

males have a distal segment which is about 30 percent shorter than the basal segment, and has a tip bent medially about 90 degrees (Eng et al. 1990). The female brood pouch is tapered at each end, typically extends to abdominal segment 8, and has a terminal opening (Eng et al. 1990). Males may be from 0.6 to 1.0 in (14 to 27 millimeters (mm)) in length, and females have been measured between 0.6 and 1.0 in (14.5 and 23 mm) long.

Further discussion on the life history and habitat requirements of Conservancy fairy shrimp can be found in the final rule to list this species (59 FR 48136).

### Longhorn Fairy Shrimp

Longhorn fairy shrimp were first collected in 1937, but were not formally described until 1990 by Eng, Belk, and Eriksen. The type specimen was collected from a sandstone outcrop pool on the Souza Ranch in Contra Costa County, California. Longhorn fairy shrimp are extremely rare, and are only known from three widely separated locations: the Altamont Pass area in Contra Costa and Alameda Counties, the western and northern boundaries of Soda Lake on the Carrizo Plain in San Luis Obispo County, and Kesterson National Wildlife Refuge in the San Joaquin Valley in Merced County. Vernal pool crustacean surveys conducted by Sugnet (1993) found only 3 occurrences of longhorn fairy shrimp out of 3,092 locations surveyed, and Helm (1998) found occurrences of longhorn fairy shrimp in only 9 of 4,008 wetlands sampled.

Longhorn fairy shrimp are distinguished from other fairy shrimp by the male's very long second antenna, which is about twice as long, relative to its body, as the second antenna of other species of *Branchinecta*. Longhorn fairy shrimp antennae range from 0.3 to 0.4 in (6.7 to 10.4 mm) in length (Eriksen and Belk 1999). Females can be recognized by their cylindrical brood pouch, which extends to below abdominal segments 6 or 7. Mature males have been measured between 0.5 to 0.8 in (12 and 21 mm) in length, and females range from 0.5 to 0.8 in (13.3 to 19.8 mm) in length (Eng et al. 1990).

Further discussion of the life history and habitat requirements of longhorn fairy shrimp can be found in the final rule to list this species (59 FR 48136).

### Vernal Pool Fairy Shrimp

Vernal pool fairy shrimp were first described by Eng et al. in 1990 from a type specimen that was collected in 1982 at Souza Ranch, Contra Costa County, California. The species occurs

in disjunct fragmented habitats distributed 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 identified in southern California and in Oregon. In Oregon, the species' distribution is limited to the vicinity of an approximately 32 square mile (mi<sup>2</sup>) 82.9 square kilometer (km<sup>2</sup>) area known as the Agate Desert in Jackson County, north of Medford. In southern California, the distribution is equally limited, with populations occurring in three areas in Riverside County.

Vernal pool fairy shrimp are characterized by the presence and size of several bulges on the male's antenna, and by the female's short, pyriform or pear shaped brood pouch. Vernal pool fairy shrimp vary in size, ranging from 0.4 to 1.0 in (11 to 25 mm) in length (Eng et al. 1990).

Vernal pool fairy shrimp are currently found in 27 counties across the Central Valley and coast ranges of California, inland valleys of southern California, and southern Oregon. Although vernal pool fairy shrimp are distributed more widely than most other fairy shrimp species, they are generally uncommon throughout their range and rarely abundant where they do occur (Eng et al. 1990; Eriksen and Belk 1999).

Further discussion of the life history and habitat requirements of vernal pool fairy shrimp can be found in the final rule to list this species (59 FR 48136).

### Vernal Pool Tadpole Shrimp

Vernal pool tadpole shrimp were initially described by Simon in 1886 and named *Lepidurus packardii*. After subsequent reclassification by Longhurst (1955), the species was given a subspecies status based primarily on the lack of apparent geographic boundaries between *L. apus* and *L. packardii* populations. Lynch (1972) resurrected *L. packardii* to full species status based on further examination of specimens, and this is the currently accepted taxonomic status of vernal pool tadpole shrimp. Vernal pool tadpole shrimp inhabit sites in California's Central Valley and San Francisco Bay area. The geographic range of this species includes disjunct occurrences found in the Central Valley from Shasta County to northern Tulare County, and in the central coast range from Solano County to Alameda County. Vernal pool tadpole shrimp are known from 160 occurrences (CNDDB 2001).

Vernal pool tadpole shrimp are distinguished by a large, shieldlike carapace, or shell, that covers the

anterior half of their body. Vernal pool tadpole shrimp have 30 to 35 pairs of phyllopods, a segmented abdomen, paired cercopods or tail-like appendages, and fused eyes. Vernal pool tadpole shrimp will continue to grow as long as their vernal pool habitats remain inundated, in some cases for 6 months or longer. They periodically shed their shells, which can often be found along the edges of vernal pools where vernal pool tadpole shrimp occur. Mature vernal pool tadpole shrimp range in size from 0.6 to 3.4 in (15 to 86 mm) in length.

Vernal pool tadpole shrimp have relatively high reproductive rates. Ahl (1991) found that fecundity increases with body size. A large female greater than 0.8 in (20 mm) in carapace length could deposit as many as 6 clutches, averaging 32 to 61 eggs per clutch, in a single wet season.

Further discussion of the life history and habitat requirements of vernal pool tadpole shrimp can be found in the final rule to list this species (59 FR 48136).

### Vernal Pool Plants Background

The 11 vernal pool plants described in this rule have developed a suite of highly specialized adaptations that allow them to survive in vernal pool habitats. All 11 species are annuals, meaning they germinate, grow, reproduce, and die within a single year. This allows the vernal pool plants to complete their life cycles during the relatively short inundation and drying periods of their vernal pool habitat.

Another adaptation of vernal pool plants is production of dormant seeds. This adaptation allows vernal pool plants to survive the hot summer months in the soil. The seeds may remain viable in the soil for many years. The number of plants present above ground may fluctuate dramatically from year to year. However, much of the population of these species exists as seeds in the soil. Vernal pool plant seeds germinate after winter rains in response to a complex set of environmental cues that are not well understood, but generally include various temperature and soil moisture. Not all of the dormant seeds will germinate in any given year. This strategy reduces the probability of local extirpation if environmental conditions change—for example, if a vernal pool dries up prematurely. It has also been suggested the strategy acts as a mechanism by which rare species may persist in unpredictable environments (Chesson and Warner 1981; Chesson and Huntly 1989; Ellner and Hairston 1994).