

support occurrences of the species within clear depression pools in sandstone outcrops (Eriksen and Belk 1999; EBRPD 2001; CNDDDB 2002). Midway in the species' range, the alkaline pools supporting longhorn fairy shrimp are found on Edminster loam and Turlock sandy loam. In the species' southern range, they are found on shallow alkaline Northern Claypan type vernal pools within a valley saltbush scrub matrix. The parent material of vernal pools greatly influences species composition and hydrologic functioning of the vernal pool (Hanes and Stromberg 1998; Holland and Jain 1981, 1988). Soils beneath vernal pools are extremely variable and are not the same as soils mapped by soil surveys, but are usually undescribed hydric inclusions which vary upon location (Holland and Dain 1990). The primary constituent elements of critical habitat for longhorn fairy shrimp are the habitat components that provide:

(i) Vernal pools, swales, and other ephemeral wetlands and depressions of appropriate sizes and depths that typically become inundated during winter rains and hold water for sufficient lengths of time necessary for longhorn fairy shrimp incubation, reproduction, dispersal, feeding, and sheltering, including but not limited to, large playa vernal pools often on basin rim landforms and alkaline soils, but which are dry during the summer and do not necessarily fill with water every year; and

(ii) The geographic, topographic, and edaphic features that support aggregations or systems of hydrologically interconnected pools, swales, and other ephemeral wetlands and depressions within a matrix of surrounding uplands that together form hydrologically and ecologically functional units called vernal pool complexes. These features contribute to the filling and drying of the vernal pool and maintain suitable periods of pool inundation, water quality, and soil moisture for vernal pool crustacean hatching, growth and reproduction, and dispersal, but not necessarily every year.

*Unit 1, Altamont Hills Unit A and B, Contra Costa and Alameda Counties (320 ac)*

This unit supports occurrences of the species within clear depression pools in sandstone outcrops (Eriksen and Belk 1999; EBRPD 2001; CNDDDB 2002). The essential habitat for the species occurs in sandstone rock outcroppings with the pools sometimes being less than a meter (3 ft) across. This is a unique habitat for longhorn fairy shrimp, and helps to maintain a diversity of habitats for the

species (criterion 2). The Altamont Hills Unit is also an important area for the species because it represents the northern limit of its range, and is one of only three locations where the species is known to occur (criterion 1).

This unit is located in Altamont Hills north and northeast of the City of Livermore, and consists of two subunits, both near the Contra Costa and Alameda County line. Subunit A is located in Contra Costa County directly north of the Alameda County line near the Vasco Caves. Subunit B is located directly in Alameda County just south of the Contra Costa County line in the vicinity of Brushy Peak. This unit is located primarily on East Bay Regional Park District and Contra Costa Water District land.

*Unit 3, Carrizo Plain Unit, San Luis Obispo, Kern, and Monterey Counties (10,466 ha (25,862 ac))*

This unit contains occurrences of the species living within Northern Claypan type vernal pools as described by Sawyer and Keeler-Wolf (1995) (CNDDDB 2001). Longhorn fairy shrimp in the Carrizo Unit are found in shallow alkaline vernal pools within a valley saltbush scrub matrix. These ecological characteristics are not represented by the other units (criterion 2). The Carrizo Plain Unit also represents the southern extent of the range of longhorn fairy shrimp (criterion 1).

This unit is located in the vicinity of California Valley and Soda Lake. State Highway 58 is located north of the unit. Most of the habitat is east of Soda Lake Road. To the east, the unit is bordered by the San Andreas Rift Zone. The Carrizo Plain Unit contains portions of the Carrizo Plain National Monument administered by the BLM, TNC, and the CDFG. The BLM lands within the unit total approximately 15,549 ac (6,220 ha), and CDFG lands total approximately 234 ac (95 ha). Other vernal pool habitats in the unit are located on private land.

**Vernal Pool Fairy Shrimp**

Vernal pool fairy shrimp are distributed across a large geographic range from southern Oregon to southern California (Eriksen and Belk 1999). Although the habitat of vernal pool fairy shrimp is highly fragmented and occurrences are isolated from each other by varying degrees across the species' range, the distribution of remaining extant occurrences is somewhat evenly spread throughout its range. Vernal pool fairy shrimp occur in a wide variety of habitat types from the Agate Desert area in southern Oregon, to throughout the Sacramento and San Joaquin valleys, the

central Coast Range, and into Riverside County, California. Although some of the habitat characteristics of the species are known, specific pool characteristics that determine suitability for vernal pool fairy shrimp hatching, growth, and reproduction are not well understood. Vernal pool fairy shrimp occurrences are known to occur in eight general areas of concentration on basin rim, low terrace, high terrace, volcanic mudflow, valley floor, alkaline playa, and coastal mountain landforms. The elevational differences in the distribution of vernal pool fairy shrimp range from near 8 m (25 ft) in the Central and Sacramento Valleys to near 150 m (500 ft) in Shasta County. A broad distribution of vernal pool fairy shrimp across its geographical and elevational distribution protects the natural environmental processes for the species and provides the best chance for retaining the species across the full extent of the species' range.

The vernal pool types and soils associated with the eight general areas of concentration of vernal pool fairy shrimp differ greatly across the geographic range of the species and lead to different species compositions and ecological conditions between vernal pool fairy shrimp occurrences. Providing for a mosaic of habitat types both between and among vernal pool species is essential because it would include the full extent of the physical and environmental conditions for the species (Barclay and Knight 1984; Bauder and McMillan 1998; Fugate 1992, 1998; Gonzales *et al.* 1996; Noss *et al.* 2002a; Noss *et al.* 2002b; Platenkamp 1998; Zedler *et al.* 1979).

Vernal pool fairy shrimp are usually found in vernal pools (79%), although they are sometimes found in a range of natural and artificially created ephemeral habitats such as alkali pools, seasonal drainages, stock ponds, vernal swales, and rock outcrops (Vollmar 2002). Vernal pool fairy shrimp are most frequently found in small (<200 m<sup>2</sup>) (<2,125 ft<sup>2</sup>) and shallow ((mean of 5 cm)(2 in)) pool habitats; however, this species can be found in large (44,534 m<sup>2</sup>)(480,967 ft<sup>2</sup>) and very deep (122 cm)(48 in) pool habitats as well (Helm and Vollmar 2002). The landform associations for the vernal pool fairy shrimp include alluvial fans, bedrock, bedrock escarpments, basin rim, floodplain, high terrace, stream terrace, volcanic mudflow, and low terrace formations (Helm 1998). The soils that contain occurrences of vernal pool fairy shrimp in the delineated units vary significantly throughout the species' range. In the north, the rare Northern Mudflow formation underlies vernal pools in Shasta and Tehama Counties.