A.24 VERNAL POOL FAIRY SHRIMP (*BRANCHINECTA LYNCHI*)

photo courtesy USFWS

A.24.1 Legal and Other Status

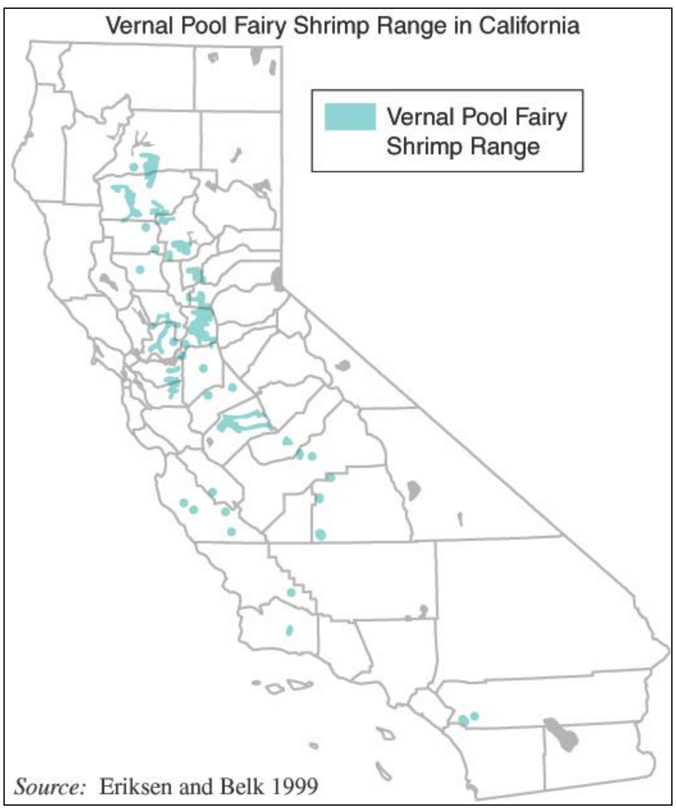
The vernal pool fairy shrimp is listed as threatened under the ESA throughout its range (59 FR 48136).

Critical habitat has been designated for vernal pool fairy shrimp, including areas in the Butte Regional HCP/NCCP Plan Area. Critical habitat includes 59,015 acres (23,883 hectares) in Unit 7 (the Vina Plains Unit), a portion of which is in Butte County, and all of which is on private property. The Vina Plains Unit is located in the northeast portion of the Sacramento Valley from Deer Creek in Tehama County to Chico in Butte County (70 FR 46924).

A.24.2 Species Distribution and Status

A.24.2.1 Range and Status

The vernal pool fairy shrimp was identified relatively recently, in 1990, and there is little information on the historical range of the species; however, it is likely the historical distribution of this species coincides with the historical distribution of vernal pools in California's Central Valley and southern Oregon. The current distribution of the vernal pool 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 in pre-agricultural times. The species is currently found in disjunct and fragmented habitats across the Central Valley of California from Shasta County to Tulare County and the central and southern Coast Ranges from northern Solano County to Ventura County, California. Additional disjunct occurrences have been found in southern California and in Jackson County, Oregon. Although the vernal pool fairy shrimp is distributed more widely than most other fairy shrimp species, it is generally uncommon throughout its range and rarely abundant where it does occur (68 FR 46684, USFWS 2005). The vernal pool fairy



Source: Eriksen and Belk 1999

shrimp is currently found in 28 counties in California where it occupies a variety of vernal pool habitats and occurs in 11 of the 17 vernal pool regions identified in California (Keeler-Wolf et al. 1998). The Agate Desert of southern Oregon comprises the northern extent of the range for the vernal pool fairy shrimp. In California, the vernal pool fairy shrimp occurs on the Thomes Creek Ecological Reserve and the Stillwater Plains preservation bank in Tehama County, and at isolated locations in Glenn and Shasta counties in the Northwestern Sacramento Valley Vernal Pool Region. In the Northeastern Sacramento Valley Vernal Pool Region, the species occurs in the vicinity of Vina Plains and the City of Chico in Tehama and Butte counties, respectively. The greatest numbers of known occurrences of the vernal pool fairy shrimp are found in the Southeastern Sacramento Vernal Pool Region in Placer, Sacramento, and San Joaquin counties, in the vicinity of Beale Air Force Base in Yuba County, and at a single location in El Dorado County. In the Solano-Colusa Vernal Pool Region, the vernal pool fairy shrimp is known from the vicinity of Jepson Prairie and the cities of Vacaville and Dixon in Solano County. In the San Joaquin Valley Vernal Pool Region, the vernal pool fairy shrimp is found at the Grasslands Ecological Area in Merced County, at the Pixley National Wildlife Refuge in Tulare County, and at isolated locations in Kings and Stanislaus counties. In the Southern Sierra Foothills Vernal Pool Region, the vernal pool fairy shrimp is known from the Stone Corral Ecological Reserve and the Hogwallow Preserve in Tulare County and from scattered locations on private land in Stanislaus, San Joaquin, Fresno, Madera, and Merced counties (USFWS 2005).

A.24.2.2 Distribution and Status in the Plan Area

There are 14 CNNDB-reported records of observations for the vernal pool fairy shrimp in Butte County, with some locations noting the species present in several pools (CNNDB 2006) (Figure A.24-1, *Vernal Pool Fairy Shrimp Modeled Habitat and Recorded Occurrences*). Occurrences have also been reported from other sources (Figure A.24-1). Along Highway 99 and Cana Highway, this species was reported from four locations in 11 pools in 1995, with fairy shrimp populations ranging from five to 50 individuals. In 1995 and 1996, this species was reported at the Foothill Park Mitigation Area vernal pools where it occurred in 57 and 97 of the vernal pools, respectively. In 1998, vernal pool fairy shrimp were reported from the Vina Plains Preserve in Butte and Tehama counties, although the number of individuals was not provided. Around Oroville, this species was recorded at six separate locations in 2004, 2005, and 2006. It was also found in 2002 at an isolated seasonal wetland northwest of Shippee, and there is a 1993 report of this species west of Themalito Afterbay, near the intersection of Highway 99 and Richvale East Road (CNDDB 2006).

A.24.3 Habitat Requirements and Special Considerations

The vernal pool fairy shrimp generally inhabits vernal pools with clear to tea-colored water in grass or mud-bottomed swales or basalt flow depression pools in unplowed grasslands, although there are a few populations in sandstone rock outcrops and alkaline vernal pools (59 FR 48136).

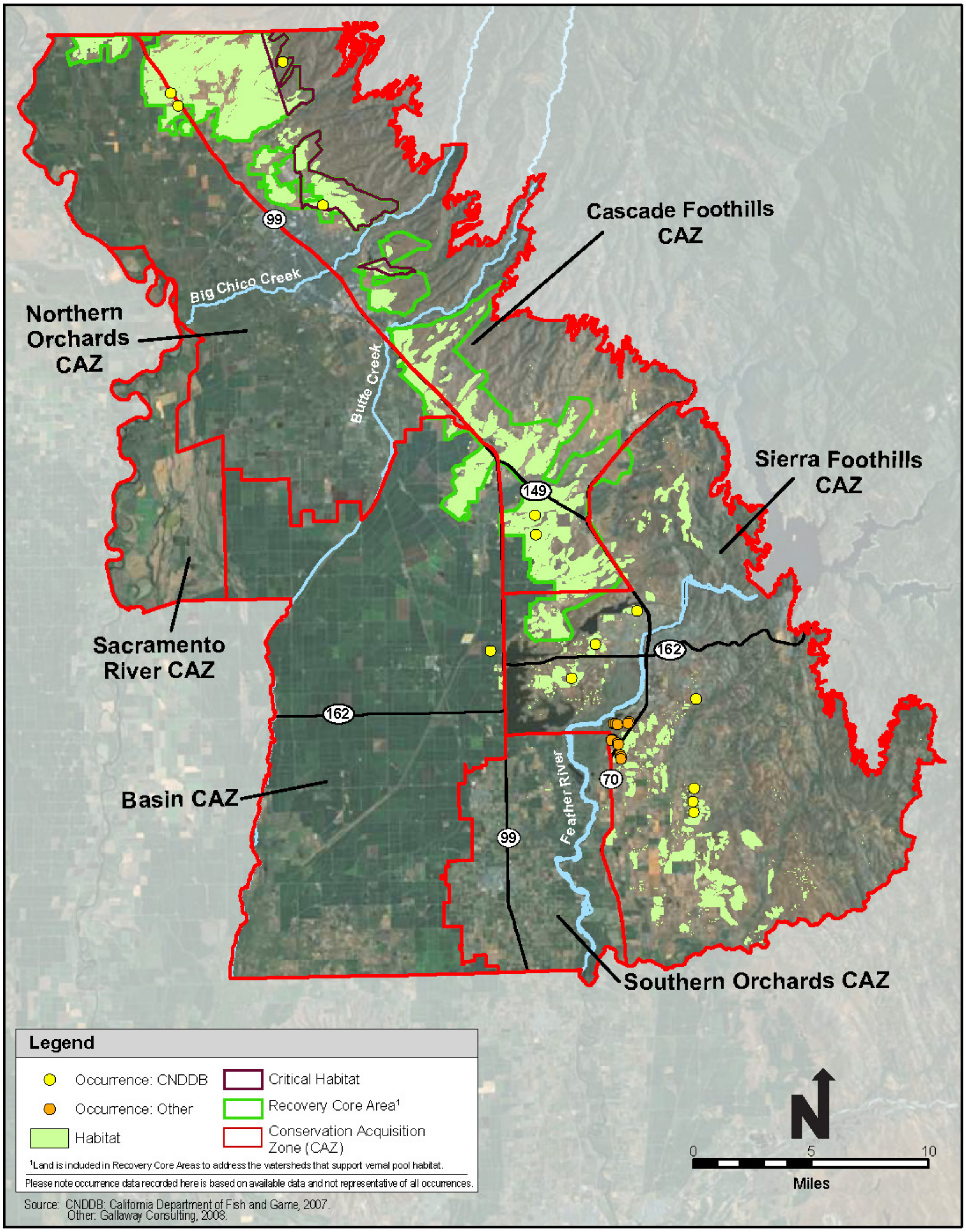


Figure A.24-1. Vernal Pool Fairy Shrimp Modeled Habitat and Recorded Occurrences

Due to local topography and geology, the vernal pool depressions are typically part of an undulating landscape, where soil mounds are interspersed with basins, swales, and drainages. Water movement within complexes allows vernal pool fairy shrimp to move between individual pools. These movement patterns, as well as genetic evidence, indicate that vernal pool fairy shrimp populations exist within, and are defined by, entire vernal pool complexes, rather than individual vernal pools (70 FR 46924, USFWS 2005). Vernal pool fairy shrimp are sporadically distributed within the vernal pool complexes, and some or many of the pools in a complex may not be inhabited during any one year (59 FR 48136).

Although the species has been collected from large vernal pools, it tends to occur primarily in smaller pools and is most frequently found in pools measuring less than 0.02 hectare (0.05 acre) in area. The vernal pool fairy shrimp typically occurs at elevations from 10 meters (33 feet) to 1,220 meters (4,003 feet), although two sites in the Los Padres National Forest have been found to contain the species at an elevation of 1,700 meters (5,600 feet). The vernal pool fairy shrimp has been collected at water temperatures as low as 0ºF (4.5ºC), and has not been found in water temperatures above about 73ºF (23ºC) (USFWS 2005). The water in these pools typically has low total dissolved solids, conductivity, alkalinity, and chloride. Soils beneath the vernal pools that support this species are extremely variable and typically are not the same as soils mapped by soil surveys, but are usually hydric inclusions that vary by location (59 FR 48136).

A.24.3.1 Community Associations

The vernal pool fairy shrimp occupies the same vernal pool habitats as many of the other vernal pool species, including several other rare and endangered vernal pool crustaceans. This species has been found in association with the vernal pool tadpole shrimp (*Lepidurus packardii*), Conservancy fairy shrimp (*Brachinecta conservatio)*, and longhorn fairy shrimp (*Brachinecta longiantenna*), all federally listed endangered; as well as the midvalley fairy shrimp (*Branchinecta mesovallensis*) and California fairy shrimp (*Linderiella occidentalis*), both USFWS species of concern. Where they coexist with other shrimp species, the vernal pool fairy shrimp tends to occur in pools of longer ponding duration and are often less abundant than the other fairy shrimp species. Given the apparently wide distribution of the vernal pool fairy shrimp and its tolerance for a wide range of conditions, it is possible that the absence of this species in certain habitats is explained by competitive exclusion by other fairy shrimp. Vernal pool tadpole shrimp are predators of vernal pool fairy shrimp, whereas vernal pool fairy shrimp feed on algae, bacteria, protozoa, rotifers, and bits of detritus (USFWS 2005).

The vernal pool fairy shrimp occurs in the same vernal pool habitats as the California tiger salamander (federally listed as threatened or endangered, depending upon the subject population) and the western spadefoot toad, a DFG Species of Special Concern. Vernal pool fairy shrimp provide an important food source for a number of species, including the western spadefoot toad. Vernal pool fairy shrimp are also a major prey item for waterfowl, such as ducks. In turn, waterfowl and other migratory birds are important dispersal agents for this and other vernal pool species (USFWS 2005).

In Butte County, plant species that have been found in the same vernal pool habitats as the vernal pool fairy shrimp include blennosperma (*Blennosperma nanum*), coyote thistle (*Eryngium vaseyi*), and goldfields (*Lasthenia* sp.). Other plant species often found in association with the vernal pool fairy shrimp include the Orcutt grasses (*Orcuttia* spp.), the rare plant species Hoover's spurge (*Chamaesyce hooveri)*, Butte County meadowfoam (*Limnanthes floccosa* ssp. *californica*), and Greene's tuctoria (*Tuctoria greenei)* (USFWS 2005, CNDDB 2006).

A.24.4 Life History

Vernal pool fairy shrimp are highly adapted to the environmental conditions of their ephemeral habitats. They are ecologically dependent on seasonal fluctuations in their habitat, such as absence or presence of water during specific times of the year, duration of inundation, and other environmental factors that include specific salinity, conductivity, dissolved solids, and pH levels (USFWS 2002). The ability of the vernal pool fairy shrimp eggs, or cysts, to remain dormant in the soil when their vernal pool habitats are dry allows offspring to survive after the death of parent shrimp. Cysts survive the hot, dry summers and cold, wet winters that follow pool dessication until the vernal pools and swales fill with rainwater and conditions are adequate for hatching. When pools refill in the same or subsequent seasons some, but not all, of the eggs may hatch. The egg bank in the soil may be made up of eggs from several years of breeding (USFWS 2006). Another important adaptation is that the vernal pool fairy shrimp has a relatively short life span, allowing it to hatch, mature to adulthood, and reproduce during the short time period when vernal pools contain water. The vernal pool fairy shrimp can reach sexual maturity in as few as 18 days at optimal conditions of 68ºF (20ºC), and can complete its life cycle in as little as 9 weeks; however, maturation and reproduction rates of vernal pool crustaceans are controlled by water temperature and can vary greatly (USFWS 2005).

A.24.5 Threats

Threats to vernal pool habitat, and vernal pool species in general (including vernal pool fairy shrimp), were identified in the Recovery Plan (USFWS 2005). In addition, the Recovery Plan identified several threats specific to the vernal pool fairy shrimp. More than half of known populations of vernal pool fairy shrimp are threatened by development or agricultural conversion. Several populations are found on military bases, and although not an immediate threat, military activities may result in the alteration of pool characteristics, including the introduction of nonnative plant species (USFWS 2005).

A.24.5.1 Habitat Loss and Fragmentation

Habitat loss and fragmentation were identified as the largest threats to the survival and recovery of vernal pool species. Habitat loss generally is a result of urbanization, agricultural conversion, and mining and can also occur as a result of habitat alteration and degradation due to changes to natural hydrology, invasive species, incompatible grazing regimes (including insufficient grazing for prolonged periods), infrastructure projects (such as roads and utility projects), recreational activities (such as off-road vehicles and hiking), erosion, climatic and environmental change, and contamination. Habitat fragmentation is also related to habitat loss when individual vernal pools become disconnected and isolated as a result of activities such as road development and other infrastructure projects. Widespread urbanization and the construction of infrastructure are major contributors to the loss of vernal pool habitats and their associated species. In addition, gravel and clay mining operations needed to support urban development, including roads and other infrastructure, have resulted in the destruction of vernal pools (USFWS 2005).

In the Northeastern Sacramento Valley Vernal Pool Region, several of the known occurrences of the vernal pool fairy shrimp are located on Caltrans rights-of-way and could be threatened by future road improvement projects in this region (USFWS 2005). In Butte County, four of the larger vernal pool complexes where vernal pool fairy shrimp have been observed in multiple pools are within the Caltrans right-of-way along Highway 99 and could be threatened by future expansion of Highway 99. The remaining 10 known occurrences in Butte County are on private property, including one in The Nature Conservancy's Vina Plains Preserve. Three of those populations are considered threatened by development, either through direct loss of habitat or indirectly though alternation of hydrology or other factors (CNDDB 2006).

A.24.5.2 Agricultural Conversion and Incompatible Livestock Grazing Practices

Land use conversion, such as from grasslands or pastures to more intensive agricultural uses, such as croplands or from one crop type to another, has contributed and continues to contribute to the decline of vernal pools in general. Although not identified as the primary threat to the vernal pool fairy shrimp populations in Butte County, several populations are in areas that are currently grazed, and changes in grazing practices could alter the vernal pool habitat making it unsuitable for this species (USFWS 2005).

A.24.5.3 Competition from Invasive Species

Vernal pool plant species have declined due to the introduction of invasive nonnative plant and animal species. Increasing dominance by competitors may also contribute to changes in hydrology and livestock grazing practices. At Camp Roberts, in San Luis Obispo County, the nonnative invasive medusa head (*Taeniatherum caput-medusae*), which also occurs in Butte County, threatened to diminish the pool area available to vernal pool fairy shrimp in two of three plots that were fenced to protect vernal pools from training activities (USFWS 2005).

A.24.5.4 Altered Hydrology

Changes in hydrology that result in a change in the timing, frequency, and duration of inundation in vernal pools can create conditions that render existing vernal pools unsuitable for vernal pool species (USFWS 2005). The vernal pool complexes in areas proposed for road improvements could be affected by alteration of hydrology which could diminish habitat for vernal pool fairly shrimp (CNDDB 2006).

A.24.5.5 Contamination

Slight changes in water chemistry directly affect sensitive vernal pool species, especially vernal pool crustaceans. Water contamination can occur from herbicides, fertilizers, and other chemicals commonly used in urban and agricultural settings. Pesticide applications for combating West Nile virus, a disease transmitted by infected mosquitoes, may also affect fairy shrimp species. Fertilizers may also contribute to the growth of invasive plants (USFWS 2005).

A.24.5.6 Other Threats

Several other threats to vernal pools and their associate species in general were identified in the Recovery Plan. Although not specifically identified as a threat to vernal pool fairy shrimp, these threats contribute to the decline of vernal pool habitats, which will affect all species that are dependent on functional vernal pool habitats for survival. Human use and recreational activities, such as off-road vehicle use, hiking, and bicycling, threaten vernal pool ecosystems. When access roads or trails are through vernal pool complexes, hydrological functions may be impaired by displaced soil causing erosion or interrupting swale connectivity. Also, off-road enthusiasts, such as bicyclists, may create dirt jump ramps, which also could result in the burial of seeds and cysts of plants and animals or soil compaction. Recreational users also may introduce, or facilitate spread of, invasive plants or dispose waste and debris into vernal pool habitat and alter the ecology (USFWS 2005).

Habitat alteration may also occur due to large-scale climate and environmental changes, such as global warming, which lead to changes in the precipitation pattern and atmospheric conditions. Most of the populations of vernal pool fairy shrimp are isolated from other populations and are distributed in discontinuous vernal pool systems. Small, isolated populations are vulnerable, which could result in extirpation from a particular area (USFWS 2005, 2006).

A.24.6 Relevant Conservation Efforts

The vernal pool fairy shrimp is protected as a threatened species under the Endangered Species Act. Approximately 13,000 acres (5,261 hectares) of vernal pool habitats, including mitigation banks, have been set aside for the vernal pool fairy shrimp specifically as terms and conditions of section 7 consultations. These areas are scattered throughout the Central Valley and represent important building blocks toward recovery of the vernal pool fairy shrimp. Throughout the range of the species, vernal pool habitats supporting populations of vernal pool fairy shrimp have been protected through a variety of other means, including preserves, refuges, and protections on private lands. In the Northeastern Sacramento Valley region, vernal pool fairy shrimp are protected on a private mitigation area and on land owned by The Nature Conservancy (USFWS 2005, CNDDB 2006).

Vernal pool habitats have been the focus of much research. Although there are numerous anecdotal accounts of the habitat requirements of the vernal pool fairy shrimp, little specific information about the conservation needs of the species has been accumulated (USFWS 2005).

A.24.7 Species Habitat Suitability Model

A.24.7.1 Habitat

Vernal pool fairy shrimp habitat includes the following BRCP mapped land cover types:

- Vernal pool;
- Altered vernal pool; and
- Grassland with vernal swale complex.

Vernal pools that may support vernal pool fairy shrimp habitat may also occur as inclusions in mapped grassland, blue oak savanna, ranchettes–open, and disturbed ground land cover types. These inclusions were not mapped because they did not meet the mapping criteria for vernal pool, altered vernal pool, and grassland with vernal swale complex land cover types.

A.24.7.2 Assumptions

The vernal pool fairy shrimp typically inhabits smaller, shallower pools within vernal pool complexes (USFWS 2007). They inhabit vernal pools with clear to tea-colored water, in grass or mud-bottomed swales or basalt-flow depression pools in unplowed grasslands (59 FR 48136). A few populations are also known from sandstone rock outcrops and alkaline vernal pools (59 FR 48136). Genetic evidence and movement ecology patterns indicate that vernal pool fairy shrimp populations exist within, and are defined by entire vernal pool complexes, rather than by individual pools (70 FR 46924, USFWS 2005).

Given these habitat preferences, suitable habitat for the vernal pool tadpole shrimp is defined as any vernal pool, altered vernal pool, and grassland with vernal swale complex within the Plan Area.

A.24.8 Recovery Plan Goals

A general statement for recovery of vernal pool fairy shrimp is presented in the USFWS (2005) Recovery Plan: to ensure protection of the full geographic, genetic, and ecological extent of this species and to improve the circumstances that caused it to be listed in the first place. Accomplishment of this goal would be achieved by protecting 80 percent of species occurrences throughout its range, including 85 percent of its suitable habitat in 38 Core Areas, including Chico, Oroville, Vina Plains, and Doe Mill in the Northeast Sacramento Vernal Pool Region, which includes the vernal pools in Butte County. In addition, the species would be reintroduced into vernal pool regions and soil types from which surveys indicate that it has been eradicated.

A.24.9 References

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