III. RECOVERY

A. GOALS

The overall goals of this recovery plan are to:

Achieve and protect in perpetuity self-sustaining populations throughout the full ecological, geographical, and genetic range of each listed species by ameliorating or eliminating the threats that caused the species to be listed.

- Delist the endangered *Eryngium constancei* (Loch Lomond button-celery), *Lasthenia conjugens* (Contra Costa goldfields), *Limnanthes floccosa* ssp. *californica* (Butte County meadowfoam), *Navarretia leucocephala* ssp. *pauciflora* (few-flowered navarretia), *Navarretia leucocephala* ssp. *plieantha* (many-flowered navarretia), *Orcuttia pilosa* (hairy Orcutt grass), *Orcuttia viscida* (Sacramento Orcutt grass), *Parvisedum leiocarpum* (Lake County stonecrop), *Tuctoria greenei* (Greene's tuctoria), *Tuctoria mucronata* (Solano grass), Conservancy fairy shrimp (*Branchinecta conservatio*), longhorn fairy shrimp (*Branchinecta longiantenna*), and vernal pool tadpole shrimp (*Lepidurus packardi*) and the threatened *Castilleja campestris* ssp. *succulenta* (fleshy owl's clover), *Chamaesyce hooveri* (Hoover's spurge), *Neostapfia colusana* (Colusa grass), *Orcuttia inaequalis* (San Joaquin Valley Orcutt grass), and *Orcuttia tenuis* (slender Orcutt grass), vernal pool fairy shrimp (*Branchinecta lynchi*), and delta green ground beetle (*Elaphrus viridis*).

- Ensure the long-term conservation of the species of concern *Astragalus tener* var. *ferrisiae* (Ferris' milk vetch), *Astragalus tener* var. *tener* (alkali milk vetch), *Atriplex persistens* (vernal pool smallscale), *Eryngium spinosepalum* (spiny-sepaled button-celery), *Gratiola heterosepala* (Boggs Lake hedge-hyssop), *Juncus leiospermus* var. *ahartii* (Ahart's dwarf rush), *Legenere limosa* (legenere), *Myosurus minimus* var. *apus* (little mousetail), *Navarretia myersii* ssp. *deminuta* (small pincushion navarretia), *Plagiobothrys hystriculus* (bearded popcorn flower), mid-valley fairy shrimp (*Branchinecta mesovallensis*), California fairy shrimp (*Linderiella occidentalis*), and western spadefoot toad (*Spea hammondii*).

The interim goals of this recovery plan are to:

- Stabilize and protect populations so further decline in species status and range are prevented.

- Conduct research necessary to refine reclassification (*i.e.*, downlisting) and recovery criteria.

- Reclassify to threatened (*i.e.*, downlist) those taxa currently federally listed as endangered. Reclassification will be appropriate when each taxon is no longer in danger of extinction throughout a significant portion of its range. Because data upon which to base decisions about reclassification and recovery are mostly lacking, downlisting and recovery criteria in this recovery plan are necessarily preliminary and may be revised as necessary data is obtained.

B. OBJECTIVES

The overall objectives of this recovery plan are to:

- Ameliorate or eliminate the threats that caused the species to be listed as endangered or threatened and ameliorate any other newly identified threats in order to be able to delist these species.

- Ameliorate or eliminate the threats that affect the species of concern and ameliorate any other newly identified threats in order to conserve these species.

- Confirm the status of *Plagiobothrys hystriculus*, currently presumed extinct. If extant populations are discovered, the ultimate goal would be to ensure the long-term conservation of this species.

- Promote natural ecosystem processes and functions by protecting and conserving intact vernal pools and vernal pool complexes within the recovery planning area to maintain viable populations of listed species and species of concern, and prevent additional threats from emerging over time. By doing so other vernal pool species that may be considered common today, and additional species that have not yet been identified or described, will be adequately conserved so that they will never need the protection of the Endangered Species Act.

C. STRATEGY

Habitat loss and fragmentation is the single largest threat to the survival and recovery of the listed species and species of concern addressed in this recovery plan. The continued existence of these species, and the prevention of future listing of species, would be ensured when sufficient populations and sub-populations of these species are protected in perpetuity from future habitat loss and fragmentation. Additionally, all other threats to the survival of these species need to be ameliorated or eliminated prior to delisting.

Most species addressed in this recovery plan are threatened by similar factors because they occupy similar vernal pool ecosystems. The primary threats that have lead to the decline of the species are outlined in the Introduction section.

To meet the goal of delisting 20 species and ensuring the long-term conservation of 13 other species, protection of habitat that represents the suite of vernal pool communities in California is necessary. This "ecosystem-level" strategy is shaped by (1) the existing conditions of vernal pool communities, (2) available information on biology, distribution, and population status of vernal pool species, and (3) the current and anticipated processes that will affect both natural and human-altered landscapes.

Recovery and long-term conservation actions contributing to the recovery strategy emphasized in this recovery plan are (1) habitat protection, (2) adaptive habitat management and monitoring, (3) status surveys, (4) research, and (5) public participation and outreach. Specifics of each strategy are provided in this chapter and in the Stepdown Narrative of this document. This recovery plan focuses on a large number of listed species and species of concern. Whenever possible, emphasis is placed on specific strategies that will benefit several species covered in this recovery plan (*i.e.*, an ecosystem approach). Since many of these species co-occur, this approach is most feasible. Where species do not co-occur, recovery and long-term conservation strategies will focus on single species.

"The recovery of endangered species and the restoration of damaged ecosystems may be the greatest technical challenge in biological conservation" (Pavlik 1996, p. 150). "Recovered" species are expected to be restored to a point where their long-term survival in nature is ensured. Criteria used to evaluate when listed species are "recovered" should include number and distribution of populations, population sizes, and probabilities of persistence over specific time periods (Mace and Lande 1991, Tear *et al.* 1993, Schemske *et al.* 1994, Carroll *et al.* 1996). However, development of realistic, appropriate recovery criteria is hampered by lack of adequate and reliable demographic and genetic data (Schemske *et al.*

National Research Council 1995, Tear *et al.* 1993, Cypher 1998) as well as by the difficulties of applying population viability analysis and extinction theory to assess likelihood of extinction in any particular situation (e.g. Mace and Lande 1991, National Research Council 1995, Taylor 1995). More and better data increase the reliability of population forecasting and assessment of recovery potential (Scott *et al.* 1995). Because new data may change our appraisal of what constitutes appropriate recovery criteria, the criteria recommended in this plan are preliminary and warrant reevaluation when additional data become available.

All species addressed in this recovery plan are threatened by habitat loss and fragmentation. Therefore, areas currently, historically, or potentially occupied by the species are recommended for habitat protection, as appropriate. Areas for habitat protection are of two general types: (1) areas currently occupied by, or providing potential habitat for, several species, or areas contributing significantly to the protection of ecologically, geographically, or genetically distinct populations or sub-populations, and (2) areas that are currently occupied by, or providing potential habitat for, a single species covered in this recovery plan. Areas to be protected for single species include those areas occupied by populations or sub-populations considered important within the species range (*e.g.*, populations or sub-populations at the edge of the species range or populations or sub-populations that help maintain genetic diversity). Factors influencing the choice of sites for protection also include habitat size, quality, connectivity, ease or feasibility of protection, ability to maintain and/or implement effective management, and overall cost of protection or long-term management. Wherever possible, protection of habitat needs to focus on larger blocks of land to provide for greater species and physical diversities, less vulnerability of the species populations to outside influences, connectivity through land with natural habitat or compatible uses that allows for movement of species between vernal pool complexes, and minimize edge effects between natural and developed land. Cooperation of private landowners on some smaller parcels will be necessary to ensure recovery of the listed species and the long-term conservation of the species of concern. Cooperative efforts with private landowners will need to utilize tools such as fee title acquisition, conservation easements, or participation in voluntary programs (*e.g.*, the Partners for Fish and Wildlife program of the U.S. Fish and Wildlife Service) to maintain or enhance habitat values for vernal pool species and their habitat while continuing certain types of land uses (*e.g.*, appropriately managed grazing).

Ultimately, habitat management plans will need to be developed and implemented for all protected lands. In many cases, effective habitat management and restoration techniques have not been developed for species covered in this recovery plan. Therefore, management at any scale must be “adaptive”, or

flexible, based on currently available scientific data, on-going research, or observed outcomes of on-going management activities. For example, control of invasive species is a high priority for many protected sites. Studies of the various strategies to control individual species need to be conducted, and in some cases, management for one species may conflict with management techniques for other species. Thus an ecosystem approach to management should be undertaken when possible, and further research is needed.

1. Individual Elements of the Recovery Strategy

a. Habitat Protection

Preservation

All habitat occupied by featured taxa is important for recovery of listed species or conservation of species of concern for two reasons: (1) vernal pool species are primarily threatened with extinction due to habitat loss and fragmentation, so additional habitat loss is counterproductive to recovery; and (2) genetic diversity within each taxon must be retained to increase a species likelihood of persistence through unpredictable events (*e.g.*, drought, climate change). Genetic composition has not been investigated for most of the featured taxa, so protection of remaining populations is prudent. By retaining the full range of site diversity and, thus, genetic diversity, in which a taxon currently or historically occurred, the likelihood of genetic persistence under unpredictable future environmental conditions is maximized. Habitat protection includes the preservation of the geographic, topographic, and edaphic features that support aggregations or systems of hydrologically interconnected vernal pools, vernal pool swales, and other ephemeral wetlands and depressions within a matrix of surrounding uplands that together form hydrologically and ecologically functional vernal pool complexes. Habitat protection can be achieved in a number of ways including land acquisition, purchase of conservation easements, and conservation agreements. In all cases, a management plan to control nonnative species and maintain the hydrology of the vernal pool complex is important to guide the management of the species. Appendix F describes numerous tools available to assist in the protection of habitat for vernal pool species, and the Stepdown Narrative includes actions to identify and protect larger vernal pool conservation areas as well as a series of research actions to characterize, maintain, and restore functional vernal pool ecosystems.

Although habitat protection of remaining vernal pools and vernal pool complexes in the vernal pool regions is a long-term goal, the core areas identified herein should be the initial focus of protection measures. Core areas are the specific sites that are necessary to recover these endangered or threatened species or to conserve

sites that are necessary to recover these endangered or threatened species or to conserve the species of concern addressed in this recovery plan. Higher recovery priorities are assigned to: (1) species with low numbers of populations or limited geographical distributions, (2) the largest blocks of habitat, (3) the largest populations of each taxon, and (4) to those populations or species representing unique ecological conditions and genotypes. Core areas may be modified in the future based upon the results of status surveys and research.

Core areas are ranked as Zone 1, 2, or 3 in order of their overall priority for recovery. We anticipate that a number of the species covered by this recovery plan can be recovered primarily through the protection of Zone 1 core areas. In particular, the most narrowly endemic species (e.g., *Limnanthes floccosa* ssp. *californica*) occur only in Zone 1 and do not merit further protection of Zone 2 habitat. On the other hand, the most widely distributed species such as vernal pool fairy shrimp and *Orcuttia tenuis* occur broadly through Zones 1 and 2. For these species protection of Zone 2 core areas will significantly contribute to recovery, and if sufficient might offset the need to protect some lands within the Zone 1 core areas. In general we consider recovery recommendations in Zones 2 and 3 to be more flexible than in Zone 1, and recovery criteria specific to Zone 2 and 3 core areas may be modified on a case by case basis based on future information. However, certain Zone 2 core areas are important for recovery of some species (*e.g.*, *Lasthenia conjugens*, longhorn fairy shrimp) that are rare and localized but have significant populations within Zone 2. Further implementation of recovery actions in vernal pool habitat outside core areas and outside vernal pool regions could be recommended for a species if recovery actions have been implemented in Zones 1, 2, and 3 and recovery has not yet been achieved.

Habitat Conservation Planning and Alternative Conservation Strategies

We have identified protection of the best vernal pool habitat as the primary method to achieve recovery of the species in this plan. However, alternative strategies such as development of Habitat Conservation Plans (HCPs) or other site-specific planning methods may present opportunities to conserve species habitat and meet the recovery criteria described in this plan. Additional guidance regarding the use of habitat conservation plans or other site-specific planning methods is provided below in Section III.E.3.

b. Adaptive Habitat Management, Restoration, Creation, and Monitoring

The most effective habitat management, restoration, and monitoring techniques for a vernal pool ecosystem are not yet fully understood, although some research

and management is in progress. Until site- and species-specific research is completed, management strategies must remain "adaptive" (*i.e.,* flexible and responsive to changing environmental strategies and incorporating results of management) and must be tied to population trends of featured species. Where populations appear to be stable or increasing, changes to existing habitat management should be approached with caution. Changes should be either small or well-supported by monitoring results or other reliable information. For populations that appear to be declining, changes in management may be indicated. Any change in habitat management techniques should be based on the best available scientific data, on-going research, observed outcomes of current management from similar situations, and a careful analysis of the consequences of the proposed management. Monitoring should be instituted if not already in place.

Although threats vary among core areas, habitat management to promote population stability of listed species and species of concern is likely to include: (1) maintaining the hydrology of the vernal pools or vernal pool complexes; (2) controlling invasive nonnative and native plants (*e.g.*, through appropriately managed burning or grazing or the use of specific herbicides); and (3) providing suitable upland habitat buffers to protect pollinators of vernal pool plants, dispersal of vernal pool plants and animals, and local watersheds, and sustain important predators of herbivores such as rodents and rabbits (*e.g.,* hawks). One of the many challenges will be coordinating management for the various species, whose needs may differ.

The recommended management actions are important to eliminate or ameliorate threats to vernal pool species, including loss, fragmentation, degradation, and alteration of habitat; competition/predation from both native and nonnative species, and other manmade factors such as disturbance of vernal pool habitats by recreational activities, inappropriate grazing regimes, and contamination by urban and agriculture activities.

In addition to specific management recommendations to ameliorate or eliminate threats, the Stepdown Narrative and recovery strategy include several recovery actions to develop mechanisms to ensure that management actions continue in perpetuity so that threats remain neutralized. These actions include:
1) establishing a range-wide recovery implementation team; 2) establishing working groups and developing participation plans for each vernal pool region; 3) developing and implementing adaptive management plans based on monitoring data and best available science; 4) assisting local governments in developing habitat conservation plans and developing land use protection measures; 5) assisting private landowners in developing landowner agreements; 6) acquiring

habitat, where necessary; 7) tracking losses and protection of suitable habitat and occurrences within core areas; and 8) ensuring mechanisms are in place to provide for the perpetual management and monitoring of core areas, vernal pool regions, or for each management unit within a vernal pool region, as appropriate. A key component of these efforts includes education and outreach to inform partners and the public about recovery needs and opportunities for vernal pool ecosystems.

Vernal pool complexes have been degraded, either by direct disturbance of the vernal pools (*e.g.*, due to poor management practices), invasion of nonnative species, or by alteration of hydrological patterns (*e.g.*, due to construction of roads through vernal pool complexes). Habitat restoration may be necessary in many instances to achieve proper functioning of a vernal pool ecosystem. Vernal pool restoration is the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning the natural and historic functions to a former or degraded vernal pool (U.S. Environmental Protection Agency 2005). Vernal pool restoration may include diverting excess surface runoff (*e.g.*, from agriculture, roads, or other urban hardscapes), reconstructing the characteristic depth from the overlying soil surface to the impermeable layer beneath (*e.g.*, removing silt accumulation from agricultural use or repairing damage due to off-road vehicle use), managing grazing appropriately, or removing competing species. Vernal pool creation is the construction of a vernal pool in an area that was not a vernal pool in the recent past (within the last 100 to 200 years) and that is isolated from existing vernal pools (U.S. Environmental Protection Agency 2005). Noss *et al.* (2002), in discussing creation projects, state "that most apparently successful projects are less than 10 years old and the long-term trends and sustainability of vernal pool flora, invertebrates, and amphibians have not been verified. For this reason, preservation must be the fundamental strategy in maintaining vernal pool ecosystems within the planning area". Vernal pool creation is considered an experimental science because the extent to which entire vernal pool plant and invertebrate communities can be successfully recreated is still unknown (M. Showers, CDFG, *in litt*, 2005). Still, preliminary results indicate that some vernal pool creation and restoration efforts have resulted in pools occupied by vernal pool fairy shrimp and vernal pool tadpole shrimp (De Weese 1998), and restoration and creation of habitat may be more useful as recovery tools for some species than others. The order of preference of habitat protection is, first, preservation of existing natural vernal pool habitat as discussed above, followed by restoration of former or degraded habitat, and lastly, creation of vernal pools if necessary to maintain the range of vernal pool habitat. Creation of vernal pools within a vernal pool complex of existing pools is not recommended because it may alter the hydrology of the existing vernal pool

system and may have adverse effects on ground-nesting bees and other upland plant and animal species.

One component of vernal pool restoration and creation is reintroduction and introduction programs to restore extirpated populations and protect individual species from the threat of extirpation. Off-site or *ex situ* methods can make the difference between survival and extinction, by preventing unique genotypes from disappearing altogether. While accession of seeds or cysts can be an important component of a comprehensive recovery strategy, it is by no means meant to replace conservation of populations in their natural habitat (*in situ*). *Ex situ* work is intended to support *in situ* conservation. Collection, storage, and propagation of seeds and cysts should only be conducted as a last resort, where necessary to preserve rare or unique genotypes or occurrences in danger of extirpation from stochastic events and only if all other methods of conservation have been insufficient. Reintroduction and introduction should be undertaken only in sites that are protected in perpetuity.

In all cases practicable, existing natural, undegraded pools should be used as a model for new creation. In doing so, it is important to consider the natural geographic, topographic and edaphic characteristics of the site where the pool or complex is to be created. Size and depth of pools to be constructed, hydrologic connections within complexes, depth from soil surface to hardpan, and upland-area to pool-area ratios are all important factors to consider before creating vernal pools. Research may be necessary to help define an appropriate relationship between uplands and vernal pools so a species self-sustainability and recovery potential is maximized. In all cases where vernal pool creation is an alternative, success criteria should be established before the vernal pool is created. These criteria should be capable of being modified and improved as new information becomes available.

Especially in core areas, a species population size must remain stable or increase in size over the long term to contribute to recovery. Declines in species populations must be halted, and likely reversed, if populations are to be self-sustaining. Demographic monitoring, which includes trend analysis and factor resolution (Pavlik 1994), is one method for predicting plant population trends and focusing efforts on the causes of population decline at a particular site. Unlike traditional monitoring methods, the concurrent evaluation of several indicators (*e.g.*, survivorship, seed production per plant, and the density of ungerminated seeds in the soil) during demographic monitoring allows for predictions of population stability to be made in a shorter time frame (*e.g.*, 2 to 4 years versus 5 to 15 years, depending on climatic conditions) and is applicable to both annual and perennial plants. Demographic monitoring has its uses in endangered species

recovery; however, it does not address the threats that caused the species to be listed. Therefore, it is not the only monitoring tool that should be used; it is one practical approach to monitoring plants and should be considered on a case by case basis.

Plant and animal species monitoring requirements may vary depending on species composition and environmental factors (*e.g.*, habitat location, seasonal timing of rainfall, cattle grazing, fires, *etc.*). In general, monitoring should be done for multiple years and should involve conducting standardized species and habitat surveys and assessments. Surveys may be more intensive at first to determine whether the objectives are being met (*e.g.*, are restored/created pools holding water? are desired plant and animal species populating the vernal pools?). If a protected area is surrounded by numerous threats, standardized surveys may be required more frequently. If a location is highly protected (*i.e.*, strictly a preserve) then monitoring requirements may not be as stringent. Ultimately, monitoring should always include assessment of the existing threats.

Recovery is the process by which the decline of a listed species is arrested or reversed, and the threats to its survival are ameliorated or eliminated so that its long-term survival is assured. Therefore, in order to delist a species, we must determine that the species is protected from, and no longer subjected to, the threats that caused it to be listed. Therefore, threats discussed previously also must be monitored to ensure recovery goals and criteria are being met.

Habitat management should be conducted, in many instances, in an experimental context to determine the effects of various factors independently and jointly, and should be linked with monitoring or other determination of population trends. Once appropriate results have been obtained, they should be applied and adaptive management implemented. Based on results of monitoring and research described below, existing habitat management plans should be revised or new plans developed to maximize the value of protected habitat for featured species.

c. Status Surveys

A status survey is a detailed process beginning with a literature review and examination of herbarium or museum specimens. All historical localities of a species are identified and historical management and land use of the site should be noted. Additional sites where the species may occur are predicted based on distributional and ecological data and management history. All of the historical and predicted sites are visited at the appropriate time of year to evaluate if the species has persisted, population size and threats at those sites are evaluated, and recommendations for conservation are made. The purpose of the status survey for

recovery purposes is to determine how a species is doing on a range wide basis, assess whether it may warrant reclassification or delisting, and identify locations within appropriate habitat that could be suitable for introduction or reintroduction efforts. Additionally, status surveys can be used to identify additional sites for protection and to identify additional management actions necessary to ameliorate or eliminate remaining threats to the species. Status surveys are needed for all taxa featured in this recovery plan. Although status surveys were conducted in the past for certain taxa, such as members of the Orcuttieae, for example, the data are more than a decade old and must be updated to aid in recovery efforts. Moreover, many known sites have not been visited in recent years, so the number of occurrences that are actually extant and the current threats to those occurrences are not documented. Periodic status surveys can eliminate these data shortfalls and ultimately are important to the recovery process where species numbers are important to the decision to downlist or delist.

d. Research

Research to further understand the effects of threats and the effectiveness of our measures to ameliorate or eliminate those threats are needed to recover and conserve the taxa featured in this recovery plan. This research includes studies related to habitat protection (*e.g.*, appropriate preserve size and location), habitat management and restoration techniques (*e.g.*, appropriate levels of burning, grazing, mowing, or rest), and species ecology and biology (*e.g.*, genetic relatedness, tolerances to environmental contaminants, and species interactions). The breeding systems and patterns of gene flow are not known for most species; however, interim adaptive management plans should be developed and implemented for protection of the species and their habitat until appropriate research is conducted. Upon learning new information, the management plans should be modified.

e. Participation and Outreach

Participation and outreach are important to the survival and recovery of the listed species and species of concern addressed in this recovery plan. Vernal pool species occur on many parcels of property owned and/or managed by dozens of different stakeholders (private landowners, Federal agencies, State agencies, and local governments). Early ownership in the recovery implementation process requires that landowners and land managers be informed so they can become effective participants in the recovery process. Many private landowners, and local agencies, are willing participants in recovery implementation efforts, but many do not have the information necessary to make informed decisions. Developing working relationships with all stakeholders, including public land

management agencies and private landowners to secure and recover vernal pool ecosystems is essential. Public land management agencies and private landowners should be informed of the presence or potential presence of vernal pool species and habitat on their property, the ecological requirements of the species, and incentives to compensate them for any efforts they take to help recover the species.

To enhance compliance with existing regulations and to better take advantage of opportunities within existing Federal, State, and local laws, regulations, and policies to conserve vernal pool resources, outreach and educational programs should be developed and implemented. We are recommending the formation of a single recovery implementation team with multiple vernal pool region-level working groups tiered off of it to implement effective outreach and education. Appendix G details outreach tools and strategies that can be used to facilitate effective public participation in the vernal pool recovery process.

Education will be a key component in increasing the public's general awareness of vernal pool ecosystems and garnering support for conservation of habitat for the covered species. Materials should be developed and distributed through existing outreach mechanisms such as newsletters, the Internet, and meetings. Specialized educational programs should be developed to educate target audiences such as school groups, landowners, and other stakeholders. A program of regular communications with public and private stakeholders is necessary to ensure mutual understanding, as well as compliance with Federal and State laws regulating vernal pool resources. It is essential to coordinate closely with local and county permitting agencies as well as State, Federal, and private interests to ensure that they understand where the covered species occur and where potential habitat exists. Outreach in the form of workshops/meetings with city and county planning staff will help stakeholders understand Federal laws, regulations, and policies concerning management of listed species and be aware of incentive programs that can assist them in protecting listed species and their habitats. Education should emphasize the benefits of vernal pool ecosystems, the compatibility of vernal pool management and managed grazing practices, and how conservation easements can benefit both landowners and the covered species. Protection of vernal pools has many ancillary benefits including protection of water quality, stormwater retention, grazing, tourism, and habitat for species not included in this recovery plan such as mammal and bird species.

2. Recovery and Conservation Strategies for Specific Species in Addition to the Five Elements of the Recovery Strategy

The recovery and conservation strategies described in the previous section, (III.C.1, Individual Elements of the Recovery Strategy) apply to all the species in this plan. The following is additional information which applies to the following individual species or groups of species.

a. Plants

Several plant species require interim monitoring at multiple locations because they are small populations and are the only representatives from a given vernal pool region or vernal pool type. Monitoring and subsequent protection of these populations prior to completion of other recovery actions for those species is necessary to ensure the species distributions throughout their range.

To prevent the decline of *Castilleja campestris* ssp. *succulenta*, *Chamaesyce hooveri*, *Eryngium constancei*, *Lasthenia conjugens*, *Limnanthes floccosa* ssp. *californica*, *Navarretia leucocephala* ssp. *pauciflora*, *Navarretia leucocephala* ssp. *plieantha*, *Parvisedum leiocarpum*, *Astragalus tener* var. *ferrisiae*, *Astragalus tener* var. *tener*, *Atriplex persistens*, *Eryngium spinosepalum*, *Legenere limosa*, *Myosurus minimus* var. *apus*, and *Navarretia myersii* ssp. *deminuta* due to loss of pollinators, research is needed to determine whether each of them is insect-pollinated. If insects are found to be important to pollination, and therefore to seed production, their habitat must be protected in each core area to contribute to the recovery of each species.

Seed banking, although by no means meant to replace conservation of wild populations in their natural habitat, can increase the survival prospects of imperiled plant species by preventing unique genotypes from disappearing altogether. Seed banking can effectively document, preserve, and maintain viable seeds of vernal pool plants in long-term storage, thereby reducing the possibility of extinction and contributing to recovery. Seed bank collection is recommended for all plant species covered in this recovery plan.

Biosystematic research, including DNA analysis, is needed for several taxa as a whole or for certain populations. The lack of certainty concerning the distribution of several taxa of concern has precluded the possibility of listing them as endangered or threatened. Some uncertainty also remains among listed taxa, particularly those for which populations intermediate in morphology are known. This knowledge is important in order to preserve the ecological and genetic diversity of each taxon. Biosystematic research is recommended for *Limnanthes*

floccosa ssp. *californica*, *Astragalus tener* var. *ferrisiae*, *Astragalus tener* var. *tener*, *Eryngium spinosepalum*, *Myosurus minimus* var. *apus*, *Navarretia leucocephala* ssp. *pauciflora*, and *Navarretia leucocephala* ssp. *plieantha*.

Although Federal regulations require status reviews of listed species every 5 years, status reviews of *Tuctoria mucronata*, *Navarretia myersii* ssp. *deminuta*, and *Plagiobothrys hystriculus* are recommended 3 years after approval of this recovery plan due to their extremely low numbers and, in the case of *P. hystriculus*, due to its possible extinction. Knowledge of these species' distribution is important to determine whether *Navarretia myersii* ssp. *deminuta* and *Plagiobothrys hystriculus* (if re-discovered) warrant listing as an endangered or threatened species and to provide immediate protection for these species and *Tuctoria mucronata* in order to help ensure their recovery or conservation.

b. Delta Green Ground Beetle

Due to the limited amount of delta green ground beetle habitat remaining and the threat posed to much of that habitat, the most important strategy for recovering the delta green ground beetle is to protect, in perpetuity, remaining suitable grassland/vernal pool habitat in the greater Jepson Prairie area, particularly designated critical habitat outside of the Jepson Prairie Preserve on the Wilcox Ranch property owned by the Nature Conservancy and Solano County. With so little habitat for the delta green ground beetle remaining, even small patches of habitat may be of benefit to the species. No specific management actions for the delta green ground beetle are included in the latest Jepson Prairie Preserve grazing plan (R. Reiner pers. comm., C. Witham pers. comm.). This oversight should be corrected, so that grazing can be used as an effective tool to adaptively manage habitat of the delta green ground beetle.

The delta green ground beetle population at the Jepson Prairie Preserve is unlikely to be able to serve as a source of individuals for an introduction effort, based on the relatively few sightings of delta green ground beetles at the Preserve since 1974. The removal of a smaller number of individuals for a captive breeding effort may be necessary to maintain the population. Therefore, concurrent with research to identify suitable habitat conditions and surveys to find potential introduction sites, a captive population of delta green ground beetles should be established to produce progeny to be used for reintroduction efforts. Goulet (1983) and Kavanaugh (pers. comm.) already have had some success in propagating the delta green ground beetle in captivity, but additional research is necessary to refine techniques for maintaining and breeding delta green ground beetles in captivity.

The paucity of information on the delta green ground beetle reduces the options available to conserve and recover this species. Managing habitat of the current population and establishing new populations will only be successful after critical information needs are addressed. Many aspects of the biology and ecology of the delta green ground beetle should be investigated including: (1) sources and rates of mortality for adults, pupae, larvae, and eggs; (2) productivity; (3) dispersal; (4) preferred habitat conditions for larvae and adults; (5) preferred sites for oviposition; (6) activity cycles, both daily and annual; and (7) timing of life-cycle stages.

c. Vernal Pool Fairy Shrimp

In the Western Riverside County vernal pool region, the recovery strategy for the vernal pool fairy shrimp builds on the strategy developed for the Riverside fairy shrimp developed in the Recovery Plan for Vernal Pools of Southern California (U.S. Fish and Wildlife Service 1998b). The strategy includes securing existing vernal pool habitats and their associated watersheds, reestablishing vernal pool habitat to its historical structure, and managing and monitoring habitat and listed species.

In the Santa Barbara vernal pool region, the recovery strategy for the vernal pool fairy shrimp includes actions for the Transverse Management area identified by the Recovery Plan for Vernal Pools of Southern California (U.S. Fish and Wildlife Service 1998b). The strategy includes protecting habitats containing vernal pool fairy shrimp populations in Los Angeles and Ventura Counties.

A site-specific recovery strategy for vernal pool fairy shrimp in the Klamath Mountains vernal pool region (consistent with the general recovery strategy identified in this document) will be developed within a recovery plan for species of the upper Rogue River Valley, which is currently in preparation at our Roseburg Field Office.

d. Western Spadefoot Toad

Where agricultural activities must coincide with the conservation of western spadefoot toad, appropriately grazed pastures will provide better habitat than intensively farmed lands subject to discing, planting, harvesting and other activities that could kill aestivating western spadefoot toads. Providing incentives to private landowners to maintain pasture (rather than converting it to row-crops) or to convert intensively-farmed land to pasture will help to maintain or increase the amount of upland habitat available to the western spadefoot toad. Coordination with local land trusts is also recommended.

Dimmitt and Ruibal (1980) found that western spadefoot toads were extremely sensitive to low frequency noises and vibrations. These disturbances caused western spadefoot toads to break dormancy and emerge from their burrows. Such disturbances pose a threat if they cause western spadefoot toads to emerge at inappropriate times, which may in turn result in mortality or reduced productivity. More data are needed to determine the significance of this threat, but efforts to protect habitat for this species should take Dimmitt and Ruibal's (1980) findings into account. When choosing sites to protect essential habitat features such as breeding ponds, sufficient upland habitat for estivation, and dispersal corridors, it may be important to consider the current and potential presence of objects or activities that create low-frequency noise. It also may be wise to protect additional habitat that can serve as a buffer against low-frequency noise around these essential habitat features.

Throughout the world, evidence is mounting that many local extirpations of amphibians are due to disease outbreaks. Small or fragmented populations may not be able to survive a disease outbreak. Ironically, some amphibian disease vectors can be carried accidentally by conservation biologists who are working to conserve amphibians. To counter this problem, researchers should follow guidelines for minimizing disease transmission when they are conducting field work with the western spadefoot toad. A suggested procedure for minimizing the potential transmission of disease and pathogens between aquatic resources is available in Appendix H.

An extremely important issue is the suitability of altered and man-made wetlands for successful reproduction by western spadefoot toads. Spadefoot toads appear to readily use such wetlands based on frequent observation of eggs and larvae. However, reproductive success has not been evaluated in these wetlands. If the characteristics of these wetlands (*e.g.*, water quality, presence of predators, longevity) permit successful reproduction by western spadefoot toads, then they potentially could contribute significantly to the conservation of this species and the creation of artificial wetlands could constitute a valuable mitigation and conservation strategy. However, it also is possible that spadefoot toads are attracted to such wetlands, but that reproductive success is poor compared to that in natural wetlands. In this situation, altered and man-made wetlands could constitute a significant threat to western spadefoot toads by acting as population "sinks." Thus, an important need is an evaluation of the reproductive success of western spadefoot toads in such wetlands as compared to natural wetlands.

Some roads threaten the conservation of the western spadefoot toad by limiting their movement. Specifically, many western spadefoot toads are run over by motor vehicles on roads that do not allow them safe passage. One means to

minimize this threat is to protect large expanses of habitat that have few roads or roads with limited vehicle use, and to limit road construction in these protected sites. When new roads are constructed within western spadefoot toad habitat, they should be designed with the welfare of this species in mind. Monitoring should be performed before road construction to find sites where western spadefoot toad dispersal routes would most likely intersect the proposed roadway. If possible, the path of the roadway should be altered to avoid these sites. If the proposed roadway still threatens to place western spadefoot toads in danger, ecopassages (passageways designed to allow safe movement of wildlife under roads) should be constructed at the most dangerous sites. Many roads already exist within the range of the western spadefoot toad. Monitoring should be conducted to determine where road-caused obstruction of dispersal and motor-vehicle caused mortality occur most frequently. Portions of roadway that are most problematic for western spadefoot toads should be retrofitted with ecopassages so as to permit safe passage of this and other species of wildlife.

Additional data also are needed on the basic life history of the western spadefoot toad, particularly demographic parameters such as survival rates and sources of mortality (for both adults and larvae), longevity, recruitment rates, reproductive success, optimal juxtaposition of upland and aquatic habitats, optimal and tolerable characteristics of aquatic habitats for reproduction and larval development, optimal upland sites for burrows, acceptable soil characteristics for subterranean dormancy, dispersal rates, and dispersal distances. Also, the effects of annual variations in environmental conditions (*e.g.*, precipitation) should be investigated.

Changes in vernal pool hydrology may adversely impact spadefoot toad populations. In particular, grazing may play an important role in maintaining vernal pool hydrology by decreasing the abundance of vegetation and therefore evapotranspiration from the pools during the spring. In a study conducted in pools inhabited by spadefoot toads, Marty (2004) found that removal of grazing led to a reduction in the inundation period of the pools below the amount of time required by the toads to successfully metamorphose. Conversely, as mentioned previously, livestock may crush or even consume egg clusters while utilizing ponds and cause direct mortality to adult and juvenile toads though trampling. Continued use may deplete water levels from ponds preventing complete metamorphosis of tadpoles or in some cases, causing accelerated metamorphosis to occur which according to Morey (1998), may result in individuals that are less fit. Therefore careful management of cattle grazing must occur to avoid these adverse effects to the spadefoot toad and its habitat.

Many of the Central Valley spadefoot toad occurrences have not been revisited or verified for over 10 years. Because of the lack of current status information over a large portion of the range and the ongoing rate of vernal pool habitat loss, a status survey, particularly of the northern and central occurrences and potential habitat, should be conducted to determine appropriate recovery criteria (Action 3 in the Stepdown Narrative).

D. VERNAL POOL REGIONS

The vernal pool regions used in this recovery plan are discrete units that will assist in identifying areas to be conserved for the recovery and conservation objectives for each species addressed in this plan. Each designated region is based largely on the presence of endemic species, with soils and geomorphology as secondary elements, and contains one or more of the vernal pool species in this recovery plan (see discussion in section I.A.2 above). Core areas, discussed further below, are distinct areas in each vernal pool region that provide the features, populations, and distinct geographic and/or genetic diversity necessary to the recovery of a species. Based upon current information, other areas within the vernal pool regions may provide similar features and/or geographic/genetic distinctness; however, they are not, at this time, the focus of our recovery effort.

Vernal pool regions are individually important to the recovery and conservation of the listed species addressed in this recovery plan because each region contains unique biotic and abiotic attributes of the species' range (such as genetic robustness, demographic robustness, important life history stages, or other features) and habitat within each region may contribute to future recovery efforts. These individual contributions from each region provide for the long-term sustainability (*i.e.*, recovery) of a species throughout its range. Each species is, however, listed based on its entire population, not as separate entities occurring in specific regions and, therefore, a species cannot be delisted by individual vernal pool region. Each species must be recovered in all of the vernal pool regions in which it occurs, and the threats that caused its listing must be ameliorated and eliminated, before it can be proposed for delisting (**Table III-1** lists the vernal pool regions designated for each species). Recovery of each listed species discussed in this recovery plan depends upon satisfying the recovery criteria for the given species. The designated vernal pool regions do not represent distinct population segments nor do they reflect designated critical habitat for any of the species covered in this recovery plan. The respective status of each species' populations in each region is highly variable, as is their potential for recovery.

Maintaining populations distributed throughout the range of each species is necessary for the long-term recovery and conservation of the listed species

covered in this recovery plan as many of these species rely on secondary dispersal mechanisms (*e.g.*, birds) to maintain their genetic diversity. Well-distributed populations help eliminate the possibility of species extinction due to further habitat loss or fragmentation and will ameliorate the vulnerability of a species to environmental fluctuations and catastrophes (Meffe and Carroll 1994). To ensure that each taxon in this recovery plan can persist despite weather variations, climate change, or catastrophic events, the suite of populations in each vernal pool region represents the full range of environmental conditions in which the taxon occurred historically. Environmental conditions to be taken into consideration when identifying areas for protection include the size and type of vernal pool, pool chemistry, underlying soils and landforms, elevations, and geographic distribution. The range of genetic variation also must be represented to allow for evolution and resilience to environmental change. Genetic diversity has not been investigated for most taxa addressed in this recovery plan, therefore, maintenance of well-distributed populations across the species range and across ecological conditions is recommended as a surrogate means to preserving genetic diversity.

While a goal of the recovery plan is to protect the long-term viability of existing populations within each vernal pool region, core areas within each vernal pool region have been identified where recovery actions will be focused (**Figure III-1** depicts a conceptual model of recovery with respect to areas within and outside of vernal pool regions or core areas). The methodology for establishing core areas stems from the premise that those core areas represent viable populations (possibly even source populations for larger metapopulations) or will contribute to the connectivity of habitat and thus increase dispersal opportunities between populations. Establishment of core areas was based on existing data on species occurrences and data from the proposed critical habitat for vernal pool crustaceans and plants. From these data, areas were selected that are 1) representative of a given species range, or 2) support a high concentration of species per unit area. Generally, sites falling into these categories are within core areas. However, some sites meeting these criteria for site selection were not included in core areas due to factors such as relatively large numbers of occurrences already within established core areas which are representative of the species distribution throughout its range, or data that indicated the populations documented from a site were extirpated. In such cases, outlier occurrences were not considered, based on the available data, to be critical to the recovery and conservation of the given species. Future analysis through the implementation of this recovery plan may support the need to incorporate these populations into vernal pool regions or core areas. Results of future status surveys and research such as the discovery of additional populations of species may also support the need to modify core area boundaries. Core area boundaries have been established

based on data from the representative distributions of species occurrence information, data layers for the proposed critical habitat for vernal pools, Holland (1998) data, watershed boundaries, other hydrographic boundaries, topographic features, roads and land use designations. Specific boundaries of core areas are mapped below in **Figures III-2 through III -17**.

Preservation and enhancement of each core area is important to maintain and possibly expand the distribution of the vernal pool species rangewide. Lands preserved within core areas will require long-term protection and management so that existing and reestablished populations remain viable. The Vernal Pool Region approach used in this recovery plan addresses the risk to long-term survival and recovery of these species by employing two widely recognized and scientifically accepted goals for promoting viable populations of listed species: (1) protection of multiple populations so that a single or series of catastrophic events cannot cause the extinction of the whole species; and (2) increasing the size of the populations in core areas to a level where threats from genetic, demographic, and normal environmental uncertainties or change are diminished (Tear *et al*. 1993, Mangel and Tier 1994, National Research Council 1995, Meffe and Carroll 1996:192). In general, the larger the number of populations and the larger the size of each population, the lower the probability of extinction (Meffe and Carroll 1996: 190, Hanski *et al.* 2002, Matthies *et al.* 2004). This basic conservation principle of population redundancy applies to all the species in this plan. By producing and maintaining well-distributed viable populations in core areas for all species in this plan, the threats noted above are minimized and the species have a greater chance of achieving long-term survival and recovery. Conversely, loss of multiple populations increases the risk that an entire species may not survive and recover.

When evaluating the potential impact of land management or land use actions that may affect the listed species addressed in this plan, we will consider whether a significant loss of habitat in one vernal pool region - without long-term compensation alleviating the impacts of that loss - would adversely affect the viability of the population in that vernal pool region as well as the long-term viability of populations in other vernal pool regions, and the species as a whole. Excessive impacts to one or more of the vernal pool regions could jeopardize the long-term survival and recovery of the affected species by increasing the vulnerability of the remaining vernal pool regions to catastrophic events. Recovery and delisting of individual species will be facilitated by meeting

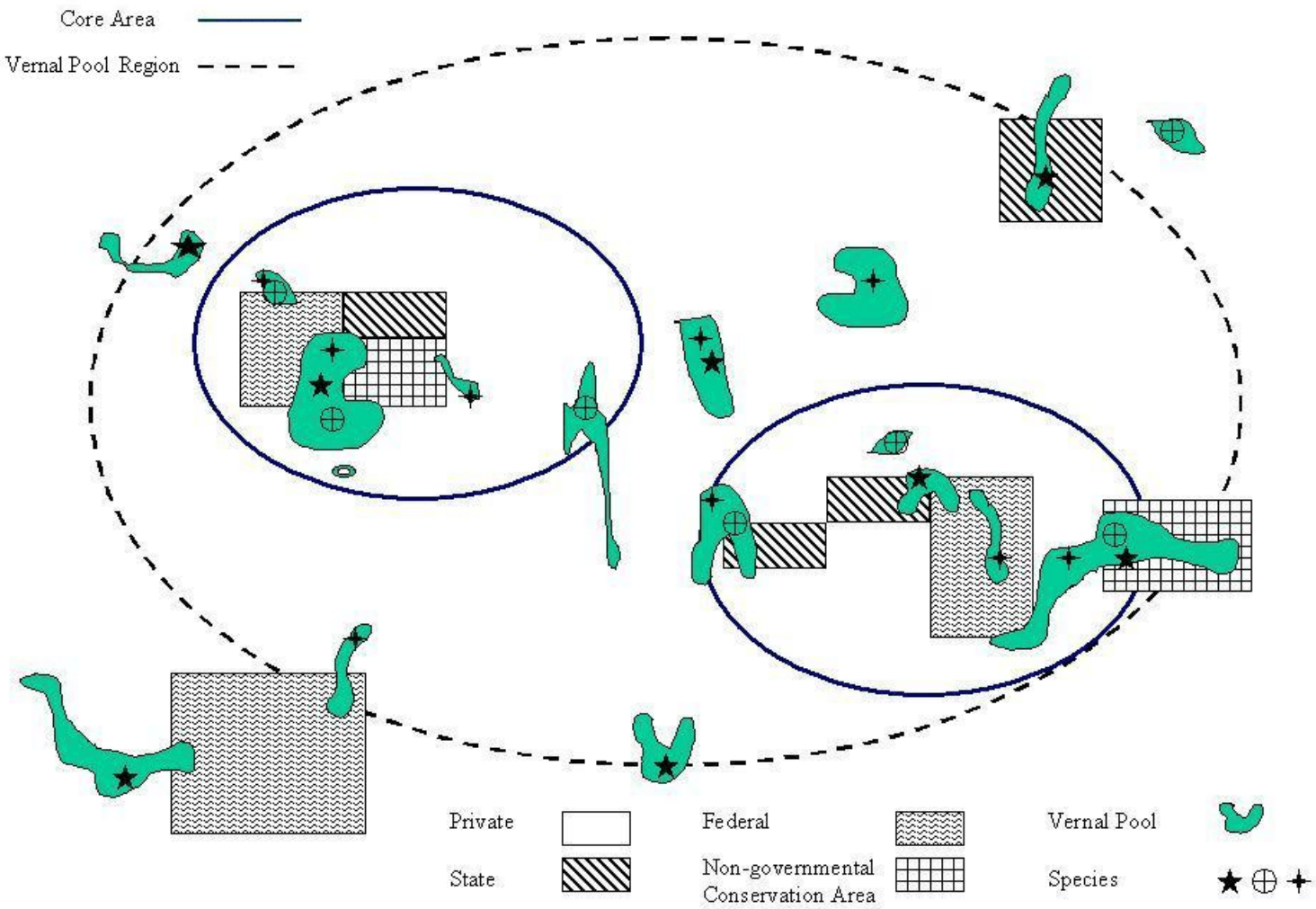

Figure III-1. Conceptual model for recovery of vernal pool ecosystem.

Figure III-2. Carrizo vernal pool region.

Figure III-2a. Central Coastal Ranges core area within the Carrizo vernal pool region.

Figure III-2b. Paso Robles core area within the Carrizo vernal pool region.

Figure III-2c. Carrizo Plain core area within the Carrizo vernal pool region.

Figure III-3. Central Coast vernal pool region.

Figure III-3a. Coal Mine Ridge and S.E. San Francisco Bay core areas within the Central Coast vernal pool region.

Figure III-3b. Ford Ord core area within the Central Coast vernal pool region.

Figure III-3c. San Benito core area within the Central Coast vernal pool region.

Figure III-3d. Fort Hunter-Liggett core area within the Central Coast vernal pool region.

Figure III-4. Klamath Mountains vernal pool region.

Figure III-4a. Agate Desert, Table Rocks, and White City core areas within the Klamath Mountains Recovery Unit.

Figure III-5. Lake-Napa vernal pool region.

Figure III-5a. Boggs Lake-Clear Lake, Jordan Park, Dry Lake, and Long Valley core areas within the Lake-Napa vernal pool region.

Figure III-5b. Diamond Mountain core area within the Lake-Napa vernal pool region.

Figure III-5c. Berryessa and Napa River core areas within the Lake-Napa vernal pool region.

Figure III-6. Livermore vernal pool region.

Figure III-6a. Altamont Hills core areas within the Livermore vernal pool region.

Figure III-7. Manchester core area within the Mendocino vernal pool region.

Figure III-8. Modoc Plateau vernal pool region.

Figure III-8a. Northern Modoc Plateau core areas within the Modoc Plateau vernal pool region.

Figure III-8b. Western Modoc Plateau core areas within the Modoc Plateau vernal pool region.

Figure III-8c. Southwestern Modoc Plateau core areas within the Modoc Plateau vernal pool region.

Figure III-8d. Southern Modoc Plateau core area within the Modoc Plateau vernal pool region.

Figure III-9. Northeastern Sacramento Valley vernal pool region.

Figure III-9a. Dales core area within the Northeastern Sacramento Valley vernal pool region.

Figure III-9b. Vina Plains and Chico core areas within the Northeastern Sacramento Valley vernal pool region.

Figure III-9c. Doe Mill, Oroville, Richvale, and Palermo core areas within the Northeastern Sacramento Valley vernal pool region.

Figure III-9d. Honcut core areas within the Northeastern Sacramento Valley vernal pool region.

Figure III-9e. Sacramento National Wildlife Refuge Llano Seco and Upper Butte Basin core areas within the Northeastern Sacramento Valley vernal pool region.

Figure III-10. Northwestern Sacramento Valley vernal pool region.

Figure III-10a. Redding and Millville Plains core areas within the Northwestern Sacramento Valley vernal pool region.

Figure III-10b. Red Bluff core area within the Northwestern Sacramento Valley vernal pool region.

Figure III-10c. Black Butte and Orland core areas within the Northwestern Sacramento Valley vernal pool region.

Figure III-11. San Joaquin Valley vernal pool region.

Figure III-11a. Caswell core area within the San Joaquin Valley vernal pool region.

Figure III-11b. Grassland Ecological Area core areas within the San Joaquin Valley vernal pool region.

Figure III-11c. Cross Creek and Pixley core areas within the San Joaquin Valley vernal pool region.

Figure III-12. Santa Barbara vernal pool region.

Figure III-12a. Lake Cachuma and Ventura County core areas within the Santa Barbara vernal pool region.

Figure III-13. Solano-Colusa vernal pool region.

Figure III-13a. Sacramento National Wildlife Refuge and Dolan core areas within the Solano-Colusa vernal pool region.

Figure III-13b. Woodland and Davis Comm. Annex core areas within the Solano-Colusa vernal pool region.

Figure III-13c. Vacaville, Jepson Prairie, Suisan Marsh, Collinsville, and Montezuma Hills core areas within the Solano-Colusa vernal pool region.

Figure III-13d. Rodeo Creek core area within the Solano-Colusa vernal pool region.

Figure III-14. Southeastern Sacramento Valley vernal pool region.

Figure III-14a. Beale and Western Placer County core areas within the Southeastern Sacramento Valley vernal pool region.

Figure III-14b. Phoenix Field Park, Mather, Stone Lake, Cosumnes/Rancho Seco, S.E. Sacramento Valley, and Jenny Lind core areas within the Southeastern Sacramento Valley vernal pool region.

Figure III-15. Southern Sierra Foothills vernal pool region.

Figure III-15a. San Joaquin, Shotgun Creek, Farmington, Waterford, Turlock and Merced core areas within the Southern Sierra Foothills vernal pool region.

Figure III-15b. Madera core areas within the Southern Sierra Foothills vernal pool region.

Figure III-15c. Table Mountain, Fresno, and Kings core areas within the Southern Sierra Foothills vernal pool region.

Figure III-15d. Cottonwood Creek, Tulare, Kaweah, Yokohl and Lake Success core areas within the Southern Sierra Foothills vernal pool region.

Figure III-16. Western Riverside County vernal pool region.

Figure III-16a. Harford Spring, Santa Rosa Plateau, Skunk Hollow, and San Jacinto-Hemet core areas within the Western Riverside County vernal pool region.

Figure III-17. San Diego vernal pool region.

Figure III-17a. Otay Mesa, Ramona, and Tierrasanta core areas within the San Diego vernal pool region.

recovery criteria for all species in all core areas for that species. In most cases, core areas attempt, to the fullest extent possible, to represent the full range of vernal pool sizes and types, soils, and within species genetic diversity for each taxon. Thus, core areas should be refined, as appropriate, when new data becomes available. Core areas and critical habitat areas differ in that core areas have no legal mandate for protection under the Endangered Species Act and solely rely upon voluntary implementation. The designation of critical habitat requires Federal agencies to consult with the Service regarding any action that could destroy or adversely modify critical habitat.

1. Carrizo Vernal Pool Region

The geographic location of the Carrizo Vernal Pool Region and associated core areas is depicted in **Figures III-2 and III-2a-c**. This vernal pool region is almost entirely in San Luis Obispo County but does incorporate small areas of adjacent Kern and Monterey Counties. It includes two separate polygons: the Carrizo Plain/San Andreas Fault zone and the Paso Robles area (Keeler-Wolf *et al*. 1998). The Carrizo Vernal Pool Region is in the Central California Coast Ranges Section of the California Coastal Range Shrub-Forest-Meadow Province (Goudey and Smith 1994). The boundaries of this vernal pool region differ from the region boundaries identified by Keeler-Wolf *et al.* (1998) in areas surrounding the Central Coast Ranges core area and Fort Hunter-Liggett core area by encompassing species occurrences within adjacent watersheds. Several types of vernal pools occur in the Carrizo Vernal Pool Region. Northern Claypan Vernal Pools form in shallow depressions north and west of the ephemeral Soda Lake and on the southern end of the Carrizo Plain, where the topography is fairly level. Sag ponds on the southern end of the Carrizo Plain occur in small basins created by movement of the earth's plates over the San Andreas fault. These sag ponds are not classified and are assigned to the undefined "Northern Vernal Pool" category. Pools which form in rock outcrops constitute another type of ephemeral pool, which is not technically a vernal pool and does not support characteristic plants, but may support fairy shrimp and spadefoot toads. Pools in the Paso Robles area also have not been classified and are thus assigned to the undefined "Northern Vernal Pool" category (Keeler-Wolf *et al*. 1998). Soils in the region are still being mapped. Landowners in the vernal pool region are the U.S. Bureau of Land Management, The Nature Conservancy, the California Department of Fish and Game, and private individuals.

2. Central Coast Vernal Pool Region

The geographic location of the Central Coast Vernal Pool Region and associated core areas is depicted in **Figures III-3 and III-3a-d**. The Central Coast Vernal

Pool Region includes several separate polygons distributed over portions of nine counties (Alameda, Fresno, Merced, Monterey, San Benito, San Mateo, Santa Clara, Santa Cruz, and Stanislaus). Within the polygons, vernal pools are scattered among valleys of the inner and outer coast ranges and the coastal plain near Monterey Bay; many are associated with fault lines (Keeler-Wolf *et al*. 1998). The boundaries of this vernal pool region differ from the region boundaries identified by Keeler-Wolf *et al*. (1998) in areas surrounding the San Benito core area, Fort Ord core area, and Central Coast Ranges core area and encompasses species occurrences within adjacent watersheds. The Central Coast Vernal Pool Region is in the same ecological section as the Carrizo Vernal Pool Region, *i.e.*, the Central California Coast Ranges Section of the California Coastal Range Shrub-Forest-Meadow Province (Goudey and Smith 1994). The vernal pools in the Central Coast Vernal Pool Region are unclassified "Northern Vernal Pools" (Keeler-Wolf *et al*. 1998). No particular soils are characteristic of the region. Landowners in the vernal pool region include the U.S. Fish and Wildlife Service, U.S. Department of Defense, U.S. Bureau of Land Management, and private individuals.

3. Klamath Mountains Vernal Pool Region

The geographic location of the Klamath Mountains Vernal Pool Region and associated core areas is depicted in **Figures III-4 and III-4a**. This vernal pool region is in the Klamath Mountains Ecoregion (Thorson *et al.* 2003) of the Sierran Steppe-Mixed Forest-Coniferous Forest-Alpine Meadow Province of the Mediterranean Regime Mountains Division. The Klamath Mountains Vernal Pool Region includes hardpan vernal pools in "mounded prairie," which is similar to mima mound topography, and basalt flow vernal pools on two flat-topped "Table Rocks" near the Rogue River. Landowners in the region include The Nature Conservancy, the U.S. Bureau of Land Management, Bureau of Reclamation, Oregon Department of Fish and Wildlife, City of Medford, and private individuals (C. Tuss, pers. comm. 2004).

In addition to the vernal pool fairy shrimp, which is addressed in this recovery plan, two listed plant species are endemic to vernal pool habitats in the Klamath Mountains Vernal Pool Region: *Limnanthes floccosa* ssp. *grandiflora* (large-flowered woolly meadowfoam) and *Lomatium cookii* (Cook's lomatium). Recovery of these plant species will be separately addressed in a recovery plan for species of the upper Rogue River Valley, currently in preparation by our Roseburg Field Office. Site-specific recovery actions and strategies for vernal pool fairy shrimp populations in the Klamath Mountains Vernal Pool Region will also be addressed in the Rogue River Valley recovery plan within the context of integrated conservation and ecosystem-level management for all three species,

consistent with the recovery criteria and generalized recovery strategy identified for vernal pool fairy shrimp in this Vernal Pool Ecosystem Recovery Plan.

4. Lake-Napa Vernal Pool Region

The geographic location of the Lake-Napa Vernal Pool Region and associated core areas is depicted in **Figures III-5 and III-5a-c**. This vernal pool region occurs primarily in Lake and Napa Counties but incorporates a small portion of northwestern Yolo County and just barely crosses into Sonoma County (Keeler-Wolf *et al*. 1998). The boundaries of this vernal pool region differs from the vernal pool region boundaries identified by Keeler-Wolf *et.al*. (1998) in the area surrounding the Diamond Mountain Core Area and encompasses species occurrences above 610 meters (2,000 feet) elevation. Additionally, the boundaries differ in the southern end of the region to capture several occurrences of rare plants. Ecological units in the Lake-Napa Vernal Pool Region are the Northern California Coast Ranges Section of the Sierran Forest-Alpine Meadows Province and the Northern California Coast Section of the California Coastal Steppe-Mixed Forest-Redwood Forest Province (Goudey and Smith 1994). Vernal pools in the region are of three types: Northern Volcanic Ashflow, Northern Basalt Flow, and unclassified "Northern Vernal Pools." Northern Volcanic Ashflow Vernal Pools often are large lakes that may remain wet in the center year-round; however, their margins function as vernal pools. The other pool types are smaller and may occur in complexes. Soil types vary throughout the region. Northern Volcanic Ashflow Vernal Pools are often on Oxalis variant soils, whereas Northern Basalt Flow Vernal Pools occur on Konocti variant soils and the Northern Vernal Pools in the region are soils of the Aiken, Bressa-Dibble complex, Contra Costa, or other series (Keeler-Wolf *et al*. 1998). Landowners in the Lake-Napa Vernal Pool Region include the California Department of Fish and Game, the Trust for Wildland Communities, and private individuals.

5. Livermore Vernal Pool Region

The geographic location of the Livermore Vernal Pool Region and associated core areas is depicted in **Figures III-6 and III-6a**. The Livermore Vernal Pool Region straddles Alameda, Contra Costa, and Santa Clara Counties, extending into southwestern San Joaquin County (Keeler-Wolf *et al*. 1998). The entire region is in the Central California Coast Ranges Section of the California Coastal Range Shrub-Forest-Meadow Province (Goudey and Smith 1994). Landforms vary from floodplains to basin rims and terraces in fairly level topography. Northern Claypan Vernal Pools are characteristic of the region, although swales and some Northern Hardpan Vernal Pools are present. Another type of ephemeral pools in the region (*tinajas*) are not technically vernal pools because they form in rock

outcrops and do not support characteristic plants, but these pools may have longhorn fairy shrimp. Soils underlying Northern Claypan Vernal Pools in the region are typically Solano fine sandy loam. The vernal pool biota in the Livermore Vernal Pool Region is similar to that of the San Joaquin Valley Vernal Pool Region, but the two regions do not merge (Keeler-Wolf *et al*. 1998).

6. Mendocino Vernal Pool Region

The geographic location of the Mendocino Vernal Pool Region and associated core area is depicted in **Figure III-7**. This vernal pool region occupies several disjunct polygons in valleys of the North Coast Ranges and on the coastal terrace near Manchester. This region is not far from, and is somewhat similar to, the Lake-Napa Vernal Pool Region (Keeler-Wolf *et al*. 1998). Like the Lake-Napa region, it spans two ecological units, the Northern California Coast Ranges Section of the Sierran Forest-Alpine Meadows Province and the Northern California Coast Section of the California Coastal Steppe-Mixed Forest-Redwood Forest Province (Goudey and Smith 1994). Unlike the Lake-Napa region, the vernal pools in the Mendocino Vernal Pool Region are all of the unclassified "Northern Vernal Pool" type. They occur singly in depressions or blocked drainages. No particular soils are characteristic of the region (Keeler-Wolf *et al.* 1998).

7. Modoc Plateau Vernal Pool Region

The geographic location of the Modoc Plateau Vernal Pool Region and associated core areas is depicted in **Figures III-8 and III-8a-d**. Most of the region is in Modoc and Lassen Counties, but it does include small areas of northeastern Shasta County, southeastern Siskiyou County, and northern Plumas County. The boundaries of this vernal pool region differ from the region boundaries identified by Keeler-Wolf *et al.* (1998) in areas surrounding the Modoc Plateau core area to encompass watersheds that may support additional populations of species covered by this recovery plan. The Lake County, Oregon population of *Gratiola heterosepala* occupies similar ecological conditions (Kaye *et al*. 1990), but is disjunct from the Modoc Plateau Vernal Pool Region. This species is well represented in other core areas throughout its range, and has not been included in this vernal pool region. Further ground truthing should be conducted to determine if additional populations should be included in this vernal pool region. The Modoc Plateau Vernal Pool Region spans the Modoc Plateau and Southern Cascades Sections of the Sierran Forest-Alpine Meadows Province (Goudey and Smith 1994). The vernal pools in the region are of the Northern Basalt Flow and Northern Volcanic Mudflow types because the substrate was formed by volcanic activity. These pools range from tiny wetlands to vernal lakes; smaller pools may

occur in complexes, whereas lakes are isolated. Typical soils in the region are of the Deven and Supan series (Keeler-Wolf et al. 1998). Landowners in the Modoc Plateau Vernal Pool Region include the U.S. National Park Service, U.S. Forest Service, U.S. Bureau of Land Management, California State Parks, and private individuals.

8. Northeastern Sacramento Valley Vernal Pool Region

The geographic location of the Northeastern Sacramento Valley Vernal Pool Region and associated core areas is depicted in **Figures III-9 and III-9a-e**. The vernal pool region extends from the Millville Plains to Sutter Buttes, including parts of Butte, Shasta, Sutter, Tehama, and Yuba Counties. It is adjacent to the Northwestern Sacramento Valley Vernal Pool Region, but the two regions differ in soil type. The boundaries of this vernal pool region differ from the region boundaries identified by Keeler-Wolf *et al.* (1998) in areas surrounding the Vina Plains core area and Sacramento Refuge Llano Seco core areas in order to encompass species occurrences. Anita, Inks, Toomes, and Tuscan series soils are most prevalent in the Northeastern Sacramento Valley Vernal Pool Region. Another differentiating feature is that *Limnanthes floccosa* ssp. *californica* is restricted to the Northeastern Sacramento Valley Vernal Pool Region (Keeler-Wolf *et al*. 1998). The Northeastern Sacramento Valley Vernal Pool Region incorporates parts of both the Mediterranean Division and the Mediterranean Regime Mountains Division. The former is represented in the vernal pool region by the Great Valley Section of the California Dry Steppe Province, whereas the latter is represented by the Northern California Interior Coast Ranges Section of the Sierran Forest-Alpine Meadows Province (Goudey and Smith 1994). Three types of vernal pools occur in the Northeastern Sacramento Valley Vernal Pool Region. Northern Volcanic Mudflow pools are widespread throughout the region but occur as small, isolated, scattered pools. Northern Hardpan Vernal Pools are found on terraces of the Vina Plains and in the Chico area, where they occur in complexes of numerous pools of varying sizes. A few Northern Basalt Flow Vernal Pools are found in the region on Table Mt. near Oroville; they are typically small and in close proximity to each other (Keeler-Wolf *et al*. 1998). Land owners for these core areas include The Nature Conservancy, the California Department of Fish and Game, the U.S. Bureau of Land Management, the U.S. Fish and Wildlife Service, U.S. Department of Defense, the City of Chico, and private individuals.

9. Northwestern Sacramento Valley Vernal Pool Region

The geographic location of the Northwestern Sacramento Valley Vernal Pool Region and associated core areas is depicted in **Figures III-10 and III-10a-c**.

The Northwestern Sacramento Valley Vernal Pool Region extends from the Redding area of Shasta County south to the Williams area of Colusa County, also including parts of Glenn and Tehama Counties. It abuts the Northeastern Sacramento Valley Vernal Pool Region in Shasta and Tehama Counties and likewise includes portions of both the Great Valley Section of the California Dry Steppe Province and the Northern California Interior Coast Ranges Section of the Sierran Forest-Alpine Meadows Province (Goudey and Smith 1994). Unlike the Northeastern Sacramento Valley Vernal Pool Region, the Northwestern Sacramento Valley Vernal Pool Region is characterized by soils of the Corning and Redding series. Most of the vernal pools in this vernal pool region are small, Northern Hardpan Vernal Pools, which occur in complexes in mima-mound topography, but those on the Stillwater Plains are larger. A few Northern Volcanic Mudflow Vernal Pools are found near Black Butte Reservoir (Keeler-Wolf *et al.* 1998). Most of the lands in Northwestern Sacramento Valley Vernal Pool Region are privately owned, but some lands are publicly owned by the California Department of Fish and Game, the City of Redding, and the U.S. Bureau of Land Management.

10. San Joaquin Valley Vernal Pool Region

The geographic location of the San Joaquin Valley Vernal Pool Region and associated core areas is depicted in **Figures III-11 and III-11a-c**. The San Joaquin Valley Vernal Pool Region occupies the trough that runs southward from San Joaquin County to Kern County, including parts of Fresno, Kings, Madera, Merced, Stanislaus, and Tulare Counties. Soils in the region are alkaline and are typically of the Lewis, Rossi, Waukena, Fresno, and Traver series. The Aeolian Hilmar and Delhi series still exists at Arena Plains Unit of Merced National Wildlife Refuge (NWR). The latter are among the rarest vernal pool soil types in the Great Valley (Silveira, pers. comm. 2004). Vernal pools in the San Joaquin Valley Vernal Pool Region are primarily the Northern Claypan type; they can exist as shallow, playa-like pools or more typical vernal pools in mima mound topography (Keeler-Wolf *et al*. 1998). The San Joaquin Valley Vernal Pool Region is entirely within the Great Valley Section of the California Dry Steppe Province (Goudey and Smith 1994). Landowners in the core areas include the California Department of Fish and Game, the Center for Natural Lands Management, the U.S. Fish and Wildlife Service, and private individuals.

11. Santa Barbara Vernal Pool Region

The geographic location of the Santa Barbara Vernal Pool Region and associated core areas is depicted in **Figures III-12 and III-12a**. This vernal pool region includes the coastal plains of San Luis Obispo, Santa Barbara, and Ventura

Counties, as well as isolated polygons in Los Angeles and Ventura Counties. Ecological units included in this vernal pool region are the Central and Southern California Coast Sections of the California Coastal Chaparral Forest and Shrub Province as well as the Southern California Mountains and Valleys Section of the California Coastal Range Shrub-Forest-Meadow Province (Goudey and Smith 1994). The boundaries of this vernal pool region differ from the region boundaries identified by Keeler-Wolf *et al.* (1998) in areas surrounding the Lake Cachuma core area and Ventura County core area in order to encompass species occurrences and vernal pool habitats in adjacent local watersheds. Vernal pools in the region are of the unclassified "Southern Vernal Pool" type, and may occur in complexes or singly. Many soil series are known from the region, including Arnold, Betteravia, Botella, Chamise, Narlon, Salinas, Santa Ynez, Shedd, and Tangair (Keeler-Wolf *et al.* 1998). Landowners in the Santa Barbara Vernal Pool Region include the U.S. Forest Service, U.S. Bureau of Land Management, and private individuals.

12. Solano-Colusa Vernal Pool Region

The geographic location of the Solano-Colusa Vernal Pool Region and associated core areas is depicted in **Figures III-13 and III-13a-d**. In addition to Solano and Colusa Counties, this vernal pool region includes a substantial area of Yolo County and small parts of Glenn, Butte, Sutter, and Contra Costa Counties. The boundaries of this vernal pool region differ from the region boundaries identified by Keeler-Wolf *et al.* (1998) in areas surrounding the Jepson Prairie and Rodeo Creek core areas to encompass species occurrences and vernal pool habitats in adjacent local watersheds. The Solano-Colusa Vernal Pool Region is analogous to the San Joaquin Valley Vernal Pool Region in that it occupies alkaline basins in the Sacramento Valley (Keeler-Wolf *et al*. 1998); likewise, it is in the Great Valley Section of the California Dry Steppe Province (Goudey and Smith 1994). Northern Claypan Vernal Pools are typical of the Solano-Colusa Vernal Pool Region. They may occur as small pools in mima-mound topography or as somewhat larger playas. Some Northern Hardpan Vernal Pools are present in the region; these pools are small and occur in complexes among mima mounds. Featured vernal pool species also occur in the saline-alkaline transition zone between vernal pools and tidal marshes in this region. The Pescadero, Riz, Sycamore, and Willows soil series are prevalent in the vernal pool region (Keeler-Wolf *et al*. 1998). Landowners in the Solano-Colusa Vernal Pool Region include the California Department of Fish and Game, the U.S. Department of Defense, the U.S. Fish and Wildlife Service, and private individuals.

13. Southeastern Sacramento Valley Vernal Pool Region

The geographic location of the Southeastern Sacramento Valley Vernal Pool Region and associated core areas is depicted in **Figures III-14 and III-14a-b**. This vernal pool region extends from southern Yolo County south to San Joaquin and Calaveras Counties, incorporating most of Sacramento County and smaller areas of Amador, El Dorado, Nevada, Placer, and Sutter Counties. It occurs on terraces in both the Great Valley Section of the California Dry Steppe Province and the Sierra Nevada Foothills Section of the Sierran Forest-Alpine Meadows Province (Goudey and Smith 1994). Northern Hardpan Vernal Pools are most common in the Southeastern Sacramento Valley Vernal Pool Region, where they occur in complexes of many small pools and swales among mima mounds on soils of the Pentz-Pardee-Red Bluff, Redding-Corning, and San Joaquin series. A few Northern Volcanic Mudflow Vernal Pools occur in Placer County on Exchequer soils. In terms of landforms and soils, the Southeastern Sacramento Valley Vernal Pool Region is similar to the Southern Sierra Foothills Vernal Pool Region, but *Orcuttia viscida* is restricted to the former (Keeler-Wolf *et al*. 1998). Among the landowners in the vernal pool region are the California Department of Fish and Game, the County of Sacramento, The Nature Conservancy, the U.S. Department of Defense, the U.S. Bureau of Land Management, private individuals, and mitigation banking organizations.

14. Southern Sierra Foothills Vernal Pool Region

The geographic location of the Southern Sierra Foothills Vernal Pool Region and associated core areas is depicted in **Figures III-15 and III-15a-d**. The Southern Sierra Foothills Vernal Pool Region occupies high and low terrace landforms ranging from the junction of San Joaquin, Stanislaus, and Calaveras Counties south to Tulare County. Portions of Fresno, Madera, Mariposa, Merced, and Tuolumne Counties also are included in the region. The Southern Sierra Foothills Vernal Pool Region is contiguous with the Southeastern Sacramento Valley Vernal Pool Region and occurs in the same two ecological units, the Great Valley Section of the California Dry Steppe Province and the Sierra Nevada Foothills Section of the Sierran Forest-Alpine Meadows Province (Goudey and Smith 1994). However, the Southern Sierra Foothills Vernal Pool Region differs in the presence of the endemic species *Orcuttia inaequalis* (Keeler-Wolf *et al*. 1998). The Southern Sierra Foothills Vernal Pool Region includes three types of vernal pools: Northern Hardpan, Northern Claypan, and Northern Basalt Flow. Due to the mima mound topography prevalent in this region, the vernal pools tend to be small; vernal pool species also occupy swales. Soil series underlying Northern Hardpan Vernal Pools in the region include Amador, Corning, Hornitos, Keyes, Pentz, Peters, Redding, San Joaquin, and Yokohl. Cometa, Lewis, Madera, and

Meikle are among the soil series associated with Northern Claypan Vernal Pools in the region, and the Hideaway series is associated with Northern Basalt Flow Vernal Pools (Keeler-Wolf *et al.* 1998). Much of the vernal pool region is in private ownership, but some of the core areas are owned by the California Department of Fish and Game, California Department of Parks and Recreation, the U.S. Bureau of Land Management, the U.S. Bureau of Reclamation, or various land trusts. The Nature Conservancy also has easements on some of the most important habitats.

15. Western Riverside County Vernal Pool Region

The geographic location of the Western Riverside Vernal Pool Region and associated core areas is depicted in **Figures III-16 and III-16a**. The *Recovery Plan for Vernal Pools of Southern California* was published prior to release of the vernal pool regions by Keeler-Wolf *et al.* (1998), thus the boundaries of the vernal pool regions and management areas identified in the recovery plan do not correlate in entirety. This vernal pool region as identified herein corresponds to the vernal pool regions of Keeler-Wolf *et al.* (1998). Western spadefoot toad and *Myosurus minimus* var. *apus* are taxa of concern featured in this recovery plan that also occur in the Western Riverside County Vernal Pool Region. This vernal pool region is mostly in Riverside County but includes a small portion of adjacent San Diego County. Topography is diverse within the vernal pool region, including low-lying basins, the high Santa Rosa Plateau, and at least one pool in the San Jacinto Mountains. All are included in the Southern California Mountains and Valleys Section of the California Coastal Range Shrub-Forest-Meadow Province (Goudey and Smith 1994). Southern Basalt Flow Vernal Pools occur on the Santa Rosa Plateau and range from small pools to a vernal lake; other pools in the region are unclassified "Southern Vernal Pools." Soils in the Western Riverside County Vernal Pool Region are alkaline and are typically of the Domino, Travers, and Willows series (Keeler-Wolf *et al*. 1998). Landowners in the region include the California Department of Fish and Game, the County of Riverside, The Nature Conservancy, and private individuals.

16. San Diego Vernal Pool Region

The geographic location of the San Diego Vernal Pool Region and associated core areas is depicted in **Figures III-17 and III-17a**. There are no federally listed taxa in the San Diego Vernal Pool Region that are addressed with respect to this recovery plan. The federally listed taxa that occur in the San Diego Vernal Pool Region were addressed in the earlier *Recovery Plan for Vernal Pools of Southern California* (U.S. Fish and Wildlife Service 1998b). The *Recovery Plan for Vernal Pools of Southern California* was published prior to release of the vernal pool

regions by Keeler-Wolf *et al.* (1998), thus the boundaries of the vernal pool regions and management areas identified in the recovery plan do not correlate entirely. This vernal pool region as identified herein corresponds to the vernal pool regions of Keeler-Wolf *et al.* (1998). This vernal pool region is necessary for the long-term conservation of western spadefoot and *Myosurus minimus* var. *apus*, which are featured taxa of concern. It includes one polygon that extends from Los Angeles County into Orange County, plus one large and two small polygons in San Diego County. This region includes the Southern California Coast Section of the California Coastal Chaparral Forest and Shrub Province and the Southern California Mountains and Valleys Section of the California Coastal Range Shrub-Forest-Meadow Province (Goudey and Smith 1994). Most of the vernal pools in this region are of San Diego Mesa Hardpan type, but San Diego Mesa Claypan Vernal Pools and unclassified vernal pools also are present. These pools are small and occur in complexes among mima mounds. Olivenhain soils underlie both pool types. Other soil series associated with San Diego Mesa Hardpan Vernal Pools include the Redding and Huerhuero series, whereas the Las Flores-Placentia series may be associated with San Diego Mesa Claypan Vernal Pools (Keeler-Wolf *et al*. 1998). These sites are owned by the U.S. Department of Defense and private individuals, respectively.

E. RECOVERY CRITERIA

Delisting and downlisting criteria in this recovery plan are necessarily preliminary and will need periodic reassessment because certain data upon which to base decisions about recovery of vernal pool species are lacking. Many research actions, monitoring programs, and status surveys are included as recovery actions in order to obtain this information. The completion of research, monitoring, and status surveys has been incorporated into recovery criteria because we recognize that many decisions on recovery implementation must be made in the future as new information is obtained. The recovery actions set up processes for evaluating and making decisions on the types, numbers, and priorities of recovery actions to be implemented. We expect that information resulting from these actions will be used to refine recovery implementation, and ultimately may be used to revise and refine the recovery criteria.

Many decisions on recovery implementation must be made in the future; the recovery actions set up processes for evaluating and making decisions on the types, numbers, and priorities of recovery actions to be implemented.

For the purposes of this recovery plan, local average rainfall is to be determined from the precipitation period of record for the local area. “Average” annual local rainfall is defined as historic mean precipitation plus or minus 35 percent. A

multi-year drought is defined as a period of 5 or more years of below average local rainfall that prevents reproduction and successful recruitment of vernal pool plants and animals. The monitoring period for measuring ecosystem function and population viability or stability consists of at least one multi-year period that includes above average, average, and below average rainfall (as defined above), a multi-year drought, and a minimum of 5 years of post-drought monitoring (*i.e.* if successful reproduction and recruitment are not demonstrated in 5 years, the monitoring will be longer). The post-drought monitoring period is set to be as long as the longest recent multi-year drought in California, which lasted 5 years. In addition, because most plant species addressed are annual plants that have high year-to-year variability in population numbers, a minimum of 5 years post-drought monitoring likely will be necessary to determine population viability. Monitoring must be established based on precipitation conditions within each vernal pool region (local rainfall) and cannot be averaged across vernal pool regions.

Recovery actions required to achieve recovery criteria are described below in section IV. Appendix I delineates connections between recovery action and the threats and recovery criteria.

1. Strategies for Accommodating and Addressing Uncertainties in Preliminary Recovery Criteria

The following describes some of the major gaps in knowledge and understanding of vernal pool species and ecosystems and species that hinder development of definitive recovery criteria, how the preliminary recovery criteria in this recovery plan have been designed to address these uncertainties, and strategies for refining recovery criteria as recovery actions are implemented.

a. Habitat Protection

Amounts and locations of habitat: The amounts and locations of habitat to protect cannot be exactly defined because we lack information on appropriate reserve size, buffers sizes necessary to minimize threats of adjacent incompatible land uses, current and historic distributions of species, basic biological needs and life histories of species, upland habitat requirements for estivation of vernal pool amphibians, upland habitat requirements of pollinators of vernal pool plants, amount of upland habitat (*i.e.*, watersheds) contributing to, and necessary for the maintenance of, vernal pool hydrological function, and landscape distribution of vernal pools and vernal pool complexes needed to provide for dispersal and genetic exchange.

The recovery criteria, strategies, and actions address these data gaps by recommending the protection of the largest degree of diversity of vernal pool habitats possible (protection of the diversity of vernal pool types, soil types, geographic distribution, and species diversity) and protection of habitat in blocks as large as possible, including the associated uplands, buffers, and contributing local watersheds. Appropriate size for effective management units should also be considered. Designation of vernal pool regions and focus on core areas within those vernal pool regions is part of the strategy used to ensure protection of diverse vernal pools and vernal pool species across the planning area.

Vernal pool regions have been designated based primarily on the currently known distribution of vernal pools as classified by Keeler-Wolf *et al.* (1998), which encompasses the range and variation of vernal pool habitats. Core areas within vernal pool regions, which are the focus for habitat protection efforts, have been defined and prioritized based on the known distribution of vernal pool species and vernal pool habitats, and include representative sites across given species' range, or support high species diversity. Protection of the majority of suitable habitat within Zone 1 core areas, and Zone 2 and 3 core areas where appropriate, is recommended to provide corridors and dispersal habitat, support metapopulation dynamics, provide for reintroduction or introduction sites, and to protect currently undiscovered populations until the actual habitat needs of vernal pool species can be better defined. Actions intended to address the gaps in information on amount and location of habitat to be protected include research on reserve design and ecological function of vernal pools, basic biology of the covered species to better determine habitat requirements, habitat mapping and analysis to better define distribution of vernal pool habitats, and status surveys to determine if populations are stable, declining or increasing, and/or determine the presence of additional populations or habitat areas that are needed to contribute to recovery.

We anticipate that a number of the species covered by this recovery plan can be recovered primarily through the protection of Zone 1 core areas. In particular, the most narrowly endemic species (e.g., *Limnanthes floccosa* ssp. *californica*) occur only in Zone 1 and do not merit further protection of Zone 2 habitat. On the other hand, the most widely distributed species such as vernal pool fairy shrimp and *Orcuttia tenuis* occur broadly through Zones 1 and 2. For these species protection of Zone 2 core areas will significantly contribute to recovery, and if sufficient might offset the need to protect some lands within the Zone 1 core areas. In general we consider recovery recommendations in Zones 2 and 3 to be more flexible than in Zone 1, and recovery criteria specific to Zone 2 and 3 core areas may be modified on a case by case basis based on future information. However, certain Zone 2 core areas are important for recovery of some species (*e.g.*, *Lasthenia conjugens*, longhorn fairy shrimp) that are rare and localized but have

significant populations within Zone 2. Further implementation of recovery actions in vernal pool habitat outside core areas and outside vernal pool regions could be recommended for a species if recovery actions have been implemented in Zones 1, 2, and 3 and recovery has not yet been achieved.

Numbers of populations and population sizes: The number of populations and population sizes that must be protected and/or reestablished in order to maintain genetic variability sufficient to allow for adaptation to changing environmental conditions and protect against the threat of stochastic events cannot be adequately defined. We currently lack various information on population genetic structure (within and among populations); current population sizes, status, and distribution; and historic population sizes and distribution of many of the species.

The recovery strategy, actions, and criteria recommend protection of populations over the entire geographic and ecological distribution of each species in order to ensure representation of genetic variation. Designation of vernal pool regions and identification of prioritized core areas for each species is intended to assist in protecting species across their full geographic and ecological distributions and thus ensure preservation of the range of genetic variation. Reintroductions and/or introductions also are recommended for vernal pool regions and soil types from which a species has been extirpated. The recovery criteria generally recommend 100 percent protection of all populations for species with currently fewer than 25 occurrences and that occur in 3 or fewer vernal pool regions, unless new populations are discovered or established (*i.e.* replacements for current occurrences). The recovery criteria generally recommend less than 100 percent protection of all species with more than 25 known occurrences as long as the species is protected throughout its geographic and ecological range. Actions intended to address the gaps in information on adequate numbers and distribution of populations to protect include research on population genetic structure (genetic variation within and among populations), habitat mapping and status surveys to identify additional populations, and research on species biology (*i.e.* dispersal mechanisms and pollination biology that would contribute to genetic exchange among populations).

b. Adaptive Habitat Management, Restoration, and Monitoring

Specific management methods, restoration techniques, expected outcomes that indicate ecosystem function and species response to management, and monitoring techniques needed to ensure threats are ameliorated or eliminated within otherwise appropriate habitat cannot be adequately defined. Most methods, expected outcomes, and monitoring techniques are not yet fully researched or tested. In addition, specific management regimes likely will need to be tailored to

site-specific conditions because threats and specific environmental conditions vary among geographic areas and species.

The recovery strategy, actions, and criteria recommend conducting standardized habitat site-assessments to identify site-specific threats, continuing current management regimes while conducting monitoring or conducting interim management and monitoring, reviewing and revising existing management plans to ensure their adequacy, and ultimately developing and implementing comprehensive long-term management plans for vernal pool habitats and species. The current strategy is to base management on existing information including knowledge of historic management regimes and observed outcomes of ongoing management, but also to incorporate new information resulting from research and monitoring. Although exact parameters cannot be defined at this time, the recovery criteria recommend that monitoring indicate ecosystem function, as shown by individual species response, has been maintained over at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring to ensure reproduction and recruitment is achieved following the drought. Actions intended to address the gaps in information on appropriate management of habitat include conducting monitoring and incorporating results into habitat management plans (*i.e.*, adaptive management), and research on habitat management, restoration, monitoring techniques, and basic species biology and ecology.

c. Status Surveys

Measures of population viability: We have addressed the need for appropriate parameters regarding basic life history and population biology and the values for those parameters through the use of monitoring and adaptive management. These parameters include current population sizes, status, and distribution, historic land use and management of the site, historic population sizes and distributions of species, demographic characteristics (such as survivorship, reproductive rates, recruitment, and dispersal capabilities), and metapopulation dynamics (extinction and colonization rates of populations). In addition, developing models of population viability for many species addressed in this plan may be hindered by the complicated life histories that involve long-lived seed and cyst stages. The demographic characteristics of these life stages may be very difficult to adequately measure and characterize. Additionally, the extreme year-to-year environmental variability and the ephemeral nature of habitats and populations may add to the difficulty of measuring population sizes, demographic characteristics, and metapopulation dynamics necessary to model population viability.

The recovery strategy, actions, and criteria recommend that populations must be stable or increasing over at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring. Monitoring populations over this multi-year period should capture the range of variability in environmental conditions and variability in population numbers and demographic characteristics. Actions intended to address gaps in information necessary to develop parameters and values to determine population viability include development of standardized species monitoring protocols, conducting periodic status surveys and reviews to develop information on changes in species status over time, and research actions to measure demographic characteristics and/or metapopulation dynamics.

d. Research

The lack of information on optimum vernal pool preserve size, optimum buffer width, and genetic variability of vernal pool species is a limiting factor in developing specific recovery criteria and prescriptive recovery actions in this recovery plan. Research on ways to ameliorate or eliminate threats will be necessary to refine recovery criteria and actions. However, the wide variety and number of information gaps creates an enormous list of potential research topics on vernal pool species ecosystem recovery. Research needs must be refined in order to ensure that research carried out will contribute directly to recovery of the covered species. In addition, many of this recovery plan's covered species and vernal pool ecosystems themselves are difficult to study because of complicated life histories, extremes in year-to-year variation in habitat conditions and population characteristics, and the ephemeral nature of vernal pool habitats. These difficulties may make certain research actions impractical or very costly and will require that research results be evaluated and immediately incorporated into every aspect of the recovery strategy prior to proceeding to the next recovery step. The recovery strategy and actions for research recommend that the existing information be evaluated and research needs be determined and prioritized in order to ensure that research actions most needed to refine recovery criteria, management, and recovery actions are carried out.

e. Participation and Outreach

The recovery plan recommends that a recovery implementation team be established to oversee implementation of recovery actions. The recovery implementation team will in turn establish vernal pool region working groups. The working groups and implementation teams will bring agency, technical, outreach, and stakeholder expertise together with site-specific information to implement recovery. These groups are expected to compile and review existing

and new information, update mapping of suitable species, habitat, occurrences, and core area boundaries, and use their expertise in making informed decisions regarding recovery actions as the recovery plan is implemented.

2. General Recovery Criteria

The following general criteria apply to all species addressed in this recovery plan. Table III-1 includes species-specific guidance regarding the percentage of suitable habitat that should be protected, the percentage of occurrences that should be protected, where reintroductions should occur, and numbers of populations from which seeds should be banked. The following description of recovery criteria provides additional detail regarding Table III-1 and its relation to each of the general recovery criteria.

1. Habitat Protection: Accomplish habitat protection that promotes vernal pool ecosystem function sufficient to contribute to population viability of the covered species.

Habitat protection includes protecting (from loss, fragmentation, and incompatible uses) diverse vernal pool habitats in large habitat blocks that include local watersheds, unoccupied pools within vernal pool complexes, and appropriate upland buffers around and between vernal pool complexes can be effectively managed to maintain hydrologic function and prevent domination by invasive species. Because some species currently are made up of only a small number of populations, reintroduction, introduction, or discovery of additional populations also will be necessary to guard against extinction events.

A. Suitable vernal pool habitat within each prioritized core area for the species is protected.

Percentages of habitat required for each prioritized core area are listed by species in **Table III-1**. This habitat includes both occupied and suitable habitat. Suitable habitat that is not currently known to be occupied must be protected to provide for corridors and dispersal habitat, metapopulation dynamics, provide for reintroduction/introduction sites, and to protect currently undiscovered populations.

As stated in Section III.C.1.a, a number of the species covered by this recovery plan may be recovered primarily through the protection of Zone 1 core areas. In particular, the most narrowly endemic species (e.g., *Limnanthes floccosa* ssp. *californica*) occur only in Zone 1 and do not

Table III-1. Species specific recovery criteria for species occurrence and habitat protection, reintroduction, and seed banking.

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
Listed Plant Species				
fleshy owl's clover *Castilleja campestris* ssp. *succulenta* (T) Delist	90%	<u>SE Sac</u> Southeast Sacramento Valley (2) 85% <u>So. Sierra Foothills</u> Fresno (2) 85% Madera (1) 95% Merced (1) 95% Table Mountain (1) 95%	Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	Each vernal pool region
Hoover's spurge *Chamaesyce hooveri* (T) Delist	80%	<u>NE Sac</u> Oroville (1) 95% Vina Plains (1) 95% <u>San Joaquin Valley</u> Grasslands Ecological Area (1) 95% <u>Solano-Colusa</u> Sacramento NWR (1) 95% <u>So. Sierra Foothills</u> Merced (1) 95% Cottonwood Creek (2) 85% Tulare (2) 85% Turlock (2) 85%	Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	each vernal pool region
Loch Lomond button-celery *Eryngium constancei* (E) Downlist	100%	<u>Lake-Napa</u> Boggs Lake-Clear Lake (1) 95% Diamond Mountain (1) 95% Dry Lake (1) 95%		each population

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
Delist	100% of newly discovered/ reintroduced populations	<u>Lake-Napa</u> Protect new populations discovered through surveys.	Additional populations in Lake and Sonoma Counties must be discovered or established in order to delist.	
Contra Costa goldfields *Lasthenia conjugens* (E) Downlist	90%	<u>Central Coast</u> Fort Ord (2) 85% SE San Francisco Bay (2) 85% <u>Lake-Napa</u> Berryessa (2) 95% Napa River (2) 85% <u>Solano-Colusa</u> Jepson Prairie (1) 95% Suisun Marsh (2) 85% Rodeo Creek (2) 85%		each vernal pool region
Delist	100% of reintroduced occurrences	<u>Lake-Napa</u> Berryessa (2) 95% <u>Livermore</u> Altamont Hills (1) 95% <u>Mendocino</u> Manchester (3) tbd [4] <u>Santa Barbara</u> tbd [4] Location within vernal pool region to be determined.	Milliken Canyon / introduction none / introduction none / introduction none / introduction 3 other introductions on appropriate soil types to replace extirpated occurrences plus other reintroductions to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
Butte County meadowfoam *Limnanthes floccosa* ssp. *californica* (E) Downlist	100%	NE Sacramento Valley Chico (1) 95% Doe Mill (1) 95% Oroville (1) 95% Vina Plains (1) 95%		each population
Delist	100% of reintroduced occurrences	NE Sacramento Valley Protect new populations discovered through surveys.	Reintroduce appropriate races to soil types to replace extirpations.	
few-flowered navarretia *Navarretia leucocephala* ssp. *pauciflora* (E) Downlist	100%	Lake-Napa Berryessa (2) 95% Boggs Lake-Clear Lake (1) 95% Dry Lake (1) 95%		each population
Delist	100% of newly discovered/ reintroduced populations	Lake-Napa Jordan Park (3) tbd [4] Any other populations discovered	Determine presence at historic locality or reintroduce.	
many-flowered navarretia[5] *Navarretia leucocephala* ssp. *plieantha* (E) Downlist	100%	Lake-Napa Boggs Lake-Clear Lake (1) 95%		each population
Delist	100% of reintroduced occurrences	See footnote	Determine presence at historic locality or reintroduce. Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
Colusa grass *Neostapfia colusana* (T) Delist	90%	<u>San Joaquin Valley</u> Grasslands Ecological Area (1) 95% <u>Solano-Colusa</u> Davis Communications Annex (1) 95% Jepson Prairie (1) 95% <u>So. Sierra Foothills</u> Farmington (2) 85% Madera (1) 95% Merced (1) 95% Turlock (2) 85% Waterford (2) 85%	Arena Plains Unit of Merced NWR none / introduction in Colusa County none / introduction Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	each vernal pool region
San Joaquin Valley Orcutt grass *Orcuttia inaequalis* (T) Delist	90%	<u>So. Sierra Foothills</u> Fresno (2) 85% Madera (1) 95% Table Mountain (1) 95% Tulare (2) 85% Any rediscovered or newly discovered occurrences	none / introduction Reintroduce to soil types and parts of the vernal pool region from which status surveys indicate the species has been extirpated.	at least one population from each core area

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
hairy Orcutt grass *Orcuttia pilosa* (E) Downlist	90%	<u>NE Sac</u> Oroville (1) 95% Vina Plains (1) 95% <u>Solano-Colusa</u> Sacramento NWR (1) 95% <u>So. Sierra Foothills</u> Madera (1) 95% Merced (1) 95% Turlock (2) 85%		at least one population from each core area
Delist	100% of reintroduced occurrences		Determine presence at historic localities or reintroduce within each vernal pool region. Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
slender Orcutt grass *Orcuttia tenuis* (T) Delist	80%	<u>Lake-Napa</u> Boggs Lake-Clear Lake (1) 95% <u>Modoc Plateau</u> Northern Modoc Plateau (2) 85% Western Modoc Plateau (2) 85% Southwestern Modoc Plateau (2) 85% Southern Modoc Plateau (2) 85% <u>NE Sac</u> Dales (2) 85% Palermo (2) 85% Vina Plains (1) 95% <u>NW Sac</u> Redding (2) 85% Millville Plains (2) 85% <u>SE Sac</u> Mather (1) 95%	Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	each vernal pool region The following core areas contain small populations or few occurrences and should be first sources for seedbanking: Boggs Lake-Clear Lake, Millville Plains, Palermo, Mather, and Redding.
Sacramento Orcutt grass *Orcuttia viscida* (E) Downlist	100%	<u>SE Sac</u> Cosumnes/Rancho Seco (1) 95% Mather (1) 95% Phoenix Field and Park (1) 95%		each population
Delist	100% of newly discovered/ reintroduced populations	<u>SE Sac</u> Any newly discovered populations.	Reintroduce to appropriate soils in the Orangevale-Folsom area and Rancho Seco area to replace extirpated occurrences. Additional populations must be discovered or established in order to delist.	
Lake County stonecrop *Parvisedum leiocarpum* (E) Downlist	100%	<u>Lake-Napa</u> Boggs Lake-Clear Lake (1) 95%		each population

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
Delist	100% of newly discovered/ reintroduced populations	<u>Lake-Napa</u> Any newly discovered populations.	Reintroduce to soil types from which status surveys indicate the species has been extirpated. Additional populations must be discovered or established in order to delist.	
Greene's tuctoria *Tuctoria greenei* (E) Downlist	80%	<u>Modoc Plateau</u> Western Modoc Plateau (2) 85% <u>NE Sac</u> Oroville (1) 95% Richvale (2) 85% Vina Plains (1) 95% <u>Solano-Colusa</u> Sacramento NWR (1) 95% <u>So. Sierra Foothills</u> Fresno (2) 85% Madera (1) 95% Merced (1) 95% Waterford (2) 85%		each vernal pool region
Delist	100% of all reintroduced populations	<u>So. Sierra Foothills</u> Madera (1) 95%	5 introductions (should include Farmington and Madera core areas) Reintroduce to vernal pool regions, counties, and soil types from which status surveys indicate the species has been extirpated. Includes Fresno, San Joaquin, Stanislaus, and Tulare Counties.	
Solano grass *Tuctoria mucronata* (E) Downlist	100%	<u>Solano-Colusa</u> Davis Communications Annex (1) 95% Jepson Prairie (1) 95%		each population

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
Delist	100% of newly discovered/ reintroduced populations	<u>Solano-Colusa</u> Jepson Prairie (1) 95%	Olcott Lake Additional populations must be discovered or established in order to delist.	
Listed Animal Species				
Conservancy fairy shrimp *Branchinecta conservatio* (E) Downlist	100%	<u>NE Sac</u> Vina Plains (1) 95% <u>San Joaquin</u> Caswell (1) 95% Grasslands Ecological Area (1) 95% <u>Santa Barbara</u> Ventura County (2) 95% <u>Solano-Colusa</u> Jepson Prairie (1) 95% Sacramento NWR (1) 95% Collinsville(1) 95% <u>So. Sierra Foothills</u> Madera (1) 95%		
Delist	100% of newly discovered/ reintroduced populations	Any newly discovered populations.	Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
longhorn fairy shrimp *Branchinecta longiantenna* (E) Downlist	100%	<u>Carrizo</u> North Carrizo Plain (2) 95% South Carrizo Plain (2) 95% <u>Livermore</u> Altamont Hills (1) 95% <u>San Joaquin</u> Grasslands Ecological Area (1) 95%		
Delist	100% of newly discovered/ reintroduced populations		Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated. Additional populations must be discovered or established in order to delist.	

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
vernal pool fairy shrimp *Branchinecta lynchi* (T) Delist	80%	<u>Carrizo</u> North Carrizo Plain (2) 85% South Carrizo Plain (2) 85% Paso Robles (2) 85% Central Coast Ranges (2) 85% <u>Central Coast</u> San Benito (2) 85% Fort Hunter-Liggett (2) 85% <u>Klamath Mtn.</u> Agate Desert (2) 85% Table Rocks (2) 85% White City (2) 85% <u>Lake-Napa</u> Napa River (2) 85% <u>Livermore</u> Altamont Hills (1) 85% <u>NE Sac</u> Chico (1) 85% Oroville (1) 85% Vina Plains (1) 85% Doe Mill (1) 85% <u>NW Sac</u> Red Bluff (2) 85% Redding (2) 85% Orland (2) 85% <u>San Joaquin</u> Caswell (1) 85% Grasslands Ecological Area (1) 85%	Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
vernal pool fairy shrimp *Branchinecta lynchi* (T) Delist (Continued)	80%	<u>Santa Barbara</u> Ventura (2) 85% Lake Cachuma (2) 85% <u>Solano-Colusa</u> Jepson Prairie (1) 85% Sacramento NWR (1) 85% Vacaville (2) 85% <u>SE Sac</u> Beale (2) 85% Cosumnes/Rancho Seco (1) 85% Mather (1) 85% Western Placer County (2) 85% <u>So. Sierra Foothills</u> Fresno (2) 85% San Joaquin (2) 85% Madera (1) 85% Merced (1) 85% Table Mountain (1) 85% Cottonwood Creek (2) 85% <u>W. Riverside</u> Skunk Hollow (2) 85% Santa Rosa Plateau (2) 85% San Jacinto-Hemet (2) 85%		
delta green ground beetle *Elaphrus viridis* (T) Delist	100%	<u>Solano-Colusa</u> Jepson Prairie (1) 95%	Additional populations must be discovered or established through reintroduction to or colonization of restored habitat in order to delist.	

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
vernal pool tadpole shrimp *Lepidurus packardi* (E) Downlist	80%	<u>Central Coast</u> SE San Francisco Bay (2) 85% <u>NE Sac</u> Chico (1) 95% Dales (2) 85% Doe Mill (2) 85% Oroville (1) 95% Vina Plains (1) 95% <u>NW Sac</u> Red Bluff (2) 85% Redding (2) 85% <u>San Joaquin</u> Grasslands Ecological Area (1) 95% Cross Creek (2) 85% <u>Solano-Colusa</u> Davis Communications Annex (1) 95% Jepson Prairie (1) 95% Collinsville (1) 95% Sacramento NWR (1) 95% Dolan (2) 85% <u>SE Sac</u> Beale (2) 85% Cosumnes/Rancho Seco (1) 95% Mather (1) 95% Western Placer County (2) 85% <u>So. Sierra Foothills</u> Madera (1) 95% Merced (1) 95% Table Mountain (1) 95% Cottonwood Creek (2) 85% Turlock (2) 85%		

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
vernal pool tadpole shrimp *Lepidurus packardi* (E) Delist	100% of reintroduced populations		Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	
Plant Species of Concern				
Ferris' milk vetch *Astragalus tener* var. *ferrisiae* (none) Conserve	100%	<u>NE Sac</u> Llano Seco (1) 95% Upper Butte Basin (1) 95% <u>Solano-Colusa</u> Dolan (2) 85% Sacramento NWR (1) 95%	none / 2 introductions	each population
alkali milk vetch[5] *Astragalus tener* var. *tener* (none) Conserve	80%	<u>Central Coast</u> SE San Francisco Bay (2) 85% <u>Livermore</u> Altamont Hills (1) 95% <u>San Joaquin</u> Grasslands Ecological Area (1) 95% <u>Solano-Colusa</u> Collinsville (1) 95% Davis Communications Annex (1) 95% Jepson Prairie (1) 95% Suisun Marsh (2) 85% Woodland (2) 85%	none / introduction none / introduction none / introduction none / introduction 1 other introduction on appropriate soil type to replace extirpated occurrence	at least one population from each core area

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
vernal pool smallscale *Atriplex persistens* (none) Conserve	90%	<u>San Joaquin</u> Grasslands Ecological Area (1) 95% <u>Solano-Colusa</u> Jepson Prairie (1) 95% Sacramento NWR (1) 95%	Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	at least one population from each core area
spiny-sepaled button-celery *Eryngium spinosepalum* (none) Conserve	90%	<u>So. Sierra Foothills</u> Fresno (2) 85% Kaweah (2) 85% Kings (2) 85% Madera (1) 95% Shotgun Creek (2) 85% Tulare (2) 85% Table Mountain (1) 95% Yokohl (2) 85% Lake Success (2) 85% Cottonwood Creek (2) 85%	Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	at least one population from each core area

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
Boggs Lake hedge-hyssop *Gratiola heterosepala* (State endangered) Conserve	80%	<u>Lake-Napa</u> Boggs Lake- Clear Lake (1) 95% <u>Modoc Plateau</u> Northern Modoc Plateau (2) 85% Western Modoc Plateau (2) 85% Southwestern Modoc Plateau (2) 85% <u>NE Sac</u> Dales (2) 85% Vina Plains (1) 95% <u>NW Sac</u> Black Butte (2) 85% Red Bluff (2) 85% <u>Solano-Colusa</u> Jepson Prairie (1) 95% <u>SE Sac</u> Mather (1) 95% Western Placer County (2) 85% <u>So. Sierra Foothills</u> Madera (1) 95% Table Mountain (1) 95%	Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	at least one population from each core area
Ahart's dwarf rush *Juncus leiospermus* var. *ahartii* (none) Conserve	100%	<u>NE Sac</u> Honcut (2) 85% <u>SE Sac</u> Jenny Lind (2) 85% Mather (1) 95% Western Placer County (2) 85%	Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	each population

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
legenere[5] *Legenere limosa* (none) Conserve	80%	<u>Central Coast</u> Coal Mine Ridge (3) tbd [4] <u>Lake-Napa</u> Boggs Lake - Clear Lake (1) 95% Napa River (2) 85% <u>NE Sac</u> Dales (2) 85% <u>NW Sac</u> Black Butte (2) 85% Red Bluff (2) 85% Redding (2) 85% <u>Solano-Colusa</u> Jepson Prairie (1) 95% <u>SE Sac</u> Beale (2) 85% Cosumnes-Rancho Seco (1) 95% Mather (1) 95% Stone Lakes (2) 85% Western Placer County (2) 85%	Reintroduce to vernal pool regions and soil types from which status surveys indicate the species has been extirpated.	at least one population from each core area
little mousetail *Myosurus minimus* var. *apus* (none) Conserve	90%	<u>San Diego</u> Ramona (2) 85% Otay Mesa (2) 85% Tierrasanta South (2) 85% <u>W. Riverside</u> Harford Springs (2) 85% San Jacinto-Hemet (2) 85% Santa Rosa Plateau (2) 85%		at least one population from each core area

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
small pincushion navarretia *Navarretia myersii* ssp. *deminuta* (none) Conserve	100%	<u>Lake-Napa</u> Long Valley (1) 95% (note: only known locality for this taxon)	none / introduction in Lake County	only known population
bearded popcorn flower *Plagiobothrys hystriculus* (none) Conserve	100%	<u>Solano-Colusa</u> Montezuma Hills (1) 95% (note: only known locality for this species; must be rediscovered)		only known population
Animal Species of Concern				
mid-valley fairy shrimp *Branchinecta mesovallensis* (none) Conserve	80%	<u>Livermore</u> Altamont Hills (1) 95% <u>San Joaquin</u> Grasslands Ecological Area (1) 95% <u>Solano-Colusa</u> Jepson Prairie (1) 95% <u>SE Sac</u> Cosumnes-Ranch Seco (1) 95% Mather (1) 95% <u>So. Sierra Foothills</u> Fresno (2) 85% Madera (1) 95%		

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
California fairy shrimp[5] *Linderiella occidentalis* (none) Conserve	80%	<u>Central Coast</u> Fort Ord (2) 85% <u>NE Sac</u> Chico (1) 95% Dales (2) 85% Vina Plains (1) 95% <u>NW Sac</u> Red Bluff (2) 85% Redding (2) 85% <u>San Joaquin</u> Caswell (1) 95% Grasslands Ecological Area (1) 95% <u>Solano-Colusa</u> Jepson Prairie (1) 95% <u>SE Sac</u> Beale (2) tbd [4] Cosumnes-Rancho Seco (1) 95% Mather (1) 95% Phoenix Field/Phoenix Park (1) 95% Western Placer County (2) 85% <u>So. Sierra Foothills</u> Fresno (2) 85% Madera (1) 95% Merced (1) 95% Table Mountain (1) 95%		

Common name(s) Scientific name (status) Recovery step	Percent occurrences to protect [1]	Percent suitable species habitat to be protected rangewide, within core areas, listed by Vernal Pool Region (Zone ranking of core area for species in parentheses)[2] Greater protection is recommended for species with more narrow distributions.	Reintroductions / Introductions recommended within vernal pool regions or core area.	Collection sources for seed / cyst banking [3]
western spadefoot toad [6] *Spea hammondii* (none) Conserve	80% (where it co-occurs with other vernal pool species)	11 of 15 vernal pool regions 85% (in each region where it co- occurs with other vernal pool species) Carrizo Central Coast NE Sac NW Sac San Diego San Joaquin Santa Barbara SE Sac Solano-Colusa Southern Sierra Foothills Western Riverside County		

[1] Percent occurrences to protect, unless additional occurrences are found (see text for description of how values were derived).

[2] Protection of suitable habitat for vernal pool fairy shrimp, the widest-ranging listed species in this plan, is 85 percent, regardless of whether the core areas in which it is found are in Zone 1 or 2

[3] Store seeds (plants) in at least two Center for Plant Conservation certified facilities.

[4] tbd = To be determined. Historic localities (most recent report at least 40 years old) where populations must be rediscovered or reintroduced are classified as Zone 3, or else may be Zone 1 or 2 if other species currently occur at the site. Ability to reintroduce may depend on amount and condition of suitable habitat and on success criteria that must be met to demonstrate for successful reintroductions. Protection of suitable habitat will be based on status surveys and assessment of habitat needs for successful reintroduction.

[5] See the Draft Santa Rosa Plains Recovery Plan (in development) for additional criteria for populations of this species in the Santa Rosa area.

[6] Western spadefoot toads occurs in a broader range of habitat types than the other species addressed in this recovery plan. Percent protection recommended for this species applies to those areas where it co-occurs with other vernal pool species within vernal pool habitats.

III-112

merit further protection of Zone 2 habitat. On the other hand, the most widely distributed species such as vernal pool fairy shrimp and *Orcuttia tenuis* occur broadly through Zones 1 and 2. For these species protection of Zone 2 core areas will significantly contribute to recovery, and if sufficient might offset the need to protect some lands within the Zone 1 core areas. In general we consider recovery recommendations in Zones 2 and 3 to be more flexible than in Zone 1, and recovery criteria specific to Zone 2 and 3 core areas may be modified on a case by case basis based on future information. However, certain Zone 2 core areas are important for recovery of some species (e.g. *Lasthenia conjugens*, longhorn fairy shrimp) that are rare and localized but have significant populations within Zone 2.

In cases where species are known to co-occur, protection of suitable habitat within core areas should focus on the rarest species. For example, in the Chico core area within the Northeastern Sacramento Valley Region, Butte County meadowfoam is the rarest of the plan's covered species and is the reason the core area is designated as Zone 1. In this example, to the extent Butte County meadowfoam occurs with other species covered under this plan, protection of suitable habitat within the Chico core area should focus on Butte County meadowfoam.

Vernal Pool Region working groups will be important for the tracking the progress of recovery efforts, including the amount of suitable habitat protected for each of the species in the core areas

B. Species occurrences distributed across the species' geographic and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there.

Table III-1 lists the percentage of occurrences that must be protected for each species, as well as the vernal pool regions and core areas within which occurrences and occupied and suitable habitat for each species should be protected to ensure occurrences are distributed across the species range. Newly discovered or introduced populations may contribute to meeting this percentage of occurrences if the population is established within a protected area and monitoring has confirmed its viability.

Vernal Pool Region working groups will be important for the tracking the progress of recovery efforts, including the numbers of occurrences protected for each of the species in the core areas.

C. Reintroductions and introductions must be carried out and meet success criteria established in action 2.5.3.7. **Table III-1** indicates which species will require specific reintroductions or introductions (introductions replace extirpated occurrences that cannot be restored to the same site as the original occurrence) and within which vernal pool regions, core areas, or counties.

D. Additional occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to recovery are protected. Any newly found occurrences may count towards recovery goals if the occurrences are permanently protected as described in this plan.

E. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring.

2. Adaptive Habitat Management and Monitoring:

A. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected in 1. A-E. above. Plans must be developed and implemented within 5 years of protection of individual parcels/properties/areas to ensure that populations are stable or increasing and progress toward reaching recovery goals is being made while additional habitat protections are being developed. Plans must include provisions for managing nonnative and native competitors, appropriate grazing, fire or other management regimes, adaptive habitat management, incorporation of new information resulting from implementation of research actions, and addressing site-specific threats.

B. Mechanisms are in place to provide for management in perpetuity and long-term monitoring of 1.A-E. above (*e.g*. funding, personnel, *etc*.).

C. Monitoring indicates ecosystem function has been maintained in the areas protected under 1.A-D for at least one multi-year period that includes above average, average, and below average local rainfall as defined above,

a multi-year drought, and a minimum of 5 years of post-drought monitoring.

D. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria (see **Table III-1**).

3. Status surveys:

A. Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (*e.g.*, evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring. (Determining when this criterion is met may rely partly on completion of research actions to model population viability or development of standardized monitoring and survey protocols to determine appropriate parameters to measure during status surveys).

B. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated.

4. Research:

A. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions.

B. Research on genetic structure has been completed (for species where necessary - for reintroduction and introduction, seed banking) and results

incorporated into habitat protection plans to ensure that within and among population genetic variation is fully represented by populations protected in Habitat Protection 1.A.-E. above.

C. Research necessary to determine appropriate parameters to measure population viability for each species have been completed.

5. Participation and Outreach:

A. Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts.

B. Vernal Pool Region working groups are established and functioning to oversee regional recovery efforts.

C. Participation plans for each Vernal Pool Region have been completed and implemented.

D. Vernal Pool Region working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria 1-4.

3. Rationale for Species-specific Recovery Criteria

Table III-1 lists specific downlisting and delisting criteria by species. The values presented were derived using information on the known occurrences, distribution, and status of the species across their ranges. Protection of a specific percentage of known occurrences *and* protection of a given percentage of suitable habitat are essential for recovery. Percentages vary by species depending on how widespread the species are and whether occurrences are already protected. The rationale for the criteria in **Table III-1** are described below.

Percent of occurrences to protect

Table III-1 lists specific percentages of known occurrences to protect for each species. These percentages range from 80 percent to 100 percent. Generally, species with currently fewer than 25 known occurrences (particularly those with disjunct occurrences) and that occur in less than 3 vernal pool regions require that 100 percent of the occurrences be protected, unless additional occurrences are discovered or established (*i.e.*, replacements for known occurrences). Fewer than 100 percent of all currently identified occurrences may be protected for species with greater numbers of occurrences and wider distributions, as long as the

species is protected throughout its geographic and ecological range. Newly discovered occurrences, found after the publication of this plan, may count toward recovery goals of acreage of habitat and number of occurrences if the new occurrences are permanently protected as described in this plan.

Species with fewer than 25 occurrences distributed within 3 or fewer vernal pool regions - For all species with fewer than 25 known occurrences distributed within 3 or fewer vernal pool regions, the preliminary recovery criteria recommend protection of 100 percent of all known occurrences, unless additional populations are found or can be established. These species include 9 listed species and 4 species of concern. The majority of the species with fewer than 25 occurrences actually have fewer than 10 occurrences and most are distributed very narrowly in only 1 or 2 counties. The remaining species are distributed in more than 1 or 2 counties, but have disjunct ranges with less than 10 occurrences in each portion of the species range. For these species, 100 percent of all known occurrences must be protected to assist in minimizing the risk of extinction from random events, and to maintain as much genetic variation as possible to maintain the species ability to respond to changing environmental conditions.

The habitat requirements for these species are poorly understood, so the likelihood that additional populations exist in unsurveyed vernal pool habitat is unknown. Because these species are narrowly endemic, it also is possible that habitat conditions necessary to support the species are very specific. The likelihood of successfully reintroducing or introducing the species to additional areas, or locating new populations may be very low. Thus we are recommending that, in addition to 100 percent protection of all known occurrences, a given percentage of all suitable habitat also must be protected (see discussion below).

Species with greater than 25 occurrences - For species with greater than 25 currently known occurrences (including 10 listed species and 9 species of concern), the preliminary recovery criteria recommend protection of 80 to 90 percent of occurrences, unless additional populations are found or established, depending on the species. Most of these species occur in several counties, have relatively contiguous distributions, and are distributed in multiple vernal pool regions. The level of protection corresponds to the number of known occurrences and the distributions of the species. Greater protection is recommended for species with more narrow distributions. Generally, the recovery criteria recommend protection of 90 percent of all known occurrences for species with greater than 25 known occurrences but that occur in 3 or fewer vernal pool regions. The recovery criteria also recommend protection of 80 percent of all known occurrences for species that occur in more than 3 vernal pool regions and with greater than 25 known occurrences. Although specific habitat requirements

and successful reintroduction techniques are not known for these species, it is possible that these more widespread species have a wider range of habitat tolerances that may increase the potential for successful reintroductions/introductions and discovery of additional populations. As above, and discussed below, a given percentage of suitable habitat also must be protected.

Percent of suitable habitat within core areas to protect:

Table III-1 lists the percentages of suitable vernal pool habitat to be protected for each core area. To simplify planning across core areas for multiple species, for each core area a Zone ranking (Zones 1, 2, and 3) has been identified that indicates the overall priority of habitat protection in that core area. Most core areas contain populations of more than one vernal pool species, so Zone rankings are based on the number of species that occur in each core area and the relative rarity of the species within that core area. Core areas were identified as Zone 1 in cases where they were occupied by very narrowly endemic species (with few populations and narrow or disjunct distributions that are known to be, or are likely to be, genetically or ecologically distinct) or where the core area supported a high diversity of the species covered by this recovery plan. Protection of Zone 1 core areas is necessary to prevent the extinction or irreversible decline of one or more species. Zone 2 core areas do not meet criteria for inclusion in Zone 1, but are generally occupied by species that are more widespread with greater numbers of occurrences, and are distributed representatively across the species' range. Protection of Zone 2 core areas is generally necessary to prevent significant declines or negative impacts short of extinction for one or more species, but in certain cases where rare or localized species have significant populations in Zone 2 core areas (*i.e.*, *Navarretia leucocephala* ssp. *pauciflora*, *Lasthenia conjugens*, longhorn fairy shrimp, Conservancy fairy shrimp) it is also necessary to prevent the extinction or irreversible decline of those species. Zone 3 core areas are not currently known to be occupied by species covered in this plan, but include historic occurrences that are potential reintroduction sites.

The recovery criteria generally recommend protection of 95 percent of suitable habitat within Zone 1 core areas and 85 percent of suitable habitat within Zone 2 core areas. Specific recommendations may vary by species based on the importance of individual core areas to recovery of a particular species, or the presence of a Fish and Wildlife Service-approved alternative conservation mechanism such as a Habitat Conservation Plan, as discussed below. For example, recommended habitat protection for vernal pool fairy shrimp, the widest-ranging species in the recovery plan, is set at 85 percent in both Zone 1 and Zone 2 core areas. For some rare and localized species that have significant

populations within Zone 2 (*Lasthenia conjugens*, *Navarretia leucocephala* ssp. *pauciflora*, longhorn fairy shrimp, Conservancy fairy shrimp), recommended habitat protection in certain Zone 2 core areas is set at 95 percent. The amount and location of habitat to be protected in core areas that only include reintroductions for a species (Zone 3 core areas) must be determined through standardized assessment of available habitat, status surveys, and development of captive propagation and reintroduction plans.

Reintroductions and introductions: Reintroductions are recommended for many species with very few occurrences or for species that have experienced multiple extirpations. Reintroductions also are recommended if status surveys indicate a species has been extirpated from a particular vernal pool region or soil type. Generally, reintroductions or introductions are recommended if any loss in number of known occurrences is, or has been, experienced for those species with less than 25 occurrences distributed in 3 or fewer vernal pool regions. Reintroductions or introductions are recommended for species with greater than 25 occurrences if greater than 10 percent loss in number of known occurrences is, or has been, experienced for those species that occur in 3 or fewer vernal pool regions. If greater than 20 percent loss in number of known occurrences is, or has been, experienced for those species that occur in more than 3 vernal pool regions, reintroductions or introductions are recommended. At this time, the current status of many populations and occurrences are unknown, so it is not possible to accurately define the numbers and locations of all reintroductions necessary to achieve recovery. Reintroductions are intended to reduce the risk of extinction due to stochastic events and/or to ensure that the species is distributed across its geographic and ecological range such that a species adaptive potential and metapopulation dynamics can be maintained. These actions will require protection of the habitat on which reintroductions or introductions will occur and may require restoration of habitat as well.

Seed banking

Seed banking is recommended for all species addressed in this recovery plan as insurance against risk of random extirpations, and particularly for species that will require reintroductions or introductions to contribute to meeting recovery criteria. Seed banking will be conducted to conserve as much genetic diversity of the species as possible. Seed banking is one means to ensure that genetic variation can be restored if extirpations or extinctions from random events occur. However, such restoration can only occur if the seeds and cysts that are banked represent the full range of genetic variation within the species. Seed banking is recommended for each population for species that have few occurrences and are narrowly distributed. For more widely distributed species, not all populations

need to be represented; however, seeds and cysts should be collected and banked from the geographic extremes of the species to capture the genetic diversity of the species.

Habitat Conservation Plans

While this recovery plan identifies a specific strategy for obtaining recovery of the covered vernal pool plant and animal species, it is not the only mechanism through which recovery may be obtained. Alternative conservation mechanisms, such as currently proposed or future Habitat Conservation Plans (HCPs) that cover the species in this plan and vernal pool habitat, may be deemed equivalent to implementation of this Recovery Plan for the covered area if they contain the following elements:
1) permanently-protected vernal pool preserves within the area covered by the Habitat Conservation Plan in large contiguous blocks of suitable habitat;
2) protection of the entire genetic range of each listed species within the area covered by the Habitat Conservation Plan;
3) protection of all populations of species with 25 or fewer total occurrences addressed in this plan within the area covered by the Habitat Conservation Plan;
4) connectivity with other preserves within the area covered by the Habitat Conservation Plan;
5) adaptive management of the preserves within the area covered by the Habitat Conservation Plan to support the species addressed in this recovery plan; and
6) sufficient funding for management, maintenance, and monitoring of the preserves in perpetuity.