

VERNAL POOL TADPOLE SHRIMP

Lepidurus packardii

USFWS: Endangered

CDFG: none

Species Account

Status and Description . The vernal pool tadpole shrimp was listed as a federally Endangered Species on September 19, 1994 (59 FR 48153). In 2005, critical habitat was designated for the vernal pool tadpole shrimp (USFWS 2005). The vernal pool tadpole shrimp is a small crustacean in the Triopsidae family. The species has dorsal compound eyes, a large shield-like carapace covering most of the body, 35 pairs of legs, and two long cercopods at the end of the last abdominal segment (Linder 1952, Longhurst 1955, Pennak 1989). Adult shrimp are 2 inches in length. Vernal pool tadpole shrimp are similar in appearance to the introduced ricefield tadpole shrimp (*Triops longicaudatus*).



California Department of Fish and Game

Range, Populations and Activity. The historic range of the vernal pool tadpole shrimp likely extended throughout the Central Valley of California. The vernal pool tadpole shrimp is currently distributed across the Central Valley of California and in the San Francisco Bay Area. Vernal pool tadpole shrimp have been documented in 19 localities. The largest concentration of occurrences is in Sacramento County, where it occurs on a number of public and private lands. It also occurs in the Stillwater Plains east of Redding in Shasta County; near Chico in Butte County; at the Vina Plains Preserve, the Dales Lake Ecological Reserve and on Caltrans land in Tehama County; near the Jepson Prairie and Travis Air Force Base in Solano County; in the Grasslands Ecological Area and on private land in Merced County; at the Stone Corral Ecological Reserve in Tulare County; at the Big Table Mountain Preserve in Fresno County; in the San Francisco National Wildlife Refuge and private land in Alameda County; and at a few locations in Yuba, Placer and Kings Counties (USFWS 2005).

The life history of the vernal pool tadpole shrimp is linked to the seasonal cycle of its vernal pool habitat. Females deposit their eggs, which are sticky and adhere well to objects, on plant matter, sediment particles, and other objects on the vernal pool bottom (Simovich *et al.* 1992). The shrimp survive the dry summer months as diapaused eggs (often called cysts) in pool sediments. After winter rains fill the pools, vernal pool tadpole shrimp populations are reestablished from cysts that lie dormant in the dry pool sediments (Lanaway 1974, Ahl 1991). Sexually mature adults have been observed in vernal pools three to four weeks after the pools had been filled (Ahl 1991). Helm (1998) found that vernal pool tadpole shrimp took a minimum of 25 days to mature and the mean age at first reproduction was 54 days. Variation in growth and maturation rates may be a result of differences in water temperature, which strongly influences the growth rates of aquatic invertebrates (USFWS 2005). Vernal pool tadpole shrimp have relatively high reproductive rates. Ahl (1991) found that fecundity increases with body size. Large females, greater than 20 millimeters (0.8 inch) carapace length, could deposit as many as 6 clutches, ranging from 32 to 61 eggs per clutch, in a single wet season (USFWS 2005). Vernal tadpole shrimp continue to grow throughout their lives, periodically molting their shells. Some cysts hatch in as little as 4 days, while others remain dormant in the soil to

hatch later in the rainy season or in the fall and winter of subsequent seasons (Ahl 1991, USFWS 1999). Vernal pool tadpole shrimp hatching is temperature dependent. Optimal hatching occurs between 10 to 15 degrees Celsius (50 to 59 degrees Fahrenheit), with hatching rates becoming significantly lower at temperatures above 20 degrees Celsius (68 degrees Fahrenheit) (Ahl 1991). Vernal pool tadpole shrimp emerge from their cysts as metanauplii, a stage which lasts for 1.5 to 2 hours. Then they molt into a larval form resembling the adult. Vernal pool tadpole shrimp mature slowly and often survive and reproduce throughout the rainy season until the pools dry up in the spring (Ahl 1991, Simovich *et al.* 1992).

The diet of vernal pool tadpole shrimp consists of organic detritus, fairy shrimp, and other invertebrates (Pennak 1989).

Vernal pool tadpole shrimp are primarily a benthic species and swim with their legs down (USFWS 1999). The shrimp also climb or scramble over objects, and plow on top of or within bottom sediments (USFWS 2001).

Habitat Use. Vernal pool tadpole shrimp inhabit seasonal, vernal pools or swales that form in slight depressions after being inundated following fall and winter rains. The pools contain clear to highly turbid water and have an impervious hardpan, claypan, or basalt layer beneath the soil surface that retains the water for a few months at a time (USFWS 1999). Populations of vernal pool tadpole shrimp inhabit vernal pool complexes rather than individual pools (Fugate 1992). These pools range in size from 2 to 356,253 square meters (Olcott Lake at Jepson Prairie), in temperature from 10 to 29 degrees Celsius, and in pH from 6.2 to 8.5 (Syrdahl 1993, King 1996, USFWS 2005). However, vernal pools exhibit daily and seasonal fluctuations in pH, temperature, dissolved oxygen, and other water chemistry characteristics (Syrdahl 1993). Although the vernal pool tadpole shrimp is found on a variety of geologic formations and soil types, Helm (1998) found that over 50 percent of vernal pool tadpole shrimp occurrences were on High Terrace landforms and Redding and Corning soils.

Population Levels and Occurrence in Plan Area. Vernal pool tadpole shrimp occur exclusively in vernal pools found within the Valley Floor Grasslands and Vernal Pools Natural Community. Vernal pool tadpole shrimp have been identified primarily in the vernal pool complexes in the Jepson Prairie area and north of the Potrero Hills and south of Highway 12. This species has also been collected in the Vacaville area and near Collinsville in the Montezuma Hills. This species can be quite abundant at times; however, the species appears to be an attractive, localized food source for waterfowl and appears to be susceptible to rapid and dramatic declines in population numbers through predation by waterfowl, particularly in vernal pools with shallow, clear water (RMI 1996). There are well over 30 reported occurrences of vernal pool tadpole shrimp within the Plan Area. (See Species Occurrence map)

Dispersal. Historically, vernal pool tadpole 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. A genetic study of the species found genetic variation was due to differences between sites, probably as a result of the spatial isolation of their habitats and their reliance on passive dispersal mechanisms (USFWS 2005). Waterfowl and shorebirds, which ingest the diapaused eggs and/or transport the eggs while attached to their legs or feathers to new habitats

(Krapu 1974, Swanson *et al.* 1974, Driver 1981, Ahl 1991), are likely to be the shrimp's primary dispersal agent (Brusca, in. litt., 1992, King, in. litt., 1992, Simovich, in. litt., 1992).

The ability of the vernal pool tadpole shrimp to disperse is important for their long-term survival and recovery 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 to 85% (USFWS 1999). Since 1973, several more acres of vernal pool tadpole 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). The CNDDDB (2003) lists 17 occurrences of vernal pool tadpole shrimp as threatened by development, 16 occurrences as threatened by agricultural conversion. Habitat loss and alteration due to water supply and flood control projects and agriculture 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).

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).

There are also threats specific to particular vernal pool tadpole shrimp populations. In Alameda County, the species is threatened by the encroachment of nonnative grasses on the San Francisco Bay National Wildlife Refuge and by urban development on private land. In the Northeastern Sacramento Valley region, most of the known occurrences of the vernal pool fairy shrimp are on Caltrans rights of way where they continue to be threatened by road improvement projects related to general urban growth (USFWS 2005). In addition, the species is known to have been parasitized by flukes (Trematoda) of an undetermined species at the Vina Plains, Tehama County (Ahl 1991). In Merced County, the species is threatened by development of the proposed University of California, Merced campus, In San Joaquin and Solano Counties, it is threatened by urban development (USFWS 2005).

Conservation Issues. The primary threats to the vernal pool tadpole shrimp in the County are urban development, agricultural conversions, agricultural use, and water supply and flood control projects. 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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