

1 **A.27 VERNAL POOL FAIRY SHRIMP**
 2 **(BRANCHINECTA LYNCHI)**

3 **A.27.1 Legal and Other Status**

4 The vernal pool fairy shrimp is listed as threatened under the
 5 ESA throughout its range (USFWS 1994).



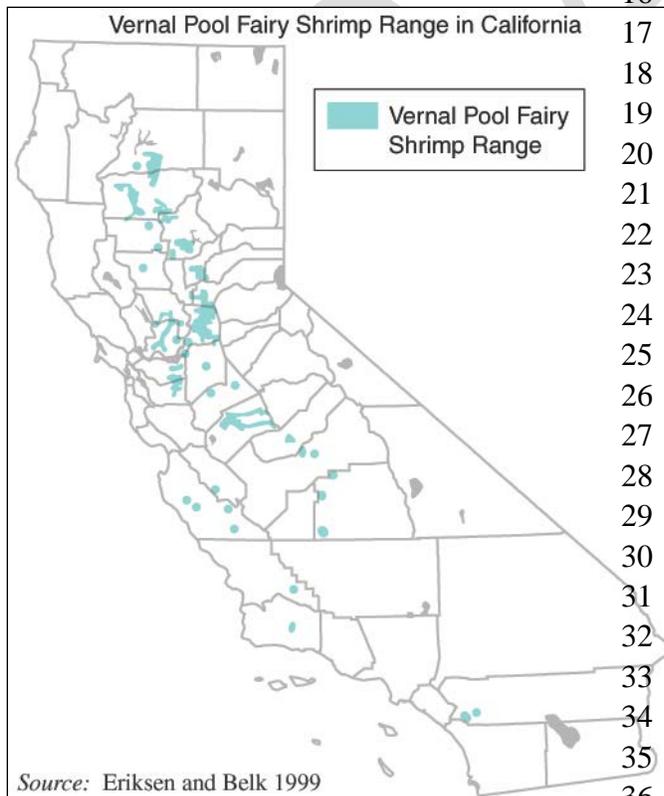
photo courtesy USFWS

6 Critical habitat has been designated for vernal pool fairy
 7 shrimp, including areas in the Butte Regional HCP/NCCP Plan Area. Critical habitat includes
 8 59,015 acres (23,883 ha) in Unit 7 (the Vina Plains Unit), a portion of which is in Butte County,
 9 and all of which is on private property. The Vina Plains Unit is located in the northeast portion
 10 of the Sacramento Valley from Deer Creek in Tehama County to Chico in Butte County
 11 (USFWS 2006).

12 **A.27.2 Species Distribution and Status**

13 **A.27.2.1 Range and Status**

14 The vernal pool fairy shrimp was identified relatively recently, in 1990, and there is little
 15 information on the historical range of the species; however, it is likely the historical distribution



16 of this species coincides with the
 17 historical distribution of vernal pools in
 18 California's Central Valley and southern
 19 Oregon. The current distribution of the
 20 vernal pool fairy shrimp in the Central
 21 Valley may be similar to its historical
 22 distribution in extent, but remaining
 23 populations are now considerably more
 24 fragmented and isolated than in pre-
 25 agricultural times. The species is
 26 currently found in disjunct and
 27 fragmented habitats across the Central
 28 Valley of California from Shasta County
 29 to Tulare County and the central and
 30 southern Coast Ranges from northern
 31 Solano County to Ventura County,
 32 California. Additional disjunct
 33 occurrences have been found in southern
 34 California and in Jackson County,
 35 Oregon. Although the vernal pool fairy
 36 shrimp is distributed more widely than

1 most other fairy shrimp species, it is generally uncommon throughout its range and rarely
2 abundant where it does occur (USFWS 2003, 2005).

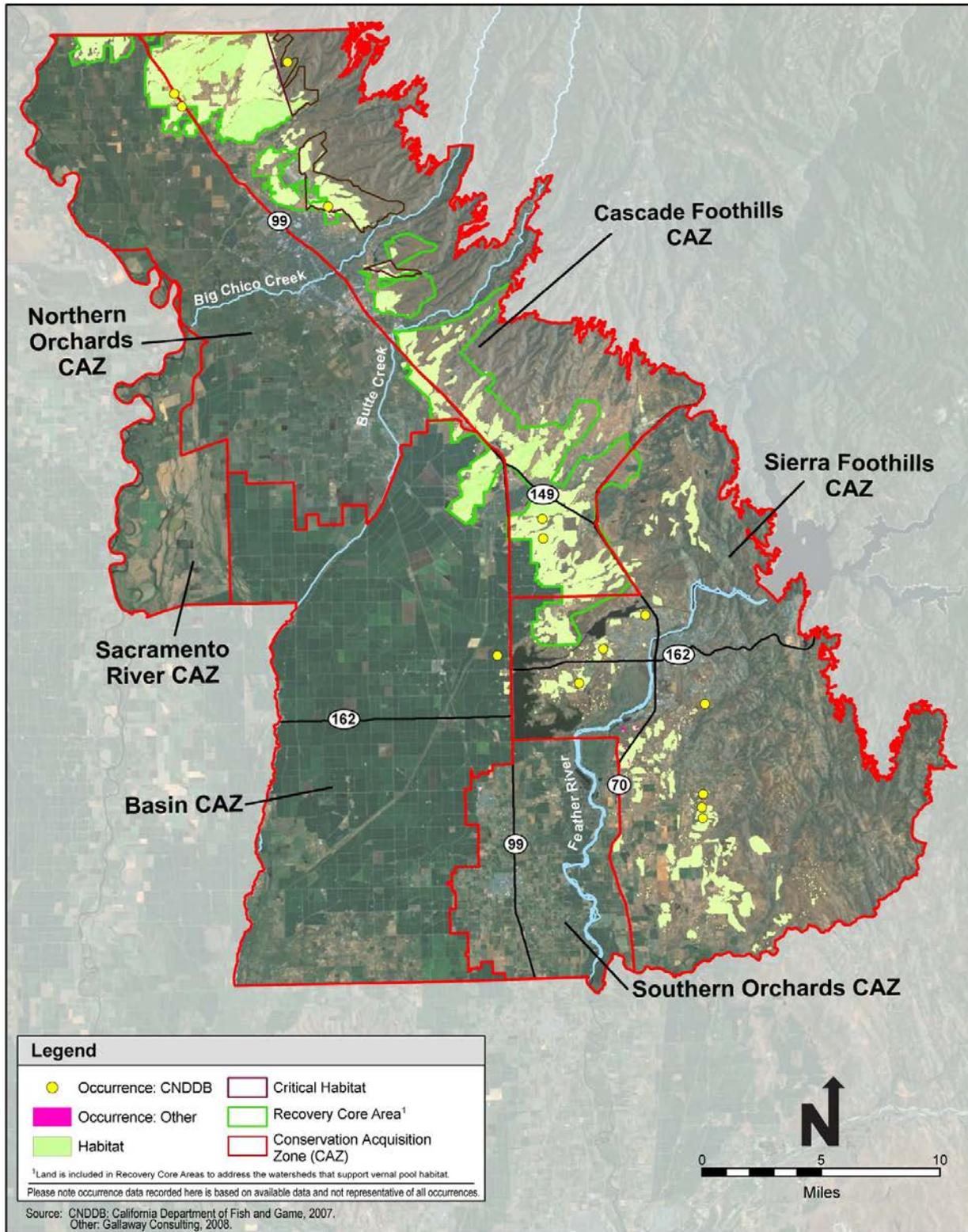
3 The vernal pool fairy shrimp is currently found in 28 counties in California where it occupies a
4 variety of vernal pool habitats and occurs in 11 of the 17 vernal pool regions identified in
5 California (Keeler-Wolf et al., 1998). The Agate Desert of southern Oregon comprises the
6 northern extent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

23 **A.27.2.2 Distribution and Status in the Plan Area**

24 There are 14 records of observations for the vernal pool fairy shrimp in Butte County, with some
25 locations noting the species present in several pools (CNNDB 2006) (Figure A-27). Along
26 Highway 99 and Cana Highway, this species was reported from four locations in 11 pools in
27 1995, with fairy shrimp populations ranging from five to 50 individuals. In 1995 and 1996, this
28 species was reported at the Foothill Park Mitigation Area vernal pools where it occurred in 57
29 and 97 of the vernal pools, respectively. In 1998, vernal pool fairy shrimp were reported from
30 the Vina Plains Preserve in Butte and Tehama counties, although the number of individuals was
31 not provided. Around Oroville, this species was recorded at six separate locations in 2004, 2005,
32 and 2006. It was also found in 2002 at an isolated seasonal wetland northwest of Shippee, and
33 there is a 1993 report of this species west of Themalito Afterbay, near the intersection of
34 Highway 99 and Richvale East Road (CNDDDB 2006).

35 **A.27.3 Habitat Requirements and Special Considerations**

36 The vernal pool fairy shrimp generally inhabits vernal pools with clear to tea-colored water in
37 grass or mud-bottomed swales or basalt flow depression pools in unplowed grasslands, although
38 there are a few populations in sandstone rock outcrops and alkaline vernal pools (USFWS 1994).



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Figure A-27. Vernal Pool Fairy Shrimp Modeled Habitat and Recorded Occurrences

1 Due to local topography and geology, the vernal pool depressions are typically part of an
2 undulating landscape, where soil mounds are interspersed with basins, swales, and drainages.
3 Water movement within complexes allows vernal pool fairy shrimp to move between individual
4 pools. These movement patterns, as well as genetic evidence, indicate that vernal pool fairy
5 shrimp populations exist within, and are defined by, entire vernal pool complexes, rather than
6 individual vernal pools (USFWS 2005, 2006). Vernal pool fairy shrimp are sporadically
7 distributed within the vernal pool complexes, and some or many of the pools in a complex may
8 not be inhabited during any one year (USFWS 1994).

9 Although the species has been collected from large vernal pools, it tends to occur primarily in
10 smaller pools and is most frequently found in pools measuring less than 0.02 hectare (0.05 acre)
11 in area. The vernal pool fairy shrimp typically occurs at elevations from 10 meters (33 feet) to
12 1,220 meters (4,003 feet), although two sites in the Los Padres National Forest have been found
13 to contain the species at an elevation of 1,700 meters (5,600 feet). The vernal pool fairy shrimp
14 has been collected at water temperatures as low as 0°F (4.5°C), and has not been found in water
15 temperatures above about 73°F (23°C) (USFWS 2005). The water in these pools typically has
16 low total dissolved solids, conductivity, alkalinity, and chloride. Soils beneath the vernal pools
17 that support this species are extremely variable and typically are not the same as soils mapped by
18 soil surveys, but are usually hydric inclusions that vary by location (USFWS 1994).

19 **A.27.3.1 Community Associations**

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

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

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

7 **A.27.4 Life History**

8 Vernal pool fairy shrimp are highly adapted to the environmental conditions of their ephemeral
9 habitats. They are ecologically dependent on seasonal fluctuations in their habitat, such as
10 absence or presence of water during specific times of the year, duration of inundation, and other
11 environmental factors that include specific salinity, conductivity, dissolved solids, and pH levels
12 (USFWS 2002). The ability of the vernal pool fairy shrimp eggs, or cysts, to remain dormant in
13 the soil when their vernal pool habitats are dry allows offspring to survive after the death of
14 parent shrimp. Cysts survive the hot, dry summers and cold, wet winters that follow pool
15 dessication until the vernal pools and swales fill with rainwater and conditions are adequate for
16 hatching. When pools refill in the same or subsequent seasons some, but not all, of the eggs may
17 hatch. The egg bank in the soil may be made up of eggs from several years of breeding (USFWS
18 2006b). Another important adaptation is that the vernal pool fairy shrimp has a relatively short
19 life span, allowing it to hatch, mature to adulthood, and reproduce during the short time period
20 when vernal pools contain water. The vernal pool fairy shrimp can reach sexual maturity in as
21 few as 18 days at optimal conditions of 68°F (20°C), and can complete its life cycle in as little as
22 9 weeks; however, maturation and reproduction rates of vernal pool crustaceans are controlled by
23 water temperature and can vary greatly (USFWS 2005).

24 **A.27.5 Threats**

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

32 **A.27.5.1 Habitat Loss and Fragmentation**

33 Habitat loss and fragmentation were identified as the largest threats to the survival and recovery
34 of vernal pool species. Habitat loss generally is a result of urbanization, agricultural conversion,
35 and mining and can also occur as a result of habitat alteration and degradation due to changes to
36 natural hydrology, invasive species, incompatible grazing regimes (including insufficient grazing
37 for prolonged periods), infrastructure projects (such as roads and utility projects), recreational

1 activities (such as off-road vehicles and hiking), erosion, climatic and environmental change, and
2 contamination. Habitat fragmentation is also related to habitat loss when individual vernal pools
3 become disconnected and isolated as a result of activities such as road development and other
4 infrastructure projects. Widespread urbanization and the construction of infrastructure are major
5 contributors to the loss of vernal pool habitats and their associated species. In addition, gravel
6 and clay mining operations needed to support urban development, including roads and other
7 infrastructure, have resulted in the destruction of vernal pools (USFWS 2005, 2006).

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

17 **A.27.5.2 Agricultural Conversion and Incompatible Livestock Grazing Practices**

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

24 **A.27.5.3 Competition from Invasive Species**

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

31 **A.27.5.4 Altered Hydrology**

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

1 **A.27.5.5 Contamination**

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

7 **A.27.5.6 Other Threats**

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

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

24 **A.27.6 Relevant Conservation Efforts**

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

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

1 **A.27.7 Species Habitat Suitability Model**

2 **A.27.7.1 Habitat**

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

- 4 • Vernal pool;
- 5 • Altered vernal pool; and
- 6 • Grassland with vernal swale complex.

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

11 **A.27.7.2 Assumptions**

12 The vernal pool fairy shrimp typically inhabits smaller, shallower pools within vernal pool
13 complexes (USFWS 2007). They inhabit vernal pools with clear to tea-colored water, in grass or
14 mud-bottomed swales or basalt-flow depression pools in unplowed grasslands (USFWS 1994). A
15 few populations are also known from sandstone rock outcrops and alkaline vernal pools
16 (USFWS 1994). Genetic evidence and movement ecology patterns indicate that vernal pool fairy
17 shrimp populations exist within, and are defined by entire vernal pool complexes, rather than by
18 individual pools (USFWS 2005, 2006).

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

22 **A.27.8 Recovery Plan Goals**

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

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1 A.27.9 References

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