

U.S. Fish and Wildlife Service, and the U.S. Air Force, respectively. All of the Fort Ord occurrences are on land within the Habitat Management Plan Habitat Reserve lands and will be conserved and managed in perpetuity (W. Collins *in litt.* 2005; U.S. Army Corps of Engineers 1997). The population at Travis Air Force Base, including over 20 acres of adjacent restored vernal pools, is protected as a special ecological preserve, with protective measures and appropriate management for the species provided in the Travis Air Force Base Land Management Plan.

Seasonal managed cattle grazing has been returned to two conservation sites supporting *Lasthenia conjugens*: 1) the Warm Springs Seasonal Wetland Unit of the Don Edwards San Francisco Bay National Wildlife Refuge in Alameda County, and 2) the State Route 4 Preserve managed by the Muir Heritage Land Trust in Contra Costa County. The *L. conjugens* population at the Warm Springs Unit has declined during the last 10 years due to many factors including competition by nonnative plant species. During this time period, grazing, which occurred intermittently at the Warm Springs Unit since the 1800s, has been excluded by the Refuge until a management plan could be developed. The decline in the *L. conjugens* population at the Warm Springs Unit cannot be attributed to a single factor, but most likely results from the complex interaction of several variables including current and historical land uses, the abiotic environment, and annual climatic variation. The increasing dominance of nonnative grasses, however, coincides with the suspension of livestock grazing, suggesting that the lack of a disturbance regime may be a primary factor in the degradation of habitat for *L. conjugens* at this site (U.S. Fish and Wildlife Service 2004). The population of *L. conjugens* at the State Route 4 Preserve, which was protected as part of compensation for the construction of the State Route 4 Gap Closure Project, has also declined in recent years. The decline may be due to a number of causes, including below normal precipitation and competition from nonnative species (Pardieck 2003). The site had been grazed heavily for many years resulting in stream channel erosion. Grazing was suspended in 2000 and the numbers of plants dropped sharply in 2001 and continued to decline the following year. Controlled grazing has been reintroduced to control the amount of seed and thatch produced by nonnative plants.

5. *LIMNANTHES FLOCCOSA* SSP. *CALIFORNICA* (BUTTE COUNTY MEADOWFOAM)

a. Description and Taxonomy

Taxonomy.—Before 1973, Butte County meadowfoam was not differentiated from the more widespread woolly meadowfoam (*Limnanthes floccosa* ssp. *floccosa*). Then, Arroyo (1973) determined that Butte County meadowfoam was a distinct taxon and gave it the scientific name *Limnanthes*

floccosa ssp. *californica*. The type locality is in Butte County between Chico and Oroville, near the intersection of State Highway 99 and Shippee Road (Arroyo 1973). An alternative common name, Shippee meadowfoam, is derived from the type locality (California Department of Fish and Game 1987a, Ornduff 1993c). *Limnanthes floccosa* ssp. *californica* is a member of the meadowfoam or false mermaid family (Limnanthaceae), which is a small family comprising only 2 genera and 10 species (Ornduff 1993c).

Description and Identification.— *Limnanthes floccosa* ssp. *californica* is a small annual with erect stems less than 25 centimeters (9.8 inches) tall. The stem and leaves are densely pubescent. The alternate leaves are pinnately compound, up to 8 centimeters (3.1 inches) long, and consist of 5 to 11 leaflets on a long petiole. The individual leaflets are approximately 1 centimeter (0.4 inch) long and vary from narrow to egg-shaped; their margins may be smooth, toothed, or lobed. A single flower arises in the axil of each upper leaf. The fragrant flowers are cup- or bowl-shaped and consist of 5 petals, 5 sepals, 5 pistils, and 10 stamens on a long flower stalk. The petals are 8 to 10 millimeters (0.31 to 0.39 inch) long, white with yellow veins, and have two rows of hairs at the base. The sepals are about the same length as the petals and are densely pubescent on both their inner and outer surfaces. Although the sepals are not fused, the dense hairs hold them together, preventing the flower from opening fully. The pistils are separate at the base, but the upper parts are fused. Each pistil is capable of producing a nutlet; the nutlets are egg-shaped, 3 to 4.5 millimeters (0.12 to 0.18 inch) long, and covered with cone-shaped tubercles. As the nutlets mature, the petals turn inward, and at maturity the entire flower, including the nutlets, falls off the plant as a unit. The diploid chromosome number for all *Limnanthes* species is 10 (Mason 1952, Arroyo 1973, McNeill and Brown 1979, Ornduff 1993c).

Limnanthes floccosa ssp. *californica* has longer sepals, petals, anthers and filaments than *L. floccosa* ssp. *floccosa*. Moreover, *L. floccosa* ssp. *floccosa* lacks rows of hairs at the petal base; the nutlet is covered with narrow, sharp-pointed tubercles; and the flowers do not open as widely as in *L. floccosa* ssp. *californica*. Among the other species that occur in the same region as *L. floccosa* ssp. *californica* are *L. alba* (white meadowfoam) and *L. douglasii* ssp. *rosea* (pink meadowfoam). *Limnanthes alba* has petals that are longer than the sepals at flowering. *Limnanthes douglasii* ssp. *rosea* has longer petals that are veined with pink and notched at the tip, and the petals turn outward as the nutlets mature.

b. Historical and Current Distribution

Historical Distribution.— *Limnanthes floccosa* ssp. *californica* has always been confined to the Northeastern Sacramento Valley Vernal Pool Region,

and in fact defines the extent of the region (Keeler-Wolf *et al.* 1998) (**Figure II-8**). This plant was first collected in 1914 at a site 13 kilometers (8 miles) north of Oroville (BioSystems Analysis, Inc. 1993), although it had not yet been recognized as a separate subspecies at that time. In her original description, Arroyo (1973) mentioned six collections, which ranged from 16 kilometers (10 miles) north of Chico south to the type locality and east to Table Mountain, which is north of Oroville. By 1988, 14 occurrences of *L. floccosa* ssp. *californica* had been reported (Arroyo 1973, McNeill and Brown 1979, Dole 1988, Jokerst 1989). Eight were within the city limits of Chico, four (including the type locality) were from the vicinity of Shippee, one was from Table Mountain, and one was from a site northeast of the town of Nord.

Current Distribution.—At least eight new occurrences of *Limnanthes floccosa* ssp. *californica* have been discovered since 1988, two occurrences have been combined in the California Natural Diversity Data Base, while one occurrence is now considered possibly extirpated, for a current total of 21 known natural occurrences (Jokerst 1989, Dole and Sun 1992, U.S. Fish and Wildlife Service 1992, California Natural Diversity Data Base 2005, C. Sellers *in litt.* 2001). The California Natural Diversity Data Base (2005) presumes that the Nord site maintains the most northerly extant occurrence of *L. floccosa* ssp. *californica*, a conclusion bolstered by the finding of 500 plants in this vicinity in 1999. The other occurrences are also presumed to be extant (California Natural Diversity Data Base 2005), although not all have been visited recently. Among the occurrences that have been revisited, many have been reduced in extent. Conversely, in several cases additional occupied habitat has been identified and expanded the boundaries of other occurrences (California Natural Diversity Data Base 2005, C. Sellers *in litt.* 2001).

Counting a recently recorded population and a formerly questionable population both in the Nord area, *Limnanthes floccosa* ssp. *californica* is thus now found in five natural centers of concentration: the Shippee Road area between Chico and Oroville; near the intersection of Highways 99 and 149, where there are five extant occurrences, five new occurrences on the Dove Ridge Conservation Bank south of Highway 149 not yet recorded in the California Natural Diversity Database, and three other centers of concentration within the City of Chico. The northern center is near the Chico Municipal Airport and consists of four occurrences, the northeastern center has a single occurrence and is known as Rancho Arroyo or Bidwell Ranch, and the southeastern center consists of two extant occurrences. In addition, a new location was found in 2005 on North Table Mountain east of the intersection of Highways 149 and 70.

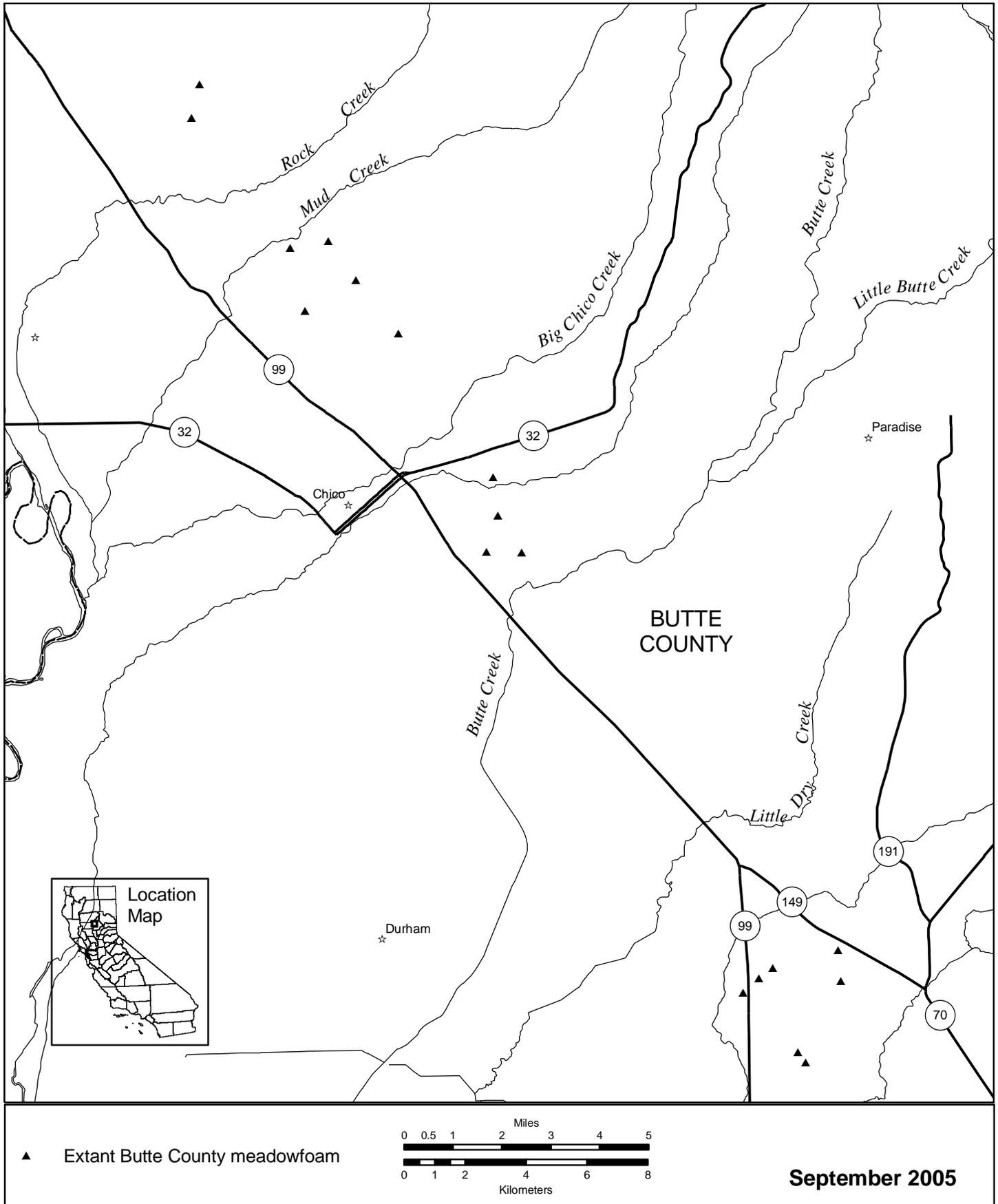


Figure II-8. Distribution of *Limnanthes floccosa* ssp. *californica* (Butte County meadowfoam).

In addition to the 21 naturally occurring populations, an experimental population of *Limnanthes floccosa* ssp. *californica* has been introduced on the Tuscan Preserve in northwestern Butte County (Kelley *et al.* 1994, C. Sellers *in litt.* 2001). The introduction site was just outside of the historical range of the taxon and thus marginally increased its range.

c. Life History and Habitat

Various species in the genus *Limnanthes* have been studied extensively because meadowfoam seeds produce an oil that is potentially valuable for many industrial and pharmaceutical uses. Research has been underway for at least two decades to identify the taxa with the most desirable features for commercial use and to cross-breed them (Pierce and Jain 1977, Brown and Jain 1979, Dole 1988). However, most of the research has been on taxa other than *L. floccosa* ssp. *californica*. Life history traits of related species are presented below when no information is available specifically for *L. floccosa* ssp. *californica*. However, it is recognized that only taxon-specific information should be used in making management decisions (Holland 1987).

Reproduction and Demography.—*Limnanthes floccosa* ssp. *californica* seeds germinate in the late fall after the rainy season begins. The earliest reported observation of seedlings is from November (M. Wacker *in litt.* 2005). Dole and Sun (1992) successfully germinated *L. floccosa* ssp. *californica* seeds under 12 hours of daylight at 15 degrees Celsius (59 degrees Fahrenheit), alternating with 12 hours of darkness at 10 degrees Celsius (50 degrees Fahrenheit). However, the optimum length of daylight and germination temperature under natural conditions have not been investigated.

Seed that does not germinate in the first year following its production may still be viable. In laboratory tests on the more common *Limnanthes floccosa* ssp. *floccosa*, two-thirds of the seed remained dormant even after exposure to favorable conditions, and some ungerminated seed remained in soil samples after 3 years (Ritland and Jain 1984). Seed dormancy also would explain population fluctuations of up to two orders of magnitude between years in *L. floccosa* ssp. *californica* (see below).

Limnanthes floccosa ssp. *californica* seedlings can apparently tolerate short periods of submergence (Jokerst 1989, Dole and Sun 1992). The seedlings develop into rosettes, which do not begin producing flowering stems immediately (McNeill and Brown 1979, Ritland and Jain 1984). *Limnanthes floccosa* ssp. *californica* typically begins flowering in February, reaches peak flowering in March, and may continue into April if conditions are suitable. Nutlets are

produced in March and April, and the plants die back by early May (Jokerst 1989, Dole and Sun 1992).

Limnanthes floccosa ssp. *californica* has floral adaptations that allow for cross-pollination by insects, but self-pollination mechanisms take over to ensure seed set if insect pollination is unsuccessful. Insects are attracted by the large flowers and production of nectar. The stamens begin shedding pollen 1 day before the stigma is receptive. Thus, during this period a given flower could not self-pollinate. If insects visit the flower during this period, they remove the pollen (Arroyo 1975). However, if pollen remains in the anthers when the stigma matures, gravity can carry it to the stigma, which is situated below the anthers (Arroyo 1973). The rate of self-pollination may vary among years or among sites, depending on the size of insect populations (Kalin 1971 in Arroyo 1973, Dole and Sun 1992). Arroyo (1975) estimated that approximately 26 percent of *L. floccosa* ssp. *californica* flowers were self-pollinated in the field during her study. However, when she excluded insects in a greenhouse study, overall seed set in *L. floccosa* ssp. *californica* was the same as that observed under natural conditions (Arroyo 1975). Cross-pollination by insects would allow opportunities for genetic recombination, unlike self-pollination.

Although most populations of *Limnanthes floccosa* ssp. *californica* have bisexual flowers, the population at the type locality contains a small percentage of male-sterile plants (Dole and Sun 1992). Pollination of male-sterile flowers can be achieved only by insects. Male sterility also has been observed in populations of two different subspecies of *L. douglasii* (Douglas' meadowfoam). In that species, male-sterile plants produced smaller flowers than were found on bisexual plants (Jain *et al.* 1978, Kesseli and Jain 1984). Moreover, in *L. douglasii* ssp. *rosea* the male-sterile flowers differed in color from the bisexual flowers, and male-sterile plants grew faster, flowered 2 to 3 days later, and produced more flowers per plant than did bisexual individuals. Seeds produced by male-sterile plants survived longer than those produced by bisexual flowers (Kesseli and Jain 1984).

The particular pollinators of *Limnanthes floccosa* ssp. *californica* have not been identified. Other meadowfoam species are pollinated by the native burrowing bees *Andrena limnanthis* and *Panurginus occidentalis* (Thorp and Leong 1998) and by honeybees (Kesseli and Jain 1984), beetles, flies, true bugs (order Hemiptera), butterflies, and moths (Mason 1952, Thorp and Leong 1998). Hybridization between *Limnanthes* taxa is limited in natural settings, due to differences in flower structure, phenology, and microhabitat (Arroyo 1973, Jain 1976b, Ritland and Jain 1984, Dole and Sun 1992). However, some hybrids between *L. floccosa* ssp. *californica* and *L. alba* have been produced under laboratory conditions (Dole and Sun 1992).

Nutlets of *Limnanthes floccosa* ssp. *californica* are apparently dispersed by water and can remain afloat for up to 3 days (Hauptli *et al.* 1978). The nutlets of *Limnanthes* taxa that grow in wet sites have larger tubercles than those adapted to dry sites. Hauptli *et al.* (1978) speculated that the tuberculate surface of such nutlets may aid in flotation by trapping air. However, most meadowfoam nutlets are dispersed only short distances. In an experiment where nine meadowfoam taxa were seeded into artificial vernal pools (Jain 1978), only four taxa colonized other parts of the pools where they had been introduced, and only two appeared in pools where they had not been seeded, even after 2 years. *Limnanthes floccosa* ssp. *californica* was not included in the study; however, *L. floccosa* ssp. *floccosa* was not found outside of the areas where it had been seeded. Thus, *L. floccosa* ssp. *californica* nutlets would not be expected to disperse beyond their pool or swale of origin. Birds and livestock are potential sources of long-distance seed dispersal, but specific instances of such dispersal have not been documented (Jain 1978).

Demographic data on *Limnanthes floccosa* ssp. *californica* include population sizes as well as estimates of survival and fecundity. Population highs for *L. floccosa* ssp. *californica* are not necessarily reached in the same year at all sites because the amount and timing of rainfall interacts with soil and topography to determine site-specific population size.

The average number of flowers and nutlets per plant also differ among sites and years. Overall, the largest populations of *Limnanthes floccosa* ssp. *californica* produce the greatest number of nutlets per plant (Dole 1988, Dole and Sun 1992). However, the number of flowers per plant is reduced in dense colonies of *L. floccosa* ssp. *californica* because individuals produce fewer branches and therefore fewer flowers. Competition from other plant species also reduces flower production (Crompton 1993, Kelley and Associates Environmental Sciences 1993b). Reproduction of *L. floccosa* ssp. *californica* may be reduced by insufficient moisture (Brown and Jain 1979) or inappropriate livestock grazing practices (Dole 1988, Dole and Sun 1992).

Several races of *Limnanthes floccosa* ssp. *californica* exist. Jokerst (1989) identified “north” and “south” races of *L. floccosa* ssp. *californica* in the Chico “sphere of influence” based on morphology. Later, in studies of enzyme systems, Dole and Sun (1992) confirmed that these races differed genetically. They also identified genetically distinct races that they called “northeast” and “southwest,” with the latter referring to the type locality. Although Arroyo (1975) had concluded that *L. floccosa* exhibited considerable genetic diversity within populations, Dole and Sun (1992) evaluated many more enzyme systems and refuted her conclusions. They found that 96 percent of genetic diversity in *L. floccosa* ssp. *californica* existed among populations and that little variability

was evident within populations. Dole and Sun speculated that the low genetic diversity was due to bottlenecks and subsequent inbreeding. In other words, if populations were reduced to only a few plants at certain times in their history, only those few individuals would have passed on their genes. Self-pollination among the remaining plants would have further restricted the gene pool. Dole and Sun (1992) used mathematical formulas to estimate an average generation time of 2 years for *L. floccosa* ssp. *californica* and to predict that a seed would be transferred between populations only once every 100 to 200 years. Although considerable morphological variability has been observed within populations, it apparently is attributable to differences in environmental response by plants of similar genetic makeup (Jain 1976a, Jokerst 1989).

Habitat and Community Associations.—*Limnanthes floccosa* ssp. *californica* is found primarily in vernal swales and to a lesser extent on the margins of vernal pools (Arroyo 1973, Dole 1988, Jokerst 1989, BioSystems Analysis, Inc. 1993, California Natural Diversity Data Base 2003). Both the swales and vernal pools where it grows are on alluvial terraces in annual grasslands with a mima mound topography (Kelley and Associates Environmental Sciences 1992b, BioSystems Analysis, Inc. 1993). Swales vary in width from narrow channels to broad, pool-like areas (LSA Associates, Inc. 1994). They may connect in branching, tree-like patterns or in net-like patterns around low mounds. Occupied swales are inundated periodically by water from the surrounding uplands, causing the soil to become saturated. However, *L. floccosa* ssp. *californica* does not persist in pools or swales that are inundated for prolonged periods or remain wet during the summer months, nor does it occur in drainages where water flows swiftly (Jokerst 1989, Kelley and Associates Environmental Sciences 1993a). One *L. floccosa* ssp. *californica* site near the Chico Municipal Airport is unusual in that it does not contain vernal pools or recognizable swales (Dole 1988, Dole and Sun 1992), which were most likely obliterated by earlier grading (Jokerst 1989).

The swales that support *Limnanthes floccosa* ssp. *californica* are generally less than 10 centimeters (3.9 inches) deep (LSA Associates, Inc. 1994) and pools are typically less than 30 meters (100 feet) long (Jokerst 1989). In vernal pools, *L. floccosa* ssp. *californica* more often grows on the margins than in the bottom, but the pattern is reversed in swales, with the plants more often growing in the center (BioSystems Analysis, Inc. 1993). This plant typically occurs in long, narrow bands in connected swales or on pool margins but can be found in irregular clusters in isolated drainages (Crompton 1993). *Limnanthes floccosa* ssp. *californica* has also been found occasionally in disturbed areas, such as drainage ditches, firebreaks, and graded sites (McNeill and Brown 1979, Jokerst 1989, Kelley and Associates Environmental Sciences 1992b, BioSystems Analysis, Inc. 1993, Kelley and Associates Environmental Sciences 1993a).

Limnanthes floccosa ssp. *californica* occurs on soils of the Tuscan-Anita and the Redding-Igo complexes, specifically on the Anita and Igo soils, which are confined to the pools and swales. Tuscan and Redding soils are restricted to the mounds. Anita soils can be up to 50 centimeters (19.7 inches) deep, whereas Igo soils are no more than 18 centimeters (7.1 inches) deep; the two soils are underlain by iron-silica cemented and indurated hardpan, respectively (Kelley and Associates Environmental Sciences 1993a). Large cobbles are often present throughout pools and swales in such areas (Jokerst 1989). *Limnanthes floccosa* ssp. *californica* has been observed on Anita clay soils annually regardless of rainfall but appears on Igo soils only in years of above average rainfall (Kelley and Associates Environmental Sciences 1992a, 1992b; Crompton 1993; R. Schonholtz *in litt.* 1995), presumably because the former can hold roughly twice as much moisture (Kelley and Associates Environmental Sciences 1993a). Confirmed occurrences have been found at 50 to 90 meters (165 to 300 feet) in elevation (McNeill and Brown 1979, California Natural Diversity Data Base 2003).

Associated species vary somewhat through the range of *Limnanthes floccosa* ssp. *californica*. In most of the occupied habitat within the City of Chico, *Limnanthes floccosa* ssp. *californica* grows with *Layia fremontii* (Fremont's tidy-tips), *Navarretia leucocephala* (whiteflower navarretia), *Blennosperma nanum* (yellow carpet), and *Lasthenia californica* (California goldfields) (Dole 1988, Dole and Sun 1992). In the Shippee area, *Limnanthes floccosa* ssp. *californica* is associated most frequently with *Juncus bufonius* (toad rush), *Erodium botrys* (long-beak heron's bill), and *Eryngium vaseyi* ssp. *vallicola* (Vasey's coyote thistle) (BioSystems Analysis, Inc. 1993). *Limnanthes floccosa* ssp. *californica* also co-occurs with *Limnanthes alba* at two occurrences and with *Limnanthes douglasii* ssp. *rosea* at five occurrences (McNeill and Brown 1979, Dole and Sun 1992, California Natural Diversity Data Base 2003). *Limnanthes floccosa* ssp. *floccosa* was observed not far from a population of *Limnanthes floccosa* ssp. *californica*, but the two subspecies were not growing together (California Natural Diversity Data Base 2003).

d. Reasons for Decline and Threats to Survival

Most species addressed in this recovery plan are threatened by similar factors because they occupy the same vernal pool ecosystems. These general threats, faced by all the covered species, are discussed in greater detail in the Introduction section of this recovery plan. Additional, specific threats to *Limnanthes floccosa* ssp. *californica* are described below.

At least seven more urbanization actions are being considered within occupied *Limnanthes floccosa* ssp. *californica* habitat in the City of Chico (Kelley and

Associates Environmental Sciences 1992c). These projects include various proposals for residential developments and expansion of the Chico Municipal Airport (U.S. Fish and Wildlife Service 1992, C. Sellers *in litt.* 2001, E. Warne pers. comm. 2001, California Natural Diversity Data Base 2003); these projects would affect two occurrences of the southeastern race and one of the northern race of the taxon. Outside of the City, residential developments and agricultural conversions are also continuing threats to some populations.

A proposed project to widen Highway 149 and build interchanges potentially threatens portions of California Natural Diversity Data Base Element Occurrence 1 and 40 of *Limnanthes floccosa* ssp. *californica* (Finn 2000, California Natural Diversity Data Base 2003), which represent the Shippee race. The California Department of Transportation plans to avoid altering the patterns of surface water flow along Gold Run Creek when they widen Highway 149, but individual pools and swales could be filled and the watersheds of others could be reduced (Finn 2000). Additionally, a casino is proposed to be constructed on a 50-acre site containing potential *Limnanthes floccosa* ssp. *californica* habitat approximately 10 miles south of the city of Chico and adjacent to and east of State Route 149, near its intersection with Highway 99.

Another example of ongoing degradation of *Limnanthes floccosa* ssp. *californica* habitat involves illegal trash dumping and off-highway vehicle use (U.S. Fish and Wildlife Service 1992). Also, competition from grasses and other weedy nonnative plants poses a potential problem to four occurrences of *L. floccosa* ssp. *californica* (California Natural Diversity Data Base 2003). For example, at the Doe Mill Preserve, competition from the nonnative grass *Taeniatherum caput-medusae* (medusahead) apparently has reduced population size and seed set in *L. floccosa* ssp. *californica* (Center for Natural Lands Management 1997). In addition, threats are also continuing due to inappropriate grazing practices in certain instances, such as insufficient grazing at the Doe Mill Preserve. Finally, two populations of *L. floccosa* ssp. *californica* are small enough (fewer than 500 plants even in favorable years) that random events could lead to their extirpation (C. Sellers *in litt.* 2001, California Natural Diversity Data Base 2003). Moreover, the narrow geographic range of the taxon increases the likelihood that a single catastrophic event could destroy all or most of the occurrences. A threat to the Doe Mill Preserve and other *L. floccosa* ssp. *californica* preserves in Butte County is their small size (Conservation Efforts below). A concern for these small preserves is that the risk of extirpation in the event of stochastic events increases if low population densities of the plants are coupled with restricted distribution.

Another potential threat is lack of pollinators. Although *Limnanthes floccosa* ssp. *californica* is capable of setting seed in the absence of insect pollinators,

continuing adaptation to environmental changes is not possible without the genetic recombination that occurs during cross-pollination. Considering the widespread habitat destruction and degradation in the area where *L. floccosa* ssp. *californica* is endemic, breeding habitat for pollinators could well be declining. However, the identity of pollinators for this subspecies must be determined before their population and habitat status can be evaluated.

e. Conservation Efforts

We listed *Limnanthes floccosa* ssp. *californica* as an endangered species on June 8, 1992 (U.S. Fish and Wildlife Service 1992). The California Fish and Game Commission had previously listed this taxon as endangered under the California Endangered Species Act in 1982 (California Department of Fish and Game 1991). *Limnanthes floccosa* ssp. *californica* has been included on the California Native Plant Society's list of rare and endangered plants for almost two decades (Smith *et al.* 1980) and is currently on List 1B with the highest endangerment rating (California Native Plant Society 2001). In 2002, critical habitat was proposed for *L. floccosa* ssp. *californica* and several other vernal pool species in *Proposed Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants in California and Southern Oregon* (U.S. Fish and Wildlife Service 2002a); however, it was eliminated from the final designation (U.S. Fish and Wildlife Service 2003). In 2005, however, critical habitat was reinstated for *L. floccosa* ssp. *californica* and several other vernal pool species in *Final Designation of Critical Habitat for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants in California and Southern Oregon; Evaluation of Economic Exclusions From August 2003 Final Designation; Final Rule* (U.S. Fish and Wildlife Service 2005).

In 1988, the City of Chico funded surveys to determine the status of *Limnanthes floccosa* ssp. *californica* (Dole 1988). Money from the California Endangered Species Tax Check-Off Fund was used to prepare a plan for conserving *L. floccosa* ssp. *californica* within the City, while allowing for continued development (Jokerst 1989). The City prepared a supplement to the conservation plan presenting a schedule for acquisition and other details of management (City of Chico 1989) and was developing a Habitat Resources Conservation Plan for *L. floccosa* ssp. *californica* and other listed species, but has abandoned the effort (J. Knight pers. comm. 1997).

Several areas have been set aside for the conservation of *Limnanthes floccosa* ssp. *californica*. These areas include the 6-hectare (15-acre) Doe Mill Preserve, a conservation easement of about 14 hectares (35 acres) on Humboldt Road, and a 2.8-hectare (7-acre) conservation easement on the publicly owned Gillick-Evans Firing Range (U.S. Fish and Wildlife Service 1992, K. Tarp pers. comm. 1997, C.

Sellers *in litt.* 2001). The City of Chico also has a conservation easement on 118 hectares (292 acres) of habitat that appears to be suitable for *L. floccosa* ssp. *californica*, although very few of the plants are present (C. Sellers *in litt.* 2001). The Dove Ridge Conservation Bank, which contains over 200 acres of vernal pool habitat, is operated as conservation bank for this and other vernal pool species. The Center for Natural Lands Management holds a conservation easement and conducts management and monitoring of the site (M. Wacker *in litt.* 2005).

Other conservation efforts for *Limnanthes floccosa* ssp. *californica* have been accomplished through mitigation programs. The Bruce-Stilson population was enhanced by spreading nutlets to unoccupied areas within a proposed preserve (Stern 1992, K. Stern *in litt.* 1994). *Limnanthes floccosa* ssp. *californica* also was introduced onto suitable, unoccupied habitat on the Tuscan Preserve (also known as Lower Wurlitzer Ranch) in 1992 and 1993 (Kelley *et al.* 1994). The population has continued to reproduce and expand, increasing to approximately 200,000 plants by the spring of 2000 (C. Sellers *in litt.* 2001).

6. NAVARRETIA LEUCOCEPHALA SSP. PAUCIFLORA (FEW-FLOWERED NAVARRETIA)

a. Description and Taxonomy

Taxonomy.—Navarretias are members of the phlox family (Polemoniaceae). Mason (1946) first gave few-flowered navarretia the Latin name *Navarretia pauciflora*. He had collected the type specimen “5 miles north of Lower Lake, Lake County” in 1945 (Mason 1946). Day (1993a) subsequently reduced few-flowered navarretia in rank and assigned it the name *Navarretia leucocephala* ssp. *pauciflora*.

Some plants exhibit characteristics intermediate between *Navarretia leucocephala* ssp. *pauciflora* and ssp. *pliantha*. According to Dr. Alva Day (A. Day *in litt.* 1993, *in litt.* 1997, pers. comm. 1997), such plants cannot be assigned definitively to either subspecies. She does not consider these intergrades (intermediate plants) to be hybrids because there is no evidence that they resulted from crosses between the two subspecies. Thus, the characterization of these intermediate plants as “intercrosses” in the final rule (U.S. Fish and Wildlife Service 1997b) was misleading. The existence of such intermediate forms was Dr. Day’s primary reason for reducing several taxa previously treated as full species to subspecies within *N. leucocephala* (Day 1993a, A. Day pers. comm. 1997). The distribution, life history, threats, conservation efforts, and recovery strategy for intergrades are discussed in the species account for *N. leucocephala* ssp. *pliantha*.