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50 CFR Part 17

Endangered and Threatened Wildlife and Plants; Critical Habitat Designation for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants in California and Southern Oregon; Proposed Rule

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RIN 1018–AI26

Endangered and Threatened Wildlife and Plants; Critical Habitat Designation for Four Vernal Pool Crustaceans and Eleven Vernal Pool Plants in California and Southern Oregon

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Proposed rule.

SUMMARY: We, the Fish and Wildlife Service (Service), propose designation of critical habitat for 4 vernal pool crustaceans and 11 vernal pool plants with a total area being proposed of approximately 672,920 hectares (ha) (1,662,762 acres (ac)). The proposed designation of critical habitat is for Conservancy fairy shrimp (*Branchinecta conservatio*) 165,820 ha (409,735 ac), longhorn fairy shrimp (*Branchinecta longiantenna*) 40,605 ha (100,333 ac), vernal pool fairy shrimp (*Branchinecta lynchi*) 457,556 ha (1,130,605 ac), and vernal pool tadpole shrimp (*Lepidurus packardi*) 291,370 ha (719,965 ac) (collectively referred to as ''vernal pool crustaceans'' in the remainder of this document), and Butte County meadowfoam (*Limnanthes floccosa* ssp. *californica*) 16,320 ha (40,326 ac), Contra Costa goldfields (*Lasthenia conjugens*) 14,499 ha (38,297 ac), Hoover's spurge (*Chamaesyce hooveri*) 81,744 ha (201,987 ac), succulent (or fleshy) owl's-clover (*Castilleja campestris* ssp. *succulenta*) 125,217 ha (309,407 ac), Colusa grass (*Neostapfia colusana*) 132,608 ha (327,670 ac), Greene's tuctoria (*Tuctoria greenei*) 142,984 ha (353,308 ac), hairy Orcutt grass (*Orcuttia pilosa*) 65,671 ha (162,272 ac), Sacramento Orcutt grass (*Orcuttia viscida*) 24,632 ha (60,865 ac), San Joaquin Valley Orcutt grass (*Orcuttia inaequalis*) 101,059 ha (249,714 ac), slender Orcutt grass (*Orcuttia tenuis*) 71,035 ha (175,524 ac), and Solano grass (*Tuctoria mucronata*) 7,345 ha (18,149 ac) (collectively referred to as ''vernal pool plants'' in the remainder of this document), pursuant to the Endangered Species Act of 1973, as amended (Act). Because many of the units proposed for different species overlap, the total critical habitat area we are proposing is much less than the sum of the areas for each species. The proposed units are in 39 counties in California and one county in southern Oregon.

If this proposed rule is made final, section 7 of the Act would prohibit destruction or adverse modification of critical habitat by any activity funded, authorized, or carried out by any Federal agency. Section 4 of the Act requires us to consider economic and other impacts of specifying any particular area as critical habitat.

We solicit data and comments from the public on all aspects of this proposal, including data on the economic and other impacts of the designation. We may revise or further refine critical habitat boundaries prior to final designation based on habitat and additional plant and animal surveys, public comments on the proposed critical habitat rule, the completion and approval of Habitat Conservation Plans (HCPs), and new scientific and commercial information, and data concerning potential economic impacts from the proposed designation.

DATES: We will accept comments from all interested parties until November 25, 2002. Public hearing requests must be received by November 8, 2002.

ADDRESSES: If you wish to comment, you may submit your comments and materials concerning this proposal by any one of several methods.

1. You may mail written comments and information to the Field Supervisor, Sacramento Fish and Wildlife Office, U.S. Fish and Wildlife Service, 2800 Cottage Way, Room W–2605, Sacramento, CA 95825.

2. You may hand deliver written comments to our Sacramento Fish and Wildlife Office at the address given above.

3. You may send comments by electronic mail (e-mail) to *fw1_vernalpool@fws.gov.* See the Public Comments Solicited section below for file format and other information about electronic filing.

Comments and materials received, as well as supporting documentation used in the preparation of this proposed rule, will be available for public inspection, by appointment, during normal business hours at the above address.

FOR FURTHER INFORMATION CONTACT: Arnold Roessler or Susan Moore, at the Sacramento Fish and Wildlife Office address above (telephone 916/414–6600; facsimile 916/414–6710). Information regarding this proposal is available in alternate formats upon request.

SUPPLEMENTARY INFORMATION:

Background

The vernal pool crustaceans and plants addressed in this proposed rule live in vernal pools (shallow depressions that hold water seasonally), swales (shallow drainages that carry water seasonally), and ephemeral freshwater habitats. None are known to occur in riverine waters, marine waters, or other permanent bodies of water. The vernal pool habitats of the four vernal pool crustaceans and eleven plants addressed in this proposed rule have a discontinuous distribution west of the Sierra Nevada that extends from southern Oregon through California into northern Baja California, Mexico (Holland and Jain 1978, 1988, Eriksen and Belk 1999).

Vernal pools are a unique kind of wetland ecosystem. Central to their distinctive ecology is the fact that they are vernal or ephemeral, occurring temporarily—typically during the spring—and then disappearing until the next year. They are wet long enough to be different in character and species composition from the surrounding upland habitats, and yet their prolonged annual dry phase prevents the establishment of species typical of more permanent wetlands. In California, where extensive areas of vernal pool habitat developed over long periods of time, unique suites of species specially adapted to the unusual conditions of vernal pools have evolved. Fish and other predators are among the species excluded by vernal pools' annual drying, so vernal pool communities have developed and flourished in the absence of many predators. California vernal pools are also renowned for their showy displays of wildflowers, blooming in concentric rings about the pools in spring. Centres of Plant Diversity, a project of the World Wide Fund for Nature (WWF) and IUCN—The World Conservation Union, has identified the vernal pools of California and Baja California, Mexico, as a center of plant diversity and endemism in North America, and considers them to be severely threatened (WWF and IUCN 2002).

Many areas in California and portions of southern Oregon have the combination of environmental conditions that favors the development of vernal pools (Keeley and Zedler 1998). The climate is of a type classified as Mediterranean, with a wet season when rainfall exceeds evaporation, filling the pools, and a dry season when evaporation is greater, drying the pools. Rainfall is relatively meager even in most wet seasons, so erosion by overflowing waters does not dissect the topographic irregularities that form vernal pool basins. Temperatures during the winter-spring wet season are mild, so plants and animals can grow, mature, and reproduce.

A second major factor in the development of vernal pools is soil. Vernal pools form where there is a soil layer below or at the surface that is impermeable or nearly impermeable to water (Smith and Verrill 1998). Precipitation and surface runoff become trapped or ''perched'' above this layer. In California, the restrictive soil layers underlying vernal pools are of four main types—hardpans, claypans, volcanic flows, and non-volcanic rock. Volcanic flows include basaltic lavas and cemented mudflows, and are most common along the lower western slope of the Sierra Nevada. Hardpans are formed by leaching, redeposition, and cementing of silica minerals from high in the soil profile to a lower (''B'') horizon (Hobson and Dahlgren 1998, Smith and Verrill 1998). Claypans are formed by another redeposition process—fine clay particles are transported to the B horizon and accumulate there. Claypans may also be augmented by redeposition of saline or alkaline compounds. Hardpans and claypans both develop gradually over thousands of years, and can be a meter (yard) or more thick. Smith and Verrill (1998) list many of the soil series associated with vernal pools in the Central Valley.

A third factor, related to soil and climate, is topography or relief. Vernal pools typically occur in landscapes that, at a broad scale, are shallowly sloping or nearly level, but on a fine scale may be quite bumpy. Complex micro-relief results in shallow, undrained depressions that form vernal pools. Some vernal pool landscapes are dotted with numerous, rounded soil mounds, referred to as mima mounds, after the well-developed mounds of the Mima Prairie in Thurston County, Washington (Scheffer 1947). Scientists still argue about the origins of these mounds, which have been attributed to forces as disparate as gophers acting over millennia (Scheffer 1947, Cox and Gakahu 1983) and the pressures of soil swelling and shrinkage during wetting and drying cycles (Hallsworth *et al.* 1955, Hobson and Dahlgren 1998)—as well as other hypotheses, many much less plausible. Focusing on the troughs rather than the mounds, Californians long referred to vernal pools as ''hog wallows,'' but unlike the buffalo wallows of the Great Plains, these wetlands have little to do with hogs or wallowing. From the air, vernal pool landscapes often show characteristic patterning, produced by plant responses to mound and trough micro-relief. This patterning has allowed detailed mapping of vernal pool habitats throughout California's Central Valley and adjacent areas (Holland 1998).

Vernal pools come in a variety of shapes and sizes, from a square meter (yard) to a hectare (2.5 ac) or more. Some larger vernal wetlands, such as the 36 ha (90 ac) Olcott Lake in the Jepson Prairie Preserve in Solano County, are also referred to as vernal lakes or playa pools or lakes. Playa pools with high alkalinity are termed alkali sinks. These larger wetlands contain many of the same animals and plants of smaller vernal pools, including many rare and endangered species.

Since appropriate combinations of climate, soil, and topography often occur over continuous areas rather than in isolated spots, vernal pools in California, particularly in the Central Valley, tend to occur in clusters, called ''complexes.'' A landscape that supports a vernal pool complex is typically a grassland, with areas of obstructed drainage that form the pools. Vernal pools can also be found in a variety of other habitats, including woodland, desert, and chaparral. The pools may be fed or connected by low drainage pathways called ''swales.'' Swales are often themselves seasonal wetlands that remain saturated for much of the wet season, but may not be inundated long enough to develop strong vernal pool characteristics. Vernal pool complexes have historically been considered poor farmland, because of their shallow, seasonally saturated or inundated and sometimes alkaline soils, and their root-restricting subsurface layer. For the same reasons, trees are relatively rare in most vernal pool complexes.

California's vernal pools begin to fill with the fall and winter rains. Before ponding occurs, there is a period during which the soil is wetted and the local water table may rise. Some pools have a substantial watershed that contributes to their water inputs; others may fill almost entirely from rain falling directly into the pool (Hanes and Stromberg 1998). Although exceptions are not uncommon, the watershed generally contributes more to the filling of larger or deeper pools, especially playa pools. Even in pools filled primarily by direct precipitation, Hanes and Stromberg (1998) report that subsurface inflows from surrounding soils can help dampen water level fluctuations during late winter and early spring. Vernal pools exhibit four major phases—the wetting phase, when vernal pool soils become saturated; the aquatic phase, when a perched water table develops and the vernal pool contains water; a water-logged drying phase, when the vernal pool begins loses water as a result of evaporation and loss to the surrounding soils but soil moisture remains high; and the dry phase, when the vernal pool and underlying soils are completely dry (Keeley and Zedler 1998). Upland areas associated with vernal pools are also an important source of nutrients to vernal pool organisms (Wetzel 1975). Vernal pool habitats derive most of their nutrients from detritus which is washed into the pool from adjacent uplands, and these nutrients provide the foundation for vernal pool aquatic communities food chain. Detritus is a primary food source for the vernal pool crustaceans addressed in this proposed rule (Eriksen and Belk 1999).

Both the amount and timing of rainfall in California vary greatly from year to year. As a result, pools may fill to different extents at different times. The duration of ponding of vernal pools also varies, and in certain years some pools may not fill at all. Many characteristics of vernal pool plants and animals are adaptations to the highly variable and unpredictable nature of vernal pools (Holland 1976, Holland and Dains 1990, King *et al.* 1996, Hanes and Stromberg 1998).

California's vernal pools are rich in species composition compared to vernal pools worldwide and contain many species that are endemic to the region (found nowhere else). In addition, while most of California's grasslands are now dominated by non-native grasses and other introduced plants, vernal pools remain a haven for native species. Invasive non-native plants have been introduced into California and have so successfully spread and reproduced in upland habitats that it is not unusual for non-natives to account for a third of the species and more than 90 percent of the biomass in a California grassland. Vernal pools have dramatically resisted this invasion with 75 to 95 percent of plant species found in vernal pools being native; and natives dominate in biomass as well as number (Holland and Jain 1978, Jokerst 1990, Spencer and Rieseberg 1998). Vernal pool communities dominated by natives persist even though they are surrounded by seas of grassland raining the seed of non-native plants. Vernal pool plant communities are able to resist invasion because of the severe ecological constraints on plants living in vernal pool environments.

The animal communities that live in vernal pools also contain diverse groups of highly specialized species. The freshwater crustacean communities of vernal pools are particularly well developed (Simovich 1998). The most visible crustaceans in vernal pools are the large branchiopods (literally, ''gill-

foots''), about 27 species in California, of which perhaps 10 are endemic (Helm 1998, Belk and Fugate 2000) and 6 are federally listed as threatened or endangered. The large branchiopods are easily visible to the naked eye, ranging up to 5 centimeters (cm) (2 inches (in)) in length, depending on the species. They include the fairy shrimps (Anostraca), tadpole shrimps (Notostraca), and clam shrimps (Conchostraca). Smaller crustaceans that are common in California vernal pools, many large enough to see without magnification, are water fleas (Branchiopoda—Cladocera), copepods (Copepoda), and seed shrimp (Ostracoda).

Amphibians and many insect species also live in vernal pools. The Pacific tree frog (chorus frog) (*Hyla* (*Pseudacris*) *regilla*) and western toad (*Bufo boreas*) are common and abundant in and around vernal pools. Two rarer amphibians native to vernal pools are the California tiger salamander (*Ambystoma californiense*) and the western spadefoot toad (*Scaphiopus* (*Spea*) *hammondii*) (Morey 1998). While dispersing bullfrogs (*Rana catesbeiana*), which are not native to California, are sometimes found in vernal pools, they do not successfully breed there because bullfrog tadpoles require two years to mature and cannot survive the dry season. These voracious introduced predators will sometimes be found resting and feeding in vernal pools close to more permanent water, frequently associated with human modifications of the landscape. Fish likewise do not inhabit vernal pools, except where temporarily introduced by humans (*e.g.*, mosquitofish (*Gambusia* sp.)) or by flooding of permanent waters.

The insect fauna of vernal pools is numerous, varied and primarily native, including aquatic beetles (Coleoptera—Dytiscidae, Hydrophilidae, Gyrinidae, Halipidae, Hydraenidae), aquatic bugs, including backswimmers (Hemiptera—Notonectidae), water boatmen (Corixidae), and water striders (Gerridae), springtails (Collembola), mayflies (Ephemeroptera), dragonflies and damselflies (Odonata), and various flies with aquatic larvae, including midges (Diptera—Chironomidae), crane flies (Tipulidae) and mosquitoes (Culicidae). Rogers (1998) found that mosquitoes generally made up less than 2 percent of the total macroscopic invertebrate population in natural and two-year old constructed pools—perhaps because many of the other insects listed above are predators. Vernal pool crustaceans are an important food source for a number of aquatic and terrestrial species. Aquatic predators include insects such as backswimmers (Family Notonectidae) (Woodward and Kiesecker 1994), predaceous diving beetles and their larvae (Family Dystictidae), and dragonflies and damselfly larvae (Order Odonate). Vernal pool tadpole shrimp are another significant predator of fairy shrimp.

The plants, invertebrate and vertebrate animals of vernal pools, and vernal pool landscapes in general, are important providers of food and habitat for waterfowl, shorebirds, wading birds, toads, frogs, and salamanders (Proctor *et al.* 1967, Krapu 1974, Swanson 1974, Morin 1987, Simovich *et al.* 1991, Silveira 1996). There is evidence that vernal pool crustaceans were used as a food source for Native Americans in California's Central Valley (Silveira 1998). During the spring, waterfowl feed on vernal pool crustaceans and other invertebrates, which are sources of protein and calcium needed for migration and egg-laying (Proctor *et al.* 1967, Silveira 1998). Vernal pool complexes contribute to continuity of wetland habitats along the Pacific Flyway (a major bird migration route). Many species feed or nest near vernal pools, for example, cliff swallows (*Hirundo fulva*) glean mud from vernal pool beds for their nests, lesser nighthawks (*Chordeiles acutipennis*) nest in dry vernal pool beds, burrowing owl (*Athene cunicularia*) and gopher (*Thomomys* sp.) burrows are found in mima mounds, and many species graze or hunt along vernal pool shorelines. Before their populations were nearly eliminated by hunting and habitat alteration, elk (*Cervus* sp.) and pronghorn antelope (*Antilocarpa americana*) undoubtedly grazed vernal pool landscapes, and have been replaced by cattle. Fishing net weights found near vernal pools suggests that California's first human populations also made use of vernal pool resources, as do hunters today (Silveira 1998).

Classification of Vernal Pools

The variability of vernal pool types has led many researchers to try and classify these ephemeral habitats. (*i.e.*, Holland (1986), Sawyer and Keeler-Wolf (1995), Ferren *et al.* (1996), Smith and Verrill (1998)). Most of these efforts have focused on classifying vernal pools based on the factors that influence variation in their physical features. Primary physical features that influence vernal pool size, depth, and soil and water chemistry include soil type, geologic formation, and landform. Landforms are physical attributes of the landscape resulting from geomorphological processes such as erosion and deposition, and include features such as alluvial terraces and basins; and volcanic mudflows and lava flows.

The types and kinds of species that are found in vernal pools are largely determined by these physical factors, including pool size, depth, area, and water and soil chemistry (Holland and Griggs 1976, Zedler 1987, Holland and Dains 1990, Eng *et al.* 1990, Simovich 1998). The physical characteristics of the vernal pool influences the life history characteristics of vernal pool species, such as the speed with which a species can mature and reproduce, the amount of soil moisture required for germination of plant seeds or hatching of invertebrate eggs or cysts, as well as tolerance to turbidity, total dissolved solids, and other aspects of vernal pool water chemistry.

Sawyer and Keeler-Wolf (1995) classified vernal pools according to a number of physical, geographic, and biological characteristics. They identified several general vernal pool types which correspond to the nature of the impermeable layer that underlay the vernal pool and assisted the pool to form. The vernal pools were identified as Northern Hardpan, Northern Claypan, Northern Basalt Flow, Northern Volcanic Mudflow, and Northern Ashflow vernal pools. Northern Hardpan vernal pools are generally formed on alluvial terraces with silicate-cement soil layers. These pool types are generally on acidic soils, and exhibit well developed mima mound topography found on the eastern margins of the Central Valley. Northern Claypan vernal pools are generally formed on impermeable surfaces created by an accumulation of clay particles. These pool types are often found on basin and basin rim landforms and tend to occur in the central portion of the Central Valley and tend to be alkaline. Vernal pools identified as Northern Volcanic Mudflow, Northern Basalt Flow, and Northern Volcanic Ashflow, are generally formed by an impervious bedrock layer of volcanic origin. These pool types are found on the eastern and coastal portions of the Central Valley, and tend to be small and restricted in distribution. Northern Basalt Flow vernal pools occur at greater elevations than other vernal pool types.

Vernal Pool Crustaceans Background

Conservancy fairy shrimp (*Branchinecta conservatio*), longhorn fairy shrimp (*Branchinecta longiantenna*), and vernal pool fairy shrimp (*Branchinecta lynchi*) are members of the aquatic crustacean order Anostraca. Vernal pool tadpole shrimp

(*Lepidurus packardi*) is a member of the aquatic crustacean order Notostraca. Vernal pool fairy shrimp are found in California and southern Oregon while the other three shrimp species are found only in California. These species have all evolved similar adaptations to the unique habitat conditions of their vernal pool habitats. The general appearance and life history characteristics of these four species will be described in combination below.

Longhorn fairy shrimp, vernal pool fairy shrimp, and Conservancy fairy shrimp (fairy shrimp) have delicate elongate bodies, large stalked compound eyes, and 11 pairs of phyllopods, or gill-like structures that also serve as legs. They swim or glide gracefully upside down by means of complex beating movements that pass in a wave-like anterior to posterior direction. Fairy shrimp are filter feeders, and consume algae, bacteria, protozoa, rotifers, and bits of detritus as they move through the water. The second pair of antennae in fairy shrimp adult males are greatly enlarged and specialized for clasping the females during copulation. The females carry eggs in an oval or elongate ventral sac (brood sac). Once fertilized, the eggs are coated with a protective protein layer that allows them to withstand heat, cold, and prolonged dehydration. The fully developed eggs are either dropped to the pool bottom or remain in the brood sac until the female dies and sinks. These dormant eggs are also known as cysts, and they can remain viable in the soil for decades after deposition (Eriksen and Belk, 1999). When the pools refill in the same or subsequent seasons, some, but not all, of the cysts may hatch (Eriksen and Belk, 1999). The cyst bank in the soil may consist of cysts from several years of breeding. The cysts that hatch may do so within days after the vernal pools fill, and rapidly develop into adults within weeks. In pools that persist for several weeks to a few months, fairy shrimp may have multiple hatches during a single season.

Vernal pool tadpole shrimp have dorsal compound eyes, a large shield-like carapace (shell) that covers most of their body and a pair of long cercopods or appendages at the end of the last abdominal segment. They are primarily benthic (living on the bottoms of the pools) animals that swim with their legs down. Vernal pool tadpole shrimp climb or scramble over objects, and plow along bottom sediments as they forage for food. Their diet consists of organic detritus (decaying matter) and living organisms, such as fairy shrimp and other invertebrates (Fryer 1987). The females deposit eggs on vegetation and other objects on the pool bottom. Like fairy shrimp, vernal pool tadpole shrimp pass the summer months as dormant cysts in the soil. Some of the cysts hatch as the vernal pools are filled with rainwater in the next or subsequent seasons, while other cysts may remain dormant in the soil for many years. When winter rains refill inhabited pools, tadpole shrimp reestablish from dormant cysts and may become sexually mature within three to four weeks after hatching (Ahl 1991, Helm 1998). Mature adults may be present in pools until the habitats dry up in the spring (Ahl 1991, Gallagher 1996).

All of the vernal pool crustacean species addressed in this proposed critical habitat designation have evolved unique physical adaptations to survive in vernal pools. The timing and duration of wet and dry phases can vary significantly from year to year, and in some years vernal pools may not inundate at all. In order to take advantage of the short inundation phase, vernal pool crustaceans have evolved short reproduction times and high reproductive rates. Most of the species addressed in this proposed rule hatch within a few days after their habitats fill with water, and can start reproducing within a few weeks (Eng *et al.* 1990, Helm 1998, Eriksen and Belk 1999). Vernal pool crustaceans can complete their entire life cycle in a single season, and some species may complete several life cycles. Vernal pool crustaceans can also produce thousands viable cysts when environmental conditions are favorable.

To survive the prolonged heat and dessication of the vernal pool dry phase, vernal pool crustaceans have developed a dormant stage. After vernal pool crustacean eggs are fertilized in the female's brood sac, the embryos develop a thick, usually multi-layered shell. When embryonic development reaches a late stage, further maturation stops, metabolism is drastically slowed, and the egg, now referred to as a cyst, enters a dormant state called diapause. The cyst is then either dropped to the pool bottom or remains in the brood sac until the female dies and sinks. Once the cyst is desiccated, it can withstand temperatures near boiling (Carlisle 1968), fire (Wells *et al.* 1997), freezing, and anoxic conditions without damage to the embryo. The cyst wall cannot be affected by digestive enzymes, and can be transported in the digestive tracts of animals without harm (Horne 1967). Most fairy shrimp cysts can remain viable in the soil for a decade or longer (Belk 1998).

Although the exact signals that cause crustacean cysts to hatch are unknown, factors such as soil moisture, temperature, light, oxygen, and osmotic pressure may trigger the embryo's emergence from the cyst (Brendonck 1996). Because the cyst contains a well developed embryo, the animal can quickly develop into a fully mature adult. This allows vernal pool crustaceans to reproduce before the vernal pool enters the dry phase, sometimes within only a few weeks (Helm 1998, Eriksen and Belk 1999). In some species, cysts may hatch immediately without going through a dormant stage, if they are deposited while the vernal pool still contains water. These cysts are referred to as quiescent, and allow the vernal pool crustacean to produce multiple generations in a single wet season as long as their habitat remains inundated.

Another important adaptation of vernal pool crustaceans to the unpredictable conditions of vernal pools is the fact that not all of the dormant cysts hatch in every season. Simovich and Hathaway (1997) found that only 6 percent of San Diego fairy shrimp cysts hatched after initial hydration, and only 0.18 percent of Riverside fairy shrimp cysts hatched. The cysts that don't hatch remain dormant and viable in the soil. These cysts may hatch in a subsequent year, and form a cyst bank much like the seed bank of annual plants. The cyst bank may be comprised of cysts from several years of breeding, and large cyst banks of viable resting eggs in the soil of vernal pools containing fairy shrimp have been well documented (Belk 1998). Based on a review of other studies (*e.g.*, Belk 1977, Gallagher 1996, Brendonck 1996), Simovich and Hathaway (1997) concluded that species inhabiting more unpredictable environments, such as smaller or shorter lived pools, are more likely to have a smaller percent of their cysts hatch after their vernal pool habitats fill with water. This strategy reduces the probability of complete reproductive failure if a vernal pool dries up prematurely. This kind of ''bet-hedging strategy'' has been suggested as a mechanism by which rare species may persist in unpredictable environments (Chesson and Warner 1981, Chesson and Huntly 1989, Ellner and Hairston 1994).

Although the vernal pool crustaceans, and particularly the fairy shrimp, addressed in this proposed rule are not often found in the same vernal pool at the same time, when coexistence does occur, it is generally in deeper, longer lived pools (Eng *et al.* 1990, Thiery 1991, Gallagher 1996, Simovich 1998). In larger pools, closely related species of fairy shrimp may coexist by hatching at different temperatures, and by

developing at different rates (Thiery 1991, Hathaway and Simovich 1996). Vernal pool crustacean species may also be able to coexist by utilizing different physical portions of the vernal pool, or by eating different food sources (Daborn 1978, Mura 1991, Hamer and Appleton 1991, Thiery 1991).

The primary historic dispersal mechanisms for the vernal pool crustaceans probably consisted of large scale flooding resulting from winter and spring rains, and dispersal by migratory birds. As a result of widespread flood control and agricultural water diversion projects developed during the twentieth century, large scale flooding is no longer a major form of dispersal for the vernal pool crustaceans. When being dispersed by migratory birds, the eggs of these crustaceans are either ingested (Krapu 1974, Swanson 1974, Driver 1981, Ahl 1991) and/or adhere to the bird's legs and feathers where they are transported to new habitats. Cysts may also be dispersed by a number of other species, such as salamanders, toads, cattle, and humans (Eriksen and Belk 1999).

The vernal pool crustaceans addressed in this proposed rule are generally confined to habitats that are low to moderate in alkalinity and dissolved salts, when compared with other aquatic systems (Ericksen and Belk 1999). Although potentially moderated by soil type, vernal pools are generally unbuffered and exhibit wide fluctuations in pH and dissolved oxygen (Keeley and Zedler 1998). Vernal pool water ion concentrations, such as sodium, potassium, calcium, chlorine, and magnesium, also experience large daily and seasonal variations. These variations are due to the concentration of ions due to evaporation, and the dilution of ions with additional rainfall throughout the wet season (Barclay and Knight 1981). How vernal pool crustacean species adapt to these fluctuations in water chemistry varies. Definitive conclusion on why the species has certain water chemistry habitat preferences is generally unknown due to the anecdotal nature of observations.

Additional information specific to each of the four individual vernal pool crustacean species described in this proposed rule is provided below.

Conservancy Fairy Shrimp

Conservancy fairy shrimp were first described in 1990 by Eng, Belk, and Eriksen. The type specimens were collected in 1982 at Olcott Lake, Solano County, California. Conservancy fairy shrimp are currently known from only eight disjunct areas—Vina plains and vicinity in southern Tehama and northern Butte County; Jepson Prairie in Solano County; Suisun Slough in southern Solano County; Sacramento National Wildlife Refuge in Glenn County; near Caswell Memorial State Park in Stanislaus County; Haystack Mountain Area in eastern Merced County; San Luis National Wildlife Refuge Complex in central Merced County, and the Mutau Flat area in the Los Padres National Forest area of northern Ventura County.

Conservancy fairy shrimp look similar to other fairy shrimp species, but can be distinguished by characteristics of the male second antenna. The second antennae of Conservancy fairy shrimp 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 14 to 27 millimeters (mm) (0.6 to 1.1 in) in length, and females have been measured between 14.5 and 23 mm (0.6 and 0.9 in) 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 antennae, which is about twice as long, relative to its body, as the second antennae of other species of *Branchinecta.* Longhorn fairy shrimp antennae range from 6.7 to 10.4 mm (0.3 to 0.4 in) 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 12 and 21 mm (0.5 to 0.8 in) in length, and females range from 13.3 to 19.8 mm (0.5 to 0.8 in) in length (Eng *et al.* 1990).

Further discussion on 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 populations have been identified in southern California and in Oregon. In Oregon, the species' distribution is limited to the vicinity of an approximately 82.9 square kilometer (sq km) (32 square mile (sq mi)) 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 11 to 25 mm (0.4 to 1.0 in) 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 on 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 packardi.* 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. packardi* populations. Lynch (1972)

resurrected *L. packardi* 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 populations 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 distinguished by a large, shield-like 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 six 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 15 to 86 mm (0.6 to 3.4 in) in length.

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

Further discussion on 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).

The habitat of the four vernal pool crustaceans is imperiled by a variety of activities, primarily by urban development, water supply and flood control activities, and conversion of land to agricultural use. Habitat loss occurs from direct destruction and modification of pools due to filling, grading, discing, leveling, and other activities, as well as modification of surrounding uplands. Vernal pool crustaceans and their habitat also are threatened by altered flood regimes, degraded water quality, siltation, erosion, grazing, improper burning, military operations, off-road vehicles, pollution, vandalism, road and trail maintenance, and introduction of non-native predators. Further discussion on threats to the vernal pool crustaceans can be found in the final rule to list these species (59 FR 48136).

Vernal Pool Plants Background

The vernal pool plants described in this proposed rule have developed a suite of highly specialized adaptations which allow them to survive in vernal pool habitats. All eleven species are annuals, meaning they germinate, grow, and reproduce 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 generally germinate after winter rains in response to a complex set of environmental cues that are not well understood, but that generally include temperature and soil moisture. Specific germination cues differ greatly among species and are discussed in more detail in the individual species descriptions below. 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. This kind of ''bet-hedging strategy'' has been suggested as a mechanism by which rare species may persist in unpredictable environments (Chesson and Warner 1981, Chesson and Huntly 1989, Ellner and Hairston 1994).

Tolerance to inundation differs greatly among species (Zedler 1987). The zonation of vernal pool plants which forms the characteristic rings of flowers around vernal pools is a result of this differential tolerance to inundation. Species that are the least tolerant to inundation grow along the margins of the pool, while those that can tolerate extended periods of inundation grow in the center of the pools.

Information on the appearance and life history of each of the eleven individual vernal pool plant species described in this proposed rule is provided below.

Butte County Meadowfoam

Butte County meadowfoam (*Limnanthes floccosa* ssp. *californica*) was first collected in 1917 at a site 16 kilometers (km) (10 mi)) north of Chico (Service 1991b), although it was recognized as a separate subspecies at that time. Kalin-Arroyo (1973) determined that Butte County meadowfoam was a distinct taxon and gave it the scientific name *Limnanthes floccosa* ssp. *californica*. The type locality is in Butte County between Chico and Oroville, near the intersection of state Highway 99 and Shippee Road (Kalin-Arroyo 1973).

Butte County meadowfoam is a small annual of the meadowfoam or false mermaid family (Limnanthaceae). It has erect stems less than 25 cm (9.8 in) tall. The stem and leaves are densely pubescent (covered with short hairs). The alternate leaves are pinnately compound (divided into distinct segments which are arranged featherlike on either side of a rachis), up to 8 cm (3.1 in) long, and consist of five to eleven leaflets on a long petiole. A single flower arises in the axil (angle between the base of a leaf and the stem) of each upper leaf. The flowers are white with yellow veins, cup or bowl-shaped, and consist of five petals, five sepals, five pistils (female reproductive structures of a flower), and ten stamens (male reproductive structures of a flower) on a long flower stalk (Kalin-Arroyo 1973, McNeill and Brown 1979, Ornduff 1993b).

Butte County meadowfoam seedlings can tolerate short periods of submergence (Jokerst 1989, Dole and Sun 1992). The seedlings develop into rosettes (clusters of leaves near the ground), which do not begin producing flowering stems immediately (McNeill and Brown 1979, Ritland and Jain 1984). Butte County meadowfoam typically begins flowering in February, reaches peak flowering in March, and may continue into April if conditions are suitable. Nutlets are produced in March and April, and the plants die back by early May (Jokerst 1989, Dole and Sun 1992).

Butte County meadowfoam is predominantly self fertilized (Dole and Sun 1992). Nutlets of Butte County meadowfoam apparently are dispersed by water; they can remain afloat for up to 3 days (Hauptli *et al.* 1978). *Limnanthes* taxa that grow in wet sites have larger tubercles than those adapted to dry sites. Hauptli *et al.* (1978) speculated that the tuberculate surface of such nutlets may aid in flotation by trapping air. However, most meadowfoam nutlets are dispersed only short distances. Thus, Butte County meadowfoam nutlets would not be expected to disperse beyond their pool or swale of origin. Birds and livestock are potential sources of long-distance seed dispersal, but specific instances of dispersal have not been documented (Jain 1978).

Butte County meadowfoam has always been confined to the Butte County (Keeler-Wolf *et al.* 1998). In her original description, Kalin-Arroyo

(1973) mentioned six collections, including the type locality. Five of those ranged from the original collection site southeast to Oroville, and the sixth was from Table Mountain north of Oroville. However, Jokerst (1983) did not find Butte County meadowfoam on Table Mountain and later suggested that the specimen had been misidentified (Service 1992a).

All 13 of the occurrences described by the CNDDB (2001) had been reported by 1988 (Kalin-Arroyo 1973, McNeill and Brown 1979, Dole 1988, Jokerst 1989). Five were in northern and northeastern Chico near the municipal airport, four (including the type locality) were from the area around Shippee (northwest of Oroville), and three from southeastern Chico. The other occurrence, northeast of the town of Nord, contained only one plant that was of questionable identity (CNDDB 2001). However, the area indicated would be in the same vicinity as the 1917 collection.

Jokerst (1989) identified ''north'' and ''south'' races of Butte County meadowfoam in the Chico ''sphere of influence'' based on morphology. Later, in studies of enzyme systems, Dole and Sun (1992) confirmed that these races differed genetically. They also identified genetically distinct races that they called ''northeast'' and ''southwest,'' with the latter referring to the type locality. They found that 96 percent of genetic diversity in Butte County meadowfoam existed among populations and that little variability was evident within populations. Dole and Sun (1992) used mathematical formulas to estimate an average generation time of 2 years for Butte County meadowfoam and to predict that a seed would be transferred between populations only once every 100 to 200 years. Although considerable morphological variability has been observed within populations, it apparently is attributable to differences in environmental response by plants of the same genetic makeup (Jain 1976, Jokerst 1989).

Two occurrences of Butte County meadowfoam have been extirpated, one each in northern and southeastern Chico (Jokerst 1989, Dole and Sun 1992, Service 1992a, CNDDB 2001). Some of the other 11 occurrences have been reduced in extent (CNDDB 2001). The most recent reports are from 1992 and additional losses could have occurred since then.

Sawyer and Keeler-Wolf (1995) mentioned Butte County meadowfoam as only associated with Northern Basalt Flow vernal pools; however, this pool type was likely based on the erroneous Table Mountain occurrence. Butte County meadowfoam occurs primarily in vernal swales and to a lesser extent on the margins of vernal pools (Kalin-Arroyo 1973, Dole 1988, Jokerst 1989, BioSystems Analysis, Inc. 1993, CNDDB 2001). Swales vary in width from narrow channels to broad, pool-like areas (LSA Associates, Inc. 1994). They may connect in branching, tree-like patterns or in net-like patterns around low mounds. Occupied swales are inundated periodically by water from the surrounding uplands, causing the soil to become saturated. However, Butte County meadowfoam does not persist in pools or swales that are inundated for prolonged periods or remain wet during the summer months, nor in drainages where water flows swiftly (Jokerst 1989, Kelley and Associates Environmental Sciences 1993). BioSystems Analysis Inc. (1993) only found it in the wettest swales in 1992 during the drought. Occupied swales are less than 10 cm (3.9 in) deep (LSA Associates, Inc. 1994) and pools are typically less than 30 m (100 ft) long (Jokerst 1989). In both swales and pools, Butte County meadowfoam may grow along the edges or in the bottom (Kalin-Arroyo 1973, Jokerst 1989). In a study of the Shippee area population (BioSystems Analysis, Inc. 1993) Butte County meadowfoam was found growing more often on pool margins than in the bottom of pools but the pattern was reversed in swales, with the plants more often growing in the center. It typically occurs in long, narrow bands in connected swales or on pool margins but can be found in irregular clusters in isolated drainages (Crompton 1993). Butte County meadowfoam has been found occasionally in disturbed areas such as drainage ditches, firebreaks, and graded sites (McNeill and Brown 1979, Jokerst 1989, Kelley and Associates Environmental Sciences 1992, BioSystems Analysis, Inc. 1993, Kelley and Associates Environmental Sciences 1993).

Further discussion on Butte County meadowfoam's life history and habitat characteristics can be found in the final rule to list the species (62 FR 54807).

Contra Costa Goldfields

Greene (1888) first described Contra Costa goldfields, as *Lasthenia conjugens,* from specimens collected near Antioch, California. Hall (1914) later lumped Contra Costa goldfields in with the common species Fremont's goldfields, which at that time was called *Baeria fremontii.* Ferris (1958) proposed the name *Baeria fremontii* var. *conjugens* to recognize the distinctiveness of *L. conjugens.* Finally, Ornduff (1966) restored Greene's original name and rank, returning this species to the genus *Lasthenia.*

Contra Costa goldfields is a showy spring annual in the aster family (Asteraceae). Its stems are 10 to 30 cm (4 to 12 in) tall, somewhat fleshy, and usually are branched. The leaves are opposite and narrow; the lower leaves are entire, but stem leaves have one or two pairs of narrow lobes. The daisy-like flower heads are solitary (Greene 1888, Ornduff 1993a).

As a vernal pool annual, seeds of Contra Costa goldfields would be expected to germinate in response to autumn rains, with the plants maturing in a single growing season, setting seed, and dying back during the summer. However, detailed research on the life cycle has not been conducted. Contra Costa goldfields flower from March through June (Ornduff 1966, Ornduff 1979, Skinner and Pavlik 1994). The flowers are self-incompatible (Crawford and Ornduff 1989). Insect visitors to flowers of *Lasthenia* belong to five orders—Coleoptera, Diptera, Hemiptera (true bugs), Hymenoptera (ants, bees and wasps), and Lepidoptera (butterflies and moths) (Thorp and Leong 1998). Most of these insects are generalist pollinators. Some *Lasthenia* are pollinated by specialist solitary bees (family Andrenidae); including two bee species in the subgenus *Diandrena* (*Andrena submoesta* and *A. puthua*) and five or six species in the subgenus Hesperandrena (*Andrena baeriae, A. duboisi, A. lativentris,* and two or three undescribed species) (Thorp and Leong 1998). The extent to which pollination of Contra Costa goldfields depends on host-specific bees or more generalist pollinators is currently unknown.

Seed dispersal mechanisms in Contra Costa goldfields are unknown. However, the lack of a pappus or even hairs on the achenes makes wind dispersal unlikely (Ornduff 1976). Seed longevity, survival rates, fecundity, and other demographic parameters have not been investigated. However, as with other vernal pool annuals, population sizes have been observed to vary by up to four orders of magnitude from year to year (CNDDB 2001).

By far the greatest concentration of this species is in Solano County where Contra Costa goldfields are found in the area east and south of the City of Fairfield. Other areas that support populations of this species include the central coast between Monterey and Alameda counties, including Fort Ord in Monterey County, San Francisco Bay National Wildlife Refuge, and near Fremont, in Alameda County. The Santa Barbara County occurrence has probably been lost due to habitat alteration

(CNDDB 2001). Contra Costa goldfields also occurs near Manchester in Mendocino County, and at Suscol Ridge in Napa County. Another Napa County site, Milliken Canyon, contained only a single plant in 1987 and may or may not be still in existence (CNDDB 2001). The other existing occurrence is near Rodeo in Contra Costa County (CNDDB 2001).

Further discussion on Contra Costa goldfields' life history and habitat characteristics can be found in the final rule to list the species (62 FR 33037).

Hoover's spurge

Hoover's spurge (*Chamaesyce hooveri*) was originally named *Euphorbia hooveri* based on a specimen collected by Hoover in Yettem, Tulare County (Wheeler 1940). Koutnik (1985) placed the species in the genus *Chamaesyce* as *Chamaesyce hooveri.*

Hoover's spurge is an annual herb of the spurge family (Euphorbiaceae). Hoover's spurge trails along the ground, forming gray-green mats 5 to 100 cm (2.0 to 39.4 in) in diameter (Broyles 1987, Stone *et al.* 1988). The stems are hairless and contain milky sap. The tiny (2 to 5 mm (0.08 to 0.20 in)) leaves are opposite, rounded to kidney-shaped, with an asymmetric base and a toothed margin. In the genus *Chamaesyce,* the structures that appear to be flowers actually are groups of flowers; each group is referred to as a cyathium (Koutnik 1993).

Few details of the life history of Hoover's spurge are known. Seeds of Hoover's spurge germinate after water evaporates from the pools; the plants cannot grow in standing water (Alexander and Schlising 1997). The indeterminate growth pattern allows the plants to continue growing as long as sufficient moisture is available. The proportion of seedlings surviving to reproduction has not been documented; in years of below normal rainfall, seedling survival was characterized as ''low'' (Stone *et al.* 1988). The phenology (timing of various stages in the life cycle of a plant) varies among years and among sites, even for those populations in close proximity (Stone *et al.* 1988). Populations in Merced and Tulare counties typically flower from late May through July, whereas those in Stanislaus County and the Sacramento Valley flower from mid-June into October (Alexander and Schlising 1997, CNDDB 2001, J. Silveira USFWS pers. comm.). Seed set apparently begins soon after flowering. Seed production has not been quantified or studied in relation to environmental factors, but Stone *et al.* (1988) reported that large plants may produce several hundred seeds. Horned larks (*Eremophila alpestris*) have been observed eating seeds of Hoover's spurge and thus may assist in seed dispersal (Alexander and Schlising 1997).

Demographic data suggest that seeds of Hoover's spurge can remain dormant until the appropriate temperature and moisture conditions occur. This is evident from the fact that plants can be absent from a given pool for up to four years and then reappear in substantial numbers. Although certain years appear to be more favorable for Hoover's spurge than others, population trends vary from pool to pool, even within the same year in the same area. Moreover, a particular year may be favorable for Hoover's spurge at one site and unfavorable at another. For example, Hoover's spurge was extremely abundant on the Vina Plains Preserve in 1995, but reached a 7-year low at Sacramento National Wildlife Refuge that year. Five occurrences of Hoover's spurge have numbered 5,000 or more plants at their maximum size. Four of those five occur on the Vina Plains, and the other occurs in Tulare County (Stone *et al.* 1988, CNDDB 2001).

Hoover's spurge probably is pollinated by insects. Related species in the spurge family are pollinated by flies (Heywood 1978, Stone *et al.* 1988). Also, glands on the plant produce nectar (Wheeler 1941), which is attractive to insects. Beetles, flies, bees and wasps, and butterflies and moths (order Lepidoptera) have been observed visiting the flowers of Hoover's spurge and may potentially serve as pollinators (Stone *et al.* 1988, Alexander and Schlising 1997). Related species in the genus *Euphorbia* typically are cross-pollinated because the female flowers on each plant mature before the male (Heywood 1978, Stone *et al.* 1988), which may or may not be the case for Hoover's spurge.

For decades, Hoover's spurge was known from only three localities—near Yettem and Visalia in Tulare County, and near Vina in Tehama County. Collections were made from these three areas in the late 1930's and early 1940's (Wheeler 1941, Munz and Keck 1959, Stone *et al.* 1988). From 1974 through 1987, 21 additional occurrences of Hoover's spurge were reported. The majority of these (15) were in Tehama County. One to three occurrences were discovered during this period in each of Butte, Merced, Stanislaus, and Tulare counties (Stone *et al.* 1988, CNDDB 2001).

The CNDDB (2001) now includes 30 occurrences of Hoover's spurge. In addition to those known historically, six occurrences were discovered in 1992 (three each in Glenn and Tulare counties). Of the 30 occurrences, one each in Tehama and Tulare counties are classified as extirpated; two others, in Butte and Tehama counties, are ''possibly extirpated'' because this species was not observed for two consecutive years (Stone *et al.* 1988, CNDDB 2001). Of the 26 occurrences presumed to be extant, only 12 have been observed within the past decade (CNDDB 2001).

The main area of concentration for Hoover's spurge is within the northeastern Sacramento Valley. The Vina Plains of Tehama and Butte counties contains 14 (53.8 percent) of the 26 extant occurrences for Hoover's spurge (CNDDB 2001) in an area approximately 91 sq km (35 sq mi) in extent (Stone *et al.* 1988). One other site in the same region is near Chico in Butte County. Seven of the extant occurrences are in Southern Sierra Foothills Vernal Pool Region, including five in the Visalia-Yettem area of Tulare County and two in the Hickman-La Grange area of Stanislaus County. Three other occurrences are on the Sacramento National Wildlife Refuge in Glenn County, which is in the Solano-Colusa Vernal Pool Region. The one other extant occurrence is on the Bert Crane Ranch in Merced County, which is within the San Joaquin Valley Vernal Pool Region (Keeler-Wolf *et al.* 1998, CNDDB 2001).

Further discussion on Hoover's spurge's life history and habitat characteristics can be found in the final rule to list the species (62 FR 14351).

Succulent Owl's-Clover

Succulent (or fleshy) owl's-clover was first described by Hoover (1936a) as *Orthocarpus campestris* var. *succulentus.* The type specimen had been collected at Ryer, in Merced County. Hoover (1968) subsequently raised succulent owl's-clover to the rank of species and assigned it the name *Orthocarpus succulentus.* Chuang and Heckard (1991) reconsidered the taxonomy of *Orthocarpus* and related genera. Based on floral morphology (external structure or form), seed morphology, and chromosome number, they transferred many species into the genus *Castilleja.* Furthermore, they determined that the appropriate rank for succulent owl's-clover was as a subspecies of *Castilleja campestris* (field owl's-clover). The scientific name currently assigned to the plant is *Castilleja campestris* ssp. *succulenta* (Chuang and Heckard 1991).

Succulent owl's-clover is a hemiparasitic (partly parasitic) annual herb belonging to the snapdragon family (Scrophulariaceae). It has erect or

decumbent stems up to 30 cm (11.8 in) long. The stems are usually unbranched and without hairs. The leaves at the base of the stem are small and scalelike, whereas those on the upper stem are lance-shaped, not lobed, thick, fleshy, brittle, and easily broken. The bracts (leaf-like structures in the flowering structure) are green, similar to but shorter than the upper leaves, and longer than the flowers. Overall, the inflorescence (entire flowering structure of a plant) may occupy as much as half of the plant's height (Hoover 1936a, Hoover 1937, Hoover 1968, Chuang and Heckard 1991, Chuang and Heckard 1993).

As with many related species, succulent owl's-clover is a hemiparasite, meaning that it obtains water and nutrients by forming root grafts with other host plants but manufactures its own food through photosynthesis (Chuang and Heckard 1991). Research on hemiparasitism has focused on related species of *Castilleja*, but not specifically on succulent owl's-clover. Many different plants can serve as hosts for a single species or even a single individual of *Castilleja*. Seeds do not require the presence of a host to germinate, and form root connections only after reaching the seedling stage. Some seedlings can survive to maturity without attaching to a host's roots, but in general reproduction is enhanced by root connections (Atsatt and Strong 1970).

The conditions necessary for germination of succulent owl's-clover seeds have not been studied, nor has the timing of seed germination been documented. Flowering occurs in April and May (Skinner and Pavlik 1994). Although many related taxa of *Castilleja* are pollinated by generalist bees (Superfamily Apoidea) (Chuang and Heckard 1991), succulent owl's-clover is thought to be self-pollinating. Among close relatives that do not require insect pollinators, flower structure and timing of stigma receptivity maximize the chances for self-fertilization and seed set. Even so, insects may transfer some pollen among individual plants and species occurring in the same area. Self-pollinating species of *Castilleja* typically occur as widely scattered individuals, rather than in dense colonies (Atsatt 1970). Succulent owl's-clover follows this pattern in part, often occurring in many pools within a complex but with fewer than 100 plants per pool. However, succulent owl's-clover also may occur in large populations within a single pool (California Natural Diversity Data Base (CNDDB) 2001). Little is known about the demography of succulent owl's-clover, although population size can fluctuate greatly from year to year. In the few populations where population size was reported for more than 1 year, fluctuations up to two orders of magnitude were noted (CNDDB 2001).

Succulent owl's-clover is known from vernal pool habitats along the Southern Sierra Foothills ranging from Madera County to a disjunct occurrence in northern San Joaquin County. The highest density of occurrences of succulent owl's-clover occurs in Merced County, but the species is also known from Fresno, Madera, Stanislaus, and San Joaquin counties.

Further discussion on succulent owl's-clover life history and habitat characteristics can be found in the final rule to list the species (62 FR 14351).

Orcuttieae Tribe

Colusa grass, hairy Orcutt grass, Solano grass, Greene's tuctoria, Sacramento Valley Orcutt grass, San Joaquin Valley Orcutt grass, and slender Orcutt grass belong to the tribe Orcuttieae in the grass family, Poaceae (Reeder 1965). Many life history characteristics are common to all members of the Orcuttieae. All are wind pollinated, but pollen probably is not carried long distances between populations (Griggs 1980, Griggs 1981, Griggs and Jain 1983). Local seed dispersal is by water, which breaks up the inflorescence (Reeder 1965, Crampton 1976, Griggs 1980, Griggs 1981). Long distance dispersal is unlikely (Service 1985c) but seed may have been carried occasionally by waterfowl (family Anatidae), tule elk (*Cervus elaphus nannoides*), or pronghorn (*Antilocapra americana*) in historical times (Griggs 1980). The seeds can remain dormant for an undetermined length of time, but at least for 3 or 4 years, and germinate underwater after they have been immersed for prolonged periods (Crampton 1976, Griggs 1980, Keeley 1998a). Unlike typical terrestrial grasses that grow in the uplands surrounding vernal pools, members of the Orcuttieae flower during the summer months (Keeley 1998a).

All members of the Orcuttieae tribe have large soil seed banks that may often be 50 times or more larger in numbers than the above ground population in any given year. In general, years of above average rainfall promote larger populations of Orcuttieae, but population responses vary by pool and by species (Griggs 1980, Griggs and Jain 1983). Population sizes have been observed to vary by one to four orders of magnitude among successive years and to return to previous levels even after 3 to 5 consecutive years when no mature plants were present (Griggs 1980, Griggs and Jain 1983, Holland 1987). Thus, many years of observation are necessary to determine whether a population is stable or declining.

All members of the Orcuttieae are endemic to vernal pools. Although the various species have been found in pools ranging widely in size, the vast majority occur in pools of 0.01 ha (0.03 ac) to 10 ha (24.7 ac) (Stone *et al.* 1988). Larger pools retain water until May or June, creating optimal conditions for Orcuttieae (Crampton 1959, Crampton 1976, Griggs 1981, Griggs and Jain 1983). Orcuttieae occur in patches within the pools that are essentially devoid of other plant species (Crampton 1959, Crampton 1976). Typically, plants near the center of a pool grow larger and produce more spikelets than those near the margins, but patterns vary depending on individual pool characteristics and seasonal weather conditions (Griggs 1980).

The specific life history requirements and distribution of each of the seven Orcuttieae species are provided below.

Colusa Grass

Colusa grass (*Neostapfia colusana*) was first described by Davy (1898), and given the Latin name *Stapfia colusana*. He had collected the type specimen near the town of Princeton in Colusa County. Davy soon realized that the name *Stapfia* had already been assigned to a genus of green algae and therefore changed the scientific name of Colusa grass to *Neostapfia colusana* (Davy 1899). Two other taxonomists proposed alternate Latin names for the genus in the same year, but neither is accepted today. No other species of *Neostapfia* are known (Reeder 1982, Reeder 1993).

Unlike terrestrial grasses, Colusa grass has pith filled stems, lacks distinct leaf sheaths and ligules, and produces exudate (aromatic, sticky fluid discharged from the plant surface). Colusa grass stems and inflorescence (flower cluster) differs from other members of the Orcuttieae. The plant is pale green when young (Davy 1898) but becomes brownish as the exudate darkens (Reeder 1982, Reeder 1993).

Existing populations of Colusa grass are concentrated northeast of the city of Merced in Merced County and east of Hickman in Stanislaus County. Colusa grass also occurs in central Merced County, in southeastern Yolo County, and in central Solano County (Stone *et al.* 1988, Keeler-Wolf *et al.* 1998, CNDDB 2001). This species has been extirpated from Colusa County (CNDDB 2001).

In the 50 years after its initial discovery (Davy 1898), Colusa grass was reported from only three sites other than the type locality; these were in Merced and Stanislaus counties. By the mid-1970's Colusa grass had been reported from a total of 11 sites in Colusa, Merced, Solano, and Stanislaus counties (Hoover 1936b, Hoover 1940, Crampton 1959, Medeiros 1976, Reeder 1982). During the 1980's, many new populations of Colusa grass were located during extensive surveys. As of 1989, 40 occurrences were extant and 11 already had been extirpated. Of the 51 occurrences known up to that point, 26 were in Merced County, 22 were in Stanislaus County, 2 were in Solano County, and one was in Colusa County (Stone *et al.* 1988, CNDDB 2001). Currently, the CNDDB (2001) considers 48 occurrences of Colusa grass to be ''presumed extant'' and 11 others as known or possibly extirpated.

Further discussion on Colusa grass's life history and habitat characteristics can be found in the final rule to list the species (62 FR 14338).

Greene's Tuctoria

Greene's tuctoria (*Tuctoria greenei*) was originally assigned its name by Vasey (1891) as *Orcuttia greenei*. Greene had collected the type specimen in 1890 ''on moist plains of the upper Sacramento, near Chico, California'' (Vasey 1891), presumably in Butte County (Hoover 1941, Crampton 1959). Citing differences in lemma morphology, arrangement of the spikelets, and other differences, Reeder (1982) segregated the genus *Tuctoria* from *Orcuttia* and created the new scientific name *Tuctoria greenei* for this species.

Greene's tuctoria is an erect to low growing annual with fragile stems that easily break apart at the nodes, which are often purplish. The leaves are flat and curve outward and the plants are sparsely hairy. The inflorescence is crowded near the tip with the lower spikelets more or less separated. Optimum germination of Greene's tuctoria seed occurs when the seed is exposed to light and anaerobic (lacking oxygen) conditions after stratification (Keeley 1988). Germination occurs several months after initial inundation (Keeley 1998a). *Tuctoria* seedlings do not develop floating juvenile leaves, as does *Orcuttia* (Griggs 1980, Keeley 1998a). The adult plants apparently do not tolerate inundation; all five Greene's tuctoria plants in a Glenn County pool died when the pool refilled during late spring rains in 1996 (Silveira *in litt.* 1997). Greene's tuctoria flowers from May to July (Skinner and Pavlik 1994), with peak flowering in June and July (Griggs 1981, Broyles 1987).

As with other vernal pool annuals, population size in Greene's tuctoria can vary enormously from year to year, and populations that have no visible plants one year can reappear in large numbers in later years. Population fluctuations may be due to annual variations in weather, particularly rainfall, to changes in management, or to a combination of the two. Such fluctuations were observed at scattered sites in Butte and Tehama counties during the 1970's (Griggs 1980, Griggs and Jain 1983) and at Sacramento National Wildlife Refuge, where the population in the single occupied pool ranged from zero to 60 plants between 1994 and 1999 (Silveira *in litt.* 2000). Fluctuations of as much as three orders of magnitude were documented on the Vina Plains Preserve during the 1980's and 1990's (Alexander and Schlising 1997)

After its discovery in Butte County in 1890, Greene's tuctoria was not seen again for over 40 years. During extensive surveys in the late 1930's, Hoover (1937, 1941) found the species at sites in Fresno, Madera, Merced, San Joaquin, Stanislaus, Tehama, and Tulare counties. In fact, he described it as the most common of all *Orcuttia* species, with which it was classified at the time. By the end of the 1980's, Greene's tuctoria had been reported from a total of 36 occurrences in the same 8 counties (Stone *et al.* 1988, CNDDB 2001).

Three additional occurrences of Greene's tuctoria have been discovered during the past decade, bringing the reported total to 39 occurrences (Oswald and Silveira 1995, CNDDB 2001). However, 19 of the historical occurrences apparently have been extirpated. The other 20 occurrences are presumed to be still in existence, although 6 of those have not been verified for more than a decade (Alexander and Schlising 1997, CNDDB 2001).

Sixty percent of the extant occurrences of Greene's tuctoria are in the Vina Plains area of Tehama and Butte counties. Eastern Merced County has about 30 percent of the known occurrences. Other occurrences are located in Glenn (Oswald and Silveira 1995) and Shasta counties (CNDDB 2001). Greene's tuctoria has been extirpated from Fresno, Madera, San Joaquin, Stanislaus, and Tulare counties (Stone *et al.* 1988, Skinner and Pavlik 1994, CNDDB 2001).

Further discussion on Greene's tuctoria's life history and habitat characteristics can be found in the final rule to list the species (62 FR 14338).

Hairy Orcutt Grass

Hoover (1941) described hairy Orcutt grass as (*Orcuttia pilosa*) from specimens he collected in Stanislaus County, ''12 miles east of Waterford'' in 1937. Hairy Orcutt grass grows in tufts consisting of numerous stems. The stems are decumbent (laying on the ground with the tip turned upward) or erect and branch from only the lower nodes. Almost the entire plant is pilose or hairy, giving it a grayish appearance. The spikelets near the tip of the inflorescence are crowded together, whereas those near the base are more widely spaced.

Griggs (1974 cited in Stone *et al.* 1988) found that stratification followed by temperatures of 15 to 32°C (59 to 90°F) was necessary for seed germination in hairy Orcutt grass. Flowering period for the plant is mid-April through July. Seed production has not been studied extensively in hairy Orcutt grass, but Griggs and Jain (1983) did note that one individual produced more than 10,000 seeds. Although the predominant pollination agent for all Orcutt grasses is wind, native bees (Halictidae) have been observed visiting the inflorescence of hairy Orcutt grass to gather pollen (Griggs 1974 cited in Stone *et al.* 1988).

Like other vernal pool annuals, the size of hairy Orcutt grass populations fluctuates dramatically from year to year. Population sizes have varied by as much as four orders of magnitude over time (Griggs 1980, Griggs and Jain 1983, Alexander and Schlising 1997). In fact, two populations that had no visible plants for three successive years exceeded 10,000 plants in the fourth year (Griggs 1980, Griggs and Jain 1983).

Hairy Orcutt grass is known from sites in the southern portion of the Sacramento Valley and the southern Sierra foothills (Keeler-Wolf *et al.* 1998). The species has been found in Tehama, Stanislaus, Madera, and Merced counties (Hoover 1941, Crampton 1959, Reeder 1982, Stone *et al.* 1988, CNDDB 2001). Hairy Orcutt grass also was collected in Glenn County, in 1937 (CNDDB 2001); the specimen has since been lost but may have been misidentified as California Orcutt grass (Silveira *in litt.* 2000). During the late 1980's, Stone *et al.* (1988) determined that 12 historical occurrences had been extirpated but they and others discovered three additional populations in Madera, Stanislaus, and Tehama counties. One other occurrence from Madera County was previously considered to be hairy Orcutt grass and is listed as such in the CNDDB (2001); however, this population since has been

identified as San Joaquin Valley Orcutt grass (Stone *in litt.* 1992).

Within the past decade, hairy Orcutt grass has been discovered in additional areas in Glenn, Madera, and Tehama counties (CNDDB 2001). Hairy Orcutt grass has also been discovered in another pool at the Vina Plains Preserve in Tehama County (Alexander and Schlising 1997). Of the 38 element occurrences listed by the CNDDB (2001), not counting the misidentified population of San Joaquin Valley Orcutt grass, 24 natural occurrences are presumed to be still in existence. Nineteen of those occurrences have been confirmed as existing within the past decade (CNDDB 2001).

Further discussion on hairy Orcutt grass's life history and habitat characteristics can be found in the final rule to list the species (62 FR 14338).

Sacramento Orcutt Grass

Hoover (1941) first described Sacramento Orcutt grass (*Orcuttia viscida*) as *Orcuttia californica* var. *viscida* based on the type specimen he collected from ''7 miles south of Folsom'' in Sacramento County. Reeder (1980) determined that the differences in morphology, seed size, and chromosome number were sufficient grounds to elevate Sacramento Orcutt grass to the species level as *Orcuttia viscida.*

In basic form, Sacramento Orcutt grass resembles other members of the tribe and genus. Although all members of the Orcuttieae produce exudate, Sacramento Orcutt grass is particularly viscid even when young. The plants are densely tufted, bluish green, and covered with hairs. The stems are erect or spreading, 3 to 10 cm (1 to 4 in) long, and do not branch. The inflorescence occupies the upper one third to one half of the stem and consists of between 5 and 15 spikelets. The spikelets are closely spaced, and although distichous (arranged in two opposing rows) are oriented towards one side of the stem.

Sacramento Orcutt grass flowers in May and June (Griggs 1977, Skinner and Pavlik 1994, Cochrane *in litt.* 1995a) and sets seed in June and July (Holland 1987). Seeds likely do not disperse far under natural conditions. In a 6-year period, an experimental population spread at most 3 m (10 ft) from the seed source, and 95 percent of plants were within 30 cm (12 in) of the source (Holland *in litt.* 1986). A demographic study conducted from 1974 to 1978 (Griggs 1980, Griggs and Jain 1983) indicated that Sacramento Orcutt grass produced an average of 500 seeds per plant. At one site in 1978, 88 percent of plants survived to maturity. The size of the seed bank stored in the soil was approximately 44 times as great as the population of growing plants (Griggs 1980, Griggs and Jain 1983). The number of plants varies with rainfall. Large numbers of plants grow only in years when seasonal rainfall exceeds 40 cm (16 in), particularly when heavy rains begin in November and continue through the end of April (Holland 1987). This species is less likely to germinate in years of below normal precipitation than are other members of the tribe (Griggs 1980, Griggs and Jain 1983).

Sacramento Orcutt grass is endemic to the southeastern Sacramento Valley (Keeler-Wolf *et al.* 1998) and always has been restricted to Sacramento County. The earliest collection was from 1936 near Phoenix Field. Three other occurrences documented in 1941 and 1958 extended the range north to Orangevale and south to near Sloughhouse. Sacramento Orcutt grass was introduced to Phoenix Park, in Sacramento County, in 1978. Three additional natural occurrences were discovered in the late 1980's, including one in extreme southeastern Sacramento County near State Highway 104. Thus, by 1990 this species was known from a total of seven natural occurrences and one introduction (Stone *et al.* 1988, CNDDB 2001).

Within the past decade, Sacramento Orcutt grass has been discovered at one new site in Sacramento County, within the previously known range. However, one entire occurrence and a portion of another have been extirpated. Thus, eight of the nine occurrences are still in existence. Five occurrences, comprising more than 70 percent of the occupied habitat, are concentrated into a single small area east of Mather Field. Two other occurrences are adjacent to each other-Phoenix Field Ecological Reserve and the introduced population at Phoenix Park. The eighth existing occurrence is near Rancho Seco Lake (Stone *et al.* 1988, Cochrane *in litt.* 1995a, CNDDB 2001).

Further discussion on Sacramento Orcutt grass life history and habitat characteristics can be found in the final rule to list the species (62 FR 14338).

San Joaquin Valley Orcutt Grass

Hoover (1936b) described San Joaquin Valley Orcutt grass (*Orcuttia inaequalis*) based on a collection from ''Montpellier [sic], Stanislaus County.'' Hoover (1941) subsequently reduced this taxon to a variety of *Orcuttia californica,* using the combination *Orcuttia californica* var. *inaequalis.* Based on differences in morphology, seed size, and chromosome number, Reeder (1980) restored the taxon to species status.

Mature plants of San Joaquin Valley Orcutt grass grow in tufts of several erect stems. The plant is grayish-green due to the long hairs on the stem and leaves and produces exudate. *Orcuttia* plants grow underwater for 3 months or more and have evolved specific adaptations for aquatic growth (Keeley 1998a).

The earliest collection of San Joaquin Valley Orcutt grass was made in 1927 from the Fresno-Madera County border near Lanes Bridge (CNDDB 2001). Hoover (1941) mentioned collections from eight sites in Fresno, Madera, Merced, Stanislaus, and Tulare counties. A total of 20 occurrences had been reported by the mid 1970's, all in the same five counties (Crampton 1959, CNDDB 2001), but none remained as of the late 1970's (Griggs 1980, Griggs and Jain 1983). However, since that time San Joaquin Valley Orcutt grass has been discovered in Merced, Madera, and Fresno counties, and recently additional occurrences of San Joaquin Valley Orcutt grass have been found, including sites in Tulare County. Of the 47 occurrences of San Joaquin Valley Orcutt grass reported in CNDDB (2001), 27 are presumed to be still in existence; 17 are certainly extirpated and 3 others are possibly extirpated because the habitat has been modified (CNDDB 2001). However, only 12 of the occurrences presumed still in existence have been revisited within the past decade, so even the most recent information is outdated. This species has been completely extirpated from Stanislaus County but remains in Fresno, Madera, Merced, and Tulare counties (Stone *et al.* 1988, Skinner and Pavlik 1994, CNDDB 2001).

Further discussion on San Joaquin Valley Orcutt grass's life history and habitat characteristics can be found in the final rule to list the species (62 FR 14338).

Slender Orcutt Grass

Slender Orcutt grass (*Orcuttia tenuis*) was first named by Hitchcock (1934). The type specimen of slender Orcutt grass was collected in Goose Valley, Shasta County, in 1912. Slender Orcutt grass grows as single stems or in small tufts consisting of a few stems. The plants are sparsely hairy and branch only from the upper half of the stem. Although the stems typically are erect, they may become decumbent if many branches form near the stem tip (Reeder 1982). The inflorescence comprises more than half of the plant's height, and the spikelets are more or less evenly spaced throughout the inflorescence.

Optimal germination of slender Orcutt grass is achieved through stratification

followed by warm days and mild nights (Griggs 1974 in Stone *et al.* 1988). Peak flowering of this species typically occurs in May in the Central Valley (Griggs 1981, Reeder 1982) but not until June or July on the Modoc Plateau (Schoolcraft *in litt.* 2000). Unlike hairy Orcutt grass and Greene's tuctoria, slender Orcutt grass is not likely to die when pools are flooded by late spring or summer rains (Griggs 1980, Griggs and Jain 1983). Conversely, drought has been known to cause 100 percent mortality (Griggs 1980, Griggs and Jain 1983).

Similar to other vernal pool annuals, slender Orcutt grass populations can vary greatly in size from year to year. Fluctuations of up to four orders of magnitude have been documented in Lake and Shasta counties (Griggs 1980, Griggs and Jain 1983). At the Vina Plains Preserve, the single population ranged in size from 1,000 to 147,700 individuals during the five times it was reported over a 13 year period (Stone *et al.* 1988, Alexander and Schlising 1997). However, slender Orcutt grass populations do not always fluctuate in size. Among five populations of slender Orcutt grass that Griggs tracked from 1973 to 1979, two in the Dales area remained at the same order of magnitude for the entire period. None of the other five species of Orcuttieae included in the study remained stable for the full 7 years (Griggs 1980, Griggs and Jain 1983).

By the mid 1980s, slender Orcutt grass was known from only 18 localities in Lake, Sacramento, Shasta, and Tehama counties (Reeder 1982, Stone *et al.* 1988). During the late 1980s, Stone *et al.* (1988) and others (CNDDB 2001) discovered 34 additional occurrences of slender Orcutt grass. Slender Orcutt grass was found primarily in Tehama County, in the vicinity of Dales and on the Vina Plains. The species was also found in the Stillwater and Millville Plains of Shasta County, and at additional sites in Shasta, Siskiyou, Lake, and Sacramento counties (Griggs and Jain 1983, Stone *et al.* 1988, CNDDB 2001). During the past decade, 27 new occurrences of slender Orcutt grass have been reported. In addition to the counties where it was reported historically, slender Orcutt grass is now known from Lassen and Plumas counties. The extirpated occurrences of slender Orcutt grass were near Reading Airport and Stillwater Plains in Shasta County and additional possibly extirpated occurrences were near Goose Valley and Battle Creek in Tehama and Shasta counties.

Further discussion on slender Orcutt grass's life history and habitat characteristics can be found in the final rule to list the species (62 FR 14338).

Solano Grass

Solano grass (*Tuctoria mucronata*) was originally described under the name *Orcuttia mucronata* based on specimens collected ''12 miles due south of Dixon, Solano County'' (Crampton 1959, p. 108). Reeder (1982) transferred this species to a new genus, *Tuctoria*, resulting in the currently accepted name *Tuctoria mucronata.*

Solano grass is grayish-green, pilose, and sticky. The tufted stems are decumbent and do not branch. The long leaves are rolled inward and have pointed tips. The base of the inflorescence is partially hidden by the uppermost leaves. As is characteristic of the genus, the spikelets are arranged in a spiral; the spikelets in the inflorescence of Solano grass are crowded together.

Solano grass typically flowers in June and sets seed during July (Holland 1987). The demography of Solano grass has not been investigated in detail. Annual estimates or counts at Olcott Lake (Holland 1987, CNDDB 2001) indicated that population sizes for this species fluctuate dramatically from year to year, as do other members of the Orcuttieae. Solano grass was not observed at Olcott Lake from 1976 through 1980, then reappeared in 1981 (Holland 1987), indicating that viable seeds can persist in the soil for a minimum of 5 years. Apparently both drought years and years of excessively high rainfall are unfavorable for Solano grass; the largest populations were observed after seasons of 45 to 60 cm (17.7 to 23.6 in) of precipitation (Holland 1987).

Prior to 1985, Solano grass was known only from Olcott Lake in Solano County, which is believed to be the type locality (Crampton 1959, CNDDB 2001). A second occurrence was discovered in 1985 approximately 4 km (2.5 mi) southwest of Olcott Lake (CNDDB 2001). Solano grass is presumed to remain at the type locality, although only four individual plants have been found within the last decade, all in 1993 (CNDDB 2001). The other Solano County site is still in existence. A third occurrence, comprising the largest population known, was discovered in 1993 on a Department of Defense (DOD) communications facility in Yolo County (CNDDB 2001).

Further discussion on Solano grass's life history and habitat characteristics can be found in the Delta Green Ground Beetle and Solano Grass Recovery Plan (Service 1985c).

The vernal pool plants are threatened by habitat loss and degradation due to urbanization, agricultural land conversion, off road vehicle use, flood control projects, highway projects, altered hydrology, landfill projects, and competition from weedy nonnative plants. The habitat of these species has been reduced and fragmented throughout their respective ranges as vernal pools continue to be eliminated. Further discussion on threats to the vernal pool plants can be found in the final rules to list these species (62 FR 34029, 62 FR 14338, 57 FR 24192, 43 FR 44810) and in the criteria section of this proposed rule.

Previous Federal Action (Vernal Pool Crustaceans)

Ms. Roxanne Bittman petitioned us to list Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and California linderiella (*Linderiella occidentalis*) as endangered species on November 19, 1990. Ms. Dee Warneycia petitioned us to list vernal pool tadpole shrimp as an endangered species on April 28, 1991. On May 8, 1992, we published a proposed rule in the **Federal Register** (57 FR 19856) to list the four fairy shrimp and vernal pool tadpole shrimp as endangered. On September 19, 1994, we published a final rule in the **Federal Register** (59 FR 48136) determining endangered status for Conservancy fairy shrimp, longhorn fairy shrimp and vernal pool tadpole shrimp and threatened status for vernal pool fairy shrimp. We withdrew the California linderiella as a species proposed for listing based on additional information received during the public review and comment period indicating that during the review period this species was more abundant than previously known.

On April 17, 1995, the Building Industry Association of Superior California (BIAC) and Marvin L.Oates (Plaintiffs) filed a lawsuit in Federal District Court for the District of Columbia against Bruce Babbit (Secretary, Department of the Interior) *et al.* (Defendants) and Environmental Defense Center and Butte Environmental Council (Defendent-Intervenors) arguing that the listing of four vernal pool crustaceans (Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp) violated the Act, the Administrative Procedures Act, the Fifth Amendment, the Tenth Amendment, and the Commerce Clause of the United States Constitution (*Building Industry Association of Superior California, et al.* v. *Babbit et al.*, CIV 95–0726 PLF). On

July 25, 1997, the district court granted the defendant's motion for summary judgement on all aspects except the decision not to designate critical habitat. The plaintiffs later amended their complaint to drop the claim relating to the designation of critical habitat and the district court vacated its ruling regarding this matter. On April 12, 2000, the Butte Environmental Council filed suit, alleging that our failure to establish critical habitat for the four vernal pool crustaceans violated the Endangered Species Act and the Administrative Procedures Act (*Butte Environmental Council* v. *White* CIV S–00–797 WES GGH). On February 9, 2001, the U.S. District Court for the Eastern District of California granted the plaintiff's motion for summary judgement and required the defendants, to the maximum extent prudent and determinable, to designate critical habitat for the four vernal pool crustaceans within six months.

On July 23, 2001, the district court approved a settlement agreement between the parties which extended the deadline for designation of critical habitat to August 15, 2002. As a condition of the settlement, we agreed to also designate critical habitat, to the maximum extent prudent and determinable, for the eleven vernal pool plants addressed in this proposed rule by the same date.

Previous Federal Action (Vernal Pool Plants)

Section 12 of the Act directed the Secretary of the Smithsonian Institution to prepare a report on plant species which were or might become endangered or threatened. The resulting report, dated January 9, 1975, reviewed the status of 3,100 vascular plants. The report categorized as endangered six of the eleven vernal pool plants under consideration here, and categorized two others as threatened. The six plants considered endangered were hairy Orcutt grass, Sacramento Orcutt grass, slender Orcutt grass, Colusa grass, San Joaquin Valley Orcutt grass, and succulent owl's clover. The two threatened plants were Contra Costa goldfields and Hoover's spurge. On July 1, 1975, the Director of the Department of the Interior published a notice (40 FR 27823) accepting the Smithsonian Institution's report as a listing petition within the context of section 4(c)(2) of the Act (petition provisions are now found in section 4(b)(3)), and of his intention to review the status of the plants covered by the report. On June 16, 1976, based on both the Smithsonian report and on public comments and data pertaining to it, we published a proposed rule (41 FR 24523) to determine approximately 1,700 vascular plants as endangered pursuant to section 4 of the Act. The 1,700 plants included all eleven vernal pool plants considered here.

We published a final rule to list Solano grass (along with four other plants) as endangered on September 28, 1978 (43 FR 44810). A recovery plan for Solano grass and the delta green ground beetle (*Elaphrus viridis*) was subsequently approved on September 11, 1985 (Service 1985c). We failed to complete final listing rules for the other ten vernal pool plants within three years of the proposed listing, however, despite amendments to the Act in 1978 requiring us to withdraw proposed rules which were more than two years old (with a one-year grace period). Accordingly, on December 10, 1979, we withdrew the proposal to list the ten remaining vernal pool plants (44 FR 70796).

We established the remaining vernal pool plants as category 1 candidate species in a Notice of Review (NOR) for plants published December 15, 1980 (45 FR 82480). Category 1 candidates were those species for which data in our possession was sufficient to support proposals to list. In a subsequent NOR published November 28, 1983 (48 FR 53640), we downgraded the status of Contra Costa goldfields, slender Orcutt grass and Colusa grass to category 2. Category 2 candidates were defined as species for which data in our possession indicated listing was possibly appropriate, but for which we lacked substantial data on biological vulnerability and threats to support listing proposals. Another NOR on September 27, 1985, left the status of the remaining vernal pool plants unchanged (50 FR 39526).

On February 2, 1988, we received a petition from the California Native Plant Society (CNPS) to emergency list Butte County meadowfoam as endangered. We published a 90-day administrative finding that the requested action might be warranted on December 30, 1988 (53 FR 53030). On February 15, 1991, we published a proposal to list Butte County meadowfoam as an endangered species (56 FR 6345), and on June 8, 1992, we published a final determination that Butte County meadowfoam was endangered (57 FR 24192).

On February 22, 1990, we published a new NOR which re-established Colusa grass and Contra Costa goldfields as category 1 candidate species (55 FR 6184). In 1991 and 1992, we received additional information regarding threats to succulent owl's-clover, and so returned this species to category 1 status on August 5, 1993 (58 FR 41700), in the same notice proposing to list succulent owl's clover and seven other vernal pool plants under the Act.

On August 5, 1993, we published a proposal to list San Joaquin Valley Orcutt grass, hairy Orcutt grass, Sacramento Orcutt grass, and Greene's tuctoria as endangered; and to list succulent owl's-clover, Hoover's spurge, Colusa grass, and slender Orcutt grass as threatened was published on August 5, 1993 (58 FR 41700). This proposal was primarily based on information supplied by reports to the CNDDB, the Status Survey of the Grass Tribe Orcuttieae and Hoover's Spurge in the Central Valley of California (Stone *et al.* 1988), and observations by numerous botanists. Prior to publishing the final rule on these eight plants, we published another NOR on September 30, 1993 (58 FR 51144), indicating that the current status of the vernal pool plants as category 1 candidates remained unchanged. We subsequently published a proposal to list Contra Costa goldfields as endangered on December 19, 1994 (59 FR 65311). Then on March 26, 1997, we published the final rule (62 FR 14338) for the eight plants proposed for listing in 1993. The final rule listed San Joaquin Valley Orcutt grass as threatened, rather than endangered as had originally been proposed, because we determined the threats to its existence to be smaller and less immediate than had previously been thought. All seven other plants were listed as proposed, resulting in a listing of hairy Orcutt grass, Sacramento Orcutt grass and Greene's tuctoria as endangered; and San Joaquin Valley Orcutt grass, succulent owl's clover, Hoover's spurge, Colusa grass and slender Orcutt grass as threatened. Later that same year (June 18, 1997) we published the final rule to list Contra Costa goldfields, the last of the vernal pool plants considered here, as endangered (62 FR 34029).

We did not identify critical habitat in the final listing rules for any of the vernal pool plants or crustaceans considered here because we determined that the threats of increased vandalism and collection of listed species in the areas thus identified would make it imprudent to do so. Based on the interpretation of section 4 of the Act in a number of judicial decisions issued after the not prudent findings for these species were made, however, we have reconsidered those determinations and now consider the designation of critical habitat for the fifteen vernal pool species to be prudent. We are therefore proposing to designate critical habitat here, for the four vernal pool

crustaceans and eleven vernal pool plants covered by the July 23, 2001, court approved settlement agreement in that case.

On August 14, 2002, we filed a motion in *Butte Environmental Council* seeking to modify the deadline of August 15, 2002, for issuance of final critical habitat determinations. We were unable to meet that deadline, and have asked the court to approve a new deadline of September 30, 2003.

Critical Habitat

Critical habitat is defined in section 3(5)(A) of the Act as: (i) The specific areas within the geographic area occupied by a species at the time it is listed in accordance with the Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) that may require special management considerations or protection; and (ii) specific areas outside the geographic area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species. ''Conservation'' means the use of all methods and procedures that are necessary to bring an endangered or threatened species to the point at which listing under the Act is no longer necessary.

Critical habitat receives protection under section 7 of the Act through the prohibition against destruction or adverse modification of critical habitat with regard to actions carried out, funded, permitted, or authorized by a Federal agency. Section 7 also requires conferences on Federal actions that are likely to result in the destruction or adverse modification of proposed critical habitat. Aside from the added protection that may be provided under section 7, the Act does not provide other forms of protection to lands designated as critical habitat. Because consultation under section 7 of the Act does not apply to activities on private or other non-Federal lands that do not involve a Federal nexus, critical habitat designation would not afford any additional regulatory protections under the Act.

Critical habitat also provides non-regulatory benefits to the species by informing the public and private sectors of areas that are important for species recovery and where conservation actions would be most effective. Designation of critical habitat can help focus conservation activities for a listed species by identifying areas that contain the physical and biological features essential for the conservation of that species, and can alert the public as well as land-managing agencies to the importance of those areas. Critical habitat also identifies areas that may require special management considerations or protection, and may help provide protection to areas where significant threats to the species have been identified, by helping people avoid causing accidental damage to such areas.

In order to be included in a critical habitat designation, the habitat must first be ''essential to the conservation of the species.'' Critical habitat designations identify, to the extent known and using the best scientific and commercial data available, habitat areas that provide at least one of the physical or biological features essential to the conservation of the species (primary constituent elements, as defined at 50 CFR 424.12(b)). Section 3(5)(C) of the Act states that not all areas that can be occupied by a species should be designated as critical habitat unless the Secretary determines that all such areas are essential to the conservation of the species. Our regulations (50 CFR 424.12(e)) also state that, ''The Secretary shall designate as critical habitat areas outside the geographic area presently occupied by the species only when a designation limited to its present range would be inadequate to ensure the conservation of the species.''

Section 4(b)(2) of the Act requires that we take into consideration the economic impact, and any other relevant impact, of specifying any particular area as critical habitat. We may exclude areas from critical habitat designation when the benefits of exclusion outweigh the benefits of including the areas within critical habitat, provided the exclusion will not result in extinction of the species.

Our Policy on Information Standards Under the Endangered Species Act, published on July 1, 1994 (59 FR 34271), provides criteria, establishes procedures, and provides guidance to ensure that our decisions represent the best scientific and commercial data available. It requires that our biologists, to the extent consistent with the Act and with the use of the best scientific and commercial data available, use primary and original sources of information as the basis for recommendations to designate critical habitat. When determining which areas are critical habitat, a primary source of information should be the listing rule for the species. Additional information may be obtained from a recovery plan, articles in peer-reviewed journals, conservation plans developed by States and surveys and studies, and biological assessments or other unpublished materials.

Section 4 of the Act requires that we designate critical habitat based on what we know at the time of designation. Habitat is often dynamic, and species may move from one area to another over time. Furthermore, we recognize that designation of critical habitat may not include all of the habitat areas that may eventually be determined to be necessary for the recovery of the species. For these reasons, critical habitat designations do not signal that habitat outside the designation is unimportant or may not be required for recovery. Areas outside the critical habitat designation will continue to be subject to conservation actions that may be implemented under section 7(a)(1) of the Act and to the regulatory protections afforded by the section 7(a)(2) jeopardy standard and the section 9 prohibitions, as determined on the basis of the best available information at the time of the action. Federally funded or assisted projects affecting listed species outside their designated critical habitat areas may still result in jeopardy findings. Similarly, critical habitat designations made on the basis of the best available information at the time of designation will not control the direction and substance of future recovery plans, HCPs, or other species conservation planning efforts if new information available to these planning efforts calls for a different outcome.

The action of designating critical habitat does not automatically lead to recovery of a listed species, but it may contribute to species recovery. Critical habitat units are not target preserve areas: designation does not target and establish specific preserves and their boundaries. Critical habitat is designated to make Federal agencies aware that these areas are critical to the species. Although the designation of critical habitat can identify areas where a variety of conservation strategies may be developed to ensure the survival and recovery of target species, the development of these strategies are most appropriately taken through local planning efforts, such as the development of HCPs. The action of designating critical habitat does not result in the creation of management plans, establish numerical population goals, and/or prescribe specific management actions, whether inside or outside of such designated critical habitat. Specific management recommendations for areas designated as critical habitat are most appropriately addressed in recovery, conservation, and management plans, and through consultations and permits under section 7 and section 10 of the Act.

Prudency Redetermination

Section 4(a)(3) of the Act, as amended, and implementing regulations (50 CFR 424.12) require that, to the maximum extent prudent and determinable, we designate critical habitat at the time the species is determined to be endangered or threatened. At the time of the final listing determination (62 FR 34029, 62 FR 14338, 59 FR 48136, 57 FR 24192), we found that designation of critical habitat was not prudent for the vernal pool crustaceans and plants (excluding Solano grass). At the time of final listing of Solano grass (43 FR 44810), we did not make any determination about whether or not designation of critical habitat was prudent. Our regulations (50 CFR 424.12(a)(1)) state that designation of critical habitat is not prudent when one or both of the following situations exist—(1) The species is threatened by taking or other human activity, and identification of critical habitat can be expected to increase the degree of such threat to the species, or (2) such designation of critical habitat would not be beneficial to the species. In our final listing rules for the vernal pool crustaceans and plants (excluding Solano grass), we believed that publication of precise maps and descriptions of critical habitat for the vernal pool crustaceans and plants could make these species more vulnerable to incidents of vandalism or other human activities such as discing, grading, or filling (62 FR 34029, 62 FR 14338, 59 FR 48136, 57 FR 24192). In addition, we determined that publication of precise maps and descriptions of critical habitat for the vernal pool plants would increase the vulnerability of these species to incidents of collection (62 FR 34029, 62 FR 14338, 57 FR 24192). Therefore, we determined that the designation of critical habitat would increase the degree of threat to the vernal pool crustaceans and plants. We also determined that designation of critical habitat was not beneficial for the vernal pool plant species (excluding Solano grass) because many populations of these species were found on private lands (62 FR 34029, 62 FR 14338, 57 FR 24192). For Butte County meadowfoam and Contra Costa goldfields, we believed that Federal involvement in the areas where these plant species occurred could be identified without designation of critical habitat (62 FR 34029, 57 FR 24192). For eight of the vernal pool plant species (succulent owl's-clover, Hoover's spurge, Colusa grass, San Joaquin Valley Orcutt grass, hairy Orcutt grass, slender Orcutt grass, Sacramento Orcutt grass, and Greene's tuctoria), we believed that Federal agencies were aware of the species' presence and were already addressing conservation efforts where the species were found on Federal lands (62 FR 14338).

In 1995, the CDFG received a grant from the U.S. Environmental Protection Agency (EPA) to map vernal pools in particular areas for conservation purposes (Vendlinski 2000). As a result of this effort, the CDFG published a report which delineated 17 vernal pool regions throughout California (Keeler-Wolf *et al.* 1998). In 1997, Robert Holland's original 1973–1974 map of vernal pools in the Central Valley was updated and the results were documented Holland (1998). In 1998, we published the Recovery Plan for Vernal Pools of Southern California (Service 1998) which outlined recovery strategies for seven vernal pool species (two vernal pool crustaceans and five vernal pool plants) including the San Diego fairy shrimp (*Branchinecta sandiegonensis*). The release of these data resulted in the widespread distribution of information about vernal pool habitat and its location to the public and to local jurisdictions for planning purposes. Since the release of these data, we have not documented an increase in the threats to the species addressed in this rule through vandalism, collection, habitat destruction, or other means. In contrast, we have witnessed an increase in public interest in the species and their conservation through survey efforts by species experts, scientific research, regional and local planning, and educational outreach. Since listing of the vernal pool crustaceans and plants, several vernal pool conservation planning efforts have been initiated by public agencies and non-government organizations. For example, in 1997 the Framework Agreement for the Interagency Vernal Pool Stewardship Initiative was signed by a number of Federal and State agencies; this agreement encourages coordination of vernal pool conservation efforts on a regional scale between the signatory agencies.

Based on the lack of an increase in vandalism threats, we have reconsidered our evaluation of our original prudency determination. We have determined that the threats to the vernal pool crustaceans and plants and their habitat from the specific instances of habitat destruction we identified in the final listing rules do not outweigh the broader educational, regulatory, and other possible benefits that a designation of critical habitat would provide for these species. The instances of likely vandalism, though real, have been relatively isolated. Consequently, we conclude that designating critical habitat will not increase incidences of habitat vandalism above current levels for these species. In the absence of finding that critical habitat would increase threats to a species, if there are any benefits to critical habitat designation, then a prudent finding is warranted. The potential benefits include: (1) Triggering consultations under section 7 of the Act in new areas where it would not otherwise occur because, for example, it is or has become unoccupied or the occupancy is in question; (2) focusing conservation activities on the most essential areas; (3) providing educational benefits to State or county governments or private entities; and, (4) preventing people from causing inadvertent harm to the species. Therefore, we conclude that the benefits of designating critical habitat on lands essential for the conservation of the vernal pool crustaceans and plants outweigh the risks of increased vandalism resulting from such designation. Critical habitat for the 4 vernal pool crustaceans and 11 vernal pool plants addressed herein is prudent and we are subsequently proposing critical habitat for them in this proposed rule.

All of the proposed critical habitat units contain one or more of the primary constituent elements for the vernal pool crustaceans or plants addressed in this proposed rule. However, as stated earlier, vernal pool crustaceans and plants occur in ephemeral pools that may not be present throughout a given year or from year to year.

In summary, in determining areas that are essential to conserve the species addressed in this proposed rule, we used the best scientific information available to us. The critical habitat areas described below constitute our best assessment of areas needed for the species' conservation.

Methods

In determining critical habitat for vernal pool crustaceans and vernal pool plants we used the best scientific and commercial data available. This included data and information contained in the final rules listing the 15 species addressed herein, research and survey observations published in peer reviewed articles, the Vernal Pools of Southern California Final Recovery Plan (Service 1998), data collected for the development of HCPs, reports submitted by biologists holding section 10(a)(1)(A) recovery permits, data collected for the development of a

Wetland Conservation Plan in Oregon, reports and documents that are on file in the Service's field offices, and personal discussions with experts outside of the Service with extensive knowledge of vernal pool species and habitats.

We utilized Geographic Information System (GIS) data derived from a variety of Federal, State, and local agencies, and from private organizations and individuals. To identify where vernal pool species and habitats occur we evaluated GIS data of vernal pool habitats by Holland (1998 and 2002), and species occurrences information from the CNDDB (2001). We presumed occurrences identified in CNDDB to be extant until we received documentation that the occurrences have been extirpated. We also relied on unpublished species occurrence data contained within our files. We produced preliminary maps using GIS information that plotted species occurrences and vernal pool habitats superimposed on SPOT imagery (CNES/SPOT Image Corporation 1993–2000). The use of SPOT imagery allowed us to identify landmarks such as roads, cities, rivers, and urban areas.

Because the minimum mapping unit of the Holland (1998 and 2002) vernal pool habitat data was 16 ha (40 ac) and the resolution of the SPOT imagery did not allow us to identify all vernal pool habitat areas, we then refined unit boundaries based on additional GIS data layers when necessary and available, including soils information from the Soil Survey Geographic (SSURGO) data bases (U.S. Department of Agriculture (USDA) 1998–2001), and the California State Soil Geographic (STATSGO) data bases (USDA 1994). We used geologic information developed by the California Department of Mines and Geology (CDMG) (2000) and Liss (2001). To identify the extent of flat or gently sloping topography where vernal pools are found we evaluated Digital Elevation Models from the U.S. Geologic Survey (2000).

We also used a number of local GIS data sets for specific areas, including information developed through the Riverside Multiple Species HCP and the Vernal Pools of Southern California Final Recovery Plan (Service 1998), habitat mapping for Butte County (EPA 1994), Tehama County (2001), Shasta County (2001) Placer County (Glazner 2001), Solano County (2000), Yolo County (1995), Sacramento County (1999) and San Joaquin County (2000) in California, and by the Rogue Valley Council of Governments in Oregon (Evans 2000). Other smaller scale mapping efforts were reviewed from Solano County Farmlands and Open Space (2000) and East Bay Regional Parks District (2001). The specific layers used and the methodology employed for each unit is described within the unit descriptions. To determine land ownership within each unit we used data from the State of California (Davis *et al.* 1998) and the U.S. Bureau of Indian Affairs in Sacramento, California (2001).

Primary Constituent Elements

In accordance with section 3(5)(A)(i) of the Act and regulations at 50 CFR 424.12, in determining which areas to propose as critical habitat, we consider those physical and biological features (primary constituent elements) that are essential to the conservation of the species and that may require special management considerations or protection. These features include, but are not limited to—space for individual and population growth, and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, and dispersal; and habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

When considering the designation of critical habitat for vernal pool crustaceans, we focused on the principal biological and physical features that support vernal pool crustacean feeding, growth, breeding, reproduction, and dispersal. Vernal pool crustaceans are found only in ephemeral wetland habitats that contain water during the winter, when temperatures are suitable for cyst hatching and juvenile development. Individuals have never been found in riverine, marine, or other permanent bodies of water.

Generally, we identified two primary constituent elements for all four vernal pool crustacean species addressed in this proposed rule. Each species has primary constituent elements that differ slightly from these general elements discussed in later sections of this rule. We determined that these proposed primary constituent elements of critical habitat provide for the physiological, behavioral, and ecological requirements of the vernal pool crustaceans.

The first primary constituent element provides the aquatic environment required for cyst incubation and hatching, growth and maturation, reproduction, feeding, sheltering, and dispersal, and the appropriate periods of dessication for cyst dormancy and to eliminate predators such as bullfrogs, fish, and other aquatic predators that depend on year round inundation of wetland habitats to survive. We conclude this element is essential to the conservation of vernal pool crustaceans because these species are ecologically dependent on seasonal fluctuations, such as absence or presence of water during specific times of the year, and duration of inundation (59 FR 48136). They cannot persist in perennial wetlands or wetlands that are inundated for the majority of the year, nor can they persist without periodic seasonal inundation.

The second primary constituent element is essential to maintain the aquatic phase of the vernal pool habitat. The entire vernal pool complex, including the pools, swales, and associated uplands, is essential to support the aquatic functions of the vernal pool habitat. Although the uplands are not actually occupied by vernal pool crustaceans, they nevertheless are essential to the conservation of vernal pool habitat and crustaceans because they maintain the aquatic phase of vernal pools and swales. Associated uplands are also essential to provide nutrients that form the basis of the vernal pool food chain, including a primary food source for the vernal pool crustaceans.

We have used vernal pool complexes as the basis for determining populations of vernal pool crustaceans since the species were first proposed for listing. The final rule to list the four vernal pool crustaceans states that ''[t]he genetic characteristics of the three fairy shrimp and vernal pool tadpole shrimp, as well as ecological conditions, such as watershed contiguity, indicate that populations of these animals are defined by pool complexes rather than by individual vernal pools' (Fugate 1992, Fugate 1998, King 1996). Therefore, the most accurate indication of the distribution and abundance of the four vernal pool crustaceans is the number of inhabited vernal pool complexes. Individual vernal pools occupied by the four species listed herein are most appropriately referred to as ''subpopulations'' (59 FR 48137). Our use of vernal pool complexes to define populations of the four listed crustaceans was upheld by the U.S. District Court in post-listing challenge to the listing (*Building Industry Association of Superior California*). The July 25, 1997, decision stated: ''The Court finds that the plaintiffs were on notice that the FWS would consider vernal pool complexes as a basis for determining fairy shrimp populations. The Court also concludes that the use of this methodology was neither arbitrary nor capricious.'' The Court of Appeals

for the D.C. Circuit upheld the district court's decision, and the Supreme Court has declined to hear the case.

In identifying specific primary constituent elements for each of the four vernal pool crustaceans, we expanded upon the general primary constituent elements described above and focused on the specific habitat requirements of each individual vernal pool crustacean species. These habitat requirements and the specific primary constituent elements for each vernal pool crustacean are described below.

Conservancy Fairy Shrimp Primary Constituent Elements

The Conservancy fairy shrimp is uniquely adapted to the ephemeral conditions of its vernal pool habitat. Helm (1998) found that the life span and maturation rate of Conservancy fairy shrimp did not differ significantly from other fairy shrimp species under the conditions he observed. Helm (1998) found that Conservancy fairy shrimp reached maturity in an average of 46 days, and lived for as long as 154 days. However, aquatic invertebrate growth rates are largely controlled by water temperature and can vary greatly (Eriksen and Brown 1980, Helm 1998). Eriksen and Belk (1999) observe that Conservancy fairy shrimp produce large cohorts of offspring, and is an ''especially hyperactive swimmer and filter feeder.'' Conservancy fairy shrimp have only been observed to produce one cohort of offspring each wet season (Eriksen and Belk 1999).

Observations suggest this species is generally found in pools that are relatively large and turbid (King *et al.* 1996, Helm 1998, Eriksen and Belk 1999). Helm (1998) found that most Conservancy fairy shrimp occurrences were generally within vernal pools formed on fertile, basin rim soils. These pool types may be over several acres in size, and are often alkaline. Soil types where the species is known to occur include Anita, Pescadero, Riz, Solano, Edminster, San Joaquin, and Peters soil series.

Conservancy fairy shrimp occur with several other vernal pool crustaceans, including vernal pool fairy shrimp, California linderiella, and vernal pool tadpole shrimp (King *et al.* 1996, Eriksen and Belk 1999, Helm 1998). In general, Conservancy fairy shrimp have very large populations within a given pool, and is usually the most abundant fairy shrimp when more than one fairy shrimp species is present (Helm 1998, Eriksen and Belk 1999). Conservancy fairy shrimp are eaten by vernal pool tadpole shrimp (Alexander and Schlising 1997), as well as a variety of insect and vertebrate predator species.

When considering the designation of critical habitat for Conservancy fairy shrimp, we focused on the principal biological and physical features that support Conservancy fairy shrimp feeding and growth, breeding and reproduction, and dispersal. These primary constituent elements are found in areas that support vernal pools, swales, or other ephemeral ponds and depressions, and their associated uplands. The primary constituent elements for Conservancy fairy shrimp include—

(1) 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 Conservancy 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

(2) 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.

All of the above described primary constituent elements do not have to occur simultaneously within a unit for the unit to constitute critical habitat for Conservancy fairy shrimp. We determined the primary constituent elements of critical habitat for Conservancy fairy shrimp based on studies on their habitat and population biology including but not limited to—Eng *et al.* 1990, Gallagher 1996, Alexander and Schlising 1997, Helm 1998, Eriksen and Belk 1999.

Longhorn Fairy Shrimp Primary Constituent Elements

Longhorn fairy shrimp are known only from three general locations, and each of these sites contain very different types of vernal pool habitats. Longhorn fairy shrimp in Contra Costa and Alameda counties live in small, clear, sandstone outcrop pools. These sandstone pools have a pH near neutral, and very low alkalinity and conductivity (Eriksen and Belk 1999). Water temperatures in these pools have been measured between 10 and 18°C (50 and 64°F). In the other two locations in Merced and San Luis Obispo counties where longhorn fairy shrimp occur, they are found in turbid, alkaline, grassland vernal pools (Helm 1998, Eriksen and Belk 1999). Water temperatures in these grassland vernal pools tend to be warmer, between 10 and 28°C (50.0 to 82.0°F). However, no experimental studies have been conducted to determine the specific habitat requirements of longhorn fairy shrimp, and until research addressing the tolerance of longhorn fairy shrimp to a range of temperatures and water chemistries, its potential to occur in other types of vernal pool habitats cannot be ruled out.

Like other fairy shrimp, longhorn fairy shrimp are highly adapted to the variable conditions of vernal pool habitats. Longhorn fairy shrimp require a minimum of 23 days, but averaged 43 days, to reach maturity in artificial pools described by Helm (1998). However, Helm (1998) found no significant differences between the life span or reproductive rate of longhorn fairy shrimp and other species of fairy shrimp he studied.

When considering the designation of critical habitat for longhorn fairy shrimp, we focused on the principal biological and physical features that support longhorn fairy shrimp feeding and growth, breeding and reproduction, and dispersal. These primary constituent elements are found in areas that support vernal pools, swales, or other ephemeral ponds and depressions and their associated uplands. The primary constituent elements for the longhorn fairy shrimp include—

(1) 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 sandstone outcrop pools and turbid alkaline pools, but which are dry during the summer and do not necessarily fill with water every year; and

(2) 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.

All of the above described primary constituent elements do not have to occur simultaneously within a unit for the unit to constitute critical habitat for longhorn fairy shrimp. We determined the primary constituent elements of critical habitat for longhorn fairy shrimp based on studies on their habitat and population biology including but not limited to— Eng *et al.* 1990, Fugate 1992, Gallagher 1996, Fugate 1998, Helm 1998, and Eriksen and Belk 1999.

Vernal Pool Fairy Shrimp Primary Constituent Elements

Vernal pool fairy shrimp generally will not hatch until water temperatures drop to below 10°C (50°F) (Gallagher 1996, Helm 1998). Vernal pool fairy shrimp are capable of hatching multiple times within a single wet season if conditions are appropriate. Helm (1998) observed 6 separate hatches of vernal pool fairy shrimp within a single wet season, and Gallagher (1996) observed 3 separate hatches of vernal pool fairy shrimp in vernal pools in Butte County.

Vernal pool fairy shrimp have been documented to live for as long as 147 days Helm (1998), but their life cycle and longevity is dependant upon water temperature as well as other environmental factors. Vernal pool fairy shrimp can reproduce in as few as 18 days at optimal conditions of 20°C (68°F) and can complete their life cycle in as little as 63 days (Gallagher 1996, Helm 1998). However, maturation and reproduction rates of vernal pool crustaceans are controlled by water temperature and can vary greatly (Eriksen and Brown 1980, Helm 1998). Helm (1998) observed that vernal pool fairy shrimp did not reach maturity until 41 days at water temperatures of 15°C (59°F). Vernal pool fairy shrimp have been collected at water temperatures as low as 4.5°C (40°F) (Eriksen and Belk 1999), however, the species has not been found in water temperatures above about 23°C (73°F) (Helm 1998, Eriksen and Belk 1999).

Vernal pool fairy shrimp occupy a variety of different vernal pool habitats, from small, clear, sandstone rock pools to large, turbid, alkaline, grassland valley floor pools (Eng *et al.* 1990, Helm 1998, CNDDB 2001). The pool types where the species has been found include Northern Hardpan, Northern Claypan, Northern Volcanic Mud Flow, and Northern Basalt Flow vernal pools which formed on a variety of geologic formations and soil types (CNDDB 2001). Although vernal pool fairy shrimp have been collected from large vernal pools, including one exceeding 10 ha (25 ac) in area (Eriksen and Belk 1999), they are most frequently found in pools measuring less than 0.02 ha (0.05 ac) in area (Helm 1998, Gallagher 1996). The species occurs at elevations from 10 m (33 ft) to 1,220 m (4,003 ft) (Eng *et al.* 1990), and is typically found in pools with low to moderate amounts of salinity or total dissolved solids (Keeley 1984, Syrdahl 1993). Vernal pools are mostly rain fed, resulting in low nutrient levels and dramatic daily fluctuations in pH, dissolved oxygen, and carbon dioxide (Keeley and Zedler 1998). Although there are many observations of the environmental conditions where vernal pool fairy shrimp have been found, there have been no experimental studies investigating the specific habitat requirements of this species.

When considering the designation of critical habitat for vernal pool fairy shrimp, we focused on the principal biological and physical features that support vernal pool fairy shrimp feeding and growth, breeding and reproduction, and dispersal. These primary constituent elements are found in areas that support vernal pools, swales, or other ephemeral ponds and depressions and their associated uplands. The primary constituent elements for vernal pool fairy shrimp include—

(1) 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 vernal pool fairy shrimp incubation, reproduction, dispersal, feeding, and sheltering, including but not limited to Northern Hardpan, Northern Claypan, Northern Volcanic Mud Flow, and Northern Basalt Flow vernal pools formed on a variety of geologic formations and soil types, but which are dry during the summer and do not necessarily fill with water every year; and

(2) 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.

All of the above described primary constituent elements do not have to occur simultaneously within a unit for the unit to constitute critical habitat for one of these species. We determined the primary constituent elements of critical habitat for vernal pool fairy shrimp based on studies on their habitat and population biology including but not limited to—Eng *et al.* 1990, Fugate 1992, Gallagher 1996, Fugate 1998, Helm 1998, and Eriksen and Belk 1999.

Vernal Pool Tadpole Shrimp Primary Constituent Elements

Although the vernal pool tadpole shrimp is adapted to survive in ephemeral vernal pool habitat, the species has a relatively long life span compared to other vernal pool crustaceans. Helm (1998) found that vernal pool tadpole shrimp lived significantly longer than any other species observed under the same conditions except California linderiella (*Linderiella occidentalis*). Vernal pool tadpole shrimp continue growing throughout their lives, periodically molting their shells. These shells can often be found in vernal pools where the species occurs. 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. Other researchers have observed that vernal pool tadpole shrimp generally take between 21 to 28 days to mature (Ahl 1991, King 1996). Ahl (1991) found that reproduction did not begin until individuals were larger than 10 mm (0.39 in) carapace length. Variation in growth and maturation rates may be a result of differences in water temperature, which strongly influences the growth rates of aquatic invertebrates.

Vernal pool tadpole shrimp occur in a wide variety of vernal pool habitats (Helm 1998). They have been found in pools with water temperatures ranging from 10°C (50°F) to 29°C (84°F) and pH ranging from 6.2 to 8.5 (Syrdahl 1993, King 1996). However, vernal pools exhibit daily and seasonal fluctuations in pH, temperature, dissolved oxygen, and other water chemistry characteristics (Syrdahl 1993, Scholnick 1995, Keeley 1998a). Determining vernal pool tadpole shrimp habitat requirements is not possible based on anecdotal evidence, and the tolerances of this species to specific environmental conditions have yet to be determined. Although vernal pool tadpole shrimp are 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. Platenkamp (1998) found that vernal pool tadpole shrimp presence differed significantly between geomorphic surfaces at Beale Air Force Base and the species was most likely to be found on Riverbank formation.

When considering the designation of critical habitat for vernal pool tadpole shrimp, we focused on the principal biological and physical features that support vernal pool tadpole shrimp feeding and growth, breeding and reproduction, and dispersal. These primary constituent elements are found in areas that support vernal pools, swales, or other ephemeral ponds and depressions and their associated uplands. The primary constituent elements for vernal pool fairy shrimp include:

(1) 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 vernal pool tadpole shrimp incubation, reproduction, dispersal, feeding, and sheltering, but which are dry during the summer and do not necessarily fill with water every year; including but not limited to vernal pools on Redding and Corning soils on high terrace landforms, and

(2) 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.

All of the above described primary constituent elements do not have to occur simultaneously within a unit for the unit to constitute critical habitat for vernal pool tadpole shrimp. We determined the primary constituent elements of critical habitat for vernal pool tadpole shrimp based on studies on their habitat and population biology including but not limited to—Longhurst 1955, Lynch 1966, Ahl 1991, King 1996, and Helm 1998.

General Primary Constituent Elements for Vernal Pool Plants

The primary constituent elements of critical habitat for vernal pool plants are those habitat components that are essential for the primary biological needs of germination, growth, reproduction, and dispersal. All of the vernal pool plants addressed in this proposed rule are found only in ephemeral wetlands including vernal pools and swales. None of these species are known to occur in permanent wetlands, and none are found in strictly upland areas that are never inundated.

Generally, we identified two primary constituent elements for all eleven vernal pool plants addressed in this proposed rule. Each species has primary constituent elements that differ slightly from these general elements discussed in later sections of this rule. We determined that these proposed primary constituent elements of critical habitat provide for the physiological and ecological requirements of the vernal pool plants.

The first primary constituent element provides the necessary soil moisture and aquatic environment required for seed germination, growth and maturation, reproduction, and dispersal, and the appropriate periods of dry-down for seed dormancy. Both the wet and dry phases of the vernal pool help to reduce competition with strictly terrestrial or strictly aquatic plant species. The wet phase provides the necessary cues for germination and growth, while the drying phase allows the vernal pool plants to flower and produce seeds. We conclude this element is essential to the conservation of the vernal pool plants because these species are ecologically dependent on seasonal fluctuations, such as absence or presence of water during specific times of the year, and duration of inundation and the rate of drying of their habitats. They cannot persist in perennial wetlands or wetlands that are inundated for the majority of the year, nor can they persist without periodic seasonal inundation.

The second primary constituent element is essential to maintain both the aquatic phase and the drying phase of the vernal pool habitat. Although the vernal pool plants addressed in this proposed rule do not occur in the strictly upland areas surrounding vernal pools, they are dependent on these upland areas to maintain the aquatic and drying phases of the vernal pool. The germination of vernal pool plants is dependant on the timing and length of inundation of the vernal pool. The rate of vernal pool drying, during which vernal pool plants must flower and produce seeds, is also largely controlled by interactions between the vernal pool and the surrounding uplands (Hanes *et al.* 1990, Hanes and Stromberg 1998).

In identifying specific primary constituent elements for each of the eleven vernal pool plant species addressed in this proposed rule, we expanded upon the general primary constituent elements described above to focus on the specific habitat requirements of each of the eleven individual species. These habitat requirements and the specific primary constituent elements for each species are described below.

Butte County Meadowfoam Primary Constituent Elements

The swales and vernal pools where Butte County meadowfoam grows are on intermediate fan terraces (Kelley and Associates Environmental Sciences 1992) in annual grasslands with a mima mound topography. Large cobbles are present throughout the pools and swales (Jokerst 1989). These pools are associated with Tuscan, Redbluff, Riverbank, and Modesto geologic formations, and most of them occur on soils of the Tuscan-Anita and the Redding-Igo complexes. Anita and Igo soils are confined to the pools and swales. Tuscan and Redding soils are restricted to the mounds. Anita soils can be up to 50 cm (19.7 in) deep, whereas Igo soils are no more than 18 cm (7.1 in) deep; the two soils are underlain by iron-silica cemented and indurated hardpan, respectively (Kelley and Associates Environmental Sciences 1993). Butte County meadowfoam has been observed on Anita clay soils annually regardless of rainfall but appears on Igo soils only in years of above average rainfall (Kelley and Associates Environmental Sciences 1992a, Crompton 1993, Schonholtz *in litt.* 1995), presumably because the former can hold approximately twice as much moisture (Kelley and Associates Environmental Sciences 1993). Confirmed occurrences have been found at 50 to 90 m (165 to 300 ft) in elevation (McNeill and Brown 1979, CNDDB 2001).

The primary constituent elements of critical habitat for Butte County meadowfoam are those habitat components that are essential for the primary biological needs of germination, growth, reproduction, and dispersal. These primary constituent elements are found in areas that support vernal pools, swales, or other ephemeral ponds and depressions and their associated uplands. The primary constituent

elements for Butte County meadowfoam include:

(1) Vernal pools, swales, and other ephemeral wetlands and depressions of appropriate sizes and depths and the adjacent upland margins of these depressions that sustain Butte County meadowfoam germination, growth and reproduction, including but not limited to vernal pool swales and the margins of vernal pools on the Tuscan, Redbluff, Riverbank, and Modesto geologic formations underlain by Tuscan-Anita and Igo-Redding complex soils among others. These habitats typically become inundated during winter rains, but are dry during the summer and do not necessarily fill with water every year; and

(2) The associated watershed(s) and hydrologic features, including the pool basin, swales, and surrounding uplands (which may vary in extent depending on pool size and depth, soil type and depth, hardpan or claypan type and extent, topography, and climate) that contribute to the filling and drying of the vernal pool or ephemeral wetland, and that maintain suitable periods of pool inundation, water quality, and soil moisture for Butte County meadowfoam germination, growth and reproduction, and dispersal, but not necessarily every year.

All of the above described primary constituent elements do not have to occur simultaneously within a unit for the unit to constitute critical habitat for Butte County meadowfoam. We determined the primary constituent elements of critical habitat for Butte County meadowfoam based on studies of their habitat and population biology including but not limited to—Kalin-Arroyo 1973, Dole 1988, Jokerst 1989, Kelley and Associates Environmental Sciences 1992a, and Crompton 1993.

Contra Costa Goldfields Primary Constituent Elements

Contra Costa goldfields typically grows in vernal pools, swales, moist flats, and depressions within a grassland matrix (CNDDB 2001). However, several historical collections were from populations growing in the saline-alkaline transition zone between vernal pools and tidal marshes on the eastern margin of the San Francisco Bay (Baye USFWS *in litt.* 2000a). The herbarium sheet for one of the San Francisco Bay specimens notes that the species also grew in evaporating ponds used to concentrate salt (Baye *in litt.* 2000b). The vernal pool types from which this species has been reported are Northern Basalt Flow, Northern Claypan, and Northern Volcanic Ashflow (Sawyer and Keeler-Wolf 1995). The landforms and geologic formations for sites where Contra Costa goldfields occurs have not yet been determined. Most occurrences of Contra Costa goldfields are at elevations of 2 to 61 m (6 to 200 ft), but the recently discovered Monterey County occurrences are at 122 m (400 ft) and one Napa County occurrence is at 445 m (1,460 ft) elevation (CNDDB 2001).

The soil types that maintain these vernal pool habitats for Contra Costa goldfields have not yet been identified for most localities. The soil series from which it is known are Aiken, Antioch, Concepcion, Conejo, Crispin, Haire, Linne, Los Robles, Rincon, Solano, and San Ysidro, plus the Arnold-Santa Ynez, Hambright-rock outcrop, and Los Osos complexes. Soil textures, where known, are clays or loams. At least in Solano County and on the shores of San Francisco Bay, Contra Costa goldfields grows in alkaline or saline-alkaline sites (Baye *in litt.* 2000a, Baye *in litt.* 2000b, CNDDB 2001).

The primary constituent elements of critical habitat for Contra Costa goldfields are those habitat components that are essential for the primary biological needs of germination, growth, reproduction, and dispersal. These primary constituent elements are found in areas that support vernal pools, swales, or other ephemeral ponds and depressions and their associated uplands. The primary constituent elements for Contra Costa goldfields include—

(1) Vernal pools, swales, moist flats, and other ephemeral wetlands and depressions of appropriate sizes and depths and the adjacent upland margins of these depressions that sustain Contra Costa goldfields germination, growth and reproduction, including, but not limited to, vernal pools on clay soils from a variety of soils series, rock outcrop pools on basalt flows, and vernal pools in saline alkaline transition zones with tidal marsh habitats. All of these habitats typically become inundated during winter rains, but are dry during the summer and do not necessarily fill with water every year; and

(2) The associated watershed(s) and hydrologic features, including the pool basin, swales, and surrounding uplands (which may vary in extent depending on pool size and depth, soil type and depth, hardpan or claypan type and extent, topography, and climate) that contribute to the filling and drying of the vernal pool or ephemeral wetland, and that maintain suitable periods of pool inundation, water quality, and soil moisture for Contra Costa goldfields germination, growth and reproduction, and dispersal, but not necessarily every year.

All of the above described primary constituent elements do not have to occur simultaneously within a unit for the unit to constitute critical habitat for Contra Costa goldfields. We determined the primary constituent elements of critical habitat for Contra Costa goldfields based on studies on their habitat and population biology including but not limited to—Ornduff 1966, Ornduff 1979, Crawford and Ornduff 1989, Skinner and Pavlik 1994.

Hoover's Spurge Primary Constituent Elements

Vernal pools from which Hoover's spurge has been reported are classified as Northern Hardpan and Northern Claypan vernal pools (Sawyer and Keeler-Wolf 1995). The pools supporting this species vary in size from 0.19 to 243 ha (0.47 to 600 ac), with a median area of 0.58 ha (1.43 ac) (Stone *et al.* 1988). Many occurrences consist of multiple pools that vary in area and in depth, yet not all pools at a site support Hoover's spurge. Deeper pools apparently provide better habitat for this species because the duration of inundation is longer. This species may occur along the margins or in the deepest portions of the dried pool bed (Stone *et al.* 1988, Alexander and Schlising 1997). A particularly important feature of Hoover's spurge microhabitat, at least in the deeper pools, is that it is nearly devoid of other vegetation, and thus competition from other plants is reduced (Stone *et al.* 1988).

Vernal pools supporting Hoover's spurge occur mostly on alluvial fans or terraces of ancient rivers or streams, with a few on the rim of the Central Valley basin. Hoover's spurge is found on a wide variety of soils, which range in texture from clay to sandy loam. Soil series from which it has been reported include Anita, Laniger, Lewis, Madera, Meikle, Riz, Tuscan, Whitney, Willows. All of these soils may not be equally suitable for this species, however. For example, in one Vina Plains pool, Hoover's spurge grew primarily in the portion that was underlain by Tuscan loam and was nearly absent from the portion underlain by Anita clay (Alexander and Schlising 1997).

In the Sacramento Valley occupied pools are on acidic soils over iron-silica cemented hardpan. Most pools supporting Hoover's spurge in the San Joaquin Valley are on neutral to saline-alkaline soils over lime-silica cemented hardpan or claypan (Broyles 1987, Stone *et al.* 1988, Sawyer and Keeler-Wolf 1995, CNDDB 2001). Occurrences of

Hoover's spurge have been reported from elevations ranging from 26 m (85 ft) in Glenn County to 128 m (420 ft) in Tehama County (CNDDB 2002).

The primary constituent elements of critical habitat for Hoover's spurge are those habitat components that are essential for the primary biological needs of germination, growth, reproduction, and dispersal. These primary constituent elements are found in areas that support vernal pools, swales, or other ephemeral ponds and depressions and their associated uplands. The primary constituent elements for Hoover's spurge include—

(1) Vernal pools, swales, and other ephemeral wetlands and depressions of appropriate sizes and depths and the adjacent upland margins of these depressions that sustain Hoover's spurge germination, growth and reproduction, including but not limited to vernal pools formed on neutral to saline-alkaline soils over lime-silica cemented hardpan or claypan, or on acidic soils over iron-silica cemented hardpan, that typically become inundated during winter rains, but are dry during the summer and do not necessarily fill with water every year; and

(2) The associated watershed(s) and hydrologic features, including the pool basin, swales, and surrounding uplands (which may vary in extent depending on pool size and depth, soil type and depth, hardpan or claypan type and extent, topography, and climate) that contribute to the filling and drying of the vernal pool or ephemeral wetland, and that maintain suitable periods of pool inundation, water quality, and soil moisture for Hoover's spurge germination, growth and reproduction, and dispersal, but not necessarily every year.

All of the above described primary constituent elements do not have to occur simultaneously within a unit for the unit to constitute critical habitat for Hoover's spurge. We determined the primary constituent elements of critical habitat for Hoover's spurge based on studies on their habitat and population biology including but not limited to—Broyles 1987, Stone *et al.* 1988, and Alexander and Schlising 1997.

Succulent Owl's-Clover Primary Constituent Elements

Succulent owl's-clover is known mostly from vernal pools occurring on alluvial terrace landforms. These pool types have been described as both Northern Claypan and Northern Hardpan vernal pools (Sawyer and Keeler-Wolf 1995) within annual grassland communities (CNDDB 2001). However, it is found on Northern Basalt Flow vernal pools on Hideaway soils series at one location in the San Joaquin Valley. It is known from both small and large pools (EIP Associates 1999). Although not all pools occupied by this taxon have been studied in detail, Stebbins *et al.* (1995) collected data on six occupied pools in Fresno and Madera counties. Some were typical ''bowl-like'' pools, whereas others were more similar to swales. This subspecies has been reported from pools with both long and short inundation periods (EIP Associates 1999) and from both shallow and ''abnormally deep vernal pools,'' but approximate depth of these pools was not given (CNDDB 2001).

Soil series supporting succulent owl's-clover include Amador, Anderson, Corning, Fallbrook, Keyes, Pentz, Ramona, Redding, San Joaquin, Vista, and Yokohl, as well as the Pollasky-Montpellier complex. Soil textures at those sites range from extremely stony loam to loamy clay. In the proposed UC Merced campus and community area, the species is found primarily on Redding gravelly loam; however, Corning, Keyes, and Pentz soils also contain occurrences of the species (EIP Associates 1999). Populations of succulent owl's-clover have been reported from elevations of 24 m (80 ft) at the San Joaquin County site to 700 m (2,300 ft) at Kennedy Table in Madera County (CNDDB 2001).

The primary constituent elements of critical habitat for succulent owl's-clover are those habitat components that are essential for the primary biological needs of germination, growth, reproduction, and dispersal. These primary constituent elements are found in areas that support vernal pools, swales, or other ephemeral ponds and depressions and their associated uplands. The primary constituent elements for succulent owl's-clover include—

(1) Vernal pools, swales, and other ephemeral wetlands and depressions of appropriate sizes and depths and the adjacent upland margins of these depressions that sustain succulent owl's-clover germination, growth and reproduction, including but not limited to hardpan vernal pools on alluvial terraces and San Joaquin, Redding, Corning, Keyes, and Pentz soils series, among others, and northern basalt flow vernal pools on Hideaway soils series, that typically become inundated during winter rains, but are dry during the summer and do not necessarily fill with water every year; and

(2) The associated watershed(s) and hydrologic features, including the pool basin, swales, and surrounding uplands (which may vary in extent depending on pool size and depth, soil type and depth, hardpan or claypan type and extent, topography, and climate) that contribute to the filling and drying of the vernal pool or ephemeral wetland, and that maintain suitable periods of pool inundation, water quality, and soil moisture for succulent owl's-clover germination, growth, reproduction, and dispersal, but not necessarily every year.

All of the above described primary constituent elements do not have to occur simultaneously within a unit for the unit to constitute critical habitat for succulent owl's-clover. We determined the primary constituent elements of critical habitat for succulent owl's-clover based on studies of their habitat and population biology including but not limited to—Hoover 1968, Chuang and Heckard 1991, Chuang and Heckard 1993, and EIP Associates 1999.

Colusa Grass Primary Constituent Elements

Colusa grass has the broadest ecological range among the Orcuttieae. It occurs on the rim of alkaline basins in the Sacramento and San Joaquin valleys, as well as on acidic soils of alluvial fans and stream terraces along the eastern margin of the San Joaquin Valley and into the adjacent foothills (Stone *et al.* 1988). Colusa grass has been found in Northern Claypan and Northern Hardpan vernal pool types (Sawyer and Keeler-Wolf 1995) within rolling grasslands (Crampton 1959). This species typically grows in the deepest portion of the pool (Crampton 1959) but also may occur on the margins (Hoover 1937, Stone *et al.* 1988). Deeper pools are most likely to provide the long inundation period required for germination (EIP Associates 1999).

Several soil series maintain the vernal pool habitats where Colusa grass is found. Solano and Yolo county sites where Colusa grass grows contain vernal pools formed by soils in the Pescadero series, whereas those in central Merced County are formed by soils in the Landlow and Lewis series (Silveira in litt. 2000). The eastern Merced County and Stanislaus County sites include vernal pool habitats formed by the Bear Creek, Corning, Greenfield, Keyes, Meikle, Pentz, Peters, Raynor, Redding, and Whitney series (Stone *et al.* 1988, EIP Associates 1999, CNDDB 2002). The type and composition of impermeable layers underlying occupied vernal pools also vary, ranging from claypan in the Sacramento Valley to lime-silica cemented hardpan in the San Joaquin Valley basins, to iron-silica cemented hardpan in the eastern margin of the San Joaquin Valley. Tuffaceous

alluvium underlies some eastern San Joaquin Valley pools and intermittent streams where Colusa grass grows (Stone *et al.* 1988).

The primary constituent elements of critical habitat for Colusa grass are those habitat components that are essential for the primary biological needs of germination, growth, reproduction, and dispersal. These primary constituent elements are found in areas that support vernal pools, swales, or other ephemeral ponds and depressions and their associated uplands. The primary constituent elements for Colusa grass include—

(1) Vernal pools, swales, and other ephemeral wetlands and depressions of appropriate sizes and depths and the adjacent upland margins of these depressions that sustain Colusa grass germination, growth and reproduction, and that typically become inundated during winter rains, including but not limited to vernal pools formed on the rim of alkaline basins in the Sacramento and San Joaquin valleys, as well as on acidic soils of alluvial fans and stream terraces along the eastern margin of the San Joaquin Valley and into the adjacent foothills. All of these pool types are dry during the summer and do not necessarily fill with water every year; and

(2) The associated watershed(s) and hydrologic features, including the pool basin, swales, and surrounding uplands (which may vary in extent depending on pool size and depth, soil type and depth, hardpan or claypan type and extent, topography, and climate) that contribute to the filling and drying of the vernal pool or ephemeral wetland, and that maintain suitable periods of pool inundation, water quality, and soil moisture for Colusa grass germination, growth and reproduction, and dispersal, but not necessarily every year.

All of the above described primary constituent elements do not have to occur simultaneously within a unit for the unit to constitute critical habitat for Colusa grass. We determined the primary constituent elements of critical habitat for Colusa grass based on studies on their habitat and population biology including but not limited to—Crampton 1976, Griggs 1980, Reeder 1982, Griggs and Jain 1983, Keeley 1998a, and Stone *et al.* 1988.

Greene's Tuctoria Primary Constituent Elements

Greene's tuctoria has been found in three types of vernal pools: Northern Basalt Flow, Northern Claypan, and Northern Hardpan (Sawyer and Keeler-Wolf 1995, Stone *et al.* 1988). Occupied pools are or were underlain by iron-silica cemented hardpan, tuffaceous alluvium, or claypan (Stone *et al.* 1988). Of pools where the species was known to be extant in 1987, the median size was 0.6 ha (1.5 ac), with a range of 50 m2 (0.01 ac) to 3.4 ha (8.4 ac) (Stone *et al.* 1988). Stone *et al.* (1988) noted that Greene's tuctoria grew in shallower pools than other members of the tribe or on the shallow margins of deeper pools, but they did not quantify pool depth. At the Vina Plains, Greene's tuctoria grew in pools of ''intermediate'' size, which dried in April or early May of 1995 (Alexander and Schlising 1997). The Central Valley pools containing Greene's tuctoria are (or were) in grasslands; the Shasta County occurrence is surrounded by pine forest (CNDDB 2001). Occupied pools in the Central Valley are (or were) at elevations of 33.5 to 134 m (110 to 440 ft) (Stone *et al.* 1988), whereas the Shasta County occurrence is at 1,067 m (3,500 ft) (CNDDB 2001).

In Tehama and Butte counties, Greene's tuctoria grows mostly on Anita clay and Tuscan loam soils, with one occurrence on Tuscan stony clay loam. Soil types are not certain for several other occurrences in this region; one is on either the Rocklin or the San Joaquin series, and the others are unknown. The single occurrence in the central portion of the Central Valley, near the Glenn and Colusa county line, is on strongly saline-alkaline Willows clay (Silveira *in litt.* 2000). On the eastern margin of the San Joaquin Valley, Greene's tuctoria is known to grow on a number of different soil series including Archerdale, Bear Creek, Exeter, Meikle, Ramona, Raynor, Redding, and San Joaquin.

The primary constituent elements of critical habitat for Greene's tuctoria are those habitat components that are essential for the primary biological needs of germination, growth, reproduction, and dispersal. These primary constituent elements are found in areas that support vernal pools, swales, or other ephemeral ponds and depressions and their associated uplands. The primary constituent elements for Greene's tuctoria include—

(1) Vernal pools, swales, and other ephemeral wetlands and depressions of appropriate sizes and depths and the adjacent upland margins of these depressions that sustain Greene's tuctoria germination, growth and reproduction, including but not limited to Northern Claypan, Northern Hardpan and Northern Basalt flow vernal pools, that typically become inundated during winter rains, but are dry during the summer and do not necessarily fill with water every year; and

(2) The associated watershed(s) and hydrologic features, including the pool basin, swales, and surrounding uplands (which may vary in extent depending on pool size and depth, soil type and depth, hardpan or claypan type and extent, topography, and climate) that contribute to the filling and drying of the vernal pool or ephemeral wetland, and that maintain suitable periods of pool inundation, water quality, and soil moisture for Greene's tuctoria germination, growth and reproduction, and dispersal, but not necessarily every year.

All of the above described primary constituent elements do not have to occur simultaneously within a unit for the unit to constitute critical habitat for Greene's tuctoria. We determined the primary constituent elements of critical habitat for Greene's tuctoria based on studies on its habitat and population biology including but not limited to—Griggs 1980, Griggs and Jain 1983, Stone *et al.* 1988, Keeley 1988, and Alexander and Schlising 1997.

Hairy Orcutt Grass Primary Constituent Elements

This species is found within vernal pools formed on high or low stream terraces and alluvial fans (Stone *et al.* 1988). The median size of occupied pools measured in the late 1980's was 1.7 ha (4.2 ac), with a range of 0.34 to 250 ha (0.8 to 617.5 ac) (Stone *et al.* 1988). At the Vina Plains, hairy Orcutt grass was found growing only in pools that held water until May, June, or July in 1995, not in those that dried in April (Alexander and Schlising 1997). This species is known from elevations of 26 m (85 ft) in Glenn County to 123 m (405 ft) in Madera County (CNDDB 2001).

Hairy Orcutt grass is found on both acidic and saline-alkaline soils, in pools with an iron-silica cemented hardpan or claypan. In Tehama and Butte counties, pools supporting hairy Orcutt grass occur on the Anita and Tuscan soil series (Stone *et al.* 1988, CNDDB 2001). At one pool in the Vina Plains that spans both Anita clay and Tuscan loam soils, hairy Orcutt grass was found growing primarily on the Anita clay (Alexander and Schlising 1997). At the Sacramento National Wildlife Refuge, hairy Orcutt grass occurs on the Willows and Riz soil series (Silveira *in litt.* 2000), whereas in the Southern Sierra Foothills Vernal Pool Region it occurs on the Cometa, Greenfield, Hanford, Meikle, and Whitney soil series (Stone *et al.* 1988).

The primary constituent elements of critical habitat for hairy Orcutt grass are those habitat components that are essential for the primary biological

needs of germination, growth, reproduction, and dispersal. These primary constituent elements are found in areas that support vernal pools, swales, or other ephemeral ponds and depressions and their associated uplands. The primary constituent elements for hairy Orcutt grass include—

(1) Vernal pools, swales, and other ephemeral wetlands and depressions of appropriate sizes and depths and the adjacent upland margins of these depressions that sustain hairy Orcutt grass germination, growth and reproduction, including but not limited to features occurring on both acidic and saline-alkaline soils, with an iron-silica cemented hardpan or claypan, and that typically become inundated during winter rains, but are dry during the summer and do not necessarily fill with water every year; and

(2) The associated watershed(s) and hydrologic features, including the pool basin, swales, and surrounding uplands (which may vary in extent depending on pool size and depth, soil type and depth, hardpan or claypan type and extent, topography, and climate) that contribute to the filling and drying of the vernal pool or ephemeral wetland, and that maintain suitable periods of pool inundation, water quality, and soil moisture for vernal pool plant germination, growth and reproduction, and dispersal, but not necessarily every year.

All of the above described primary constituent elements do not have to occur simultaneously within a unit for the unit to constitute critical habitat for hairy Orcutt grass. We determined the primary constituent elements of critical habitat for hairy Orcutt grass based on studies on their habitat and population biology including but not limited to—Crampton 1959, Medeiros, 1976, Griggs 1980, Griggs and Jain 1983, Stone *et al.* 1988, Durgarian 1995, and Alexander and Schlising 1997.

Sacramento Orcutt Grass Primary Constituent Elements

Sacramento Orcutt grass has been found in Northern Hardpan and Northern Volcanic Mudflow vernal pools (Sawyer and Keeler-Wolf 1995). It occurs on high terrace sites (Stone *et al.* 1988) at elevations of 46 to 82 m (150 to 270 ft) (CNDDB 2001). Occupied pools occur in blue oak woodland and annual grassland (Crampton 1959, Griggs 1977, CNDDB 2002). Among occupied pools discovered prior to 1988, the median area was 0.28 ha (0.69 ac) and ranged from 0.1 ha (0.25 ac) to 0.82 ha (2.03 ac). Soils underlying pools where Sacramento Orcutt grass grows are acidic with an iron-silica hardpan (Stone *et al.* 1988), and the pools contain numerous cobbles (Crampton 1959, Stone *et al.* 1988). Four of the known occurrences are on soils in the Redding series, two are on Red Bluff-Redding complex soils, two are (or were) on Xerarents-urban land-San Joaquin complex, and one is on Corning complex soils.

The primary constituent elements of critical habitat for Sacramento Orcutt grass are those habitat components that are essential for the primary biological needs of germination, growth, reproduction, and dispersal. These primary constituent elements are found in areas that support vernal pools, swales, or other ephemeral ponds and depressions and their associated uplands. The primary constituent elements for Sacramento Orcutt grass include—

(1) Vernal pools, swales, and other ephemeral wetlands and depressions of appropriate sizes and depths and the adjacent upland margins of these depressions that sustain Sacramento Orcutt grass germination, growth and reproduction, including but not limited to vernal pools on high terrace landforms on acidic soils such as Red Bluff, Redding, and Corning soil series. These habitats typically become inundated during winter rains, but are dry during the summer and do not necessarily fill with water every year; and

(2) The associated watershed(s) and hydrologic features, including the pool basin, swales, and surrounding uplands (which may vary in extent depending on pool size and depth, soil type and depth, hardpan or claypan type and extent, topography, and climate) that contribute to the filling and drying of the vernal pool or ephemeral wetland, and that maintain suitable periods of pool inundation, water quality, and soil moisture for Sacramento Orcutt grass germination, growth and reproduction, and dispersal, but not necessarily every year.

All of the above described primary constituent elements do not have to occur simultaneously within a unit for the unit to constitute critical habitat for Sacramento Orcutt grass. We determined the primary constituent elements of critical habitat for Sacramento Orcutt grass based on studies on their habitat and population biology including but not limited to—Crampton 1959, Griggs 1980, Griggs and Jain 1983, Holland 1987, and Stone *et al.* 1988.

San Joaquin Valley Orcutt Grass Primary Constituent Elements

San Joaquin Valley Orcutt grass occurs on alluvial fans, high and low stream terraces (Stone *et al.* 1988), and tabletop lava flows (Stebbins *et al.* 1995, CNDDB 2001). This species has been reported in Northern Claypan, Northern Hardpan, and Northern Basalt Flow vernal pools (Sawyer and Keeler-Wolf 1995) within rolling grassland (Crampton 1959). Occupied pools range in surface area from 0.014 to 4.9 ha (0.05 to 12.1 ac), with a median area of 0.62 ha (1.54 ac) (Stone *et al.* 1988). San Joaquin Valley Orcutt grass has been reported from elevations of 30 to 755 m (100 to 2,475 ft); the highest elevation sites are those on the volcanic tabletops of Fresno and Madera counties (Stebbins *et al.* 1995, CNDDB 2001).

The pools where San Joaquin Valley Orcutt grass is known to occur form on acidic soils that vary in texture from clay to sandy loam. Soil series represented include the Hideaway series on Fresno-Madera County volcanic tabletops, and Amador, Cometa, Corning, Greenfield, Los Robles, Madera, Peters, Pollasky-Montpellier complex, Raynor, Redding, and San Joaquin soil series elsewhere in the range. The impermeable layer at historical or extant occurrences included iron-silica cemented hardpan, tuffaceous alluvium, and basaltic rock from ancient volcanic flows (Stone *et al.* 1988, Stebbins *et al.* 1995, EIP Associates 1999, CNDDB 2001).

The primary constituent elements of critical habitat for San Joaquin Valley Orcutt grass are those habitat components that are essential for the primary biological needs of germination, growth, reproduction, and dispersal. These primary constituent elements are found in areas that support vernal pools, swales, or other ephemeral ponds and depressions and their associated uplands. The primary constituent elements for San Joaquin Valley Orcutt grass include—

(1) Vernal pools, swales, and other ephemeral wetlands and depressions of appropriate sizes and depths and the adjacent upland margins of these depressions that sustain San Joaquin Orcutt grass germination, growth and reproduction, including but not limited to vernal pools on alluvial fans, high and low stream terraces, and tabletop lava flows. These habitats typically become inundated during winter rains, but are dry during the summer and do not necessarily fill with water every year; and

(2) The associated watershed(s) and hydrologic features, including the pool

basin, swales, and surrounding uplands (which may vary in extent depending on pool size and depth, soil type and depth, hardpan or claypan type and extent, topography, and climate) that contribute to the filling and drying of the vernal pool or ephemeral wetland, and that maintain suitable periods of pool inundation, water quality, and soil moisture for San Joaquin Valley Orcutt grass germination, growth and reproduction, and dispersal, but not necessarily every year.

All of the above described primary constituent elements do not have to occur simultaneously within a unit for the unit to constitute critical habitat for San Joaquin Valley Orcutt grass. We determined the primary constituent elements of critical habitat for San Joaquin Valley Orcutt grass pools based on studies on their habitat and population biology including but not limited to—Crampton 1959, Griggs 1980, Griggs and Jain 1983, Stone *et al.* 1988, Stebbins *et al.* 1995, Keeley 1998a, and EIP Associates 1999.

Slender Orcutt Grass Primary Constituent Elements

Slender Orcutt grass is found primarily on substrates of volcanic origin (Crampton 1959, Corbin and Schoolcraft 1989). Vernal pools in which slender Orcutt grass grows are classified as Northern Volcanic Ashflow and Northern Volcanic Mudflow vernal pools (Sawyer and Keeler-Wolf 1995). Impervious layers range from iron-silica hardpan to bedrock (Stone *et al.* 1988, Corbin and Schoolcraft 1989, CNDDB 2001). Among the populations studied by Stone and others (1988), the median area of pools occupied by slender Orcutt grass was 0.65 ha (1.6 ac) and ranged from 0.08 to 45 ha (0.2 to 111 ac). On the Modoc Plateau, occupied pools known as of 1989 ranged in size from 2 to 40 ha (5 to 100 ac) and were typically at least 30 cm (11.8 in) deep; this species was restricted to the deepest areas of these pools (Corbin and Schoolcraft 1989). Slender Orcutt grass occurs through a wide range of elevations corresponding to its broad geographical range. The lowest reported elevation was 27 m (90 ft) in Sacramento County (Stone *et al.* 1988) and the highest was 1,756 m (5,761 ft) in Plumas County (Corbin *in litt.* 1999).

Soil types supporting vernal pools where slender Orcutt grass is known to occur are diverse, ranging from slightly to strongly acidic (Stone *et al.* 1988) and from clay to sandy, silty, or cobbly loam (Corbin and Schoolcraft 1989, CNDDB 2001). The soil series has not been reported for all slender Orcutt grass sites but the species has been reported on Collayomi-Aiken-Whispering complex and the Konocti-Hambright complex soils. Modoc Plateau occurrences occur on the Gooval, Lasvar, Lasvar-Pitvar complex, and Nosoni soil series, whereas occurrences in northeastern Sacramento Valley are on the Anita, Guenon, Inks, Inskip, Laniger, Moda, Redding, Toomes, and Tuscan soil series. The Redding soil series also supports slender Orcutt grass in Sacramento County (Stone *et al.* 1988, CNDDB 2001).

Vegetation types in which the occupied pools occur are diverse, ranging from grassland and oak woodland to mixed conifer forest, silver sagebrush (*Artemisia cana*) flats, and sedge meadows (Crampton 1959, CNDDB 2001). Associated species vary throughout the range of slender Orcutt grass. Although slender Orcutt grass grows in the same vernal pool complexes as hairy Orcutt grass in Tehama County (including the Vina Plains Preserve) and Sacramento Orcutt grass in Sacramento County, it has not been found to share any pools with either species (Stone *et al.* 1988, Cochrane *in litt.* 1995a, Alexander and Schlising 1997, CNDDB 2001).

The primary constituent elements of critical habitat for slender Orcutt grass are those habitat components that are essential for the primary biological needs of germination, growth, reproduction, and dispersal. These primary constituent elements are found in areas that support vernal pools, swales, or other ephemeral ponds and depressions and their associated uplands. The primary constituent elements for slender Orcutt grass include—

(1) Vernal pools, swales, and other ephemeral wetlands and depressions of appropriate sizes and depths and the adjacent upland margins of these depressions that sustain slender Orcutt grass germination, growth and reproduction, including but not limited to Northern Volcanic Ashflow and Northern Volcanic Mudflow vernal pools (Sawyer and Keeler-Wolf 1995) with iron-silica and bedrock hardpan impervious layers, and that typically become inundated during winter rains, but are dry during the summer and do not necessarily fill with water every year; and

(2) The associated watershed(s) and hydrologic features, including the pool basin, swales, and surrounding uplands (which may vary in extent depending on pool size and depth, soil type and depth, hardpan or claypan type and extent, topography, and climate) that contribute to the filling and drying of the vernal pool or ephemeral wetland, and that maintain suitable periods of pool inundation, water quality, and soil moisture for slender Orcutt grass germination, growth and reproduction, and dispersal, but not necessarily every year.

All of the above described primary constituent elements do not have to occur simultaneously within a unit for the unit to constitute critical habitat for slender Orcutt grass. We determined the primary constituent elements of critical habitat for slender Orcutt grass based on studies on their habitat and population biology including but not limited to—Griggs 1980, Griggs 1981, Reeder 1982, Griggs and Jain 1983, Stone *et al.* 1988, Corbin and Schoolcraft 1989, and Alexander and Schlising 1997.

Solano Grass Primary Constituent Elements

Solano grass has been found only in the Northern Claypan type of vernal pool (Sawyer and Keeler-Wolf 1995) within annual grassland (CNDDB 2001). Pools where Solano grass occurs tend to be milky from suspended sediments (Holland 1987). The occupied pools in Solano County are more properly described as alkaline playas or intermittent lakes due to their large surface area (Crampton 1959), whereas those at the Yolo County site are ''relatively small'' (Witham *in litt.* 2000a). Soils underlying known Solano grass sites are saline-alkaline clay or silty clay in the Pescadero series (Crampton 1959, CNDDB 2001). Known occurrences are at elevations of approximately 5 to 11 m (15 to 35 ft) (CNDDB 2001).

The primary constituent elements of critical habitat for Solano grass are those habitat components that are essential for the primary biological needs of germination, growth, reproduction, and dispersal. These primary constituent elements are found in areas that support vernal pools, swales, or other ephemeral ponds and depressions and their associated uplands. The primary constituent elements for Solano grass include:

(1) Vernal pools, swales, and other ephemeral wetlands and depressions of appropriate sizes and depths and the adjacent upland margins of these depressions that sustain Solano grass germination, growth and reproduction, including but not limited to Northern Claypan vernal pools (Sawyer and Keeler-Wolf 1995) on saline-alkaline clay or silty clay in the Pescadero soil series that typically become inundated during winter rains, but are dry during the summer and do not necessarily fill with water every year; and

(2) The associated watershed(s) and hydrologic features, including the pool basin, swales, and surrounding uplands (which may vary in extent depending on pool size and depth, soil type and depth, hardpan or claypan type and extent, topography, and climate) that contribute to the filling and drying of the vernal pool or ephemeral wetland, and that maintain suitable periods of pool inundation, water quality, and soil moisture for Solano grass germination, growth and reproduction, and dispersal, but not necessarily every year.

All of the above described primary constituent elements do not have to occur simultaneously within a unit for the unit to constitute critical habitat for Solano grass. We determined the primary constituent elements of critical habitat for Solano grass based on studies on their habitat and population biology including but not limited to—Griggs 1980, Holland 1987, and Stone *et al.* 1988.

Criteria Used To Identify Critical Habitat

In accordance with section 3(5)(A)(I) of the Act and regulations at 50 CFR 424.12 in determining which areas to propose as critical habitat, we are required to base critical habitat determinations on the best scientific and commercial data available and to consider those physical and biological features that are essential to the conservation of the species and that may require special management considerations or protection. Such requirements include but are not limited to: space for individual and population growth, and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, rearing of offspring; and habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species. Our implementing regulations at 50 CFR 424.12(e) indicate that the Secretary shall designate as critical habitat areas outside the geographical area presently occupied by a species only when a designation limited to its present range would be inadequate to ensure the conservation of the species.

The primary objective in designating critical habitat is to identify areas that are considered essential for the conservation of the species, and to highlight specific areas where special management considerations or protections are necessary. The Act defines the term ''conservation'' to mean ''the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with scientific resources management such as research, census, law enforcement, habitat acquisition and maintenance, propagation, live trapping, and transplantation * * *'' Section 4(f)(1) of the Act provides for the development and implementation of recovery plans ''for the conservation and survival of endangered species and threatened species,'' and directs that such plans incorporate ''a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species;'' and ''objective, measurable criteria which, when met, would result in a determination * * * that the species be removed from the list.''

General Criteria

The Service currently is preparing a draft recovery plan that will describe measures and actions necessary for the conservation and survival of the vernal pool species addressed in this proposed rule. In determining the size, number, and location of areas to propose as critical habitat we have considered the features necessary for conservation of each species as recommended by the vernal pool recovery team, other vernal pool experts, peer reviewed literature, scientific reports, and other information in our files. We do not, however, anticipate that these areas include all of the habitat areas that may eventually be determined to be necessary for the conservation of the species addressed herein. For these reasons, critical habitat designations do not signal that habitat outside the designation is unimportant or may not be required for recovery.

The conservation of species addressed in this rule depends on removing and alleviating the factors that threaten them, including factors that led to their population decline and subsequent Federal listing. Most species addressed in this proposed rule are threatened by common factors because they occupy the same vernal pool ecosystems.

Holland (1998) estimated that almost three-quarters of vernal pool habitats in the Central Valley of California had been lost by 1997. Loss of habitat has been even more complete in areas outside of the Central Valley. In the central coast area, at least 90 percent of historic vernal pools have been destroyed, and most remaining pools have been degraded (Ferren and Pritchett 1988). In southern California estimated loss of vernal pool habitat ranges from 95 percent to nearly total (Bauder 1986, 1987, Bauder and McMillan 1998). In Oregon, 60 percent of vernal pool habitats have been destroyed, and only 18 percent of the remaining habitats are considered intact (Oregon Natural Heritage Program 1997, Borgias and Patterson 1999). As a result of widespread habitat loss, most of the species addressed in this rule are now limited to a fraction of their former ranges.

Beginning around the mid-1800s, vernal pool habitats were destroyed as a result of conversion to agriculture and water diversion and impoundment projects (Frayer *et al.* 1989, Holland 1998, Kreissman 1991). In more recent years, vernal pool habitats have been lost primarily as a result of widespread urbanization (Bauder 1986, Bauder and McMillan 1998). Much of the loss of habitat was the result of residential, commercial, and industrial development projects. The construction of infrastructures associated with urbanization has also contributed greatly to loss of vernal pool habitats, including the construction of highways, wastewater treatment plants, sewer lines, water supply projects, and other utility projects associated with urbanization in California.

In some areas, conversion of vernal pool habitats to intensive agricultural uses continues to contribute to the decline of vernal pool habitats and the species that inhabit them. From 1992 to 1998, 50,825 ha (125,591 ac) of grazing land were converted to other agricultural uses in the Central Valley of California (California Department of Conservation 2001). It is likely that much of this land supported vernal pools. Holland estimated that more than 12,950 ha (32,000 ac) of vernal pool habitats had been lost in the San Joaquin valley vernal pool region from the late 1980s until 1997, mostly as a result of agricultural conversion (Holland 1998). Through consultation under section 7 of the Act, we reviewed projects converting more than 6,070 ha (15,000 ac) of vernal pool habitats to intensive agricultural uses.

Vernal pool species are also threatened by other activities that indirectly destroy vernal pool ecosystems and render them unsuitable for vernal pool species, including activities that alter hydrology, introduce contaminants, cause erosion or sedimentation, and introduce non-native species into vernal pool ecosystems. Maintaining habitat integrity was identified by the vernal pool recovery team as an important consideration in planning recovery strategies for the species addressed in

this proposed rule (Vernal Pool Recovery Team *in litt.* 1996). The recovery of the species addressed in this proposed rule will depend on the development of recovery strategies that eliminate or minimize these threats so that populations can stabilize, and future declines will be minimized.

Alteration of vernal pool hydrology can dramatically degrade vernal pool habitats. Vernal pool hydrology can be altered by a variety of activities, including the construction of roads, trails, ditches, or canals that can block the flow of water into, or drain water away from, vernal pools and vernal pool complexes (CNDDB 2001). Runoff from irrigated agricultural lands, storm water drains, or developed areas covered with concrete, asphalt, or irrigated lawns can dramatically alter the hydrology of adjacent vernal pools (Bauder 1987, Clark *et al.* 1998). As described in the primary constituent element section of this rule, all of the species addressed herein depend on specific timing and duration of inundation to complete their life cycles. Altered vernal pool hydrology can harm vernal pool species by preventing germination or hatching, preventing growth and maturation, and by preventing reproduction and disrupting gene flow and dispersal. Altered hydrology can also allow invasion of habitats and extirpation of vernal pool species by dominant upland or aquatic species.

Vernal pool species have also declined as a result of water contamination. Vernal pool crustaceans, in particular are highly sensitive to the water chemistry of their vernal pool habitats, and contamination of vernal pools may injure or kill them (Belk 1977, Eng *et al.* 1990, Gonzalez *et al.* 1996). Toxic chemicals, such as petroleum products, pesticides, herbicides, adjuvants, fertilizers, and soap may wash into vernal pools during development of adjacent areas. Vernal pools adjacent to existing developments may also be contaminated from roadway contaminants in surface runoff (*e.g.*, grease, oil, and heavy metals). Contamination may result from discharge of fertilizers and pesticides into surface waters from golf courses, irrigated agricultural lands, or landscaped residential areas (Petrovic 1990). In addition to altered hydrology and contamination, vernal pool species have declined as a result of a variety of other incompatible land uses including off road vehicle use, dumping, vandalism, erosion and sedimentation (Service 1994c, CNDDB 2001).

Additional threats to vernal pool species include the negative effects of fragmentation and isolation on populations that were once part of larger interconnected habitats, and the effects of small population sizes and loss of genetic diversity that result from habitat fragmentation. Fragmentation threatens the elimination of some populations with unforeseen natural and anthropogenic catastrophic events. Vernal pool species in these small habitat patches are also vulnerable to random fluctuations in habitat availability due to annual weather patterns and other environmental factors. They are also more vulnerable to extirpation from random fluctuations in demographic factors, such as birth rates and death rates (Lesica and Allendorf 1995).

Fragmentation of vernal pool complexes could contribute significantly to the loss of genetic diversity among vernal pool species and reduce the likelihood of recolonization events following population extinction by limiting opportunities for dispersal (King 1996, Fugate 1998). The fragmentation of vernal pool habitats may decrease the ability of avian species to move between remaining patches of vernal pool habitats (Silveira 1998), which would contribute to the isolation of vernal pool crustacean populations by reducing cyst dispersal between remaining vernal pool habitat patches (Proctor 1964, Krapu 1974, Swanson 1974, Driver 1981, Ahl 1991). Fragmentation of vernal pool areas could reduce the availability of habitat for pollinator species, and decrease or eliminate seed production of many vernal pool plants (Thorp and Leong 1998).

As described in the Primary Constituent Element section of this proposed rule, the conservation of the wetted area of the vernal pool alone is not sufficient to provide the hydrologic conditions necessary for the reproduction, feeding, sheltering, and dispersal of the vernal pool species addressed in this proposed rule. To maintain the integrity of the vernal pool habitat and prevent extirpation of vernal pool species resulting from altered hydrology, contamination, sedimentation, and other factors which originate in the uplands surrounding the vernal pools it is equally necessary to conserve the surrounding micro-watershed and associated uplands that directly surround and feed the wetted area of the vernal pool or pool complex.

The boundaries of vernal pool complexes, including vernal pools, swales, and the associated uplands, where vernal pool species are known to occur in California have been mapped by Holland (1998, 2002) and by a number of local and state organizations throughout California and in Oregon. The soil types and geologic formations which support vernal pools have also been mapped, and the associated landforms have been identified. We utilized these boundaries to identify areas that support vernal pools, swales, and the associated uplands that comprise the hydrological unit of the vernal pool complex necessary for vernal pool crustacean growth, reproduction, feeding, and dispersal and vernal pool plant germination, growth, and reproduction. We relied on these mapped boundaries to identify vernal pool complexes as intact, hydrologically functioning units. We did not dissect or fragment existing complexes within this designation. However, we do not believe the entire watershed of vernal pool habitats, as depicted by CALWATER or other watershed mapping efforts, is essential to the conservation of the species, and we are not proposing to designate entire watersheds as critical habitat.

Maintaining the range of habitat types in which a species is known to occur has been identified as an important element in species recovery (Vernal Pool Recovery Team *in litt.* 1996). Protecting environmental variability will reduce the chance of losing populations that are important for their genetic uniqueness and adaptation to local environmental conditions (Fugate 1992, King 1996, Linhart and Grant 1996, Fugate 1998). Environmental factors such as hydrology, soil composition and chemistry, pool size, and water chemistry, play a major role in determining species presence and composition in vernal pool plants (Holland and Griggs 1976, Holland and Dains 1990, Jokerst 1990, Stallings and Warren 1996). The presence and species composition of vernal pool crustaceans is also largely determined by physical factors such as pool size, depth, area, and water chemistry (Eng *et al.* 1990, Gonzales *et al.* 1996, Hathaway and Simovich 1996, Simovich and Hathaway 1997, Platenkamp 1998, Simovich 1998, Helm 1998). Variation in these factors contributes to the wide range of life history strategies observed in vernal pool crustaceans and plants, and to the high levels of species diversity observed in vernal pool ecosystems in general. Various efforts to classify vernal pools, including Sawyer and Keeler-Wolf 1995, Keeler-Wolf *et al.* 1998, Smith and Verrill 1998, have identified the locations and distributions of these different pool types. We consulted these sources of information to ensure we have accurately identified the range of

habitats in which each of the 15 species addressed in this proposed rule are known to occur.

Special Management Considerations

In proposing critical habitat, we also have considered how this designation highlights habitat that needs special management considerations or protection. For example, we have many regional HCPs under development, and this designation will be useful in helping applicants determine what vernal pool habitat areas should be highest priority for special management or protection, and where there may be more flexibility in conservation options. This designation will guide them and us in ensuring that all local habitat conservation planning efforts are consistent with conservation objectives for these species.

Once a vernal pool habitat has been protected from direct filling, it is still necessary to ensure that the habitat is not rendered unsuitable for vernal pool species because of factors such as altered hydrology, contamination, non-native species invasions, or other incompatible land uses. Even the best designed vernal pool preserve may still be susceptible to alterations that render it unsuitable for vernal pool species. Many of the factors that cause the decline and extirpation of vernal pool species can be controlled through special management actions. Examples of special management actions that may be necessary to prevent further declines and loss of populations of species addressed in this rule include—

(1) Actions to prevent or reduce competition of vernal pool plants with invasive species. Many of the species addressed in this rule are threatened by invasion of non-native species (CNDDB 2001). Special management actions can be taken to reduce the negative effects of such invasions. For example, grazing can be effectively used to control a variety of upland exotic plants. However, the timing and intensity of grazing is critical to its success as a management tool, and these factors should be closely monitored. Alternatively, inappropriate grazing can also pose a threat to many of the vernal pool plant species (CNDDB 2001). Prescribed burning is another management tool that may be effective in controlling non-native plant species (Pollack and Kan 1998). Fire must also be appropriately timed and fire frequency is important. The potential for alteration of nutrient cycling must be also considered. Other management techniques for control of invasive species include mowing, hand removal, and selective herbicide applications. Any technique employed must be carefully controlled and monitored to ensure that it does not negatively affect the vernal pool species.

(2) Actions to restore vernal pool hydrology. Alteration of natural hydrology threatens many of the species addressed in this proposed rule (CNDDB 2001). In many cases other threats, such as the invasion of non-native species or contamination, are facilitated by alterations of natural vernal pool hydrology. Special management actions, such as the removal of dams or other structures which artificially increase the length of vernal pool inundation, the removal of ditches that artificially drain vernal pools, or the construction of berms or reconstruction of culverts to prevent water from flowing artificially into vernal pools from adjacent areas, can be taken to restore natural vernal pool hydrology. Modification of grazing regimes may also restore natural vernal pool hydrology (Barry 1998). Monitoring of vernal pool hydrology is important to ensure that restoration actions are successful.

(3) Actions to reduce human degradation of vernal pools. Special management actions such as fencing, trail building, and posting signs can help to reduce human activities that threaten vernal pool species. These actions may reduce the damage resulting from off-road vehicle use, dumping, and vandalism that threatens many of the species addressed in this proposed rule.

(4) Actions to restore severely degraded habitats. Active restoration of highly degraded vernal habitats may be necessary in some areas. Such restoration may involve earth moving activities designed to restore historic pool and swale topography and to reestablish natural vernal pool hydrology (*e.g.*, Ferren and Hubbard 1998, Black and Zedler 1998). These types of actions are extremely complex, and require diligent planning and monitoring to ensure their success. Active restoration is only recommended for seriously degraded habitats that otherwise would not maintain natural vernal pool ecosystem processes.

Summary of Proposed Designation

Table 1 shows approximate areas of proposed critical habitat, by unit and species. Because of overlap between units established for different species, the total of all critical habitat proposed is much less than the sum of critical habitat areas proposed for each species. Lands proposed are under private, State, and Federal ownership and divided into 128 Critical Habitat Units. The table provides separate columns for privately owned land subject to conservation easements or agreements and other privately owned lands.

TABLE 1.—APPROXIMATE AREAS OF PROPOSED CRITICAL HABITAT FOR THE VERNAL POOL CRUSTACEANS AND PLANTS IN CALIFORNIA AND OREGON

Critical habitat units	Federal		State and local		Private (conservation)		Private (other)		Total	
	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres
Conservancy Fairy Shrimp										
1	0	0	0	0	6,747	16,672	13,799	34,097	20,546	50,769
2	5,187	12,816	0	0	0	0	531	1,313	5,718	14,129
3	241	596	329	814	1,072	2,648	8,285	20,471	9,927	24,529
4	0	0	0	0	0	0	603	1,490	603	1,490
5	299	739	0	0	0	0	3	7	302	746
6	427	1,056	11	26	4,566	11,283	58,746	145,160	63,750	157,525
7	12,765	31,542	3,096	7,649	1,119	2,765	29,163	72,060	46,142	114,016
8	18,042	44,581	0	0	0	0	789	1,950	18,831	46,531
Species Total ..	36,961	91,330	3,435	8,489	13,504	33,368	111,919	276,548	165,820	409,735
Longhorn Fairy Shrimp										
1 A–B	0	0	0	0	0	0	321	794	321	794

TABLE 1.—APPROXIMATE AREAS OF PROPOSED CRITICAL HABITAT FOR THE VERNAL POOL CRUSTACEANS AND PLANTS IN CALIFORNIA AND OREGON—Continued

Critical habitat units	Federal		State and local		Private (conservation)		Private (other)		Total	
	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres
2	9,413	23,258	3,096	7,651	1,119	2,765	16,189	40,003	29,817	73,677
3	6,293	15,549	94	233	0	0	4,079	10,080	10,466	25,862
Species Total	15,705	38,807	3,191	7,884	1,119	2,765	20,590	50,877	40,605	100,333
Vernal Pool Fairy Shrimp										
1 A–G	0	0	0	0	0	0	862	2,130	862	2,130
2 A–E	0	0	0	0	0	0	911	2,251	911	2,251
3 A–C	0	0	0	0	0	0	931	2,301	931	2,301
4 A–B	175	432	0	0	0	0	186	460	361	892
5	17	42	0	0	53	130	1,779	4,397	1,849	4,569
6	0	0	175	433	0	0	18,386	45,432	18,562	45,865
7	0	0	0	0	6,747	16,672	17,136	42,343	23,883	59,015
8	0	0	0	0	0	0	5,760	14,233	5,760	14,233
9	76	187	0	0	7	17	1,374	3,394	1,456	3,598
10	5,187	12,816	0	0	0	0	531	1,313	5,718	14,129
11	2,035	5,028	0	0	0	0	818	2,021	2,853	7,049
12	0	0	0	0	64	157	19,324	47,748	19,387	47,905
13	6	16	0	0	0	0	14,859	36,717	14,866	36,733
14	0	0	630	1,557	4,014	9,918	21,956	54,253	26,600	65,728
15	0	0	60	149	0	0	1,563	3,863	1,624	4,012
16	1,015	2,507	1,038	2,564	1,137	2,809	31,721	78,381	34,910	86,261
17	0	0	170	420	0	0	486	1,201	656	1,621
18	0	0	0	0	0	0	7,105	17,55	77,105	17,557
19 A–C	0	0	64	157	288	711	3,004	7,424	3,356	8,292
20	299	739	0	0	0	0	3	7	302	746
21	7	17	25	61	0	0	25,285	62,479	25,317	62,557
22	3	8	11	26	3,464	8,559	40,628	100,391	44,106	108,984
23	13,943	34,452	3,096	7,649	1,119	2,765	37,753	93,287	55,911	138,153
24 A–B	0	0	0	1	0	0	17,231	42,578	17,232	42,579
25	65	161	0	0	0	0	929	2,295	994	2,456
26 A–C	0	0	348	861	0	0	2,845	7,030	3,193	7,891
27 A–B	2,742	6,776	490	1,210	1,325	3,274	3,285	8,117	7,842	19,377
28	1,581	3,906	2	5	0	0	46,542	115,004	48,125	118,915
29 A–C	20,586	50,868	0	0	0	0	20,468	50,576	41,054	101,444
30	6,293	15,549	94	233	0	0	4,079	10,080	10,466	25,862
31	2,236	5,526	0	0	0	0	6,163	15,228	8,399	20,754
32	18,042	44,580	0	0	0	0	790	1,951	18,831	46,531
33 A–C	0	0	0	0	0	0	2,319	5,730	2,319	5,730
34	0	0	761	1,880	830	2,052	127	314	1,718	4,246
35	0	0	0	0	0	0	97	239	97	239
Species Total	74,307	183,610	6,963	17,206	19,047	47,064	357,239	882,725	457,556	1,130,605
Vernal Pool Tadpole Shrimp										
1	17	42	0	0	53	130	1,779	4,397	1,849	4,569
2	6,226	15,383	437	1,081	6,320	15,617	7,463	18,441	20,446	50,522
3	0	0	0	0	6,747	16,672	17,136	42,343	23,883	359,015
4	127	313	0	0	84	208	15,764	38,953	15,975	39,474
5	5,187	12,816	0	0	0	0	531	1,313	5,718	14,129
6	0	0	0	0	0	0	526	1,299	526	1,299
7	2,035	5,028	0	0	0	0	818	2,021	2,853	7,049
8	6	16	0	0	0	0	14,859	36,717	14,866	36,733
9	0	0	630	1,557	4,039	9,981	24,393	60,275	29,063	71,813
10	130	321	0	0	0	0	62	153	192	474
11	760	1,879	1,038	2,565	1,136	2,808	31,675	78,269	34,610	85,521
12	0	0	0	0	0	0	603	1,490	603	1,490
13	0	0	0	0	0	0	9,408	23,246	9,408	23,246
14	10	24	0	0	0	0	448	1,108	458	1,132
15	3	8	11	26	4,566	11,283	66,496	164,309	71,076	175,626
16	13,943	34,452	3,096	7,649	1,119	2,765	37,753	93,287	55,911	138,153
17	85	209	174	430	259	639	223	551	740	1,829
18	0	0	348	861	0	0	2,845	7,030	3,193	7,891
Species Total	28,528	70,491	5,734	14,169	24,324	60,103	232,784	575,202	291,370	719,965

TABLE 1.—APPROXIMATE AREAS OF PROPOSED CRITICAL HABITAT FOR THE VERNAL POOL CRUSTACEANS AND PLANTS IN CALIFORNIA AND OREGON—Continued

Critical habitat units	Federal		State and local		Private (conservation)		Private (other)		Total	
	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres
Butte County Meadowfoam										
1	0	0	0	0	0	0	6,105	15,086	6,105	15,086
2	0	0	0	0	0	0	3,508	8,667	3,508	8,667
3	9	22	0	0	0	0	1,687	4,169	1,696	4,191
4	0	0	0	0	0	0	5,011	12,382	5,011	12,382
Species Total ..	9	22	0	0	0	0	16,311	40,304	16,320	40,326
Colusa Grass										
1	130	322	0	0	0	0	62	152	192	474
2	94	233	258	637	1,137	2,809	5,664	13,996	7,153	17,675
3	0	0	0	0	0	0	16,475	40,709	16,475	40,709
4	0	0	0	0	1	2	35,133	86,812	35,134	86,814
5	0	0	25	61	0	0	19,825	48,988	19,850	49,049
6	427	1,055	11	26	0	0	45,204	111,698	45,642	112,779
7 A–B	1,422	3,514	0	0	0	0	6,741	16,656	8,163	20,170
Species Total ..	2,074	5,124	293	724	1,138	2,811	129,104	319,011	132,608	327,670
Contra Costa Goldfields										
1	0	0	0	0	0	0	1,067	2,637	1,067	2,637
2	0	0	0	0	0	0	411	1,016	411	1,016
3	0	0	0	0	0	0	274	678	274	678
4	1,954	4,828	122	301	0	0	5,809	14,355	7,885	19,484
5 A–B	0	0	0	0	0	0	410	1,014	410	1,014
6	0	0	0	0	0	0	242	599	242	599
7	0	0	291	718	0	0	1,088	2,688	1,378	3,406
8	448	1,108	0	0	0	0	10	24	458	1,132
9	3,370	8,326	2	4	0	0	0	1	3,372	8,331
Species Total ..	5,772	14,262	414	1,023	0	0	9,313	23,012	15,499	38,297
Greene's Tuctoria										
1	903	2,231	0	0	0	0	70	172	972	2,403
2	0	0	0	1	7,096	17,534	4,577	11,310	11,674	28,845
3	0	0	0	0	0	0	979	2,418	979	2,418
4	0	0	0	0	4	9	295	729	299	738
5	5,187	12,816	0	0	0	0	531	1,313	5,718	14,129
6	0	0	0	0	1	2	36,413	89,976	36,414	89,978
7	427	1,056	11	26	4,566	11,283	68,703	169,762	73,707	182,127
8	0	0	0	0	0	0	13,222	32,670	13,222	32,670
Species Total ..	6,517	16,103	11	27	11,667	28,828	124,789	308,350	142,984	353,308
Hairy Orcutt Grass										
1	0	0	0	0	6,219	15,366	2,530	6,251	8,748	21,617
2	0	0	0	0	0	0	979	2,418	979	2,418
3	5,187	12,816	0	0	0	0	531	1,313	5,718	14,129
4	7	17	25	61	0	0	25,286	62,482	25,318	62,560
5	0	0	0	0	0	0	9,085	22,448	9,085	22,448
6	0	0	4	10	0	0	15,820	39,090	15,824	39,100
Species Total ..	5,194	12,833	29	71	6,219	15,366	54,231	134,002	65,671	162,272
Hoover's Spurge										
1	0	0	0	1	7,096	17,534	4,577	11,310	11,674	28,845
2	0	0	0	0	0	0	979	2,418	979	2,418
3	5,187	12,816	0	0	0	0	531	1,313	5,718	14,129
4	0	0	0	0	1	2	16,838	41,607	16,839	41,609
5	0	0	24	60	0	0	19,826	48,989	19,850	49,049
6	3,232	7,985	0	0	0	0	11,078	27,374	14,310	35,359
7 A–D	13	33	355	877	0	0	12,007	29,668	12,375	30,578

TABLE 1.—APPROXIMATE AREAS OF PROPOSED CRITICAL HABITAT FOR THE VERNAL POOL CRUSTACEANS AND PLANTS IN CALIFORNIA AND OREGON—Continued

Critical habitat units	Federal		State and local		Private (conservation)		Private (other)		Total	
	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres
Species Total ..	8,432	20,834	380	938	7,097	17,536	65,836	162,679	81,744	201,987
Sacramento Orcutt Grass										
1	0	0	3	7	0	0	26	65	29	72
2	0	0	0	0	0	0	8,853	21,875	8,853	21,875
3	0	0	247	610	3,135	7,747	12,368	30,561	15,750	38,918
Species Total ..	0	0	250	617	3,135	7,747	21,247	52,501	24,632	60,865
San Joaquin Valley Orcutt Grass										
1	427	1,056	11	26	3,464	8,559	41,742	103,142	45,643	112,783
2	0	0	0	0	433	1,070	21,062	52,044	21,495	53,114
3	0	0	0	0	0	0	20,936	51,733	20,936	51,733
4	0	0	0	1	0	0	3,233	7,989	3,234	7,990
5 A–B	150	370	0	0	263	650	1,310	3,238	1,723	4,258
6 A–B	0	0	199	491	0	0	7,829	19,345	8,028	19,836
Species Total ..	577	1,426	210	518	4,160	10,279	96,113	237,491	101,059	249,714
Slender Orcutt Grass										
1 A–I	18,527	45,780	37	92	0	0	4,702	11,618	23,266	57,490
2 A–C	33	81	0	0	53	130	5,014	12,390	5,100	12,601
3	6,226	15,384	437	1,080	6,320	15,617	7,463	18,441	20,446	50,522
4	0	0	0	1	7,096	17,534	4,577	11,310	11,674	28,845
5 A–B	0	0	5	13	78	192	1,613	3,986	1,696	4,191
6	0	0	0	0	0	0	8,853	21,875	8,853	21,875
Species Total ..	24,786	61,245	480	1,186	13,547	33,473	32,222	79,620	71,035	175,524
Solano Grass										
1	130	321	0	0	0	0	62	153	192	474
2	94	233	257	636	1,137	2,809	5,665	13,997	7,153	17,675
Species Total ..	224	554	257	636	1,137	2,809	5,727	14,150	7,345	18,149
Succulent Owl's Clover										
1	0	0	0	0	0	0	1,051	2,598	1,051	2,598
2	0	0	0	0	0	0	14,131	34,917	14,131	34,917
3 A–B	427	1,056	11	26	4,566	11,283	58,348	144,177	63,353	156,542
4	5	13	56	139	0	0	33,009	81,565	33,071	81,717
5	0	0	0	1	0	0	11,888	29,374	11,888	29,375
6 A–B	150	371	174	429	259	639	1,141	2,819	1,723	4,258
Species Total ..	583	1,440	241	595	4,825	11,922	119,569	295,450	125,217	309,407

Species Specific Criteria

After developing the general criteria described previously, we conducted a species by species review based on the specific habitat requirements, primary constituent elements, and individual threats to each species addressed in this proposed rule. The specific unit description for each species is described below.

Conservancy Fairy Shrimp Criteria

In proposing critical habitat units for Conservancy fairy shrimp, we evaluated the life history and current distribution of the species described in the background section of this rule, the primary constituent elements described in the primary constituent element section of this rule, and the threats to the species described above, in addition to those described below. This information allowed us to determine which areas are likely to contribute to the conservation of Conservancy fairy shrimp and to delineate units so that threats to these species might be minimized.

Conservancy fairy shrimp are known only from eight disjunct areas: the Vina Plains area and vicinity in southern Tehama and northern Butte County; Jepson Prairie and Suisun Slough in southern Solano County; Sacramento National Wildlife Refuge in Glenn and Colusa counties; near Caswell Memorial State Park in Stanislaus County; near Haystack Mountain in Merced County; at the San Luis National Wildlife Refuge Complex in western Merced County, and at the Mutau Flat area in the Los Padres National Forest area of northern Ventura County.

Conservancy fairy shrimp continues to be threatened by all of the factors which lead to the original listing of this species, primarily habitat loss through agricultural conversion and

urbanization. Helm (1998) found that most Conservancy fairy shrimp occurrences were on Anita, Pescadero or Peters Clay soils. These fertile, basin rim soils were among the first areas converted to agriculture in the 19th century, suggesting that a disproportionate amount of Conservancy fairy shrimp habitat may have been lost early in California's history (Helm 1998).

In addition to direct habitat loss, almost one third of the known occurrences of Conservancy fairy shrimp are threatened by alterations of hydrology, including the construction of drainage channels, diking, and inappropriate water diversion within managed wetland areas in Merced and Solano counties (CNDDB 2002). Other threats include possible introduction of predators (*e.g.*, bullfrogs, crayfish, fish) either directly or through alteration of drainage patterns (CNDDB 2002). Off-road vehicles also represent a threat to the continued survival of Conservancy fairy shrimp populations (Hathaway *et al.* 1996). In some cases, special management actions may be necessary to prevent these threats from extirpating occurrences of Conservancy fairy shrimp.

Conservancy Fairy Shrimp Review

We conducted a regional review across the range of Conservancy fairy shrimp to evaluate and select areas that are essential to the conservation of the species and that may require special management actions. Important factors we considered were the known presence of the species and the presence of the primary constituent elements essential to the conservation of the species. A specific description of each area is outlined below.

Unit 1, Vina Plains Unit, Butte and Tehema Counties (20,546 ha (50,769 ac))

This unit is proposed as critical habitat for Conservancy fairy shrimp because it contains occurrences of the species (CNDDB 2002) within vernal pools found on Anita clay and Tuscan loam soils (EPA 1994, Holland 1998, Tehama County 1999, USDA 2001). These soils support pool types that remain inundated for sufficient periods of time to allow Conservancy fairy shrimp to hatch, mature, and reproduce, but do not contain water during the summer preventing the invasion of predator species such as bullfrogs and fish. This unit represents the northern extent of Conservancy fairy shrimp range.

Conservancy fairy shrimp in this area occupy vernal pools that are classified as Northern Hardpan by Sawyer and Keeler-Wolf (1995) and occur on the Tuscan, Red Bluff, and Riverbank geologic formations. Within this unit vernal pools occur in complexes with a range of pool sizes, from over several acres to less than a tenth of an acre, in areas of hummocky ground on old terraces above recent river flood plains below the foothills (Alexander and Schlising 1997, Keeler-Wolf *et al.* 1998). The boundaries of this unit were delineated to include the interconnected pools, swales, and interconnected uplands mapped by Holland (1998) that contribute to the filling and drying of the vernal pools where Conservancy fairy shrimp occur, and maintain suitable periods of pool inundation, water quality, and soil moisture for Conservancy fairy shrimp hatching, growth and reproduction, and dispersal, but not necessarily every year.

This unit includes relatively undisturbed, hydrologically intact vernal pool habitats, that will likely continue to support natural vernal pool ecosystem processes and maintain suitable habitat conditions for Conservancy fairy shrimp. This area also provides seasonal habitat for waterfowl and other migratory bird species which aid in the dispersal of Conservancy fairy shrimp among vernal pools within the unit, and between other habitats across the species range.

The majority of the lands included within this unit are privately owned. This unit contains TNC's Vina Plains preserve as well as other TNC lands 2,264 ha (5,660 ac) and conservation easements 4,348 ha (10,870 ac). The NRCS also holds WRP conservation easements or agreements on 57 ha (142 ac). The preserve contains over 300 species of plants, and diverse communities of aquatic invertebrates. Since the 1960's, the Vina Plains area has been the focus of a number of research projects, including long-term adaptive management and monitoring efforts evaluating of the effects of grazing and fire on vernal pool plants, animals, and ecosystems (Griggs 2000). Much of the basic life history information known about vernal pool crustaceans was collected at Vina Plains (*e.g.* Lanway 1974, Ahl 1991, Syrdahl 1993, Gallagher 1996). The results of this research have provided crucial information to guide management and monitoring of vernal pool ecosystems and to identify factors which influence population dynamics of a number of endangered species, including Conservancy fairy shrimp. The Vina Plains is open to the public and provides excellent outreach and educational opportunities. In addition to TNC, the importance of vernal pool habitats in this area has been recognized by the CDFG, the Service, the EPA, the CNPS, the NRCS's WRP, and by researchers at the CSU at Chico, who have all supported research and conservation efforts for Conservancy fairy shrimp and other vernal pool species within this unit. Urban development north of Chico and the conversion of grazed lands to more intensive agricultural uses threaten vernal pool habitat within this unit.

The Vina Plains Unit extends from south of Deer Creek to north of Rock Creek and the Chico Airport near the City of Chico. State Highway 99 bisects this unit. The western boundary generally parallels the Southern Pacific Railway line. The eastern boundary of this unit extends to the boundary of the East Red Bluff watershed. This unit overlaps Unit 7 for vernal pool fairy shrimp and Unit 3 for vernal pool tadpole shrimp and contains part of Unit 1 for hairy Orcutt grass, Unit 2 for Greene's tuctoria, Unit 1 for Hoover's spurge, and Unit 4 for slender Orcutt grass. Additional sensitive species occurring in this unit include California linderiella and Bogg's Lake hedge-hyssop.

Unit 2, Colusa Unit, Sacramento Valley, Glenn and Colusa Counties (5,718 ha (14,129 ac))

This unit is proposed as critical habitat for Conservancy fairy shrimp because it contains occurrences of the species within large, alkaline vernal pools formed on the Modesto geologic formation on Willows and Riz soils that provide the primary constituent elements essential to the conservation of the Conservancy fairy shrimp (Holland 1998, Silveira 2000, CNDDB 2002). Conservancy fairy shrimp in this area occupy pools that are often large, shallow and alkaline. They may display white salt deposits following pool drying. These pool types remain inundated for sufficient periods of time to allow Conservancy fairy shrimp to hatch, mature, and reproduce, but do not contain water during the summer, preventing the invasion of predator species such as bullfrogs and fish. This area is important to maintain the diversity of habitats in which Conservancy fairy shrimp occur.

This unit is primarily located on the Sacramento National Wildlife Refuge (5,126 ha (12,816 ac)). Any additional lands within this unit are privately owned. The refuge supports over 355 native plant taxa, including a number of rare alkaline species (Oswald and Silveira 1995). Vernal pool habitats on the refuge are specifically managed for

the conservation of listed species, and to promote habitat for migratory birds and waterfowl. As a result this unit also provides essential habitat for avian species that aid in the dispersal of Conservancy fairy shrimp and other vernal pool crustacean cysts. The Sacramento National Wildlife Refuge contains the only remnants of the widespread Colusa Plains vegetation that once covered the entire Colusa Basin (Silveira 2000). Vernal pool habitats within the area have become greatly fragmented and isolated from other habitats in the region.

The boundaries of this unit were delineated to include the interconnected pools, swales, and interconnected uplands mapped by Holland (1998) that contribute to the filling and drying of the vernal pools where Conservancy fairy shrimp occur, and maintain suitable periods of pool inundation, water quality, and soil moisture for Conservancy fairy shrimp hatching, growth and reproduction, and dispersal, but not necessarily every year.

This unit occupies vernal pool habitat east of Interstate 5 to the Colusa Trough from Riz Road on the north and Delevan Road on the south. This unit coincides with vernal pool fairy shrimp Unit 10, vernal pool tadpole shrimp Unit 5, Unit 3 for hairy Orcutt grass, and Unit 3 for Hoover's spurge. Other rare vernal pool species found in this unit include pappose spikeweed, Fremont's goldfields, alkali goldfields, Scribe's popcorn flower, Hoover's downingia, folded downingia, Heckard's peppergrass, heartscale, brittlescale, San Joaquin spearscale, Ferris' milk-vetch, spike-primrose, sessile mousetail, and the federally listed as endangered palmate-bracted bird's beak.

Unit 3, Jepson Prairie Unit, Solano County (9,927 ha (24,529 ac))

This unit is proposed as critical habitat for Conservancy fairy shrimp because it includes numerous occurrences of the species within one of the most pristine, intact vernal pool ecosystems remaining in California (Holland 1998, Solano County 1999, Solano County Farmland and Open Space 2001, CNDDB 2002). The unit boundary was drawn to include the vernal pools where Conservancy fairy shrimp occur, including the 32 ha (80 ac) Olcott Lake and other large playa pools associated with Solano Loam and Pescadero soil series. Conservancy fairy shrimp in this unit occupy vernal pool complexes extending from Jepson Prairie west towards the City of Fairfield. Within these complexes larger pools often occur with smaller pools and hogwallow depressions. Together the pools, swales, and associated uplands maintain the necessary timing and frequency of inundation for Conservancy fairy shrimp hatching, growth, and reproduction, but are dry during the summer. The relatively undisturbed, hydrologically intact condition of the Jepson Prairie increases the likelihood that it will continue to support natural vernal pool ecosystem processes and maintain suitable habitat conditions for Conservancy fairy shrimp. This unit also provides habitat for avian species that aid in the dispersal of Conservancy fairy shrimp and other vernal pool crustacean cysts.

In addition to Conservancy fairy shrimp, the greater Jepson Prairie grassland area supports a diverse community of native plants and animals, including the only known occurrence of Delta green ground beetle, and occurrences of Solano grass, Colusa grass, California tiger salamander, vernal pool tadpole shrimp, vernal pool fairy shrimp, alkali milk-vetch, Bogg's Lake hedge-hyssop, legenere, California linderiella, and midvalley fairy shrimp. The southwestern portion of this unit contains vernal pool habitats near the Potrero Hills south of Travis Air Force Base. These vernal pool habitats occur in close proximity to tidal marshes and contain habitat for Contra Costa goldfields.

This unit includes the Jepson Prairie Preserve, jointly managed by the Solano County Farmlands and Open Space Foundation and the UC Reserve System. Jepson Prairie has long been recognized as an outstanding example of vernal pool ecosystems. In 1987 NPS named Jepson Prairie a National Natural Landmark, a designation given to sites that provide high quality habitat for threatened or endangered species. Jepson Prairie is the target of ongoing conservation planning efforts and active management. As part of the UC Reserve System, this area provides critical research opportunities for scientists to study Conservancy fairy shrimp, and to determine their response to different management regimes. Conducting this research is essential to ensure the conservation of Conservancy fairy shrimp and other vernal pool species. This unit also contains land owned by the CDFG (319 ha (797 ac)), and State Land Commission (7 ha (17 ac)), as well as conservation easements held by TNC (623 ha (1,090)) and by NRCS under the WRP program (436 ha (1,090 ac). The unit also includes portions of Travis Air Force Base (DOD lands totaling 238 ha (596 ac)). Within the greater Jepson Prairie grassland area, existing vernal pools are threatened by agricultural conversion, landfill expansion, power plant construction, and utility maintenance. Urbanization in the vicinity of Fairfield and Suisun, and landfill expansion projects in the vicinity of the Protero Hills, threaten vernal pool habitats in the area.

This unit occurs in the southern portion of Solano County, east and south of the City of Fairfield, south and southwest of the City of Dixon, and north of Nurse Slough and the confluence of the Sacramento and San Joaquin rivers. This unit contains Unit 3 for Colusa grass, Unit 2 for Solano grass, and overlaps with Unit 4 for Contra Costa goldfields. This unit is encompassed by Unit 11 for vernal pool tadpole shrimp and Unit 16 for vernal pool fairy shrimp.

Unit 4, Montezuma Unit, Solano County (603 ha (1,490 ac))

This unit is proposed as critical habitat for Conservancy fairy shrimp because it contains vernal pools that support the necessary timing, frequency, and duration of inundation essential for Conservancy fairy shrimp feeding, sheltering, reproducing, and dispersing (Lipton in litt. 2002, Levine Fricke Restoration Corp 2000). This is the most recently discovered occurrence of Conservancy fairy shrimp, and one of the only areas where this species occurs in the saline-alkaline transition zone between vernal pools and tidal marshes.

Most of the habitats within this unit are on private land, although portions of the Hill Slough Wildlife Area managed by the CDFG are also included within this unit. The primary threats to vernal pool habitats within this unit are alterations to hydrology from filling, diking, and dredging activities which may occur in the tidal marsh. This unit is also proposed so that special management actions may be taken to prevent the degradation of Conservancy fairy shrimp occurrences through alteration of the hydrology of their vernal pool habitats.

This unit is located near the Suisun Marsh in southern Solano County, east of Montezuma Slough and west of Collinsville Road; the northernmost portion of this unit is bisected by Birds Landings Road. Portions of this unit coincide with Unit 12 for vernal pool tadpole shrimp. In addition to Conservancy fairy shrimp, this unit contains occurrences of other rare vernal pool species including vernal pool fairy shrimp, alkali milk-vetch and dwarf downingia.

Unit 5, Northern San Joaquin Valley Unit, Stanislaus County (302 ha (746 ac))

This unit is proposed as critical habitat for Conservancy fairy shrimp because it contains the species within alkali sink vernal pools formed on Fresno series soils (CNDDB 2002). The unit boundary was designated to include the vernal pool complex mapped by Holland (1998) that maintains the necessary timing and frequency of inundation for Conservancy fairy shrimp hatching, growth, and reproduction, but is dry in the summer. The minimum mapping unit of Holland (1998) of 16 ha (40 ac) did not allow us to exclude all non-vernal pool areas from within the unit boundary. However, the entire unit is located within the San Joaquin River National Wildlife Refuge and restoration is currently the focus of conservation planning efforts by the Service. Additional restoration designed to enhance habitat for riparian species, as well as migratory birds and waterfowl, is also currently underway. This unit is proposed so that special management actions, including appropriate wetland management, can be taken to maintain the natural hydrology of the vernal pools where Conservancy fairy shrimp are known to occur. This unit is over 70 km (43 mi) from the nearest unit to the south and over 40 km (25 mi) from the nearest unit to the north. Such isolated populations may have genetic characteristics essential to overall long-term conservation of the species (*i.e.* they may be genetically different than more central populations) (Lesica and Allendorf 1995, Fugate 1998).

Lands within this unit form a mosaic of riparian habitat, wetlands, and grasslands. The San Joaquin River National Wildlife Refuge is the primary wintering site of 98 percent of the Aleutian Canada geese that winter in the Valley (October—April), and it is a major wintering and migration area for lesser and greater sandhill cranes, cackling Canada geese, and white-fronted geese. These migratory birds act as dispersal agents for Conservancy fairy shrimp and other vernal pool crustacean species.

This unit is situated west of the City of Modesto and east of the confluence of the San Joaquin and Stanislaus rivers. Caswell Memorial State Park lies just north of this unit. This unit is bisected by the Hetch Hetchy Aqueduct and State Highway 132. This unit overlaps vernal pool fairy shrimp Unit 20. It is also contains California linderiella and California tiger salamander occurrences, in addition to a number of rare non-vernal pool species including the federally listed endangered riparian wood rat and riparian brush rabbit.

Unit 6, Merced Unit, Merced and Mariposa Counties (63,750 ha (157,525 ac)

This unit is proposed as critical habitat for Conservancy fairy shrimp because it contains occurrences of the species within large, playa vernal pools found on Raynor Cobbly clay soils on the Mehrten Formation (CNDDB 2001, EIP Associates 1999). These pool types provide the necessary length and timing of inundation essential for the conservation of Conservancy fairy shrimp. The Merced Unit encompasses the largest block of pristine, high density vernal pool grasslands remaining in California (Vollmar 1999). The relatively undisturbed, hydrologically intact condition of the unit increases the likelihood that it will continue to support natural vernal pool ecosystem processes and maintain suitable habitat conditions for Conservancy fairy shrimp. Genetic analyses of vernal pool tadpole shrimp revealed that occurrences in this unit were genetically different from other occurrences in California, and that this area was isolated from other vernal pool habitats (King 1996). Given that Conservation fairy shrimp and vernal pool tadpole shrimp are dispersed in similar ways, it is reasonable to assume that Conservancy fairy shrimp occurrences in this areas are also isolated from other occurrences throughout its range, and may also have unique genetic characteristics.

Vernal pool habitats in eastern Merced County are seriously threatened by irrigated agriculture, upland housing development, and the proposed UC Merced campus and associated development. Effects associated with the UC campus and associated community could result in loss and degradation of vernal pool habitats within this unit. However, the recent draft biological opinion for the UC Merced campus and community developed environmental parameters which should reduce impacts to vernal pool habitats. Merced County and the CDFG are currently gathering data on presence, distribution, and microhabitat preferences of vernal pool crustaceans to aid in developing long-term conservation planning strategies for eastern Merced County. There is interest among ranch owners to establish conservation easements that will support rangeland and vernal pool conservation. The Conservancy fairy shrimp occurrence at the Flying M Ranch is already being managed through a conservation easement with TNC that conserves over 2,023 ha (5,000 ac) of vernal pool and upland habitat. Land ownership within the unit includes approximately 419 ha (1,048 ac) of DOD, (3 ha (8 ac) of BLM, and 10 ha (26 ac) of California State Parks. TNC has a total of 4,513 ha (11,283 ac) of conservation easements within this unit.

A majority of the vernal pool habitat in the Merced Unit is in eastern Merced County. The eastern edge of the unit overlaps into western Mariposa County and in the south it extends to Deadman Creek. The northern boundary parallels the Merced River. The unit is located east of Highway 99 and the City of Merced, Planada, and Le Grand. The eastern boundary extends into the low elevation foothills of the Sierra Nevada. The boundaries of this unit overlap with San Joaquin Valley Orcutt grass Units 2 and 3, Colusa grass Units 7, Greene's tuctoria Unit 6, succulent owl's-clover Units 3B, vernal pool fairy shrimp Unit 22, and vernal pool tadpole shrimp Unit 15. Other sensitive vernal pool species found within this unit include California tiger salamander, shining navarretia, dwarf downingia, Bogg's Lake hedge-hyssop, western spadefoot toad, and California linderiella.

Unit 7, Grassland Ecological Unit, Madera, Merced and Stanislaus Counties (46,142 ha (114,016 ac))

We propose this area as critical habitat for Conservancy fairy shrimp because it supports multiple occurrences of the species within large, playa vernal pools of the Edminstor and Kesterson soil series (Holland 1998, USDA 2001, CNDDB 2002). The unit boundary was drawn to include Conservancy fairy shrimp and the vernal pool complexes mapped by Holland (1998) where the species is known to occur. These features maintain the necessary length and timing of inundation for Conservancy fairy shrimp hatching, maturation, and reproduction, but are dry in the summer and do not support aquatic species such as fish or bullfrogs. Conservancy fairy shrimp are found in large numbers throughout this unit, making this area a potential source for propagules dispersing to Conservancy fairy shrimp habitats to the south in Ventura County, to the east in eastern Merced County, and to the north in Stanislaus County. This unit is also proposed as critical to ensure that special management actions are taken to prevent or reverse changes in hydrology, contamination from adjacent land use, and invasion by aquatic species that threaten Conservancy fairy shrimp occurrences within this unit.

This area contains the largest intact vernal pool habitat for Conservancy fairy shrimp in the San Joaquin Valley (Holland 1998). This unit also provides essential habitat for migratory waterfowl that aid in the dispersal of Conservancy fairy shrimp and other vernal pool crustacean cysts. The Grassland Ecological Unit includes Kesterson, San Luis, and Merced National Wildlife Refuges (12,765 ha (31, 542 ac)), CDFG lands (1,703 ha (4,257 ac)), CDFG administration lands (1,052 ha (2,631 ac)), California State Parks (1,358 ha (3,394 ac)), and private lands protected by WRP easements or agreements (54 ha (134 ac)). Combined, these lands are known as the Grasslands Ecological Area, a 66,773 ha (160,000 ac) area which supports the largest remaining areas of several rare valley floor habitats within the San Joaquin valley, including examples of alkali grasslands, alkali scrublands, wild rye grasslands, cotton wood riparian forests, vernal marshes, relict dune lands, and high quality vernal pool habitats.

The unit lies north of the City of Los Banos, southwest of the City of Merced, and is bisected by the San Joaquin River. This unit represents Unit 23 for vernal pool fairy shrimp and Unit 16 for vernal pool tadpole shrimp. The western half of this unit represents Unit 2 for longhorn fairy shrimp and the eastern half represents Unit 8 for Colusa grass, and Unit 6 for Hoover's spurge. In addition to the species mentioned above, vernal pool smallscale, alkali milk-vetch, western spadefoot toad, and California linderiella are present within this unit as well.

Unit 8, Ventura County Unit, Ventura, Santa Barbara, and Los Angeles Counties (18,831 ha (46,531 ac))

The Ventura County unit consists of one area in the north-central portion of Ventura County. Vernal pool fairy shrimp and Conservancy fairy shrimp are known to co-occur at relatively high elevation (~1,700 m (5,500 ft)) forested sites within the Los Padres National Forest. All of this unit is owned by the USFS. Almost all of the known localities that possess these two species within the state of California exist at much lower elevations in grassland habitats. The map polygon perimeter consists of an area that is known to contain vernal pool and Conservancy fairy shrimp occurrences and isolated pools that provide habitat for the two species. The Ventura County unit is essential for the conservation of Conservancy fairy shrimp because it contains high elevation (~ 1,700 m (5,500 ft)) ephemeral aquatic environments that are rarely associated with fairy shrimp. The Ventura County sites that are occupied by Conservancy fairy shrimp are 124 km (200 m) from other species occurrences in the Great Central Valley, thereby suggesting that the Ventura County population(s) is geographically isolated from the population(s) that occur farther east and north. Such isolated and peripheral populations may have genetic characteristics that are different than more central populations, and may be important for conservation (Lesica and Allendorf 1995, Fugate 1998).

Longhorn Fairy Shrimp Criteria

In proposing critical habitat units for longhorn fairy shrimp we evaluated the life history and current distribution of the species described in the background section of this rule, the primary constituent elements described in the primary constituent element section of this rule, and the threats to the species described under vernal pool crustaceans above and additional threats described below. This information allowed us to determine which areas are likely to be essential to the conservation of these species.

Longhorn fairy shrimp are currently known from three locations, Altamont Pass area at the Contra Costa and Alameda county line, San Luis National Wildlife Refuge Complex in western Merced County, and the Soda Lake area in San Luis Obispo County. Longhorn fairy shrimp near Soda Lake occur both on protected land within the Carrizo National Monument, and on private land. The occurrences on private land are threatened by proposed development of ranchettes, production of animals used in biotechnology industries, and road construction. Longhorn fairy shrimp occurrences in the Altamont Pass area in Contra Costa and Alameda counties have been heavily impacted by wind energy development, although some of these occurrences are currently protected from development on land owned by the East Bay Regional Parks District (EBRPD) (Eng *et al.* 1990, EBRPD 2001). Longhorn fairy shrimp are protected from development on the Kesterson National Wildlife Refuge in Merced County, however, these occurrences are threatened by wetland management practices that have led to prolonged inundation of longhorn fairy shrimp habitats and inadvertent introduction of fish and bullfrogs (CNDDB 2001).

In areas where longhorn fairy shrimp habitats have been protected, the species may be still be threatened if adequate monitoring and management is not conducted. Management and monitoring are necessary to recognize and protect populations from indirect effects, such as changes in hydrology, contamination, siltation, erosion, competition with non-native species, and human-related disturbance, such as off road vehicle use.

Longhorn Fairy Shrimp Unit Review

We conducted a review of the currently known range of longhorn fairy shrimp to evaluate and select areas that are essential to the conservation of the species and that may require special management. Important factors we considered were the presence of the species and the primary constituent elements essential to the conservation of the species. A specific description of each area is outlined below.

Unit 1, Altamont Hills Unit A and B, Contra Costa and Alameda Counties (322 ha (795 ac))

This unit is proposed as critical habitat for longhorn fairy shrimp because it supports occurrences of the species within clear depression pools in sandstone outcrops (Eriksen and Belk 1999, EBRPD 2001, CNDDB 2002). These pool types become inundated during winter rains and hold water for sufficient lengths of time necessary for longhorn fairy shrimp incubation, reproduction, dispersal, feeding, and sheltering, but are dry during the summer and do not necessarily fill with water every year; This is an unique habitat for longhorn fairy shrimp, and helps to maintain a diversity of habitats for the species. The Altamont Hills Unit is an important area for longhorn fairy shrimp because it represents the northern limit of the species range, and is one of only 3 locations where the species is known to occur throughout their entire range. Longhorn fairy shrimp in the Altamont Hills Unit are located about 100 km (60 mi) northwest of the next known occurrence at Kesterson National Wildlife Refuge in Merced County (Eriksen and Belk 1999). It is likely these occurrences have genetic characteristics that differ from other occurrences in other portions of the species range, and these characteristics may be important for the conservation of longhorn fairy shrimp (Fugate 1992, 1998). Each of these locations reduces the probability that a chance event would result in the extinction of the species.

This unit is located primarily on EBRPD and Contra Costa Water District land. 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. A large number of federally listed and sensitive species are found within this area, including the California red legged frog, San Joaquin kit fox, California tiger salamander and California linderiella.

Unit 2, Grassland Ecological Unit, Madera, Merced and Stanislaus Counties (29,817 ha (73,677 ac))

This unit is proposed as critical habitat for longhorn fairy shrimp because it contains turbid alkaline vernal pools on Edminster loam and Turlock sandy loam that support occurrences of the species (USDA 2001, Holland 1998, CNDDB 2002). This is the only location where longhorn fairy shrimp occur in the Central Valley of California. Longhorn fairy shrimp within this unit are threatened by altered hydrology and invasion of aquatic predators. This unit is also designated so that special management actions can be taken to maintain the appropriate timing, frequency, and duration of inundation of longhorn fairy shrimp habitat essential to the conservation of longhorn fairy shrimp within managed wetland areas.

This unit is over 209 km (130 mi) from the longhorn fairy shrimp occurrence to the south, and over 80 km (50 mi) from longhorn fairy shrimp occurrences to the north. This occurrence is likely genetically different from the two other occurrences (Fugate 1992, 1998). Longhorn fairy shrimp are known from only 3 locations, and each of these locations is important to the conservation of this species by providing a buffer against catastrophic or stochastic events which could extirpate any one occurrence and seriously reduce the likelihood of survival and recovery of the species as a whole.

This unit includes natural habitats within the San Joaquin River watershed. The Grassland Ecological Unit includes Kesterson, San Luis, and Merced National Wildlife Refuges (9,303 ha (23, 258 ac)), CDFG lands (1,703 ha (4,257 ac)), CDFG administration lands (1,052 ha (2,631 ac)), California State Parks (1,358 ha (3,394 ac)), private lands protected by WRP easements or agreements (54 ha (134 ac)), and numerous other Federal and private conservation easements. Combined, these lands are known as the Grasslands Ecological Area, a 66,773 ha (160,000 ac) area which supports the largest remaining areas of several rare valley floor habitats within the San Joaquin valley, including examples of alkali grasslands, alkali scrub lands, wild rye grasslands, cotton wood riparian forests, vernal marshes, relict dune lands, and high quality vernal pool habitats. Threats to vernal pool habitats in this unit include agricultural conversion, changes in hydrology, contamination from adjacent land use, and invasion by aggressive plants.

The unit lies north of the City of Los Banos, southwest of the City of Merced, and is bisected by the San Joaquin River. This unit overlaps Unit 23 for vernal pool fairy shrimp, Unit 16 for vernal pool tadpole shrimp, and Unit 7 for Conservancy fairy shrimp. In addition to the species mentioned above, vernal pool smallscale, Alkali milk-vetch, western spadefoot toad, and California linderiella are present within this unit as well.

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

This unit is proposed as critical habitat for longhorn fairy shrimp because it contains occurrences of the species living within Northern Claypan type vernal pools as described by Sawyer and Keeler-Wolf (1995) (CNDDB 2001). Longhorn fairy shrimp in the Carrizo Unit are found in shallow alkaline vernal pools within a Valley Saltbush Scrub matrix adjacent to the 1214 ha (3,000 ac) Soda Lake, the largest alkali wetland in central and southern California, which provides a winter haven for thousands of migratory birds.

The Carrizo Plain Unit represents the southern extent of the range of longhorn fairy shrimp. Longhorn fairy shrimp in the Carrizo Plain Unit are located 235 km (146 mi) southeast of the closest known occurrences at Kesterson National Wildlife Refuge in Merced County (Eriksen and Belk 1999). Such isolated populations may have genetic characteristics essential to overall long-term conservation of the species (Fugate 1998). The Carrizo Plain contains examples of native bunch grass, needle grass, and blue grass grasslands, as well as populations of federally listed San Joaquin kit fox, blunt nosed leopard lizard, giant kangaroo rat, California jewel flower, Lost Hills salt brush, Kern mallow and San Joaquin wooly threads (The Nature Conservancy 2001). North of the Carrizo Plain, vernal pools that occur along the San Andreas fault are small sag pond types surrounded by annual grassland or Interior Coast Range Saltbush Scrub (Keeler-Wolf *et al.* 1998). 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 6,220 ha (15,549 ac) and the CDFG lands total approximately 93 ha (233 ac). Other vernal pool habitats in the unit are located on private land.

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, however, Soda Lake Road crosses through the western edge of the unit in several areas. To the east, the unit is bordered by the San Andreas Rift Zone. This unit coincides with vernal pool fairy shrimp Unit 25.

Vernal Pool Fairy Shrimp Criteria

In proposing critical habitat units for vernal pool fairy shrimp we evaluated the life history and current distribution of the species, the primary constituent elements, and the current threats to the species. This information allowed us to determine which areas are likely to contribute to the conservation of vernal pool fairy shrimp and to delineate units so that threats to these species might be minimized.

The historic range of vernal pool fairy shrimp extended throughout the low and mid-elevation regions of the Central Valley into southern and coastal California and southern Oregon Agate Desert. Vernal pool fairy shrimp have been extirpated from a number of their historic occurrences as a result of urban development and conversion to agriculture. Rapid urbanization in Placer, Sacramento, and Tehama counties, California, has accounted for the majority of recent vernal pool fairy shrimp extirpations, although conversion to agriculture in San Joaquin, Merced, and other counties also has contributed to the continued decline of this species.

Remaining vernal pool fairy shrimp occurrences continue to be threatened by all of the factors that historically led to the decline of this species. CNDDB (2001) estimates that 34 percent of the remaining occurrences of this species are threatened by development and agricultural conversion. Another 15 percent are threatened by military activities (CNDDB 2001). An additional 15 percent are threatened by operations and maintenance activities within utility and transportation right-of-ways, including grading, discing, and trenching activities which destroy the topographical features necessary for vernal pool habitats to support occurrences of vernal pool fairy shrimp (CNDDB 2001). Pesticide and herbicide use within utility easements also threaten many occurrences of vernal pool fairy shrimp (CNDDB 2001). Other vernal pool fairy shrimp occurrences are

threatened by off road vehicle use, logging, mining, vandalism, dumping, and expansion of landfills (CNDDB 2001).

Numerous occurrences of vernal pool fairy shrimp are threatened by altered hydrology. In some cases vernal pools have been altered so that they contain water year round, allowing predators such as bullfrogs and fish to colonize vernal pool habitats (CNDDB 2001). In other cases artificial run off has resulted in the delivery of materials that destroy vernal pool water quality, including sediment from cement plants, pesticides from vineyards and other irrigated agricultural lands, pesticides from golf courses, and sediment from surrounding developments (CNDDB 2001).

Vernal Pool Fairy Shrimp Unit Review

We conducted a regional review across the range of vernal pool fairy shrimp to evaluate and select vernal pool habitats that are essential to the conservation of the species and that require special management. Important factors we considered were the known presence of vernal pool fairy shrimp and the presence of vernal pools and vernal pool complexes supporting the hydrological characteristics necessary to provide the primary constituent elements essential to the conservation of the species.

We identified areas that support high numbers of vernal pool fairy shrimp occurrences identified by CNDDB (2002) within vernal pool complexes containing the primary constituent elements for the species mapped by Holland (1998) and a number of other sources throughout the range of the species. We have identified areas necessary to conserve the species by maintaining a portion of the species current range and distribution and including some of the different kinds of habitats in which the species is known to occur. However, as is the case with all critical habitat designations, areas outside of this designation may still prove to be necessary to the recovery of this species. A description of each area is outlined below.

Oregon

Vernal pool fairy shrimp are the only species addressed in this proposed rule that occur in Oregon. Four units in Oregon are proposed as essential to the conservation of vernal pool fairy shrimp. The Oregon units occur approximately 200 km (125 mi) north of the nearest unit proposed for this species in California.

Unit 1A, B, C ,D, E, F, and G, North Agate Desert Unit, Jackson County (862 ha (2,130 ac))

This unit consists of seven subunits, all located to the north of Little Butte Creek. Three of the subunits are west of the Rogue River, and the remaining four are to the east. All but one of these subunits are located to the south of U.S. Route 234 (Sam's Valley Highway). The one remaining unit is located to the east of the Rogue River, about 2.4 km (1.5 mi) north of the confluence with Reese Creek. This unit represents the northern limit of the species' distribution and therefore may contribute significantly to the species' genetic diversity (Lesica and Allendorf 1995). It is of sufficient size to sustain the natural ecosystem processes (*e.g.*, fires) that have historically influenced vernal pool habitat and is disjunct from the nearest other unit proposed for Oregon, Unit 4, by over 3.2 km (2 mi).

Unit 2A, B, C, D, and E, White City East Unit, Jackson County (911 ha (2,251 ac))

This unit consists of five subunits, located east of U.S. Route 62 (Crater Lake Highway) and south and southeast of Dutton Road. The largest and easternmost of the subunits occurs just to the east and north of Agate Lake. This unit provides the easternmost extent of the species' range in Oregon. It represents a significant component of the species' original range in the state and is of a sufficient size to sustain the natural ecosystem processes (*e.g.*, fires) that have historically influenced vernal pool habitat. It is disjunct by more than 1.6 km (1 mi) from Unit 3, White City West, and by approximately 5.6 km (3.5 mi) from the North Agate Desert Unit.

Unit 3A, B, and C, White City West Unit, Jackson County (931 ha (2,301 ac))

This unit consists of three subunits, located west of Agate Road, south of the Rogue River, and east of Bear Creek. This unit contains the best remaining examples of the original Agate Desert mounded prairie habitat. It is of sufficient size to sustain the natural ecosystem processes (*e.g.*, fires) that have historically influenced vernal pool habitat; it is disjunct from the White City East Unit by more than 1.6 km (1 mi) and from the Table Rocks Unit by over 2.4 km (1.5 mi).

We believe that, taken together, the proposed Agate Desert units (Units 1–3) comprise a functional vernal pool complex consisting of vernal pools, mounded prairie and associated uplands, where natural processes, including connectivity, function within or near the natural range of variability. Each of the three proposed Agate Desert units is essential to the conservation of vernal pool fairy shrimp populations in the Agate Desert.

Unit 4A and B, Table Rocks Unit, Jackson County (361 ha (892 ac))

This unit consists of two subunits, located on two flat-topped mesas known as Upper and Lower Table Rocks, situated north and west of the Rogue River. These rimrock features are remnants of ancient lava flows that filled portions of the Rogue River nearly 10 million years ago (Bureau of Land Management (BLM) 1998). Subsequent erosion of softer geologic layers has left these harder, andesite (volcanic rock) formations rising some 245 m (800 ft) above the present Rogue Valley. Vernal pools on the Table Rocks differ from those of the Agate Desert, in that they are formed over an impervious layer of bedrock. This unit represents a unique habitat for vernal pool fairy shrimp in Oregon; Table Rocks fairy shrimp populations differ ecologically from fairy shrimp populations in the Agate Desert. The Table Rocks Unit is disjunct from the North Agate Desert Unit by over 3.2 km (2 mi), and from the White City West Unit by approximately 2.4 km (1.5 mi).

California

Unit 5, Redding Unit, Shasta County (1,849 ha (4,569 ac))

This unit is proposed as critical habitat for vernal pool fairy shrimp because it contains the largest intact vernal pool habitat in the northern portion of vernal pool fairy shrimp's range in California. Occurrences of the species (CNDDB 2002) within vernal pools mapped by Holland (1998) are found on old alluvial terraces above the Sacramento River and often on Redding and Corning soil complexes (Shasta County 2001). Generally these pools are small in size, although the Stillwater Plains area supports unique pools which are several acres in size. These vernal pools provide feeding and sheltering habitat for the species and remain inundated for sufficient lengths of time to allow vernal pool fairy shrimp to hatch, mature, and reproduce.

The boundaries of the unit were delineated to include the interconnected pools, swales, and associated uplands mapped by Holland (1998) that contribute to the filling and drying of the vernal pools where vernal pool fairy shrimp occur, and which maintain suitable periods of pool inundation, water quality, and soil moisture for vernal pool fairy shrimp hatching, growth, reproduction, and dispersal.

This unit supports systems of hydrologically interconnected pools and swales 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 crustaceans to complete their life-cycle.

This unit represents contains all of the primary constituent elements for the species and comprises the northern extent of the species range in California. Because occurrences within this unit are at the limit of the species range in California they may have genetic characteristics essential to overall long-term conservation of the species (*i.e.*, they may be genetically different than more central populations) (Fugate 1992, 1998, Lesica and Allendorf 1995).

Most of the land included within this unit is privately owned. The BLM owns 17 ha (42 ac) within this unit and a further 52 ha (130 ac) is private land protected under conservation easement or agreement as part of the Wetlands Reserve Program (WRP). The Stillwater Plains Conservation Bank, specifically established to contribute to the recovery of vernal pool fairy shrimp, is located within this unit. The City of Redding and other local and state planning organizations are currently developing a HCP to provide for the conservation of vernal pool fairy shrimp. This unit would provide an area where conservation efforts for vernal pool fairy shrimp could take place.

This unit is located in the area east of the Redding Municipal Airport between Airport Road to the west and Deschutes Road to the east. The unit extends to Dersch Road in the south and towards Lassen Park Highway in the north. This unit comprises a portion of the Stillwater Plains. This unit overlaps slender Orcutt grass Unit 2B and vernal pool tadpole shrimp Unit 1. Other sensitive species occurring within this unit include Red Bluff dwarf rush (*Juncus leiospermus* var. *leiospermus*), California linderiella (*Linderiella occidentalis*), Henderson's bent grass (*Agrostis hendersonii*), and four angled spike rush (*Eleocharis quadrangulata*).

Unit 6, Red Bluff Unit, Tehama County (18,562 ha (45,865 ac)

This unit is proposed as critical habitat for vernal pool fairy shrimp because it contains the species (CNDDB 2002) within vernal pools mapped by Holland (1998) and the pools contain water for sufficient periods of time necessary for vernal pool fairy shrimp incubation, reproduction, dispersal, feeding, and sheltering. Vernal pool fairy shrimp within this unit occur within vernal pools formed on alluvial terraces west of the Sacramento River and associated with Newville/Corning and Redding/Corning soil complexes (USDA 2001) exhibiting well developed mima mound topography. The vernal pools within this unit are generally small and may not be inundated long enough to support other longer-lived vernal pool species.

The boundaries of the unit were delineated to include the interconnected pools, swales, and associated uplands mapped by Holland (1998) that contribute to the filling and drying of the vernal pools where vernal pool fairy shrimp occur, and which maintain suitable periods of pool inundation, water quality, and soil moisture for vernal pool fairy shrimp hatching, growth, reproduction, and dispersal. This unit contains several large (*i.e.*, over (4,068 ha) 10,000 ac) vernal pool habitat complexes. These areas are relatively undisturbed, hydrologically intact vernal pool habitats that will likely continue to support natural vernal pool ecosystem processes and maintain suitable habitat conditions for vernal pool fairy shrimp. This unit also provides essential habitat for migratory waterfowl that aid in the dispersal of vernal fairy shrimp and other vernal pool crustacean cysts.

The majority of the lands included within this unit are privately owned. The CDFG owns 175 ha (433 ac) within this unit. Urban expansion from the city of Red Bluff, and agricultural conversion in other portions of the unit, threaten existing vernal pool fairy shrimp habitats throughout this unit. However, this unit also contains large private conservation areas established specifically to contribute to the recovery of vernal pool fairy shrimp and compensate for the loss of vernal pool habitat, including the 2,023 ha (5,000 ac) Tehama Fiber Farm mitigation area. CDFG's Thomes Creek Ecological Reserve is also located within this unit.

This unit extends from southwest of Red Bluff at Red Bank Creek south to Thomes Creek. The eastern boundary includes the vernal pool habitat from the Southern Pacific Railroad near Coyote Creek south paralleling Interstate 5 to Thomes Creek. Other vernal pool species occurring within this unit include Boggs Lake hedge-hyssop (*Gratiola heterosepela*), Baker's navarretia (*Navarretia leucocephala* ssp. *bakeri*), Red Bluff dwarf rush, Douglas' pogogyne (*Pogogyne douglasii*), western spadefoot toad (*Scaphiopus hammondi*), legenere (*Legenere limosa*), California linderiella, Ahart's paronychia (*Pyronychia ahartii*), Henderson's bent grass, and dwarf downingia (*Downingia pusilla*).

Unit 7, Vina Plains Unit, Tehama, and Butte Counties (23,883 ha (59,015 ac))

This unit is proposed as critical habitat because it contains vernal pool fairy shrimp (CNDDB 2001) living within large vernal pool grassland areas 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 (EPA 1994, Holland 1998, Tehama County 1999). The boundaries of this unit were delineated to include the interconnected pools, swales, and uplands mapped by Holland (1998) that contribute to the filling and drying of the vernal pools where vernal pool fairy shrimp occur, and maintain suitable periods of pool inundation, water quality, and soil moisture for vernal pool fairy shrimp to complete their life-cycles.

The vernal pools within this unit contain water during the winter, and provide the necessary length and timing of inundation, water quality, and freedom from predation that allow vernal pool fairy shrimp to hatch, feed, reproduce, and shelter. Vernal pool fairy shrimp in this unit occur within Northern Volcanic Mudflow vernal pools, these pools are generally small and tend to be inundated for relatively short periods of time. Vernal pool fairy shrimp are also found within larger vernal pools forming on hardpans within this unit. These pools tend to be larger and longer lasting than Northern Volcanic Mudflow pools, and may also support occurrences of other, longer lived species such as Conservancy fairy shrimp.

The pool types within this unit maintain the diversity of habitats in which vernal pool fairy shrimp are known to occur and provide relatively undisturbed, hydrologically intact vernal pool habitats that will likely continue to support natural vernal pool ecosystem processes and maintain suitable habitat conditions for vernal pool fairy shrimp. This unit also provides habitat for migratory waterfowl that aid in the dispersal of vernal pool fairy shrimp and other vernal pool crustacean cysts.

The majority of the lands included within this unit are privately owned. This unit contains The Nature Conservancy's (TNC) Vina Plains preserve as well as other TNC lands 2,264 ha (5,660 ac) and conservation

easements 4,348 ha (10,870 ac). Other ownership within this unit includes 57 ha (142 ac) of private land protected under conservation easement or agreement under the Natural Resource Conservation Services's (NRCS) Wetland Reserve Program (WRP). The Vina Plains area has been the focus of a number of research projects, including long-term adaptive management and monitoring efforts evaluating the effects of grazing and fire on vernal pool plants, animals, and ecosystems (Griggs 2000). Much of the basic life history information known about vernal pool crustaceans was collected at Vina Plains (*e.g.*, Lanway 1974, Ahl 1991, Syrdahl 1993, Gallagher 1996). The importance of the Vina Plains area has been recognized by a number of state, local, and Federal agencies, and they have been the focus of several conservation planning efforts. TNC, CDFG, the Service, the EPA, the CNPS, the NRCS WRP, and researchers from California State University (CSU) at Chico have all supported research and conservation efforts for vernal pool species within this unit.

This unit is located in the northeastern portion of the Sacramento Valley from Deer Creek in Tehama County to Chico in Butte County. The unit extends south and east of the Sacramento River paralleling the low elevation foothill region of the Sierra Nevada and represents the northeastern extent of vernal pool fairy shrimp's range in California. This unit coincides with Unit 3 for vernal pool tadpole shrimp, and incorporates Unit 1 for Conservancy fairy shrimp, Unit 4 for slender Orcutt grass, Unit 2 for Greene's tuctoria, Unit 1 for hairy Orcutt grass, Unit 1 for Hoover's spurge, and Units 1 and 2 for Butte County meadowfoam. Other vernal pool species occurring within this unit include Boggs Lake hedge-hyssop, Red Bluff dwarf rush, Douglas' pogogyne, western spadefoot toad, legenere, California linderiella, California tiger salamander (*Ambystoma californiense*), Ahart's paronychia, Henderson's bent grass, Sanford's arrowhead (*Sagittaria sanfordii*), and dwarf downingia.

Unit 8, Orland Unit, Tehama County (5,760 ha (14,233 ac)

This unit is proposed as critical habitat for vernal pool fairy shrimp because it contains occurrences of the species and vernal pools, swales, and associated uplands that support vernal pool fairy shrimp (Holland 1998, Tehama County 2001, CNDDB 2002). Vernal pool fairy shrimp in this unit are found in vernal pools formed on alluvial terraces west of the Sacramento River and associated with Anita clay and Tuscan loam soils (USDA 1994). These vernal pools are generally small, and exhibit well developed mima mound topography. They contain water for sufficient periods of time necessary for vernal pool fairy shrimp incubation, reproduction, dispersal, feeding, and sheltering.

The boundaries of this unit were delineated to include the interconnected pools, swales, and associated uplands mapped by Holland (1998) that contribute to the filling and drying of the vernal pools where vernal pool fairy shrimp occur, and maintain suitable periods of pool inundation, water quality, and soil moisture for vernal pool fairy shrimp hatching, growth and reproduction, and dispersal, but not necessarily every year. 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.

This unit contains large vernal pool habitat areas in the northwestern portion of the range of vernal pool fairy shrimp. These areas provide relatively undisturbed, hydrologically intact vernal pool habitats that will likely continue to support natural vernal pool ecosystem processes and maintain suitable habitat conditions for vernal pool fairy shrimp. These vernal pool habitats support systems of hydrologically interconnected pools and swales within a matrix of surrounding uplands that together form hydrologically and ecologically functional units called vernal pool complexes.

This unit extends from the Tehama/Glenn county border in the south, west of Ingrahm Road and east of the Black Butte Reservoir, to the vicinity of Rice Creek in the north. This unit also contains a Pacific Gas and Electric (PG&E) pipeline mitigation area established specifically for the conservation of vernal pool fairy shrimp. Other vernal pool species occurring within this unit include Baker's navarretia, western spadefoot toad, Ahart's paronychia, and dwarf downingia. All the lands within this unit are privately owned.

Unit 9, Oroville Unit, Butte County (1,456 ha (3,598 ac))

This unit is proposed as critical habitat for vernal pool fairy shrimp because it supports vernal pools, swales, and associated uplands mapped by Holland (1998) and by the EPA (1994) and contains vernal pool fairy shrimp (CNDDB 2001). Vernal pool fairy shrimp within this unit live within pools occurring primarily on the Tuscan geologic formation (Liss 2001, Keeler-Wolf *et al.* 1998), which are some of the few remaining examples of Northern Volcanic Mudflow vernal pools described by Sawyer and Keeler-Wolf (1995). Northern Volcanic Mudflow vernal pools are generally small and tend to be inundated for relatively short periods of time. These pool types are essential to maintain the diversity of habitats in which vernal pool fairy shrimp are known to occur. Vernal pool fairy shrimp are also found living in Northern Hardpan vernal pools within this unit. These pools tend to be larger and longer lasting than the Northern Volcanic Mudflow pools.

The boundaries of the unit were delineated to include the interconnected pools, swales, and associated uplands mapped by Holland (1998) that contribute to the filling and drying of the vernal pools where vernal pool fairy shrimp occur, and which maintain suitable periods of pool inundation, water quality, and soil moisture for vernal pool fairy shrimp hatching, growth, reproduction, and dispersal. The majority of the lands included within this unit are privately owned. This unit contains Service lands (76 ha (187 ac)) and 7 ha (17 ac) of CDFG administered land. This unit contains a few areas that have been preserved within the City of Chico. However, the amount of vernal pool habitat currently protected within the unit is very small. Urban expansion, particularly in the vicinity of Chico, is the greatest threat to existing vernal pool habitats throughout this unit.

This unit occupies an area from near Chico south to near the intersection of Highway 99 and State Route 149 in Butte County. The unit extends southeast of the Sacramento River paralleling the low elevation foothill region of the Sierra Nevada. This unit is part of Unit 4 for vernal pool tadpole shrimp, and incorporates Unit 3 for Greene's tuctoria, Unit 2 for hairy Orcutt grass, Unit 2 for Hoover's spurge, and Unit 3 for Butte County meadowfoam. Other vernal pool species occurring within this unit include Boggs Lake hedge-hyssop, Red Bluff dwarf rush, Douglas' pogogyne, western spadefoot toad, legenere, California linderiella, California tiger salamander, Ahart's paronychia, Henderson's bent grass, Sanford's arrowhead, and dwarf downingia.

Unit 10, Sacramento National Wildlife Refuge Unit, Glenn and Colusa Counties (5,718 ha (14,129 ac))

This unit is proposed as critical habitat for vernal pool fairy shrimp because it contains occurrences of the species (CNDDB 2002) within the vernal pools and swales mapped by Holland (1998). Vernal pool fairy shrimp in this unit live within Northern Claypan vernal pools, as defined by Sawyer and Keeler-Wolf (1995). These vernal pools are associated with alkaline soils, such as Willows and Riz soils series, and typically form alkali playas which are larger and contain a more diverse species composition than the hardpan pools further south (Keeler-Wolf *et al.* 1998). These pools are inundated for a sufficient period of time to support all of the life history requirements of vernal pool fairy shrimp. Vernal pools on the Sacramento National Wildlife Refuge Complex , are often large, shallow and alkaline (Silveira 2000). Vernal pool habitats on the refuge are specifically managed for the conservation of listed species, and to promote habitat for migratory birds and waterfowl.

The Sacramento National Wildlife Refuge contains the last remnants of the widespread Colusa Plains vegetation that once covered the entire Colusa Basin (Silveira 2000). Vernal pool habitats within the area have become greatly fragmented and isolated from other habitats in the region due to land conversion to agriculture. This unit is important to maintain opportunities for vernal pool fairy shrimp dispersal between units to the north, over 50 km (31 mi) distant, and those to the south, over 110 km (68 mi) distant. Without this unit, vernal pool fairy shrimp occurrences to the north and south would be more than 160 km (100 mi) distant from one another, a distance at which genetic evidence indicates they are effectively isolated (Fugate 1992, 1998).

The boundaries of the unit were delineated to include the interconnected pools, swales, and associated uplands mapped by Holland (1998) and identified by the Service (Silveira 2000) that contribute to the filling and drying of the vernal pools where vernal pool fairy shrimp occur, and which maintain suitable periods of pool inundation, water quality, and soil moisture for vernal pool fairy shrimp hatching, growth, reproduction, and dispersal.

This unit is primarily located on the Sacramento National Wildlife Refuge (5,126 ha (12,816 ac)). Any additional lands within this unit are privately owned. This unit overlaps with Unit 6 for Greene's tuctoria, Unit 3 for hairy Orcutt grass, Unit 3 for Hoover's spurge, and Unit 2 for Conservancy fairy shrimp. Other important vernal pool and associated upland species found in the unit include pappose spikeweed (*Hemizonia parryi* ssp. *rudis*), Fremont's goldfields (*Lasthenia fremontii*), alkali goldfields (*Lasthenia platycarpha*), Scribe's popcorn flower (*Plagiobothrys scriptus*), Hoover's downingia (*Downingia bella*), folded downingia (*Downingia ornatissima* var. *ornatissima*), Heckard's peppergrass (*Lepidium latipes* var. *heckardii*), heartscale (*Atriplex cordulata*), brittlescale (*Atriplex depressa*), San Joaquin spearscale (*Atriplex joaquiniana*), Ferris' milkvetch (*Astragalus tender* var. *farrisiae*), spike-primrose (*Boisduvalia stricta*), sessile mousetail (*Myosurus sessilis*), and palmate-bracted bird's beak (*Cordylanthus palmatus*).

Unit 11, Beale Unit, Yuba and Placer Counties (2,853 ha (7,049 ac))

We propose the Beale Unit as essential for the conservation of vernal pool fairy shrimp because it contains large, relatively undisturbed vernal pool grassland habitats and a diversity of vernal pool habitat types supporting vernal pool fairy shrimp (CNDDB 2001, Jones and Stokes 1997b, Jones and Stokes 2002, Platenkamp 1998). Vernal pool fairy shrimp within this unit are found throughout several large vernal pool complexes. These complexes occur on four major geologic formations: the Modesto Formation; the Riverbank Formation; the Laguna Formation; and the Mehrten Formation (Platenkamp 1998). These habitats provide the hydrological characteristics necessary for vernal pool fairy shrimp growth, reproduction, dispersal, and other primary constituent elements essential to the conservation of this species. Different geologic formations provide a diversity of habitats for vernal pool fairy shrimp primarily through their effects on pool size and depth (Platenkamp 1998, Helm 1998).

This unit contains DOD land (419 ha (1,048 ac)) at Beale Air Force Base and BLM (3 ha (8 ac)) lands. Other lands within this unit are located on private property, and are threatened by agricultural conversion, urban expansion, and the expansion of Highway 70 and other transportation projects planned in the region. This unit is found east of Yuba City and State Highway 65, generally south of Hammonton Road and north of South Beale Road and 6th Street. The unit includes the western portion of Beale Air Force Base, west of Erle Street and Doolittle Drive. Other rare vernal pool species found within this unit include vernal pool tadpole shrimp and California linderiella.

Unit 12, Western Placer County Unit (19,387 ha (47,905 ac))

The Western Placer Unit was identified as critical habitat for vernal pool fairy shrimp because it contains numerous occurrences of the species (CNDDB 2001). The unit boundary was drawn to include these occurrences and the vernal pool complexes in which they occur as mapped by Holland (1998) and Glazner (2001) and as visible on SPOT imagery. These complexes form interconnected hydrologic units of pools, swales and uplands that together maintain the timing and duration of inundation necessary for vernal pool fairy shrimp to hatch, mature, and reproduce. Vernal pool fairy shrimp within this unit occur in both Northern Hardpan and Northern Volcanic Mudflow vernal pools as described by Sawyer and Keeler-Wolf (1995). This unit also supports vernal pool fairy shrimp found in vernal pools on Exchequer soils on the Mehrten geologic formation, a rare type of Northern Volcanic Mudflow vernal pool which has been reduced to only a few acres in extent. The pools are relatively short lived and do not provide habitat for most other species of fairy shrimp (CNDDB 2001).

This unit includes a large number of conservation areas established specifically to contribute to the recovery of vernal pool fairy shrimp partly established through conservation efforts under section 7 of the Act. These include the Ahart Preserve, one of the few remaining examples of Northern Volcanic Mudflow vernal pools in the region, as well as the Orchard Creek Conservation Bank. This conservation bank was established for the protection of vernal pool fairy shrimp and to compensate for the loss of thousands of acres of vernal pool grassland habitats throughout Placer and Sacramento counties. Additional smaller conservation areas in this unit are located within the cities of Lincoln and Roseville, and in Placer County. Approximately 20 percent of all mitigation areas established for the long-term protection of vernal pool fairy shrimp are found within this unit. Placer County is currently developing a HCP for the conservation of vernal pool fairy shrimp in this area. A WRP easement of 63 ha (157 ac) is within this unit.

The Western Placer Unit contains 70 percent of the remaining vernal pool habitats in Placer County. TNC identified this area as one of the

outstanding vernal pool sites remaining in the Sacramento Valley. Vernal pool habitats within this unit are threatened by the development of large transportation projects, the development of a university and associated infrastructure, residential developments, gravel mining operations, and agricultural conversion in the western portion of Placer County.

This unit generally occurs in western Placer County immediately north of the Sacramento County line, north of the City of Roseville and the City of Rocklin. The northern boundary occurs just north of the City of Lincoln. This unit occurs mostly west of State Highway 65. This unit provides habitat for sensitive vernal pool species such as Bogg's Lake hedge-hyssop, Red Bluff dwarf rush, western spadefoot toad, legenere, California linderiella, Ahart's paronychia, and dwarf downingia. A number of riparian species are also found in this unit in the vernal pool grasslands that border Coon Creek.

Unit 13, Mather Unit, Sacramento County (14,866 ha (36,733 ac))

This unit is proposed as critical habitat for vernal pool fairy shrimp because it contains occurrences of the species and vernal pool habitats that sustain the necessary timing and length of inundation required for the species to hatch, mature, reproduce, disperse, and enter dormancy (Holland 1998, Sacramento County 1999, CNDDB 2001). Vernal pool fairy shrimp in this unit occur within a diversity of vernal pool habitats, including young or low terrace vernal pools on the Riverbank Formation, old or high terrace vernal pools on the Laguna and Arroyo Seco geologic formations, and Northern Volcanic Mudflow vernal pools on the Mehrten and Valley Springs geologic formations.

This unit includes several conservation areas established by private entities, including the Sunrise Douglas Conservation Bank, the Arroyo Seco Conservation Bank, the Churchill Downs mitigation area, and Teichert mitigation areas. These areas were established specifically to contribute to the conservation of vernal pool fairy shrimp, and represent compensation measures for the loss of thousands of acres of vernal pool fairy shrimp habitat within Sacramento County. The continued functioning of these areas is essential to the conservation of vernal pool fairy shrimp and other vernal pool species. The boundaries of the unit were delineated to include the interconnected pools, swales, and associated uplands mapped by Holland (1998) that contribute to the filling and drying of the vernal pools where vernal pool fairy shrimp occur, and which maintain suitable periods of pool inundation, water quality, and soil moisture for vernal pool fairy shrimp hatching, growth, reproduction, and dispersal.

This area supports a diversity of vernal pool species and habitats, and is the focus of numerous conservation planning efforts. This area has been identified by the Sacramento Valley Open Space Conservancy, the CNPS, and TNC as an excellent example of vernal pool grasslands, supporting a rich and diverse community of vernal pool endemic plants and animals within Sacramento County. This unit contains areas on private, county, and Federal land, including lands leased or owned by Sacramento County at Mather Regional Park, the former Mather Air Force Base, and at the county landfill. BLM owns 6 ha (18 ac) within this unit. Vernal pool habitats in this unit are threatened by urbanization from the expanding cities of Sacramento and Elk Grove. Conversion to intensive agriculture, particularly vineyards, is also a significant threat to vernal pool fairy shrimp in this unit.

This unit includes the area to the southeast of the City of Sacramento in Sacramento County, east of Highway 99 and south of Interstate 80. The unit is generally east of Bradshaw Road, northwest of Grant Line Road, west of Scott Road, and includes a portion of Mather Field. The unit is bisected by the Folsom South Canal. This unit also represents Unit 8 for vernal pool tadpole shrimp, and contains Unit 6 for slender Orcutt grass and Unit 2 for Sacramento Orcutt grass. In addition to these species, this unit contains occurrences of many other rare, endemic vernal pool species including midvalley fairy shrimp (*Branchinecta mesovalliensis*), Bogg's Lake hedge-hyssop, western spadefoot toad, legenere, California linderiella, and Ahart's paronychia.

Unit 14, Cosumnes Unit, Sacramento County (26,600 ha (65,728 ac))

This unit is proposed as critical habitat for vernal pool fairy shrimp because it supports the species (CNDDB 2001) and its habitat (Holland 1998, Sacramento County 1999). The unit boundary was drawn to include several large vernal pool complexes mapped by Holland (1998) and numerous individual vernal pools mapped by Sacramento County (1999) and visible on SPOT imagery. Together, these identified habitats represent some of the largest remaining vernal pool complexes in the Sacramento Valley that provide the necessary timing and duration of inundation for vernal pool fairy shrimp hatching, growth, and reproduction. Vernal pool fairy shrimp within this unit are found in a diversity of pool types, including Northern Volcanic Mudflow vernal pools on Pardee and Pentz soils, vernal pools occurring on low terrace landforms associated with San Joaquin soils, and vernal pools occurring on high terrace landforms associated with Redding and Corning soils. These pool types provide a diversity of habitats for this species. The large vernal pool complexes found within this unit provide relatively undisturbed, hydrologically intact vernal pool habitats that support natural vernal pool ecosystem processes and maintain suitable habitat conditions for vernal pool fairy shrimp.

Many areas within this unit include actively restored and created vernal pools that support occurrences of vernal pool fairy shrimp (CNDDB 2001). This unit is also proposed as critical habitat to encourage that special management actions will be taken so that these areas continue to provide the necessary timing and length of inundation for vernal pool fairy shrimp survival. In many cases, the special management action necessary will simply be to monitor vernal pool hydrology to verify the success of the restoration effort.

This unit contains a number of conservation areas established specifically to contribute to the conservation of vernal pool fairy shrimp, and to compensate for the loss of thousands of acres of vernal pool grassland habitats throughout the Sacramento Valley. Many areas within this unit are managed specifically to provide habitat for migratory waterfowl, this unit also provides essential habitat for avian species that aid in the dispersal of vernal pool fairy shrimp and other vernal pool crustacean cysts.

This unit contains state and federally owned land, as well as private properties. Portions of the Cosumnes River Preserve occur within this unit. The Cosumnes River Preserve is jointly owned and managed by a variety of state, local, and Federal agencies including the BLM , CDFG, Ducks Unlimited, Inc., California Department of Water Resources, Sacramento Co. Dept. of Regional Parks, Open Space, and Recreation, TNC, and the Wildlife Conservation Board. The Cosumnes River Preserve encompasses and protects thousands of acres of wetlands and adjacent uplands, oak woodlands, and riparian forests along the Cosumnes River, the only undammed river on the west slope of the Sierra. The Cosumnes floodplain is a haven for tens of thousands of migratory waterfowl, songbirds, and raptors, a large portion of

the Central Valley's population of greater sandhill cranes, and for rare reptiles and mammals like the river otter and threatened giant garter snake. Several large, diverse, vernal pool landscapes are protected within this unit including the Howard Ranch and Valensin Ranch. The Clay Station Mitigation Bank, Laguna Creek Mitigation Bank, and the Borden Ranch Mitigation site are included in this unit, as well as a number of smaller conservation areas including the Rancho Seco Preserve. Land ownership and protection within the unit includes CDFG (630 ha (1,557 ac)), TNC (3,988 ha (9,970 ac)) lands and WRP easements (4 ha (11 ac)). This area has been identified by the Sacramento Valley Open Space Conservancy, the CNPS, and TNC as an excellent example of vernal pool grasslands, supporting a rich and diverse community of vernal pool endemic plants and animals within Sacramento County. Urban expansion, conversion from grazing to other agricultural practices, particularly vineyards, have greatly affected existing vernal pool habitats throughout this unit.

This unit for vernal pool fairy shrimp occupies the area south of Deer Creek and Cosumnes River to just north of the Sacramento and San Joaquin county line near Simmerhorn Road. The eastern boundary is the low elevation foothills near the Amador county line. The western limit follows Dillard Road south to Colony Road near Herald. This unit also coincides with Unit 10 for vernal pool tadpole shrimp, and Unit 3 for Sacramento Orcutt grass. Other sensitive species found within this unit include Bogg's Lake hedge-hyssop, western spadefoot toad, legenere, California linderiella, California tiger salamander, Ahart's paronychia, Henderson's bent grass, Sanford's arrowhead, pincushion navarretia (*Navarretia myersii* ssp. *deminuta*), and dwarf downingia.

Unit 15 Vacaville Unit, Solano County (1,624 ha (4,012 ac))

This unit is proposed as critical habitat because it contains vernal pool fairy shrimp within large vernal pool complexes (Holland 1998, Solano County 2000, CNDDB 2001). This unit contains vernal pool fairy shrimp occurring within vernal pools and swales formed on Corning gravelly loam soil series, which form Northern Hardpan vernal pools (Sawyer and Keeler-Wolf 1995). These pool types maintain the necessary conditions for vernal pool fairy shrimp hatching, feeding, reproduction, and dispersal (CNDDB 2001).

The Vacaville Unit supports the only examples of Northern Hardpan vernal pool types, including high terrace vernal pools on Corning soils, on the western side of the valley. These unique habitats are necessary to maintain the diversity of habitats in which vernal pool fairy shrimp are known to occur. This unit is located primarily on private land although the State Land Commission owns approximately (60 ha (149 ac)) within this unit. Vernal pool habitats within this unit are threatened by urbanization from the expanding City of Vacaville. Solano County is currently developing a HCP which will address the conservation of vernal pool fairy shrimp in this area.

The Vacaville Unit is situated north and northeast of the City of Vacaville. The eastern boundary parallels Interstate 80, the northern boundary parallels Midway Road, and the western boundary is near Browns Valley Road. This unit also provides habitat for vernal pool tadpole shrimp, dwarf downingia, as well as Swainson's hawks (*Buteo swainsoni*) and burrowing owls.

Unit 16, Jepson Prairie Unit, Solano County (34,910 ha (86,261 ac))

We propose this area as critical habitat for vernal pool fairy shrimp because it supports numerous occurrences of the species (CNDDB 2001) living within systems of hydrologically interconnected pools and swales within a matrix of surrounding uplands that together form hydrologically and ecologically functional vernal pool complexes. These features contribute to the filling and drying of the vernal pools where vernal pool fairy shrimp are known to occur, and maintain suitable periods of pool inundation, water quality, and soil moisture for vernal pool fairy shrimp hatching, growth and reproduction, and dispersal. These features have been identified and mapped by Solano County (2000), Holland (1998), and the Solano County Farmlands and Open Space (2000). The Jepson Prairie Unit encompasses the greater Jepson Prairie grassland area, one of the most pristine, intact vernal pool ecosystems remaining in California. Jepson Prairie contains large, playa-like vernal pools which may be over several acres in size, including the 32 ha (80 ac) Olcott Lake. These larger pools often occur in complexes with smaller pools and hogwallow depressions.

This unit includes one of only two large contiguous areas of habitat remaining for vernal pool fairy shrimp on the floor of the Central Valley. The relatively undisturbed, hydrologically intact condition of the Jepson Prairie increases the likelihood that it will continue to support natural vernal pool ecosystem processes and maintain suitable habitat conditions for vernal pool fairy shrimp. This unit also provides essential habitat for migratory waterfowl that aid in the dispersal of vernal pool fairy shrimp and other vernal pool crustacean cysts. Vernal pool fairy shrimp in the Jepson Prairie grassland area inhabit unique combinations of low terrace and basin rim landform vernal pools on a diversity of soil types.

Jepson Prairie has long been recognized as an outstanding example of vernal pool ecosystems. In 1987 the National Park Service (NPS) named Jepson Prairie a National Natural Landmark, a designation given to sites that provide high quality habitat for threatened or endangered species. Jepson Prairie is the target of ongoing conservation planning efforts and active management. As part of the UC Reserve System, this area also provides critical research opportunities for scientists to study vernal pool species, including vernal pool fairy shrimp.

The unit contains 1,038 ha (2,564 ac) owned and or administered by CDFG. Additional lands are owned by DOD (760 ha (1,879 ac)), California State Parks (15 ha (38 ac)), and the State Land Commission (109 ha (273 ac)). NRCS holds easements or agreements protecting 436 ha (1,090 ac) of private land in the unit under the WRP program. TNC also holds a conservation easement on 623 ha (1,558 ac) in the unit. The Jepson Prairie Preserve is jointly managed by the Solano County Land Trust and the UC Reserve System. CDFG owns several ecological reserves in the vicinity of Jepson Prairie. This unit also contains several privately owned mitigation areas, and portions of Travis Air Force Base. Within the greater Jepson Prairie grassland area, existing vernal pools are threatened by agricultural conversion, landfill expansion, power plant construction, and utility maintenance.

This unit is located in the southern portion of Solano County, southeast of Interstate 80 and the cities of Fairfield and Vacaville, north of Grizzly Bay and Montezuma Slough, west of the Sacramento River and the Solano and Sacramento County line, and south of Midway Road and the City of Dixon. The unit is bisected by Highway 13. This unit is also described as Unit 11 for vernal pool tadpole shrimp. This unit contains Unit 3 for Colusa grass, Unit 2 for Solano grass, Unit 3 for Conservancy fairy shrimp, and Unit 4 and portions of Unit 5 for Contra Costa goldfields. Other rare vernal pool species which occur in

this unit include alkali milk-vetch (*Astragalus tener* var. *tener*), Ferris's milk-vetch, vernal pool small scale (*Atriplex persistens*), dwarf downingia, Delta green ground beetle (*Elaphrus viridus*), Bogg's Lake hedge-hyssop, Ricksecker's water scavenger beetle (*Hydrochara rickseckeri*), California linderiella, midvalley fairy shrimp, legenere, and California tiger salamander.

Unit 17, Napa River Unit, Napa and Sonoma Counties (656 ha (1,621 ac))

We propose this unit as critical habitat for vernal pool fairy shrimp because it contains vernal pools where vernal pool fairy shrimp are known to occur (CNDDB 2001). The boundaries of this unit were designed to include vernal pool complexes mapped by Holland (1998) and within the Fagan Marsh Ecological Area owned by the CDFG (420 ha (901 ac)) that contribute to the inundation patterns, water quality, and soil moisture for vernal pool fairy shrimp hatching, growth and reproduction, and dispersal, but not necessarily every year. The minimum mapping unit of Holland (1998) of 16 ha (40 ac) and the resolution of the SPOT imagery did not allow us to identify all vernal pool habitat areas which provide the primary constituent elements for vernal pool fairy shrimp in this area. The unit boundary was designated to exclude tidal marsh habitats in the south, and urban and agricultural areas along the northern and eastern boundaries. The Napa River parallels the western boundary of this unit.

This unit represents the western extent of vernal pool fairy shrimp range. Such isolated and peripheral populations may be essential to the conservation of this species because of their genetic uniqueness (Fugate 1992, 1998, Lessica and Allendorf 1995). This unit represents the only area where vernal pool fairy shrimp occur in vernal pool habitats forming a transition zone with tidal marshes. This unit is located on private and CDFG land, including the Napa-Sonoma Marsh and Fagan Marsh Wildlife Areas. Habitats within this unit are primarily threatened by urbanization from the City of Napa.

Most of this unit is situated south and southwest of the City of Napa; primarily west of Highway 29, south of Highway 12, and east of Highway 121. This unit forms a narrow strip following the northwestern banks of the Napa River and extending westward along Hudeman and Schell sloughs. This unit is also identified as Unit 3 for Contra Costa goldfields. Other rare vernal pool species found in this unit include the alkali milk-vetch.

Unit 18, San Joaquin Unit, San Joaquin County (7,105 ha (17,557 ac))

This unit is proposed as critical habitat for vernal pool fairy shrimp because it contains vernal pool habitats identified by Holland (1998) and San Joaquin County (1998) that support populations of vernal pool fairy shrimp (CNDDB 2001). This unit contains vernal pool fairy shrimp occurrences found within Northern Volcanic Mudflow vernal pools on the Laguna geologic formation, as well as high terrace pools on the Valley Springs geologic formation. The Northern Volcanic Mudflow vernal pools tend to be short-lived, and are a relatively rare habitat type for vernal pool fairy shrimp. This unit contains the largest vernal pool complex remaining in San Joaquin County and the southern Sacramento Valley, and contains the necessary geographic, topographic, and edaphic features to support vernal pool fairy shrimp occurrences found within this unit. San Joaquin County has completed a HCP, which includes measures to protect conversion of vernal pool fairy shrimp habitat from vernal pools grasslands to vineyards. Conversion from grazing to other agricultural practices have greatly reduced the remaining acreage of vernal pool habitats throughout this unit.

This unit occupies the area from the Calaveras River south to Duck Creek. The eastern boundary extends to near Valley Springs at the intersection of State routes 12 and 26. The western boundary extends to near Tully Road east of the City of Lodi. This unit also coincides with Unit 14 for vernal pool tadpole shrimp. Other sensitive vernal pool species found within this unit include western spadefoot toad and California tiger salamander. All the land within this unit is privately owned.

Unit 19A, B, and C, Altamont Hills Unit, Contra Costa and Alameda counties (3,356 ha (8,292 ac))

This unit is proposed as critical for vernal pool fairy shrimp because it contains vernal pool habitats mapped by Holland (1998) and East Bay Regional Parks District (2001) supporting vernal pool fairy shrimp occurrences identified by CNDDB (2001). Vernal pool fairy shrimp have been discovered in very small (less than 1 m (3.3 ft) in diameter) clear water depression pools in sandstone outcrops in the area (Eriksen and Belk 1999). The unit represents the only known location that supports vernal pool fairy shrimp within sandstone outcrop pools (Eriksen and Belk 1999).

Vernal pool fairy shrimp in the Altamont Hills Unit are located over 60 km (40 miles) from the closest known occurrence to north in Solano County and to the south in Stanislaus County, and over 60 km (40 mi) from the next occurrence to the west in San Joaquin County. These populations may be genetically different from other vernal populations because of their relative isolation (Fugate 1998).

The unit is comprised of three subunits in the general vicinity of Mount Diablo and Morgan Territory Regional Park. The unit primarily consists of private land, with 64 ha (157 ac) owned by the state and an additional 288 ha (711 ac) administered by the California Department of Fish and Game for conservation purposes.

This unit overlaps Unit 7 for Contra Costa goldfields. The unit lies north of Corral Hollow Road, west of Clifton Court Forebay, east of the City of Danville, southeast of Concord, and south of Antioch. It includes vernal pool habitat within the Altamont Hills, around the northern and eastern boundaries of the City of Livermore, and east of the Altamont Hills and west of Clifton Court Forebay. The unit includes Fricke Lake which supports a large population of California tiger salamanders.

Unit 20, Caswell Unit, Stanislaus County (302 ha (746 ac))

This unit is proposed as critical habitat for vernal pool fairy shrimp because it contains vernal pools, swales, and other ephemeral wetlands and depressions of appropriate sizes and depths that typically become inundated for sufficient lengths of time necessary for vernal pool fairy shrimp incubation, reproduction, dispersal, feeding, and sheltering, but which are dry during the summer (Holland 1998, CNDDB 2001). This unit also supports 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 (Holland 1998). 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 fairy shrimp hatching, growth and reproduction, and dispersal, but not necessarily every year. This unit includes vernal pool complexes mapped by Holland (1998) where vernal pool fairy shrimp have been documented by CNDDB (2001).

This unit is located within the San Joaquin River National Wildlife Refuge

and efforts to restore vernal pool habitats are currently underway. Additional restoration designed to enhance habitat for riparian species, as well as migratory birds and waterfowl, is also being conducted. The San Joaquin River National Wildlife Refuge is the primary wintering site of 98 percent of the Aleutian Canada geese that winter in the Central Valley (October–April), and it is a major wintering and migration area for lesser and greater sandhill cranes, cackling Canada geese, and white-fronted geese. These migratory birds act as important dispersal agents for vernal pool fairy shrimp. Lands within this unit form a mosaic of riparian habitat, wetlands, and grasslands.

This unit is over 75 km (47 mi) from the nearest unit to the north. Such isolated populations may have genetic characteristics essential to overall long-term conservation of the species (*i.e.* they may be genetically different than more central populations) (Fugate 1992, 1998). This unit may be threatened by agricultural development, oil and natural gas exploration and development, and conversion from grazing to other agricultural practices. Water management practices may also threaten vernal pool fairy shrimp in this unit if natural vernal pool hydrology is altered.

This unit is situated west of the City of Modesto and east and southeast of the confluence of the San Joaquin and Stanislaus rivers. Caswell Memorial State Park lies just north of this unit and is not included. The San Joaquin River forms the western boundary of the unit. The unit is bisected by the Hetch Hetchy Aqueduct, State Highway 132, and the Tuolumne River. Roughly the northern one-third of this unit overlaps with Unit 5 for Conservancy fairy shrimp. It is also contains California linderiella and California tiger salamander occurrences, in addition to a number of rare non-vernal pool species, including the federally listed endangered riparian wood rat and riparian brush rabbit.

Unit 21, Stanislaus Unit, Stanislaus and Merced Counties (25,317 ha (62,557 ac))

This area is proposed as critical habitat for vernal pool fairy shrimp because it contains occurrences of the species within large, relatively intact, and contiguous vernal pool complexes ranging from the floor of the valley to the low elevation foothills (Holland 1998, CNDDB 2001). These areas are essential to the conservation of vernal pool fairy shrimp because they provide relatively undisturbed, hydrologically intact vernal pool habitats that will likely continue to support natural vernal pool ecosystem processes and maintain suitable habitat conditions for vernal pool fairy shrimp. This unit contains vernal pool fairy shrimp living within hardpan pools that occur on soils of alluvial fans and terraces forming numerous small pools and swales on mima mound topography. Soils supporting these vernal pools are typically older than those of the alluvial terraces in the Sacramento area. These pools provide the necessary timing and length of inundation for vernal pool fairy shrimp to complete their life cycle, reproduce, and disperse.

The Stanislaus Unit is in the northern portion of the chain of vernal pools that runs through the southern Sierra Nevada foothills, within the Southern Sierra Foothill vernal pool region described by Keeler-Wolf *et al.* (1998). This vernal pool region contains 35 percent of all remaining vernal pool habitat in the Central Valley, and is extremely important to the conservation of vernal pool fairy shrimp and other vernal pool species. Land ownership within this unit includes the BLM (7 ha (17 ac)) and the California State Parks (25 ha (61 ac)). The well-known Hickman pools in Stanislaus County are located within this unit. Not only does the Hickman pool complex contain one of the largest vernal lakes in California at more than 121 ha (300 ac), but it also exhibits tremendous biodiversity, including one of the largest concentrations of imperiled amphibians (Medeiros 2000). However, the watershed containing the Hickman vernal pools has been breached by hundreds of acres of orchards that have been planted upstream. While most of the watershed has been managed over the years in a trust of the Fred Robinson family, the integrity of the vernal pool ecosystem is threatened by agricultural development and potential biocide pollution (Medeiros 2000).

The Stanislaus Unit is located in the southeast corner of Stanislaus County and the northeast corner of Merced County. It lies between the Tuolumne River and the Merced River. The Mariposa County line is located east of the unit. Turlock Lake and Dawson Lake are adjacent to the northern boundary. County Road J9 and the High Line Canal are west of the unit. This unit coincides with vernal pool tadpole shrimp Unit 16. It includes succulent owl's-clover Unit 3, hairy Orcutt grass Unit 5, Colusa grass Unit 6, and Hoover's spurge Unit 5. Other sensitive vernal pool species found within this unit include western spadefoot toad, dwarf downingia, California linderiella, California tiger salamander, and Hartweg's golden sunburst (*Pseudobahia bahiifloia*).

Unit 22, Merced Unit, Merced and Mariposa Counties (44,106 ha (108,984 ac)

We propose this unit as critical habitat for vernal pool fairy shrimp because it encompasses the largest block of pristine, high density vernal pool grasslands supporting the species remaining in California (Holland 1998, Vollmar 1999, CNDDB 2001). These habitats provide the primary constituent elements essential for vernal pool fairy shrimp. There are more documented occurrences of vernal pool fairy shrimp in this unit than any other area throughout the species range (CNDDB 2001). Almost 15 percent of all remaining vernal pool habitats in the Central Valley are located within this unit (Holland 1998).

The Merced Unit is located midway in a chain of vernal pool complexes that straddles the valley floor and the foothills of the southern Sierra Nevada. This unit helps to maintain connectivity between vernal pool fairy shrimp habitats on the valley floor and habitats to the north and south of the Merced Unit. Genetic analyses of vernal pool tadpole shrimp revealed that occurrences in this unit were genetically different from other sampled occurrences in California, and that this area had likely been isolated from other vernal pool habitats for a significant period of time (King 1996). Given that vernal pool fairy shrimp and vernal pool tadpole shrimp are dispersed in similar ways, it is reasonable to assume that vernal pool fairy shrimp occurrences in this area are also isolated from other occurrences throughout its range.

This unit contains habitat for three listed branchiopods, six listed plants, and a suite of sensitive species. Forty percent of vernal pool habitats in the Southern Sierra Foothill vernal pool region are found within this unit. The integrity of the vernal pool complexes in eastern Merced is seriously threatened by irrigated agriculture, upland housing development, and the proposed UC Merced Campus and associated development. Construction of facilities to educate and serve twenty-five thousand UC students as well as faculty, staff, and their families within the vernal pool complexes in eastern Merced County could have a major impact on vernal pool fairy shrimp occurrences. However, the recent draft biological opinion for the UC Merced campus and community developed environmental parameters which should reduce impacts to vernal pool habitats. Indirect and cumulative impacts of the

proposed 1,673 ha (4,133 ac) campus and associated community may be minimized with the creation of a 2,036 ha (5,030 ac) preserve intended to protect sensitive vernal pool habitat, to be purchased with money donated by the Packard Foundation.

A majority of vernal pool habitat in the Merced Unit is in Merced County. The eastern edge of the unit overlaps into Mariposa County. Bear Creek flows along the southern boundary of the unit, crossing through it in several locations. The City of Merced is south of the unit, Bear Reservoir is southeast of the unit and the Castle Airport is located outside of the southwest boundary. The northern boundary parallels the Merced River. The entire unit is located east of Highway 99. Land ownership within the unit includes approximately 3 ha (8 ac) of BLM, and 10 ha (26 ac) of California State Parks. TNC has a total of 4,513 ha (11,283 ac) of conservation easements within this unit. The Merced Unit coincides with vernal pool tadpole shrimp Unit 13, succulent owl's-clover Unit 4, San Joaquin Valley Orcutt grass Unit 2, Colusa grass Unit 7, and Conservancy fairy shrimp Unit 6. Other sensitive vernal pool species found within this unit include the California tiger salamander, shining navarretia (*Navarretia nigelliforms* ssp *radians*), dwarf downingia, Bogg's Lake hedge-hyssop, western spadefoot toad, and California linderiella.

Unit 23, Grassland Ecological Unit, Merced County (55,910 ha (138,153 ac))

We propose this unit as critical based upon the presence of vernal pools and vernal pool fairy shrimp. This unit supports numerous occurrences of vernal pool fairy shrimp within a diversity of vernal pools supported by a number of different soil types, including Delhi-Dello-Himar, Solano-Caypay-Willows, Rossi-Waukena, and Lewis-Landlow soils (CNDDB 2001, USDA 2001). This diversity of soils creates a wide range of vernal pool shapes, sizes, and physical characteristics which provide the essential timing, frequency, and length of inundation necessary for the conservation of the species. This unit contains numerous large, intact vernal pool grasslands, and is one of only two areas on the floor of the Central Valley that provide expansive areas of vernal pool complexes within which vernal pool fairy shrimp can hatch, mature, and reproduce. These areas will likely continue to support natural vernal pool ecosystem processes and maintain suitable habitat conditions for vernal pool fairy shrimp. This unit also provides habitat for migratory waterfowl that aid in the dispersal of vernal pool fairy shrimp and other vernal pool crustacean cysts. This is the only area where all four vernal pool crustaceans addressed in this proposed rule are known to co-occur.

The Grasslands Unit includes Kesterson, San Luis, and Merced National Wildlife Refuges, as well as several Federal and State conservation easement areas, lands owned by the California State Parks and Wildlife Areas, and private lands. Land ownership within the unit includes the Service (13,943 ha (34,452 ac)), CDFG lands (1703 ha (4,257 ac)), California State Parks (1,357 ha (3,392 ac)), CDFG administered lands (1,052 ha (2,631 ac)) and WRP conservation easements (54 ha (134 ac)). All other lands within this unit are privately owned. Together, these areas are known as the Grasslands Ecological Area. This area supports diverse wetland habitats including seasonally flooded marshlands, semi-permanent marsh, riparian habitat, wet meadows, vernal pools, native uplands, pastures, and native grasslands. Wetlands within this area, including seasonal marsh and open water habitats, constitute 30 percent of the remaining wetlands in California's Central Valley and are extremely important to Pacific Flyway waterfowl populations. Over 60 million duck use-days and 3 million goose use-days occur annually in this unit. This habitat also supports a diversity of other migratory birds, including raptors, shorebirds, wading birds, and other wildlife species.

This unit contains over 50 percent of the remaining vernal pool habitats within the San Joaquin Valley identified by Holland (1998). This area is an important portion of the geographic distribution of vernal pool fairy shrimp within the San Joaquin Valley. Threats to vernal pool fairy shrimp within this unit include conversion to agriculture, changes in hydrology, invasion by aggressive plants, and certain wetland management practices.

The unit lies north of the City of Los Banos, southwest of the City of Merced, and is bisected by the San Joaquin River. This unit also represents Unit 24 for tadpole shrimp. The western half of this unit also represents Unit 2 for longhorn fairy shrimp and the eastern half represents Unit 8 for Colusa grass, Unit 8 for Hoover's spurge, and Unit 7 for Conservancy fairy shrimp. In addition to the species mentioned above, other sensitive vernal pool species occur within the unit including Hispid's bird beak, Sanford's arrowhead, heartscale, brittlescale, vernal pool smallscale, delta button celery, alkali milk-vetch, California tiger salamander, western spadefoot toad, and California linderiella.

Unit 24A and B, Madera Unit, Madera and Fresno Counties (17,232 ha (42,579 ac))

The Madera Unit is proposed as critical habitat for vernal pool fairy shrimp because it contains occurrences of the species living within hardpan vernal pool complexes composed of numerous small pools and swales on mima mound topography (Holland 1998, Keeler-Wolf *et al.* 1998, CNDDB 2001). These vernal pools occur on alluvial fans and terraces and provide the necessary timing and duration of inundation essential to the conservation of vernal pool fairy shrimp. South of this unit in Fresno County these pools become less common as the soils that support them are less widespread (Keeler-Wolf *et al.* 1998).

Located in western Madera County, this unit is located between the Fresno River and San Joaquin River. Land ownership within this unit includes 0.4 ha (1 ac) of CDFG lands. All other land within this unit is privately owned. All vernal pools in this unit are located east of Highway 99 and the Atchison, Topeka, and Santa Fe Railroad, extending east toward the low elevation foothill region of the Sierra Nevada. State Route 145 bisects the unit. The Madera Unit encompasses San Joaquin Valley Orcutt grass Unit 5a, hairy Orcutt grass Unit 7, and succulent owl's-clover Unit 7a. Other sensitive vernal pool species found within this unit include California linderiella, California tiger salamander, and western spadefoot toad.

This unit consists of two subunits. Subunit A contains vernal pool habitats south of Millerton Lake. The western boundary of this unit is bordered by the San Joaquin River. Gordon Road cuts through the southernmost tip of the unit. Owens Mountain and Table Mountain Rancheria are located east of the Unit. The Friant Kern Canal crosses through the unit in a southeasterly direction. Subunit B is located mostly west of State Route 41 along Little Dry Creek and Cottonwood Creek.

Unit 25, Kennedy Table Unit, Madera County (994 ha (2,456 ac))

We propose this unit as critical habitat because it contains vernal pools and vernal pool fairy shrimp (Holland 1998, CNDDB 2001). Vernal pool fairy shrimp within this unit live within rare Northern Basalt Flow vernal pool complexes that provide the necessary topographic and edaphic conditions essential to the conservation of the species. Northern Basalt Flow vernal

pools within this unit are perched on narrow, sinuous basalt mesas above the surrounding low-lying terrain, and typically contain small, irregularly clustered pools with ''flashy hydrology'' (pools fill and dry quickly) (Keeler-Wolf *et al.* 1998). These pool types provide the necessary timing and length of inundation for vernal pool fairy shrimp to hatch, mature, and reproduce, but do not stay inundated long enough to allow the invasion of aquatic species (CNDDB 2001). The Kennedy Table Unit is over 50 km (31 mi) from the next closest unit to the south and over 65 km (40 mi) from the nearest unit to the north. Such peripheral populations may have genetic characteristics essential to overall long-term conservation of the species (*i.e.*, they may be genetically different than more central populations) (Fugate 1998).

This unit is located north and west of the Fresno County line on Kennedy Table in Madera County. It is northeast of Millerton Lake, and the San Joaquin River flows east and south of it. Land ownership within this unit includes 65 ha (161 ac) of BLM lands. All other land within this unit is privately owned. This unit coincides with vernal pool tadpole shrimp Unit 19, succulent owl's-clover Unit 8A and B, San Joaquin Valley Orcutt grass units 5B and 6A, and hairy Orcutt grass Unit 10. In addition to these federally listed species other sensitive vernal pool species found within this unit include California linderiella, California tiger salamander, and the western spadefoot toad. In addition to these, the federally endangered Hartwig's golden sunburst also occurs within this unit.

Unit 26A, B, and C, Cross Creek Unit, Tulare and Kings Counties (3,193 ha (7,891 ac))

This unit is proposed as critical for vernal pool fairy shrimp because it contains vernal pools that support occurrences of the species (Holland 1998, CNDDB 2001). Vernal pool fairy shrimp in this area occur in vernal pools formed on Lewis and Youd soils (USDA 2001). This area represents the southern extent of vernal pool fairy shrimp range along the eastern margin of the Central Valley, and is the largest contiguous vernal pool habitat in this region (Holland 1998, CNDDB 2001).

This unit contains the CDFG's Sequoia Field and Stone Corral Ecological Reserves in Tulare County. These reserves are one of the few vernal pool conservation areas in the eastern portion of the San Joaquin Valley, and they have been the focus of several monitoring and management efforts. Land ownership within this unit includes 348 ha (861 ac) of CDFG lands. All other land within this unit is privately owned. TNC, Tulare County, and the Sierra Los Tulares Land Trust have identified this area as one of the best remaining examples of vernal pool habitats in the region. Much of the vernal pool habitat within Tulare County has been severely degraded and converted. The conversion of habitat adjacent to this unit to urbanized areas, orchards, and other forms of irrigated agriculture continues to threaten the long-term viability of the vernal pools within this unit.

This unit is comprised of three subunits. Subunit A is located in northwest Tulare County and contains vernal pool habitat located west of Seville. The Friant Kern Canal is north of the unit and the Cottonwood Creek Levee is south of the unit. Road 140 runs west of the unit. Subunit B contains vernal pools in northeastern Kings County and northwestern Tulare County. Highway 99 and St. Johns River cut through the unit in a southeasterly direction. Cross Creek and Cottonwood Creek cut through the unit in a southwesterly direction. Road 112 is east of the unit and the Lakeland Canal is west of the unit. The towns of Goshen and Visalia are south of the unit and Traver and London are north of the unit. Subunit C is known as Sequoia Field Unit and is located in northwestern Tulare County. This unit is south of County Road J36. Road 112 crosses through the western edge of the unit, Avenue 352 crosses through the southern edge, and State Route 63 crosses through the eastern edge. The Cross Creek Unit coincides with vernal pool tadpole shrimp Unit 20 and contains portions of San Joaquin Valley Orcutt grass Unit 8 and Hoover's spurge Unit 9. Other sensitive vernal pool species found within this unit include the California tiger salamander, spiny-sepaled button-celery, and western spadefoot toad.

Unit 27A and B, Pixley Unit, Tulare County (7,842 ha) 19,377 ac))

This unit is proposed for vernal pool fairy shrimp because it contains the largest contiguous area of habitat for the species in the southern portion of the San Joaquin Valley, and supports vernal pools that provide the necessary timing and length of inundation essential to the conservation of vernal pool fairy shrimp (Holland 1998, CNDDB 2001). Vernal pool fairy shrimp in this area occur within Northern Claypan vernal pools that tend to be alkaline and larger than other vernal pool fairy shrimp habitats, such as those found on the eastern margin of the San Joaquin Valley.

This unit contains wintering areas for migratory waterfowl, shorebirds, marsh, and waterbirds in the southern San Joaquin Valley, and include natural valley grasslands and developed marsh habitats within the Pixley National Wildlife Refuge complex (2,742 ha (6, 776 ac)). Other ownership within this unit include CDFG (490 ha (1,210 ac)) and TNC lands (1,309 ha (3,274 ac)). All other lands within this unit are privately owned. These habitats are important for migratory waterfowl that aid in the dispersal of vernal pool fairy shrimp and other vernal pool crustacean cysts. This unit represents one of only three areas designated for vernal pool fairy shrimp in the San Joaquin Valley vernal pool region described by Keeler-Wolf *et al.* (1998). The refuge also provides habitat for the endangered San Joaquin kit fox and the blunt-nosed leopard lizard. Vernal pool fairy shrimp within this unit are threatened by agricultural development, oil and natural gas exploration and development, subdivision of ranches and land grants, urban expansion, and conversion from grazing to other agricultural practices.

This unit consists of two subunits that lie south of the Cities of Hanford and Lemoore, north of the City of Wasco, and east of the City of the Tulare. In addition to vernal pool fairy shrimp, western spadefoot toad and California tiger salamander are present within this unit.

Unit 28, San Benito County Unit, San Benito and Monterey Counties (48,125 ha (118,915 ac))

The San Benito County unit is located in the southwestern portion of San Benito County and the eastern-most portion of Monterey County. This unit consists of a distinct collection of seasonally flooded wetlands west of the Great Central Valley, and overlaps a portion of the Central Coast vernal pool region that has been delineated by the CDFG (Keeler-Wolf *et al.* 1998). The proposed critical habitat unit contains a minimum of 13 vernal pool complexes that are 7 to 144 ha (17 to 356 ac) in size, and also includes a number of unmapped vernal pools or pool complexes that are less than 4 ha (10 ac) in size. Focused surveys for vernal pool fairy shrimp have not been conducted within the proposed critical habitat unit, and it is therefore likely that this species is present in many, if not most, of the vernal pool complexes that have not been censussed due to habitat similarity to where the occurrences have been documented. This conclusion is supported by the fact that two-thirds of vernal pool fairy shrimp occurrences

that have been documented within the critical habitat unit were not located within large vernal pool complexes, but were instead found in smaller, unmapped vernal pools. Land ownership within this unit includes BLM (1,581 ha (3,906 ac)) and State Land Commission (2 ha (5 ac)). All other lands within this unit are privately owned. The critical habitat unit perimeter is defined by the presence of low slope areas within watershed boundaries that are known to contain vernal pool fairy shrimp occurrences and vernal pool habitats. Conservation of vernal pools in the San Benito County unit is necessary to maintain and restore occurrences of vernal pool fairy shrimp that are disjunct from other listed fairy shrimp localities in the Great Central Valley.

Unit 29A, B, and C, Central Coastal Ranges Unit, Monterey and San Luis Obispo Counties (41,054 ha (101,444 ac))

The Central Coastal Ranges Unit includes three subunits that occur in Monterey and San Luis Obispo counties. The three subunits include areas at or adjacent to Fort Hunter Liggett, Camp Roberts, and the city of Paso Robles. The vast majority of the Fort Hunter Liggett subunit overlaps the military reservation, and also includes a small portion of privately owned land east of the military base. Land ownership within this unit includes DOD (20,585 ha (50,866 ac)) and BLM (1 ha (2 ac)). All other lands within this unit are privately owned. Intensive surveys on Fort Hunter Liggett have documented the occurrence of listed fairy shrimp in a minimum of 65 different pools within the base boundary (Fort Hunter Liggitt 2000). Several additional pools in restricted access areas on the base have not been surveyed, and some of these are also likely to possess listed fairy shrimp. The majority of the Camp Roberts subunit includes land within that military base boundary, and includes a limited amount of privately owned land north and southeast of the military base. Surveys on Camp Roberts have documented the presence of vernal pool fairy shrimp at 61 sites (Jones and Stokes 1997a). One hundred and nineteen additional sites were also found to possess unidentified juvenile fairy shrimp, and the inability to document the presence of other fairy shrimp taxa on the base suggests that these pools are therefore likely to contain listed species. The Paso Robles subunit consists of a polygon that is 3.2 to 24 km (2 to 15 mi) northeast of the city boundary. A limited number of surveys for fairy shrimp within the subunit have been conducted by California Department of Transportation staff along State Highway 46. These surveys have documented the occurrence of vernal pool fairy shrimp within the subunit (Mitch Dallas, California Department of Transportation, pers. comm.). The Paso Robles subunit possesses several large vernal pool complexes that are 42,314 ha (105,776 ac) in size. The discovery of vernal pool fairy shrimp in the area 6 km (4 mi) east of the city suggests that the species is likely to be widely dispersed in remnant vernal pools or complexes that still exist within the critical habitat subunit. The Fort Hunter Liggett subunit occurs within the Central Coast vernal pool region that has been delineated by the CDFG (Keeler-Wolf *et al.* 1998), and the Camp Roberts and Paso Robles subunits occur within the Carrizo vernal pool region. The subunit perimeters are defined by the presence of low slope areas within watershed boundaries that are known to contain vernal pool fairy shrimp and vernal pool habitats. Conservation of vernal pools in the region is necessary to stabilize and recover remnant populations of vernal pool fairy shrimp in the central coastal county area of southern California.

Unit 30, Carrizo Plain Unit, San Luis Obispo County (10,466 ha (25,862 ac))

This unit is proposed as critical for vernal pool fairy shrimp because it contains vernal pool habitats identified by Holland (2002) and that support occurrences of vernal pool fairy shrimp (CNDDB 2001). Vernal pool fairy shrimp found in the Carrizo Plain live within Northern Claypan vernal pools (Sawyer and Keeler-Wolf 1995) which occur in numerous shallow alkaline depressions within a Valley Saltbush Scrub matrix. These pools provide all of the primary constituent elements essential for the conservation of vernal pool fairy shrimp, as well as the edaphic and geologic features necessary to maintain the hydrology of the vernal pool complexes.

Many vernal pools in the region are adjacent to the 1,214 ha (3,000 ac) Soda Lake, the largest alkali wetland in central and southern California, which provides a winter haven for thousands of migratory birds. Vernal pool fairy shrimp in the Carrizo Plain Unit are located 235 km (146 mi) southeast of the closest known occurrences at Kesterson National Wildlife Refuge in Merced County. Such isolated and peripheral populations may have genetic characteristics that are different than more central populations, and may be important for conservation (Lesica and Allendorf 1995, Fugate 1998). The Carrizo Plain Unit is the only area where vernal pool fairy shrimp are known from saline salt brush scrub vernal pool habitats.

The Carrizo Plain contains examples of native bunch grass, needle grass, and blue grass grasslands, as well as populations of federally listed San Joaquin kit fox, blunt nosed leopard lizard, giant kangaroo rat, California jewel flower, Lost Hills salt brush, Kern mallow and San Joaquin wooly threads. Most of the habitat within this unit is part of the Carrizo Plain National Monument, which is administered by the BLM, TNC, and the CDFG. The BLM lands within the unit total approximately 6,220 ha (15,549 ac) and the CDFG lands total approximately 93 ha (233 ac). Other vernal pool habitats in the unit are located on private land.

This unit includes vernal pool habitat in the interior basin of the Carrizo Plain. It encompasses California Valley and Soda Lake. State Highway 58 is located north of the unit. Most of the habitat is east of Soda Lake Road, however, Soda Lake Road crosses through the western edge of the unit in several areas. To the east, the unit is bordered by the San Andreas Rift Zone. This unit coincides with longhorn fairy shrimp Unit 3.

Unit 31, Lake Cachuma Area, Santa Barbara County (8,399 ha (20,754 ac))

The Lake Cachuma critical habitat unit is located within a 16 km (10 mi) radius of the northwestern portion of Lake Cachuma in central Santa Barbara County. The unit boundary has been delineated to include hydrologic units that contain vernal pool fairy shrimp and vernal pool habitats. Vernal pool complexes within the unit vary in size from 16 to 81 ha (40 to 199 ac). Surveys for fairy shrimp species have rarely been conducted within the unit. A portion of the unit overlaps the Santa Barbara vernal pool region that has been delineated by the CDFG (Keeler-Wolf *et al.* 1998). The Lake Cachuma unit is essential for the conservation of vernal pool fairy shrimp because it contains seasonally flooded aquatic environments that contain markedly disjunct species occurrences. Landownership within this unit includes U.S. Forest Service (USFS) (2,199 ha (5,434 ac)) and BLM (37 ha (92 ac)). Other land within this unit is privately owned.

Unit 32, Ventura County Unit, Ventura County (18,831 ha (46,531 ac))

The Ventura County unit is located in the north-central portion of Ventura County. All the lands within this unit are owned by the USFS. Vernal pool

fairy shrimp and Conservancy fairy shrimp are known to co-occur at relatively high elevation (~1700 m (5500 ft)) forested sites within the Los Padres National Forest. Almost all of the known localities that possess these two species within the state of California exist at much lower elevations in grassland habitats. The critical habitat perimeter consists of an area that is known to contain vernal pool and Conservancy fairy shrimp occurrences and isolated pools that provide habitat for the two species. Fairy shrimp surveys have rarely been conducted in the proposed critical habitat unit. The Ventura County unit is essential for the conservation of vernal pool fairy shrimp because it contains ephemeral aquatic environments that are rarely associated with fairy shrimp, and the occupied sites represent markedly disjunct occurrences for the species.

Unit 33A, B, and C San Jacinto-Hemet Unit, Riverside County (2,319 ha (5,730 ac)).

This unit lies in the southern portion of the San Jacinto Valley and contains two primary subunits (San Jacinto and Hemet), the latter of which is itself divided into two smaller subunits (33B and 33C). Unit 33 consists of the remnant alkali playa associated with the San Jacinto River (subunit A) and the upper Salt Creek drainage (subunits B and C). Large portions of the alkali willow soils associated with these watercourses have been historically altered by drainage projects and agriculture resulting in the degradation or destruction of vernal pool habitat. The unit consists of areas where vernal pool fairy shrimp remain extant and/or where essential hydrology and alkali soils are intact supporting vernal pool and alkali playa habitat. All the lands within this unit are privately owned.

The San Jacinto primary subunit (subunit 33A) consists of lands along the San Jacinto River floodplain from the Ramona Expressway westward past Interstate 215 to the upper reaches of the northern portion of Railroad Canyon Reservoir. The lands delimited by this subunit represent the largest remaining contiguous alkali playa/vernal pool habitat within the historic range of vernal pool fairy shrimp in southern California. The subunit contains multiple extant vernal pools and complexes scattered along the river floodplain with intact water circulation processes and alkaline soil substrates preferred by vernal pool fairy shrimp.

A presence/absence survey for federally listed fairy shrimp was conducted in a portion of the pools in this subunit in the spring of 2000. No listed fairy shrimp were detected. However, not all vernal pool basins filled in the spring of 2000, and of those that did, not all retained water throughout the sample period. Additionally, no survey for fairy shrimp cysts (dry season survey) has been conducted. Therefore, the survey effort is inconclusive for the presence of listed fairy shrimp species. However, the common versatile fairy shrimp (*Branchinecta lindahli*) was detected in these pools (Bomkamp 2000). Further, the threatened spreading navarretia (*Navarretia fossalis*), the threatened thread-leaved brodiaea (*Brodiaea filifolia*), and the endangered San Jacinto Valley crownscale (*Atriplex coronatum* var. *notatior*) have also been documented within this subunit. These species are all associated with vernal pool and alkali playa habitats.

Even though the presence of vernal pool fairy shrimp in the San Jacinto River floodplain has not been established, the vernal pool alkali playa habitat of subunit 33A is considered to be essential for the conservation of vernal pool fairy shrimp in southern California. As previously indicated, these pools contain the largest remaining contiguous alkali playa/vernal pool habitat within the historic range of vernal pool fairy shrimp in southern California, as well as appropriate water circulation patterns, alkali soils, and relatively close proximity to the occupied Hemet primary subunit.

The Hemet primary subunit (subunits 33B and 33C) include the west Hemet vernal pool complex along Florida Avenue (subunit 33B), as well as a small area east of Warren Road and north of Tres Cerritos (subunit 33C). Vernal pool fairy shrimp have been documented in the southwestern portion of the vernal pool complex. The remainder of this proposed subunit contains lands within the watershed of the occupied pool complex and other vernal pools in the basin. Lands within the watershed have been included to maintain the integrity of the surface flow and water quality to the pool complexes and playa overall.

In addition to vernal pool fairy shrimp, several federally listed plants including the threatened spreading navarretia, the threatened thread-leaved brodiaea, the endangered California Orcutt grass (*Orcuttia californica*), and the endangered San Jacinto Valley crownscale have also been documented within this subunit. These species are all associated with vernal pool and alkali playa habitats.

Unit 33 includes areas where vernal pool fairy shrimp are extant and recovery value for this species is high because of appropriate hydrology, soils and alkali vernal pool habitat. The alkali soils and their associated hydrology in the unit are essential to the conservation of vernal pool fairy shrimp in southern California (Service 1998).

Unit 34, Santa Rosa Plateau Unit, Riverside County (1,718 ha (4,246 ac))

The Santa Rosa Plateau critical habitat unit is on a large mesa made of basaltic and granitic substrates within the Santa Rosa Plateau Ecological Reserve. The unit contains one of the largest remaining vernal pool complexes in southern Riverside County and includes a series of large and small pools in which several sensitive or federally listed fairy shrimp have been documented. These include the vernal pool fairy shrimp (Angelos 1998), the endangered Riverside fairy shrimp (*Streptocephalus woottoni*) (Service 2001), and the Santa Rosa fairy shrimp (*Linderiella santarosae*) (Angelos 1998). Additionally, the federally endangered California Orcutt grass is documented from the pool complex (Service 1998). This unit was designated as critical habitat for the Riverside fairy shrimp on May 30, 2001 (66 FR 29384). This vernal pool complex represents the southwestern limit of occupied vernal pool fairy shrimp habitat. It is also a unique habitat for vernal pool fairy shrimp, therefore, the fairy shrimp in these pools may have genetic characteristics important to the overall long-term conservation of the species (*i.e.*, they may be genetically different from more centrally located populations) (Lesica and Allendorf 1995). Conservation of this vernal pool basin and its associated watershed is essential to the conservation of the vernal pool fairy shrimp, and the Riverside fairy shrimp in southern California, as indicated in the Vernal Pools of Southern California Recovery Plan (Service 1998). Property ownership and protection within this unit includes CDFG (761 ha (1,880 ac)), TNC (77 ha (1,902 ac)), and TNC conservation easements (150 ha (375 ac)).

Unit 35, Skunk Hollow Unit, Riverside County (97 ha (239 ac))

The Skunk Hollow vernal pool complex consist of a single, large (approximately 14 ha (35 ac)) vernal pool and its essential associated watershed in western Riverside County. All the lands within this unit are privately owned. Several federally listed species have been documented from the Skunk Hollow vernal pool basin. These include the threatened vernal pool fairy shrimp (Simovich in Litt 2001), the endangered Riverside fairy shrimp

(Service 2001), the threatened spreading navarretia, and the endangered California Orcutt grass (Service 1998). The vernal pool complex and watershed is currently protected as part of a reserve established within an approved mitigation bank in the Rancho Bella Vista Habitat Conservation Plan (HCP) area and as part of the conservation measures contained in the Assessment District 161 Subregional HCP. While neither HCP include the vernal pool fairy shrimp as a covered species, both HCPs provide protection for the vernal pool complex and its associated watershed in perpetuity. Further, the HCPs address the endangered Riverside fairy shrimp as a covered species. Because we believed that the management and protections afforded the vernal pool complex and the Riverside fairy shrimp were adequate for the long-term conservation of this complex and this species, and it is in the long-term survival interest of the species to preserve the partnerships that we had developed with the local jurisdiction and project proponents in the development of the HCPs, we excluded the Skunk Hollow vernal pool complex from critical habitat for the Riverside fairy shrimp. We do not believe that this exclusion from critical habitat would result in the extinction of this Riverside fairy shrimp.

Even though the two HCPs do not have the vernal pool fairy shrimp listed as a covered species, we believe that the protections and management afforded the Skunk Hollow vernal pool complex and the other listed vernal pool species through the terms and conditions of those HCPs are adequate to ensure the long-term conservation of the vernal pool fairy shrimp as well. Therefore similar to the Riverside fairy shrimp, we believe that the benefits of the exclusion of the Skunk Hollow vernal pool complex from critical habitat for the vernal pool fairy shrimp outweighs the benefit of its inclusion. Additionally, we do not believe that this exclusion would result in the extinction of the vernal pool fairy shrimp.

Vernal Pool Tadpole Shrimp Criteria

In proposing critical habitat units for vernal pool tadpole shrimp we evaluated the life history and current distribution of the species, the primary constituent elements, and the threats to the species. This information allowed us to determine which areas are likely to contribute to the conservation of vernal pool tadpole shrimp and to delineate units so that threats to this species might be minimized.

CNDDB (2001) estimates that 32 percent of the remaining occurrences of this species are threatened by development and agricultural conversion. Other vernal pool tadpole shrimp occurrences are threatened by off road vehicle use, road construction and maintenance, mining, and landfill construction (CNDDB 2001). Several occurrences are threatened by intentional discing and draining of their habitats (CNDDB 2001). Vernal pool tadpole shrimp occurrences have been extirpated as a result of urban development, primarily in Sacramento and Tehama counties.

Numerous occurrences of vernal pool tadpole shrimp are threatened by altered hydrology. In some cases vernal pool tadpole shrimp habitat has been altered so that it contains water year round, allowing predators such as bullfrogs and fish to colonize the areas (CNDDB 2001). In other cases artificial run off has resulted in the delivery of materials that destroy vernal pool water quality, including pesticides from vineyards and other irrigated agricultural lands, pesticides from golf courses, and sediment from surrounding developments (CNDDB 2001). Several vernal pool tadpole shrimp occurrences are threatened by wetland management activities that are designed to transform their vernal pool habitats into permanent marshes for the benefit of other species (CNDDB 2001). Several other occurrences are threatened by the construction of drainage ditches, which artificially drain vernal pool tadpole shrimp habitats (CNDDB 2001).

Vernal Pool Tadpole Shrimp Unit Review

We conducted a regional review across the current range of vernal pool tadpole shrimp to evaluate and select areas that are essential to the conservation of the species and that may require special management actions. Important factors we considered were the presence of vernal pool tadpole shrimp and the presence of the primary constituent elements essential to the conservation of the species. We identified areas that support vernal pool tadpole shrimp occurrences identified by CNDDB (2002) within large vernal pool complexes mapped by Holland (1998) and other local sources throughout the range of the species. We have identified the areas necessary to maintain vernal pool tadpole shrimp range and distribution and to include some of the different kinds of habitats in which the species is known to occur. A specific description of each area is outlined below.

Unit 1, Stillwater Plains Unit, Shasta County (1,849 ha (4,569 ac))

This unit is proposed as critical habitat for vernal pool tadpole shrimp because it contains the species (CNDDB 2002) within vernal pools mapped by Holland (1998) which are found on old alluvial terraces above the Sacramento River, often on Redding and Corning soil complexes (Shasta County 2001). Generally these pools range in size, from small (10 m^2) (30 sq ft.) to several ha (ac) in size at the Stillwater Plains area. These vernal pools provide feeding and sheltering habitat for the species and remain inundated for sufficient lengths of time to allow vernal pool fairy shrimp to hatch, mature, and reproduce.

This unit represents critical habitat for vernal pool fairy shrimp because it contains all of the primary constituent elements for the species, and supports systems of hydrologically interconnected pools and swales 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 crustaceans to complete their life cycles.

The vernal pool tadpole shrimp within this unit were found to be genetically different from other populations, particularly those in the foothills of the Sierra Nevada (King 1996). This unit also comprises the northern extent of the species range in California, and such isolated populations may be essential to the overall long-term conservation of the species (Fugate 1992, 1998, Lesica and Allendorf 1995). The boundaries of the unit were delineated to include the interconnected pools, swales, and associated uplands mapped by Holland (1998) that contribute to the filling and drying of the vernal pools where vernal pool fairy shrimp occur, and which maintain suitable periods of pool inundation, water quality, and soil moisture for vernal pool tadpole shrimp hatching, growth, reproduction, and dispersal.

This unit includes the Stillwater Plains Conservation Bank. The Stillwater Plains Conservation Bank was established specifically for the conservation of vernal pool tadpole shrimp, and has been used as mitigation for the destruction of other vernal pool tadpole shrimp habitats throughout the northeastern Sacramento Valley area. Most of the land included within this unit is privately owned, but 52 ha (130

ac) of that is protected by WRP easements or agreements. The BLM owns 17 ha (42 ac). Urban expansion from the Redding Area, and conversion from grazing to other agricultural practices continue to threaten vernal pool tadpole shrimp occurrences throughout this unit.

This unit is located in the area east of the Redding Municipal Airport between Airport Road to the west and Deschutes Road to the east. The unit extends to Dersch Road in the south and towards Lassen Park Highway in the north. This unit comprises a portion of the Stillwater Plains. This unit overlaps slender Orcutt grass Unit 2B and vernal pool fairy shrimp unit 5. Other sensitive species occurring within this unit include Red Bluff dwarf rush (*Juncus leiospermus* var. *leiospermus*), California linderiella (*Linderiella occidentalis*), Henderson's bent grass (*Agrostis hendersonii*), and four angled spike rush (*Eleocharis quadrangulata*).

Unit 2, Dales Unit, Shasta and Tehama Counties (20,446 ha (50,522 ac))

This unit is proposed as critical habitat for vernal pool tadpole shrimp because it contains the species and vernal pools, swales, and other ephemeral wetlands and depressions of appropriate sizes and depths necessary for vernal pool tadpole to complete their life cycle (Holland 1998, CNDDB 2001). This unit is one of the few areas where vernal pool tadpole shrimp are known to occur in Northern Mudflow vernal pools. Northern Mudflow vernal pools are generally small and tend to be inundated for relatively short periods of time (Keeler-Wolf *et al.* 1998).

The boundaries of the unit were delineated to include the interconnected pools, swales, and associated uplands mapped by Holland (1998) that contribute to the filling and drying of the vernal pools where vernal pool fairy shrimp occur, and which maintain suitable periods of pool inundation, water quality, and soil moisture for vernal pool tadpole shrimp hatching, growth, reproduction, and dispersal.

This unit contains some of the largest remaining vernal pool complexes supporting vernal pool tadpole shrimp in the northern portion of the species range, including the Dales Plains. These areas provide relatively undisturbed, hydrologically intact vernal pool habitats that will likely continue to support natural vernal pool ecosystem processes and maintain suitable habitat conditions for vernal pool tadpole shrimp. This unit also provides habitat for migratory waterfowl that aid in the dispersal of vernal pool tadpole shrimp and other vernal pool crustacean cysts.

Land ownership within this unit includes BLM (6,226 (15,383 ac)), CDFG (392 ha (981 ac)), State Land Commission (40 ha (100 ac)). The CDFG administers approximately 17 ha (42 ac) and the TNC has conservation easements on 6,230 (15,575 ac) within this unit. The remaining lands included within this unit are privately owned. The CDFG has protected some vernal pool areas at Dales Lake Ecological Reserve. The importance of these vernal pool habitats has been recognized by a number of state, local, and Federal agencies, and they have been the focus of several conservation planning efforts. Portions of the CDFG Battle Creek Wildlife Area are found within this unit but the amount of vernal pool habitat currently protected within the unit is very small. Vernal pool habitats within this unit are fragmented and threatened by urban expansion, subdivision of ranches and land grants, and conversion from grazing to other agricultural practices.

This unit is located from Battle Creek on the Shasta/Tehama County line south of Balls Ferry to Paynes Creek near Dales. The vernal pool habitats west of Inskip Hill are included in this unit, as well as the area west of the Sacramento River known as Table Mountain and Table Mountain Lake. This unit coincides with Unit 3 for slender Orcutt grass. Other vernal pool species occurring within this unit include Bogg's Lake hedge-hyssop, Red Bluff dwarf rush, legenere, California linderiella, Ahart's paronychia, Henderson's bent grass, and Sanford's arrowhead.

Unit 3, Vina Plains Unit, Tehama and Butte Counties (23,883 ha (59,015 ac))

This unit is proposed as critical habitat because it contains occurrences of vernal pool tadpole shrimp (CNDDB 2001) living within large vernal pool grassland areas that support aggregations or systems of hydrologically interconnected pools, swales, and other ephemeral wetlands and within a matrix of surrounding uplands that together form hydrologically and ecologically functional units (EPA 1994, Holland 1998, Tehama County 1999). 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 tadpole shrimp hatching, growth and reproduction, and dispersal. This unit is one of the few areas where vernal pool tadpole shrimp are known to occur in Northern Basalt Flow vernal pools. Northern Basalt Flow vernal pools are limited to ancient terraces and hilltops that comprise some of the oldest geologic formations in California. This unit also provides habitat for migratory waterfowl that aid in the dispersal of vernal pool tadpole shrimp and other vernal pool crustacean cysts.

This unit contains the vernal pool grassland area known as Vina Plains, which is managed by TNC. The Vina Plains area has been the focus of a number of research projects, including long-term adaptive management and monitoring efforts evaluating the effects of grazing and fire on vernal pool plants, animals, and ecosystems (Griggs 2000). Much of the basic life history information known about vernal pool crustaceans was collected at Vina Plains (*e.g.*, Lanway 1974, Ahl 1991, Syrdahl 1993, Gallagher 1996).

The majority of the lands included within this unit are privately owned. This unit contains TNC's Vina Plains preserve as well as other TNC lands 2,264 ha (5,660 ac) and conservation easements 4,348 ha (10,870 ac). The unit also includes 57 ha (142 ac) of private lands protected by WRP easements or agreements. This unit is located in the northeastern portion of the Sacramento Valley from Deer Creek in Tehama County to Big Chico Creek north of Chico in Butte County. This unit is one of only two vernal pool tadpole shrimp units within the Northeastern Sacramento Valley vernal pool region identified by CDFG (Keeler Wolf *et al.* 1998). The unit extends south and east of the Sacramento River paralleling the low elevation foothill region of the Sierra Nevada. This unit coincides with Unit 7 for vernal pool fairy shrimp, and incorporates Unit 1 for Conservancy fairy shrimp, Units 4 for slender Orcutt grass, Unit 2 for Greene's tuctoria, Unit 1 for hairy Orcutt grass, Unit 1 for Hoover's spurge, and Units 1 and 2 for Butte County meadowfoam. Other vernal pool species occurring within this unit include Bogg's Lake hedge-hyssop, Red Bluff dwarf rush, Douglas' pogogyne, western spadefoot toad, legenere, California linderiella, California tiger salamander, Ahart's paronychia, Henderson's bent grass, Sanford's arrowhead , and dwarf downingia.

Unit 4, Oroville Unit, Butte and Yuba Counties (15,975 ha (39,474 ac))

This unit is proposed as critical habitat for vernal pool tadpole shrimp because it contains occurrences of the species and vernal pools, swales, and other ephemeral wetlands and depressions of appropriate sizes and depths necessary for vernal pool tadpole shrimp to complete their life cycle (Holland 1998, CNDDB 2001, Silveira