

e. Conservation Efforts

Of the 53 midvalley fairy shrimp occurrences in the California Natural Diversity Data Base (2003), roughly 19 (36 percent) are directly threatened by proposed development projects, while 22 (41.5 percent) are on protected lands. The protected lands include two National Wildlife Refuges, several vernal pool mitigation banks, a California Department of Fish and Game ecological reserve, and several Nature Conservancy conservation easements. Sacramento and Merced Counties have the most threatened occurrences, with seven and five, respectively. Threats in Sacramento County mostly involve urban development projects, while the primary threat in Merced County is construction of the proposed University of California, Merced, campus. Merced County also has the highest number of protected occurrences, with a total of 14 occurrences located on lands that have been set aside for the conservation of vernal pool species. These lands are intended to function as conservation areas to offset the direct, indirect, and cumulative effects of the new university campus. Three ranches containing conservation easements held by The Nature Conservancy (totaling about 9,900 hectares [24,500 acres]) contain known midvalley fairy shrimp sightings. The easements are permanent, will generally be managed by The Nature Conservancy, and cannot be extinguished by selling the land to a new owner (J. Single *in litt.* 2003; U.S. Fish and Wildlife Service, *in litt.* 2003).

2. CALIFORNIA FAIRY SHRIMP (*LINDERIELLA OCCIDENTALIS*)

a. Description and Taxonomy

Taxonomy.—The California fairy shrimp (*Linderiella occidentalis*) was first described as *Branchinecta occidentalis* by Dodds (1923) from specimens collected at Stanford University, Santa Clara County, California. Linder (1941) moved this species into the genus *Pristicephalus*, but discussed the possibility that the genus *Pristicephalus* should be absorbed into the genus *Eubbranchipus*. However, he did not have the specimens necessary to make that determination. Pennak (1953) assigned California fairy shrimp specimens to the genus *Eubbranchipus*. Brtek (1964) erected the family Linderiellidae, and placed the California fairy shrimp in the genus *Linderiella*. This taxonomic placement is still recognized (Belk and Brtek 1995). The California fairy shrimp was the only recorded species in the Family Linderiellidae in North America until 1994, when the Santa Rosa fairy shrimp (*Linderiella santarosae*) was collected and described from southern California by Thiery and Fugate (1994).

Description and Identification.—Unlike the other fairy shrimp addressed in this recovery plan, the California fairy shrimp is a member of the family Linderiellidae. It is smaller than fairy shrimp in the family Branchinectidae, and

has red eyes, and conical, horn-like antennae appendages. Male California fairy shrimp are approximately 9 millimeters (0.35 inch) long, and females are about 10 millimeters (0.39 inch) in length (Dodds 1923).

The California fairy shrimp is one of two species of *Linderiella* described in North America. Both the California fairy shrimp and the Santa Rosa fairy shrimp are endemic to California (Eng *et al.* 1990, Thiery and Fugate 1994). These two species can be identified by the male's second antennae, and by their cysts. The male California fairy shrimp has a thinner, straighter second antennae than the Santa Rosa fairy shrimp. The cysts of the California fairy shrimp have sharper and longer spines than the Santa Rosa fairy shrimp, whose cysts have more tulip-shaped spines (Thiery and Fugate 1994).

The California fairy shrimp may also be confused with species of *Branchinecta* or *Eubbranchipus*, as evidenced by its being placed in both these genera in the past (Dodds 1923, Pennak 1953). However, *Eubbranchipus* has an obvious frontal appendage, while the California fairy shrimp has no frontal appendage. In California, *Linderiella* and *Eubbranchipus* have completely separate distributions as well. The California fairy shrimp can be differentiated from species of *Branchinecta* by its red eyes and smaller size. The second antennae of the California fairy shrimp are also simpler than those of *Branchinecta* species, lacking outgrowths or protuberances (Belk 1975, Eng *et al.* 1990, Eriksen and Belk 1999).

b. Historical and Current Distribution

Historical Distribution.—The California fairy shrimp was identified relatively recently, in 1990, and there is little information on the historical range of the species. However, the California fairy shrimp is currently known to occur in a wide range of vernal pool habitats in the Central Valley of California. It is likely the historical distribution of this species coincides with the historical distribution of Central Valley vernal pools. Holland (1978) estimated that roughly 1,600,000 hectares (4,000,000 acres) of vernal pool habitat existed in the Central Valley during pre-agricultural times. He found that although the current distribution of vernal pools is similar to their historical distribution in extent, Central Valley vernal pools are now far more fragmented and isolated from each other than during historical times. Central Valley vernal pools currently occupy only about 25 percent of their former land area (Holland 1998).

The historical distribution of the California fairy shrimp in Southern California may also have been similar to the historical distribution of its vernal pool habitat in that region. Unlike the Central Valley, where vernal pool habitats were historically widespread, vernal pools in Southern California were probably always

limited in area and extent. Even so, vernal pool habitats in this area were once far more extensive than they are today (Bauder and McMillan 1998, Mattoni and Longcore 1998). In Los Angeles County, coastal prairie and associated vernal pools may have historically occupied as much as 9,308 hectares (23,000 acres) (Mattoni *et al.* 1997). Vernal pools in San Diego County probably covered 51,800 hectares (128,000 acres) prior to intensive agriculture and urbanization (Bauder and McMillan 1998). The California fairy shrimp was likely historically present in available vernal pool habitats in Riverside, Los Angeles, Ventura, and Orange Counties. The historical distribution of the California fairy shrimp in the Central Coast, Carrizo, and Santa Barbara Vernal Pool Regions is not known.

Current Distribution.—The current distribution of the California fairy shrimp in the Central Valley may be similar to its historical distribution in extent, but remaining populations are now considerably more fragmented and isolated than during pre-agricultural times. The California fairy shrimp is currently known from the Central Valley and Coast ranges of California (**Figure II-40**). There are currently 238 reported occurrences of California fairy shrimp in the California Natural Diversity Data Base (2005). In the Northwestern Sacramento Valley Vernal Pool Region the California fairy shrimp is found in the vicinity of Redding on the Stillwater Plains in Shasta County and at a single occurrence in Tehama County. In the Northeastern Sacramento Valley Vernal Pool Region the species is known from the vicinity of Vina Plains and the Dales Lake Ecological Reserve in Tehama County and from a single occurrence in Butte County. In the Southeastern Sacramento Valley Vernal Pool Region the California fairy shrimp is found at Beale Air Force Base in Yuba County, at scattered locations in western Placer County, at McClellan Air Force Base and other locations in Sacramento County, and at a single location in San Joaquin County. In the Santa Rosa Vernal Pool Region (as identified by Keeler-Wolf *et al.* 1998), the California fairy shrimp is known from the vicinity of the cities of Healdsburg, Santa Rosa, and Sebastopol in Sonoma County (refer to the Draft Santa Rosa Plains Recovery Plan [in development] regarding these populations). The California fairy shrimp is also known from a single occurrence in the Livermore Vernal Pool Region in Alameda County. The California fairy shrimp occurs in the vicinity of Jepson Prairie in the Solano-Colusa Vernal Pool Region. In the Central Coast Vernal Pool Region the California fairy shrimp occurs on private property and at Fort Ord and Fort Hunter Liggett in Monterey and San Benito Counties. In the San Joaquin Vernal Pool Region the California fairy shrimp is known from the Grasslands Ecological Area in Merced County and from a single occurrence in Stanislaus County. In the Southern Sierra Foothills Vernal Pool Region the species is known from the Big Table Mountain Preserve and private land in Fresno County, from Bureau of Reclamation and private lands in Madera County, and from a few scattered locations on private land in Merced, and Stanislaus Counties. The California fairy shrimp is also known from isolated

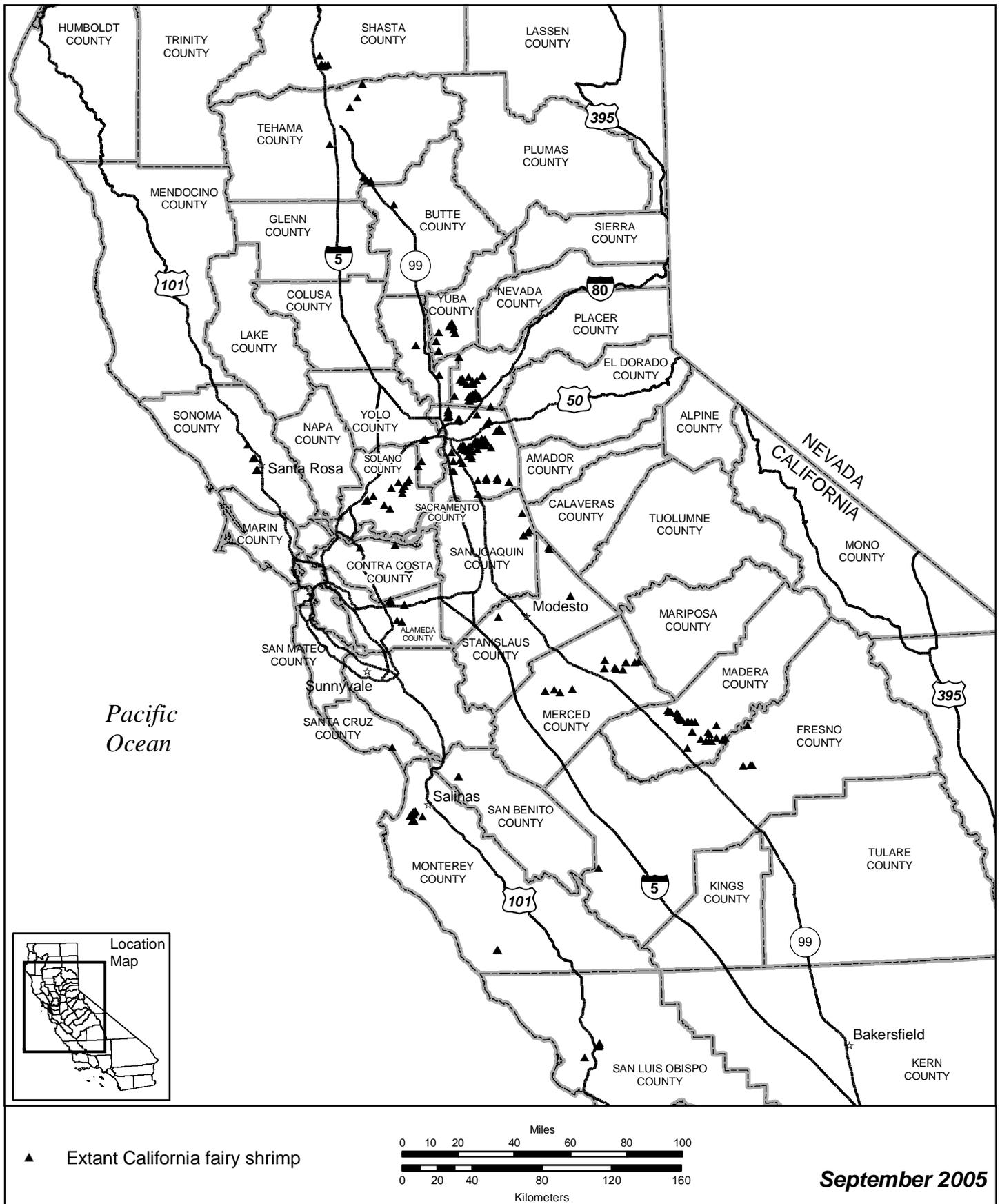


Figure II-40. Distribution of California fairy shrimp (*Linderiella occidentalis*).

occurrences in Santa Barbara and Ventura Counties in the Santa Barbara Vernal Pool Region.

c. Life History and Habitat

Life History.—The California fairy shrimp is uniquely adapted to the astatic conditions of vernal pool habitats. This species is the longest lived of the Central Valley fairy shrimp species (Eriksen and Belk 1999). Helm (1998) found that the California fairy shrimp required a minimum of 31 days and an average of 43 days to reproduce, and was observed to live as long as 168 days. California fairy shrimp eggs can hatch when temperatures drop below 20 degrees Celsius (68 degrees Fahrenheit), although optimum hatching may occur at 10 degrees Celsius (50 degrees Fahrenheit) (Eriksen and Belk 1999). The California fairy shrimp may have relatively small clutch sizes. Dodds (1923) reported that brood pouches he examined never contained more than six eggs. California fairy shrimp have been observed in pools with 4- to 16-week durations, and mortality was caused by pool drying (Gallagher 1996). When pools almost dried, Gallagher (1996) observed California fairy shrimp surviving in the pool bottoms, suggesting they may be tolerant of high temperatures and low levels of dissolved oxygen.

Habitat.—The California fairy shrimp is the most widely distributed fairy shrimp in California. The California fairy shrimp has been documented on most land forms, geologic formations, and soil types supporting vernal pools in California. Helm (1998) found the California fairy shrimp in pools ranging in size from 1 to 52,500 square meters (from 10.8 square feet to 13 acres). Other studies have also documented California fairy shrimp in vernal pools ranging widely in size (Syrdahl 1993, Alexander and Schlising 1997). However, the California fairy shrimp tends to be in deeper pools (Platenkamp 1998). The California fairy shrimp is tolerant of a wide range of water temperatures, and has been found in pools with temperatures from 5 to 29.5 degrees Celsius (41 to 85 degrees Fahrenheit) (Syrdahl 1993). California fairy shrimp are often found in pools with clear to turbid water with pH ranging from 6.1 to 8.5, low (13 to 170 parts per million) alkalinity and low (33 to 273 parts per million) total dissolved solids (Eng *et al.* 1990, Syrdahl 1993, Eriksen and Belk 1999). California fairy shrimp have been found in vernal pools ranging in elevation from 10 to 1,159 meters (30 to 3,800 feet) above sea level (Eriksen and Belk 1999).

Community Associations.--The range of the California fairy shrimp overlaps the range of most other large branchiopods that occur in the Central Valley of California. The California fairy shrimp is frequently collected from the same pools as the vernal pool fairy shrimp, where the former is usually numerically dominant (Eriksen and Belk 1999).

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 California fairy shrimp are described below.

According to the California Natural Diversity Database (2005), 42 occurrences of California fairy shrimp are threatened by development, and 13 occurrences are threatened by agricultural conversion.

In the Northwestern Sacramento Valley Vernal Pool Region, the California fairy shrimp is threatened by development on private lands in Shasta and Tehama Counties. In the Northeastern Sacramento Valley Vernal Pool Region the species is threatened by development on private land in Butte County.

The California fairy shrimp is threatened by development in Alameda County in the Livermore Vernal Pool Region. The California fairy shrimp is threatened by development where it occurs on private land in Solano County in the Solano-Colusa Vernal Pool Region. In the Central Coast Vernal Pool Region the California fairy shrimp is threatened by development on private land in Monterey County.

In the San Joaquin Vernal Pool Region the California fairy shrimp is threatened by development on private land in Stanislaus County.

In the Southern Sierra Foothill Vernal Pool Region the species is threatened by development and incompatible land uses on Bureau of Reclamation land in Madera County, and on private land in Madera, Merced, and Stanislaus Counties.

Refer to the Draft Santa Rosa Plains Recovery Plan (in development) for information regarding threats facing the California fairy shrimp in the Santa Rosa Vernal Pool Region, as identified by Keeler-Wolf *et. al.* (1998). The California fairy shrimp is also threatened by development in Santa Barbara and Ventura Counties in the Santa Barbara Vernal Pool Region.

e. Conservation Efforts

While no actions have been taken specifically to conserve California fairy shrimp, a number of populations occur on protected lands. There are currently 238 reported occurrences of California fairy shrimp in the California Natural Diversity Data Base (2005). Approximately 33 percent of the documented populations are

on private land without protection and ownership is unknown for 18 percent (California Natural Diversity Data Base 2003). Of these occurrences, 25 are within existing reserves or mitigation sites: 17 private reserves or mitigation sites, 4 State-owned reserves, and 4 federally-owned reserves (California Natural Diversity Data Base 1997). The California fairy shrimp is protected from direct habitat loss at the Stillwater Plains in Shasta County in the Northwestern Sacramento Valley Vernal Pool Region. In the Northeastern Sacramento Valley Vernal Pool Region the species is protected at the Vina Plains and the Dales Lake Ecological Reserve in Tehama County. In the Southeastern Sacramento Valley Vernal Pool Region the California fairy shrimp is protected from development at Beale Air Force Base in Yuba County, McClellan Air Force Base in Sacramento County, and on a variety of private mitigation areas throughout the region. In the Central Coast Vernal Pool Region the California fairy shrimp is protected from direct habitat loss at Fort Ord and Fort Hunter Liggett in San Benito County. In the San Joaquin Vernal Pool Region the California fairy shrimp is protected from direct habitat loss at the Grasslands Ecological Area in Merced County. In the Southern Sierra Foothill Vernal Pool Region the species is protected from direct habitat loss at the Big Table Mountain Preserve in Fresno County. A cooperative group consisting of the California Department of Fish and Game, California Department of Parks and Recreation, Sierra Foothills Conservancy, Bureau of Land Management, and Bureau of Reclamation has developed a management and monitoring plan for the Big Table Mountain Preserve. Initial efforts focus on grazing as a means to control nonnative grasses while comparing population trends of threatened and endangered species in grazed and ungrazed portions of the tableland (M. Griggs *in litt.* 2000). The California Department of Fish and Game conducted botanical studies on this Preserve in conjunction with a grazing study for the last 5 years and will continue monitoring the Big Table Mountain Preserve in conjunction with the grazing lease (M. McCrary, pers comm). The California fairy shrimp is also protected on the Santa Rosa Plateau in Riverside County in the Western Riverside County Vernal Pool Region.

3. WESTERN SPADEFOOT TOAD (*SPEA HAMMONDII*)

a. Description and Taxonomy

Taxonomy.—Spadefoot toads are members of the family Pelobatidae. Two closely related genera of spadefoot toads have been recognized within this family: *Scaphiopus* and *Spea* (Cannatella 1985, Weins and Titus 1991). We will collectively refer to members of this family in this document as spadefoot toads unless otherwise stated. Western spadefoot toads are officially recognized within the genus *Spea* (Weins and Titus 1991), although many literature sources reference *Scaphiopus* as the genus. Species relationships within *Spea* have been difficult to define due to morphological homogeneity among species. At least