

VERNAL POOL FAIRY SHRIMP

Branchinecta lynchi

USFWS: Threatened

CDFG: none

Species Account

Status and Description. The vernal pool fairy shrimp was listed as a federally Threatened Species on September 19, 1994 (59 FR 48153). Critical habitat was designated for the vernal pool fairy shrimp in 2005 (USFWS 2005). The vernal pool fairy shrimp is a small crustacean in the Branchinectidae family. The species has elongate bodies, large-stalked compound eyes, no carapaces (hard protective outer covers), and 11 pairs of swimming legs (Eng *et al.* 1990). Adult shrimp range between 0.4-1.0 inches in length (Eng *et al.* 1990).



Vernal pool fairy shrimp are similar in appearance to Colorado fairy shrimp (*Branchinecta coloradensis*). However, the basal segment outgrowth below and posterior to the pulvillus of the antennae of male vernal pool fairy shrimp is ridge-like, while the basal segment outgrowth of the Colorado fairy shrimp is cylindrical and usually larger (Eng *et al.* 1990). The vernal pool fairy shrimp has a shorter, pyriform brood pouch, whereas the Colorado fairy shrimp has a longer, fusiform brood pouch (Eng *et al.* 1990).

Range, Populations and Activity. The historic range of the vernal pool fairy shrimp likely coincided with the historical distribution of vernal pools in the Central Valley of California, southern California and southern Oregon (USFWS 2005). The vernal pool fairy shrimp is currently found in 28 counties across the Central Valley and coast ranges of California, and in Jackson County of southern Oregon. The greatest number of known vernal pool fairy shrimp occurrences are in the Sacramento Valley, in scattered vernal pool habitats in El Dorado, Placer, Sacramento and San Joaquin counties, and in the vicinity of Beale Air Force Base in Yuba County. Vernal pool fairy shrimp populations also occur in the Agate Desert of southern Oregon; the Thomes Creek Ecological Reserve, the Stillwater Plains preservation bank and near the Vina plains in Tehama County; near the City of Chico in Butte County; near the Jepson Prairie and the Cities of Vacaville and Dixon in Solano County; the Grasslands Ecological Reserve in Merced County; the Pixley National Wildlife Refuge, the Stone Corral Ecological Reserve and the Hogswallow Preserve in Tulare County; the Springtown area of Alameda County; near the Byron Airport in Contra Costa County; at Fort Hunter Legget in Monterey County; at Camp Roberts and near Soda Lake in San Luis Obispo County; in Cachuma Canyon in Santa Barbara County; in the Carlsberg vernal pools and in Los Padres National Forest in Ventura County; in the Cruzan Mesa vernal pools in Los Angeles County; at Skunk Hollow in Riverside County; and at isolated locations in Fresno, Glenn, King, Madera, Napa, Shasta, San Benito and Stanislaus counties (USFWS 2005). Although the vernal pool fairy shrimp is more widely distributed than other special status fairy shrimp species in the County, it is generally uncommon throughout its range, and rarely abundant where it does occur (Eng *et al.* 1990, Eriksen and Belk 1999).

Female vernal pool fairy shrimp carry their eggs in a pyriform brood pouch on their abdomen. Eggs are either dropped to the pool bottom or remain in the brood sac until the female dies and sinks

(Federal Register 1994). Resting (summer) eggs are known as cysts and are capable of withstanding heat, cold, and prolonged dry periods. The cyst bank in the soil may be comprised of cysts from several years of breeding (Donald 1983). As the vernal pools refill with rainwater, in the same or subsequent seasons, some of the cysts may hatch. Early stages of fairy shrimp develop rapidly into adults. These non-dormant populations often disappear early in the season, long before the vernal pools dry up (Federal Register 1994). The vernal pool fairy shrimp can reach sexual maturity in as few as 18 days at optimal conditions of 20 degrees Celsius (68 degrees Fahrenheit) and can complete its life cycle in as little as nine weeks (Gallagher 1996, Helm 1998), although it takes longer under non-optimal water temperatures. In larger pools that hold water for longer durations, vernal pool fairy shrimp are capable of hatching multiple times if water temperatures drop to below 10 degrees Celsius (50 degrees Fahrenheit) (Gallagher 1996, Helm 1998). Helm (1998) observed vernal pool fairy shrimp living for as long as 147 days. The species has been collected from early December to early May (Federal Register 1994).

The diet of vernal pool fairy shrimp consists of algae, bacteria, protozoa, rotifers, and bits of organic detritus (Pennak 1989). Vernal pool fairy shrimp are preyed on by many species including vernal pool tadpole shrimp (USFWS 2005), the western spadefoot toad (Simovich *et al.* 1992), and waterfowl such as ducks (Proctor *et al.* 1967, Krapu 1974, Swanson *et al.* 1974, Silveira 1996).

Vernal pool fairy shrimp swim or glide upside down by means of beating movements that pass along their 11 pairs of swimming legs in a wave-like motion from head to tail.

Habitat Use and Species Associations. The vernal pool fairy shrimp occupies a variety of vernal pool habitats, from small, clear sandstone rock pools to large, turbid, alkaline, grassland valley floor pools (Engman *et al.* 1990, Helm 1998). Vernal pool fairy shrimp typically inhabit smaller pools, most frequently less than 0.02 hectare in area (Gallagher 1996, Helm 1998). Inhabited pools occur at elevations ranging from 10 to 1,220 meters and have water temperatures between 4.5 and 23 degrees Celsius (40 and 73 degrees Fahrenheit) (Eriksen and Belk 1999). The water in occupied pools typically has low total dissolved solids (salinity), conductivity, alkalinity, and chloride content (Collie and Lathrop 1976). Vernal pools are often rain fed, resulting in low nutrient levels and dramatic daily fluctuations in pH, dissolved oxygen and carbon dioxide (Keeley and Zedler 1998). Vernal pool fairy shrimp are sporadically distributed within vernal pool complexes (Federal Register 1994) where some or many of the pools in a complex may not be inhabited during any one year.

The vernal pool fairy shrimp is found in the same habitats as many other vernal pool species. Plant species that have been found in vernal pools occupied by the vernal pool fairy shrimp include alkali milk vetch (*Astragalus tener* var. *tener*), Sacramento saltbrush (*Atriplex persistens*), succulent owl's clover (*Castilleja campestris* ssp. *succulenta*), Hoover's spurge (*Chamaesyce hooveri*), spiny-sealed button celery (*Eryngium spinosepalum*), Bogg's lake hedge hyssop (*Gratiola heterosepala*), false Venus' looking glass (*Legenere limosa*), Butte County meadowfoam (*Limnanthes floccosa* ssp. *californica*), Colusa grass (*Neostapfia colusana*), all of the grass species (*Orcuttia* ssp.), and Greene's tuctoria (*Tuctoria greenei*). The vernal pool fairy shrimp has been found in the same vernal pool habitats as many other vernal pool crustaceans, including the vernal pool tadpole shrimp, the California fairy shrimp, the Conservancy fairy shrimp, the longhorn fairy shrimp, and the midvalley fairy shrimp (USFWS 2005). However, vernal pool fairy shrimp are rarely found in the same pools as other fairy shrimp species, and where they do co-exist with other species, the vernal pool fairy shrimp is never the numerically dominant species (Eng *et al.* 1990). Given the apparently

wide distribution of this species and its tolerance for a wide range of conditions, it is possible that the absence of the vernal pool fairy shrimp in certain habitats is explained by competitive exclusion by other fairy shrimp (Helm 1998, Eriksen and Belk 1999). While not typically in the same pools, the vernal pool fairy shrimp occupies the same vernal pool habitats as the delta green ground beetle, and California tiger salamander and the western spadefoot toad.

Population Levels and Occurrence in Plan Area. Vernal pool fairy shrimp occur in the vernal pools located within the Valley Floor Grasslands and Vernal Pools Natural Community. Vernal pool fairy shrimp have been found in most of the remaining vernal pool complexes in the Plan Area. As discussed above, it is a widely distributed species occurring in a smaller size range of pools, but tends to occur at relatively low population levels. At least 40 records of the vernal pool fairy shrimp are occurrences in the Plan Area. (See Species Occurrence map)

Dispersal. Historically, vernal pool fairy shrimp might have dispersed via large scale flood events that allowed the species to colonize different individual pools or pool complexes (USFWS 1999). Urban development and the construction of dams, levees, and other flood control measures have limited this dispersal method. Waterfowl and shorebirds, which ingest the diapaused eggs and/or transport the eggs to new habitats while attached to their legs or feathers (Krapu 1974, Swanson *et al.* 1974, Driver 1981, Ahl 1991). Waterfowl or shorebirds are likely the shrimp's primary dispersal agent (Brusca, in. litt., 1992, King, in. litt., 1992, Simovich, in. litt., 1992). Cysts may also be dispersed and transported in mud on cattle and other livestock that graze in vernal pool areas.

The ability of the species to disperse is important for the long-term survival and recovery of the species as the dispersing individuals can re-colonize areas subjected to localized extinctions.

Threats to the Species. Historically, this species is believed to have been found in vernal pool complexes throughout the Central Valley. According to Holland (1978), between 67 and 88% of vernal pool habitat in the Central Valley was lost by 1973. The Service's analysis of Holland's report determined a more accurate historic loss estimate of 60-85% (USFWS 1999). Since 1973, several more acres of vernal pool fairy shrimp habitat, which are seasonal vernal pools, have been lost or altered by human activities. Between 1987 and 1992, 467 acres of wetlands in the Central Valley, the majority of which were vernal pools, were filled (USFWS 1992). Holland (1999) estimated the average rate of loss of vernal pool habitat in California was 1.4 % per year in the late 1980s to mid 1990s. Rapid urbanization of the Central Valley of California currently poses the most severe threat to the species (USFWS 2001). Habitat loss and alteration due to water supply and flood control projects and agriculture, and agricultural conversions (e.g., from rangeland to leveled, irrigated crops or vineyards or orchards) are also major threats to the species existence. Other threats to the shrimp include off-road vehicle use, certain mosquito abatement measures, pesticides/herbicide use, alterations in vernal pool hydrology, fertilizer contamination, invasive non-native plants, gravel mining, and contaminated stormwater runoff (USFWS 1999).

Specific threats include military activities at Camp Roberts and on the Fort Hunter Liggett Military Reservation, Caltrans highway expansion in the northeastern Sacramento Valley, development of the University of California, Merced campus in Merced County, and urban development and agricultural conversion where it occurs on private land in the San Joaquin Valley and in Solano, Los Angeles, Riverside and Ventura Counties in California and Jackson County in Oregon (USFWS 2005). The

primary threats to the vernal pool fairy shrimp in Solano County are urban development, agricultural conversions, agricultural use, and water supply and flood control projects.

These factors have resulted in the isolation and fragmentation of habitats, often precluding dispersal between populations or sub-populations. This fragmentation results in small isolated populations. Ecological theory suggests that these populations could be highly susceptible to extinction due to chance events, inbreeding depression, or additional environmental disturbance (Gilpin and Soule 1986, Goodman 1987a,b). Should extinction occur in a population that has been fragmented, the opportunities for recolonization could be greatly reduced due to geographical isolation from other populations (USFWS 2001).

Conservation Issues. Conservation efforts for the vernal pool fairy shrimp include a newsletter dedicated to the species by the Inland Invertebrate Working Group, research on vernal pool habitats, and the protection of 5,261 hectares of vernal pool habitats, including mitigation banks, that have been set aside specifically for this species (USFWS 2005). The vernal pool fairy shrimp is protected on the Jepson Prairie Preserve and the Travis Air Force Base in Solano County. However, it is also found on private land within the County where it is threatened by urban development. State and local laws and regulations have not been passed to protect the shrimp and other regulatory mechanisms have proven ineffective (USFWS 1999).

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