agencies, and because of the lack of funds to finalize reports and decisions, restoration activities proposed for the area have been delayed. Despite the delay, the Land Conservancy of San Luis Obispo County has purchased two land parcels and an easement on the parcel containing the *Arenaria paludicola* population in lower Black Lake Canyon. The Land Conservancy has begun to remove the small eucalyptus trees in one of the parcels to reduce water drawdown by the trees, thereby enhancing habitats where *Arenaria paludicola* and *Rorippa gambelii* may occur (R. Belknap, pers. comm. 1995).

The Enhancement Plan also recommended a redefinition of the Sensitive Resource Area boundary to include, at a minimum, all land within 46 meters (150 feet) of the edge of existing wetlands and the stream channel. In addition, the plan recommended stringent standards limiting development within the Sensitive Resource Area, and requirements for erosion control and the protection of sensitive resources in the surrounding buffer.

Implementation of the Enhancement Plan is of the utmost importance in ensuring the protection of these two endangered plants.

As of 1998, most property owners at Black Lake Canyon have been notified of the need to protect the species. Although the area is somewhat protected through restricted access into the canyon bottom by fences and "No Trespassing" signs installed by landowners, other management activities directed at maintaining the survival of populations of *Arenaria paludicola* and *Rorippa gambelii* have been limited. The Land Conservancy of San Luis Obispo County is preparing an erosion control plan for the canyon and will work with landowners to implement erosion control measures on private land (R. Belknap, pers. comm. 1995).

Conservation measures in the dune lakes area include the designation of two lakes and surrounding land as the Oso Flaco Lake Natural Area by the California Department of Parks and Recreation (CDPR), and the Natural Area's management by The Nature Conservancy from 1990 until 1996, when CDPR resumed management. Revegetation is being attempted in some areas, particularly at Oso Flaco Lake, but it has not yet been completely successful in stabilizing the dunes (Wickenheiser 1989). Relatively recently, off-road vehicle access was prohibited in this area and actions have been taken to limit human traffic in the dunes. In 1982, the causeway or road across Oso Flaco Lake, built in the 1940s, was blocked off to allow only foot traffic, and a boardwalk from the west shore of the lake to the beach was built in 1992 to prevent foot traffic in revegetation areas. A new footbridge designed to discourage foot traffic in the dunes crosses the lake, connecting the causeway to the boardwalk.

The California Department of Fish and Game (CDFG) recently sponsored a study of the biology of *Arenaria paludicola* and *Rorippa gambelii*. Results (Mazer and Waddell 1994a and 1994b) are summarized in the Life History section above. Since preparation of the draft recovery plan, the following actions have also been undertaken: CDFG sponsored a recovery workshop that focused on recovery needs of the two species, an evaluation of potential introduction sites for *Rorippa gambelii* on Vandenberg Air Force Base was completed (Keil 1997), and vegetative propagation of *Arenaria paludicola* for eventual outplanting is underway at the Santa Barbara Botanic Garden. The U.S. Fish and Wildlife Service recently provided the CDFG with funds to continue experimental propagation and outplanting of these two plants.

## H. RECOVERY STRATEGY

The recovery strategy for *Arenaria paludicola* and *Rorippa gambelii* involves six major steps, described in detail in the next section. These steps are to 1) protect, maintain, and enhance habitats; 2) monitor and document species populations and habitat characteristics; 3) conduct research on the ecology and biology of the species; 5) expand existing populations; 5) establish new populations; and 6) evaluate progress and update management and recovery guidelines.

Of these six steps, the establishment of new populations is by far the most controversial (Fiedler 1991, Falk and Olwell 1992). However, given the small numbers of individuals and populations of these two taxa, establishing new populations appears to be the only way to achieve sufficient security for these plants to allow their reclassification to threatened status.

Tables 1 and 2 indicate that very few of the sites historically occupied by *Arenaria paludicola* and *Rorippa gambelii* have suitable habitat remaining. The dune lakes area, within the vicinity of the existing populations, is the historic location most likely to provide suitable habitat for both taxa. Although the dune lakes should be considered for introductions for both species, establishing populations at these sites would do little to spread the risk from random naturally occurring events. For *Arenaria paludicola*, wetlands in the Tacoma area in the State of Washington may offer potential introduction sites, although consideration would need to be given to the appropriateness of using genetic stock from California if there is a possibility that a different stock still exists in the Tacoma area.

Many other sites that might have provided suitable habitat within the historic range of the species have already met the same fate as the historic sites, namely alteration or destruction of habitat from human activities. Three sites still support wetland habitats, though the suitability of the sites for these two taxa requires further assessment. These three sites are: 1) San Mateo Creek at San Onofre Park in Orange County, 2) San Antonio Creek drainage on Vandenberg Air Force Base in Santa Barbara County, and 3) several small wetlands at Golden Gate National Recreation Area in San Francisco County. Although protecting existing habitat is essential to preventing the extinction of the species in California, it is unlikely these species can be recovered if additional

populations are not established. Recovery Task 5 will guide efforts toward identifying additional areas that are suitable for establishing new populations.

This plan covers the conservation of these plants only in the United States. Little is known about the distributions or threats to these species in Mexico. The plan encourages the seeking of information on the plants' ranges and status in Mexico in the expectation that the information would help understand how to conserve them in the United States, but the plan does not provide for funding of collection of data from Mexico.

# II. RECOVERY

## A. OBJECTIVES AND CRITERIA

### 1. Interim Objectives

The status of both species, particularly *Arenaria paludicola*, is so critical at this point that the interim objective is to prevent extinction. Further losses of the plants and their habitats should be prevented, and threats to their survival should be eliminated. The primary habitat protection measure is to assure the effectiveness of the Sensitive Resource Area and buffer boundaries at Black Lake Canyon, currently the only location supporting both species.

Reclassification criteria can be quantified in terms of 1) minimum numbers of individuals and populations, 2) their distributions, and 3) their ability to be self-sustaining and survive over some period of time. However, at present, the number of individuals and populations of *Arenaria paludicola* and *Rorippa gambelii* in California is very small, and research on the population biology of these species has only begun. Until more is known about their population dynamics, criteria for determining their recovery in terms of self-sustaining populations are not credible. The minimum number of individuals needed for a population to be self-sustaining is not currently known. Moreover, inter-population relationships potentially affecting species survival also are unknown.

The main objective for the long-term management and recovery of *Arenaria paludicola* and *Rorippa gambelii* is to secure viable, self-sustaining populations of both species in their natural habitats. The objective is to reclassify them from endangered to threatened status, and ultimately to delist them completely.

### 2. Preliminary Downlisting Criteria

Preliminary criteria for downlisting are 1) new plants of each species are established so that there are at least 5 populations of at least 500 individuals each, 2) some of these populations occur in permanently protected habitats in Black Lake Canyon and the dune lakes area, 3) some of the populations must be in other areas of suitable habitat within the species' historical ranges in the United States, and 4) the populations remain viable for at least 5 years.

Viable populations are defined as those that are showing natural reproduction and either stable or increasing in size over time, without artificial augmentation. Assuming that it would take at least 5 years to establish these populations, the earliest date for reclassifying these plants to threatened status would then be around the year 2007. These criteria should be reevaluated and updated as new information about the species and their habitats becomes available.

Permanent protection of habitats means not only protection of the sites through permanent securing of the sites through ownership or conservation easements, permanent arrangements for appropriate management, and substantial progress by managers toward assuring habitats are appropriately managed to minimize threats from hydrology (too much, too little, or contaminated water; including lowering of water levels caused by Eucalyptus trees), erosion from sand dunes or sand cliffs, and the effects of ecological succession (such as encroachment by willows). There must be actual progress in these areas, not merely recognition that something should be done.

## B. STEPDOWN NARRATIVE

### 1. Protect, maintain, and enhance species habitats.

The most important immediate objective in the recovery plan for *Arenaria paludicola* and *Rorippa gambelii* is the protection of their habitats.

#### 11. Coordinate among agencies involved in recovery activities.

Activities and information associated with implementation of the recovery plan and the resolution of potential jurisdictional issues must be coordinated on a regular (e.g. annual or twice-a-year) basis among involved parties, including the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Air Force, California Department of Fish and Game, California Department of Parks and Recreation, San Luis Obispo County, The Land Conservancy of San Luis Obispo County, The Nature Conservancy, the California Coastal Conservancy, California Native Plant Society, university and research departments, botanic gardens and herbaria, property owners, and other individuals knowledgeable about the species and their habitats.

All existing plans, data, and information pertinent to the recovery of the two species must be synthesized and shared effectively by promoting information exchange and

discussion between all agencies, groups, and individuals mentioned above. Interagency workshops will continue to be held to facilitate information transfer.

**12. Define and maintain the sensitive Resource Area boundary and restrictions at Black Lake Canyon.**

A final definition of the Sensitive Resource Area and buffer boundaries and restrictions or planning area standards at Black Lake Canyon needs to be made; these boundaries and restrictions must be enforced. Implementation of these recommendations is the responsibility of San Luis Obispo County.

**121. Define Sensitive Resource Area boundary and restrictions.**

The County of San Luis Obispo should complete the process to adopt the Sensitive Resource Area boundary and restrictions as identified in the Enhancement Plan (LCSLO 1992). The Enhancement Plan recommends a redefinition of the Sensitive Resource Area boundary to include, at a minimum, all land within 46 meters (150 feet) of the edge of existing wetlands and the stream channel. In addition, the plan recommends stringent standards limiting development within the Sensitive Resource Area, and requirements for erosion control and the protection of sensitive resources in the surrounding buffer. Since *Arenaria paludicola* and *Rorippa gambelii* occur only in saturated or wet soils, any activity that could have a negative impact on water quality and water levels within the canyon must be addressed in county land-use planning activities.

**122. Enforce Sensitive Resource Area boundary and restrictions.**

The Sensitive Resource Area boundary and restrictions must be enforced. Constructing boundary fences and posting signs would serve to discourage vandalism, habitat destruction, and collection of the species.

**13. Establish protection agreements.**

Protection of sensitive wetland habitats that harbor *Arenaria paludicola* and *Rorippa gambelii* can be facilitated by establishing protection agreements with landowners.

**131. Establish agreements with private landowners.**

Protection of sensitive wetland habitats at Black Lake Canyon, where land is privately owned, can be facilitated by contacting landowners and establishing voluntary protection agreements with them.

**132. Establish agreements for publicly owned land.**

In the case of publicly owned land, such as land around the dune lakes owned by the California Department of Parks and Recreation and leased out for agricultural purposes (some of which result in agricultural runoff that could provide habitat for *Rorippa gambelii*), protective agreements should be incorporated into the leases with private parties.

**133. Establish agreement with Vandenberg Air Force Base**

Although the site is relatively undisturbed at this time, it is within a half mile of a heavily populated residential area and a highway. Establishing an agreement with Vandenberg Air Force Base would emphasize the importance of maintaining the integrity of this site and ensuring that it is not inadvertently impacted by Air Force activities. An agreement should include measures to establish protected status for the site, to monitor the population and the site annually, and to inform the Fish and Wildlife Service and California Department Fish and Game of their status annually for at least several years.

**14. Acquire key land parcels and conservation easements.**

In combination with Task # 13, approximately 36 hectares (90 acres) in parcels or easements should be acquired for land containing appropriate wetland habitat in Black Lake Canyon.

**141. Acquire land parcels.**

Land parcels should be acquired when landowners are agreeable, and then set aside as rare plant preserves. That land would provide potential reintroduction sites for the two species.

**142. Acquire conservation easements.**

When land parcels are not available, conservation easements should be acquired to protect habitats and to minimize further loss of native habitat.

**15. Enhance existing habitat at Black Lake Canyon.**

Removal of exotic species, especially eucalyptus trees that may be drawing water from bottom wetlands at Black Lake Canyon, is a high priority task (Morey 1990; Wickenheiser and Morey 1990; LCSLO 1992).

### 151. Conduct test removals of exotic species.

The effects of removing eucalyptus trees and other exotic species, including veldt grass, on native vegetation and canyon bottom habitats must be investigated in test plots before large-scale removal is attempted. Eucalyptus tree removal in the canyon could cause erosion and sedimentation into wetland habitats. All adverse impacts should be avoided. Experiments should be designed and implemented.

### 152. Remove exotic species and revegetate with native species.

Sub-tasks for the first phases of exotic species removal are outlined in the Enhancement Plan (LCSLO 1992). Actions include permitting, boundary surveying, improving access roads, downing and removing trees and invasive weeds, site cleaning, and erosion control. Cleared habitats should be revegetated with native species typically found in the area.

### 153. Plan and implement long-term control of exotic species.

Long-term control and eradication of resprouting eucalyptus trees and of any other invasive exotic species that may occur should be planned and implemented.

## 16. Continue to protect, maintain, and enhance habitat in the Dune Lakes area.

As the manager of the Oso Flaco Lake Natural Area, The California Department of Parks and Recreation should continue its efforts to maintain and enhance all protected areas of the dune lakes. If additional rare plant or animal habitats become known, these areas also should be protected.

### 161. Maintain existing access and traffic restrictions at Oso Flaco Lake.

Restrictions for preventing off-road vehicle use should be enforced and maintained continually. Existing fences, road blocks, signs, and controlled access routes to recreation areas such as the boardwalk and footbridge at Oso Flaco Lake, should be maintained. Foot traffic or other types of traffic in the dune wetland areas, particularly margins, which could support *Rorippa gambelii* populations, should be prevented.

### 162. Extend restrictions to include the Little Oso Flaco Lake habitat.

At Little Oso Flaco Lake, the area north of the shore and a drainage ditch between the lake and agricultural fields has the potential to support a relatively large population of *Rorippa gambelii*. This habitat currently shows many signs of degradation and human disturbance, including dumping of trash, use of agricultural equipment, and apparent recent dredging. This habitat should be

protected by maintaining at least a limited buffer zone around the ditch, and preventing clearing of vegetation and dredging in the ditch.

**163. Stabilize sand dunes by revegetation in the Dune Lakes area.**

Sand dunes in the dune lakes area with native species should be revegetated after results of previous revegetation efforts have been coordinated. The dunes must be stabilized using erosion control measures, so that sand does not encroach into *Rorippa gambelii* habitat.

While local dune stabilization is needed in the dune lakes area, this stabilization is not expected to create conflicts with broader conservation goals to remobilize many California coastal dunes that have become stabilized as a result of the proliferation of European beachgrass, *Ammophila arenaria* (U.S. Fish and Wildlife Service 1998).

**17. Communicate species and habitat protection information to all concerned parties.**

The benefits of protecting listed species and restoring degraded habitats to their native state should be explained clearly to all concerned parties.

**171. Develop and disseminate informational material.**

Educational pamphlets should be developed and distributed to landowners and the general public about the species, their habitats, and the necessity to protect them.

**172. Hold public meetings.**

The U.S. Fish and Wildlife Service and San Luis Obispo County should hold informal public meetings and/or participate in community events to explain recovery activities for the species, and to solicit cooperation and comments from interested parties.

**2. Document and monitor population and habitat characteristics.**

A regular and systematic monitoring program to track new and existing populations should be initiated and maintained.

**21. Conduct plant surveys.**

Comprehensive surveys for both species should be conducted at least in areas within their historic ranges in California, and in Washington for *Arenaria paludicola*. Populations should be mapped, herbarium voucher specimens collected if feasible,

census counts made, and data reported to the California Natural Diversity Data Base (CNDDB) or heritage programs in other states. Information on the plants' ranges and status in Mexico will be sought, although support for field work is outside the scope of this plan.

**22. Protect newly discovered populations.**

If new populations are found in the United States, their habitats should be protected using appropriate measures as described for existing species habitats in Task #1.

**23. Monitor all populations and habitats.**

Monitoring to track all populations and their habitats should be conducted at least annually, during the species' identifiable life history periods. Monitoring data should be analyzed to make comparisons between monitoring periods. An annual monitoring report should be prepared and distributed (see Task #11).

Populations should be mapped, counted, and evaluated for reproductive output. To ensure directly comparable results over time, permanent plots should be established to monitor the plants. For *Arenaria paludicola*, with extremely low numbers of individuals, regular counts of plants would be beneficial to monitor survival, even if no further research is possible, for fear of adversely affecting the limited number of plants. All field survey data should be carefully documented, and updated information should be provided to the California Natural Diversity Data Base.

Habitat characteristics should be measured and recorded for undisturbed existing and new potential habitat, as well as for habitats that are managed or enhanced in any way. Characteristics that should be monitored include hydrology (water quality, groundwater levels, water runoff, etc.), soils, microtopography, slope, exposure, associated vegetation, and climate (rainfall, temperature, number of sunny or foggy days). Factors such as the ecological succession, the presence of pollinators, predators, diseases, pest attacks, competition, and natural and human disturbances should be documented. Characterizing existing habitat will help illuminate ecological factors affecting the species and also will aid in locating appropriate new sites for outplanting.

**3. Conduct research on the ecology and biology of the species.**

Because little information exists on the ecology and population biology of *Arenaria paludicola* and *Rorippa gambelii*, an organized research program should be developed, based on well-defined goals and methods.

**31. Identify potential impacts of conducting research.**

Before conducting research, possible impacts on existing populations should be assessed. The research work should operate within these limits to prevent injury to the plants.

**32. Determine population characteristics and life history of the species.**

Investigating the stability of the species' populations should start with examination of the number of individuals in each population, the number and distribution of populations, geographic range, and the probable causes of endangerment. The aim of this research is to understand population trajectories (rate and direction of population fluctuations). The research should be able to provide demographic information covering all life stages: seed, seedling, juvenile, young adult, and adult. Reproductive processes of the species should be studied carefully, including the importance of asexual versus sexual methods, as well as flowering, pollination, fruiting, viable seed output, seed dispersal, and germination.

It is essential to identify which of the life history stages and processes examined above has the greatest effect on population growth, and the species' persistence. The probability of the species surviving from one stage through to the next should be investigated, if appropriate studies can be designed.

The effects of all potential threats due to the physical environment should also be examined, including fluctuating water levels, changes in water quality, natural or human disturbances, and the effects of erosion and sedimentation.

Finally, the effects of certain biological factors potentially impacting the species have not been studied systematically and should be investigated further. Factors include competition, especially from introduced plants, for water, nutrients, light, and space, as well as disease, and predation, including the impact of thrips as pollen predators on *Rorippa gambelii*.

**33. Evaluate species' tolerances.**

Research results should be used to evaluate species tolerances to environmental and biological changes, limiting factors, and habitat requirements under controlled conditions (i.e. in a greenhouse setting, or under natural conditions, but with sufficient controls). These evaluations should be used in conjunction with the results from monitoring to develop management and recovery recommendations.

**34. Investigate the effects of genetic diversity.**

Research on genetic diversity may contribute to understanding the causes of rarity. Comparisons between these species and species of the same genus that are not in decline might help to determine if rarity is related to genetic uniformity (Mazer and Waddell 1994).

## 4. Augment existing populations

In addition to protecting existing and newly discovered habitats of *Arenaria paludicola* and *Rorippa gambelii*, monitoring these populations and their habitats, and conducting research on the biology and ecology of the two species, attempts should be made to augment existing populations.

**41. Assess the availability of plant material for propagation.**

Based on knowledge of population numbers, we must assess the quantity of plant material that could be used from existing populations to attempt off-site propagation without endangering the survival of the species in the wild.

**42. Conduct propagation experiments.**

Before trying to conduct outplantings to establish new populations, off-site propagation techniques need to be developed and greenhouse populations established. The first step is to determine the feasibility of off-site propagation of the species through experiments to evaluate factors including seed viability, storage, germination, and survival.

**43. Establish greenhouse populations.**

A minimum of three greenhouse populations should be established by salvaging seed bank material from soil collected at existing sites, as well as from seed and vegetative material from plants. Propagating plants in the future should incorporate reproductive material from as many source populations as possible to ensure genetic diversity. Small-scale growth of the two species has been attempted indoors by researchers at the University of California, Santa Barbara (Mazer and Waddell 1994), and by individuals living in the San Luis Obispo area (B. Deneen, pers. comm. 1994; D. Gurney, pers. comm. 1994). Botanical gardens interested in rare plant cultivation for conservation purposes, such as those affiliated with the Center for Plant Conservation, should be contacted and become involved. University researchers and private individuals already interested in the propagation of these species should be encouraged to continue their efforts. Care must be taken to minimize problems with diseases and insects during greenhouse propagation — diseases or infesting insects may spread from propagated plants to wild ones.

**44. Investigate methods for augmenting populations.**

Potential methods of manipulation for increasing existing populations, such as artificial hand pollination, should first be studied in greenhouse populations (Task # 43). Methods found to be applicable should be used to enlarge existing populations.

**45. Conduct experimental habitat enhancement.**

Previous observations of *Rorippa gambelii* habitat indicate that this species may benefit from some level of disturbance and clearing (Price 1989). This observation should be investigated by experimenting with limited clearing of existing wetland habitat, and monitoring the plots to determine whether the recruitment and survival of *Rorippa gambelii* plants is facilitated by controlling competition through limited clearing. Manipulations on the small lake above the *Arenaria paludicola* population could provide information on effective management techniques and creation of new habitat (R. Belknap, pers. comm. 1995).

**46. Conduct experimental outplantings at existing population sites.**

A limited number of greenhouse-propagated seedlings should be transplanted to existing population sites. Care must be taken to avoid the transfer of disease or destructive insects from the greenhouse to the wild populations.

**47. Monitor experimental reintroductions.**

Experimental test plots should be established, mapped, and monitored regularly to determine population and habitat parameters. The monitoring interval will be determined during the development of the monitoring program. Appropriate reintroduction techniques should be developed based on the results of these experimental reintroductions.

**48. Conduct larger-scale outplantings based on experimental results.**

Larger-scale outplantings should be carried out using techniques developed from small-scale experiments. Outplanted individuals should be mapped, and monitored during routine population monitoring (Task # 23).

**5. Establish new populations**

Because *Arenaria paludicola* and *Rorippa gambelii* currently have very restricted distributions in California, establishment of new populations within the historic range of the species at potentially suitable sites other than at historic sites should be attempted. If new populations are successfully established, it will reduce the likelihood that a

catastrophic event could result in the extinction of the species with their current restricted distributions.

**51. Locate appropriate new wetland habitat for outplanting.**

Habitat similar to existing habitat in terms of physical characteristics and associated vegetation, within the historical range of the species should be selected as outplanting sites. Because habitat conditions at potentially suitable sites could vary widely with increasing distance from the currently occupied sites, it would be prudent to first target sites in southern California for the outplantings that are derived from Southern California stocks. Dune wetland marshes within the current or historic range of the species could be used as new habitats, as well as the margins of lakes and creeks. Management of these new sites would be facilitated if access to them is protected and they are owned by public agencies or land and resource conservation groups, or have effective conservation easements.

In Black Lake Canyon, due to the present and projected continued lowering of the aquifer in the lower canyon and the stability or rise of the groundwater table in the upper canyon, outplantings of the species could be located in the upper canyon marshes, where the hydrology may be more favorable (D. Chipping, California Native Plant Society, pers. comm. 1994). At Oso Flaco Lake, it may be possible to establish new plants in marshy areas, or to establish new populations in nearby dune lakes.

For *Arenaria paludicola*, efforts could be expanded to potentially suitable sites in northern California, Oregon, or the Puget Sound area of Washington. However, it would be prudent to precede this effort with an assessment of whether using genetic material from California in these locations is appropriate if there is a possibility that the species is still present in the Tacoma area. If other species of *Arenaria* occur in these locations, their potential for hybridization with *Arenaria paludicola* could undermine efforts to establish genetically intact material.

Based on an initial assessment of potentially suitable habitat in California, three areas have been identified that may contain potential introduction sites outside the Dune Lakes area. These three areas are San Mateo Creek in San Onofre State Park in Orange County, the San Antonio Creek drainage on Vandenberg Air Force Base in Santa Barbara County, and wetlands in Golden Gate National Recreation Area in San Francisco County. These three areas should undergo a thorough evaluation to determine suitability as introduction sites.

**52. Conduct experimental habitat enhancement.**

Similar to habitat enhancement efforts for existing populations (Task # 45), experimentation with limited clearing of new habitat should be conducted in preparation for outplanting of experimental introductions.

### 53. Apply Appropriate Habitat Enhancement Techniques.

Based on results from habitat enhancement experiments, appropriate techniques to enhance new habitat should be applied at the newly located potential introduction sites.

### 54. Conduct experimental introductions.

The first outplantings will be experimental, and will be designed using knowledge obtained from previous research (Task # 45) and from plant growers. Test plots should be established.

### 55. Monitor experimental introductions.

Experimental test plots should be mapped and monitored regularly for changes in population and habitat parameters. Mappable parameters include soils, microtopography, slope, exposure, associated vegetation, and weather. Hydrology should be monitored. Factors such as ecological succession, the presence of pollinators, predators, diseases, pest attacks, competition, and natural and human disturbances also should be documented. Appropriate introduction techniques should be developed based on the results of these experimental introductions.

### 56. Conduct Larger-Scale Outplantings Based on Experimental Results.

Larger-scale outplantings should be carried out using techniques developed from small-scale experiments. These introductions could be carried out at the same sites used for experimentation, or at other new appropriate sites.

### 57. Monitor and Document the Newly Established Populations.

Maintaining a continuous record on the progress of the newly established populations through long-term monitoring is of great importance. Monitoring should be done for no fewer than 10 years, though preferably longer. Should the status of the species remain tenuous, monitoring may need to continue indefinitely.

Similar to the monitoring of existing populations, the new populations should be mapped, counted, and evaluated for reproductive output. All field survey data should be carefully documented, and updated information should be provided to the California Natural Diversity Data Base. In addition, habitat characteristics should be measured and recorded for the introduction sites.

## 6. Evaluate Progress and Update Management and Recovery Guidelines.

Results of all recovery activities should be evaluated and incorporated into updated management and recovery guidelines for the species. All relevant information should be distributed (see Task # 11).

### 61. Refine quantitative recovery criteria.

After sufficient monitoring and research results are available, trends in population and habitat dynamics can be established, and quantitative recovery criteria should be formulated for each species. Specific criteria include estimates of minimum population size, age structures of populations, and number of self-sustaining populations necessary for survival. Estimates should be made of the time necessary to propagate new plants, and to establish viable populations.

### 62. Update management and recovery guidelines.

Not much is known about the population dynamics of *Arenaria paludicola* and *Rorippa gambelii*, nor about their habitats. As new information becomes available, management and recovery guidelines should be updated.

# III. LITERATURE CITED


Abrams, L., and R.S. Ferris. 1944. *Illustrated flora of the Pacific states.* Volume II. Stanford University Press. Stanford, California. 635 pp.

Al-Shehbaz, I.A., and R.C. Rollins. 1988. A reconsideration of *Cardamine curvisiliqua* and *C. gambelii* as species of *Rorippa* (Cruciferae). *Journal of the Arnold Arboretum* 69: 65-71.

Bonilla, B.J. 1992. Flora y vegetación acuática vascular de las Lagunas de Zempoala, Morelos, México. Tesis de maestría en ciencias (biología). Facultad de Ciencias, Universidad Nacional Autónoma de México. México, D.F. 134 pp.

California Natural Diversity Data Base. 1987. Unpublished California native species field survey forms for *Arenaria paludicola* Submitted by Dr. Malcolm McLeod. California Department of Fish and Game. Sacramento, California.

_____. 1994. CNDDB RareFind report for *Arenaria paludicola* and *Rorippa gambelii.* California Department of Fish and Game. Sacramento, California.

Dial, K. 1980. Barka Slough: Resources inventory and management recommendations. U.S. Department of the Interior, Fish and Wildlife Service, Laguna Niguel Field Office. Laguna Niguel, California.

Falk, D.A., and P. Olwell. 1992. Scientific and policy considerations in restoration and reintroduction of endangered species. Rhodora, Vol. 94, No. 879:287-315.

Fiedler, P.L. 1991. Mitigation-related transplantation, relocation and reintroduction projects involving endangered and threatened, and rare plant species in California. Report prepared for California Department of Fish and Game, Sacramento. Contract No. FG-8611.

Gamon, J. 1991. Report on the status of *Arenaria paludicola* Robinson. Prepared for the U.S. Fish and Wildlife Service, Boise Field Office. Boise, Idaho. 20 pp.

Hartman, R.L. 1993. *Arenaria*, pp. 478-480 *in* Hickman, J.C. (ed.). *The Jepson manual, higher plants of California.* University of California Press. Berkeley, California. 1,400 pp.

Hitchcock, J.C.. *Arenaria*, pp. 251-261 *in* Hitchock, J.C. and A. Cronquist. 1964. *Vascular plants of the Pacific Northwest, part 2: Salicaceae to Saxifragaceae.* University of Washington Press, Seattle, Wash. 597 pp.

Holland, V.L., and M. McLeod. 1992. Chapter II, Resource inventory. In: Draft enhancement plan, Black Lake Canyon, San Luis Obispo County, 11-48 pp. Prepared by The Land Conservancy of San Luis Obispo County. Prepared for The California Coastal Conservancy. San Luis Obispo, California.

Hoover, R.F. 1947. Herbarium labels from voucher specimens of *Arenaria paludicola* Collected by R.F. Hoover, Herbarium of California Polytechnic State University, San Luis Obispo, California.

_____. 1970. The vascular plants of San Luis Obispo County, California. University of California Press. Berkeley, California. 350 pp.

Keil, D.J. 1997. Evaluation of potential introduction sites for *Rorippa gambelii* (Gambel's water cress) on Vandenberg Air Force Base. Prepared for U.S. Fish and Wildlife Service, Ventura Fish and Wildlife Office. 12 pp. Plus maps and tables.

Kellogg, A. 1863. Description of a new species of Alsine. *Proceedings of the California Academy of Natural Sciences* 3:61.

Mason, H.L. 1957. *A Flora of the marshes of California.* University of California Press. Berkeley, California. 878 pp.

Mazer, S.J., and T.A. Waddell. 1994a. Study to determine preliminary recommendations for the management and recovery of Gambel's watercress (*Rorippa gambelii*) and Marsh Sandwort (*Arenaria paludicola*). Draft report submitted to Calif. Dept. of Fish and Game, Sacramento.

_____. 1994b. Distribution abundance, and reproductive biology of field and greenhouse populations of Gambel's watercress (*Rorippa gambelii*: Brassicaceae) and marsh sandwort (*Arenaria paludicola*: Caryophyllaceae) recommendations for management and recovery. Report submitted to Calif. Dept. of Fish and Game, Sacramento.

McClelland Engineers, Inc. 1988. Draft environmental impact report, Black Lake Canyon Planning Area standards and Sensitive Resource Area boundary general plan Amendment. Prepared for Office of Environmental Coordinator, San Luis Obispo County. San Luis Obispo, California.

McEwen, M. 1997. Proposed field survey of water quality for recovery and protection of rare plants in Black Lake Canyon. Proposal submitted to the Land Conservancy of San Luis Obispo County. 25 pp.

Morey, S.C. 1990. A management strategy for the recovery of marsh sandwort (*Arenaria paludicola*). Endangered Plant Program, Natural Heritage Division, California Department of Fish and Game. Sacramento, California. 14 pp.

Munz, P.A. 1974. *A Flora of Southern California.* University of California Press. Berkeley, California. 1086 pp.

Munz, P.A., and D.D. Keck. 1968. *A California flora with Supplement.* University of California Press. Berkeley, California. 1681+224 pp.

Price, R.A. 1989. Field Studies on *Rorippa gambelii.* Prepared for the Endangered Plant Program, Natural Heritage Division, State of California Department of Fish and Game. Sacramento, California. 6 pp.

Robinson, B.L. 1894. Contributions from the Gray Herbarium of Harvard University, New Series, No. VI, I. — The North American Alsineae. *Proceedings of the American Academy of Sciences* 28:298.

Rollins, R.C. 1993. Rorippa, pp. 434–435 *in* Hickman, J.C. (ed.). *The Jepson manual, Higher plants of California.* University of California Press. Berkeley, California. 1400 pp.

Skinner, M.W., and B.M. Pavlik (Eds.). 1994. *Inventory of rare and endangered vascular plants of California.* Special Publication No. 1 (Fifth Edition). California Native Plant Society. Sacramento, California. 336 pp.

Smith, C.F. 1976. *A flora of the Santa Barbara Region.* Santa Barbara Museum of Natural History. Santa Barbara, California. 331 pp.

The Land Conservancy of San Luis Obispo County. 1992. Draft enhancement plan, Black Lake Canyon, San Luis Obispo County. Prepared for The California Coastal Conservancy. San Luis Obispo, California. 131 pp.

U.S. Fish and Wildlife Service. 1997. Draft recovery plan for the Morro shoulderband snail and four plants from Western San Luis Obispo County, California. U.S. Fish and Wildlife Service, Region 1, Portland, Oregon.

_____. 1998. Seven coastal plants and the Myrtle's silverspot butterfly recovery plan. U.S. Fish and Wildlife Service, Region 1, Portland, Oregon.

Wickenheiser, L.P. 1989. Report to the Fish and Game Commission on the status of Gambel's watercress (*Rorippa gambelii*). Status Report 89-27, Natural Heritage Division, State of California Department of Fish and Game. Sacramento, California. 18 pp.

Wickenheiser, L.P., and S.C. Morey. 1990. A management strategy for the recovery of Gambel's Watercress (*Rorippa gambelii*). Endangered Plant Program, Natural Heritage Division, State of California Department of Fish and Game. Sacramento, California. 19 pp.

# IV. IMPLEMENTATION SCHEDULE

The table that follows is a summary of scheduled actions and costs for the *Arenaria paludicola* and *Rorippa gambelii* Recovery Plan. It is a guide to meet the objectives of this plan, as elaborated upon in Part II, Stepdown Narrative. This table indicates the tasks to meet the objectives, agencies that are responsible to perform these tasks, a time-table for accomplishing these tasks, and the estimated costs to accomplish these tasks. Implementing Part III is the action of the recovery plan that, when accomplished, will bring about the recovery of these endangered species, and protect their habitat. Initiation of these tasks is subject to the availability of funds.

Priorities in column one of the following implementation schedule are assigned as follows:

Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2: An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

Priority 3: All other actions necessary to provide for full recovery of the species.

**Codes used in the Implementation Schedule:**

Task: Cont = Continual. Task will be implemented on an annual basis once it is begun.
Ong = Ongoing. Task is currently being implemented and will continue until no longer necessary for recovery.
Total Cost = projected cost of task from start to completion.

Responsible Parties:

| | | |
|---|---|---|
| CDFG | - | California Department of Fish and Game |
| CDPR | - | California Dept. of Parks and Recreation |
| LCSLO | - | Land Conservancy of San Luis Obispo County |
| SBBG | - | Santa Barbara Botanic Garden |
| SLOC | - | County of San Luis Obispo |
| TNC | - | The Nature Conservancy |
| USAF | - | U.S. Air Force, Vandenberg Air Force Base |
| USFWS | - | U.S. Fish and Wildlife Service, Ecological Service |
| * | - | Asterisk indicates lead for multi-party task. |

## Recovery Plan Implementation Schedule for *Arenaria paludicola* and *Rorippa gambelii*

| Priority | Task Number | Task Description | Task Duration (Years) | Responsible Party | Total Cost | Cost Estimates, in thousands of dollars per fiscal year. FY 1 | FY 2 | FY 3 | FY 4 | FY 5 | FY 6 | FY7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Need 1: Protect, Maintain, and Enhance Species Habitats** | | | | | | | | | | | | |
| 1 | 1.1 | Coordinate among involved agencies | Ongoing | CDFG* | 10 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | | | USFWS | 7.5 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 |
| 1 | 1.2.1 | Define SRA boundary and restrictions | 2 | SLOC* | 7.5 | 3.5 | 3.5 | 0 | 0 | 0 | 0 | 0 |
| | | | | LCSLO | 2.5 | 2.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1.2.2 | Enforce SRA boundary and restrictions | Ongoing | SLOC* | 5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| 1 | 1.3.1 | Establish agreements with private owners | 2 | CDFG* | 2 | 1 | 1 | | | | | |
| | | | | USFWS | 1 | 0.5 | 0.5 | | | | | |
| | | | | SLOC | 1 | 0.5 | 0.5 | | | | | |
| 1 | 1.3.2 | Establish agreements with public owners | 2 | CDFG* | 2 | 1 | 1 | | | | | |
| | | | | USFWS | 1 | 0.5 | 0.5 | | | | | |
| | | | | SLOC | 1 | 0.5 | 0.5 | | | | | |
| 1 | 1.3.3 | Establish agreement with Vandenberg Air Force Base | 2 | USAF | 2 | 1 | 1 | | | | | |
| | | | | USFWS | 2 | 1 | 1 | | | | | |
| | | | | CDFG | 1 | 0.5 | 0.5 | | | | | |
| 1 | 1.4.1 | Acquire land parcels | Ongoing | CDPR<br>CDFG*<br>USFWS<br>TNC | To be determined | | | | | | | |
| 1 | 1.4.2 | Acquire conservation easements | 5 | CDFG* | 50 | 10 | 10 | 10 | 10 | 10 | 0 | 0 |
| | | | | USFWS | 2.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 |
| | | | | TNC | 2.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0 |
| 1 | 1.5.1 | Conduct test removals of exotic species | 8 | CDFG | 10 | 5 | 5 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1.5.2 | Remove exotic species and revegetate with natives at Black Lake Canyon | Continuing | CDFG | 75 | 0 | 0 | 15 | 15 | 15 | 15 | 15 |
| 1 | 1.5.3 | Conduct long-term exotics control | Continuing | CDFG | 15 | 0 | 0 | 0 | 0 | 5 | 5 | 5 |
| 1 | 1.6.1 | Maintain access restrictions | Ongoing | TNC | 20 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

| Priority | Task Number | Task Description | Task Duration (Years) | Responsible Party | Cost Estimates, in thousands of dollars per fiscal year. Total cost | FY 1 | FY 2 | FY 3 | FY 4 | FY 5 | FY 6 | FY7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.6.2 | Extend restrictions to Little Oso Flaco | Continuing | TNC | 20 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 1 | 1.6.3 | Stabilize dunes in dune lakes area | 5 | TNC | 25 | 5 | 5 | 5 | 5 | 5 | 0 | 0 |
| 3 | 1.7.1 | Develop and distribute informational materials | 3 | CDFG* | 5 | 4 | 0.5 | 0.5 | 0 | 0 | 0 | 0 |
| | | | | USFWS | 1 | 0 | 0.5 | 0.5 | 0 | 0 | 0 | 0 |
| 3 | 1.7.2 | Hold public meetings | 1 | CDFG* | 2 | 1 | 1 | | | | | |
| | | | | USFWS | 2 | 1 | 1 | | | | | |
| | | **Need 1 Subtotal Cost:** | | | **277.5** | **46.75** | **41.25** | **38.25** | **37.25** | **42.25** | **26.25** | **26.25** |
| **Need 2: Monitor and Document Species, Population, and Habitat Characteristics** | | | | | | | | | | | | |
| 1 | 2.2 | Protect newly discovered populations | Continuing | CDFG* USFWS TNC | To be determined | | | | | | | |
| 2 | 2.1 | Conduct surveys | 2 | CDFG* | 12 | 5 | 6 | 1 | 0 | 0 | 0 | 0 |
| | | | | USFWS | 1.5 | 0.5 | 0.5 | 0.5 | 0 | 0 | 0 | 0 |
| | | | | TNC | 1 | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 |
| 2 | 2.3 | Monitor populations and habitats | Continuing | CDFG* | 35 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 |
| | | | | TNC | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| | | **Need 2 Subtotal Cost:** | | | **56.5** | **10.2** | **11.2** | **5.7** | **4.2** | **4.2** | **4.2** | **4.2** |
| **Need 3: Conduct Research on the Ecology and Biology of the Species** | | | | | | | | | | | | |
| 2 | 3.1 | Identify impacts of research | 1 | CDFG* | 1 | 1 | | | | | | |
| | | | | USFWS | 1 | 1 | | | | | | |
| 2 | 3.2 | Determine population characteristics | 5 | CDFG* | 20 | 4 | 4 | 4 | 4 | 4 | 0 | 0 |
| | | | | USFWS | 20 | 4 | 4 | 4 | 4 | 4 | 0 | 0 |
| 2 | 3.3 | Evaluate tolerances | 5 | CDFG* | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| | | | | USFWS | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |

| Priority | Task Number | Task Description | Task Duration (Years) | Responsible Party | Cost Estimates, in thousands of dollars per fiscal year. Total cost | FY 1 | FY 2 | FY 3 | FY 4 | FY 5 | FY 6 | FY7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 3.4 | Investigate genetic diversity | 5 | CDFG* | 10 | 2 | 2 | 2 | 2 | 2 | 0 | 0 |
| | | | | USFWS | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| | | **Need 3 Subtotal Cost:** | | | **67** | **15** | **13** | **13** | **13** | **13** | **0** | **0** |
| **Need 4: Augment Existing Populations** | | | | | | | | | | | | |
| 1 | 4.1 | Assess propagation material | 1 | CDFG* | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | USFWS | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 4.2 | Conduct propagation experiments | 2 | CDFG* | 1 | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 |
| | | | | USFWS | 1 | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 |
| 1 | 4.3 | Establish greenhouse populations | 3 | CDFG* | 6 | 2 | 2 | 2 | 0 | 0 | 0 | 0 |
| | | | | USFWS | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| | | | | SBBG | 0.75 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |
| 1 | 4.4 | Investigate methods for augmentation | 3 | CDFG* | 6 | 2 | 2 | 2 | 0 | 0 | 0 | 0 |
| | | | | USFWS | 6 | 2 | 2 | 2 | 0 | 0 | 0 | 0 |
| 1 | 4.5 | Conduct experimental habitat enhancement | 3 | CDFG* | 4 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |
| | | | | USFWS | 4 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |
| | | | | LCSLO | 2 | 1 | 0.5 | 0.5 | 0 | 0 | 0 | 0 |
| | | | | TNC | 2 | 1 | 0.5 | 0.5 | 0 | 0 | 0 | 0 |
| 1 | 4.6 | Transplant at existing sites | 2 | CDFG* | 4 | 0 | 0 | 2 | 2 | 0 | 0 | 0 |
| | | | | USFWS | 4 | 0 | 0 | 2 | 2 | 0 | 0 | 0 |
| | | | | TNC | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| | | | | LCSLO | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 4.7 | Monitor experimental reintroductions | Continuing | CDFG* | To be determined | | | | | | | |
| | | | | USFWS | | | | | | | | |
| | | | | LCSO | | | | | | | | |
| | | | | TNC | | | | | | | | |
| | | **Need 4 Subtotal Cost:** | | | **68.25** | **18.25** | **14.25** | **19.25** | **7.5** | **1.5** | **1.5** | **1.5** |

| Priority | Task Number | Task Description | Task Duration (Years) | Responsible Party | Cost Estimates, in thousands of dollars per fiscal year. Total cost | FY 1 | FY 2 | FY 3 | FY 4 | FY 5 | FY 6 | FY7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Need 5: Establish New Populations** | | | | | | | | | | | | |
| 1 | 5.1 | Survey for new habitats | 2 | CDFG* | 4 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| | | | | USFWS | 4 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| 1 | 5.2 | Conduct experimental habitat enhancement | 2 | CDFG* USFWS | | | | | To be determined (TBD) | | | |
| 1 | 5.3 | Apply habitat enhancement tech. | 8 | CDFG* USFWS | | | | | | To be determined | | |
| 1 | 5.4 | Conduct experimental reintroductions | 2 | CDFG* USFWS | | | | | | To be determined | | |
| 1 | 5.5 | Monitor experimental reintroductions | Continuing | CDFG* USFWS | | | | | | | To be determined | |
| 1 | 5.6 | Conduct large-scale outplantings | 3 | CDFG* USFWS | | | | | | | | To be determined |
| 2 | 5.7 | Monitor new populations | Continuing | CDFG* USFWS | | | | | | | | To be determined |
| | | **Need 5 Subtotal Cost:** | | | **8** | **4** | **4** | **(TBD)** | **(TBD)** | **(TBD)** | **(TBD)** | **(TBD)** |
| **Need 6: Evaluate Progress and Update Management and Recovery Guidelines** | | | | | | | | | | | | |
| 3 | 6.1 | Refine quantitative recovery criteria | 1 | CDFG* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | | | USFWS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 3 | 6.2 | Update management and recovery guidelines | 1 | CDFG* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | | | USFWS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | | **Need 6 Subtotal Cost:** | | | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **4** |
| **TOTAL COST:** | | | | | **488.25** | **97.45** | **86.95** | **76.2** | **61.95** | **60.95** | **31.95** | **35.95** |

**APPENDIX A:** Summary of the Agency and Public Comments on the Draft Recovery Plan for the Marsh Sandwort and Gambel's Watercress

On February 3, 1995, the Service released a partial draft recovery plan to selected parties for a 30-day review period. On July 12, 1996, the Service circulated an early draft of the recovery plan at a recovery workshop sponsored by the California Department of Fish and Game (CDFG) with 21 participants. On June 23, 1997, the Service released the Draft Recovery Plan for the Marsh Sandwort and Gambel's Watercress for a 60-day comment period that ended on August 22, 1997, for Federal agencies, State and local governments, and members of the public (62 Federal Register 33798).

In response to the two review/comment periods, thirteen letters were received from a total of ten parties, each containing varying numbers of comments. Federal, State, and local jurisdictions that responded included the Army Corps of Engineers, the California Department of Fish and Game, and the County of San Luis Obispo. Copies of the draft recovery plan were sent to a total of 50 interested parties. Of these, three individuals were asked to peer review the document; all three peer reviewers responded. Peer reviewers were selected on their familiarity with either a taxonomic group, a geographic area, and/or jurisdictional issues.

**The number of parties responding, by affiliation:**

| | |
|---|---|
| Federal agencies | 1 |
| State agencies | 1 |
| Local governments | 1 |
| Environmental/conservation organizations | 4 |
| Academia/professionals | 3 |

**Summary of Significant Comments and Service Responses**

The Service reviewed all of the comments received during the two comment periods and the CDFG recovery workshop. Comments that were either technical in nature, or were updating the information in the draft recovery plan have been incorporated into the appropriate section of the recovery plan. Several suggested alterations to the implementation schedule's priorities or budget, based on a review of land and water management issues, especially around Oso Flaco Lake.

One commenter noted that the plan's reclassification criteria for the two plants (5 populations of 500 plants) appeared somewhat arbitrary in view of the plan's acknowledgement that until further research is conducted on their population dynamics, quantifiable criteria for determining their recovery in terms of self-sustaining populations are not credible." The commenter recommended that the plan not consider reclassification until further research supports quantitative criteria.

The Service response is that it is reasonable to tentatively prescribe recovery criteria that would at least demonstrate population stability and good habitat management over a period of years, making a substantially improved situation over what currently exists. The Service anticipates developing much

better information on the status and needs of these plants, based on surveys, research, and monitoring prescribed in the plan.

Another comment suggested a more formal site selection process prior to introducing these plants to presently-unoccupied sites to start new populations.

The Service response is that few sites seem likely to be available, so there is no need for a formal winnowing process. Sites do need to be chosen carefully, based on the best available information from field work.

Several comments suggested shifts of emphasis or concurred with parts of the plan. While these review comments were very helpful, they mostly did not result in changes to the recovery plan. The Service did not receive any comments that it considered controversial or significant in the sense of making a difference in the fundamental way that recovery of the two plant species is being approached.

The Service is grateful to individuals who provided new biological information for the final version of the plan.

Any interested parties with outstanding concerns are invited to contact the Service at the address below:

U.S. Fish and Wildlife Service
Ventura Fish and Wildlife Office
2493 Portola Road, Suite B
Ventura, California 93003
phone # 805/644-1766

**APPENDIX B:** List of Parties That Commented on the Draft Recovery Plan

The draft plan was sent to 50 parties. The following parties commented on the draft plan. Asterisks * indicate designated peer reviewers.

Ray Belknap
Land Conservancy of San Luis Obispo County
San Luis Obispo, CA

David Castanon
Army Corps of Engineers
Ventura, CA

Deneen, Bill
Nipomo, CA

Ronald Hartman
Univ. of Wyoming
Laramie, WY

*Hillyard, Deborah
Plant Ecologist
California Department of Fish and Game
Aromas, CA

McLeod, Malcolm
California Native Plant Society
San Luis Obispo, CA

Morey, Sandra
Coordinator, Endangered Plant Program
California Dept. of Fish and Game
Sacramento, CA

Richard Schubel
Army Corps of Engineers
Ventura, CA

*Kara Woodruff Smith
The Nature Conservancy
Guadalupe, CA

*Wier, Eric
Office of Environmental Coordinator
San Luis Obispo, CA

Wilken, Dieter
Director of Research
Santa Barbara Botanic Garden
Santa Barbara, CA

Region 1
U.S. Fish and Wildlife Service
Ecological Services
911 N.E. 11th Avenue
Portland, Oregon 97232-4181



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