United States Fish and Wildlife Service

Biological Opinion on the Proposed

University of California Merced Campus

2002

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W2605
Sacramento, California 95825-1846

IN REPLY REFER TO
1-1-02-I-2926

August 19, 2002

Mike Jewell
Chief, Central Valley/Nevada Section
Regulatory Branch
U. S. Army Corps of Engineers
Sacramento District
Sacramento, California 95814-2922

Subject: Final Biological Opinion on the Proposed University of California Merced Campus, Phase 1 and Campus Buildout (Corps # 199900203) and Infrastructure Project (Corps # 200100570)

Dear Mr. Jewell:

Please find enclosed the Final Biological Opinion on the Proposed University of California Merced Campus, Phase 1 and Campus Buildout. The University proposes to fill 86 acres of waters of the United States in the Campus Buildout portion (approximately 806 acres) and the County of Merced proposes to fill 4.49 acres of waters of the United States with interrelated proposed activities (Infrastructure Project). The Corps has issued two public notices (PN 199900203 and PN 200100570) with these applications and has decided to process both applications jointly. The enclosed Final Biological Opinion addresses both applications as one proposed project.

If you have any questions about this Final Biological Opinion, please contact Susan Jones or Karen Harvey of my staff at (916) 414-6600.

Sincerely,

Cay C. Goude

Cay C. Goude
Assistant Field Supervisor

Enclosure

cc:
University of California, Merced (Attn: Ric Notini)
UC Development Office, Merced County (Attn: Bob Smith)
California Department of Fish and Game (Attn: Pat Brantley)

United States Department of the Interior

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Sacramento Fish and Wildlife Office
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IN REPLY REFER TO:
1-1-02-F-0107

August 19, 2002

Mr. Michael S. Jewell
Chief, Central California/Nevada Section
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Subject: Formal Section 7 Consultation on the University of California, Merced Campus and Infrastructure Project (199900203), Merced County, California

Dear Mr. Jewell:

This is in response to your February 22, 2002, request for formal consultation with the U.S. Fish and Wildlife Service (Service) on the University of California, Merced campus and infrastructure project in Merced County, California. Your request was received in our office on February 25, 2002. This document represents the Service's biological opinion on the effects of the action on the fleshy (=succulent) owl's-clover (*Castilleja campestris* ssp. *succulenta*), Colusa grass (*Neostapfia colusana*), San Joaquin Valley Orcutt grass (*Orcuttia inaequalis*), hairy Orcutt grass (*Orcuttia pilosa*), Hoover's spurge (*Chamaesyce hooveri*), Greene's tuctoria (*Tuctoria greenei*), Hartweg's golden sunburst (*Pseudobahia bahiifolia*), vernal pool fairy shrimp (*Branchinecta lynchi*), Conservancy fairy shrimp (*Branchinecta conservatio*), vernal pool tadpole shrimp (*Lepidurus packardi*), valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), bald eagle (*Haliaeetus leucocephalus*), and San Joaquin kit fox (*Vulpes macrotis mutica*), in accordance with section 7 of the Endangered Species Act of 1973, as amended (Act).

We are providing a conference opinion on the mountain plover (*Charadrius montanus*), a species that has been proposed for listing. We are also providing technical assistance for the California tiger salamander (*Ambystoma californiense*) and midvalley fairy shrimp (*Branchinecta mesovallensis*) in the Conservation Recommendations section of this biological opinion. The midvalley fairy shrimp is currently under petition to be listed and the California tiger salamander is a candidate for listing.

This biological opinion is based on information provided in the July 2002, *Supplement to Biological Assessment for UC Merced Campus and Infrastructure in Support of UC Merced*, the February 8, 2002, *Biological Assessment, CWA Section 404 Permit Applications for UC Merced Campus Project and County of Merced Infrastructure in Support of UC Merced Project*, the August 2001, *University of California, Merced Long Range Development Plan Draft*, and the January 2002, *Final Environmental Impact Reports*, as well as numerous telephone conversations and regular meetings involving individuals representing the University of California (University), Merced County (County), the U.S. Army Corps of Engineers (Corps), the Environmental Protection Agency (EPA), and the California Department of Fish and Game (CDFG), field investigations, and other sources of information. A complete administrative record of this consultation is on file in this office.

The University is proposing to develop the main campus in phases. Construction of the first phase (Phase 1) of the campus is scheduled to begin in the summer of 2002 on approximately 104 acres of the existing 197-acre Merced Hills Golf Course located outside of any wetlands or other areas under the Corps jurisdiction pursuant to the Clean Water Act. The Phase 1 Campus site does not support suitable habitat for wetland dependent species; therefore, it will not result in direct effects on these species or their habitats. Based on the Conservation Measures as proposed, the Service has determined that effects from Phase 1 are insignificant and are not likely to adversely affect the fleshy owl's-clover, Colusa grass, San Joaquin Valley Orcutt grass, hairy Orcutt grass, Hoover's spurge, Greene's tuctoria, Hartweg's golden sunburst, vernal pool fairy shrimp, Conservancy fairy shrimp, vernal pool tadpole shrimp, valley elderberry longhorn beetle, bald eagle, and San Joaquin kit fox. In addition, because the water supply for Phase 1 will be within the confines of the 1995 Operations Criteria and Plan (OCAP) biological opinion, Phase 1 is not likely to adversely affect the delta smelt or the Sacramento splittail. Unless new information indicates that Phase 1 will affect any listed species in a way not considered in this biological opinion, no further consultation for Phase 1 of the Campus under the Act is necessary. If new information comes to light that indicates the action may affect listed species, please contact us immediately.

Consultation History

The proposed University of California Merced (UC Merced) Campus is the product of more than 15 years of public involvement, planning efforts, and extensive analyses. In addition to obtaining direct input from concerned citizens and interested organizations as part of the planning and environmental review processes, the University and Merced County have engaged in discussions with various local, State, and Federal agencies since the mid-1990s. Correspondence and informal discussions between the University and the Service have included:

- On November 28, 1994, the Service submitted a letter commenting on the Site Selection Draft Environmental Impact Report (EIR). In this letter, the Service raised concerns over project-related effects to fleshy owl's-clover, California tiger salamander, western spadefoot toad (*Scaphiopus hammondii*), vernal pool fairy shrimp, valley elderberry longhorn beetle, bald eagle, ferruginous hawk (*Buteo regalis*), burrowing owl (*Athene cunicularia hypugea*), and San Joaquin kit fox potentially occurring at the Lake Yosemite Site, in addition to concerns regarding the other two finalist sites. The letter also recommended development of a Habitat Conservation Plan which would encompass most or all habitats of listed species in the county in order to address ongoing loss and fragmentation of habitat in Merced County in light of projected population growth.

- During 1999 and 2000, the University and County engaged in discussions with the Service, Corps, EPA and the CDFG regarding the location of the UC Merced Campus and effects to biological resources. As a result of these discussions, in late 2000, the University proposed to shift the UC Merced Campus site from its original location to the location of the Applicants' Proposed Projects as described above.

- In March 2001, the University and County submitted a Draft Comprehensive Alternatives Analysis (CAA) prior to filing formal 404 permit applications in order to identify potential alternatives that could be evaluated further under the Clean Water Act (CWA) Section 404(b)(1) Guidelines once the formal application process commenced. The Draft CAA is not being used to further analyze alternatives regarding the 404(b)(1) analysis as it did not meet the criteria of the 404(b)(1) Guidelines. Agency comments and subsequent discussions regarding the preliminary CAA resulted in further direction regarding the 404(b)(1) alternatives analysis. This direction will be reflected in the more detailed alternatives analysis to be prepared pursuant to the 404(b)(1) Guidelines. This analysis also will be coordinated with preparation of documents to be prepared under the National Environmental Policy Act.

- The local and State environmental review processes also afforded an opportunity to solicit input from the Service on the Proposed Projects. On March 19, 2001, the Service provided written comments on the Notices of Preparation for the EIRs. This letter included a list of species that may occur in, or be affected by, projects in Merced County, and general guidelines for identification and conservation of project effects.

- During preparation of the Long Range Development Plan (LRDP) Draft Environmental Impact Report (DEIR) and the University Community Plan (UCP) DEIR from March through August, 2001, the County and University engaged in a series of discussions with the Service and CDFG regarding the level of information needed for the agencies to assess project-related effects to listed species. During these discussions, the Service raised a number of concerns related to direct and indirect effects on vernal pool species, potential effects to movement corridors for the San Joaquin kit fox, cumulative and growth inducing effects of the LRDP and UCP, and effects to anadromous fish in Merced River potentially resulting from surface-water diversion.

- On October 9, 2001, the Service and CDFG provided one letter jointly commenting on the Draft EIRs for the UC Merced LRDP and UCP. In the joint letter, the Service and CDFG reiterated concerns over direct, indirect, growth-inducing, and cumulative effects to listed species, including potential effects to anadromous fish that would result from the diversion of surface water from Merced River. Concerns were raised regarding potential effects to a number of listed species. These concerns have been addressed as part of the preparation of the Final EIR for the UC Merced LRDP, and are being addressed in the UCP Final EIR. The University and County will continue to work with the various State and Federal agencies to address the concerns stated in the comments on the Draft EIRs.

- In late 2001 and early 2002, the University and County met regularly with the Service and CDFG staff to discuss content and level of analyses to be included in the Biological Assessment.

- On February 25, 2002, the Service received a letter from the Corps dated February 22, 2002, requesting the initiation of formal consultation for fleshy (succulent) owl's-clover, Colusa grass, San Joaquin Valley Orcutt grass, vernal pool fairy shrimp, Conservancy fairy shrimp, vernal pool tadpole shrimp, bald eagle, San Joaquin kit fox, and mountain plover. The *Biological Assessment, CWA Section 404 Permit Applications for UC Merced Campus Project and County of Merced Infrastructure in Support of UC Merced Project*, dated February 8, 2002, was submitted at the same time. As part of this package, the University submitted the Resource Mitigation Plan and the County submitted its Habitat Mitigation Plan for the infrastructure project.

- From April 2002 to June 2002 the Service met regularly with the University, County, Corps, and CDFG to further discuss information needs, the analysis, proposed conservation measures, and compensation plans.

- On July 8, 2002, the Service received a Supplement to the Biological Assessment from the UC containing additional information needed for the section 7 consultation and the Phase 1 water memo.

BIOLOGICAL OPINION

Background Regarding UC Merced

The University of California (University) has proposed the development of a major research university (UC Merced) on approximately 2,000 acres located in Merced County, California. As more fully described in the Biological Assessment (BA), dated February 8, 2002, prepared by the University and the County for Campus Buildout and the Infrastructure Project, UC Merced is proposed to include a 910-acre "Main Campus," a 340-acre "Campus Land Reserve" and a 750-acre "Campus Natural Reserve." As presently proposed, and as reflected in a draft "University Community Plan" and draft environmental impact report circulated by Merced County, a 2,000-acre campus-oriented community (Campus Community) would be developed adjacent to UC Merced to provide housing and commercial and other uses needed to support UC Merced. The proposed location of UC Merced and the Campus Community are shown, in their regional context, on attached Figure 1.

Although the first phase of development of UC Merced (approximately 104 acres within the Main Campus located on an existing golf course) will not result in the fill of waters of the United States (as described below), development of the remaining portions of the Main Campus (Campus Buildout) will result in the fill of approximately 86 acres of waters of the United States under the jurisdiction of the Corps. Accordingly, on November 9, 2001, the University submitted to the Corps an application for a Department of the Army (DA) permit under Section 404 of the Clean Water Act to fill such jurisdictional waters in connection with Campus Buildout. Development of Campus Buildout will require the installation of roadways and other public infrastructure, the development of which infrastructure will also result in the fill of jurisdictional waters. On February 8, 2002, the County submitted to the Corps an application for a DA permit under Section 404 to fill approximately 4.49 acres of jurisdictional waters in connection with the development of that infrastructure (Infrastructure Project). On February 8, 2002, the University submitted supplemental information to the Corps in support of the UC Merced section 404 permit application.

Because of the relationship between Campus Buildout and the Infrastructure Project, the permit applications submitted by the University and the County are being processed jointly, and the Corps has issued two public notices in connection with those applications (PN 199900203 and PN 200100570).

Consultation Process

As described above, prior to the issuance by the Corps of fill permits, Applicants' Proposed Projects will be subject to a variety of analyses, including review under the National Environmental Policy Act (NEPA) and application of the criteria set forth in the 404(b)(1) Guidelines, including a complete Least Environmentally Damaging Practicable Alternative (LEDPA) analysis. These analyses may result in modifications to the Applicants' Proposed Projects, possibly including changes to their sizes, configurations or locations, to the extent those changes are practicable and consistent with the University and the County's stated project purposes. The University's stated purpose is to establish a major research university in Merced County that will ultimately support 25,000 full-time equivalent students, with an associated community needed to support the University. The County's stated project purpose is to support the proposed UC Merced campus with necessary infrastructure adjacent to the proposed campus.

In light of the possibility of such modifications, the Applicants have prepared a BA Supplement to provide a broader analysis of the effects of Applicants' Proposed Projects, i.e., as they may be modified as a result of the NEPA, LEDPA or other analytic processes. This will allow the Service to: (1) complete a comprehensive evaluation of the potential effects of development of Campus Buildout and the Infrastructure Project, together with interrelated and interdependent actions (as described in the BA), and conclude formal consultations; (2) ensure that the Service's analysis contemplates not just the Applicants' preferred proposals for development (as they may be modified by the Corps' regulatory process), but any alternative within the area shown on Figure 1 (Study Area) that may result from application of federal regulatory standards; and (3) provide valuable, up-front biological information that can be used by the Corps to aid in their environmental review under NEPA and the section 404(b)(1) Guidelines.

In order to have a reliable analytic guide to govern the Service's biological analysis, the Applicants have agreed to a set of environmental parameters that will govern the development and operation of the Applicants' Proposed Projects as they may be modified during the Corps' regulatory processes. These Parameters are intended to avoid, minimize or mitigate effects on federally-listed species that may otherwise result from any development activities that ultimately receive Section 404 authorization by the Corps. The Applicants have agreed that these Parameters will apply to the Applicants' Proposed Projects and any alternative within the Study Area that ultimately may be approved by the Corps. The Service has assumed in conducting its biological analysis that the Parameters will be implemented as a part of the Proposed Actions.

Description of the Proposed Action

As described above, the Service's analysis is assumes the possibility that the Applicants' Proposed Projects may be modified during the NEPA process or as a result of the Corps' LEDPA analysis. Because the Preferred Alternative may be different (or in a different location) from the Applicants' Proposed Projects, the Service's analysis is is sufficiently broad to cover any alternative that is eventually preferred by the Corps and located within the Study Area. As described above, the Service's analysis is assumes implementation or satisfaction of the Parameters, which the Applicants have agreed will be implemented in connection with whichever alternative obtains section 404 authorizations.

The actions evaluated by the Service during the present consultation (Proposed Actions) can be defined as: "Campus Buildout and the Infrastructure Project, as proposed or as those projects may be modified or relocated within the Study Area as a result of the Corps' decisionmaking processes, subject to and in light of the Parameters as described in Section III of the BA Supplement." These Proposed Actions, together with the effects of interrelated and interdependent actions, serve as the basis for the Service's biological opinion.

In addition to the Parameters, the Proposed Actions are assumed to incorporate the "Conservation Measures" described in Part IV of the BA Supplement and as stated in the Description of the Proposed Action of this biological opinion. These Conservation Measures were originally proposed and adopted by the University in connection with its environmental review of the LRDP under the California Environmental Quality Act (CEQA). The BA expands upon the conservation measures originally proposed in the University's and County's CEQA documents and applies them specifically to the Proposed Projects. For the purposes of this consultation, the University and the County have further refined these measures to make them applicable to any alternative that may be approved by the Corps within the Study Area. The Service has considered these measures as a part of the Proposed Actions.

Study Area

The Study Area subject to the Service's review as a part of this consultation, as shown in Figure 1, has been expanded to include certain areas located outside of the Study Area described in the BA. The Study Area was configured to allow consideration of potential effects of locating the Proposed Actions in a variety of settings. This configuration allowed analysis of various project designs entailing combinations of lands supporting agricultural and other types of development, as well as undeveloped lands in the vicinity of the Applicants' Proposed Projects. The boundary was delineated along recognizable roads within the Study Area vicinity (with the exception that the VST land boundary was used in the northeast). Highly developed lands near the City of Merced were considered to be infeasible for Campus and Campus Community development, and were excluded from the Study Area.

Although the Applicants' Proposed Projects would not be expected to result in species-related effects within these additional areas, certain of the Parameters (e.g., development of a regional conservation strategy) are intended to limit the effects of other projects that might occur within this broader area. Moreover, there is some possibility that the Corps' review under NEPA may involve alternatives that could result in such effects. Therefore, this biological opinion is based on a review of the species-related resources within this broader area, and evaluates the potential effects of the Proposed Actions to the extent they would involve these areas.

Phase 1 of UC Merced

The University is proposing to develop the Main Campus in phases. Construction of the first phase of the Main Campus would begin in 2002 at the southern end of the Main Campus, on approximately 104 acres of the existing 197-acre Merced Hills Golf Course located outside of any wetlands or other areas under Corps jurisdiction pursuant to the Clean Water Act (Figure 2). Upon opening, Phase 1 will accommodate approximately 1,000 students and 500 faculty and staff, with increasing enrollment over the next four years to reach a total of approximately 3,600 students and 1,180 faculty and staff.

Phase 1 will consist of approximately 18 acres of academic core uses, 33 acres of student housing, 13 acres of campus logistical support facilities, 15 acres of athletic and recreation fields, and 24 acres of parking. The Phase 1 academic core, upon opening, would consist of a Science and Engineering Building, a Classroom Building, and a Library/Information Technology Center. Initial campus housing and dining facilities would be located to the southwest of the academic facilities. Necessary utilities including a central plant, surface parking and road infrastructure also would be constructed. Additional facilities are planned for construction between 2004 and 2008 and include additional student housing and dining, a Recreation Center, a Campus Logistical Support Facilities Building, a second Science and Engineering Building, and a Social Science and Management Building. All off-site infrastructure required to serve Phase 1 will consist of existing roadways and installation of utilities within existing roadway rights-of-way.

The Phase 1 Campus boundary is located outside the watersheds of existing vernal pools and other wetlands to assure that no significant adverse changes occur in the biological functioning of the vernal pools and swales outside of that boundary. No fill activities are proposed within existing vernal pools and wetlands as part of Phase 1. None of the improvements required as part of Campus Buildout and the Infrastructure Project are required for Phase 1. Although two vernal pools are located adjacent to the northern boundary of the Phase 1 Campus site, these pools are upgradient of the existing golf course access road, which will be used for construction access to the Phase 1 site, and they are located outside of the footprint of the construction area. Thus, because all Phase 1 construction will occur within the Phase 1 boundary and outside of the watersheds of existing vernal pools, swales, and other wetland resources, Phase 1 will not impact downgradient or upgradient wetlands.

Although Section 404 authorizations are not required for Phase 1, these development activities are an integral part of the Main Campus. Accordingly, this analysis is addresses the potential effects of the development of Phase 1.

The Parameters

As described above, the University and the County have agreed that the Parameters will apply to any Preferred Alternative that may be selected by the Corps within the Study Area. These Parameters are not, however, intended to control the Corps' analysis under the laws and regulations applicable to the Corps. Where applicable, these Parameters apply both to the development projects specifically proposed by the University, the County, and to other development occurring within the Study Area. In addition to the Parameters, the University and the County have proposed a number of additional "Conservation Measures" which, in many cases, will serve to implement the Parameters described and are considered part of the Proposed Actions.
The Parameters are as follows:

1. Development of Conservation Strategy

    a. The Applicants will prepare and implement, in coordination with the Service and CDFG, a comprehensive strategy that incorporates the Conservation Measures for the San Joaquin kit fox, vernal pool plant species and branchiopods, and other protected species to guide the development and implementation of specific conservation for the Proposed Actions and as needed to assure that other development within the Study Area is consistent with the Conservation Strategy as described in parameter 1b, below.

    b. The Conservation Strategy will include monitoring and adaptive management measures and be consistent with and intended to implement the Recovery Plan for Upland Species of the San Joaquin Valley, California, and any future federal recovery planning efforts.

2. Parameters for Covered Projects

    a. All conservation actions described below will be developed and implemented by the appropriate party, including the CDFG where appropriate. These conservation actions include, among other things, completion by the Applicants of the Conservation Strategy; completion of a review by the Service of all preserve lands which have been acquired (i.e., in fee or easement) to date to determine the applicability for conservation for protected species; advance Service review and approval of further fee or easement acquisitions; and completion of a Resource Mitigation Plan (to be prepared for the Main Campus as described below) and Habitat Mitigation Plan (to be prepared for the Infrastructure Project as described below) consistent with the parameters set forth herein. The Resource Mitigation Plan and Habitat Mitigation Plan will include, among other things and in addition to the measures set forth in the BA supplement, management strategies and financial assurances for the monitoring and management of preserve lands and a strategy for addressing indirect effects. All the above, including the terms and conditions of conservation easements and management plans, and the adequacy of funding assurances, will be subject to review and approval by the Corps and the Service.

b. The Applicants will develop, in coordination with the Service, Corps, and CDFG, a plan to address potential effects to the San Joaquin kit fox, which will be consistent with the Conservation Strategy and may be included in the Resource Mitigation Program and/or Habitat Mitigation Plan. This plan, at a minimum, will address a migration corridor to the north and northeast of the Proposed Actions (as presently proposed by the Applicants) to be protected and maintained through acquisitions and other possible actions (e.g., passage over canals). Any such acquisitions will be consistent with the establishment of a connection to the Sandy Mush Road area.

c. The extent and nature of proposed conservation, and any proposed ratios, for grassland and vernal pool species will be at least equivalent to those set forth in the BA and will be approved by the Service and the Corps together with any avoidance and minimization measures.

d. Management plans and adequate financial assurances for long-term monitoring and management of identified preserve lands will be provided to and approved by the Service and the Corps.

e. No direct impact to Conservancy fairy shrimp, including its watershed, will occur. Indirect effects to the Conservancy fairy shrimp will be minimized and avoided to the maximum extent practicable. Any unavoidable indirect effects to occupied Conservancy fairy shrimp habitat will be compensated through the preservation of habitat within areas approved by the Service and the Corps as set forth more specifically below and found in the BA supplement.

f. For San Joaquin Valley Orcutt grass, Colusa grass, fleshy owl's-clover, hairy Orcutt grass, Hoover's spurge, Greene's tuctoria, and Hartweg's golden sunburst, the University will, to the maximum extent practicable, avoid and minimize effects on these federally listed plant species through siting, design, and conservation measures. Any occupied habitat of these seven listed species will be preserved within areas approved by the Service as set forth more specifically below in the Conservation Measures. For effects to vernal pools and associated habitats, as well as any other wetlands, the Applicants will develop and implement a restoration/creation plan focusing on areas where the vernal pool signature or suitable extirpated habitat is still present or other suitable areas. This plan will include appropriate monitoring and adaptive management measures, together with adequate financial assurances, to be reviewed and approved by the Service and the Corps.

3. Parameters Regarding Development and Other Discretionary Projects in the Study Area

a. Merced County will provide written assurance to the Service and the Corps that for all discretionary projects permitted by the County within the Study Area, other than the Proposed Actions, that may result in take of a listed species, Merced County will require compliance with the Endangered Species Act. This provision will include projects served by state or federally-funded roadways or other infrastructure that may be developed to serve the Campus or the Campus Community.

b To ensure no effect on Merced River and delta species (which are not subject to this consultation), withdrawals from the Merced River resulting from the Covered Projects (i.e., for recharge purposes) will be within the parameters of the existing OCAP biological opinion and formal consultation. The Applicants will also provide evidence that groundwater pumping and stormwater discharges will not affect listed species.

<u>Conservation Measures</u>

This section describes conservation measures that the University and the County have agreed to apply in order to avoid, minimize, and compensate for potential effects that the Proposed Actions could have on listed species. Conservation measures for the Proposed Actions are presented first; these are followed by specific conservation measures for the Phase 1 Campus project.

The Conservation Measures include a variety of avoidance, minimization, and compensation measures for effects on wetlands and other biological resources. For the proposed UC Merced Campus, these measures are included within the RMPs' following elements: siting and design, construction mitigation, operations and maintenance, compensation, and adaptive management. For the Infrastructure Project, these measures are included within the HMP's following elements: avoidance and minimization, compensation and monitoring and adaptive management, as describe further below. The Conservation Measures for the Campus Community (an interrelated and interdependent project) are based upon the objectives and policies in the draft UCP.

Adopted Environmental Commitments for the UC Merced Campus

The most important conservation measures that apply to the Proposed Actions are the Parameters, which describe commitments for additional planning, analysis, and actions that will be conducted in response to the final selection of a Preferred Alternative through the NEPA and Section 404(b)(1) processes. The Parameters also identify the requirement for Service approval of specific conservation measures that will be proposed by the University as a part of the Proposed Actions. In many cases, the specific conservation measures described below will implement the Parameters. Conservation measures will be refined in accordance with the Parameters. These measures will be subject to extensive consultation with and approval by the Service, CDFG, and the Corps.

The Resource Mitigation Plan for Campus Buildout

In connection with its environmental review of the UC Merced Campus in compliance with the CEQA, the University committed to develop and implement a Resource Mitigation Program to mitigate the effects of the University's proposed Campus Buildout on a broad variety of biological and wetland resources. As described in the initial BA, one component of this program is a proposed Resource Mitigation Plan for Federally Listed Species that May Be Affected by the Establishment of the University of California, Merced. This initial Resource Mitigation Plan (RMP) accompanied the University's application for a Section 404 permit for the Applicants' Proposed Projects. The initial RMP included avoidance, minimization, and compensation actions (conservation measures) to address the potential effects on listed species of the University's specific Campus Buildout proposal. The RMP remains a record of the University's commitments that are relevant to the Applicants' Proposed Projects, as well as commitments that are applicable to any other site or configuration within the Study Area that may be identified as the Preferred Alternative through the NEPA and Section 404 processes.

The original RMP was programmatic in nature. It described a series of conservation program elements to avoid, minimize, and compensate for effects of the proposed campus configuration on listed species, during its various stages of planning, construction, and operation. Thus, major program elements included Campus siting, design, construction, operation and maintenance, compensation, and adaptive management. Like the Parameters, the original RMP specifically recognized that additional analysis and planning would be required to develop specific conservation programs and specific measures and that the Service would have involvement in development of these measures as well as authority to approve them.

The shift in focus, for purposes of section 7 consultation, from the Applicants' Proposed Projects to the Proposed Actions, together with application of the Parameters, has necessitated a modification of the conservation measures originally identified in the RMP. Because the Applicants' Proposed Projects are within the Study Area under evaluation in project section 7 consultation, the Conservation Measures remain generally applicable to the Proposed Actions. The conservation measures presented in this section include the measures identified in the original RMP, the Infrastructure Project Habitat Mitigation Plan (HMP), the policies contained in the County's Draft UCP, and the Parameters to ensure that construction of a Campus, Infrastructure Project and University Community elsewhere in the Study Area would not result in jeopardy to listed species.

The conservation measures demonstrate the process and specific commitments that the University is committed to employ, consistent with the Parameters, to avoid, minimize, and compensate for the effects of constructing a UC Merced Campus, Infrastructure project, and associated University Community in the Study Area.

LRDP Biological Resource Policies and Mitigation Measures

As part of the LRDP for the Applicants' Proposed Projects, the University adopted 11 LRDP policies governing the protection of biological resources. These policies required that the University ensure no net loss of wetlands functions and values and avoid and minimize effects on annual grassland habitats and special-status species and their associated habitats. Where direct effects to special-status species cannot be avoided completely, the University is required to compensate through preservation, creation, restoration, or enhancement.

The Final LRDP EIR contains 11 major conservation measures to mitigate effects on biological resources caused by the Applicants' Proposed Projects. These conservation measures require the University to develop and implement a Resource Mitigation Program that will result in the acquisition and preservation of substantial acreages of vernal pool-dominated grassland habitat and other wetland resources throughout eastern Merced County, and in the restoration, enhancement, or creation of wetland resources within these preserved areas. The RMP is a component of the Final LRDP EIR Resource Mitigation Program. Additionally, the Final LRDP EIR conservation measures require the protection of and compensation for direct effects on special-status species (vernal pool crustaceans, San Joaquin kit fox, special-status plants, California tiger salamander, and avian species). The University is also required to implement grassland management strategies and minimization measures to address indirect and cumulative effects on special-status species and their associated habitats.

In connection with its review of the Infrastructure Project and the Campus Community in compliance with CEQA, the County committed to develop and implement a HMP to mitigate the effects of the Infrastructure Project and the Campus Community on a broad variety of biological and wetland resources. The Infrastructure Project HMP provides specific mitigation to avoid, minimize, and compensate for effects to biological resources caused by implementation of the Infrastructure Project. Similarly, the County has prepared a draft University Community Plan (UCP) which includes objectives and policies intended to offset adverse effects to biological resources. Pursuant to these policies, the County either will expand the Infrastructure Project HMP to address additional resource effects of the Campus Community or it will develop project-specific HMPs for each individual project within the Campus Community.

Compensation Measures for Phase 1

In addition to the summary of Conservation Measures to which the University and County have committed for purposes of section 7 consultation on the Proposed Actions, the University has proposed specific Conservation Measures applicable to the Phase 1 Campus. While listed species issues will be addressed for the remainder of the Proposed Actions through subsequent planning, implementation, and Service approval of conservation measures consistent with the Parameters, a specific location and configuration for the Phase 1 Campus has been determined. Consequently, for purposes of this consultation, the Supplemental BA contains specific conservation measures to address effects of the Phase 1 Campus on listed species. This detailed conservation program is presented in Adopted Conservation Measures for the Phase 1 Campus Project, following the description of conservation measures for the overall campus.

Campus Siting Measures

The University will implement a variety of measures to minimize effects of campus siting in the Study Area. First, the University has avoided certain important areas as part of its proposal to develop the proposed UC Merced Campus. Second, conservation easements have been acquired, or will be acquired, for substantial areas of key habitat for listed species within the Study Area. These measures will be identified, evaluated, and augmented as needed to meet the requirements of the Parameters, and will be subject to review and approval by the Service.

The Parameters and the requirement to select the LEDPA for campus siting ensure that the Campus will not be relocated or reconfigured in a way that leads to more effects than would occur if the Applicants' Proposed Projects were selected as the Preferred Alternative.

Siting Commitments Made for the Currently Proposed Campus Location

The following siting requirements were applied by the University to determine the preferred configuration and location of the Proposed Project for CEQA purposes in order to avoid effects to listed species. These measures include: (1) establishing the northern boundary of the Main Campus to reduce effects to the clay playa east of Lake Yosemite; (2) locating the Main Campus to avoid the watershed of the vernal pool occupied by Conservancy fairy shrimp; (3) locating the Main Campus and Campus Land Reserve to maintain a 250-foot setback from the watershed supporting the Conservancy fairy shrimp; and (4) designing the Campus to minimize fragmentation of habitat in the vernal-pool dominated grassland habitat. These restrictions, in conjunction with the Parameters, will continue to apply to any Campus configuration that may be approved in accordance with this biological opinion.

Restrictions on Campus Siting Imposed by Existing and Pending Conservation Easements

Constraints on siting the Proposed Actions within the Study Area are imposed both by the Parameters and by existing and pending commitments to protect lands through acquisition of conservation easements.

The Parameters specify the development of a conservation strategy for the San Joaquin kit fox, vernal pool species, and other species within the Study Area prior to siting and implementing the Applicants' Proposed Actions. The parameters also call for a Resource Mitigation Plan and Habitat Management Plan for the Campus and Infrastructure projects, respectively, that will: address a movement corridor for San Joaquin kit fox to the north and east of the location of the Applicants' Proposed Projects; avoid any impact on the habitat of Conservancy fairy shrimp and its surrounding watershed; and acquire compensation lands at a ratio equal to or greater than that specified in the project BA. Implementation of these measures will constrain the availability of land available for campus siting to those that would result in equal or fewer effects than those identified in the BA for the Applicants' Proposed Projects.

As part of planning for protection and compensation for effects of the Proposed Actions, the University and the Wildlife Conservation Board (WCB) (in cooperation with CDFG) have initiated cooperative efforts to acquire conservation easements on lands that would protect listed species and their habitats in eastern Merced County. Lands within the Study Area with existing and pending easements are shown in Figure 4 and are summarized in Table 1. Easement lands have been selected for their high value to listed species, as well as for their general ecosystem values. The easement program is discussed in detail below (Overview of Existing Land Acquisition Program). The State has secured these lands under conservation easement because of their high habitat values.

Accordingly, because these lands will be under conservation easement, development of the Proposed Actions will not occur on these easement lands.

Campus Design Measures

At least thirty days prior to issuance of construction contracts for various phases of campus development, the University will incorporate conservation measures into the design phase to avoid and minimize direct and indirect effects on listed species and their habitats within areas adjacent to the Proposed Actions. The adopted measures will be reviewed by the Service within a reasonable time and modified or augmented as necessary to meet the conservation requirements of the Parameters. Specific conservation measures adopted by the University for Campus design are discussed below.

- Control stormwater and irrigation runoff to avoid and minimize effects on natural hydrology and vernal pool ecosystems. A stormwater management system will be designed, constructed, and operated to avoid and minimize alteration of natural hydrologic regimes, increases in sediment and nutrient loading, and introduction of pesticide or other hazardous material in runoff. This system will be established to avoid and minimize indirect effects on aquatic systems in areas outside the Campus that may support listed species. The stormwater management system will be designed to control runoff within the boundaries of the Campus, with temporary storage in detention basins (which will result in some groundwater recharge), and then discharged to surface stream systems to mimic the natural pattern of runoff into these systems. The campus exterior will be carefully designed to ensure that no unnatural runoff is delivered to surrounding lands.

- Construct perimeter fencing to discourage human and pet disturbance of adjacent habitat areas. Prior to start of Phase 1 construction, perimeter fences will be constructed along the Campus boundary (between developed areas and any area that could provide access to adjacent habitat areas for listed species) to discourage trespass by humans and dogs.

- Incorporate measures into lighting design to minimize escape of light into habitat areas. To minimize effects of introducing light from the Campus into adjacent habitat areas, the Campus exterior lighting system will be designed to locate, shield, and direct lighting to minimize stray "trespassing" of light into adjacent habitat areas.

Construction Measures

The University will prepare and implement a Construction Mitigation Plan for each major phase of Campus Buildout Development to avoid and minimize direct and indirect effects of construction activities on listed species and those candidate species that the Service has requested to be treated as listed species. Many of these construction measures are standard measures typically required by the Service for major construction projects in San Joaquin Valley habitats that support listed species. The measures will be adapted in the construction mitigation plans for each individual construction phase and action, and the plans will be approved by the Service, as specified in the Parameters. The Construction Mitigation Plans will address, at a minimum, the following conservation measures:

- designation of a biological monitor to be onsite whenever new ground disturbance occurs or when any ground disturbance occurs within 250 feet of adjacent habitat areas;
- reporting of biological monitoring results;
- incorporation of species protection obligations into construction contracts;
- training for construction personnel (including multilingual training, if needed);
- incorporation of best management practices (BMPs), including dust-control measures, erosion reduction and sediment control, and restricted equipment refueling and maintenance practices;
- construction staking, flagging, signage, and fencing;
- identification of construction staging areas in the Construction Mitigation Plan and monitoring establishment and operations at these sites by a biological monitor;
- salvage of plants and invertebrates for use in wetland restoration (if approved by the Service);
- construction measures to minimize take of San Joaquin kit foxes, including preconstruction surveys and controls on activities of construction activities and personnel, as described in the Service's Standardized Recommendations for Protection of the San Joaquin Kit Fox Prior to or During Ground Disturbance (1999);
- prevention and control of undesirable invasive plant species;
- postconstruction monitoring and conservation; and
- application of all relevant construction conservation measures to construction activities associated with habitat restoration and creation on conservation easement lands.

The Construction Mitigation Plan for each phase will be subject to review and approval by the Service, the CDFG, and the Corps prior to ground disturbance.

Campus Operations and Maintenance Measures

The University will adopt and implement measures to protect habitat values and minimize effects of Campus operations and maintenance (O&M) activities on adjacent listed species. The measures to provide this protection will be incorporated into the various elements of the overall Campus facilities management program (e.g., work program descriptions, training programs). These Campus O&M actions will be subject to review and approval by the Service, the Corps, and CDFG. The University Environmental Manager will be responsible for ensuring that these requirements are integrated into the Campus O&M program as each phase of development proceeds.

The O&M conservation measures will include the following measures:

- Implement a continuous public education program. The University will implement a continuous public education program to inform students, staff, and faculty of the sensitive resources within undeveloped areas of the Campus and on lands adjacent to the Campus to promote the need to protect these resources. The program will be implemented through media and direct contact methods, outreach, signage, and interpretive exhibits.

- Establish Campus-wide leash rules and an animal control program. The University will adopt rules requiring that pets be leashed and develop an animal control enforcement program to discourage movement of free ranging dogs onto adjacent lands that are occupied or suitable for listed species.

- Minimize use of herbicides and other pesticides. The University will incorporate procedures into its management of developed ornamental landscapes and undeveloped lands to minimize pesticide use and to avoid and minimize potential for effects on listed species from movement of herbicides and other pesticides (e.g., through drift or runoff). This program will include development of a pesticide use plan as part of an overall Integrated Pest Management (IPM) plan for the Main Campus that specifies restrictions and conditions of pesticide application. Control of runoff was addressed previously in Campus Design Measures.

- Develop an invasive species control program. The University will control invasive weeds that may pose threats to sensitive resources on surrounding lands by restricting landscape use of species that may pose threats, establishing an ongoing IPM program for weed control on developed lands, and controlling weed populations that establish on the Campus during construction activities or on vacant Campus lands prior to development activities.

- Develop a management plan for the management of conservation lands. The University will prepare a Management Plan to establish the management measures and maintenance of preserve lands and to protect listed species on all lands that will be controlled by the University through ownership or acquisition of conservation easements and for lands under Wildlife Conservation Board (WCB) easements. Lands under University ownership include the Campus Natural Reserve and the Virginia Smith Trust Remainder Property that will be placed under conservation easement, and any other lands for which title or easements are acquired by the University itself as part of the UC Merced Project. Under the Management Plan, these lands will be actively managed. Lands which have been or will be acquired by the WCB also will be covered by the Management Plan, although they may be managed differently from University-owned easement lands and their management will not be the University's responsibility. The Management Plan will be prepared in consultation with the Service and CDFG as specified in the Parameters, and will provide an umbrella strategy for the management of the preserve lands as a whole, taking into account the different levels of management and methods of financing that may apply to various properties. The Management Plan will specify management policies and practices to limit and control human access, approve and manage research and educational uses, control pets and nonnative animal and plant species, conduct livestock grazing, prevent and control wildfires, and enhance habitat conditions.

Compensation Measures for the Proposed Actions

In accordance with the Parameters, the University will develop a comprehensive program to compensate for the direct and indirect effects of the Proposed Actions on listed species through acquisition and protective management of existing habitat as well as acquisition and restoration of previously degraded habitats. Substantial accomplishments have been achieved for the acquisition portion of the compensation plan.

The University will complete a Project Compensation Plan to address acquisition and management of lands supporting high-quality habitats and lands that will be restored to provide wetland compensation. The Project Compensation Plan will identify specific preserve lands that will be used to compensate for species take and habitat losses, measures that will be undertaken to implement compensation, resulting habitat benefits derived from compensation, and an adaptive management program to implement compensation actions over time. The plan will be prepared to respond to the specific effects of the Preferred Alternative.

The Project Compensation Plan will describe the site characteristics, proposed activities, and resulting conditions for each proposed compensation area to verify their appropriateness in offsetting project-related effects. The Compensation Plan will fulfill the requirements listed below.

- Identify Appropriate Ownership of Preserve Lands. For conservation lands currently owned in fee by the University, the University will identify the appropriate conservation entity (e.g., NRS, UC, or other conservation entity) to hold fee title and/or conservation easements to the preserve lands in perpetuity. For WCB acquired conservation lands, the WCB will identify the appropriate conservation entity. All conservation easements for future Preserve Land acquisitions will be reviewed and approved by the Service to ensure that (1) the lands sought for protection are appropriate to serve as mitigation; and (2) the easements themselves contain, among other things, appropriate use restrictions, management requirements and provisions for monitoring by the Service and the Corps.

- Identify Management Budgets and Funding. The University will establish appropriate funding mechanisms and a budget for the perpetual management and monitoring of the CNR and Virginia Smith Trust (VST) Remainder Property lands. Additional funding will be identified for the management of preserve lands acquired after issuance of the BO, depending on the level of management necessary to meet the compensation requirements of the project. As specified in the Parameters, the University will ensure the availability of adequate financing to implement the Management Plans.

- Identify Wetland Habitat Restoration Actions. The Plan will describe all lands and wetland areas to be preserved, enhanced, restored, or created. It will also clearly describe all conservation measures to be implemented. The Project Compensation Plan will define the applicable preserve criteria, habitat restoration protocol, and success criteria for special-status species on the conservation lands.

- Identify Management Programs. The Project Compensation Plan will establish a long-term protocol for management and maintenance of habitats for special-status species occurring in CNR and VST Remainder Property lands and will identify management practices which could be implemented on future WCB preserve lands. Funding assurances to support management on the CNR and VST Remainder Property will be reviewed and approved by the Service, CDFG, and the Corps.

- Prepare a Comprehensive Monitoring Program. A monitoring program will be developed that describes the monitoring requirements for each compensation area. The monitoring program will identify specific methods and performance standards that must be achieved for conservation applied to each species. Monitoring will address basic compliance (e.g., Were required actions performed?), and effectiveness questions (i.e., Were the actions successful in accomplishing the compensation goals of the plan?).

Surveys will be conducted by qualified specialists to monitor the status of listed species on compensation lands. The surveys will monitor progress over a 10-year period (or as otherwise required in the plan) in meeting the success criteria specified in the Project Compensation Plan for each site. The monitoring plan also will identify needs for adaptive management. Access will be specified for the Service, CDFG, and the Corps to verify management and monitoring results and compliance with the BO and Section 404 permit.

- Identify Adaptive Management Protocols. The Plan will contain an adaptive management component that will describe the process by which monitoring results will be used to evaluate the effectiveness of management activities, how the management program or specific practices may be modified to achieve the compensation objectives of the site, and when and how approvals for such changes will be acquired.

In order to fulfill the above requirements and as specified in the Parameters, the Compensation Plan will incorporate:

- a review by the Service and CDFG of existing and pending easements to evaluate their applicability for conservation of protected species in the Study Area;
- measures to provide funding for management and monitoring of the CNR and VST Remainder and preserve lands secured for wetland creation or restoration;
- establishment of a kit fox movement corridor to the north and east of the Applicants' Proposed Projects;
- other possible actions (e.g., passage over canals) to enhance kit fox movement;
- compensation of any unavoidable effects on Conservancy fairy shrimp by preservation of Service-approved habitats;
- for effects on San Joaquin Orcutt grass, Colusa grass, fleshy owl's-clover, hairy Orcutt grass, Greene's tuctoria, Hoover's spurge, Bogg's Lake hedge-hyssop, or Hartweg's golden sunburst, preservation of habitat occupied by these species;
- preservation of occupied habitat for effects on all special status plant species evaluated in the Supplemental Biological Assessment; and,

- development and implementation of a restoration/creation plan for effects on vernal pools and associated habitats that focuses on areas supporting vernal pool "signatures" or other suitable sites and that includes an appropriate monitoring plan and financial assurances.

The specific scope of compensation activities identified in the Habitat Compensation plans (i.e., acreages, locations, proposed management and enhancement activities) will be determined in part by the effects for which they are intended to compensate. In accordance with the Parameters, the plans will be prepared with Service and CDFG involvement and subject to approval by each agency as well as by the Corps.

The following sections describe current compensation land commitments, the proposed planning processes for future compensation, the management commitments to be applied to compensation areas, and proposed strategies to compensate for various listed species groups.

Overview of Existing Land Acquisition Program

The land and easement acquisition program for UC Merced has been initiated by the University and the WCB as a result of direction and funding provided by the California Legislature and several private foundations. The land acquisition program is designed to compensate for the potential effects of the Proposed Actions and related development on listed species. Because many of the species that may be affected by the Preferred Alternative require vernal pools and associated seasonal wetland habitats, this compensation effort is closely coordinated with the strategy to compensate for effects on wetlands and other waters of the United States.

The University and the WCB have initiated a program to secure large tracts of land supporting concentrations of high-quality vernal pools and related aquatic habitats in the Study Area. Although some of the initial lands acquired for compensation by the University were directly associated with Campus Buildout under the Applicants' Proposed Projects, these lands are committed for protection through acquisition of conservation easements. Additional management and protection measures may vary depending on the final Preferred Alternative and the resulting requirements for project conservation.

The University has acquired title to the 7,030-acre VST property. Of this area, 910 acres was designated for development for the Main Campus in the context of the Applicants' Proposed Projects. The Applicants' Proposed Projects also includes the 750-acre Campus Natural Reserve (CNR) and the 340-acre Campus Land Reserve (CLR). The remaining 5,030-acre portion of the VST property (VST Remainder Property), which is owned by the University but is not formally part of the UC Merced Campus, has been committed to preservation through a conservation easement and will be managed to maintain and enhance its natural environmental functions and values.

The CNR and the VST Remainder Property (which together comprise 5,780 acres, see Figure 4) will remain in an undeveloped state, will be managed under a conservation easement approved by the Service, and will be dedicated entirely to conservation and limited controlled research and educational activities. This management will be subject to an adaptive management plan to be reviewed and approved by the Service and other agencies. Activities and public access on the CNR and the VST Remainder Property are restricted, with recreational activities being entirely prohibited.

The CNR, and possibly the VST Remainder Property, will be managed as part of the University of California Natural Reserve System (NRS) or will be managed by the Campus in a manner consistent with NRS guidelines. Thus, regardless of the outcome of the section 7 and Clean Water Act 404 permit processes, the University will protect a total of 5,780 acres that may be used to compensate for effects of the Campus on wetlands and listed species. The funding ultimately allocated to additional easement acquisition may be influenced by the Preferred Alternative's size and location and the consequent need for compensation.

Compensatory Wetland Mitigation Plan

The University will prepare and submit to the Service, CDFG, and the Corps for review and approval a detailed Compensatory Wetland Mitigation Plan for onsite and offsite wetland preservation, enhancement, and/or restoration and creation conservation efforts. The goal of the Compensatory Wetland Mitigation Plan is to ensure that there will be no net loss of wetland functions resulting from construction and long-term use of the Proposed Actions, and to ensure that take and other effects on listed species dependent on these habitats are fully offset. The Compensatory Wetland Mitigation Plan will identify a combination of wetland preservation, enhancement, restoration and creation efforts that will achieve the no net loss standard. The Compensatory Wetland Mitigation Plan will be based on a holistic watershed-level approach involving a wide range of aquatic habitats and their surrounding upland environments.

As previously discussed, large parcels encompassing intact watersheds have been selected preferentially for acquisition for conservation. The Compensatory Wetland Mitigation Plan will incorporate each of the broad approaches included in the wetland conservation strategy based on requirements specified in the University's "Compensatory Wetland Strategy: Mitigation Design Criteria", as well as direction in this biological opinion and the Section 404 permit.

The Compensatory Wetland Mitigation Plan will incorporate measures to meet the following objectives:

- ensure that the University will preserve a minimum of 10 acres of vernal pool-dominated grasslands for each acre of vernal pool-dominated grasslands developed or filled;

- evaluate and incorporate existing easement protections and other enhancement activities on preserved lands as needed to achieve the requirement for no net loss in wetland functions;

- restore wetlands by reestablishing or enhancing areas where the vernal pool signature is still present, to achieve a minimum acreage ratio of 1:1 replacement for vernal pools and other seasonal wetlands that would be filled by the Proposed Actions; and

- if the 1:1 replacement ratio cannot be met through restoration of degraded seasonal wetland habitats, meet the ratio through creation of such habitats in other suitable areas.

The University will prepare a Wetland Restoration/Creation Site Design Plan for each conservation site identified in accordance with the conservation requirements specified in the Compensatory Wetland Mitigation Plan. The Site Design Plan will focus on sites where the vernal pool signature is still present or other suitable areas identified for restoration/creation potential. Wetland delineations will be performed for any areas proposed for wetland enhancement; any activities that may require a permit under Section 404 of the Clean Water Act will receive permits prior to work initiation. Any proposal for wetland restoration or creation will be designed to meet, at a minimum, the requirements contained in the Resource Mitigation Plan (see Exhibit A in the Supplemental BA).

The Wetland Restoration/Creation Site Design Plan will include appropriate monitoring and adaptive management measures reviewed and approved by the Service, the Corps, and CDFG. Monitoring and evaluation of created or restored wetlands will be conducted for a minimum period of 10 years to ensure conformance with success criteria; monitoring is expected to be conducted in years 1, 2, 3, 5, 7, and 10, or as otherwise determined in the approved plan, and reported to the agencies. Adequate financial assurances will be provided in the plan to conduct management and monitoring.

Compensation Plan for Protected Species

In accordance with the Parameters, the University will prepare and implement a Compensation Plan for Protected Species, which will be subject to review and approval by the Service. This plan will clearly describe all specific conservation measures to be implemented, performance criteria, monitoring protocols, appropriate contingency measures, and a long-term maintenance plan. The Compensation Plan for Protected

Species will outline the compensation strategy to address effects of the Preferred Alternative on all species that may be affected by the Proposed Actions. The Compensation Plan for Protected Species will be developed by the University in coordination with the Service, CDFG, and the Corps. The BA for the Applicants' Proposed Projects (EIP Associates 2002) provides more detail on the measures and standards to be used in compensating for individual species. Table 2 presents a summary of species occurrences for the various lands acquired to date.

Compensation Strategy for Listed Plants

In addition to previously described measures to avoid and minimize effects on listed plant populations through siting, design, and construction conservation, the University will compensate for unavoidable effects on populations of listed plants. This program is consistent with Parameter 2f, which specifies that effects on listed plant species will be mitigated by preservation of occupied habitat in areas approved by the Service.

The objectives of the compensation program for listed plants are:

- preserve two plant occurrences of generally equal or greater size than each occurrence of the same listed species eliminated by campus construction (2:1 ratio); and,
- achieve the preservation objective within a 10-mile radius of the Proposed Actions to the extent feasible.

The compensation program for listed plants will be implemented through land acquisition, protection, and enhancement. The lands for which easements have been acquired or are pending, (including the CNR and VST lands to be owned and protected by the University) will be considered first as the basis for achieving the compensation objective for listed plants.

As described in the BA for the Applicant's proposed project (EIP 2002), lands acquired for listed plant compensation will be preserved in perpetuity and will include sufficient buffers to protect populations from potential perturbations. Funding for management and monitoring of these compensation areas will be assured to the Service and other agencies.

The existing CNR and VST easement lands support vernal pools occupied by fleshy owl's-clover, eight occurrences of Colusa grass, and one occurrence of San Joaquin Valley Orcutt grass. None of the other listed plant species have been detected on these lands.

Compensation Strategy for Conservancy Fairy Shrimp

The only known population of Conservancy fairy shrimp in the Study Area occurs on CNR lands, although some unsurveyed suitable habitat may be present in the Study Area. Effects on Conservancy fairy shrimp have been addressed for the Applicants' Proposed Projects through avoidance of direct effects by means of project siting and design, and through measures to prevent indirect effects from the adjacent campus. The Parameters also specify, as a project commitment, that no effects on Conservancy fairy shrimp, including the watershed of the pool in which it occurs, will result from the Proposed Actions. The University configured the CNR in such a way that it would encompass the entire watershed of the playa pool occupied by Conservancy fairy shrimp; this watershed is protected by a conservation easement and commitments to provide protective management. Accordingly, even if the location or configuration of the Proposed Actions should differ from those of the Applicants' Proposed Projects, the conservation easement and commitments to provide protective management for the CNR will continue to apply.

The Parameters also specify that indirect effects on Conservancy fairy shrimp and its watershed will be avoided and minimized to the maximum extent practicable and that any unavoidable indirect effects on habitat occupied by the species will be compensated through preservation of habitat in areas approved by the Service. The University has committed to monitoring and management of the CNR to minimize and avoid direct effects. If the Proposed Actions occur at the Applicants' Proposed Projects site, all additional protection measures (to address potential effects of the adjacent campus) will be implemented. Siting of the Proposed Actions elsewhere may diminish the need for these protections.

The specific measures identified to protect the CNR from disturbance on adjacent campus lands include ongoing monitoring and management of the CLR and CNR to minimize potential threats from alteration of hydrology, degradation of water quality, establishment of invasive plant species, unauthorized human use, competition or predation from nonnative species, and other threats. Because habitat for Conservancy fairy shrimp will not be disturbed by Campus construction activities and will be protected from indirect effects, no other habitat compensation is proposed for this species.

If the Preferred Alternative for Campus Buildout is relocated from the site of the Applicants' Proposed Projects to a new location within the Study Area, any potential habitat for Conservancy fairy shrimp that might be affected would be identified and surveyed. If surveys indicate the species is present, the occupied pool and its watershed would be avoided, as specified in the Parameters, and any indirect effects would be minimized using appropriate techniques as described above. Because direct effects would be avoided under the Proposed Action, no other habitat compensation may be necessary.

Compensation Strategy for Other Protected Vernal Pool Crustaceans

The previously described avoidance and minimization measures for vernal wetlands and Conservancy fairy shrimp will provide protection for other protected crustaceans (i.e., vernal pool fairy shrimp, vernal pool tadpole shrimp, and midvalley fairy shrimp). Moreover, previously described measures addressing vernal wetland habitat restoration will restore habitat that may by suitable for these species. Nonetheless, some loss of occupied or potential habitat for these species could occur under the Proposed Actions and is expected to occur under the Applicants' Proposed Projects.

The Parameters specify that the nature and extent of proposed compensation, including ratios, will be at least equivalent to those identified in the BA (EIP 2002). Although wetland acreage has not been precisely quantified on the other 20,288 acres acquired by WCB, preliminary estimates indicate that at least 2,100 acres of suitable vernal wetland habitat (i.e., vernal pool, clay playa, pool/swale complex, and mima mound habitat) are present on these lands, see Table 4-3 in the Supplemental BA (Jones & Stokes 2002).

Compensation Strategy for San Joaquin Kit Fox

As specified in Parameter 2b, the Applicants have agreed to prepare and implement, in coordination with the Service and CDFG, a comprehensive strategy for the conservation of the San Joaquin kit fox. The strategy will address a migration corridor east and north of the Applicants' Proposed Projects site; this corridor will be maintained through land acquisitions (fee title or conservation easement) as well as other actions, if feasible, such as enhanced passage over existing MID canals. The Parameters specify that such land acquisitions will be consistent with the establishment of a connection to the Sandy Mush Road area.

The 806-acre Campus Buildout area within the Applicants' Proposed Projects is potential habitat that is suitable for long-distance movement and as potential denning and foraging habitat for the San Joaquin kit fox. The University has agreed to compensate for the removal of this habitat at a ratio at or above the 3:1 standard typically required by the Service. All protected lands for which fee title or easements have been acquired by the University [VST and CNR and WCB) (Figure 4)] are considered suitable kit fox habitat. As described in the RMP for the Project BA (Jones & Stokes 2002), the acquisition and management of VST and CNR lands would protect 5,780 acres.

Potential effects of the Applicants' Proposed Project on kit fox movement have been compensated through acquisition of lands to provide a corridor along the east and north sides of the proposed Campus and University Community [acquisition and management of CNR, VST, and Cyril Smith Trust (CST) lands] and by WCB preservation of other lands within the general movement corridor in eastern Merced County. Construction of additional crossings of the MID canals in the Study Area that have been proposed for Phase 1 would also, if approved by MID, improve potential for kit fox passage in this area. These actions are considered consistent with and supportive of the establishment of a connection with the Sandy Mush Road area. Figure 3 provides a map of existing and proposed kit fox crossings over the various canals.

Incorporation of Adaptive Management and Monitoring into Management Plans

Management Strategies for University-owned Lands

Pursuant to the overall management plans, the University will include detailed management and monitoring measures for the CNR and VST lands, which will be under conservation easement regardless of the location of the Preferred Alternative. The Management Plan will include:

- compensation goals and measurable objectives;
- maps and descriptions of the management area; compensation habitat within each site; and any areas to be enhanced, restored, or used for habitat creation;
- description of how the compensation habitat meets preserve criteria specified in the RMP;
- descriptions of the mechanisms (e.g., conservation easement, deed restrictions) to protect the compensation habitat in perpetuity, and the appropriate land use restrictions to prevent incompatible activities;
- identification of the parties responsible for implementing the management and monitoring plan;
- description of and restrictions on recreational, educational, and scientific activities that will be permitted in the compensation habitat and protocols for approving specific research and educational uses;
- methods for controlling/eliminating unwanted or illegal uses of the property;
- details regarding planned habitat restoration/enhancement measures;
- monitoring measures, protocols, length of monitoring periods;
- short-term and long-term maintenance and adaptive management measures to adjust management based on monitoring results; and
- funding assurances for restoration/enhancement, long-term monitoring, management, and reporting provided by the University.

The Management Plans also will address active management for the CNR and VST remainder property, and the conservation easements will allow the following management measures:

- grazing management practices;
- control of invasive plant and animal species; and
- fuel management practices.

Management Strategies for WCB Preserve Lands

The Management Plan would also establish the management measures and maintenance of preserve lands under WCB easements. The properties that currently are or will be under WCB conservation easements possess significant conservation values. The intent of the easement program is to support habitats that preserve and maintain these values. Although WCB easement lands may be managed differently from University-controlled preserve lands, under the terms of the easements, habitats will be protected and maintained including unplowed grasslands, vernal pools, swales and other wetlands, natural stream courses and waterways, unfragmented open space, and corridors for the unimpaired passage of wildlife. These natural communities provide habitat for many rare and common native wildlife species including raptors, waterfowl, and vernal pool plants and animals.

Management of WCB preserve lands will be conducted under the terms of the conservation easements in place for each property. Thus, the conservation values would be preserved and maintained subject to the terms and conditions of the conservation easements through ranching and grazing activities that do not diminish or impair the conservation values and that can in some ways support and enhance the conservation value. Conservation easements will allow the easement holder to work with the landowner to preserve, protect, identify, monitor (including the right to access the property to conduct evaluations of wetland quantity and quality, evaluations of habitat quantity and quality, and to survey for threatened and endangered species and monitor their populations), enhance, and restore in perpetuity the conservation values. As described above, any future easement terms will be examined to ensure that they are adequate for lands that are determined to be critical to meeting the Parameters and other compensation and mitigation needs of the Proposed Actions, including the monitoring of and access to preserve lands to assure that management measures are achieved and effective. Management objectives include maintaining cattle ranching as the primary land use through the acquisition of compatible conservation easements, maintaining healthy populations of special status species, and improving the ecological health of the area by encouraging modifications to ranching practices such as fencing riparian areas to allow seasonal grazing, as well as encouraging other practices conducive to the improvement of habitat. Parameter 2 (a) will require close coordination with easement holder(s) and state and local agencies to provide access for management and monitoring activities.

<u>Adopted Conservation Measures for Phase 1 Campus Project</u>

As previously noted, a specific location and design for the Phase 1 Campus have been determined. Its impacts are subject to evaluation based on the described project and the adopted Conservation Measures. Although the Phase 1 Campus project will result in minimal effects on listed species because of the absence of vernal pools and other wetland habitats within the Phase 1 Campus boundaries, detailed conservation measures applicable to Phase 1 have been incorporated into the Phase 1 Campus design to ensure that effects are avoided or minimized (see Figure 3). These conservation measures focus on indirect effects on adjacent wetland-dependent listed species and on the San Joaquin kit fox.

Design Measures

- Control stormwater and irrigation runoff to avoid and minimize effects on natural hydrology and vernal pool ecosystems. The University will control stormwater drainage for the Phase 1 Campus site through design measures to direct runoff to appropriate stormwater detention facilities within the Campus. This runoff will then be discharged to existing drainages at rates that maintain current hydrologic conditions. Facilities at the periphery of the campus will be designed to ensure that runoff does not flow into adjacent habitats, even in substantial rain events. This measure will minimize alteration of natural hydrologic regimes, sediment and nutrient loading, and introduction of pesticides or other hazardous material in runoff, thereby avoiding and minimizing indirect effects on aquatic systems in areas outside the Phase 1 Campus that may support listed species.

- No stormwater runoff from the Phase 1 Campus will be discharged into adjacent vernal pool and seasonal wetland habitat areas. Similarly, design of drainage facilities and systematic use of water conservation measures will prevent irrigation runoff from ornamental landscaping to vernal pool ecosystems. (See Operations and Maintenance Measures for further discussion of management of ornamental landscapes following Phase 1 Campus construction.)

- Construct perimeter fencing to discourage human and pet disturbance of adjacent habitat areas. The University will design and construct perimeter fences along the Phase 1 Campus boundary within 1 mile of habitat areas that are known or have potential to be occupied by listed species prior to campus construction. To discourage entry of dogs into adjacent habitats, fencing will utilize a lower hog-wire mesh panel (i.e., a 2-inch mesh on a 24- to 30-inch lower panel) or other means to discourage dog passage.

- Incorporate measures into lighting design to minimize escape of light into habitat areas. To minimize effects of introducing light from the Phase 1 Campus into adjacent habitat areas that may be suitable for the San Joaquin kit fox, California tiger salamander, and other species, the Campus exterior lighting system will be designed to locate, shield, and direct lighting to minimize stray "trespassing" of light into occupied and suitable habitats.

Construction Measures

The University will develop and implement a comprehensive Construction Mitigation Plan to avoid and minimize potential for direct disturbance of listed species within and adjacent to the Phase 1 Campus site. The Construction Mitigation Plan will be approved by the Service before the University initiates ground-disturbing activities. The Plan will be implemented during construction. Measures specified in the Plan are further described below.

- Designate an environmental monitor. An environmental monitor will be employed by the University to monitor and/or implement construction conservation measures and to report on compliance of contractors with conservation requirements. The monitor will report directly to the Campus Environmental Manager. The monitors will be qualified and permitted to conduct required conservation activities and to report on compliance issues. Based on reports of noncompliance with environmental requirements, the Campus Environmental Manager will be authorized to stop work to assess noncompliance and prevent further resource damage.

- Report on environmental monitoring results. Monitoring reports will be filed regularly according to schedules established in the Phase 1 Campus Construction Mitigation Plan. Reporting schedules will be determined based on the potential for threats to listed species and other environmental resources. For example, daily reporting may be required during initial ground-disturbing activities when substantial environmental conservation measures are employed, whereas monitoring frequency may be reduced after initial site development to reflect lower potential for effects. Reports will be submitted to the Service and CDFG.

- Incorporate species protection obligations into construction contracts. All contracts between the University and contractors and between construction management firms and subcontractors will include the provisions identified in the BA, this biological opinion, and Service-approved construction plans for protecting listed species and habitats as terms and conditions. Specific penalties for violations will be identified in construction contracts; the penalties could include warnings, removal of individual violators from the project, termination of contacts, and payment of damages.

- Conduct environmental sensitivity training for all construction personnel. Prior to initiating work at the construction sites, all construction personnel will receive training regarding the sensitive nature of the areas adjacent to the Phase 1 Campus and their obligations to protect sensitive resources. The training materials will be submitted to the Service and other agencies for approval prior to initiation of training. Training materials will be prepared in both English and Spanish and will be translated to other languages if necessary. At a minimum, the training will include descriptions of the species at risk and their habitats, the importance of the species and their habitats, the general measures that are being implemented to conserve sensitive areas/species as they relate to the project, and the boundaries within which the project may be accomplished. Specific obligations of construction personnel and consequences of violating work requirements will be provided. Videos, brochures, books, and briefings may be used in the training session.

- Incorporate best management practices. Standard construction BMPs will be incorporated into construction designs and plans and specifications; contractors will be required to employ these BMPs during construction. These practices will include dust-control measures; erosion reduction and sediment control (including use of silt screens, sediment fences, weed-free straw bales, sand bags, and water bars); and restricted equipment refueling and maintenance practices. A spill-response plan will be prepared for the site to ensure prompt capture and clean-up of any accidental releases of fuels or any other hazardous materials in use at the site.

- Fence project boundaries and sensitive resources. Temporary or permanent fencing will be installed by contractors under the direction of environmental monitors prior to initiation of construction activities along the boundaries of the construction areas within the Phase 1 Campus site and adjacent areas of suitable habitat. These fences will be installed to prevent construction vehicles from straying into adjacent habitats suitable for listed species.

- Implement construction measures to minimize take of the San Joaquin kit fox. Preconstruction surveys will be conducted in construction areas in accordance with the kit fox protocol described in the Service's (1999*a*) Standardized Recommendations for Protection of the San Joaquin Kit Fox Prior to or During Ground Disturbance. These surveys will be conducted in areas of suitable annual grassland habitat to be disturbed on the Phase 1 Campus site and within a 250-foot buffer around such areas. Surveys will be completed prior to any ground disturbance to eliminate or minimize any possibility of injuring or harassing this kit foxes. Preconstruction surveys for kit fox dens will be conducted no more than 30 days prior to any construction-related activities. Dens found to be inactive within the site or buffer will be hand excavated by a biologist to a depth at which the den becomes fewer than 4 inches in diameter. If an active kit fox den is detected within or immediately adjacent to the area of work (i.e., within 250 feet), construction will stop within 250 feet of the den, and the Service and CDFG will be consulted to determine how to proceed.

The following measures will be imposed on construction personnel to protect kit foxes from harm during construction:

1) all food-related items will be properly stored, trash will be disposed and removed offsite, and signs indicating that the feeding of wildlife is prohibited will be placed at the construction site;

2) construction-related vehicle traffic will occur primarily between dawn and dusk and will be limited to 20 mph on unpaved roads to reduce the potential of road mortality of kit foxes;

3) any trench or pit will be covered or provided with escape ramps at the end of each work day to prevent kit foxes (or other species) from becoming entrapped;

4) pipes, culverts, etc., more than four inches in diameter will be stored in such a way as to prevent foxes or other species from using these areas as temporary refuges, and these structures will be thoroughly inspected each morning for kit foxes or other species prior to being moved;

5) no firearms will be allowed on the construction sites; and

6) no pets will be permitted on construction sites.

- Implement construction measures to minimize effects on California tiger salamander. The golf course is not considered to support suitable breeding habitat for the tiger salamander, and aestivation habitat is limited or absent. Based on previous surveys, breeding ponds are isolated from the project site by MID canals, although a small possibility exists that a small tiger salamander population persists on adjacent lands. The following measures will be coordinated with CDFG and the Service.

1) Winter surveys will be conducted at vernal pools and ponds on the project site and in areas within 0.6 mile of the project site from which tiger salamanders could access the site.

2) For construction activities within 0.6 mile of occupied breeding ponds, drift fences (or other effective salamander barriers) will be erected around the

construction area before February 1 in the winter prior to the start of construction to exclude breeding salamanders from the construction site.

- Prevent introduction and establishment of invasive species. To discourage establishment of invasive species within the Phase 1 Campus, construction contracts will include requirements that any plant materials, seeds, or other organic material (e.g., hay) used during project construction for erosion control or revegetation of disturbed areas be free of invasive species. Furthermore, all earthmoving equipment will be washed to remove vegetative material before being brought onsite.

- Conduct post-construction monitoring and conservation. Post-construction monitoring will be conducted to verify completion of conservation requirements for project completion. Subsequent monitoring will be conducted to document the effectiveness of design and conservation measures applied to prevent or reduce effects on listed species' habitats (e.g., erosion control, function of drainage systems) for time periods specified in the site-specific Construction Mitigation Plan. If measures are determined not to meet conservation performance standards, remediation will be performed to correct the problems; these remedial measures will be further monitored.

Monitor vernal pools adjacent to Phase 1. The University will undertake monitoring of vernal pools adjacent to Phase 1 to evaluate whether conservation measures were effective in avoiding and minimizing effects on vernal pools and associated species. The monitoring program will be conducted for 5 years unless and until a subsequent permit is issued that authorizes the loss of the subject vernal pools.

A total of seven vernal pools that are within 250 feet of the Phase 1 boundary (subject pools) will be monitored for effects of Phase 1 development. In addition, a similar number of vernal pools of similar character (i.e., depths and plant communities) located clearly outside of any area of potential effect also will be monitored in a similar manner (reference pools). A comparison of monitoring results from the subject and reference vernal pools will provide a basis for determining whether any observed changes in the character of subject pools are more likely to be a result of normal annual or seasonal variations or an indirect impact from adjacent development.

Monitoring will be conducted to characterize the duration and extent of inundation and turbidity in pools. To conduct monitoring, a staff gage (graduated in inches or 0.1 feet) will be installed in each subject and reference vernal pool. Water depths will be monitored on a biweekly basis throughout the rainy season until the vernal pools desiccate in the spring. Turbidity will be monitored by estimating visibility within pools and recording any other indications of suspended sediment. This type of vernal pool naturally has relatively low turbidity; higher turbidity would be considered as an indication of erosion or sedimentation upstream in the watershed.

Vegetation in each of the monitored vernal pools will be surveyed each spring during the height of the flowering period after the pools dry out. The relative abundance or cover of each species occurring in the pools will be identified. Each plant species observed in the vernal pools will be classified as a vernal pool endemic, vernal pool associate, other wetland species, or upland species. Vernal pool endemics are those species found almost exclusively in vernal pools. Vernal pool associates are those species that may be commonly found in vernal pools but are also commonly found in other types of seasonal wetlands. Other wetland species are those species that normally occur in wetlands but very rarely, if ever, are found in vernal pools. Subject and reference vernal pools will be compared on the basis of abundance or cover of individual species and by species categories. This monitoring will be conducted by a qualified botanist.

In addition to the monitoring described above, the immediate perimeter of the Phase 1 site will be monitored on a monthly basis to determine if any trash, debris, or other materials have been disposed of outside the perimeter fence. This survey will also include monitoring to evaluate if any surface runoff from within Phase 1 is being released to adjacent lands. If any problems are identified, they will be immediately reported to the Service and the Corps and corrected.

Operations and Maintenance Measures

Management of the Remaining Golf Course Area: The University has agreed that it will not irrigate the portions of the golf course outside the Phase 1 Campus boundary, and vegetation will be managed by mowing or cattle grazing during the period prior to development of Campus Buildout under the Applicants' Proposed Projects. No pesticides (insecticides, herbicides, or rodenticides) will be applied except as necessary to control noxious weeds that may threaten adjacent lands, and then only if such application is consistent with a management plan approved by the Service and CDFG. These measures are expected to improve the habitat values associated with portions of the golf course outside of the Phase 1 boundary. The Service has indicated that these enhancements will not, however, increase the overall level of compensation required by the University in connection with the conversion of the golf course, as a whole, to campus uses.

Fire Protection: To provide for fire protection during operations, a firebreak will be constructed within a 30-foot swath located primarily within the Phase 1 Campus boundary. The firebreak may be located within the remainder of the golf course where it abuts the Phase 1 Campus. Preconstruction den surveys for kit fox (see measures above) will be conducted within suitable habitat to be affected by the construction of the firebreak.

Measures to Minimize Effects of the Phase 1 Campus on Adjacent Habitats

These measures entail the management actions that will be undertaken during management of the Phase 1 Campus and other acquired University lands to protect habitat values for listed species on adjacent lands and to minimize effects of the Campus on these lands.

Measures to be incorporated into the Campus Facilities Management Plan include public education, leash laws and enforcement, restrictions on use of pesticides in Campus landscape management through development of an IPM plan, restrictions on use of invasive plants in landscaping, control of invasive weeds in undeveloped areas of the Campus, and monitoring activities. The University Environmental Manager will be responsible for ensuring that these requirements are integrated into the various elements of the overall Campus facilities management program (e.g., work program descriptions, training programs).

- Implement a continuous public education program. The University will develop and implement a continuous public education program at the Campus to inform students, staff, and faculty of sensitive resources outside the perimeter of the Phase 1 Campus (especially the CNR area occupied by Conservancy fairy shrimp, as well as VST and other easement lands) and the need to protect these resources. The initial public education program will be approved by the Service, but will be designed to be adaptive in response to observed educational needs. This will be an ongoing program in recognition of the need for frequent communication with a transient student population. The education program will also be designed and implemented to ensure communication with non-English-speaking Campus staff.

  Communications will include a variety of media and contact methods. These could include orientation materials for new students, outreach through Campus publications, and curriculum to educate residents about unique biological resources, signage of Campus boundaries near sensitive areas, incorporation of information on sensitive resources into the curriculum, and carefully supervised involvement of students in the management and monitoring of University lands supporting sensitive resources, including the CLR and CNR.

  The University may consider developing an interpretive exhibit and a limited interpretive trail system on existing roads within future Campus lands or the CLR. Such a system would allow students and other residents to learn about and appreciate the unique natural resources of the area and these resources' sensitivity to disturbance. Any such program would be carefully located and managed to minimize effects on biological values of habitats and listed species and be subject to review and approval by the Service.

- Establish Campus-wide leash laws and an animal control program. The University will enact and enforce leash laws for the Campus to discourage movement of free-ranging dogs onto adjacent habitat areas, including the CLR and CNR. The University will likely enter into an MOU with Merced County Animal Control for this service. Enforcement personnel will be educated regarding the importance of control and limits of control actions within the Reserves.

- Prevent damage from herbicides and pesticides. To avoid and minimize potential for effects on listed species from drift of herbicides and other pesticides, a pesticide use plan that outlines accepted conditions for uses of herbicide and other pesticides will be prepared and approved by the Service as a part of the overall IPM plan for the Phase 1 Campus. Potential restrictions may include restrictions of certain compounds, modes of application, conditions of application (e.g., wind speeds, proximity to the CLR), and maintenance activities.

- Discourage establishment of invasive weeds. Invasive weeds will be controlled through management of the Phase 1 Campus. Management practices will include restricting landscape use of species that may pose threats to surrounding lands, establishing an ongoing IPM program for weed control on developed lands, and controlling weed populations that establish on the Campus during construction activities or on vacant lands prior to construction.

Compensation Measures for Phase 1

Phase 1 of the UC Merced project will primarily affect the existing golf course and approximately 12 acres of associated grassland habitat. The grassland habitat was previously graded during golf course construction. No wetland areas suitable for vernal pool species will be affected by Phase 1 Campus construction. Development of the golf course could result in effects on the kit fox through habitat loss that could affect fox movements in the Study Area. Therefore, the University has agreed to commit to implement conservation measures to protect and enhance habitats in the immediate vicinity of the Phase 1 Campus, prior to or simultaneous with actions at the Phase 1 site. These measures include acquiring and managing a wetland compensation site 0.5 mi. southeast of the Phase 1 site to provide additional benefits for kit fox, temporary reversion of the golf course to grassland habitat during the period before commencement of Campus Buildout construction, and initiating protective management to provide temporal benefits attributable to enhancement on the CNR and VST remainder lands. These measures are discussed in the following sections.

Conservation Measures for San Joaquin Kit Fox

The proposed conservation measures would include acquisition and protection of a 96-acre area located east of the Phase 1 Campus. This area has been set aside as a vernal pool conservation area to address prior activities related to construction of the golf course. A conservation easement for the property, subject to review and approval by the Service and the Corps, will be granted to The Nature Conservancy, but the University will retain responsibility for long-term protection and management of the site. This site will be managed to maintain and enhance its capability to support San Joaquin kit fox.

In connection with Phase 1, an additional canal crossing will be situated to encourage kit fox access to the CNR/VST/CST corridor lands that are protected under easement. This crossing is expected to be placed on the east side of the proposed Campus Community and would provide access for construction and monitoring of the Phase 1 wetland compensation site.

In addition, approximately 94 acres of the existing golf course will be allowed to return to its "natural" condition and will no longer be managed as a golf course. This area is expected to become dominated within several years by nonnative annual grasses typical of surrounding lands. The area may receive limited irrigation to encourage transition to natural conditions and to discourage colonization by noxious weeds. The passive restoration of this area to nonnative grassland habitat will afford improved habitat for kit foxes immediately adjacent to the Phase 1 Campus. The enhancement of the golf course remainder is considered to partially offset any potential effects of the loss of golf course and adjacent grassland habitats during construction of Phase 1. As this area is within a later phase of the Applicants' Proposed Projects, this area will not be afforded permanent protection.

Enhancement will be accomplished by allowing xeric vegetation to expand from within the site and to colonize from adjacent lands in response to elimination of golf course maintenance practices (frequent mowing, irrigation, fertilization, and weed control). The modifications will not include any substantial efforts to reestablish natural land forms and vegetative communities. Vegetation will be managed by mowing or cattle grazing during the period prior to development of Campus Buildout. No pesticides (insecticides, herbicides, or rodenticides) will be applied except as necessary to control noxious weeds that may threaten adjacent lands, and then, only if such application is consistent with a management plan approved by the Service, the Corps, and CDFG.

Management of the Campus Natural Reserve and VST Remainder Property for Multiple Species

The University has acquired and will manage the lands identified in the Applicants' Proposed Projects as the CNR and the VST Remainder Property. The advance acquisition and preservation of these lands prior to Phase 1 construction will provide temporal benefits for San Joaquin kit fox and other species.

Adopted Environmental Commitments for the Infrastructure Project

Habitat Mitigation Plan

Merced County has developed a Habitat Mitigation Plan to avoid, minimize, and compensate for impacts to biological resources resulting from implementation of the Infrastructure Project. In addition, the HMP describes a process for determining mitigation standards to be applied to the Infrastructure Project based upon site-specific habitat evaluation of both the project site and the preserve lands. The HMP includes the following elements: avoidance and minimization element, compensation element, and monitoring and adaptive management element.

Avoidance and Minimization Element: Measures to avoid and minimize effects of the Infrastructure Project will be incorporated into the final infrastructure design plan. These measures include, at a minimum, specific design features such as surface water management (storm drainage and treatment facilities) roadway culverts to maintain watershed integrity, and perimeter landscaping and fencing. the storm drainage system is designed to capture the storm water run-off from impervious roadway surfaces. Several in-channel settling basins will provide passive water quality treatment.

Construction Measures: Merced County Department of Public Works will prepare and implement a construction mitigation plan for the Infrastructure Project containing, at a minimum: incorporation of best management practices, incorporation of conservation measures into construction contracts, training for construction personnel, construction fencing, salvage of plants and invertebrates, construction measures to avoid kit fox take, invasive species control, and environmental compliance monitoring. The construction mitigation plan will be subject to review and approval by the Service.

Compensation Element: The Compensation Element provides for the development of compensation measures based on compensatory mitigation standards which require that all impacts to wetland habitats and species be mitigated fully by achieving no net loss of wetland functions and values within the region over the life of the Infrastructure Project. The mitigation standards will be based upon an evaluation of site-specific habitat functions and values. No fewer than 3 acres of wetlands will be preserved, enhanced, restored and/or created for each acre of wetlands preserved. Associated upland habitats will be preserved at no fewer than 9 acres of upland for each acre of wetland preserved.

Monitoring Element and Adaptive Management: The Monitoring Element and Adaptive Management program are designed to maintain and improve habitat functions and values and to sustain existing populations of sensitive species on the preserve lands. Site specific monitoring and adaptive management will be subject to Service approval and will include a description of the management actions necessary to meet conservation objectives, monitoring requirements, short-term and long-term maintenance and adaptive management measures to adjust to monitoring, and a description of corrective measures. Adequate funding assurances (i.e., a performance bond) will be provided in an amount sufficient to cover the costs of designing and implementing an adequate mitigation plan.

Adopted Environmental Commitments for the Campus Community

The Conservation Measures for the Campus Community (an interrelated and interdependent project) are based upon on the objectives and policies contained in the draft UCP. The draft UCP includes objectives and policies intended to mitigate adverse effects to biological resources. Pursuant to these policies, the County either will expand the Infrastructure Project HMP (described above) to address additional resource impacts of the Campus Community or it will develop project-specific HMPs for each individual project within the Campus Community.

The draft UCP provides for the protection of wetland resources in eastern Merced County by ensuring no net loss of wetlands functions and values through habitat preservation, restoration, creation, and/or enhancement. To achieve this objective, mitigation standards would be developed based on a habitat function and valuation process. Protected habitat would be monitored and managed to maintain wetland habitat quality. The County would ensure that direct and indirect effects to wetlands habitats are minimized through promotion of environmentally sensitive project siting and design at the specific plan level and in accordance with the Parameters. As described in Chapter V of the original BA for the Applicants' Proposed Projects, additional conservation measures for listed or proposed species would be implemented including, preservation of vernal-pool grassland habitats to support vernal pool species and fleshy owl's-clover, preservation of foraging habitat for mountain plover and Swainson's hawk, and preservation of grassland habitat to compensate for potential effects on the San Joaquin kit fox.

Status of the Species

Fleshy Owl's-clover (*Castilleja campestris* subspecies *succulenta*)

The Service (1997*a*) listed fleshy owl's-clover as federally threatened in 1997. California State Fish and Game Commission listed the same taxon with the common of succulent owl's-clover as endangered in 1979 (California Department of Fish and Game 1991). The California Native Plant Society considered the species to be rare and endangered 5 years earlier (Powell 1974) and still includes fleshy owl's-clover on its List 1B, noting that it is "endangered in a portion of its range" (Skinner and Pavlik 1994) and "fairly endangered in California" (Tibor 2001). As of 2000, the California Department of Fish and Game regards the status of fleshy-owl's clover to be declining (CDFG 2001).

Robert Hoover (1936*a*) first named fleshy owl's-clover, giving it the scientific name *Orthocarpus campestris* variety *succulentus*. The type specimen had been collected at Ryer, in Merced County. Hoover (1968) raised fleshy owl's-clover to the rank of species and assigned it the name *Orthocarpus succulentus*. Chuang and Heckard (1991) reconsidered the taxonomy of *Orthocarpus* and related genera. Based on floral morphology, seed morphology, and chromosome number, they transferred many species into the genus *Castilleja*. Furthermore, they determined that the appropriate rank for fleshy owl's-clover was as a subspecies of field owl's-clover (*Castilleja campestris*). Thus, the scientific name currently assigned to fleshy owl's-clover is *Castilleja campestris* subspecies *succulenta*, whereas field owl's-clover is *C. campestris* subspecies *campestris* (Chuang and Heckard 1991). Owl's-clovers are members of the figwort or snapdragon family (Scrophulariaceae). Another common name for fleshy owl's-clover is succulent owl's-clover (Skinner and Pavlik 1994).

Life History and Habitat

Fleshy owl's-clover has rather intricate flowers. The corolla consists of two lips. The upper lip is narrow, pointed, and beak-like; whereas the lower lip has three sac-like pouches topped by three tiny upright lobes. Each anther contains two sacs, which differ in size and are offset on the filament. Immediately below the corolla is the calyx, which is the set of sepals. Fleshy owl's-clover has four sepals that are fused at the base, creating the calyx tube. Together, all the flowers plus the bracts comprise the inflorescence.

Fleshy owl's-clover has erect or decumbent stems up to 11.8 inches long. The stems are usually unbranched and without hairs. The leaves at the base of the stem are small and scale-like, whereas those on the upper stem are 0.6 to 1.6 inches long, lance-shaped, not lobed, thick, fleshy, and easily broken. The bracts are green, similar to but shorter than the upper leaves, and longer than the flowers. Overall, the inflorescence may occupy as much as half of the plant's height and be 0.8 to 1.2 inches wide. The flowers are closely spaced within the inflorescence. Within a single flower, the sepals are fused to varying degrees, so the calyx is not symmetrical. The corolla is yellow or orange and 0.4 to 0.6 inch long, with the upper lip slightly longer than the lower. The stigma reaches just to the tip of the upper lip. The lower anther sac is approximately half as long as the upper sac. Seed capsules are 0.20 to 0.28 inch long and contain many dark brown, spindle-shaped seeds (Hoover 1936*a*, Hoover 1937, Hoover 1968, Heckard 1977, Chuang and Heckard 1991, Chuang and Heckard 1993). Fleshy owl's-clover has a diploid chromosome number of 24 (Chuang and Heckard 1993).

The brittle leaves are key characteristics for identification of fleshy owl's-clover. The most similar taxon is field owl's-clover. Field owl's-clover has branched stems; thin, flexible, non-fleshy leaves; larger, lighter-yellow flowers; a stigma that protrudes beyond the upper lip of the flower; a lower anther sac that is no more than one-third the size of the upper; and more rounded seeds. Field owl's-clover occurs farther north than does fleshy owl's-clover (Hoover 1937, Hoover 1968, Heckard 1977). Other *Castilleja* species have lobed leaves and bracts, and the bracts are often colored.

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

The conditions necessary for germination of fleshy owl's-clover seeds have not been studied, nor has the timing of seed germination been documented. Flowering occurs in April and May (Skinner and Pavlik 1994). Although many related taxa of *Castilleja* are pollinated by generalist bees (Superfamily Apoidea) (Chuang and Heckard 1991), fleshy owl's-clover is thought to be self-pollinating (Heckard in litt. 1977). Among close relatives that do not require insect pollinators, flower structure and timing of stigma receptivity maximize the chances for self-fertilization and seed set. Even so, insects may transfer some pollen among individual plants and species occurring in the same area. Self-pollinating species of *Castilleja* typically occur as widely scattered individuals, rather than in dense colonies (Atsatt 1970). Fleshy owl's-clover follows this pattern in part, often occurring in many pools within a complex but with fewer than 100 plants per vernal pool. However, fleshy owl's-clover also may occur in large populations within a single vernal pool [California Natural Diversity Data Base (CNDDB) 2000]. Little is known about the demography of fleshy owl's-clover, although occurrence size can fluctuate greatly from year to year. In the few instances where occurrence size was reported for more than 1 year, fluctuations up to two orders of magnitude were noted (CNDDB 2000).

The soil types and series have not been reported for all of the areas and occurrences where fleshy owl's-clover grows. At the proposed University of California-Merced site, 81.4 percent of the individual vernal pools where this taxon was found were in vernal pools on Redding gravelly loam, 9.5 percent were on Corning gravelly sandy loam, 6.4 percent were on Corning gravelly loam, 1.7 percent were on Keyes gravelly loam, 0.7 percent were on Keyes gravelly clay loam, and 0.3 percent were on Pentz loam soil mapping units (EIP Associates 1999*a*).

Occurrences of fleshy owl's-clover have been reported from elevations of 80 feet at the San Joaquin County site to 2,300 feet at Kennedy Table in Madera County (CNDDB 2000). Plants most commonly reported as occurring with fleshy owl's-clover are Fremont's goldfields (*Lasthenia fremontii)* (EIP Associates 1999*a*), downingia, three-colored monkey-flower (*Mimulus tricolor*), vernal pool popcorn flower (*Plagiobothrys stipitatus*), and coyote-thistle (*Eryngium* species) (CNDDB 2000). Other special status plants variously and irregularly grow with fleshy owl's-clover at one to five sites each; these include Colusa grass (*Neostapfia colusana*), San Joaquin Valley Orcutt grass (*Orcuttia inaequalis*), hairy Orcutt grass (*Orcuttia pilosa*), Boggs Lake hedge-hyssop (*Gratiola heterosepala*) (EIP Associates 1999*a*, CNDDB 2000), and spiny-sepaled button-celery (*Eryngium spinosepalum*) (EIP Associates 1994).

<u>*Historical and Current Distribution*</u>

Between 1937 and 1986, fleshy owl's-clover was reported from 33 localities (Hoover 1937, Hoover 1968, CNDDB 2000), all in the Southern Sierra Foothills Vernal Pool Region (Keeler-Wolf *et al.* 1998). Sixteen of those occurrences, including the type locality, were in eastern Merced County. Six occurrences each were in Fresno and Madera counties and five others were in Stanislaus County (CNDDB 2000). Although only 6 of the 33 historical occurrences of fleshy owl's-clover have been visited since they were first reported, the California Natural Diversity Data Base (2000) presumes that 32 of them are extant because no evidence to the contrary has been submitted. One occurrence in Fresno County is considered to be "possibly extirpated" (CNDDB 2000) because the site had been disced when it was last visited in 1981. Since 1990, 18 new localities for fleshy owl's-clover have been discovered; 12 of them have been cataloged as element occurrences by the California Natural Diversity Data Base but the other data have not yet been processed. Among these localities are seven in Fresno County, five in Merced County (one of which is extensive), five in Madera County, and one in northern San Joaquin County (EIP Associates 1994, EIP Associates 1999*a*, CNDDB 2000).

An extensive occurrence of fleshy owl's-clover occurs in the action area of the proposed UC Merced campus and its associated community. Fleshy owl's-clover has been found in 296 vernal pools in the proposed campus and community area, although only 34 percent of the area was surveyed intensively (EIP Associates 1999*a*). Considering the criteria that the California Natural Diversity Data Base uses to define element occurrences, the documented localities in that area are estimated to comprise at least 25 element occurrences (calculated by E. Cypher from maps in EIP Associates 1999*a*). Counting the 44 element occurrences already catalogued (CNDDB 2000), the estimated 25 on the proposed UC Merced site, and assuming that each of the five other uncatalogued localities represent a single element occurrence, 74 occurrences of fleshy owl's-clover are now presumably extant. All but one of these occurrences are in the Southern Sierra Foothills Vernal Pool Region; the San Joaquin County occurrence is in the Southeastern Sacramento Valley Vernal Pool Region (Keeler-Wolf *et al.* 1998).

The primary area of concentration for fleshy owl's-clover is in eastern Merced County, northeast of the city of Merced. In addition to the proposed University of California campus and community, this area includes the Flying M Ranch and adjacent ranch land. At least 45 occurrences (19 catalogued element occurrences, the 25 estimated above, plus 1 additional occurrence that has not been catalogued), or 61 percent of the total known, occur in this area of concentration. A secondary area of concentration is in southern Madera County and northern Fresno County from just west of Highway 41 east to Academy and north to Miller's Corner, with 15 occurrences (20 percent). Two smaller areas of concentration, which include five occurrences (7 percent) each but contain large numbers of plants, are near Cooperstown in Stanislaus County and the "tabletop" mountains near Millerton Lake in Fresno and Madera counties. Scattered occurrences include two (3 percent) at Castle airport northwest of Merced, one (1 percent) near Wildcat Mountain in Fresno County, and the one (1 percent) in San Joaquin County. Large areas of suitable habitat remain unsurveyed, particularly in northern Merced County (EIP Associates 1999*a*) and between the northern Stanislaus County and northern San Joaquin County sites (Stebbins in litt. 2000*b*); thus, additional occurrences are likely to be found if additional targeted botanical surveys are conducted.

Fleshy owl's-clover occurs in Northern Claypan and Northern Hardpan vernal pools (Sawyer and Keeler-Wolf 1995) within annual grassland communities (CNDDB 2000). The species is known from both small and large pools (EIP Associates 1999*a*, Stebbins in litt. 2000*a*). Although not all pools occupied by this taxon have been studied in detail, Stebbins and others (1995) collected data on six occupied pools in Fresno and Madera counties. Some were typical "bowl-like" pools, whereas others were more similar to swales. Approximate pool area ranged from 0.07 to 1.61 acres, depth from 11.8 to 15.0 inches, and pH of the soil underlying the pools from 5.00 to 6.24 (Stebbins *et al.* 1995). This subspecies has been reported from pools with both long and short inundation periods (EIP Associates 1999) and from both shallow and "abnormally deep" vernal pools," but approximate depth of these pools was not given (CNDDB 2000).

<u>Hoover's Spurge (*Chamaesyce hooveri*)</u>

The Service listed Hoover's spurge as a threatened species in 1997 (Service 1997*a*). Hoover's spurge is not listed under the California Endangered Species Act (California Department of Fish and Game 1986). The California Native Plant Society included Hoover's spurge on its first list of rare plants (Powell 1974); currently, Hoover's spurge is on the California Native Plant Society's List 1B and is considered to be "endangered in a portion of its range" and "fairly endangered in California" (Skinner and Pavlik 1994, Tibor 2001).

Hoover's spurge was originally named *Euphorbia hooveri* based on a specimen collected by Hoover in Yettem, Tulare County (Wheeler 1941). At that time, the genus *Euphorbia* was viewed as comprising several subgenera, including *Chamaesyce* and *Euphorbia*.

Webster (1975) subsequently elevated the subgenus *Chamaesyce* to the rank of genus based on growth patterns and physiology. The currently-accepted scientific name, *Chamaesyce hooveri,* was validated when Koutnik (1985) published the new combination. Hoover's spurge is a member of the spurge family (Euphorbiaceae).

Hoover's spurge trails along the ground, forming gray-green mats 2.0 to 39.4 inches in diameter (Broyles 1987, Stone *et al.* 1988). The stems are hairless and contain milky sap. The tiny 0.08-0.20 inch leaves are opposite, rounded to kidney-shaped, with an asymmetric base and a toothed margin. In the genus *Chamaesyce,* the structures that appear to be flowers actually are groups of flowers; each group is referred to as a cyathium. The cyathium in Hoover's spurge consists of a tiny, cup-like structure 0.08 inch in diameter containing five clusters of male flowers and a single female flower. None of the flowers have petals, but white appendages on the edge of the cup resemble petals. Each appendage is divided into three to five finger-like projections approximately 0.04 inch long. The appendages are attached to four reddish glands situated along the margin of the cup. The tiny, white seeds are contained in a spherical capsule 0.08 inch in diameter on a stalk that hangs over the edge of the cup. One cyathium is located between each pair of leaves (Wheeler 1941, Munz and Keck 1959, Koutnik 1993).

Several other species of *Chamaesyce* have similar ranges to Hoover's spurge and may occur in the same habitats. Contura Creek sandmat or Yerba golondrina *(C. ocellata* ssp. *ocellata)* is yellowish-green, has untoothed leaves, and lacks appendages on the glands. Stony Creek spurge or Rattan's sandmat (*C. ocellata* ssp. *rattanii*) has hairy stems and leaves and the gland appendages are entire. Thyme-leaved spurge (*C. serpyllifolia*) also has entire appendages and further differs from Hoover's spurge in microscopic characters of the female flower (Wheeler 1941, Munz and Keck 1959, Koutnik 1993).

Life History and Habitat

Hoover's spurge is a summer annual, but few details of its life history are known. Seeds of Hoover's spurge germinate after water evaporates from the pools; the plants cannot grow in standing water (Alexander and Schlising 1997). The indeterminate growth pattern allows the plants to continue growing as long as sufficient moisture is available. The proportion of seedlings surviving to reproduction has not been documented; in years of below-normal rainfall, seedling survival was characterized as "low" (Stone *et al.* 1988). Phenology varies among years and among sites, even for those populations in close proximity (Stone *et al.* 1988). Populations in Merced and Tulare counties typically flower from late May through July, whereas those in Stanislaus County and the Sacramento Valley flower from mid-June into October (Alexander and Schlising 1997, Silveira in litt. 2000, CNDDB 2001). Seed set apparently begins soon after flowering. Seed production has not been quantified or studied in relation to environmental factors, but Stone *et al.* (1988) reported that large plants may produce several hundred seeds.

Horned larks (*Eremophila alpestris*) have been observed eating seeds of Hoover's spurge and may assist in seed dispersal (Alexander and Schlising 1997).

Demographic data suggest that seeds of Hoover's spurge can remain dormant until the appropriate temperature and moisture conditions occur. This is evident from the fact that plants can be absent from a given pool for up to four years and then reappear in substantial numbers (Table 3). Although certain years appear to be more favorable for Hoover's spurge than others, occurrence trends vary from pool to pool, even within the same year in the same area (Table 3). Moreover, a particular year may be favorable for Hoover's spurge at one site and unfavorable at another. For example, Hoover's spurge was extremely abundant on the Vina Plains Preserve in 1995 (Table 4), but reached a 7-year low at Sacramento National Wildlife Refuge that year (Table 3). Five occurrences of Hoover's spurge have numbered 5,000 or more plants at their maximum size. Four of those five occur on the Vina Plains, and the other occurs in Tulare County (Stone *et al.* 1988, CNDDB 2001). In a 1995 study of occurrence characteristics on the Vina Plains Preserve, Alexander and Schlising (1997) found that among the four pools where Hoover's spurge grew, density ranged from 0.1 to 6 plants per 0.01 to 0.56 per square foot and frequency ranged from 0.6 to 14.1 percent. Patterns of distribution varied among the pools, from scattered plants to clumps to a "ring" of plants (Alexander and Schlising 1997).

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

The type of photosynthesis found in *Chamaesyce* species, known as C_4 photosynthesis, differs from that of most plants, including *Euphorbia* species (Welkie and Caldwell 1970). This mechanism for capturing energy from sunlight is an adaptation to growth in hot, sunny, dry environments (Salisbury and Ross 1978).

Hoover's spurge is restricted to vernal pools (Stone *et al.* 1988, Koutnik 1993, Skinner and Pavlik 1994). Natural pools in which it occurs are classified as Northern Hardpan and Northern Claypan vernal pools (Sawyer and Keeler-Wolf 1995). In addition, Hoover's spurge has been reported from several pools that were formed artificially when drainage was blocked in appropriate soil types (CNDDB 2001). The pools supporting this species vary in size from 0.19 ha to 243 hectares (0.47 to 600 acres), with a median area of 1.43 acres (Stone *et al.* 1988). Many occurrences consist of multiple pools that vary in area and in depth, yet not all pools at a site support Hoover's spurge. Deeper pools apparently provide better habitat for this species because the duration of inundation is longer. This species may occur along the margins or in the deepest portions of the dried pool bed (Stone *et al.* 1988, Alexander and Schlising 1997). A particularly important feature of Hoover's spurge microhabitat, at least in the deeper pools (Stebbins in litt. 2000*a*), is that it is nearly devoid of other vegetation, and thus competition from other plants is reduced (Stone *et al.* 1988).

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

In the Northeastern Sacramento Valley Vernal Pool Region, occupied pools are on acidic soils over iron-silica cemented hardpan. Most pools supporting Hoover's spurge in the San Joaquin Valley, Solano-Colusa, and Southern Sierra Foothills vernal pool regions are on neutral to saline-alkaline soils over lime-silica cemented hardpan or claypan (Broyles 1987, Stone *et al.* 1988, Sawyer and Keeler-Wolf 1995, CNDDB 2001). Occurrences of Hoover's spurge have been reported from elevations ranging from 85 feet in Glenn County to 420 feet in Tehama County (CNDDB 2001).

Table 3. Distribution and abundance of Hoover's spurge at Sacramento National Wildlife Refuge, Glenn and Colusa Counties. Data courtesy of Joseph Silveira, Sacramento National Wildlife Refuge Complex, Willows, CA.

Pool Code	Number of plants							
	1992	1993	1994	1995	1996	1997	1998	1999
TAB – 1	1,000	1,000	900	50	400	100	400	400
TAB – 3	—[1]	110	0	0	0	0	0	0
TAB – 4	—	200	30	0	0	0	0	0
TAB – 5	—	150	0	0	0	0	75	300
TAB – 6	—	—	—	—	100	400	70	0
TC – 1	400	500	0	0	110	25	0	0
TC – 2	25	160	75	50	65	50	125	50
TC – 3	25	100	40	0	30	100	80	150
TC – 4	—	—	—	—	—	—	140	0
P1.1 – 1	500	250	1	0	0	200	300	200
T18 – 2	—	100	40	0	0	0	0	0
Total	≥1,950	≥2,570	≥1,086	≥100	≥705	≥875	1,190	1,100

[1] Occurrence not yet discovered.

Table 4. Distribution and abundance of Hoover's spurge at Vina Plains Preserve, Tehama County. Primary data reproduced from Alexander and Schlising (1997) with permission.

Pool Code	Number of plants					
	1983	1986	1990	1992	1994	1995
1	2,000-3,000	> 10,000[1]	—[2]	—	—	183,400
17	2,000-3,000	>1,000[1]	—	—	—	3,900
22	6	<50[1]	—	—	—	0
34	1,500	>1,000[1]	2,312	16	—	5,600
35	2,000-3,000	>1,000[1]	—	—	—	2,000
36	25	0[1]	—	—	1	1
Total	7,531-10,531	>13,050	≥2,312	≥16	≥1	194,900

[1] Stone *et al.* (1988).
[2] Data not available.

Throughout its range, two of the most frequent associates of Hoover's spurge are the rare vernal pool grasses Greene's tuctoria (*Tuctoria greenei*) and hairy Orcutt grass, at 12 and 10 occurrences, respectively. In four of these cases, all three species grow in the same pool (Alexander and Schlising 1997, CNDDB 2001). However, Hoover's spurge tends to grow in different portions of the pools than these federally listed grasses (Stone *et al.* 1988, Alexander and Schlising 1997). Other plants featured in this recovery plan that grow with Hoover's spurge at one to four sites are (in descending order of frequency) vernal pool smallscale (*Atriplex persistens*), spiny-sepaled button-celery, Colusa grass, San Joaquin Valley Orcutt grass, Ferris' milk-vetch (*Astragalus tener* var. *ferrisiae*), and Boggs lake hedge-hyssop (Oswald and Silveira 1995, Alexander and Schlising 1997, CNDDB 2001). In the Vina Plains, other common associates of Hoover's spurge are hairy pepperwort or water shamrock (*Marsilea vestita*), common coyote-thistle or Great Valley eryngo (*Eryngium castrense*), field bindweed (*Convolvulus arvensis*), and white tumbleweed or prostrate pigweed (*Amaranthus albus*) (Alexander and Schlising 1997). In Glenn, Merced, and Tulare counties, spreading alkaliweed (*Cressa truxillensis*), inland saltgrass (*Distichlis spicata*), alkali seaheath or frankenia (*Frankenia salina*), Great Valley gumweed (*Grindelia camporum*), and other plants tolerant of saline-alkali soils are typical associates of Hoover's spurge (Stone *et al.* 1988, Silveira in litt. 2000, CNDDB 2001).

Historical and Current Distribution

For decades, Hoover's spurge was known from only three localities: near Yettem and Visalia in Tulare County, and near Vina in Tehama County. Collections were made from these three areas in the late 1930's and early 1940's (Wheeler 1941, Munz and Keck 1959, Stone *et al.* 1988). From 1974 through 1987, 21 additional occurrences of Hoover's spurge were reported. The majority of these (15) were in Tehama County. One to three occurrences were discovered during this period in each of Butte, Merced, Stanislaus, and Tulare counties (Stone *et al.* 1988, CNDDB 2001). The historical localities for this species were in the Northeastern Sacramento Valley, San Joaquin Valley, Solano-Colusa, and Southern Sierra Foothills vernal pool regions (Keeler-Wolf *et al.* 1998).

The California Natural Diversity Data Base (2001) now includes 30 occurrences of Hoover's spurge. In addition to those known historically, six occurrences were discovered in 1992 (three each in Glenn and Tulare counties). Of the 30 occurrences, one each in Tehama and Tulare counties are classified as extirpated; two others, in Butte and Tehama counties, are "possibly extirpated" because this species was not observed for 2 consecutive years (Stone *et al.* 1988, CNDDB 2001). Of the 26 occurrences presumed to be extant, only 12 have been observed within the past decade (CNDDB 2001).

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

Colusa Grass (*Neostapfia colusana*)

The Service (1997*a*) listed Colusa grass as a threatened species in 1997. Colusa grass has been state-listed as endangered since 1979 (California Department of Fish and Game 1991) and has been considered to be rare and endangered by the California Native Plant Society since 1974 (Powell 1974). The California Native Plant Society now includes Colusa grass on List 1B and considers it to be "endangered throughout its range" (Skinner and Pavlik 1994) and "seriously endangered in California" (Tibor 2001). The California Department of Fish and Game considers the status of Colusa grass to be declining (CDFG 2001).

Joseph Burtt-Davy (1898) first described Colusa grass, giving it the Latin name *Stapfia colusana*. He had collected the type specimen near the town of Princeton in Colusa County. Davy soon realized that the name *Stapfia* had already been assigned to a genus of green algae and therefore changed the scientific name of Colusa grass to *Neostapfia colusana* (Davy 1899). Two other taxonomists proposed alternate Latin names for the genus in the same year, but for very different reasons neither is accepted today. *Davyella*, the name proposed by Hackel, was rejected under international rules of plant taxonomy because the legitimate name *Neostapfia* had been published one month earlier (Reeder 1982). The name *Anthochloa colusana* was used for decades after Scribner (1899) published the combination in the mistaken belief that Colusa grass was closely related to South American species of that genus. However, Robert Hoover (1940) evaluated the many differences between *Anthochloa* and *Neostapfia* and concluded that the latter should be considered a distinct genus. Since that time, the accepted name for Colusa grass has been *Neostapfia colusana*. No other species of *Neostapfia* are known (Reeder 1982, Reeder 1993).

Colusa grass is member of the subfamily Chloridoideae in the grass family (Poaceae) and is in the Orcuttieae tribe, which also includes *Orcuttia* and *Tuctoria* (Reeder 1965, Keeley 1998*a*). *Neostapfia* is the most primitive member of the tribe (Keeley 1998*a*).

All members of the Orcuttieae share several characteristics that differ from many other grasses. Most grasses have hollow stems, but the Orcuttieae have stems filled with pith. Another difference is that the Orcuttieae produce two or three different types of leaves during their life cycle, whereas most grasses have a single leaf type throughout their life span. The juvenile leaves of the Orcuttieae, which form underwater, are cylindrical and clustered into a basal rosette. After the water dries, terrestrial leaves form in all species of the tribe; these leaves have flattened blades and are distributed along the stem (Keeley 1998*a*). Orcuttia species have a third type of leaf that is not found in *Neostapfia* or *Tuctoria* (Reeder 1982, Keeley 1998*a*). The terrestrial leaves of the Orcuttieae also differ from other grasses in other respects. Whereas grass leaves typically are differentiated into a narrow, tubular sheath that clasps the stem tightly and a broader blade that projects away from the stem, terrestrial leaves of the Orcuttieae are broad throughout and the lower portion enfolds the stem only loosely. The Orcuttieae also lack a ligule, which is a leaf appendage commonly found in other grasses (Reeder 1965, Reeder1982, Keeley 1998*a*). Another characteristic common to all Orcuttieae is the production of an aromatic exudate, which changes from clear to brown during the growing season (Reeder 1965, Reeder 1982). The exudate most likely helps to repel herbivores (Crampton 1976, Griggs 1981).

The Orcuttieae are similar to other grasses in their flower structure. Grasses do not have petals and sepals like most other flowering plants, so their flowers are inconspicuous. Grass flowers are reduced to florets, which include several stamens (three in the Orcuttieae) and one pistil enclosed in two scales known as the lemma and palea. A spikelet consists of one or more florets and may have one or two glumes at its base. The grass inflorescence typically includes several to many spikelets, which are attached to a central stem known as the rachis. A grass fruit, which is known as a caryopsis or grain, consists of a single seed fused to the fruit wall. Each floret is capable of producing one grain.

Life History and Habitat

Compared to other members of the Orcuttieae, Colusa grass shows fewer adaptations to existence underwater, indicative of its relatively primitive evolutionary position and the shorter duration of underwater growth (Keeley 1998*a*). The aquatic seedlings of Colusa grass have only one or two juvenile leaves (Keeley 1998*a*). The terrestrial stage consists of multiple stems arising in clumps from a common root system. The stems are decumbent and have a characteristic zigzag growth form (Crampton 1976). Overall stem length ranges from 3.9 to 11.8 inches. The entire plant is pale green when young (Davy 1898) but becomes brownish as the exudate darkens (Reeder 1982, Reeder 1993). Leaf length is 2.0 to 3.9 inches (Hitchcock and Chase 1971). Each stem produces one dense, cylindrical inflorescence that is 0.8 to 3.1 inches long and 0.31 to 0.47 inch broad. Within the inflorescence, the spikelets are densely packed in a spiral arrangement; the tip of the rachis projects beyond the spikelets. Each spikelet typically contains five florets but does not have glumes. The fan-shaped lemmas are approximately 0.20 inch long. The pollen grains are 0.10 inch long and are coated with exudate. Colusa grass has a diploid chromosome number of 40 (Reeder 1982, Reeder 1993).

Unlike terrestrial grasses, Colusa grass has pith-filled stems, lacks distinct leaf sheaths and ligules, and produces exudate. Colusa grass differs from other members of the Orcuttieae in that it has zigzag stems, cylindrical inflorescences, and fan-shaped lemmas and lacks glumes, whereas the other genera within the tribe have fairly straight stems and possess glumes. Additionally, *Orcuttia* species have distichous spikelets and narrow, 5-toothed lemmas, and *Tuctoria* species have spikelets arranged in a loose spiral, and narrow, more-or-less entire lemmas. Colusa grass is not likely to be confused with *Anthochloa*, despite their former taxonomic affiliation. The latter does not occur in North America, is perennial, does not have glands, the inflorescence is not cylindrical, and the spikelets have glumes (Hoover 1940).

Many life-history characteristics are common to all members of the Orcuttieae. These characteristics include their annual nature and all exhibit C_4 photosynthesis (Downton 1975, Griggs 1981, Keeley 1998*a*). All are wind-pollinated, but pollen probably is not carried long distances between populations (Griggs 1980, Griggs and Jain 1983). Local seed (i.e., caryopsis) dispersal is by water, which breaks up the inflorescences (Reeder 1965, Crampton 1976, Griggs 1980, Griggs 1981). Long-distance dispersal is unlikely (Service 1985), but seed may have been carried occasionally by waterfowl (family Anatidae), tule elk (*Cervus elaphus nannoides*), or pronghorn (*Antilocapra americana*) in historical times (Griggs 1980). The seeds can remain dormant for an undetermined length of time, but at least for 3 or 4 years, and germinate underwater after they have been immersed for prolonged periods (Crampton 1976, Griggs 1980, Keeley 1998*a*). Unlike typical terrestrial grasses that grow in the uplands surrounding vernal pools, members of the Orcuttieae flower during the summer months (Keeley 1998*a*).

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

All members of the Orcuttieae are endemic to vernal pools. Although the various species within the tribe have been found in pools ranging widely in size, the vast majority occur in pools of 0.025 acres to 24.7 acres (Stone *et al.* 1988). Large pools such as these retain water until May or June, creating optimal conditions for Orcuttieae (Crampton 1959, Crampton 1976, Griggs 1981, Griggs and Jain 1983). Within the pools, Orcuttieae occur in patches that are essentially devoid of other plant species (Crampton 1959, Crampton 1976). Typically, plants near the center of a pool grow larger and produce more spikelets than those near the margins, but patterns vary depending on individual pool characteristics and seasonal weather conditions (Griggs 1980).

In an experiment where Colusa grass was grown along with Greene's tuctoria and two species of *Orcuttia* (Keeley 1998*a*), seeds of Colusa grass took approximately 3 months to germinate following inundation, longer than all other species. Unlike *Orcuttia* species, Colusa grass does not produce flattened, floating juvenile leaves (Reeder 1982, Keeley 1998*a*). Germination and seedling development have not been studied in the wild but are assumed to be similar to those of *Tuctoria* species, which have similar seedlings. Thus, Colusa grass seed would be expected to germinate in late spring when little standing water remains in the pool, and flowering would begin approximately 3 to 4 weeks later, as observed for *Tuctoria* (Griggs 1980). Flowering individuals of Colusa grass have been collected as early as May throughout the range of the species (CNDDB 2000). Colusa grass spikelets break between the florets (Reeder 1993), shattering as soon as the inflorescence matures (Crampton 1976).

Reproductive and survival rates have not been reported, but annual monitoring confirms that occurrence sizes of Colusa grass vary widely from year to year. Over a 6-year monitoring period, the occurrence at the Bert Crane Ranch in Merced County dropped from 250 individual plants in 1987 to zero in 1989 and 1990 but rebounded to over 2,000 plants in 1992 (Silveira in litt. 2000). At Olcott Lake in Solano County, the lowest occurrence of the decade was 1,000 plants in 1994 yet was followed by a high of over 1 million plants the following year (CNDDB 2000).

Colusa grass has the broadest ecological range among the Orcuttieae. The species is often found in vernal pools on the rim of alkaline basins in the Sacramento and San Joaquin valleys, as well as on acidic soils of alluvial fans and stream terraces along the eastern margin of the San Joaquin Valley and into the adjacent grassland foothills (Stone *et al.* 1988). Elevations range from 18 feet to approximately 350 feet at known sites (CNDDB 2000). Colusa grass has been found in Northern Claypan and Northern Hardpan vernal pool types (Sawyer and Keeler-Wolf 1995) within rolling grasslands (Crampton 1959). The species grows in vernal pools ranging from 0.02 to 617.5 acres, with a median size of 0.5 acre, and also occurs in the beds of intermittent streams and in artificial ponds (Stone *et al.* 1988, EIP Associates 1999*a*). This species typically grows in the deepest portion of a vernal pool or stream bed (Crampton 1959, Stone *et al.* 1988) but also may occur on the margins (Hoover 1937, Stone *et al.* 1988). Deeper pools and stock ponds are most likely to provide the long inundation period required for germination (EIP Associates 1999*a*).

Several soil series are represented throughout the range of Colusa grass. Solano and Yolo county sites have soils in the Pescadero series, whereas those in central Merced County have soils in the Landlow and Lewis series (Silveira in litt. 2000). The eastern Merced County and Stanislaus County sites include the Bear Creek, Corning, Greenfield, Keyes, Meikle, Pentz, Peters, Raynor, Redding, and Whitney series (Stone *et al.* 1988, EIP Associates 1999*a*, CNDDB 2000). The type and composition of impermeable layers underlying occupied vernal pools also vary, ranging from claypan in the Sacramento Valley to lime-silica cemented hardpan in the San Joaquin Valley basins, to iron-silica cemented hardpan in the Sierran foothills. Tuffaceous alluvium underlies some eastern San Joaquin Valley pools and intermittent streams where Colusa grass grows (Stone *et al.* 1988).

Colusa grass usually grows in single-species stands within vernal pools, rather than intermixed with other plants. Thus, associated species in this case are plants that occur in different zones of the same pools but are present in the same season. For example, Crampton (1959) observed that Colusa grass dominated pool beds, with hairy Orcutt grass forming a band around the upper edge of the stand. In saline-alkaline sites, common associates of Colusa grass are frankenia and saltgrass, whereas on acidic sites associates include coyote-thistle, turkey mullein (*Eremocarpus setigerus*), and vernal pool popcorn flower (Stone *et al.* 1988, EIP Associates 1999*a*). Other Federally listed plants grow in the same vernal pools as Colusa grass. Among these species, the most frequent associate is San Joaquin Valley Orcutt grass (seven co-occurrences), followed by hairy Orcutt grass (four), Solano grass (three), and Hoover's spurge (Stone *et al.* 1988, EIP Associates 1999*a*, CNDDB 2000, Silveira in litt. 2000). Greene's tuctoria formerly grew in one vernal pool with Colusa grass, but the former species no longer occurs there (Stone *et al.* 1988, CNDDB 2000).

Historical and Current Distribution

In the 50 years after its initial discovery (Davy 1898), Colusa grass was reported from only three sites other than the type locality; these were in Merced and Stanislaus counties. By the mid-1970's Colusa grass had been reported from a total of 11 sites in Colusa, Merced, Solano, and Stanislaus counties (Hoover 1936*b*, Hoover 1940, Crampton 1959, Medeiros 1976, Reeder 1982). During the 1980's, many new populations of Colusa grass were located during extensive surveys. As of 1989, 40 occurrences were extant and 11 already had been extirpated. Of the 51 occurrences known up to that point, 26 were in Merced County, 22 were in Stanislaus County, 2 were in Solano County, and 1 was in Colusa County (Stone *et al.* 1988, CNDDB 2000). These occurrences were in the San Joaquin Valley, Solano-Colusa, and Southern Sierra Foothills vernal pool regions (Keeler-Wolf *et al.* 1998).

Although fewer than one-quarter of the historical occurrences have been visited within the past decade, their status is presumed to be the same as on the last visit (CNDDB 2000). Currently, the California Natural Diversity Data Base (2000) considers 44 occurrences of Colusa grass to be "presumed extant" and 11 others as known or possibly extirpated. However, two of the element occurrences in the California Natural Diversity Data Base (numbers 53 and 60) actually represent an identical site, and thus 43 occurrences would be presumed extant. The tally of extant occurrences includes two in Yolo County that were discovered during the 1990's but does not include the six occupied pools in Merced County that were discovered during 1999 (EIP Associates 1999*a*). The Merced latter sites likely will qualify as at least five separate element occurrences when they are processed by the California Natural Diversity Data Base (calculated by E. Cypher from data in EIP Associates 1999*a*). Thus, the following discussion is based on an estimated 48 extant occurrences (43 unique from the California Natural Diversity Data Base plus 5 that have not yet been processed).

The extant occurrences of Colusa grass occur primarily in the Southern Sierra Foothills Vernal Pool Region, where they are concentrated northeast of the city of Merced in Merced County (24 occurrences) and east of Hickman in Stanislaus County (16 occurrences). Of the remaining eight extant occurrences, four are in central Merced County, representing the San Joaquin Valley Vernal Pool Region. The others are in the Solano-Colusa Vernal Pool Region, with two each in southeastern Yolo and central Solano counties (Stone *et al* 1988, Keeler-Wolf *et al.* 1998, CNDDB 2000). This species has been extirpated from Colusa County (CNDDB 2000).

San Joaquin Valley Orcutt grass (*Orcuttia inaequalis*)

San Joaquin Valley Orcutt grass was federally listed as a threatened species in 1997 (Service 1997*a*). The California State Fish and Game Commission listed San Joaquin Valley Orcutt grass as endangered in 1979 (California Department of Fish and Game 1991). The California Native Plant Society has considered this species to be rare and endangered for even longer (Powell 1974). Currently, San Joaquin Valley Orcutt grass is on the California Native Plant Society's List 1B and is rated as "endangered throughout its range" (Skinner and Pavlik 1994) and "seriously endangered in California" (Tibor 2001). California Fish and Game views the status of San Joaquin Valley Orcutt grass as declining due to population and habitat losses and ongoing threats to extant populations which include urbanization, agricultural land conversions, discing, hydrological modifications to vernal pools, and late spring grazing (CDFG 2001).

Robert Hoover (1936*b*) first published the scientific name *Orcuttia inaequalis* for San Joaquin Valley Orcutt grass. A 1935 collection from "Montpellier [sic], Stanislaus County" was cited as the type specimen (Hoover 1936*b*). Robert Hoover (1941) subsequently reduced this taxon to a variety of California Orcutt grass (*Orcuttia californica*), using the combination *O. californica* variety *inaequalis*. Based on differences in morphology, seed size, and chromosome number, Reeder (1980) restored the taxon to species status, and the scientific name *Orcuttia inaequalis* is currently in use (Reeder 1993). San Joaquin Valley Orcutt grass is a member of the grass family, subfamily Chloridoideae, and is in the tribe Orcuttieae (Reeder 1965). The genus *Orcuttia* is the most evolutionarily advanced group within the tribe (Keeley 1998*a*, Boykin in litt. 2000). Alternate common names for this species are San Joaquin Valley Orcuttia (Smith *et al.* 1980) and San Joaquin Orcutt grass (Service 1985).

Characteristics common to all members of the Orcuttieae were described in the Colusa grass species account and will not be repeated here. Species in the genus *Orcuttia* are characterized by an inflorescence consisting of narrow, flattened, distichous spikelets, each of which has two glumes at the base. *Orcuttia* species produce three different types of leaves during their life cycle: a submerged basal rosette of five to eight cylindrical, juvenile leaves; intermediate leaves in which the submerged portion is cylindrical but the upper portion has a flat, floating blade; and terrestrial leaves with a flattened blade and loosely sheathing base, which develop after the pools dry (Keeley 1998*a*).

Mature plants of San Joaquin Valley Orcutt grass grow in tufts of several erect stems, each of which ranges from 2.0 to 11.8 inches in length. The entire plant is grayish-green due to the long hairs on the stem and leaves and produces exudate. Terrestrial leaves are 0.08 to 0.16 inch wide. The oval lemmas are 0.16 to 0.20 inch long and their tips are divided into five teeth approximately 0.08 inch long; the central tooth is longer than the others, hence the name *inaequalis* ("unequal"). Each spikelet is flattened and contains 4 to 30 florets. Both rows of spikelets grow toward one side. The spikelets are crowded near the top one-third of the stem, producing a head-like inflorescence 0.8 to 1.4 inches long. Each caryopsis is 0.05 to 0.06 inch long (Hoover 1941, Crampton 1976, Reeder

1982, Reeder 1993). The seeds averaged 1×10^{-5} ounce in one population, although seed weight likely varies among sites (Griggs 1980). San Joaquin Valley Orcutt grass has a diploid chromosome number of 24 (Reeder 1980, Reeder1982).

The pith-filled stems, lack of both leaf sheaths and ligules, and presence of exudate distinguish San Joaquin Valley Orcutt grass (and all members of the Orcuttieae) from grasses in other tribes. The elongate, distichous spikelets with oval lemmas and glumes differentiate *Orcuttia* species from *Neostapfia,* which has a cylindrical head with the spikelets arranged in a spiral, fan-shaped spikelets and lemmas, and no glumes. The unequal lemma teeth in San Joaquin Valley Orcutt grass distinguish it from hairy and slender Orcutt grasses. California Orcutt grass (*Orcuttia californica*) is similar to San Joaquin Valley Orcutt grass but the former does not have a head-like inflorescence, has few hairs on the plant, and grows only near the California-Mexico border. San Joaquin Valley Orcutt grass has shorter lemmas, shorter bristles, and smaller seeds than differs from Sacramento Orcutt grass. Furthermore, each species of *Orcuttia* has a unique chromosome number (Reeder 1982).

Life History and Habitat

Many life-history characteristics for San Joaquin Valley Orcutt grass are common to the entire tribe and have been discussed previously (see Status of the Species for Colusa grass). Certain other aspects of the life history are shared by *Orcuttia* and *Tuctoria* species but not by *Neostapfia*. One of these is the pattern of flowering. The first two flowers on a given plant of San Joaquin Valley Orcutt grass open simultaneously and do not produce pollen until the ovaries are no longer receptive. Thus, if an individual plant is fertilized, it must be with pollen from another separate individual plant. Flowers that open subsequently may receive pollen from the same plant or others (Griggs 1980). *Orcuttia* and *Tuctoria* species are believed to be outcrossers based on estimates of genetic diversity (Griggs 1980, Griggs and Jain 1983). Seed production in *Orcuttia* and *Tuctoria* species can vary two- to three-fold among years (Griggs 1980, Griggs and Jain 1983).

Another suite of life-history characteristics is shared among all Orcutt grasses (*Orcuttia* species) but not other genera in the Orcuttieae. Seeds of *Orcuttia* species germinate underwater in January and February (Griggs 1980, Griggs and Jain 1983, Keeley 1998*a*) after being colonized by aquatic fungi Griggs (1980, 1981). This observation was supported by Keeley's (1988) research, which indicated that fungicide inhibited germination of California Orcutt grass seeds but did not affect Greene's tuctoria seeds. Detailed germination studies have not been conducted on all species, but cold treatment and other forms of stratification promoted germination in California (Keeley 1988), hairy, and slender Orcutt grasses (Griggs 1974 cited in Stone *et al.* 1988) and most likely benefit other *Orcuttia* species as well. In an experimental study of California Orcutt grass (Keeley 1988), seeds germinated equally well in light or dark conditions and could germinate whether exposed to air or in anaerobic conditions; maximum germination was achieved in anaerobic conditions following cold stratification.

Orcuttia plants grow underwater in vernal pools for 3 months or more and have evolved specific adaptations for aquatic growth (Keeley 1998*a*). Among these adaptations is the formation of the three different leaf types. The well-developed rosette of juvenile leaves is more specialized compared to those in *Neostapfia* or *Tuctoria* species (Keeley 1998*a*). The floating-leaf stage is unique to *Orcuttia* species; these leaves form as water in the pool warms and remain as long as the standing water lasts (Hoover 1941, Griggs 1980, Griggs 1981, Reeder 1982, Keeley 1998*a*). The anatomy of the aquatic leaves (both juvenile and floating types) is unusual in that certain structures typically associated with C_4 photosynthesis are not present, even though C_4 photosynthesis does take place. Aquatic leaves of *Orcuttia* species also lack stomata, even though they are present on the juvenile leaves of both *Neostapfia* and *Tuctoria* (Keeley 1998*a*, 1998*b*).

As soon as the pools dry, normally in June or July, Orcutt grasses begin producing their typical terrestrial leaves (Hoover 1941, Griggs 1980, Griggs 1981, Reeder 1982, Keeley 1998*a*). Inflorescences appear within a few days after the water evaporates. June and July are the peak months of flower production for most species, although flowering may continue into August and September in years of above-normal precipitation (Griggs 1980, Griggs 1981). Late-spring rains may prolong the flowering season (Griggs 1981, Griggs and Jain 1983), but inundation is more likely to kill flowering individuals if enough rainfall occurs and the water ponds long enough. Spikelets break apart and scatter their seeds when autumn rains arrive (Reeder 1965, Crampton 1976, Griggs 1980, Griggs 1981).

Another aspect of ecology that is shared among *Orcuttia* species but has not been found in either *Neostapfia* nor *Tuctoria* is that Orcutt grasses accumulate acid on their leaf surfaces as a by-product of photosynthesis (Keeley 1998*b*). The acid, which is not the same as the aromatic exudate, apparently accumulates in glands on the leaves. The acid is thought to repel insect herbivores and apparently is more effective than the exudate because the individual plants that produce only exudate are more likely to be consumed by insects than those that produce and accumulate acid (Keeley 1998*b*)

Griggs (1980) conducted demographic and genetic studies of one Fresno County occurrence of San Joaquin Valley Orcutt grass during spring 1976. In that year, each plant in the occurrence produced an average of approximately 8 stems, 1,783 florets, and 254 seeds. The floret-to-seed ratio indicated a relatively good rate of pollination. Seedling survival rates were not determined. Annual occurrence estimates indicated that 1976 and 1978 were favorable years for the Fresno County population. Genetic diversity was high, even among plants grown from seeds collected from the same plant; among-population diversity was not evaluated for this species. The enzyme systems of San

Joaquin Valley Orcutt grass were most similar to those of slender Orcutt grass (Griggs 1980, Griggs and Jain 1983).

Typical habitat requirements for all members of the Orcuttieae were described under Colusa grass. San Joaquin Valley Orcutt grass occurs in vernal pools on alluvial fans, high and low stream terraces (Stone *et al.* 1988), and tabletop lava flows (Stebbins *et al.* 1995, CNDDB 2000). This species grows in Northern Claypan, Northern Hardpan, and Northern Basalt Flow vernal pools (Sawyer and Keeler-Wolf 1995) within rolling grassland (Crampton 1959). Occupied pools range in verna pool surface area from 0.05 to 12.1 acres, with a median area of 1.54 acres (Stone *et al.* 1988). San Joaquin Valley Orcutt grass has been reported from elevations of 100 to 2,475 feet; the highest elevation sites are those on the tabletops of Fresno and Madera counties (Stebbins *et al.* 1995, CNDDB 2000).

Soils underlying San Joaquin Valley Orcutt grass vernal pools are acidic and vary in texture from clay to sandy loam. Soil series represented include the Hideaway series on Fresno-Madera County tabletops, and Amador, Cometa, Corning, Greenfield, Madera, Peters, Raynor, San Joaquin, and Redding soil series elsewhere in the range. Underlying layers at historical or extant occurrences included iron-silica cemented hardpan, tuffaceous alluvium, and basaltic rock from ancient volcanic flows (Stone *et al.* 1988, Stebbins *et al.* 1995, EIP Associates 1999*a*, CNDDB 2000).

The plants most commonly associated with San Joaquin Valley Orcutt grass are coyote-thistle, vernal pool popcorn flower, Colusa grass, dwarf woolly-heads (*Psilocarphus brevissimus*), and turkey mullein. Currently, other federally listed vernal pool plant species co-occurs or historically co-occurred with San Joaquin Valley Orcutt grass. In descending order by number of co-occurrences, these are Colusa grass (nine), fleshy owl's-clover (five), hairy Orcutt grass (two), and Hoover's spurge (one) (*EIP Associates 1999a*, CNDDB 2000, Witham in litt. 2000).

Historical and Current Distribution

San Joaquin Valley Orcutt grass always has been restricted to the Southern Sierra Foothills Vernal Pool Region (Keeler-Wolf *et al.* 1998). The earliest collection was made in 1927 from the Fresno-Madera County border near Lanes Bridge (CNDDB 2000). Hoover (1941) mentioned collections from eight sites in Fresno, Madera, Merced, Stanislaus, and Tulare counties. A total of 20 occurrences had been reported by the mid-1970's, all in the same five counties (Crampton 1959, CNDDB 2000); but, none remained as of the late 1970's (Griggs 1980, Griggs and Jain 1983). However, 20 new occurrences were discovered within the following decade, including 16 in Merced County, 3 in Madera County, and 1 in Fresno County (Stone *et al.* 1988, CNDDB 2000).

Since 1990, six additional occurrences of San Joaquin Valley Orcutt grass have been found, including one in Tulare County (EIP Associates 1999*a*, CNDDB 2000, Witham in litt. 2000) and another has been established artificially (Stebbins *et al.* 1995). Of the 47 occurrences of San Joaquin Valley Orcutt grass ever reported, 27 are presumed to be extant; 17 are extirpated and 3 others are possibly extirpated because the habitat has been modified (CNDDB 2000). However, only 12 of the 27 presumed extant occurrences have been revisited within the past decade. Therefore, the most recent status information is not current. This species has been completely extirpated from Stanislaus County but remains in Fresno, Madera, Merced, and Tulare counties (Stone *et al.* 1988, Skinner and Pavlik 1994, CNDDB 2000).

San Joaquin Valley Orcutt grass does not occur outside of the Southern Sierra Foothills Vernal Pool Region (Keeler-Wolf *et al.* 1998). The primary area of occurrence concentration for this species is northeast of Merced in Merced County, with 14 occurrences (52 percent) on the Flying M Ranch and adjacent lands (EIP Associates 1999*a*, CNDDB 2000, Witham in litt. 2000). The Lanes Bridge area of Madera and Fresno counties has the second highest concentration of San Joaquin Valley Orcutt grass, with seven occurrences (26 percent), including the introduced population. The remaining six occurrences include three in the Le Grand area of Merced County, two on the tabletops near the San Joaquin River in Madera and Fresno counties, and one in northwestern Tulare County (Stone *et al.* 1988, Stebbins *et al.* 1995, CNDDB 2000).

Hairy Orcutt Grass (*Orcuttia pilosa*)

The Service listed hairy Orcutt grass as an endangered species in 1997 (Service 1997*a*). Hairy Orcutt grass has been state listed as endangered since 1979 (California Department of Fish and Game 1991) and was identified as rare and endangered by the California Native Plant Society 5 years earlier (Powell 1974). The California Native Plant Society still considers this species to be "endangered throughout its range" and "seriously endangered in California" and includes it on List 1B (Skinner and Pavlik 1994, Tibor 2001). California Department of Fish and Game (2001) considers the status of hairy Orcutt grass to be declining due to habitat losses from development and conversion of vernal pool habitat to agricultural uses.

Robert Hoover (1941) published the scientific name *Orcuttia pilosa* for hairy Orcutt grass, and it has remained unchanged since. He collected the type specimen in Stanislaus County, "12 miles east of Waterford" (Hoover 1941) in 1937. Hoover (1937) initially identified that specimen as *O. tenuis* but later recognized that it represented a new species (Hoover 1941). Hairy Orcutt grass is in the tribe Orcuttieae of the grass family (Reeder 1965). This species also has been known by the common names hairy Orcuttia (Smith *et al.* 1980) and pilose Orcutt grass (Service 1985).

Characteristics shared among all members of the tribe or among species in the genus *Orcuttia* were described in the Colusa grass and San Joaquin Valley Orcutt grass accounts. Hairy Orcutt grass grows in tufts consisting of numerous stems. The stems are decumbent or erect and branch from only the lower nodes. Stems are 2.0 to 7.9 inches long and 0.04 to 0.08 inch in diameter (Stone *et al.* 1988). Almost the entire plant is pilose, giving it a grayish appearance. The terrestrial leaves are 0.12 to 0.24 inch wide. The inflorescence is 2.0 to 3.9 inches long and contains between 8 and 18 flattened spikelets. The spikelets near the tip of the inflorescence are crowded together, whereas those near the base are more widely spaced. Each spikelet consists of 10 to 40 florets and two tiny 0.12 inch glumes. The lemmas are 0.16 to 0.20 inch long, with five teeth of equal size. Each caryopsis is 0.07 to 0.08 inch long (Hoover 1941, Reeder 1982, Reeder 1993) and weighs 0.6 to 3.4 x 10^{-5} ounces (Griggs 1980). Hairy Orcutt grass has a diploid chromosome number of 30 (Reeder 1982).

Hairy Orcutt grass is most likely to be confused with slender Orcutt grass. However, hairy Orcutt grass has broader stems and leaves, branches originating from the lower nodes, smaller spikelets that are crowded near the rachis tip, smaller grains, a later flowering period, and a different chromosome number (Reeder 1982). Other *Orcuttia* species typically have unequal lemma teeth and differ in seed size and chromosome number from *O. pilosa* and *O. tenuis* (Reeder 1982).

<u>Life History and Habitat</u>

The life-history characteristics common to all members of the Orcuttieae were presented under Colusa grass, and others shared by all *Orcuttia* species were described under San Joaquin Valley Orcutt grass.

Griggs (1974 cited in Stone *et al.* 1988) found that stratification followed by temperatures of 59 to 90°F was necessary for seed germination in hairy Orcutt grass. Flowering individuals have been observed as early as mid-April in Madera County (Durgarian 1995). Populations in Glenn County began flowering at the beginning of May 1993. However, heavy rains in late May and early June of that year refilled the five pools that were being monitored, causing 80 percent to 100 percent of the plants to die before they set seed (Table 5). Seed production has not been studied extensively in hairy Orcutt grass, but Griggs and Jain (1983) did note that one individual produced more than 10,000 seeds. Although the predominant pollination agent for all Orcutt grasses is wind, native bees (Halictidae) have been observed visiting the inflorescences of hairy Orcutt grass to gather pollen (Griggs 1974 cited in Stone *et al.* 1988).

Like other vernal pool annuals, the size of hairy Orcutt grass populations fluctuates dramatically from year to year (Tables 5 and 6). Occurrence sizes have varied by as much as four orders of magnitude over time (Griggs 1980, Griggs and Jain 1983, Alexander and Schlising 1997). Two populations that had no visible plants for three successive years exceeded 10,000 individual plants in the fourth year (Griggs 1980, Griggs and Jain 1983). However, populations that number fewer than 100 plants in even the most favorable years are not likely to persist. The small populations may become established and probably begin with chance dispersal events but never build up enough of a soil seed bank to become established. This phenomenon was noted at the Sacramento National Wildlife Refuge (Table 5), the Vina Plains (Table 6), and an unspecified location where the occurrence consisted of six plants in 1973, dropped to zero the following year, and was considered to be extirpated when no plants reappeared by 1978 (Griggs 1980, Griggs and Jain 1983).

Table 5. Distribution and abundance of hairy Orcutt grass at Sacramento National Wildlife Refuge, Glenn and Colusa Counties. Data courtesy of Joseph Silveira, Sacramento National Wildlife Refuge Complex, Willows, CA.

Pool Location	Number of plants						
	1993[1]	1994	1995	1996	1997	1998[2]	1999
TAB–2	1,000 (200)	2,400	4,000	3,000	3,250	0	1,100
TAB–3	20 (0)	0	0	0	0	0	0
TC–1	3,000 (0)	0	500	50	400	0	0
P1.1–1	1,000 (2)	20	50	30	40	0	10
T18–1	1,000 (0)	120	500	400	0	0	100
T18–3	—[3]	—	—	—	300	0	20
Total	≥6,020 (202)	≥2,540	≥5,050	≥3,480	3,990	0	1,130

[1] Plants fully germinated and began flowering by 5 May; the refuge received approximately 4.5 inches of rain during 26-30 May and 4-6 June, refilling pools and killing most plants. Survivors in parentheses; TAB–2 plants "resprouted".
[2] Except for T18–1, pools remained full into June; plants in T18–1 germinated in early May but died when pool refilled with early June rainfall.
[3] Occurrence not yet discovered.

Table 6. Distribution and abundance of hairy Orcutt grass at Vina Plains Preserve, Tehama County. Primary data reproduced from Alexander and Schlising (1997) with permission.

Pool Code	Number of plants			
	1980	1983	1986	1995
1	300	10,000	>10,000[1]	1,355,800
14	—[2]	2	—	0
17	—	<10,000	>1,000[1]	3,987,900
22	—	<100	—	0
34	—	3,000	~5,000[1]	1,913,400
35	—	5,000-10,000	~5,000[1]	4,205,300
36	—	—	"few"[1]	0
Total	≥300	≥28,102	>21,000	11,462,400

[1] Stone *et al.* (1988).
[2] Data not available.

Densities of hairy Orcutt grass were determined at the Vina Plains Preserve in 1995. Among four pools where this species grew, densities ranged from 4.2 to 44.0 plants per square foot (Alexander and Schlising 1997). The high densities illustrate that although the total occurrence size seems large, the individuals grow in close proximity.

This species is found on high or low stream terraces and alluvial fans (Stone *et al.* 1988). Hairy Orcutt grass occurs in Northern Basalt Flow, Northern Claypan, and Northern Hardpan vernal pools (Sawyer and Keeler-Wolf 1995) within annual grassland (CNDDB 2001). The median size of occupied vernal pool complexes measured in the late 1980's was 4.2 acres, with a range of 0.8 to 617.5 acres (Stone *et al.* 1988). At the Vina Plains, hairy Orcutt grass was found growing only in pools that held water until May, June, or July in 1995, not in those that dried in April (Alexander and Schlising 1997). This species is known from elevations of 85 feet in Glenn County to 405 feet in Madera County (CNDDB 2001).

Hairy Orcutt grass is found on both acidic and saline-alkaline soils, in vernal pool complexes with an iron-silica cemented hardpan or claypan. In the Northeastern Sacramento Valley Vernal Pool Region, pools supporting hairy Orcutt grass occur on the Anita and Tuscan soil series (Stone *et al.* 1988, CNDDB 2001). At one vernal pool in the Vina Plains that spans both Anita clay and Tuscan loam soils, hairy Orcutt grass was found growing primarily on the Anita clay (Alexander and Schlising 1997). In the Solano-Colusa Vernal Pool Region, hairy Orcutt grass occurs in vernal pools on the Willows and Riz soil series (Silveira in litt. 2000), whereas in the Southern Sierra

Foothills Vernal Pool Region it occurs in vernal pools on the Cometa, Greenfield, Hanford, Meikle, and Whitney soil series (Stone *et al.* 1988).

Common associates of hairy Orcutt grass throughout its range include coyote-thistle and vernal pool popcorn flower. Hairy Orcutt grass also co-occurs at numerous sites with other rare plants featured in this recovery plan, including Colusa grass in the San Joaquin Valley and Hoover's spurge and Greene's tuctoria in the Sacramento Valley (Stone *et al.* 1988, Alexander and Schlising 1997, CNDDB 2001). Additional associates in the San Joaquin Valley include vinegar weed (*Trichostema lanceolatum*) and mayweed or stinking chamomile (*Anthemis cotula*) (Stone *et al.* 1988). Hairy Orcutt grass formerly occurred in one pool with San Joaquin Valley Orcutt grass (Crampton 1959), but the habitat has since been converted to almond orchards (CNDDB 2001). In the Vina Plains, other common associates of hairy Orcutt grass are water shamrock, bindweed, and white tumbleweed (Alexander and Schlising 1997). Both hairy Orcutt grass and slender Orcutt grass grow on the Vina Plains but do not occur in the same pools (Stone *et al.* 1988, Alexander and Schlising 1997). At least in 1995, the Vina Plains pools where hairy Orcutt grass grew had few spring-flowering annuals (Alexander and Schlising 1997).

Historical and Current Distribution

Prior to the surveys by Stone *et al.* (1988), hairy Orcutt grass had been reported from 25 sites, primarily in the Northeastern Sacramento Valley and Southern Sierra Foothills vernal pool regions (Keeler-Wolf *et al.* 1998). These included eight occurrences each in Tehama and Stanislaus counties, six in Madera County, and two in Merced County (Hoover 1941, Crampton 1959, Reeder 1982, Stone *et al.* 1988, CNDDB 2001). Hairy Orcutt grass also was collected in the Solano-Colusa Vernal Pool Region, Glenn County, in 1937 (CNDDB 2001); the specimen has since been lost but may have been misidentified as California Orcutt grass (Oswald and Silveira 1995, Silveira pers. comm. 1997, Silveira in litt. 2000). During the late 1980's, Stone *et al.* (1988) determined that 12 historical occurrences had been extirpated; but, they and others discovered three additional populations in Madera, Stanislaus, and Tehama counties. One other occurrence from Madera County (Element Occurrence #29) was previously considered to be hairy Orcutt grass and is listed as such in the CNDDB (2001); however, this occurrence since has been identified as San Joaquin Valley Orcutt grass.

Within the past decade, hairy Orcutt grass has been discovered at eight new natural occurrences: five in Glenn County, two in Madera County, and one in Tehama County (CNDDB 2001). Hairy Orcutt grass also has been discovered in another pool at the Vina Plains Preserve in Tehama County (Alexander and Schlising 1997); this pool may represent a separate occurrence or it may be an extension of Element Occurrence 25. In addition, this species has been introduced into a created pool in Madera County (Durgarian 1995, Stebbins *et al.* 1995, CNDDB 2001). Of the 38 element occurrences listed by the California Natural Diversity Data Base (2001), not counting the misidentified occurrence of San Joaquin Valley Orcutt grass, 23 natural occurrences and the introduced occurrence are presumed to be extant. Nineteen of those occurrences have been confirmed as extant within the past decade (CNDDB 2001).

Currently, the main area of concentration for hairy Orcutt grass (nine extant occurrences) is the Vina Plains in Tehama County, which is in the Northeastern Sacramento Valley Vernal Pool Region. An isolated occurrence in southern Butte County is in the same region. Ten occurrences are in the Southern Sierra Foothills Vernal Pool Region, including seven in Madera County between the city of Madera and Millerton Lake and three in eastern Stanislaus County. All four extant occurrences in the Solano-Colusa Vernal Pool Region are on the Sacramento National Wildlife Refuge in Glenn County. Hairy Orcutt grass apparently has been extirpated from Merced County (Stone *et al.* 1988, Keeler-Wolf *et al.* 1998, CNDDB 2001).

Hartweg's Golden Sunburst (*Pseudobahia bahiifolia*)

The Service (1992) originally proposed endangered status for *Pseudobahia peirsonii*. Information provided during the public comment period convinced the agency that endangered status was not appropriate, and thus this species was federally listed as threatened (Service 1997*a*). The California Fish and Game Commission listed *Pseudobahia peirsonii* as an endangered species in 1987 (California Department of Fish and Game 2001). It is on the California Native Plant Society's List 1B and is considered by that organization to be "seriously endangered" (Tibor 2001). The California Department of Fish and Game (2001) considers the 1999 status of Hartweg's golden sunburst to be declining.

This species has undergone numerous name changes over the past 150 years, primarily because taxonomists had differing points of view regarding the relationship of this genus to other genera in its family (Carlquist 1956). The original name published by George Bentham (1849) was *Monolopia bahiaefolia*. Asa Gray (1865) changed the name to *Lasthenia bahiaefolia*, then reconsidered and returned it to *Monolopia* (Gray 1876); in the latter publication, Gray subdivided the genus into sections and noted that this species belonged in the section *Pseudo-Bahia* of the genus *Monolopia*. The next name proposed for this species was *Eriophyllum bahiaefolium* (Greene 1897). Finally, Rydberg (1915) assigned the name *Pseudobahia bahiaefolia*; he changed the genus name to a single word, rather than the hyphenated *Pseudo-Bahia* that Gray (1876) had used as a section name. Dale Johnson (1978) corrected a minor spelling error so the scientific name would conform with accepted rules of botanical nomenclature (Stebbins 1991), but Rydberg remains the accepted author of the name. Thus, the name that is in use today is *Pseudobahia bahiifolia*.

The type locality for *Pseudobahia bahiifolia* is Cordua's farm at the junction of the Yuba and Feather rivers in Yuba County (Bentham 1849), which is near Marysville (McVaugh

1970). Karl Hartweg had collected the type specimen there in 1847 (Hartweg 1848, Johnson 1978). Both common names for this species, Hartweg's golden sunburst and Hartweg's pseudobahia, commemorate the original collector. The common name Hartweg's golden sunburst is currently preferred because it does not incorporate the scientific name of the genus (Stebbins 1991).

Pseudobahia bahiifolia is one of three species in the genus, all of which are restricted to California (Johnson 1993). The others are *P. heermannii* and *P. peirsonii* (San Joaquin adobe sunburst). The genus *Pseudobahia* is in the Asteraceae (aster or sunflower family).

Certain features are common to all species in the genus *Pseudobahia*. All are small annual plants that are covered with woolly hairs and have alternate leaves. They have yellow, daisy-like flower heads that are borne singly at the tip of each branch. Each flower head is approximately 1 inch across. The outer, petal-like flowers in these heads are known as ray flowers; they are up to 0.4 inch long and are pistillate. The center of each flower head contains many tiny disk flowers that are no more than 0.12 inch long and are bisexual. Approximately eight greenish phyllaries are partially joined to form a cup-like structure below the ray flowers. Each of the ray and disk flowers produces a flattened, oblong achene that is sparsely covered with tiny hairs and does not have a pappus (Rydberg 1915, Johnson 1993).

Pseudobahia bahiifolia plants range from 2 to 8 inches tall. Their narrow leaves are 0.3 to 1.0 inch long and are either entire or have three small lobes. Each head has between three and eight phyllaries, which are joined for approximately half their length, and the same number of ray flowers as it does phyllaries. The achenes of this species are black and range from 0.06 to 0.10 inch in length. The diploid chromosome number of *Pseudobahia bahiifolia* is 8 (Rydberg 1915, Johnson 1993).

The most similar species to *Pseudobahia bahiifolia* are its close relatives, *P. heermannii* and *P. peirsonii*. Both *P. heermannii* and *P. peirsonii* have *pinnately lobed* leaves, in contrast to the entire or three-lobed leaves of *P. bahiifolia* (Stebbins 1991, Johnson 1993). *Pseudobahia heermannii* plants also are larger than those of *P. bahiifolia* and have reddish stems (Johnson 1978). *Pseudobahia peirsonii* differs further in that its phyllaries are connected only at their bases, rather than being joined approximately halfway as in *P. bahiifolia* (Stebbins 1991, Johnson 1993).

Other genera that are similar in appearance to *Pseudobahia* and occur within its range include *Eriophyllum* (woolly sunflower), *Lasthenia* (goldfields), and *Monolopia* (hillside daisy). The alternate leaves of *Pseudobahia* species differentiate them from the other three genera, in which at least the lowermost leaves are opposite (Stebbins 1991, Johnson 1993, Keil 1993). The flattened achenes and lack of a pappus in *Pseudobahia* species further differentiate this genus from *Eriophyllum*, which has angled achenes and a pappus of scales in most species (Carlquist 1956, Stebbins 1991, Keil 1993).

Life History and Habitat

The reproduction of *Pseudobahia bahiifolia* has not been studied but is probably similar to that of other spring annuals in the southern Sierra foothills. The seeds probably germinate during the winter months because small plants have been observed in late January and early February. *Pseudobahia bahiifolia* typically flowers in March and April (Johnson 1978, Stebbins 1991, Tibor 2001), but in years with late rains flowering may continue into early May. The seeds probably begin maturing as the flowers in each wither, so seed-set and flowering are essentially concurrent. The achenes do not have any particular adaptations that would indicate dispersal by either wind or animals, so they are probably dispersed by gravity. However, one possible instance of wind dispersal was noted in Madera County, where *Pseudobahia bahiifolia* plants appeared on a mound of stockpiled soil. Either the seeds were carried in by the wind or they were already present in the soil. Pollination ecology and reproductive biology have not been studied.

Population sizes of *Pseudobahia bahiifolia* vary greatly from year to year (Stebbins 1991). For example, periodic monitoring at Element Occurrence 21 revealed that the number of plants varied from 150 in 1987 to 2,000 in 1989 to 800 in 1990 and 2,500 in 1992 (CNDDB 2001). Other annuals with extremely variable occurrence sizes typically have a persistent seed bank that forms in the soil, and the number of growing plants in a given year is influenced by rainfall and temperature patterns.

Judging by the maximum occurrence size ever reported, many of the extant occurrences of *Pseudobahia bahiifolia* seem to be very small. However, several occurrences have only a single occurrence estimate that was obtained in 1990 during a prolonged drought. At their maximum, four occurrences consisted of fewer than 100 plants (Element Occurrences 17, 25, 28, and 29), four consisted of between 100 and 500 plants each (Element Occurrences 3, 15, 22, and 23), three (Element Occurrences 18, 21, and 26) had well over 1,000 plants, and the remaining two had unknown occurrence sizes, although one was characterized as "small" (CNDDB 2001).

Pseudobahia bahiifolia primarily grows in grasslands, but it can also occur in the transition zone between grassland and blue oak woodland (Stebbins 1991, CNDDB 2001). The optimal habitat is north- or northeast-facing slopes of small hills or mima mounds among sparse annual grass cover (Stebbins 1991). In mima mound topography, vernal pools often occur in the depressions between the mounds, but *Pseudobahia bahiifolia* is in the uplands, not in the vernal pools themselves. In Stanislaus County, *Pseudobahia bahiifolia* is found almost exclusively on soils of the Amador series, although one site is on Pentz soils. In Fresno and Madera counties the soils are of the Rocklin series, whereas the Merced County site is on a combination of Amador and

Hornitos soils. Soil types are not known for the historical occurrence in Yuba County. Where the soil texture is known, it is loam or sandy loam; several sites in the vicinity of Friant in Madera county are on soils high in pumice content (Stebbins 1991, CNDDB 2001). The lowest known elevation where *Pseudobahia bahiifolia* grew was 50 feet at the extirpated Yuba County locality. Among the extant sites, the lowest elevation is 220 feet in Stanislaus County, with the highest at 460 feet at several sites in Fresno and Madera counties (CNDDB 2001).

The most commonly reported associate of *Pseudobahia bahiifolia* is the nonnative grass *Bromus madritensis* ssp. *rubens*. Other frequent associates are the nonnative forbs *Erodium botrys* (broad-leaved filaree) and *E. cicutarium* (red-stemmed filaree); the native forbs *Lasthenia fremontii* (Fremont's goldfields), *Lepidium nitidum* (shining peppergrass), and *Lupinus bicolor* (miniature lupine); and the nonnative grass *Bromus hordeaceus* (Stebbins 1991, CNDDB 2001).

Historical and Current Distribution

Pseudobahia bahiifolia occurred historically in the central Sacramento Valley, eastern San Joaquin Valley, and in the low foothills to the east of the latter (Stebbins 1989). During the nineteenth century, *Pseudobahia bahiifolia* was reported from two sites: the type locality in Yuba County and north of the town of Snelling in Stanislaus County, where it was collected in 1894 (Stebbins 1991). By the year 2000, a total of 20 occurrences had been reported, including 11 in Stanislaus County, 4 in Fresno County, 3 in Madera County, 1 in Merced County, and 1 (the type locality) in Yuba County (CNDDB 2001). The approximate extent of the range was 200 miles. *Pseudobahia bahiifolia* probably occurred in the counties between Stanislaus and Yuba historically but was not officially documented before being extirpated (Stebbins 1991). New occurrences were still being discovered as of 2000, when the one in Merced County was found (CNDDB 2001).

Of the 20 *Pseudobahia bahiifolia* occurrences documented historically, 13 are presumed to be extant and 4 are known to be extirpated (CNDDB 2001). Some suitable habitat remains in the vicinity of the other three occurrences but *Pseudobahia bahiifolia* plants have not been found at those sites for many years and probably are extirpated. Of the 13 occurrences that are presumed to be extant, most (6) are in Stanislaus County, followed by Fresno County with 4, Madera County with 2, and Merced County with 1 (CNDDB 2001). The species has been extirpated from Yuba County (Element Occurrence 10). The other occurrences that are known or presumed to be extirpated included five (Element Occurrences 5, 6, 7, 8, and 11) in Stanislaus County and one (Element Occurrence 1) in Madera County (CNDDB 2001). Thus, the current extent of the range is approximately 95 miles, a 52.5 percent reduction from the historical extent, although only 35 percent of the known occurrences may have been extirpated.

The main areas of concentration for *Pseudobahia bahiifolia* are near Friant, where six extant occurrences are clustered on either side of the San Joaquin River in Fresno and Madera counties, and near Cooperstown in Stanislaus County, with six occurrences. These two areas incorporate over 99 percent of the individual plants that have been counted in the past decade (CNDDB 2001). Only 1 of the 13 extant occurrences of *Pseudobahia bahiifolia* is in public or conservation ownership. Element Occurrence 21 near Friant Dam in Fresno County is partially owned by the U.S. Bureau of Reclamation (Faubion pers. comm. 2001), and another part is under a conservation easement held by the Sierra Foothill Conservancy. In 1990, the protected area contained approximately 500 plants of the 800 total in the occurrence (Stebbins 1991).

Eleven of the extant *Pseudobahia bahiifolia* occurrences are in the Great Valley Section of California, including seven in the Camanche Terraces Subsection (Element Occurrences 3, 15, 17, 18, 27, 28, and 29) and four (Element Occurrences 21, 22, 23, and 24) in the Hardpan Terraces Subsection of the Great Valley Section. The other two extant occurrences (Element Occurrences 25 and 26) are in the Lower Granitic Foothills Subsection of the Sierra Nevada Foothills Section. All but one of the occurrences known or presumed to be extirpated was in the Camanche Terraces Subsection of the Great Valley Section; the other (Element Occurrence 1) was in the Hardpan Terraces Subsection of the Great Valley Section (U.S. Department of Agriculture 1994).

Greene's Tuctoria (*Tuctoria greenei*)

The Service listed Greene's tuctoria as federally endangered in 1997 (Service 1997*a*). California listed Greene's tuctoria as rare in 1979 (California Department of Fish and Game 1991), and the California Native Plant Society had recognized it as rare and endangered even earlier (Powell 1974). Currently, the California Native Plant Society includes Greene's tuctoria on List 1B and ranks it as "endangered throughout its range" (Skinner and Pavlik 1994) and "seriously endangered in California" (Tibor 2001). The California Department of Fish and Game considered the status of Greene's Orcutt grass is declining (California Department of Fish and Game 2001).

George Vasey (1891) originally assigned the name *Orcuttia greenei* to this species. Edward Greene had collected the type specimen in 1890 "on moist plains of the upper Sacramento, near Chico, California" (Vasey 1891), presumably in Butte County (Hoover 1941, Crampton 1959). Citing differences in lemma morphology, arrangement of the spikelets, and other differences, John Reeder (1982) segregated the genus *Tuctoria* from *Orcuttia* and created the new scientific name *Tuctoria greenei* for this species. Subsequent research suggests that *Tuctoria* is intermediate in evolutionary position between the primitive genus *Neostapfia* and the advanced genus *Orcuttia* (Keeley 1998*a*, Boykin in litt. 2000). The genus *Tuctoria* is in the grass family, subfamily Chloridoideae, and is a member of the Orcuttieae tribe, which also includes *Neostapfia* and *Orcuttia* (Reeder 1965, Keeley 1998*a*). A wide variety of common names have been used for this species, including Chico grass (Scribner 1899), awnless Orcutt grass (Abrams 1940), Greene's Orcuttia (Smith *et al.* 1980), and Greene's Orcutt grass (California Department of Fish and Game 1991, Service 1985).

The basic characteristics pertaining to all members of the Orcuttieae were described in the Colusa grass account. The genus *Tuctoria* is characterized by flattened spikelets similar to those of *Orcuttia* species except that the spikelets of *Tuctoria* grow in a spiral, as opposed to a distichous, arrangement. *Tuctoria* species have short-toothed, narrow lemmas. The juvenile and terrestrial leaves of *Tuctoria* are similar to those of *Orcuttia* but *Tuctoria* does not produce the floating type of intermediate leaves (Reeder 1982, Keeley 1998*a*). *Tuctoria* is intermediate in the degree of aquatic specialization between *Neostapfia* and *Orcuttia* (Keeley 1998*a*).

Greene's tuctoria grows in tufts of several stems, which are erect or decumbent and break easily at the base. The entire plant tends to be pilose but is only slightly viscid. The stems are usually 2.0 to 5.9 inches tall and are not branched. Greene's tuctoria has purplish nodes and leaves no wider than 0.20 inch. The inflorescence can be as much 3.1 inches long; it may be partly hidden by the leaves when young but is held above the leaves at maturity. The inflorescence usually consists of 7 to 15 spikelets but may contain as many as 40. The spikelets are arranged in a spiral, with those in the upper half crowded together and those near the base more widely separated. Each spikelet consists of 5 to 15 florets and two glumes. The lemmas are 0.16 to 0.20 inch long and have squarish tips with 5 to 9 very short teeth; the central tooth is tipped by a very small spine. The roughened seeds are approximately 0.08 inch long (Vasey 1891, Hoover 1941, Griggs 1977, Stone *et al.* 1988, Reeder 1982) and weigh approximately 1.8×10^{-5} ounce (Griggs 1980). Greene's tuctoria has a diploid chromosome number of 24 (Reeder 1982).

Greene's tuctoria is differentiated from Orcutt grasses by the spiral arrangement of spikelets and lack of floating juvenile leaves, from Colusa grass by the shape of the spikelets and the inflorescence, and from both by the shape of the lemmas. Greene's tuctoria can be distinguished from Solano grass by the squarish lemma tip; smaller, roughened seeds; and inflorescence held above the leaves in the former. Both can be told from the remaining *Tuctoria* species by stem length, seed shape, and range. The chromosome number of Greene's tuctoria also differs from the other two species in the genus (Reeder 1982).

Life History and Habitat

The basic life history strategy and habitat requirements of *Tuctoria* species were described under Colusa grass and San Joaquin Valley Orcutt grass and will not be repeated here.

Optimum germination of Greene's tuctoria seed occurs when the seed is exposed to light and anaerobic conditions after stratification (Keeley 1988). Germination occurs approximately months following inundation (Keeley 1998*a*). *Tuctoria* seedlings do not develop floating juvenile leaves, as does *Orcuttia* (Griggs 1980, Keeley 1998*a*). The plants apparently do not tolerate inundation; all five Greene's tuctoria plants in a Glenn County pool died when the pool refilled during late spring rains in 1996 (Silveira pers. comm. 1997). Greene's tuctoria flowers from May to July (Skinner and Pavlik 1994), with peak flowering in June and July (Griggs 1981, Broyles 1987).

As with other vernal pool annuals, occurrence size in Greene's tuctoria can vary enormously from year to year, and populations that have no visible plants one year can reappear in large numbers in later years. Occurrence fluctuations may be due to annual variations in weather, particularly rainfall, to changes in management, or to a combination of the two. Such fluctuations were observed at scattered sites in Butte and Tehama counties during the 1970's (Griggs 1980, Griggs and Jain 1983) and at Sacramento National Wildlife Refuge, where the occurrence in the single occupied pool ranged from zero to 60 plants between 1994 and 1999 (Silveira in litt. 2000). Fluctuations of as much as three orders of magnitude were documented on the Vina Plains Preserve during the 1980's and 1990's (Table 7). The high 1995 occurrence estimates followed a winter of favorable rainfall (Alexander and Schlising 1997) and long period without livestock grazing; cattle grazing on the Vina Plains Preserve was discontinued in the growing season of 1987-1988 and did not resume until the growing season of 1995-1996 (Alexander in litt. 1998).

Table 7. Distribution and abundance of Greene's tuctoria at Vina Plains Preserve, Tehama County. Primary data reproduced from Alexander and Schlising (1997) with permission.

Pool Code	Number of plants				
	1983	1986	1987	1988	1995
14	95	—[1]	>1,000	—	96,400
21	<30,000	>1,000[2]	—	2,000	106,300
22	300	<1,000[2]	—	—	173,200
35	"few hundred"	0[2]	—	—	225,600
36	present	<100[2]	—	—	0
37	present	0[2]	—	—	1,319
Total	>30,395	≥2,000	≥1,000	≥2,000	602,819

[1] Data not available.
[2] Stone *et al.* (1988).

However, populations that decline to zero and then do not reappear under favorable conditions may in fact be extirpated. A Stanislaus County occurrence (Element Occurrence 39) numbered fewer than 100 plants in 1973, dropped to 2 the following year, and remained at zero for the next 3 years (Griggs 1980, Griggs and Jain 1983). The occurrence was not monitored for the following decade. The vernal pool was still intact as of 1986, but Greene's tuctoria was not observed during surveys that year; however, the winter had been drier than average. In 1987, following a winter of favorable rainfall, Greene's tuctoria still was not present even though Colusa grass was found in large numbers (Stone *et al.* 1988). The area had been "rather heavily grazed" in 1987 (Stone *et al.* 1988), but livestock grazing intensity during the 1970's was not known.

In a demographic study conducted during 1977 and 1978 on two populations of Greene's tuctoria from Butte and Tehama counties, 0 to 54 percent of seedlings survived to maturity. Plants that reached flowering stage achieved a density of 7.6 to 12.4 per square foot and averaged 111 seeds per plant (Griggs 1980, Griggs and Jain 1983). In 1995, density of Greene's tuctoria on the Vina Plains Preserve ranged from 7 to 133 plants per 0.7 to 12.4 per square foot (Alexander and Schlising 1997).

A study of genetic partitioning in five species of *Orcuttia* and *Tuctoria* (Griggs 1980, Griggs and Jain 1983) revealed that Greene's tuctoria had the lowest genetic diversity (50 percent) of the species studied. As with the other species, plants originating from the same seed parent accounted for about the same degree of genetic diversity (44 percent) as others within the same occurrence (46 percent). Only 10 percent of the total genetic variability observed in the species was due to between-population differences. This means that just a few of the same alleles dominated in the populations studied. However, Griggs' genetic study included only two populations from adjacent counties (Butte and Tehama) and did not consider geographically distant occurrences.

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

In the Northeastern Sacramento Valley Vernal Pool Region, Greene's tuctoria grows mostly on Anita clay and Tuscan loam soil series, with one occurrence on Tuscan stony clay loam. Soil types and series are not certain for several other occurrences in this region; one is on either the Rocklin or the San Joaquin series, and the others are unknown. The single occurrence in the Solano-Colusa Vernal Pool Region is on strongly saline-alkaline Willows clay (Silveira in litt. 2000). In the Southern Sierra Foothills Vernal Pool Region, Greene's tuctoria is known to grow on a number of different soil series including Archerdale, Bear Creek, Exeter, Meikle, Ramona, Raynor, Redding, and San Joaquin. Soil types and series have not been determined for occurrences in the other regions.

At the Vina Plains Preserve, frequent associates of Greene's tuctoria are common coyote-thistle and water shamrock (Alexander and Schlising 1997). Elsewhere in the Sacramento Valley and in the San Joaquin Valley, Greene's tuctoria often grows in association with Vasey's coyote-thistle, vernal pool popcorn flower, and foxtail (*Alopecurus saccatus*). The rare and federally listed Hoover's spurge co-occurs with Greene's tuctoria at six sites in the Sacramento Valley. Other rare plants that grow in the same vernal pools with Greene's tuctoria at one or two occurrences are hairy Orcutt grass, slender Orcutt grass, and Boggs Lake hedge-hyssop (Broyles 1987, Stone *et al.* 1988, CNDDB 2001).

Historical and Current Distribution

After its discovery in Butte County in 1890, Greene's tuctoria was not seen again for over 40 years. During extensive surveys in the late 1930's, Robert Hoover (1937, 1941) found the species at 12 sites in Fresno, Madera, Merced, San Joaquin, Stanislaus, Tehama, and Tulare counties. Robert Hoover described the taxon as the most common of all *Orcuttia* species, with which it was classified at the time. By the end of the 1980's, Greene's tuctoria had been reported from a total of 36 occurrences in the same 8 counties (Stone *et al.* 1988, CNDDB 2001). Of these, 21 were in the Southern Sierra Foothills Vernal Pool Region and 15 were in the Northeastern Sacramento Valley Vernal Pool Region.

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

Twelve of the extant occurrences (60 percent) are in the Vina Plains area of Tehama and Butte counties, within the Northeastern Sacramento Valley Vernal Pool Region. Eastern Merced County, in the Southern Sierra Foothills Vernal Pool Region, has six extant occurrences (30 percent). The other two extant occurrence are in Glenn (Oswald and Silveira 1995) and Shasta counties (CNDDB 2001); the former is in the Solano-Colusa Vernal Pool Region, and the latter is in the Modoc Plateau Vernal Pool Region (Keeler-Wolf *et al.* 1998). Greene's tuctoria has been extirpated from Fresno, Madera, San Joaquin, Stanislaus, and Tulare counties (Stone *et al.* 1988, Skinner and Pavlik 1994, CNDDB 2001).

<u>Vernal Pool Crustaceans - Conservancy Fairy Shrimp (*Branchinecta conservatio*), Vernal Pool Fairy Shrimp (*Branchinecta lynchi*), and Vernal Pool Tadpole Shrimp (*Lepidurus packardi*)</u>

Conservancy fairy shrimp and vernal pool tadpole shrimp were federally listed as endangered, and vernal pool fairy shrimp were federally listed as threatened under the Act, throughout their range in 1994 (59 **FR** 48153). Conservancy fairy shrimp and vernal pool fairy shrimp are members of the aquatic crustacean order Anostraca. The vernal pool tadpole shrimp is a member of the aquatic crustacean order Notostraca.

Vernal pool fairy shrimp are found only in ephemeral freshwater habitats in California and Southern Oregon and the other two species are found only in ephemeral freshwater habitats in California. These species have all evolved similar adaptations to the unique habitat conditions of their vernal pool habitats. The general appearance and life history characteristics of these three species will be described in combination below. Following this description, information pertinent to each species' biology is provided.

Life History and Habitat of Vernal Pool Crustaceans

Vernal pool fairy shrimp and Conservancy fairy shrimp (fairy shrimp) have delicate elongate bodies, large stalked compound eyes, and 11 pairs of phyllopods, or gilllike structures that also serve as legs. They swim or glide gracefully upside down by means of complex beating movements that pass in a wave-like anterior to posterior direction. Fairy shrimp are filter feeders, and consume algae, bacteria, protozoa, rotifers, and bits of detritus as they move through the water. The second pair of antennae in fairy shrimp adult males are greatly enlarged and specialized for clasping the females during copulation. The females carry eggs in an oval or elongate ventral brood sac. The eggs are either dropped to the pool bottom or remain in the brood sac until the female dies and sinks. After fertilization, the eggs are coated with a protective protein layer that allows them to withstand heat, cold, and prolonged dehydration. These dormant eggs are also known as cysts, and they can remain viable in the soil for decades after deposition. When the pools refill in the same or subsequent seasons, some, but not all, of the cysts may hatch. The cyst bank in the soil may consist of cysts from several years of breeding. The cysts that hatch may do so within days after the vernal pools fill, and rapidly develop into adults. In pools that persist for several weeks to a few months, fairy shrimp may have multiple hatches during a single season (59 **FR** 48136).

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

Vernal pool crustaceans breathe primarily through their phyllopods. When dissolved oxygen concentrations are low, fairy shrimp can be seen at the water's surface, circulating oxygen. In addition to phyllopods, fairy shrimp exchange oxygen through other surfaces of their body, particularly the thorax and abdomen (Ericksen and Belk 1999). Oxygen is more readily available in cooler water, below 68 degrees Fahrenheit (° F), and oxygen requirements may explain why most species endemic to the Central Valley hatch in the winter and live in cooler water habitats.

The hydrology that maintains the pattern of inundation and drying characteristic of vernal pool habitats is complex. Vernal pool habitats form in depressions above an impervious soil layer (duripan) or rock substrate. After winter rains begin, this impervious layer prevents the downward percolation of water and creates a perched water table causing the depression (or pool) to fill. Due to local topography and geology, the depressions are generally part of an undulating landscape, where soil mounds are interspersed with basins, swales, and drainages (Nikiforoff 1941, Holland and Jain 1978). These features form an interconnected hydrological unit known as a vernal pool complex. Although vernal pool hydrology is driven by the input of precipitation, water input to vernal pool basins also occurs from surface and subsurface flow from the swale and upland portions of the complex (Zedler 1987, Hanes *et al.* 1990, Hanes and Stromberg 1998). Surface flow through the swale portion of the complex allows vernal pool species to move directly from one vernal pool to another. Upland areas are a critical component of vernal pool hydrology because they directly influence the rate of vernal pool filling, the length of the inundation period, and the rate of vernal pool drying (Zedler 1987, Hanes and Stromberg 1998).

The Service has used vernal pool complexes as the basis for determining populations of vernal pool crustaceans since the species were first proposed for listing. The final rule to list the four vernal pool crustaceans states that "The genetic characteristics of the three fairy shrimp and vernal pool tadpole shrimp, as well as ecological conditions, such as watershed contiguity, indicate that populations of these animals are defined by pool complexes rather than by individual vernal pools" (Fugate 1992, Fugate 1998, King 1996). Therefore, the most accurate indication of the distribution and abundance of the three vernal pool crustaceans is the number of inhabited vernal pool complexes. Individual vernal pools occupied by the three species listed herein are most appropriately referred to as "subpopulations" (FR 59:48137).

All of the vernal pool crustacean species addressed in this biological opinion have evolved unique physical adaptations to survive in vernal pools. Vernal pool environments are characterized by a short inundation phase during the winter, a drying phase during the spring, and a dry phase during the summer (Holland and Jain 1978). The timing and duration of these phases can vary significantly from year to year, and in some years vernal pools may not inundate at all. In order to take advantage of the short inundation phase, vernal pool crustaceans have evolved short reproduction times and high reproductive rates. The listed crustaceans generally hatch within a few days after their habitats fill with water, and can start reproducing within a few weeks (Eng *et al.* 1990, Helm 1998, Eriksen and Belk 1999). Vernal pool crustaceans can complete their entire life cycle in a single season, and some species may complete several life cycles. Vernal pool crustaceans can also produce numerous offspring when environmental conditions are favorable. Some species may produce thousands of cysts during their life spans.

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

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

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

Although the vernal pool crustaceans, and particularly the fairy shrimp, addressed in this biological opinion are not often found in the same vernal pool at the same time, when coexistence does occur, it is generally in deeper, longer lived pools (Eng *et al.* 1990, Thiery 1991, Gallagher 1996, Simovich 1998). In larger pools, closely related species of fairy shrimp may coexist by hatching at different temperatures, and by developing at different rates (Thiery 1991, Hathaway and Simovich 1996). Vernal pool crustacean species may also be able to coexist by utilizing different physical portions of the vernal pool or by eating different food sources (Daborn 1978, Mura 1991, Hamer and Appleton 1991, Thiery1991). Maeda-Martinez (1997) reviewed much of the literature on large branchiopod coexistence and concluded that species distribution patterns likely result from differences in the physical environment of the ephemeral habitat, differences in the life history and habitat requirements of different species, and factors such as colonization, extirpation, and random events. The role of competition in structuring vernal pool crustacean communities is not well understood.

Upland areas associated with vernal pools are also an important source of nutrients to vernal pool organisms (Wetzel 1975). Vernal pool habitats derive most of their nutrients from detritus which is washed into the pool from adjacent uplands, and these nutrients provide the foundation for vernal pool aquatic communities food chain. Detritus is a primary food source for the vernal pool crustaceans (Eriksen and Belk 1999). Vernal pool crustaceans are an important food source for a number of aquatic and terrestrial species. Aquatic predators include insects such as backswimmers (Family Notonectidae) (Woodward and Kiesecker 1994), predaceous diving beetles and their larvae (Family Dystictidae), and dragonflies and damselfly larvae (Order Odonate). Vernal pool tadpole shrimp are another significant predator of fairy shrimp. Vernal pools provide important habitat for resident and migratory birds, particularly waterfowl and shorebirds. Birds are particularly attracted to the pools because they offer foraging habitat at a time of year when resources are limited (Silveira 1998), and vernal pools help link aquatic resources in the California portion of the Pacific Flyway. Vernal pool crustaceans provide important proteins and calcium vital to the energetic needs of migratory bird migration and reproduction (Proctor *et al.* 1967, Silveira 1998). Vernal pool crustaceans are a major food source for a number of terrestrial vertebrate predators including water fowl, wading birds, toads, frogs, and salamanders (Proctor *et al.* 1967, Krapu 1974, Swanson 1974, Morin 1987, Simovich *et al.* 1991, Silveira 1998). Vernal pool crustaceans depend on the absence of water during the summer months to discourage aquatic predator species such as bullfrogs, garter snakes, and fish (Eriksen and Belk 1999). There is evidence that vernal pool crustaceans were used as a food source for Native Americans in California's Central Valley.

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

Vernal pool crustaceans are often dispersed from one pool to another through surface swales that connect one vernal pool to another. These dispersal events allow for genetic exchange between pools and create a population of animals that extends beyond the boundaries of a single pool. Instead, populations of vernal pool crustaceans are defined by the entire vernal pool complex in which they occur (Simovich *et al.* 1992, King 1996). These dispersal events also allow vernal pool crustaceans to move into pools with a range of sizes and depths. In dry years, animals may only emerge in the largest and deepest pools. In wet years, animals may be present in all pools, or in only the smallest pools. The movement of vernal pool crustaceans into vernal pools of different sizes and depths allows these species to survive the environmental variability that is characteristic of their habitats.

The vernal pool crustaceans addressed in this biological opinion are generally confined to habitats that are low to moderate in alkalinity and dissolved salts, when compared with other aquatic systems (Ericksen and Belk 1999). Although potentially moderated by soil type, vernal pools are generally unbuffered and exhibit wide fluctuations in pH and dissolved oxygen. Vernal pools may change 3 to 4 pH units within a few hours (Keeley and Zedler 1998). Vernal pool water ion concentrations, such as sodium, potassium, calcium, chlorine, and magnesium, also experience large daily and seasonal variations. These variations are due to the concentration of ions as a result of evaporation, and the dilution of ions with additional rainfall throughout the wet season (Barclay and Knight 1981). How vernal pool crustacean species adapt to these fluctuations in water chemistry is unknown. Gonzalez *et al.* (1996) studied ion regulation in several fairy shrimp species in Southern California and found that some species are hyperosmotic regulators, and use active transport to maintain internal ion concentrations above that in the external environment. These species typically inhabit pools with low ion concentrations. Other species can tolerate higher ion concentrations in the external environment by hyporegulating, or maintaining internal levels below that of the water around them. Some species are also able to osmoconform, and allow their internal chemistry to match external ion concentrations. These differences in ion regulation may explain why some species are limited to certain habitats. Although there are numerous observations of the water chemistry of vernal pools where vernal pool crustaceans have been collected, wide variations in vernal pool water chemistry and the anecdotal nature of these observations preclude definitive conclusions about water chemistry habitat preferences.

Additional information specific to each of the three individual vernal pool crustacean species described in this biological opinion is provided below.

Additional Information for Vernal Pool Fairy Shrimp and Distribution

Although most species of fairy shrimp look generally similar, vernal pool fairy shrimp are characterized by the presence and size of several bulges on the male's antenna, and by the female's short, pyriform or pear shaped, brood pouch. They vary in size, ranging from 0.4 to 1.0 inch in length (Eng *et al.* 1990).

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

Helm (1998) observed vernal pool fairy shrimp living for as long as 147 days. The species can reproduce in as few as 18 days at optimal conditions of 68°F and can complete its life cycle in as little as 9 weeks (Gallagher 1996, Helm 1998). However, maturation and reproduction rates of vernal pool crustaceans are controlled by water temperature and can vary greatly (Eriksen and Brown 1980, Helm 1998). Helm (1998) observed that vernal pool fairy shrimp did not reach maturity until 41 days at water temperatures of 59°F. Vernal pool fairy shrimp has been collected at water temperatures as low as 40°F (Eriksen and Belk 1999), however, the species has not been found in water temperatures above about 73°F (Helm 1998, Eriksen and Belk 1999).

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

The vernal pool fairy shrimp is known from 32 populations extending from Stillwater Plain in Shasta County through most of the length of the Central Valley to Pixley in Tulare County, and along the central coast range from northern Solano County to Pinnacles in San Benito County (Eng et al. 1990, Fugate 1992, Sugnet 1993) and a disjunct population on the Agate Desert in Oregon. Five additional, disjunct populations exist: one near Soda Lake in San Luis Obispo County; one in the mountain grasslands of northern Santa Barbara County; one on the Santa Rosa Plateau in Riverside County, one near Rancho California in Riverside County and one on the Agate Desert near Medford, Oregon. Three of these isolated populations each contain only a single pool known to be occupied by the vernal pool fairy shrimp.

Additional Information for Conservancy Fairy Shrimp and Distribution

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

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

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

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

Additional Information for Vernal Pool Tadpole Shrimp and Distribution

Vernal pool tadpole shrimp are distinguished by a large, shieldlike carapace, or shell, that covers the anterior half of their body. They resemble horse shoe crabs. Vernal pool tadpole shrimp have 30 to 35 pairs of phyllopods, a segmented abdomen, paired cercopods or taillike appendages, and fused eyes. Vernal pool tadpole shrimp will continue to grow as long as their vernal pool habitats remain inundated, in some cases for six months or longer. They periodically shed their shells, which can often be found along the edges of vernal pools where vernal pool tadpole shrimp occur. Mature vernal pool tadpole shrimp range in size from 0.6 to 3.4 inches in length.

Vernal pool tadpole shrimp have relatively high reproductive rates. Ahl (1991) found that fecundity increases with body size. Large females, greater than .8 inch carapace length, could deposit as many as 6 clutches, averaging 32 to 61 eggs per clutch, in a single wet season. Vernal pool tadpole shrimp sex ratios can vary (Ahl 1991, Sassaman 1991).

After winter rains fill their vernal pool habitats, dormant vernal pool tadpole shrimp cysts may hatch in as little as 4 days (Ahl 1991, Rogers in litt. 2001). Additional cysts produced by adult tadpole shrimp during the wet season may hatch without going through a dormant period (Ahl 1991). Vernal pool tadpole shrimp emerge from their cysts as metanaupliu, a larval stage which lasts for 1.5 to 2 hours. Then they molt into a larval form resembling the adult.

Helm (1998) found that vernal pool tadpole shrimp took a minimum of 25 days to mature and the mean age at first reproduction was 54 days. Other researchers have observed that vernal pool tadpole shrimp generally take between 3 and 4 weeks to mature (Ahl 1991, King 1996). Ahl (1991) found that reproduction did not begin until individuals were larger than 0.39 inch carapace length. Variation in growth and maturation rates may be a result of differences in water temperature, which strongly influences the growth rates of aquatic invertebrates.

Vernal pool tadpole shrimp will survive for as long as their habitats remain inundated, sometimes for 6 months or more (Ahl 1991, Gallagher 1996, Helm 1998). They continue growing throughout their lives, periodically molting their shells. These shells can often be found in vernal pools where the species occurs. Vernal pool tadpole shrimp hatching is temperature dependent. Optimal hatching occurs between 50 and 59° F, while hatching rates become significantly lower at temperatures above 68°F (Ahl 1991).

Vernal pool tadpole shrimp occur in a wide variety of vernal pool habitats including vernal pools, clay flats, ephemeral stock ponds, roadside ditches, and road ruts (Helm 1998, Jones & Stokes 2002). They have been found in pools with water temperatures ranging from 50° F to 84° F and pH ranging from 6.2 to 8.5 (Syrdahl 1993, King 1996). However, vernal pools exhibit daily and seasonal fluctuations in pH, temperature, dissolved oxygen, and other water chemistry characteristics (Syrdahl 1993, Scholnick

1995, Keeley 1998). Determining vernal pool tadpole shrimp habitat requirements is not possible based on anecdotal evidence, and the tolerances of this species to specific environmental conditions have yet to be determined. Although vernal pool tadpole shrimp are found on a variety of geologic formations and soil types, Helm (1998) found that over 50 percent of vernal pool tadpole shrimp occurrences were on High Terrace landforms and Redding and Corning soils. Plantenkamp (1998) found that vernal pool tadpole shrimp presence differed significantly between geomorphic surfaces at Beale Air Force Base and the species was most likely to be found on Riverbank formation.

Vernal pool tadpole shrimp can be difficult to detect because of the animals' habit of dwelling on muddy pool bottoms, where they may burrow through vegetative layers. Also, because eggs may lay dormant for as long as four years, populations may go undetected through one or two years of wet season sampling (Rogers 2001).

King (1996) studied genetic variation among vernal pool tadpole shrimp populations at 20 different sites in the Central Valley. She found that 96 percent of the genetic variation measured was due to differences between sites. This result corresponds with the findings of other researchers that vernal pool crustaceans have low rates of gene flow between separated sites. The low rate of exchange between vernal pool tadpole shrimp populations is probably a result of the spatial isolation of their habitats and their reliance on passive dispersal mechanisms. However, King (1996) also estimated that gene flow between pools within the same vernal pool complex was much higher, and concluded that vernal pool crustacean populations should be defined by vernal pool complex, not by the boundaries of an individual vernal pool.

Based on genetic differences, King (1996) separated vernal pool tadpole shrimp populations into two distinct groups. One group was comprised of animals inhabiting the floor of the Central Valley, near the Sacramento and San Joaquin Rivers. The other group contained vernal pool tadpole shrimp from sites along the eastern margin of the valley. King (1996) concluded that these two groups may have diverged because cyst dispersal by overland flooding historically connected populations on the valley floor, while populations on the eastern margin of the valley were not periodically connected by large scale flooding, and were therefore historically more isolated. When dispersal of these foothill populations occurred, it was probably through different mechanisms such as migratory birds. King (1996) also found that populations in eastern Merced County, in the vicinity of the Flying M Ranch and the proposed University of California (UC) Merced campus, were very different from all other populations studied. She concluded, particularly because it is found on very ancient soils, that this group may have been isolated from other populations very early.

The vernal pool tadpole shrimp is sparsely distributed along the Central Valley from east of Redding in Shasta County south to Fresno County, and in a single vernal pool complex located on the San Francisco Bay National Wildlife Refuge in Alameda County. It inhabits vernal pools containing clear to highly turbid water, ranging in size from 5 square meters (54 square feet) in the Mather Air Force Base area of Sacramento County, to the 36-hectare (89-acre) Olcott Lake at Jepson Prairie in Solano County.

Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*)

The valley elderberry longhorn beetle (beetle) was listed as a threatened species under the Act on August 8, 1980 (45 **FR** 52803). Critical habitat for the species was designated and published in 50 CFR §17.95. Two areas along the American River in the Sacramento metropolitan area have been designated as critical habitat for the beetle. Critical habitat for this species has been designated along the lower American River at Goethe and Ancil Hoffman parks (American River Parkway Zone) and at the Sacramento Zone, an area about a half mile from the American River downstream from the American River Parkway Zone. In addition, an area along Putah Creek, Solano County, and the area west of Nimbus Dam along the American River Parkway, Sacramento County, are considered essential habitats, according to the Valley Elderberry Longhorn Beetle Recovery Plan (Service 1984). These areas support large numbers of mature elderberry shrubs with extensive evidence of use by the beetle.

The valley elderberry longhorn beetle is a large (about one inch long), black and red cerambycid beetle. Males and females exhibit sexual dimorphism with the female.

Life History and Habitat

The beetle is dependent on its host plant, elderberry, which is a locally common component of the remaining riparian forests and savannah areas and, to a lesser extent, the mixed chaparral-foothill woodlands of the Central Valley. Beetles remain within the stems and trunks of elderberry shrubs as larvae and pupae for one to two years. Use of the elderberry shrubs by the animal, a wood borer, is rarely apparent. Frequently, the only exterior evidence of the shrub's use by the beetle is an exit hole created by the larva just prior to the pupal stage. Observations made within elderberry shrubs along the Cosumnes River and in the Folsom Lake area indicate that larval galleries can be found in elderberry stems with no evidence of exit holes; the larvae either succumb prior to constructing an exit hole or are not far enough along in the developmental process to construct an exit hole. Larvae appear to be distributed in stems which are 1.0 inch or greater in diameter at ground level. The *Valley Elderberry Longhorn Beetle Recovery Plan* (Service 1984) and Barr (1991) contain further details on the beetle's life history.

Population densities of the beetle are probably naturally low (Service 1984); and it has been suggested, based on the spatial distribution of occupied shrubs (Barr 1991), that the beetle is a poor disperser. Low density and limited dispersal capability cause the beetle to be vulnerable to the negative effects of the isolation of small subpopulations due to habitat fragmentation.

Historical and Current Distribution

When the beetle was listed, the species was known from fewer than 10 localities along the American River, the Merced River, and Putah Creek. By the time the *Valley Elderberry Longhorn Beetle Recovery Plan* was issued, additional species localities had been found along the American River and Putah Creek. As of 1998, the California Natural Diversity Database (CNDDB) included 181 occurrences for this species in 44 drainages throughout the Central Valley, from a location along the Sacramento River in Shasta County, southward to an area along Caliente Creek in Kern County (CNDDB 1998). The beetle continues to be threatened by habitat loss and fragmentation, predation by Argentine ants (*Linepithema humile*), and possibly other factors such as pesticide drift, nonnative plant invasion, and grazing.

Bald Eagle (*Haliaeetus leucocephalus*)

The bald eagle was first listed as endangered in 1967, under the Endangered Species Preservation Act of 1966. On February 14, 1978, the bald eagle was designated under the Endangered Species Act of 1973, as amended, as endangered throughout the lower 48 states except in Michigan, Minnesota, Wisconsin, Washington, and Oregon, where it was designated as threatened (43 **FR** 6230). A recovery plan was released in 1986 for the recovery and maintenance of bald eagle populations in the 7-state Pacific recovery region (Idaho, Nevada, California, Oregon, Washington, Montana, and Wyoming) (Service 1986). In recent years, the status of bald eagle populations has improved throughout the United States. It was downlisted from endangered to threatened on July 12, 1995, throughout the lower 48 states (60 **FR** 36000). A proposed rule to remove the species from the list of endangered and threatened wildlife was made on July 6, 1999 (64 **FR** 36454) but this rule has not been finalized.

Critical habitat has not been designated for this species. In addition to the Act, the bald eagle is protected under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§703-712) and the Bald Eagle Protection Act of 1940, as amended (16 U.S.C. §§668-668d). The bald eagle is listed as endangered under the California Endangered Species Act and designated as a California fully protected species.

The adult bald eagle is recognized by its white head and tail contrasting against its dark brown body as well as its wingspan which can be greater than 6.5 feet.

Life History and Habitat

The bald eagle is a generalist and opportunistic predator and scavenger adapted to aquatic ecosystems. It frequents estuaries, large lakes, reservoirs, major rivers, and some coastal habitats. Its primary foods, in descending order of importance are: fish (taken both alive and as carrion), waterfowl, mammalian carrion, and small birds and mammals.

Bald eagles are highly maneuverable in flight and frequently perch-hunt. Diurnal perches are used during foraging; these usually have a good view of the surrounding area and are often the highest perch sites available (Service 1986). They are also known to hunt by coursing low over the ground or water. In general, foraging habitat consists of large bodies of water or free-flowing rivers with abundant fish and adjacent snags and other perches (Zeiner *et al.* 1990).

The CDFG's fish stocking program throughout California's lakes, reservoirs and rivers has provided an abundant prey base of fish for the bald eagle. In the northern California lakes, 4,000 pounds of salmonids are stocked in approximately 57 bodies of water each year. That includes approximately 200 to 350 pounds of fish 10 to 12 inches in length. For recreational fishing, 70,000 pounds of fish averaging approximately 0.5 pound each are annually stocked in approximately 62 different bodies of water in the southern Sierra Nevada. In stocking programs in northern California, up to 20 percent of the released hatchery trout may die soon after release and many initially inhabit the top of the water column because of increased oxygen levels there. In one study, bald eagles were observed taking fish carrion at the stocking location at the Shasta Reservoir (Detrich 1978).

Though the construction of dams has limited the range of anadromous fish, an important historic bald eagle prey base, reservoir construction and the stocking of fish in reservoirs in the west have provided bald eagles with habitat for population expansion following their mid-century decline which resulted from DDT poisoning, degradation of historical nesting habitat, and persecution by humans (Detrich 1986, Service 1986). Food habitat studies of reservoir-nesting bald eagles in the west have focused on populations in northern California and Arizona (Hunt *et al.* 1992, Jackman *et al.* 1999).

The bald eagle is long-lived, and individuals do not reach sexual maturity until four or five years of age. Breeding generally occurs February to July (Zeiner *et al.* 1990) but breeding can be initiated as early as January 1 via courtship, pair bonding, and territory establishment. The breeding season normally ends approximately August 31 when the fledglings have begun to disperse from the immediate nest site. One to three eggs are laid in a stick platform nest 50 to 200 feet above the ground and usually below the tree crown (Zeiner *et al.* 1990). Incubation may begin in late February to mid-March, with the nestling period extending to as late as the end of June. From June thru August, the chicks remain restricted to the nest until they are able to move around within their environment. Bald eagles are susceptible to disturbance by human activity during the breeding season, especially during egg laying and incubation, and such disturbances can lead to nest desertion or disruption of breeding attempts (Service 1986).

Nesting territories are normally associated with lakes, reservoirs, rivers, or large streams and are usually within 2 miles from water bodies that support an adequate food supply (Lehman 1979, Service 1986). Some of California's breeding birds winter near their nesting territories. Most nesting territories in California occur from 1,000 to 6,000 feet elevation, but nesting can occur from near sea level to over 7,000 feet (Jurek 1988).

In the Pacific Northwest, bald eagle nests are usually located in uneven-aged (multi-storied) stands with large, old trees (Anthony *et al.* 1982). Most nests in California are located in ponderosa pine and mixed-conifer stands and nest trees are most often ponderosa pine (*Pinus ponderosa*) (Jurek 1988). Other site characteristics, such as relative tree height, tree diameter, species, position on the surrounding topography, distance from water, and distance from disturbance, also appear to influence nest site selection (Lehman *et al.* 1980, Anthony and Isaacs 1981). Bald eagles often construct up to five nests within a territory and alternate between them from year to year (Service 1986). Nests are often reused and eagles will add new material to a nest each year (DeGraaf *et al.* 1991).

Trees selected for nesting are characteristically one of the largest in the stand or at least co-dominant with the over-story, and usually have stout upper branches and large openings in the canopy that permit nest access (Service 1986). Nest trees usually provide an unobstructed view of the associated water body and are often prominently located on the topography. A survey of nest trees used in California found that about 71 percent were ponderosa pine, 16 percent were sugar pine (*Pinus lambertiana*), and 5 percent were incense-cedar (*Librocedrus decurrens)*, with the remaining 8 percent distributed among five other coniferous species (Lehman 1979).

Lehman (1979) found that 70 percent of the nest trees surveyed were classified as highly susceptible to beetle infestation, probably a function of eagle's using mature and over mature trees. Ninety-three percent of the nest trees were 21-60 inches in diameter (mean diameter was 43.1 inches) and 92 percent were greater than 76 feet tall (mean height was 111.9 feet). Seventy-three percent of the nest sites were within 0.5 mile of a body of water, 87 percent within 1 mile, and none were over 2 miles from water. Other trees, such as snags, trees with exposed lateral limbs, or trees with dead tops, are often also present in nesting territories and are used for perching or as points of access to and from the nest. Such trees also provide vantage points from which territories can be guarded and defended. Nearby trees may also screen the nest from human disturbances or provide protection from wind damage (Jurek 1988).

Two habitat characteristics appear to play a significant role in habitat selection during the winter: diurnal feeding perches, as described above, and communal night roost areas. Communal roosts are usually near a rich food resource (Service 1986), although Keister and Anthony (1983) found that bald eagles used forest stands with older trees as far as 9.6 miles from the food source in the Klamath Basin. The areas used as communal roosts in the Klamath Basin were the forest stands with old (mean age of roost trees was 236 years), open-structured trees that were close to the feeding areas. In stands where ponderosa pine was dominant, the pine was used almost exclusively for roosting. In forest stands that are uneven-aged in the Pacific Northwest, communal roosts have at least a remnant of large, old trees (Anthony *et al.* 1982).

Most communal winter roosts used by bald eagles throughout the recovery areas offer considerably more protection from the weather than diurnal habitat (Service 1986). Isolation from disturbances is an important feature of bald eagle wintering habitat. Excessive human activity may be the reason why some suitable wintering habitat is not used by bald eagles (Service 1986). Human activity near wintering eagles can adversely affect eagle distribution and behavior (Stalmaster and Newman 1978).

Historical and Current Distribution

The bald eagle was historically abundant throughout North America except extreme northern Alaska and Canada and central and southern Mexico (60 **FR** 36000). After World War II, the use of dichlorodiphenyltrichloroethane (DDT) and other organochlorine compounds became widespread, and bald eagle populations plummeted. The bald eagle population has increased in number and expanded in range as a result of the banning of pesticides, habitat protection, and other recovery efforts. Between 1974 and 1995, the number of occupied breeding areas in the lower 48 states increased by 462 percent. The species has been doubling its breeding population every six to seven years since the late 1970s (60 **FR** 36000).

In California, bald eagles breed almost exclusively within Butte, Lake, Lassen, Modoc, Plumas, Shasta, Siskiyou, and Trinity counties. This species formerly nested along the Big Sur coast, and into the 1950s at a few scattered locations from San Luis Obispo County south to San Diego County. They also formerly nested on all the Channel Islands. Due primarily to eggshell thinning effects of DDT, the breeding population in California was reduced from thousands to about 20 breeding pairs, located in remote mountainous area in the far northern portion of the State (Small 1994).

As a result of recovery efforts including captive breeding and relocation, the California breeding population has increased. By 1994, the California breeding population was estimated at 70 breeding pairs, at scattered areas in north-central California, northeastern California, and the Sierra foothills (Small 1994). The California bald eagle nesting population has increased in recent years from fewer than 30 occupied territories in 1977 to 151 occupied territories in 1999 (Jurek, 2000). Wintering activity occurs throughout the state except for the desert regions east of the Los Angeles Basin (Gertsch *et. al* 1994). Wintering habitat is associated with open bodies of water, with some of the largest wintering bald eagle populations occurring in the Klamath Basin (Detrich 1981, 1982). Smaller concentrations of wintering birds are found at most of the larger lakes and man-made reservoirs in the mountainous interior of the north half of the state and at scattered reservoirs in central and southwestern California. California's breeding population is resident year-long in most areas as the climate is relatively mild (Jurek

1988). Between mid-October and December, migratory bald eagles arrive in California from areas north and northeast of the state. The wintering populations remain in California through March or early April.

San Joaquin Kit Fox (*Vulpes macrotis mutica*)

The San Joaquin kit fox was federally listed as endangered on March 11, 1967 (32 **FR** 4001) and listed by the State as threatened on June 27, 1971. The Service wrote a recovery plan in 1983 and revised it in 1998. The plan is called the *Recovery Plan for Upland Species of the San Joaquin Valley, California* (*Upland Species Recovery Plan*). There has been no critical habitat designated for the kit fox.

The kit fox is the smallest canid species in North America with the males averaging 5 pounds and the females averaging 4.6 pounds (Morrell 1972). The kit fox has relatively large ears set close together and a long, bushy, distinctly black-tipped tail that is typically carried low and straight. Fur color varies geographically and seasonally, but is most commonly described as buff or tan in the summer, and yellowish gray or silver gray in the winter (McGrew 1979, Morrell 1972).

Life History and Habitat

Kit foxes occur in a wide variety of habitats, including grasslands and scrub lands in the southern part of their range, and grasslands and oak woodlands in the northern part of their range. Kit foxes survive in habitats that have been modified by humans, including an agricultural matrix of row crops, irrigated pasture, orchards, vineyards, and grazed annual grasslands. Kit foxes are active at dusk and during the night, and sleep in underground dens during the day. They often change dens and numerous dens may be used throughout the year. Home ranges of from fewer than 1 square mile up to approximately 12 square miles have been reported (Morrell 1972, Knapp 1978, Zoellick *et al.* 1987, Paveglio and Clifton 1988, Spiegel and Bradbury 1992, White and Ralls 1993).

The kit fox is an opportunistic feeder, and its diet varies geographically, seasonally, and annually with variation and abundances of prey. Kit foxes in the northern part of their range have been found to primarily feed on ground squirrels (Orloff *et al.*, 1986), while in the southern portion of the range kangaroo rats have been found to be the main prey source. Kit foxes have been found to prey on ground nesting birds (Scrivner *et al.* 1987a) and to supplement their diets with vegetation, mainly grasses (Morrell 1971).

Kit foxes can breed when 1 year old, but may not breed their first year of adulthood (Morrell 1972). Adult pairs remain together all year, sharing the home range but not necessarily the same den (Ralls pers. comm. 2000). During September and October, adult females begin to clean and enlarge natal dens. Mating and conception take place between late December and March. Litters of from two to six pups are born sometime between February and late March (Egoscue 1962). Pups emerge above ground at about one month of age. After 4 or 5 months, usually in August or September, the family bonds begin to dissolve and the young begin dispersing.

During a 6-year study at the Elk Hills Naval Petroleum Reserves in Kern County pups dispersed an average of 5.0 miles, plus or minus 0.9 mile (Scrivner *et al.* 1987b). The study was conducted in an area in which there is little agricultural or urban development; therefore, foxes were probably not forced to disperse long distances due to lack of suitable habitat in the vicinity of their natal range. Maximum reported distances include 25 miles (Getz pers. comm. 2000) and approximately 45 miles (White pers. comm. 1996). Adult and juvenile kit foxes radiocollared at the Elk Hills Naval Petroleum Reserves dispersed through disturbed habitats, including agricultural fields, oil fields, rangelands, and across highways and aqueducts (Service 1998).

A study of kit fox movement on the Elk Hills Naval Petroleum Reserves, California, found that 99 percent of all kit fox movements occurred in terrain with slopes fewer than 6 degrees or 10.5 percent (Koopman 1995). Most kit fox home ranges were bordered on at least one side by low hills, yet kit fox movements into these areas were rare. A 1998 study found that topographic ruggedness was the only variable consistently affecting the spatial distribution of kit foxes at the Naval Petroleum Reserves, California, being that there was a negative association between capture rates of kit foxes and ruggedness (Warrick *et al.* 1998). Kit fox populations in the northwestern extreme of the species' range, as well as western San Joaquin County, occur in habitat with steep terrain with up to 30 percent slopes (Orloff *et al.* 1986; Jones and Stokes 1992). Consequently, the evidence suggests uncertainties regarding the effect of slopes on kit fox dispersal.

Historical and Current Distribution

The San Joaquin kit fox historically was distributed within an 8,700-square mile range in central California from the vicinity of Tracy in the upper San Joaquin Valley south to the Tehachapi Mountains in Kern County. San Joaquin kit foxes are currently limited to remaining grassland, saltbush, open woodland, alkali sink valley floor habitats, and other similar habitats located along bordering foothills and adjacent valleys and plains of the San Joaquin Valley. There has never been a comprehensive survey of San Joaquin kit foxes or their habitat. What little is known comes from incidental sightings, local surveys, and research projects.

Kit foxes are known to be in the vicinity of the Study Area due to recent cursory spotlighting surveys for the UC Merced project, and chance encounters between Caltrans biologists and kit foxes. Reliable sightings were made in April and May of 2001, 8 miles and 12 miles south of the Study Area (Johnson 2001, Nunes and Johnson 2001). Chambers Group reported a kit fox 9 miles west of the Study Area on the outskirts of

Atwater (Chambers Group 2001). One kit fox was seen in broad daylight with the help of a scent dog on the Ichord Ranch, in the Study Area in 2002 (Clark and Smith 2001). Studies done in the 1980s in western Merced County showed there to be a population of foxes there (Briden *et al* 1987); no similar studies have been conducted in eastern Merced County in the vicinity of the Study Area. Reported sightings are rare in the hills bordering the east side of the San Joaquin Valley due to a lack of public roads in the hills, a lack of kit fox surveys, and undulating topography that makes kit fox hard to see. Even if spot light surveys had been done, we now know that spot light surveys only detect about 20 percent of the foxes that are in an area (Bell pers. comm. 2001).

The *Upland Species Recovery Plan* identifies a movement corridor on the east side of the San Joaquin Valley from Madera County through Merced and Stanislaus Counties to San Joaquin County. Three kit fox sightings are recorded near La Grange north of the Study Area (CDFG 1994, Clifton 1998) in the eastside corridor. In addition, the *Upland Species Recovery Plan* describes an east-west linkage corridor along Sandy Mush Road that connects the corridor in eastern Merced County to a subpopulation in the Kesterson National Wildlife Refuge where a number of sightings have been recorded (ESRP 2000).

Recovery Needs

The *Upland Species Recovery Plan* identifies numerous recovery actions and tasks for this species, including the following tasks, which are pertinent to this analysis:

- Maintain and enhance kit fox movement between the Mendota area, Fresno County, natural lands in western Madera County, and natural lands along Sandy Mush Road and in the wildlife refuges and easement lands of Merced County.

- Link natural lands in the Sandy Mush Road area of Merced County with the northeastern edge of the Valley (Recovery Task 5.1.8, Priority 2).

- Protect existing kit fox habitat in the northern, northeastern, and northwestern segments of their geographic range and existing connections between habitat in those areas and habitat further south.

- Determine current geographic distribution and population status of kit foxes, with special emphasis on potential habitat in eastern Madera, Merced, Stanislaus and San Joaquin Counties, and the Salinas-Pajaro Region.

<u>Mountain Plover *(Charadrius montanus)*</u>

The mountain plover was proposed for Federal listing as threatened on February 16, 1999 (64 **FR** 7587). The mountain plover is about 9 inches in length, and is slightly smaller than the killdeer, both of which are in the Plover Family (Charadriidae). The mountain plover is drab and brownish in winter, the season that it can be found in California's Central Valley. Summer breeding grounds are in the Western Plains states. The mountain plover is a State Species of Special Concern.

Habitat

The mountain plover is associated with shortgrass and shrub-steppe landscapes throughout its breeding and wintering range. Mountain plovers evolved on grasslands that were inhabited by large numbers of nomadic grazing ungulates such as bison, elk, pronghorn, and burrowing mammals such as kangaroo rats, prairie dogs, and badgers (Knopf 1996*a*). The herbivores dominated the grassland landscape at both breeding and wintering sites, and their grazing, wallowing, and burrowing activities created and maintained a mosaic of vegetation and bare ground to which mountain plovers became adapted (Dobkin 1994, Knopf 1996*a*). Unlike most other plovers, mountain plovers are rarely found near water. Habitat in its wintering grounds includes open fields, "bare" ground of burned or heavily grazed grasslands, and other open areas. Mountain plovers forage for insects, and can be seen running rapidly along the ground and then stopping. Although cultivated land is used by mountain plovers, Knopf and Rupert (1995) found that wintering mountain plovers preferred alkali flats, burned grasslands, and grazed annual grasslands to cultivated sites. Mountain plovers spend about 5 months in wintering habitat (Knopf and Rupert 1996), and begin leaving wintering areas by mid-March (Knopf and Rupert 1995).

Historical and Current Distribution

Mountain plovers spend the summer in the Great Plains, and migrate across the Rocky Mountains in both spring and fall. Historically, mountain plovers have been observed during the winter in California, Arizona, Texas, and Nevada; the California coastal islands of San Clemente Island, Santa Rosa Island; and, the Farallon Islands (Strecker 1912; Swarth 1914; Alcorn 1946; Jurek 1973; Jorgensen and Ferguson 1984; Garrett and Dunn 1981; Deuel in litt. 1992). In Mexico, wintering mountain plovers have been sighted in Baja, California, as well as north-central and northeastern Mexico, specifically in Chihuahua, Coahuila, Sonora, Nuevo Leon, and San Luis Potosi (Russell and Lamm 1978, Garza de Leon in litt. 1990, Stenzel in litt. 1992, Estelle pers. comm. 1998).

Between 1966 and 1991, the continental population of the mountain plover declined an estimated 63 percent. Currently, the majority of mountain plovers appear to winter in California, with fewer reported from Texas, Arizona, and Mexico. The only published scientific study of mountain plovers on their wintering habitat documented movement patterns, habitat preferences, and winter survival rates in the San Joaquin Valley and Carrizo Plain Natural Area of California (Knopf and Rupert 1995). Due to the lack of published information on wintering birds, the Service examined Christmas Bird Count data, notes of California sightings compiled from *American Birds*, National Wildlife

Refuge records, BLM surveys, and other information, in compiling information to support listing the mountain plover (Lowe in litt. 1989, Deuel in litt. 1992).

In California, mountain plovers are most frequently reported and found in the greatest numbers in two general locations--(1) in the Central Valley south of Sacramento and west of U.S. Highway 99, and (2) the Imperial Valley in southern California. Throughout these areas, sightings occur on agricultural fields and uncultivated sites; uncultivated sites are preferred habitat (Knopf and Rupert 1995).

Within the Central Valley, flocks of up to 1,100 birds have been seen recently in Tulare County (Knopf and Rupert 1995). The Carrizo Plain Natural Area in San Luis Obispo County also is recognized as an important wintering site, with wintering birds reliably reported from the west side of the Carrizo Plain Natural Area since 1971 (Fitton in litt. 1992). The Sacramento Valley portion of the Central Valley also provides wintering habitat for flocks of mountain plovers within Solano and Yolo Counties. During the 1998 census, 230 and 187 mountain plovers were observed within each of these counties, respectively (Hunting in litt., 1998).

About 2,000 mountain plovers were counted on agricultural fields in the Imperial Valley in 1994 (Barnes, in litt. 1994). At other locations in southern California, birds have been seen at Harper Dry Lake, Antelope Valley, San Jacinto Lake Wildlife Area, and the Tijuana River Valley (Garrett pers. comm. 1989, Cardiff pers. comm. 1992, Paulek pers. comm. 1992, Copper in litt. 1992). Mountain plovers are considered extirpated (extinct) from Orange County (Harper in litt. 1990).

Environmental Baseline

Fleshy Owl's-Clover

Reasons for Decline and Threats to Survival

The status of most fleshy owl's-clover populations is unknown because many occurrence sites have not been visited for decades. Inappropriate cattle grazing and trampling degraded three occurrences of fleshy owl's-clover. One of the same sites plus three others were degraded by discing (CNDDB 2000). One of the latter occurrences is listed as "possibly extirpated" due to discing. However, fleshy owl's-clover persisted at another site that had been disced, although the population size was reduced by an order of magnitude (CNDDB 2000). One Fresno County occurrence that was disced most likely has been extirpated because oats have been planted on the site (Stebbins in litt. 2000*a*).

A wide variety of factors threaten the continued existence of fleshy owl's-clover, including urban development, year-round or summer livestock grazing, changes in hydrology, agricultural conversion, gravel mining, and small occurrence size (CNDDB 2000). Construction of the proposed new University of California campus in Merced County, plus the associated residential community and access roads, threatens the extensive occurrence in that area. Of the 25 occurrences estimated on the proposed campus and associated community, 10 occurrences of fleshy owl's-clover occur in the area that is expected to be developed within the next 15 years (calculated by E. Cypher from maps and information in EIP Associates 1999). Different types of urban development that threaten numerous known occurrences include planned housing subdivisions in Fresno, Madera, and San Joaquin counties; a freeway expansion in Madera County; and a proposed landfill in Fresno County (Service 1997a, CNDDB 2000, Stebbins in litt. 2000*b*).

Approximately two-thirds of the reported occurrences, including those at the proposed University of California Merced site, were subject to cattle grazing when they were discovered (EIP Associates 1999, CNDDB 2000). However, cattle grazing is not necessarily detrimental to fleshy owl's-clover. Winter and spring grazing may assist in the growth of individual plants in controlling nonnative grass invasions (Stebbins in litt. 2000*a*). Stebbins *et al.* (1995, p. 30) noted that among the sites they studied, those that were grazed "did not appear to suffer long term damage due to grazing." Damage from livestock would be harmful when pools are dry and during the time that the water is evaporating; thus, summer or year-round grazing poses a threat (Stebbins in litt. 2000*a*).

Hydrological alterations can create conditions unsuitable for fleshy owl's-clover and other vernal pool plants by increasing or decreasing the depth and/or duration of inundation. Threats due to alterations in natural hydrology include the Merced County Stream Channel Project proposed by the U.S. Army Corps of Engineers (Service 1997*a*) and proposed enlargement of Burns Reservoir in Merced County (CNDDB 2000), which collectively threaten seven occurrences of fleshy owl's-clover. Expansion of agricultural operations threatens three occurrences in Fresno and Madera counties that are surrounded by orchards, vineyards, or citrus groves (CNDDB 2000). Also, populations in grain fields already have been subject to discing, as mentioned above. A proposed gravel mine threatens one occurrence in Fresno County (Service 1997*a*).

Lastly, threats posed by small occurrence size are less immediate but also potentially significant. Random genetic, environmental, or other processes can lead to the extirpation of small populations; adequate populations would be in the range of thousands to millions (Shaffer 1981, Thomas 1990, Menges 1991). Species that are subject to extreme fluctuations in occurrence size from year to year are particularly vulnerable to chance events (Thomas 1990). Among the 24 occurrences of fleshy owl's-clover for which size estimates were given, 10 occurrences consisted of fewer than 100 plants at their peak size (CNDDB 2000, Stebbins in litt. 2000*b*).

The little information that is known regarding fleshy owl's-clover has been obtained incidental to other proposed projects. Several occurrences were discovered during surveys related to the extension of State Highway 41 (Stone in litt. 1992, CNDDB 2000). Data on characteristics of selected pools were obtained through the vernal pool characterization study funded by the California Department of Fish and Game and the Service (Stebbins *et al.* 1995). In a study funded by the California Department of Transportation to evaluate the success of vernal pool creation, fleshy owl's-clover was seeded into one created pool but did not become established (Durgarian 1995).

Hoover's spurge

Reasons for Decline and Threats to Survival

One occurrence of Hoover's spurge in Tulare County and another in Tehama County were destroyed when the areas were converted for agricultural use (CNDDB 2001). Hoover's spurge has not been seen in several years at two of the Vina Plains occurrences where natural vegetation remains. Conditions at those sites changed so that the barren areas required by Hoover's spurge no longer were available, probably because cattle were removed from the Vina Plains for a period of eight years (Silveira in litt. 2000).

Agricultural conversion continues to threaten Hoover's spurge, particularly in Stanislaus County (Stone *et al.* 1988). However, more subtle factors such as changes in hydrology, invasion by aggressive plants, and inappropriate livestock grazing regimes constitute a greater threat to survival of the species at this time. Five of the remaining occurrences of Hoover's spurge are subject to obvious hydrologic threats; four of the five are in the San Joaquin Valley and the fifth is in the Vina Plains. Hydrology has been altered by construction of levees and other water barriers and by runoff from adjacent agricultural operations, roads, and culverts. Due to these hydrological changes, some vernal pools receive insufficient water and others remain flooded for too long to allow growth of Hoover's spurge. Although no occurrences have been completely extirpated due to hydrologic changes, the species has been eliminated from one or more individual pools at several sites and a number of the remaining populations seem to be declining (Stone *et al.* 1988, Stebbins *et al.* 1995, CNDDB 2001).

Competition from invasive native or nonnative plant species threatens nine of the extant occurrences, including eight in the Vina Plains and one on the Sacramento National Wildlife Refuge in Glenn County (CNDDB 2001). Native competitors of Hoover's spurge include coyote-thistle, alkali-mallow (*Malvella leprosa*), lippia or tangle frogfruit (*Phyla nodiflora*), hard-stemmed bulrush (*Scirpus acutus* var. *occidentalis*), alkali or saltmarsh bulrush (*Scirpus maritimus*), and rough cocklebur (*Xanthium strumarium*). Nonnative competitors include bindweed (a noxious weed according to Dempster 1993) and swamp pricklegrass (*Crypsis schoenoides*) (Silveira in litt. 2000, CNDDB 2001). On the Vina Plains Preserve, the pools with Hoover's spurge also had the highest frequency of bindweed, at least in 1995 (Alexander and Schlising 1997). Increasing dominance by these competitors may be associated with changes in hydrology and livestock grazing practices (Stone *et al.* 1988, Alexander and Schlising 1997, CNDDB 2001).

The issue of livestock grazing effects on Hoover's spurge is complex and much data are lacking to support incidental accounts. In general, "moderate" levels of grazing appear to be compatible with Hoover's spurge and presumably benefit the species by reducing competition from other plants (Stone *et al.* 1988). Livestock do not eat Hoover's spurge because it grows so close to the ground and possibly because the milky sap is toxic (Wheeler 1941, Stone *et al.* 1988). During 1986 and 1987, Stone *et al.* (1988) deemed the intensity of cattle grazing at most Hoover's spurge sites to be appropriate. Several species experts (Stone *et al.*1988, Silveira in litt. 2000, Stebbins in litt. 2000*a*) have cautioned that decreases in grazing intensity could be detrimental to Hoover's spurge. On the other hand, cattle trampling has seriously reduced Hoover's spurge populations at one site each in Butte and Stanislaus counties (Stone *et al.* 1988), and increased summer stocking rates at other sites could similarly damage those populations.

Small occurrence size is a serious threat for at least four of the known occurrences, which total fewer than 100 individuals even in favorable years (CNDDB 2001). Such small populations are subject to extirpation from random events (Shaffer 1981, Menges 1991).

Colusa Grass

Reasons for Decline and Threats to Survival

Colusa grass declined primarily because pools in which it occurred were destroyed by conversion to irrigated agriculture, primarily to orchards and vineyards (Crampton 1976, Medeiros 1976, CNDDB 2000). Other factors that extirpated populations of Colusa grass included altered hydrology, surface disturbance, and excessive livestock grazing. At least 9, and possibly 11, occurrences have been extirpated, although several others most likely were eliminated before being reported (Stone *et al.* 1988). The Yolo County occurrences have been damaged by herbicide application (Witham in litt. 2000).

The same factors that contributed to the decline of Colusa grass continue to pose threats to the species. Agricultural conversion is most likely to occur in eastern Stanislaus County and threatens the 16 occurrences (33 percent) there. Dry-land farming there is gradually being replaced by irrigated agriculture; the former apparently is compatible with the persistence of Colusa grass, but the latter is not (Crampton 1959, Crampton 1976). Changes in natural hydrology, such as draining pools or creating reservoirs, could create unsuitable conditions for Colusa grass by decreasing or increasing inundation periods. Increased grazing intensity or summer grazing would threaten Colusa grass, even though moderate cattle grazing in spring in some instances has not posed a problem (Stone *et al.* 1988). Sheep grazing is compatible if the flock is removed before Colusa grass begins growth for the year. However, sheep trampling and bedding during the seedling and flowering stages are detrimental (Witham in litt. 2000).

Another threat to the survival of Colusa grass comes from indirect effects related to the construction of the proposed UC Merced campus and associated community in Merced County. Six occurrences of Colusa grass were observed in the Study Area in special-status plant surveys conducted in 1999-2001. All six of these occurrences are on VST Remainder Property land, which the University has committed to preserve. The documented occurrences should not be viewed as an exhaustive inventory because not all pools were surveyed in the 1999-2001 surveys. Therefore, it is possible that there are additional occurrences on VST lands and on lands proposed for development of the Applicants' Proposed Projects, which may be directly effected. The CNDDB also lists an historic occurrence in the western portion of the Study Area; however, this occurrence has not been observed since 1943 and is described as possibly extirpated. The species was not found on lands for which WCB has acquired or will acquire title or conservation easements.

Additional factors threaten the survival of Colusa grass, particularly the problem of small occurrence size. Although populations may drop to only a few visible plants in certain years, seven consisted of fewer than 100 plants even at their peak (CNDDB 2000) and thus are likely to represent small populations. Nonnative plants such as swamp grass and alkali mallow, and invasive native species such as cocklebur and lippia could out-compete Colusa grass and may be particular problems in combination with other factors such as decreased inundation and inappropriate livestock grazing (Stone *et al.* 1988, Witham in litt. 2000). Grasshopper foraging has been observed on Colusa grass (Stone *et al.* 1988), but the extent of this threat is unknown. The two Yolo County occurrences are threatened by herbicide run-off from adjacent agricultural operations (CNDDB 2000).

<u>San Joaquin Valley Orcutt Grass</u>

<u>Reasons for Decline and Threats to Survival</u>

All of the habitat of San Joaquin Valley Orcutt grass in Stanislaus County and much of that in Madera and Fresno counties has been converted to irrigated agriculture, especially to almond orchards and vineyards (Stone *et al.* 1988, CNDDB 2000). The majority of sites were converted by the late 1970's (Griggs 1980, Griggs and Jain 1983). Altered hydrology and development (residential, commercial, and recreational) eliminated several other populations (Stone *et al.* 1988, CNDDB 2000). Dryland grain farming has modified vernal pool habitats supporting San Joaquin Valley Orcutt grass in Madera and Merced counties, and occurrences are presumed to be extirpated from these areas (CNDDB 2000). However, Crampton (1959, 1976) indicated that San Joaquin Valley Orcutt grass could persist despite dryland farming, and the species was rediscovered at one such site after having been absent for several years (CNDDB 2000). Summer livestock grazing or heavy use by cattle damaged two populations each in Madera and Merced counties (Stone *et al.* 1988, CNDDB 2000); their current status is not known.

The primary threats facing the remaining extant occurrences of San Joaquin Valley Orcutt grass are altered livestock grazing regimes, agricultural conversion, and small occurrence size (Stone *et al.* 1988, CNDDB 2000). Most extant populations are currently grazed. According to Stone *et al.* (1988) and Stebbins (in litt. 2000*a*), moderate cattle grazing in spring is compatible with persistence of San Joaquin Valley Orcutt grass, and possibly beneficial, but increased stocking rates or summer or year-round grazing would be detrimental. Conversion to irrigated agriculture is most likely at sites that currently are dry-farmed. Small populations are at risk of extirpation due to chance events (Menges 1991), particularly those that fluctuate greatly from year to year (Thomas 1990). Omitting those described only as "abundant," occurrence size has been estimated for 14 of 23 occurrences of San Joaquin Valley Orcutt grass. Three occurrences numbered fewer than 10 plants each, even in favorable years (Stone in litt. 1992, Stebbins *et al.* 1995, CNDDB 2000).

Additional threats to San Joaquin Valley Orcutt grass are varied. Four of the extant occurrences in Madera County are in the path of the proposed extension of state Highway 41 (Stone in litt. 1992). Three other occurrences in Madera and Fresno counties are threatened by a proposed residential development (Stone *et al.* 1988, Stebbins *et al.* 1995, CNDDB 2000). Altered hydrology, competition from other plants, and off-road vehicles are potential threats at a few sites (Stone *et al.* 1988). Foraging by grasshoppers (family Acrididae) and mice (order Rodentia) occasionally poses problems (Stebbins *et al.* 1995, CNDDB 2000). In some years, grasshoppers (family Acrididae) consumed entire populations of San Joaquin Valley Orcutt grass before they set seed (Griggs and Jain 1983, Stone *et al.* 1988).

Hairy Orcutt Grass

Reasons for Decline and Threats to Survival

Historically, habitat loss was the primary factor responsible for the decline of hairy Orcutt grass. Of the 11 element occurrences considered by the California Natural Diversity Data Base (2001) to be extirpated, 4 in Stanislaus County were converted to almond orchards or vineyards (Stone *et al.* 1988, CNDDB 2001). Most of the conversion occurred prior to 1976 (Crampton 1959, Crampton 1976, Medeiros 1976, Reeder 1982). Two other occurrences in Madera County were lost by development for residences and orchards. The other five occurrences, which were in Madera, Merced, and Stanislaus counties, are listed as extirpated because the habitat was being used for irrigated pasture or dry farming or had been disced when they were last visited in 1986 and 1987 (Stone *et al.* 1988). However, continued field visits are advisable because another occurrence reappeared several years after discing (CNDDB 2001).

Hairy Orcutt grass no longer occurs in the Glenn County pool where it was found in 1937 because the area is now a permanent pond (Silveira pers. comm. 1997). Inappropriate hydrology also may be responsible for the loss of one other occurrence (Table 5) in a vernal pool at the Sacramento National Wildlife Refuge (Silveira in litt. 2000). The occurrence consisted of 20 plants when it was first discovered in 1993, but those plants died before setting seed due to flooding from a summer rainstorm, and none have been seen since that time (Silveira in litt. 2000). The occurrence could reappear in future years if a substantial soil seed bank exists, and thus it is presumed to be extant.

Two occurrences on the Vina Plains Preserve apparently have died out because the populations were too small to be viable. The two Vina Plains occurrences consisted of 2 plants and fewer than 100, respectively, in 1983 and no plants have been observed since that time (Alexander and Schlising 1997). The California Natural Diversity Data Base (2001) considers the former to be "possibly extirpated" but lists the latter as "presumed extant." Even taking into consideration the capacity for wide variations in occurrence size from year to year, the small initial occurrence size and the absence of plants for over 20 years lead to the conclusion that these populations have been extirpated. Trampling by cattle and competition from invasive plants may have contributed to their disappearance (CNDDB 2001). However, the few plants observed at these occurrences may have been the result of random dispersal events and may never have represented established populations, as described by Alexander and Schlising (1997) for the Vina Plains Preserve.

Habitat loss continues to pose a threat to the survival of hairy Orcutt grass. Agricultural and residential development are proceeding in the vicinity of the remaining Stanislaus and Madera county occurrences and may lead to the destruction of additional populations in the foreseeable future (Stone *et al.* 1988). Cattle grazing was an ongoing land use at 20 occurrences when they were last visited, including 6 where this species may already be extirpated (CNDDB 2001). Three occurrences are believed to have been eliminated by "excessive" livestock grazing, and seven others were damaged by summer grazing or overuse. However, "moderate" grazing in spring likely is compatible (Stone *et al.* 1988) and may be beneficial (Stebbins in litt. 2000*a*). Competition from invasive plants is an increasing problem throughout the range of hairy Orcutt grass (Stone *et al.* 1988). Several researchers (Stone *et al.* 1988, Alexander and Schlising 1997) have suggested that cattle may have carried in seeds of nonnative plants, and disturbance from trampling may have facilitated their establishment. Bindweed has increased in frequency in the Vina Plains since 1984, and cocklebur is still present. Pools where hairy Orcutt grass grows had higher frequencies of these invasive species than did other pools on the Vina Plains Preserve in 1995 (Alexander and Schlising 1997). Altered hydrology may have contributed to the presence of invasive plants in the pools (Stebbins in litt. 2000*a*).

Survey efforts for vernal pools, such as those by Crampton (1959) and Medeiros (1976) documented the occurrence and extirpation of hairy Orcutt grass populations. The most recent, most comprehensive effort was that by Stone and others (1988) in conjunction with the status survey for the Orcuttieae. A 1995 ecological study of hairy Orcutt grass and other rare vernal pool plants and animals at the Vina Plains Preserve (Alexander and Schlising 1997) was funded by the Service and the California Department of Fish and Game using section 6 funds.

Hartweg's golden sunburst

Reasons for Decline and Threats to Survival

Residential development, agricultural conversion, and possibly cattle grazing and mining have contributed to the decline of *Pseudobahia bahiifolia*. Residential development has extirpated two occurrences (Element Occurrences 6 and 7) near La Grange in Stanislaus County and possibly a third (Element Occurrence 5). The site of Element Occurrence 1 in Madera County was converted to a pistachio orchard. Element Occurrence 8 in Stanislaus County apparently has been eliminated by inappropriate cattle grazing and trampling. The exact locations of the type locality in Yuba County (Element Occurrence 10) and Element Occurrence 11 in Stanislaus County are not certain so the specific cause of extirpation cannot be pinpointed. However, residential and industrial development and agriculture have eliminated all suitable habitat from the vicinity of Element Occurrence 10. Similarly, a quarry and agricultural operations have destroyed virtually all of the suitable habitat in the area of Element Occurrence 11 (Stebbins 1991, CNDDB 2001).

Several occurrences that remain extant have declined due to habitat fragmentation or degradation. Element Occurrences 25 and 26 most likely are remnants of an occurrence that was once continuous in the area but has been impacted by a quarry that mines pumice (CNDDB 2001). The number of *Pseudobahia bahiifolia* plants has declined at Element Occurrence 21 in Fresno County due to competition with the nonnative grass *Avena* species (Faubion pers. comm. 2001). Inappropriately heavy livestock grazing and trampling during a prolonged drought also degraded many of the occurrences (Stebbins 1991).

The primary threat to *Pseudobahia bahiifolia* is habitat loss through development. All six occurrences in the Friant area of Fresno and Madera counties are threatened by development. Proposed housing developments threaten Element Occurrences 22 and 23. Residential development also is a possibility at the privately-owned portion of Element Occurrence 21 and Element Occurrence 24, especially if Fresno extends its city limits out to Millerton Lake, which is under consideration. The land that includes Element Occurrences 25 and 26 has been bought by a developer, but his particular plans are unknown (Hartesveldt pers. comm. 2001); Element Occurrence 26 comprises the largest known occurrence of *Pseudobahia bahiifolia* (CNDDB 2001). The quarry near Friant is not a current threat because the operators are merely processing already excavated pumice and do not anticipate additional quarrying for many years. However, the second-largest occurrence of *Pseudobahia bahiifolia* (Element Occurrence 18 in Stanislaus County) is threatened by potential expansion of a quarry (Stebbins 1991, CNDDB 2001).

Eleven occurrences of *Pseudobahia bahiifolia* are accessible to livestock and could be threatened by inappropriate grazing practices. Grazing levels are inappropriate if they result in trampling of *Pseudobahia bahiifolia* plants, consumption of flower heads before the seeds disperse, or excessive soil erosion. However, "moderate" grazing early in the growing season may be beneficial to reduce competition from aggressive plants (Stebbins 1991). Among the 11 extant occurrences subject to grazing, four are threatened directly by excessive use. In addition, an inappropriate grazing regime is contributing to soil erosion at Element Occurrence 18, where the second-largest occurrence of *Pseudobahia bahiifolia* grows on the bank above a creek (Stebbins 1991, CNDDB 2001). Competition remains a threat at a site near the Friant dam (Faubion pers. comm. 2001) and another near the frianite quarry. Miscellaneous threats to *Pseudobahia bahiifolia* include road widening at Element Occurrence 25, and off-highway vehicle use at Element Occurrences 21 and 26 (CNDDB 2001).

The four occurrences with fewer than 100 plants and another with fewer than 200 plants may be in danger of extirpation from random events. When this species was listed as endangered (Service 1997*a*), 11 of 16 extant populations were reported to consist of fewer than 200 plants and thus were in danger of extirpation from random events. The current count differs from that reported in the final rule due to updated information on several of the populations. The counts in the final rule were based on data as of 1990. Since that time, two of the small occurrences have been extirpated by development and two others probably have been extirpated by habitat degradation in combination with their small occurrence size; two others have increased in size to more than 200 plants; one that is described as "small" does not have an occurrence figure so cannot be categorized reliably; and one new occurrence of 65 plants has been discovered (CNDDB 2001).

<u>Greene's tuctoria</u>

<u>*Reasons for Decline and Threats to Survival*</u>

One of the primary causes of extirpation for Greene's tuctoria was conversion to irrigated agriculture; 11 of 19 (57.9 percent) extirpated occurrences were due at least in part to agricultural conversions. Stanislaus and Fresno counties experienced the greatest loss to agricultural conversion, with four and three such extirpations, respectively. Excessive livestock grazing was the sole or partial cause of extirpation for six populations (31.6 percent) (Stone *et al* 1988, CNDDB 2001).

Greene's tuctoria is less tolerant of livestock grazing and competition from other plants than most of the other Orcuttieae, probably because it occurs in portions of pools that dry early in the spring. Anecdotal evidence of its lower tolerance to grazing is that Greene's tuctoria has disappeared from one grazed site where Hoover's spurge still occurs and from another site where Colusa grass remains (CNDDB 2001). Fifteen of the 20 remaining populations are subject to cattle grazing and associated trampling, and at least 4 of those are declining (Stone *et al.* 1988, CNDDB 2001). Four other occurrences on the Vina Plains Preserve had been declining (Stone *et al.* 1988, CNDDB 2001) but these occurrences improved after grazing was discontinued. Competition from weedy plants, such as the native cocklebur and the nonnative swamp grass, apparently is reducing occurrence vigor at six localities in the Sacramento and San Joaquin valleys (Stone *et al.* 1988, CNDDB 2001). Agricultural conversion remains a threat to the Merced County populations, which are the only ones remaining in the San Joaquin Valley. Grasshoppers can consume entire populations of Greene's tuctoria before they set seed (Griggs 1980, Griggs and Jain 1983, Stone *et al.* 1988).

Small occurrence size (fewer than 100 plants) poses a possible threat to the persistence of several occurrences. One occurrence in Merced County consisted of only a single plant in 1987, and one in Butte County contained 75 plants (Stone *et al.* 1988, CNDDB 2001). The Shasta County occurrence of Greene's tuctoria also may have declined to the point where it could be extirpated by random causes. Although this occurrence of Greene's tuctoria consisted of 2,500 plants in 1993 and 1994, the occurrence declined to 120 in 1996 and 35 in 1998 despite favorable hydrological conditions. However, additional investigation of all four populations is necessary to determine whether or not larger soil seed banks exist.

Surveys by Hoover (1937, 1941) documented the historic range of Greene's tuctoria. Later surveys by Crampton (1959) and Medeiros (1976) revealed the destruction of various occurrences. The most recent comprehensive survey (Stone *et al.* 1988) was funded by the Service to determine the status of Greene's tuctoria and related species. During the course of their surveys and related projects, Stone and others (1988) discovered four populations that were previously unknown. Research conducted by Griggs (1980) provided insights into the demography, ecology, and genetics of Greene's tuctoria, among other species. As part of his research, Griggs attempted to introduce Greene's tuctoria to two pools in Butte County, but the species never became established. Keeley (1988) conducted research on the conditions necessary for germination. The Service and California Department of Fish and Game supported an ecological study of Greene's tuctoria and other rare species on the Vina Plains Preserve in 1995 (Alexander and Schlising 1997).

<u>Conservancy Fairy Shrimp, Vernal Pool Fairy Shrimp, and Vernal Pool Tadpole Shrimp</u>

<u>*Reasons for Decline and Threats to Survival*</u>

Holland (1978) estimated that about two thirds of the grasslands that once supported vernal pools in the Central Valley had been destroyed by 1973 with an associated loss of nearly 90 percent of vernal pool habitat. In subsequent years, a substantial amount of the remaining habitat for vernal pool crustaceans has been destroyed with estimates of habitat loss ranging from two to three percent per year (Holland 1988). State and local laws and regulations have not been passed to protect these species, and other regulatory mechanisms necessary for the conservation of the habitat of these species have proven ineffective. This includes the substantial amount of vernal pool habitat being converted for human uses in spite of Federal regulations implemented to protect wetlands.

The habitat of the three vernal pool crustaceans is imperiled by a variety of activities, primarily by urban development, water supply and flood control activities, and conversion of land to agricultural use. Habitat loss occurs from direct destruction and modification of pools due to filling, grading, discing, leveling, and other activities, as well as modification of surrounding uplands. Vernal pool crustaceans and their habitat also are threatened by altered flood regimes, degraded water quality, siltation, erosion, grazing, improper burning, military operations, off-road vehicles, pollution, certain mosquito abatement measures, pesticide/herbicide use, vandalism, road and trail maintenance, introduction of nonnative predators, alterations of vernal pool hydrology, fertilizer and pesticide contamination, invasions of aggressive nonnative plants, gravel mining, and contaminated stormwater runoff.

In addition to direct habitat loss, the vernal pool habitat for listed vernal pool crustaceans is also highly fragmented throughout their ranges due to the nature of vernal pool landscapes and the conversion of natural habitat by human activities. Such fragmentation results in small, isolated populations of listed crustaceans which may be more susceptible to extinction due to random demographic, genetic, and environmental events (Gilpin and Soule 1988, Goodman 1987 *a, b*). Should an extirpation event occur in an occurrence that has been fragmented, the opportunities for recolonization would be greatly reduced due to physical (geographical) isolation from other (source) populations.

In areas where vernal pool crustacean habitats have been protected, the species may still be threatened if adequate monitoring and management is not conducted. Management and monitoring are necessary to recognize and protect populations from indirect effects, such as changes in hydrology, contamination, siltation, erosion, competition with nonnative species, and human-related disturbance, such as off road vehicle use. Vernal pool fairy shrimp, Conservancy fairy shrimp, and vernal pool tadpole shrimp continue to be threatened by all of the factors which led to the original listing of this species, primarily habitat loss through agricultural conversion and urbanization (CNDDB 2002).

Helm (1998) found that most Conservancy fairy shrimp occurrences were on Anita, Pescadero or Peters Clay soils. These fertile basin rim soils were among the first areas converted to agriculture in the 19th century, suggesting that a disproportionate amount of

Conservancy fairy shrimp habitat may have been lost early in California's history (Helm 1998). In addition to direct habitat loss, almost one third of the known occurrences of Conservancy fairy shrimp are threatened by alterations of hydrology, including the construction of drainage channels, diking, and inappropriate water diversion within managed wetland areas in Merced and Solano counties (CNDDB 2002). Other threats include possible introduction of predators (e.g., bullfrogs, crayfish, fish) either directly or through alteration of drainage patterns (CNDDB 2002). Off-road vehicles also represent a threat to the continued survival of Conservancy fairy shrimp populations (Hathaway *et al.* 1996). In some cases, special management actions may be necessary to prevent these threats from extirpating occurrences of Conservancy fairy shrimp.

Vernal pool tadpole shrimp occurrences have been extirpated as a result of urban development, primarily in Sacramento and Tehama counties. CNDDB (2001) estimates that 32 percent of the remaining occurrences of this species are threatened by development and agricultural conversion. Other vernal pool tadpole shrimp occurrences are threatened by off road vehicle use, road construction and maintenance, mining, and landfill construction (CNDDB 2001). Several occurrences are threatened by intentional discing and altered hydrology of their habitats (CNDDB 2001). In some cases vernal pool tadpole shrimp occurrences have been altered so that they contain water year round, allowing predators such as bullfrogs and fish to colonize vernal pool habitats (CNDDB 2001). In other cases artificial run off has resulted in the delivery of materials that destroy vernal pool water quality, including pesticides from vineyards and other irrigated agricultural lands, pesticides from golf courses, and sediment from surrounding developments (CNDDB 2001). Several vernal pool tadpole shrimp occurrences are threatened by wetland management activities that are designed to transform their vernal pool habitats into permanent marshes for the benefit of other species (CNDDB 2001). Several other occurrences are threatened by the construction of drainage ditches, which artificially drain vernal pool tadpole shrimp habitats (CNDDB 2001).

Vernal Pool Crustaceans in Merced County

Eastern Merced encompasses the largest block of pristine, high density vernal pool grasslands remaining in California (Holland 1998, Vollmar 1999). The vernal pool grasslands in eastern Merced are located midway in a chain of vernal pool complexes that straddles the valley floor and the southern Sierra Nevada foothills. Habitat in the Study Area helps to maintain connectivity between remaining vernal pool habitat on the valley floor and habitats to the north and south. The relatively undisturbed, hydrologically intact condition of the area increases the likelihood that it will continue to support natural vernal pool ecosystem processes and maintain suitable habitat conditions for vernal pool fairy shrimp, Conservancy fairy shrimp, and vernal pool tadpole shrimp.

Genetic analyses of vernal pool tadpole shrimp revealed that occurrences in this unit were genetically different from other occurrences in California, and that this area had likely been isolated from other vernal pool habitats for a significant period of time (King 1996). Given that vernal pool crustaceans are dispersed in similar ways, it is reasonable to assume that Conservancy fairy shrimp and vernal pool fairy shrimp occurrences in this area are also isolated from other occurrences throughout their range. Such isolated populations may have genetic characteristics essential to overall long-term conservation of the species (i.e. they may be genetically different than more central populations) (Lesica and Allendorf 1995).

According to the 1997 National Resources Inventory, released by the Natural Resources Conservation Service (1997), California ranked sixth in the nation in number of acres of private land developed between 1992 and 1997, at nearly 695,000 acres. State and local laws and regulations do not protect listed vernal pool crustaceans, while other laws and regulations, including the Clean Water Act, have not effectively maintained habitat necessary to conserve and recover these species. Although developmental pressures continue, only a small fraction of vernal pool habitat is protected from the threat of destruction.

According to Holland (1998), approximately 30,317 acres of vernal pool grasslands were lost in Merced County over a period of ten years from 1987 to 1997, thus resulting in a cumulative loss of 10.72 percent and an annual loss of 1.13 percent. Vernal pool grasslands in Merced County typically support numerous pools of various sizes. Many of these pools and surrounding upland habitats are essential for the conservation and recovery of listed species. Because of the limited and disjunct distribution of vernal pools, coupled with the even more limited distribution of special-status vernal pool crustaceans, any reduction in vernal pool habitat quantity could adversely affect these species. The integrity of the vernal pool complexes in eastern Merced is seriously threatened by irrigated agriculture and urban development.

Vernal Pool Fairy Shrimp in Merced County

While most of the vernal pool fairy shrimp populations in California have been affected by habitat fragmentation, eastern Merced County populations are currently among the least fragmented in the State (Holland 1998). There are more documented occurrences of vernal pool fairy shrimp in eastern Merced than any other area throughout the species range (CNDDB 2001). Almost 15 percent of all remaining vernal pool habitats in the Central Valley are located within eastern Merced (Holland 1998). There are a total of 301 vernal pool fairy shrimp occurrences identified in 26 counties in California. Fifty-seven (19 percent) of the occurrences are located in Merced County, a large majority of which are within the Study Area (CNDDB 2002). The Study Area represents a small portion of the entire species-wide range for vernal pool fairy shrimp. However, because of the limited and disjunct distribution of this species within its range, any reduction in vernal pool habitat quantity could adversely affect this species. The Study Area contains multiple large vernal pool fairy shrimp occurrences that are capable of producing large numbers of cysts in good years, which is important for this species to survive through a variety of natural and environmental changes, as well as stochastic (random) events.

The vernal pool fairy shrimp was found widely distributed throughout the Natural Communities Conservation Plan/Habitat Conservation Plan (NCCP/HCP) survey area covering 45,000 acres of ranchland throughout eastern Merced County. Vollmar Consulting (2002) conducted surveys on three properties where easements have been or will be acquired by WCB; these surveys located vernal pool fairy shrimp in 19-59 percent of pools surveyed. This species was seldom found in the large pools targeted for Conservancy fairy shrimp surveys, and percent occupancy rate was significantly higher in areas with flat to low-gradient terrain (Vollmar 2001).

The vernal pool fairy shrimp is the most widely distributed of the three vernal pool crustacean species in the Study Area. It has been found in every vernal pool complex surveyed in the Study Area in a wide variety of pool sizes and topographic conditions. The species was identified in more than 60 percent of the pools that were sampled for the LRDP and UCP surveys within the Study Area. Based on the documented presence of more than 10,500 pools within the VST and CNR, the species could be expected to occur in more than 5,700 pools in these two areas. Although some portions of the Study Area have not been surveyed, this species is presumed to be present in all suitable habitat.

Conservancy Fairy Shrimp in Merced County

Only 18 populations of Conservancy fairy shrimp are known, distributed in disjunct occurrences in Tehama, Butte, Glenn, Solano, Stanislaus, Merced, and Ventura counties. The CNDDB (2002) lists 6 occurrences in Merced County. Because of the limited distribution of this species, every occurrence is considered significant in terms of species survival and recovery.

The Study Area and surrounding habitat contain occurrences of the species within large, playa vernal pools found on Raynor Cobbly clay soils on the Merhten Formation (CNDDB 2001, EIP Associates 1999*b*). These pool types provide the necessary length and timing of inundation essential for the conservation of Conservancy fairy shrimp. There are three large playa pools in the central rangeland portion of eastern Merced; one occurrence each on Flying M Ranch, Ichord Ranch and VST/University land (Vollmar 2002).

The Conservancy fairy shrimp was found in two large pools during NCCP/HCP surveys of eastern Merced County. One of these two pools was a previously known location for the species on the Flying M Ranch east of the Study Area, originally recorded by Eng *et al.* (1990). The second is a newly discovered occurrence on a ranch just east of the Study Area. Dr. Brent Helm who participated in these surveys identified three other pools, in addition to the three known occurrences, in eastern Merced County with high potential to support the species. These three pools were dry when the surveys were conducted and therefore could not be sampled. The Conservancy fairy shrimp occurrence at the Flying M Ranch, just outside of the eastern boundary of the Study Area, is already being managed through a conservation easement with TNC that conserves over 5,000 acres of vernal pool and upland habitat.

A single occurrence has been documented in the Study Area; this occurrence occupies a large (509,000 ft^2) playa-type vernal pool on Raynor Clay in the southern portion of the CNR, which was established to protect the occupied pool and its watershed from development effects. Conservancy fairy shrimp were not found in other playa-type pools in the survey area, although vernal pool fairy shrimp were found in some of these pools.

Helm (1998) states that pools where this species is found are generally turbid because of the large wind-exposed surface and fine substrate. The aerial photographs of the Study Area, and vernal pool grassland habitat east of it, show that the pools where the Conservancy fairy shrimp were found exhibit a much higher level of turbidity than the pools where this species was not found. Sampling was specially designed for the detection of this species, focusing on large pools and pools with appropriate soils. The pool where this species was found within the CNR exhibited special habitat characteristics not found in other pools within the Study Area (the largest pool with milky turbidity). Therefore, in view of the specialized habitat requirements of this species, it is unlikely that populations of Conservancy fairy shrimp occur in any pools where they have not already been documented within the Study Area.

Vernal Pool Tadpole Shrimp in Merced County

There are a total of 157 known occurrences of vernal pool tadpole shrimp in 17 counties. Approximately 11 percent of the CNDDB occurrences are located in Merced County (CNDDB 2002). Vernal pool grasslands in eastern Merced County contain more documented occurrences of the species than any other area throughout the species range (CNDDB 2001). Eastern Merced County contains almost 15 percent of all remaining vernal pool habitats in the Central Valley, and 40 percent of vernal pool habitats along the eastern margin of the San Joaquin Valley are found within this area (Holland 1998). Genetic analyses of vernal pool tadpole shrimp revealed that occurrences in this area are genetically different from other occurrences (King 1996). Of all occurrences studied, King (1996) found these to be the most highly divergent.

Vernal pool tadpole shrimp were found concentrated in the central and southern regions of the NCCP/HCP survey area in eastern Merced County. This species was found in only 6.1 percent of the pools sampled during random stratified surveys (86 out of 1,408 pools). Of the five ranches where it was recorded during surveys for the NCCP/HCP, it was most abundant on two ranches (60.7 percent and 47.5 percent occupancy rates).

Vollmar Consulting attributed this to the fact that these ranches support a high density of larger pools and deeper pools (Vollmar 2001).

Vernal pool tadpole shrimp were found in four pools in the eastern portion of the Study Area, on VST lands east of the proposed Phase 1 development on the golf course in pools surrounding Black Rascal Creek during the 1999 and 2000 surveys for the LRDP. During surveys for the Campus Parkway, vernal pool tadpole shrimp were found in approximately 47 percent (146 out of 313) of the pools sampled in the Black Rascal Creek Complex and approximately 26 percent (33 out of 128) of the pools in the Upper Terrace Complex (URS 2000).

The vernal pool tadpole shrimp was found within the Study Area in a clumped distribution, primarily in the eastern portion within the Black Rascal Creek watershed. However, the species potentially occurs in other pools within the Study Area because representative sampling was conducted in the LRDP survey area, and not all pools were sampled. Also, this species may have gone undetected during sampling, because it can burrow into pool bottoms. In addition, one or two years of surveys may not adequately assess the presence or absence of vernal pool tadpole shrimp, because the cysts of this species have been known to lie dormant for as long as four years. The local distribution of vernal pool tadpole shrimp can fluctuate from year to year due to extirpations within pools and recolonization through water flow or via waterfowl. Because of this species' occurrence dynamics, the survey limitations, and the lack of specific known habitat conditions that would explain why this species would not occupy particular pools, it should be assumed that vernal pool tadpole shrimp may potentially occur in all vernal pools within the Study Area.

Valley Elderberry Longhorn Beetle

Reasons for Decline and Threats to Survival

The following paragraphs analyze the effects of past and ongoing factors leading to the current status of the species, its habitat and ecosystem throughout its range. They include an analysis of effects from projects that have received incidental take authorization for the beetle since the species was listed, and an evaluation of conservation efforts aimed at minimizing these effects, based on the best available information.

Habitat loss has been ranked as the single greatest threat to biodiversity in the United States (Wilcove *et al.* 1998). In the 1980 final rule to list the beetle as threatened, habitat destruction was cited as the primary factor contributing to the need to federally list the species. As stated in the final rule, by the time the species was listed its habitat had largely disappeared throughout much of its former range due to agricultural conversion, levee construction, and stream channelization. The 1984 recovery plan reiterated that the primary threat to the beetle was loss and alteration of habitat by agricultural conversion, grazing, levee construction, stream and river channelization, removal of riparian vegetation, riprapping of shoreline, plus recreational, industrial and urban development (Service 1984).

Riparian forests, the primary habitat for the beetle, have been severely depleted throughout the Central Valley over the last two centuries as a result of expansive agricultural and urban development (Katibah 1984, Thompson 1961, Roberts *et al.* 1977). Since colonization, these forests have been "...modified with a rapidity and completeness matched in few parts of the United States" (Thompson 1961). As of 1849, the rivers and larger streams of the Central Valley were largely undisturbed. They supported continuous bands of riparian woodland four to five miles in width along some major drainages such as the lower Sacramento River, and generally about two miles wide along the lesser streams (Thompson 1961). Most of the riverine floodplains supported riparian vegetation to about the 100-year flood line (Katibah 1984). A large human population influx occurred after 1849, however, and much of the Central Valley riparian habitat was rapidly converted to agriculture and used as a source of wood for fuel and construction to serve a wide area (Thompson 1961). By as early as 1868, riparian woodland had been severely impacted in the Central Valley, as evidenced by the following excerpt:

> This fine growth of timber which once graced our river [Sacramento], tempered the atmosphere, and gave protection to the adjoining plains from the sweeping winds, has entirely disappeared - the woodchopper's axe has stripped the river farms of nearly all the hard wood timber, and the owners are now obliged to rely upon the growth of willows for firewood. (Cronise 1868, *in* Thompson 1961).

The clearing of riparian forests for fuel and construction made this land available for agriculture (Thompson 1977). Natural levees bordering the rivers, once supporting vast tracts of riparian habitat, became prime agricultural land (Thompson 1961, 1977). As agriculture expanded in the Central Valley, needs for increased water supply and flood protection spurred water development and reclamation projects. Artificial levees, river channelization, dam building, water diversion, and heavy groundwater pumping further reduced riparian habitat to small, isolated fragments (Katibah 1984). In recent decades, these riparian areas have continued to decline as a result of ongoing agricultural conversion as well and urban development and stream channelization. As of 1989, there were over 100 dams within the Central Valley drainage basin, as well as thousands of miles of water delivery canals and streambank flood control projects for irrigation, municipal and industrial water supplies, hydroelectic power, flood control, navigation, and recreation (Frayer *et al.* 1989). Riparian forests in the Central Valley have dwindled to discontinuous strips of widths currently measurable in yards rather than miles.

Some accounts state that the Sacramento Valley supported approximately 775,000 to 800,000 acres of riparian forest as of approximately 1848, just prior to statehood (Smith

1977, Katibah 1984). No comparable estimates are available for the San Joaquin Valley. Based on early soil maps, however, more than 921,000 acres of riparian habitat are believed to have been present throughout the Central Valley under pre-settlement conditions (Katibah 1984). Another source estimates that of approximately 5,000,000 acres of wetlands in the Central Valley in the 1850s, approximately 1,600,000 acres were riparian wetlands (Warner and Hendrix 1985, Frayer *et al.* 1989).

California Department of Fish and Game (CDFG) riparian vegetation distribution map illustrates that by 1979, about 102,000 acres of riparian vegetation was remaining in the Central Valley. This represents a decline in acreage of approximately 89 percent as of 1979 (Katibah 1984). More extreme figures were given by Frayer *et al.* (1989), who reported that woody riparian forests in the Central Valley had declined to 34,600 acres by the mid-1980s (from 65,400 acres in 1939). Although these studies have differing findings in terms of the number of acres lost (most likely explained by differing methodologies), they attest to a dramatic historic loss of riparian habitat in the Central Valley. As there is no reason to believe that riparian habitat suitable to the beetle (occupied by elderberry shrubs) would be destroyed at a different rate than other riparian habitat, we can assume that the rate of loss for beetle habitat in riparian areas has been equally dramatic.

A number of studies have focused on riparian loss along the Sacramento River, which supports some of the densest known populations of the beetle. Approximately 98 percent of the middle Sacramento River's historic riparian vegetation was believed to have been extirpated by 1977 (McGill 1979). The State Department of Water Resources estimated that native riparian habitat along the Sacramento River from Redding to Colusa decreased from 27,720 acres to 18,360 acres (34 percent) between 1952 and 1972 (McGill 1979, Conrad *et al.* 1977). The average rate of riparian loss on the middle Sacramento River was 430 acres per year from 1952 to 1972, and 410 acres per year from 1972 to 1977. In 1987, riparian areas as large as 180 acres were observed converted to orchards along this river (McCarten and Patterson 1987).

Barr (1991) examined 79 sites in the Central Valley supporting beetle habitat. When 72 of these sites were re-examined by researchers in 1997 (Collinge *et al.* 2001), seven no longer supported beetle habitat. This represents a decrease in the number of sites with beetle habitat by approximately nine percent in six years. There is no comparable information on the historic loss of non-riparian beetle habitat such as elderberry savanna and other vegetation communities where elderberry occurs (oak or mixed chaparral-woodland, or grasslands adjacent to riparian habitat). However, all natural habitats throughout the Central Valley have been heavily impacted within the last 200 years (Thompson 1961), and we can therefore assume that non-riparian beetle habitat also has suffered a widespread decline. This analysis is focuses on loss of riparian habitat because the beetle is primarily dependent upon riparian habitat. Adjacent upland areas are also likely to be important for the species, but this upland habitat typically consists of oak woodland or elderberry savanna bordering willow riparian habitat (Barr 1991). The riparian acreage figures given by Frayer *et al.* (1989) and Katibah (1984) included the oak woodlands concentrated along major drainages in the Central Valley, and therefore probably included lands we would classify as upland habitat for the beetle adjacent to riparian drainages.

Between 1980 and 1995, the human population in the Central Valley grew by 50 percent, while the rest of California grew by 37 percent. The Central Valley's population was 4.7 million by 1999, and it is expected to more than double by 2040. The American Farmland Trust estimates that by 2040 more than 1 million cultivated acres will be lost and 2.5 million more put at risk (Ritter 2000). With this growing population in the Central Valley, increased development pressure is likely to result in continuing loss of riparian habitat.

While habitat loss is clearly a large factor leading to the species' decline, other factors are likely to pose significant threats to the long term survival of the beetle. Only approximately 20 percent of riparian sites with elderberry observed by Barr (1991) and Collinge *et al.* (2001) support beetle populations (Barr 1991, Collinge *et al.* 2001). Jones and Stokes (1988) found 65 percent of 4,800 riparian acres on the Sacramento River to have evidence of beetle presence. The fact that a large percentage of apparently suitable habitat is unoccupied suggests that the valley elderberry longhorn beetle is limited by factors other than habitat availability, such as habitat quality or limited dispersal ability.

Destruction of riparian habitat in central California has resulted not only in a loss of acreage, but also in habitat fragmentation. Fahrig (1997) states that habitat fragmentation is only important for habitats that have suffered greater than 80 percent loss. Riparian habitat in the Central Valley, which has experienced greater than 90 percent loss by most estimates, would meet this criterion as habitat vulnerable to effects of fragmentation. Existing data suggests that beetle populations, specifically, are affected by habitat fragmentation. Barr (1991) found that small, isolated habitat remnants were less likely to be occupied by beetles than larger patches, indicating that beetle subpopulations are extirpated from small habitat fragments. Barr (1991) and Collinge *et al.* (2001) consistently found beetle exit holes occurring in clumps of elderberry bushes rather than isolated bushes, suggesting that isolated shrubs do not typically provide long-term viable habitat for this species. Local populations of organisms often undergo periodic colonization and extinction, while the metapopulation (set of spatially separated groups of a species) may persist (Collinge 1996).

Habitat fragmentation can be an important factor contributing to species declines because: (1) it divides a large population into two or more small populations that become more vulnerable to direct loss, inbreeding depression, genetic drift, and other problems associated with small populations; (2) it limits a species' potential for dispersal and colonization; and (3) it makes habitat more vulnerable to outside influences by increasing the edge to interior ratio (Primack 1998). These factors, as they relate to the beetle, are discussed below.

Small, isolated subpopulations are susceptible to extirpation from random demographic, environmental, and/or genetic events (Shaffer 1981, Lande 1988, Primack 1998). While a large area may support a single large population, the smaller subpopulations that result from habitat fragmentation may not be large enough to persist over a long time period. As a population becomes smaller, it tends to lose genetic variability through genetic drift, leading to inbreeding depression and a lack of adaptive flexibility. Smaller populations also become more vulnerable to random fluctuations in reproductive and mortality rates, and are more likely to be extirpated by random environmental factors.

Species that characteristically have small population sizes, such as large predators or habitat specialists, are more likely to become extinct than species that typically have large populations (Primack 1998). Also, a species with low population density (few individuals per unit area) tends to have only small populations remaining if its habitat is fragmented. Populations of species that naturally occur at lower density become extinct more rapidly than do those of more abundant species (Bolger *et al.* 1991). The species may be unable to persist within each fragment, and gradually die out across the landscape.

The beetle, a specialist on elderberry plants, tends to have small population sizes, and to occur in low densities (Barr 1991, Collinge *et al.* 2001). Collinge *et al.* (2001) compared resource use and density of exit holes between the beetle and a related subspecies, the California elderberry longhorn beetle (*Desmocerus californicus californicus*). The beetle tended to occur in areas with higher elderberry densities, but had lower exit hole densities than the California elderberry longhorn beetle. With extensive riparian habitat loss and fragmentation, these naturally small populations are broken into even smaller, isolated populations. Once a small population has been extirpated from an isolated habitat patch, the species may be unable to re-colonize this patch if it is unable to disperse from nearby occupied habitat.

Insects with limited dispersal and colonization abilities may persist better in large habitat patches than small patches because small fragments may be insufficient to maintain viable populations and the insects may be unable to disperse to more suitable habitat (Collinge 1996). Studies suggest that the beetle is unable to re-colonize drainages where the species has been extirpated, because of its limited dispersal ability (Barr 1991, Collinge *et al.* 2001). Huxel and Hastings (1999) used computer simulations of colonization and extinction patterns for the beetle based on differing dispersal distances, and found that the short dispersal simulations best matched the 1997 census data in terms of site occupancy. This data suggests that in the natural system dispersal and, thus, colonization is limited to nearby sites. At spatial scales greater than 0.62 mile, such as across drainages, beetle occupancy appears to be strongly influenced by regional extinction and colonization processes, and colonization is constrained by limited dispersal (Collinge *et* *al.* 2001). Except for one occasion, drainages examined by Barr that were occupied in 1991 remained occupied in 1997 (Collinge *et al.* in 2001). The one exception was Stoney Creek, which was occupied in 1991 but not in 1997. All drainages found by Barr (1991) to be unoccupied in 1991 were also unoccupied in 1997. This data suggests that drainages unoccupied by the beetle remain so.

Habitat fragmentation not only isolates small populations, but also increases the interface between habitat and urban or agricultural land, increasing negative edge effects such as the invasion of nonnative species (Huxel 2000, Soule 1990) and pesticide contamination (Barr 1991). There are several edge effect-related factors that may be related to the decline of the beetle.

Recent evidence indicates that the invasive Argentine ant poses a risk to the long-term survival of the beetle. Surveys along Putah Creek found beetle presence where Argentine ants were not present or had recently colonized, and beetle absence from otherwise suitable sites where Argentine ants had become established (Huxel 2000). The Argentine ant has negatively impacted populations of other native arthropod species (Holway 1995, Ward 1987). Predation on eggs, larvae, and pupae are the most likely effects these ants have on the beetle. In Portugal, Argentine ants have been found to be significant egg predators on the eucalyptus borer (*Phorocantha semipunctata*), a cerambycid like the beetle. Egg predation on the beetle could lead to local extirpations, as indicated by a population viability study suggesting that egg and juvenile mortality are significant factors affecting probability of extinction for the beetle (Huxel 2000, Collinge, 2001). The Argentine ant has been expanding its range throughout California since its introduction around 1907, especially in riparian woodlands associated with perennial streams (Holway 1995, Ward 1987). Huxel (2000) states that, given the potential for Argentine ants to spread with the aid of human activities such as movement of plant nursery stock and agricultural products, this species may come to infest most drainages in the Central Valley along the valley floor, where the beetle is found.

Direct spraying and drift of pesticide, including herbicides and/or insecticides, in or near riparian areas (which is done to control mosquitos, crop diseases, invasive and/or undesirable plants, or other pests) is likely to adversely affect the beetle and its habitat. Although there have been no studies specifically focusing on the effects of pesticides on the beetle, the beetle is likely to be adversely affected by pesticides because pesticides often affect numerous non target invertebrate species. As of 1980, the prevalent land use adjacent to riparian habitat in the Sacramento Valley was agriculture, even in regions where agriculture was not generally the most common land use (Katibah *et al.* 1984), therefore, the species is likely vulnerable to pesticide contamination from adjacent agricultural practices. Recent studies of major rivers and streams documented that 96 percent of all fish, 100 percent of all surface water samples and 33 percent of major aquifers contained one or more pesticides at detectable levels (Gilliom 1999). Pesticides were identified as one of the 15 leading causes of impairment for streams included on the

Federal Water Pollution Control Act, as amended (Clean Water Act), section 303(d) lists of impaired waters. As the beetle occurs primarily in riparian habitat, the contamination of rivers and streams affects this species and its habitat. Pesticides have been identified as one of a number of potential causes of pollinator species' declines and declines of other insects beneficial to agriculture (Ingraham *et al.* 1996); therefore, it is likely that the beetle, typically occurring adjacent to agricultural lands, has suffered a decline due to pesticides.

Competition from invasive nonnative plants such as giant reed (*Arundo donax*) negatively affects riparian habitat supporting the beetle. Giant reed, a native of Asia, has become a serious problem in California riparian habitats, forming dense, homogenous stands essentially devoid of wildlife. The giant reed has an extensive root system allowing it to resprout rapidly after any disturbance and out-compete native riparian vegetation. Giant reed also introduces a frequent fire cycle into the riparian ecosystem, disrupting natural riparian dynamics and eventually forming homogenous climax communities. The extent to which giant reed has affected elderberry specifically, however, has not been studied.

Grazing by livestock damages or destroys elderberry plants and inhibits regeneration of seedlings. Cattle readily forage on new growth of elderberry, which may explain the absence of beetles at manicured elderberry stands (Service 1984). Habitat fragmentation exacerbates problems related to nonnative species invasion and cattle grazing by increasing the edge-to-interior ratio of habitat patches, facilitating the penetration of these influences.

Valley Elderberry Longhorn Beetles in Merced County

As of 1998, the California Natural Diversity Database included 194 extant occurrences for this species. Four of these occurrences are from Merced County. The four occurrences are located west of the city of Merced. The nearest documented occurrences of the valley elderberry longhorn beetle to the project Study Area are from locations on the Merced River (CNDDB 2000). No elderberry beetles have been reported within the Study Area or surrounding areas. The closest known occurrence is more than 10 miles from the Study Area. This lack of records, however, does not indicate lack of suitable habitat in the Study Area. Vollmar Associates (2002) reported finding elderberry shrubs on 8 of 12 ranches surveyed in eastern Merced County, including several within the Study Area. While much of the Study Area consists of agricultural lands that are too disturbed by farming activities or upland areas that are too dry to support elderberries, the shrubs are expected to occur along larger streams (e.g., Bear Creek, Black Rascal Creek, Fahrens Creek), along smaller drainages (Owens Creek, and Duck Creek), and locally in uplands. Numerous elderberry shrubs with and without exit holes are present along Bear Creek and surrounding drainages. These habitat sites are close in proximity to facilitate beetle dispersal into the proposed Study Area.

Bald Eagle

Reasons for Decline and Threats to Survival

The bald eagle once nested throughout much of North America near coasts, rivers, lakes, and wetlands. The species experienced population declines throughout most of its range, including California, due primarily to environmental contamination from the use of DDT and other persistent organochlorine compounds, habitat loss and degradation, shooting, and other disturbances (Detrich 1986, Stalmaster *et al.* 1985, Service 1986). A recovery plan was released in 1986 for the recovery and maintenance of bald eagle populations in the 7-state Pacific recovery region (Idaho, Nevada, California, Oregon, Washington, Montana, and Wyoming) (Service 1986). In recent years, the status of bald eagle populations has improved throughout the United States. The observed increase in population is believed to be the result of a number of protective measures enacted throughout the range of the species since the early 1970s including listing of the species. These measures include the banning of the pesticide DDT, stringent protection of nest sites, and protection from shooting, however, bald eagles are still susceptible to a number of threats.

Bald eagles are susceptible to disturbance by human activity during the breeding season, especially during egg laying and incubation. This includes recreational activities, fluctuating fish populations and availability of roost trees as a result of reservoir level fluctuations, risk of wild fire, fire suppression activities, fragmentation of habitat, home sites, campgrounds, mines, timber harvest, and roads. Such disturbances can lead to nest desertion or disruption of breeding attempts. Human activities are more likely to disturb bald eagles when located near roosting, foraging, and nesting areas (Stalmaster and Kaiser 1998, Stalmaster *et al.* 1985, Service 1986). Human interference, such as recreational activity, has also been shown to disrupt the feeding behavior of bald eagles (Stalmaster and Newman 1978, Knight and Knight 1984). Such disturbance can result in increased energy expenditures due to avoidance flights and decreased energy intake due to interference with feeding activity (Stalmaster and Newman 1978).

Many studies have documented a threshold at which human activities elicit response for eagles (Stalmaster and Newman 1978, Knight and Knight 1984), though other studies show little direct effect of human activities on bald eagle nesting attempts (Mathisen 1968, Fraser *et al.* 1985). Human induced failures are likely one-time catastrophic events (i.e., firearm target practice) occurring near nests early in the nesting season, which often escape detection (Jackman and Hunt 2000). Several authors have demonstrated that nesting and foraging eagles avoid areas of human use or development (Buehler *et al.* 1991, McGarigal *et al.* 1991, Brown and Steven 1997). Individual pairs of nesting bald eagles exhibit varying level of tolerance to disturbance throughout the breeding season and during periods of foraging.

Bald eagles are vulnerable to electrocution from and collision with transmission lines and towers. Orlendorff and Lehman (1986) collected reports dated from 1965-1985 of bald eagles colliding with transmission lines around the world. The reported mortality rate for bald eagles was 87 percent. They suggested that the heavy weight of eagles could be a factor in the higher mortalities for eagles than for other small buteos. They also observed eagle flight patterns in wintering areas in the vicinity of proposed transmission line routes in California. Eagles were observed flying through drainages, canyons, and saddles, across low ridges, over valleys, and were concentrated above high ridges. Eagles usually flew above 100 feet from the ground.

Bald Eagles in Merced County

Bald eagles winter regularly in eastern Merced County (Vollmar Consulting 2002). During NCCP/HCP surveys for eastern Merced, bald eagles were observed a minimum of seven times, soaring over vernal pool/grassland habitat, perching in trees adjacent to reservoirs and riparian areas, and "perching" on mima mounds adjacent to vernal pools. Until the NCCP/HCP surveys were conducted, there were no reported occurrences of bald eagles breeding in eastern Merced County. One bald eagle nest was found in 2001, along the south bank of the Chowchilla River. At least one bald eagle young fledged from this nest. This nest site is approximately 8 miles from the original Study Area.

Bald eagles were observed on several occasions during surveys for the LRDP. Up to 12 individuals have been observed soaring over grasslands in the Study Area. During winter 2000 vernal pool fairy shrimp surveys for the Campus Parkway, an adult bald eagle was observed flying east to west near the intersection of Lake and Bellevue Roads. On at least four separate days during the winter 1999 vernal pool fairy shrimp surveys, one or two adult bald eagles were observed soaring over grasslands to the east of the proposed Campus Parkway (EIP 2002). Given that bald eagles forage over large areas, it is assumed that eagles forage in suitable habitats throughout the Study Area.

Bald eagles may be attracted to the Study Area by Lake Yosemite, which may supply fish and waterfowl as a prey source. Locations of bald eagle day roost sites have been reported on Lake Yosemite, although the locations of evening roosts in this area are unknown (Vollmar 2001). Eagles likely use grassland habitats within the Study Area occasionally during the winter to forage for carrion, waterfowl, mammals, and waders, to supplement foraging at Lake Yosemite. Grasslands and irrigated pasture north of Cardella Road provide suitable foraging habitat for bald eagles. South of Cardella Road, irrigated pasture is flood irrigated and isolated from other suitable foraging areas by row crops or orchards, making this area less likely to support foraging activities for this species. Bald eagles likely do not nest in the vicinity of the Study Area, as suitable nesting habitat in the form of stands of large riparian trees is not present, and eagles were not observed during the breeding season. Potential bald eagle nesting habitat is present along the Merced and Chowchilla Rivers.

As described above, bald eagles have been observed in the Study Area during the winter. Bald eagles use Lake Yosemite for foraging and potentially for evening roosting. Eagles likely also use vernal pool grassland habitat within the Study Area occasionally during the winter to forage for carrion, waterfowl, mammals, and waders.

San Joaquin Kit Fox

Reasons for Decline and Threats to Survival

The status (i.e., distribution, abundance) of kit fox has decreased since its listing as a federally-endangered species in 1967, and this trend is reasonably certain to continue into the foreseeable future unless measures to protect, sustain, and restore suitable habitats, and alleviate other threats to their survival and recovery, are implemented. This finding is derived from the supporting conclusions and evidence provided in the remainder of this section.

Supporting Conclusion 1

Fewer than 20 percent of the habitat within the historical range of the kit fox remained when the subspecies was listed as federally-endangered in 1967, and there has been a substantial net loss of habitat since that time.

Historically, San Joaquin kit foxes occurred throughout California's Central Valley and adjacent foothills. Extensive land conversions in the Central Valley began as early as the mid-1800s with the Arkansas Reclamation Act. By the 1930's, the range of the kit fox had been reduced to the southern and western parts of the San Joaquin Valley (Grinnell *et al.* 1937). The primary factor contributing to this restricted distribution was the conversion of native habitat to irrigated cropland, industrial uses (e.g., hydrocarbon extraction), and urbanization (Laughrin 1970, Jensen 1972, Morrell 1972, 1975). Approximately one-half of the natural communities in the San Joaquin Valley were tilled or developed by 1958 (Service 1980*a*).

This rate of loss accelerated following the completion of the Central Valley Project and the State Water Project, which diverted and imported new water supplies for irrigated agriculture (Service in litt. 1995a). Approximately 1.97 million acres of habitat, or about 66,000 acres per year, were converted in the San Joaquin region between 1950 and 1980 (California Department of Forestry and Fire Protection 1988). The counties specifically noted as having the highest wildland conversion rates included Kern, Tulare, Kings and Fresno, all of which are occupied by kit foxes. From 1959 to 1969 alone, an estimated 34 percent of natural lands were lost within the then-known kit fox range (Laughrin 1970).

By 1979, only approximately 370,000 acres out of a total of approximately 8.5 million acres on the San Joaquin Valley floor remained as non-developed land (Williams 1985, Service 1980a). Data from the California Department of Fish and Game (1985) and Service file information indicate that between 1977 and 1988, essential habitat for the blunt-nosed leopard lizard (*Gambelia sila*), a species that occupies habitat that is also suitable for kit foxes, declined by about 80 percent – from 311,680 acres to 63,060 acres, an average of about 22,000 acres per year (Biological Opinion for the Interim Water Contract Renewal, Ref. No. 1-1-00-F-0056, February 29, 2000). Virtually all of the documented loss of essential habitat was the result of conversion to irrigated agriculture. During 1990 to 1996, a gross total of approximately 71,500 acres of habitat were converted to farmland in 30 counties (total area 23.1 million acres) within the Conservation Program Focus area of the Central Valley Project. This figure includes 42,520 acres of grazing land and 28,854 acres of "other" land, which is predominantly comprised of native habitat. During this same time period, approximately 101,700 acres were converted to urban land use within the Conservation Program Focus area (California Department of Conservation 1994, 1996, 1998). This figure includes 49,705 acres of farmland, 20,476 acres of grazing land, and 31,366 acres of "other" land, which is predominantly comprised of native habitat. Because these assessments included a substantial portion of the Central Valley and adjacent foothills, they provide the best scientific and commercial information currently available regarding the patterns and trends of land conversion within the kit fox's geographic range.

In summary, more than one million acres of suitable habitat for kit foxes have been converted to agricultural, municipal, or industrial uses since the listing of the kit fox. In contrast, fewer than 500,000 acres have been preserved and/or are subject to community-level conservation efforts designed, at least in part, to further the conservation of the kit fox (See Table 2)(Service 1998).

Supporting Conclusion 2

The destruction and fragmentation of habitat are reasonably certain to reduce the status of the kit fox.

Land conversions contribute to declines in kit fox abundance through direct and indirect mortalities, displacement, reduction of prey populations and denning sites, changes in the distribution and abundance of larger canids that compete with kit foxes for resources, and reductions in carrying capacity. Kit foxes may be buried in their dens during land conversion activities (Knapp and Chesemore 1987, Van Horn pers. comm. 2000), or permanently displaced from areas where structures are erected or the land is intensively irrigated (Jensen 1972, Morrell 1975). Furthermore, even moderate fragmentation or loss of habitat may significantly impact the abundance and distribution of kit foxes. Capture rates of kit foxes at the Naval Petroleum Reserves in Elk Hills were negatively associated with the extent of oil-field development after 1987 (Warrick and Cypher 1998). Likewise, the California Energy Commission found that the relative abundance of kit foxes was lower in oil-developed habitat than in nearby undeveloped habitat on the

Lokern (Spiegel 1996). Researchers from both studies inferred that the most significant effect of oil development was the lowered carrying capacity for populations of both foxes and their prey species owing to the changes in habitat characteristics or the loss and fragmentation of habitat (Spiegel 1996, Warrick and Cypher 1998).

Kit foxes maintain core home range areas that are exclusive to mated pairs and their offspring (White and Ralls 1993, Spiegel 1996, White and Garrott 1997). This territorial spacing behavior eventually limits the number of foxes that can inhabit an area owing to shortages of available space and/or per capita prey. Hence, as habitat is fragmented or destroyed, the carrying capacity of an area is reduced and a larger proportion of the population is forced to disperse. Increased dispersal generally leads to lower survival rates and, in turn, decreased abundance because greater 65 percent of dispersing juvenile foxes die within 10 days of leaving their natal range (Koopman *et al.* 2000).

Dens are essential for the survival and reproduction of kit foxes which use them year-round for shelter and escape, and in the spring for rearing young (REFS). Hence, kit foxes generally have dozens of dens scattered throughout their territories (REFS). However, land conversion reduces the number of typical, earthen dens available to kit foxes. For example, the average density of typical, earthen kit fox dens at the Naval Hills Petroleum Reserves was negatively correlated with the intensity of petroleum development (Zoellick *et al.* 1987), and almost 20 percent of the dens in developed areas were found to be in well casings, culverts, abandoned pipelines, oil well cellars, or in the banks of sumps or roads (O'Farrell 1983). These results are important because the California Energy Commission found that, even though kit foxes frequently used pipes and culverts as dens in oil-developed areas of western Kern County, only earthen dens were used to birth and wean pups (Spiegel 1996). Similarly, kit foxes in Bakersfield use atypical dens, but have only been found to rear pups in earthen dens (Kelly pers. comm. 2000). Hence, the fragmentation of habitat and destruction of earthen dens could adversely impact the reproductive success of kit foxes. Furthermore, the destruction of earthen dens may also affect kit fox survival by reducing the number and distribution of escape refuges from predators.

Land conversions and associated human activities can lead to widespread changes in the availability and composition of mammalian prey for kit foxes. For example, oil field disturbances in western Kern County have resulted in shifts in the small mammal community from the primarily granivorous species (e.g., *Dipodomys*) that are the staple prey of kit foxes (Spiegel 1996, Cypher *et al.*, in press), to species adapted to early successional stages and disturbed areas (e.g., California ground squirrels (*Spermophilus beecheyi*), murid rodents (Spiegel 1996, Cypher *et al.*, in press). Because more than 70 percent of the diets of kit foxes usually consist of abundant leporids (*Lepus*, *Sylvilagus*) and rodents (e. g., *Dipodomys spp.*), and kit foxes often continue to feed on their staple prey during ephemeral periods of prey scarcity, such changes in the availability and/or selection of foraging sites by kit foxes could influence their reproductive rates, which are strongly influenced by food supply and decrease during periods of prey scarcity (White and Garrott 1997, 1999).

Land conversions and associated human activities have led to changes in the distribution and abundance of coyotes (*Canis latrans*), which compete with kit foxes for resources. Coyotes occur in most areas with abundant populations of kit foxes and, during the past few decades, coyote abundance has increased in many areas owing to a decrease in ranching operations, favorable landscape changes, and reduced control efforts (Orloff *et al.* 1986, Cypher and Scrivner 1992, White and Ralls 1993, White *et al.* 1995). Increases in coyote abundance coincided with decreases in the abundances of kit foxes in these same areas, and coyotes were responsible for 50-87 percent of fox deaths in the declining populations (Cypher and Scrivner 1992, Disney and Spiegel 1992, Standley *et al.* 1992, Ralls and White 1995). Land-use changes also contributed to the expansion of nonnative red foxes (*Vulpes vulpes*) into areas inhabited by kit foxes. Historically, the geographic range of the red fox did not overlap with that of the San Joaquin kit fox. By the 1970's, however, introduced and escaped red foxes had established breeding populations in many areas inhabited by San Joaquin kit foxes (Lewis *et al.* 1993). The larger and more aggressive red foxes are known to kill kit foxes (Ralls and White 1995), and could displace them, as has been observed in the arctic when red foxes expanded into the ranges of smaller arctic foxes (Hersteinsson and Macdonald 1992).

Extensive habitat destruction and fragmentation have contributed to smaller, more-isolated populations of kit foxes. Small populations have a higher probability of extinction than larger populations because their low abundance renders them susceptible to stochastic (i.e., random) events such as high variability in age and sex ratios, and catastrophes such as floods, droughts, or disease epidemics (Lande, 1988, Frankham and Ralls 1998, Saccheri *et al.*, 1998). Similarly, isolated populations are more susceptible to extirpation by accidental or natural catastrophes because their recolonization has been hampered. These chance events can adversely affect small, isolated populations with devastating results, as evidenced by the decimation of the sole colony of black-footed ferrets (*Mustela nigripes*) following its infection with canine distemper (May 1986). Extirpation can even occur when the members of a small population are healthy, because whether the population increases or decreases in size is less dependent on the age-specific probabilities of survival and reproduction than on raw chance (sampling probabilities). Owing to the probabilistic nature of extinction, many small populations will eventually lose out and go extinct when faced with these stochastic risks (Caughley and Gunn 1996).

Many populations of kit fox are at risk of chance extinction owing to small population size and isolation. This risk has been prominently illustrated during recent, drastic declines in the populations of kit foxes at Camp Roberts and Fort Hunter Liggett. Captures of kit foxes during annual livetrapping sessions at Camp Roberts decreased from 103 to 20 individuals during 1988 to 1991. This decrease continued through 1997 when only three kit foxes were captured (White *et al.* 2000). A similar decrease in kit fox abundance occurred at nearby (approximately 20 km) Fort Hunter Liggett, and only 2 kit foxes have been observed on this installation since 1995 (Clark pers. comm. 2000). It is unlikely that the current low abundances of kit foxes at Camp Roberts and Fort Hunter Liggett will increase substantially in the near future owing to the limited potential for recruitment. The chance of substantial immigration is low because the nearest core population on the Carrizo Plain is distant (greater than 80 km) and separated from these installations by barriers to fox movement such as roads, developments, and irrigated agricultural areas. Also, there is a relatively high abundance of sympatric predators and competitors on these installations that contribute to low survival rates for kit foxes and, as a result, may limit population growth (White *et al.* 2000). Hence, these populations are currently on the verge of extinction.

The destruction and fragmentation of habitat could also eventually lead to reduced genetic variation in populations of kit foxes that are small and geographically isolated. Historically, kit foxes likely existed in a metapopulation structure of core and satellite populations, some of which periodically experienced local extinctions and recolonization (Service 1998). Preliminary genetic assessments indicate that historic gene flow among populations was quite high, with effective dispersal rates of at least one to 4 dispersers per generation (Schwartz pers. comm. 2000). This level of genetic dispersal should allow for local adaptation while preventing the loss of any rare alleles. Based on these results, it is likely that northern populations of kit foxes were once panmictic (i.e., randomly mating in a genetic sense), or nearly so, with southern populations. In other words, there were no major barriers to dispersal among populations. Current levels of gene flow also appear to be adequate, however, extensive habitat loss and fragmentation continues to form more or less geographically distinct populations of foxes, which could potentially reduce genetic exchange among them. An increase in inbreeding and the loss of genetic variation could increase the extinction risk for small, isolated populations of kit foxes by interacting with demography to reduce fecundity, juvenile survival, and lifespan (Lande 1988, Frankham and Ralls 1998, Saccheri *et al.* 1998). One area of particular concern is the locale of Santa Nella in western Merced County where pending development plans threaten to eliminate the little suitable habitat that remains and provides a dispersal corridor for kit foxes between the northern and southern portions of their range. Preliminary estimates of expected heterozygosity from foxes in this area indicate that this population may already have reduced genetic variation. Other populations that may be showing the initial signs of genetic isolation are the Lost Hills area and populations in the Salinas-Pajaro River watershed (i.e., Camp Roberts and Fort Hunter Liggett). Preliminary estimates of the mean number of alleles per locus from foxes in these populations indicate that allelic diversity is lower than expected. Although these results may, in part, be due to the small number of foxes sampled in these areas, they may also be indicative of an increase in the amount of inbreeding due to population subdivision (Schwartz pers. comm. 2000). Further sampling and analyses are necessary to adequately assess the effects of these potential genetic bottlenecks.

Supporting Conclusion 3

The loss and fragmentation of habitat by agricultural, municipal, and industrial developments continue to be the primary threats to the survival and recovery of the kit fox, and are reasonably certain to continue into the foreseeable future.

As the human population of central California increases, and more land is converted to municipal and industrial uses, the amount and quality of habitat suitable for kit foxes will inevitably decrease. It has been estimated that between 12,000 and 50,000 acres of land are converted from agricultural use to urban use per year in the Central Valley; a number that is expected to increase in the future (Sokolow 1997). Conversion of agricultural land to urban use between 1995 and 2040 has been predicted to exceed 1,000,000 acres (Thompson *et al.* 1995). The Program Environmental Impact Statement for the Central Valley Project Improvement Act forecasts that municipal and industrial land uses in the Central Valley will increase 50 percent in the next 30 years (Bureau of Reclamation 1997).

This reliable delivery of Federal/State water may contribute for the conversion of habitat throughout the Valley, which could reduce habitat for kit foxes both within and outside the surface delivery areas. Our recent estimate the rate of land conversion in counties that receive Interim Water Contract water, and are within the range of the kit fox, is approximately 9,000 acres per year (Biological Opinion for the Interim Water Contract Renewal, Ref. No. 1-1-00-F-0056, February 29, 2000). Although this rate of conversion is projected to decrease in some counties as the amount of remaining native habitat diminishes, substantial conversion is expected to continue into the foreseeable future as agriculture expands into new areas. Also, the integration of this Federal water with the totality of water supplies in the region will provide water districts and land owners with the flexibility to transfer water to lands throughout the San Joaquin Valley. Consequently, while in some cases Friant or Interim surface water deliveries may not be used directly to convert habitat for listed species, they could serve to free, expedite, or otherwise make available other water sources that can be used to convert habitat of listed species. Thus, enclaves of habitat within the service area boundaries will gradually be lost to agricultural conversions, urban development, and/or other operations. Also, continued water delivery to the identified service areas will preclude some restoration of former habitats for the kit fox. Furthermore, changes to more-intensive farming practices (e.g., from dryland farming to irrigated agriculture or from discing to deep-ripping) and the proliferation of vineyards could increase the severity of agricultural effects on kit foxes and their staple prey species. For example, the rapid conversion of habitat to vineyards along State Highway 46 is threatening the viability of an essential linkage between the Salinas-Pajaro River watershed and the Carrizo Plain and San Joaquin Valley.

To affect these types of impacts, programs such as CVPIA (b)(1)other and CVPCP are designed to restore habitat for threatened and endangered species. Friant water contractors, and part of their long term contract commitments, have agreed not to deliver water to landowners converting native lands and have contributed funding to numerous restoration activities.

The proliferation of electrical generation facilities in the southern part of the San Joaquin Valley will also facilitate private development in areas occupied by kit foxes. According to the Energy Element of the Kern County General Plan, 25 cogeneration projects (representing 994 MW) had begun operation in Kern County by 1990 and an additional 25 projects with a combined output of 1,076 MW were permitted, under construction, or had permit applications pending (Sunrise Cogeneration and Power Project Biological Assessment, June 23, 1999). Currently, there are two 300 MW cogeneration plants in the Kern River oil field and a 225 MW Midway Sunset Cogeneration plant in the Midway Sunset field. However, several additional large-scale generation facilities are pending or proposed, including the 1,000 MW La Paloma project, 500 MW Elk Hills, 320 MW Sunrise Cogeneration and Power project, and the 500 MW Midway Sunset Cogeneration Company project. Although it is impossible to determine where the electricity generated by these facilities will actually be used because it will be introduced into the power grid, it is reasonably certain that the increased electricity will affect the density, distribution, scope, duration, or timing of growth and development in central California and, as a result, indirectly affect the distribution and abundance of kit foxes.

Oil fields in the southern half of the San Joaquin Valley also continue to be an area of expansion and development activity (Sunrise Cogeneration and Power Project Biological Assessment, June 23, 1999). This expansion is reasonably certain to increase in the near future owing to market-driven increases in the price of oil. The cumulative and long-term effects of oil extraction activities on kit fox populations are not fully known, but recent studies indicate that moderate- to high-density oil fields may contribute to a decrease in carrying capacity for kit foxes owing to habitat loss or changes in habitat characteristics (Spiegel 1996, Warrick and Cypher 1998).

In summary, the new infrastructure and increased reserve capacity necessary for continued population growth and development within the Central Valley is currently being provided. There are no limiting factors or regulations that are likely to retard this development or force it to other areas which are already served. Hence, it is reasonably certain that development will continue to destroy and fragment kit fox habitat into the foreseeable future.

Supporting Conclusion 4

Other threats to the survival and recovery of kit foxes have not been alleviated.

Since the listing of the kit fox in 1967, several other threats that limit and/or regulate their populations have been identified. These threats are described in the following paragraphs:

Competitive Interactions with Other Canids: The diets and habitats selected by coyotes and kit foxes living in the same areas are often quite similar (White *et al.* 1995, Cypher and Spencer 1998). Hence, the potential for resource competition between these species may be quite high when prey resources are scarce such as during droughts (which are quite common in semi-arid, central California). Coyotes may attempt to lessen resource competition with kit foxes by killing them. Coyote-related injuries accounted for 50-87 percent of the mortalities of radiocollared kit foxes at Camp Roberts, the Carrizo Plain Natural Area, the Lokern Natural Area, and the Naval Petroleum Reserves (Cypher and Scrivner 1992, Standley *et al.* 1992, Ralls and White 1995, Spiegel 1996). Coyote-related deaths of adult foxes appear to be largely additive (i. e., in addition to deaths caused by other mortality factors such as disease and starvation) rather than compensatory (i. e., tending to replace deaths due to other mortality factors; White and Garrott 1997). Hence, the survival rates of adult foxes decrease significantly as the proportion of mortalities caused by coyotes increase (Cypher and Spencer 1998, White and Garrott 1997), and increases in coyote abundance may contribute to significant declines in kit fox abundance (Cypher and Scrivner 1992, Ralls and White 1995, White *et al.* 1996). There is some evidence that the proportion of juvenile foxes killed by coyotes increases as fox density increases (White and Garrott 1999). This density-dependent relationship would provide a feedback mechanism that reduces the amplitude of kit fox population dynamics and keeps foxes at lower densities than they might otherwise attain. In other words, coyote-related mortalities may dampen or prevent fox population growth, and/or accentuate, hasten, or prolong population declines.

The increased abundance and distribution of nonnative red foxes will also likely adversely impact the status of kit foxes because they are closer morphologically and taxonomically, and would likely have higher dietary overlap than coyotes, potentially resulting in more intense competition for resources. Two documented deaths of kit foxes due to red foxes have been reported (Ralls and White 1995), and red foxes appear to be displacing kit foxes in the northwestern part of their range (Lewis *et al.* 1993). At Camp Roberts, red foxes have usurped several dens that were used by kit foxes during previous years (California Army National Guard, Camp Roberts Environmental Office, unpubl. data). In fact, opportunistic observations of red foxes in the cantonment area of Camp Roberts have increased 5-fold since 1993, and no kit foxes have been sighted or captured in this area since October 1997. Also, a telemetry study of sympatric red foxes and kit foxes in the Lost Hills area has detected spatial segregation between these species, suggesting that kit foxes may avoid or be excluded from red fox-inhabited areas (Kelly pers. comm. 2000). Such avoidance would limit the resources available to local populations of kit foxes and possibly result in decreased fox abundance and distribution.

Disease: Wildlife diseases do not appear to be a primary mortality factor that consistently limits kit fox populations throughout their range (McCue and O'Farrell, 1988, Standley and McCue 1992, Miller *et al.* 1998). However, central California has a high incidence of wildlife rabies cases (Schultz and Barrett 1991), and high seroprevalences of canine distemper virus and canine parvovirus indicate that kit fox populations have been exposed to these diseases (McCue and O'Farrell, 1988, Standley and McCue 1992, Miller *et al.* 1998). Hence, disease outbreaks could potentially cause substantial mortality or contribute to reduced fertility in seropositive females, as was noted in closely-related swift foxes (*Vulpes velox*) (Miller *et al.* 1998). For example, there are some indications that rabies virus may have contributed to a catastrophic decrease in kit fox abundance at Camp Roberts, San Luis Obispo County, California, during the early 1990's. San Luis Obispo County had the highest incidence of wildlife rabies cases in California during 1989 to 1991, and striped skunks (*Mephitis mephitis*) were the primary vector (Barrett 1990, Schultz and Barrett 1991, Reilly and Mangiamele 1992). A rabid skunk was trapped at Camp Roberts during 1989 and two foxes were found dead due to rabies in 1990 (Standley *et al.* 1992). Captures of kit foxes during annual livetrapping sessions at Camp Roberts decreased from 103 to 20 individuals during 1988 to 1991. Captures of kit foxes were positively correlated with captures of skunks during 1988 to 1997; suggesting that some factor(s) such as rabies virus was contributing to concurrent decreases in the abundances of these species. Also, captures of kit foxes at Camp Roberts were negatively correlated with the proportion of skunks that were rabid when trapped by County Public Health Department personnel two years previously. These data suggest that a rabies outbreak may have occurred in the skunk population and spread into the fox population. A similar time lag in disease transmission and subsequent population reductions was observed in Ontario, Canada, although in this instance the transmission was from red foxes to striped skunks (Macdonald and Voigt 1985).

Pesticides and Rodenticides: Pesticides and rodenticides pose a threat to kit foxes through direct or secondary poisoning. Kit foxes may be killed if they ingest rodenticide in a bait application, or if they eat a rodent that has consumed the bait. Even sublethal doses of rodenticides may lead to the death of these animals by impairing their ability to escape predators or find food. Pesticides and rodenticides may also indirectly affect the survival of kit foxes by reducing the abundances of their staple prey species. For example, the California ground squirrel, which is the staple prey of kit foxes in the northern portion of their range, was thought to have been eliminated from Contra Costa County in 1975, after extensive rodent eradication programs. Field observations indicated that the long-term use of ground squirrel poisons in this county severely reduced kit fox abundance through secondary poisoning and the suppression of populations of its staple prey (Orloff *et al.* 1986).

Kit foxes occupying habitats adjacent to agricultural lands are also likely to come into contact with insecticides applied to crops owing to runoff or aerial drift. Kit foxes could be affected through direct contact with sprays and treated soils, or through consumption of contaminated prey. Data from the California Department of Pesticide Regulation indicate that acephate, aldicarb, azinphos methyl, bendiocarb, carbofuran, chlorpyrifos, endosulfan, s-fenvalerate, naled, parathion, permethrin, phorate, and trifluralin are used within one mile of kit fox habitat. A wide variety of crops (alfalfa, almonds, apples, apricots, asparagus, avocados, barley, beans, beets, bok choy, broccoli, cantaloupe, carrots, cauliflower, celery, cherries, chestnuts, chicory, Chinese cabbage, Chinese greens, Chinese radish, collards, corn, cotton, cucumbers, eggplants, endive, figs, garlic, grapefruit, grapes, hay, kale, kiwi fruit, kohlrabi, leeks, lemons, lettuce, melons, mustard, nectarines, oats, okra, olives, onions, oranges, parsley, parsnips, peaches, peanuts, pears, peas, pecans, peppers, persimmons, pimentos, pistachios, plums, pomegranates, potatoes, prunes, pumpkins, quinces, radishes, raspberries, rice, safflower, sorghum, spinach, squash, strawberries, sugar beets, sweet potatoes, Swiss chard, tomatoes, walnuts, watermelons, and wheat), as well as buildings, Christmas tree plantations, commercial/industrial areas, greenhouses, nurseries, landscape maintenance, ornamental turf, rangeland, rights of way, and uncultivated agricultural and non-agricultural land, occur in close proximity to San Joaquin kit fox habitat.

Efforts have been underway to reduce the risk of rodenticides to kit foxes (Service in litt. 1993). The Federal government began controlling the use of rodenticides in 1972 with a ban of Compound 1080 on Federal lands pursuant to Executive Order. Above-ground application of strychnine within the geographic ranges of listed species was prohibited in 1988. A July 28, 1992, biological opinion regarding the Animal Damage Control (now known as Wildlife Services) Program by the U.S. Department of Agriculture found that this program was likely to jeopardize the continued existence of the kit fox owing to the potential for rodent control activities to take the fox. As a result, several reasonable and prudent measures were implemented, including a ban on the use of M-44 devices, toxicants, and fumigants within the recognized occupied range of the kit fox. Also, the only chemical authorized for use by Wildlife Services within the occupied range of the kit fox was zinc phosphide, a compound known to be minimally toxic to kit foxes (Service 1992).

Despite these efforts, the use of other pesticides and rodenticides still pose a significant threat to the kit fox, as evidenced by the death of 2 kit foxes at Camp Roberts in 1992 owing to secondary poisoning from chlorophacinone applied as a rodenticide, (Berry *et al.* 1992, Standley *et al.* 1992). Also, the livers of 3 foxes that were recovered in the City of Bakersfield during 1999 were found to contain detectable residues of the anticoagulant rodenticides chlorophacinone, brodifacoum, and bromadiolone.

To date, no specific research has been conducted on the effects of different pesticide or rodent control programs on the kit fox (Service 1998). This lack of information is problematic because Williams (in litt. 1989) documented widespread pesticide use in known kit fox and Fresno kangaroo rat (*Dipodomys nitratoides exilis*) habitat adjoining agricultural lands in Madera County. In a separate report, Williams (in litt. 1989) documented another case of pesticide use near Raisin City, Fresno County, where treated grain was placed within an active Fresno kangaroo rat precinct. Also, farmers have been allowed to place bait on Reclamation property to maximize the potential for killing rodents before they entered adjoining fields (Biological Opinion for the Interim Water Contract Renewal, Ref. No. 1-1-00-F-0056, February 29, 2000). A September 22, 1993, biological opinion with the EPA regarding the regulation of pesticide use (31 registered chemicals) through administration of the Federal Insecticide, Fungicide, and Rodenticide Act found that use of the following chemicals would likely jeopardize the continued existence of the kit fox: 1) aluminum and magnesium phosphide fumigants, 2) chlorophacinone anticoagulants, 3) diphacinone anticoagulants, 4) pival anticoagulants, 5) potassium nitrate and sodium nitrate gas cartridges, and 6) sodium cyanide capsules (Service 1993). Reasonable and prudent alternatives to avoid jeopardy included restricting the use of aluminum/magnesium phosphide, potassium/sodium nitrate within the geographic range of the kit fox to qualified individuals, and prohibiting the use of chlorophacinone, diphacinone, pival, and sodium cyanide within the geographic range of the kit fox, with certain exceptions (e.g., agricultural areas that are greater than 1 mile from any kit fox habitat). (1999 National Pesticide Consultation with EPA) However, the EPA's position on the use of rodenticides within the geographic range of the kit fox is that rodent control compounds will have no adverse effects on the kit fox provided that EPA registered compounds are applied with strict observance of EPA approved label restrictions. Even the minimal evidence provided above tends to refute this position.

<u>Section 9 Violations and Noncompliance with the Terms and Conditions of Existing Biological Opinions</u>: The intentional or unintentional destruction of areas occupied by kit foxes is an issue of serious concern. Section 9 of the Act prohibits the "take" (e.g., harm, harass, pursue, injure, kill) of federally-listed wildlife species. "Harm" (i.e., "take") is further defined to include habitat modification or degradation that kills or injures wildlife by impairing essential behavioral patterns including breeding, feeding, or sheltering. Congress established two provisions (sections 7 and 10) that allow for the "incidental take" of listed species of wildlife by Federal agencies, non-Federal government agencies, and private interests. Incidental take is defined as "incidental to, and not the purpose of, the carrying out of an otherwise lawful activity." Such take requires a permit from the Secretary of the Interior that anticipates a specific level of take for each listed species. If no permit is obtained for the incidental take of listed species, the individuals or entities responsible for these actions could be liable under the enforcement provisions of section 9 of the Act if any unauthorized take occurs.

There are numerous examples of section 9 violations; tables 8 and 9 present examples of such violations that the Service is aware of in five San Joaquin Valley counties as of September 1999 (attached). The violations listed in the tables affected vernal pool grasslands, which are used by kit foxes as well as protected vernal pool crustaceans and plants. In the five counties, a total of 9,820 acres of habitat is known to have been destroyed without incidental take authority from the Service. In Merced County 3,180 acres have been documented as destroyed without authorization.

Risk of Chance Extinction Owing to Small Population Size, Isolation, and High Natural Fluctuations in Abundance: Historically, kit foxes may have existed in a metapopulation structure of core and satellite populations, some of which periodically experienced local extinctions and recolonization (Service 1998). Today's populations exist in an environment drastically different from the historic one, however, and extensive habitat fragmentation will result in geographic isolation, smaller population sizes, and reduced genetic exchange among populations; all of which increase the vulnerability of kit fox populations to extirpation. Populations of kit foxes are extremely susceptible to the risks associated with small population size and isolation because they are characterized by marked instability in population density. For example, the relative abundance of kit foxes at the Naval Petroleum Reserves, California, decreased 10-fold during 1981 to 1983, increased 7-fold during 1991 to 1994, and then decreased 2-fold during 1995 (Cypher and Scrivner 1992, Cypher and Spencer 1998). Similarly, the relative abundance of kit foxes at the Camp Roberts Army National Guard Training Site, California, decreased 4-fold during 1989 to 1991, increased 2-fold in 1994, and decreased 5-fold during 1995 (Berry and Standley 1992, Eliason unpubl. data). Rapid decreases in the population density of kit foxes have also been detected at other sites (Ralls and White 1995, Spiegel 1996).

Desert systems are characterized by unpredictable fluctuations in precipitation, which lead to high frequency, high amplitude fluctuations in the abundance of mammalian prey for kit foxes (Williams and Germano 1992, Goldingay *et al.* 1997, White and Garrott 1999, Cypher *et al.* 1992). Because the reproductive and neonatal survival rates of kit foxes are strongly depressed at low prey densities (White and Ralls 1993, White and Garrott 1997, 1999), periods of prey scarcity owing to drought or excessive rain events can contribute to population crashes and marked instability in the abundance and distribution of kit foxes (White and Garrott 1999). In other words, unpredictable, short-term fluctuations in precipitation and, in turn, prey abundance can generate frequent, rapid decreases in kit fox density that increase the extinction risk for small, isolated populations.

Supporting Conclusion 5

To date, conservation efforts for kit foxes have not been successful at reversing the declining trend in kit fox status, and the conservation needs of kit foxes have not been met.

The kit fox was listed as federally-endangered on March 11, 1967 (32 *Federal Register* 4001). The principal reason for this action was the extensive loss, degradation, fragmentation, and isolation of habitats for kit foxes owing to agricultural, industrial, and urban developments in the San Joaquin Valley. Critical habitat was not designated for this subspecies.

A recovery plan approved in 1983 proposed interim objectives of halting the decline of the kit fox and increasing population sizes above 1981 levels (Service 1983). Six recovery tasks were proposed in this plan. The first task was to reduce or reverse the rate of habitat destruction by initiating a program of essential habitat management, protection, and acquisition. The goal was to protect a total of 25,000 acres in western Kern County and the Carrizo Plain in eastern San Luis Obispo County. Although no specific "program" was initiated, there was a coordinated effort by agencies and nonprofit organizations (e.g., U.S. Bureau of Land Management, California Department of Fish and Game, California Energy Commission, Reclamation, Service, and The Nature Conservancy) to acquire and manage lands for this purpose. Purchases most significant to conservation efforts were the acquisitions in the Carrizo Plain Natural Area, Ciervo-Panoche Natural Area, and the Lokern Natural Area. To date, however, the target goal for acquisition has been met only for the Carrizo Plain.

The second task was to acquire additional information necessary to understand the ecological life history requirements of the kit fox and to determine their compatibility with native and nonnative sympatric species and human activities. Many research programs were developed in the following years to answer such questions, and today there are hundreds of published and unpublished papers and reports regarding the kit fox. Although there are still many information gaps that need to be filled to conserve the kit fox, our knowledge regarding this subspecies and threats to its recovery have greatly improved since 1983.

The third task was to restore degraded essential habitats by enhancing natural routes and rates of vegetation. Although much of the land protected under task 1 has been managed for the kit fox, it has not reached or retained the goal of 1.4 adult kit foxes per square mile (Service 1993).

Task 4 was to monitor progress of recovery by determining changes in kit fox distribution and abundance, habitat losses or gains, rates of habitat restoration, and acquisition of new information concerning kit foxes. Although scattered monitoring programs have provided site-specific information on the trends in some populations of kit foxes (e.g., Elk Hills, Camp Roberts, Carrizo Plain), there has never been a range wide survey to determine kit fox abundance and distribution (Service 1998). Furthermore, most monitoring programs are not conducted with sufficient rigor or defined goals to allow for the effective interpretation of trends and implementation of management actions to benefit recovery.

The fifth task was to investigate the feasibility of reintroductions in portions of the original range of the kit fox. Minimal research has been conducted on this task (Service 1998).

The sixth task was to develop strategies for integrating recovery plan objectives into development and management goals for the southern San Joaquin Valley. There has been, and continues to be, much progress on this task. Habitat conservation plans, biological opinions, and resource management plans all take into account goals for kit fox recovery, and should contribute to the long-term survival of the kit fox by implementing conservation measures that fully offset the temporary and permanent loss of kit fox habitat by preserving habitat in other areas that are more essential for the survival and recovery of the kit fox. As alluded to in the previous section, however, there have been many failures of these plans and opinions where conservation measures have been ineffective or not implemented.

By the mid 1990's, it became clear that the goals outlined in the 1983 recovery plan were either inadequate, or the tasks were not being sufficiently implemented, to halt the decline of the kit fox and reverse this trend toward recovery. Hence, the status of the kit fox was assessed in 1995 during the critical needs analysis for the Biological Opinion for Interim Contract Renewal (Service in litt. 1995). That analysis found that the kit fox had critical needs, which were defined as any intrinsic state or external situation that threatens a species with extinction or preclusion of recovery and requires action during the next year to improve or avoid a further deterioration of that species' chances of survival and recovery. These critical needs were used to revise and/or develop additional recovery tasks and priorities for the kit fox.

The revised 1998 *Recovery Plan* identified a goal of establishing a viable complex of kit fox populations (i.e., a viable metapopulation) on private and public lands throughout the geographic range of the kit fox. The viability of the metapopulation hinges on the protection and management of 3 core populations, 9 satellite populations, and intervening linkage areas that encompass as much of the environmental and geographic variation of the historic geographic range as possible. The 3 core populations are located in the Carrizo Plain Natural Area, western Kern County, and the Ciervo-Panoche area. Satellite populations and linkages were to be established and/or protected in the northern range and Valley edges (Alameda, Contra Costa, San Joaquin, and Stanislaus counties), northern Valley floor (Merced and Madera counties), central Valley floor (Fresno County), west-central Valley edge (Fresno and Kings counties), southeast Valley floor (Tulare and Kern counties), Kettleman Hills (Fresno, Kings, and Kern counties), southwestern Valley floor (Kern County), Salinas-Pajaro Rivers watershed (Monterey, Santa Benito, and San Luis Obispo counties), and upper Cuyama Valley (Santa Barbara and San Luis Obispo counties). These areas must be secured and protected from uses that are incompatible with the conservation of the kit fox. The Recovery Plan called for protecting at least 90 percent of the existing habitat in western Kern County and the

Ciervo-Panoche areas, and 100 percent of the existing habitat in the Carrizo Plain Natural Area. Service-approved management plans that include the long-term survival of the kit fox as a primary objective must be implemented for each of these recovery areas. In order for the Service to delist the kit fox, the abundance of each core population, and at least 3 of the satellite populations, must be stable or increasing through one precipitation cycle, and there must be demonstrated population interchange between one or more core populations and the satellite populations.

To date, the goal of the *Recovery Plan* has not been met, and none of the current threats to the survival and recovery of the kit fox have been alleviated through conservation efforts. Fewer than 10 percent of the historic range of the kit fox existed when the revised *Recovery Plan* was issued in 1998. As outlined in previous sections, the unpermitted conversion of habitat in the San Joaquin Valley has continued at a rate of more than 9,800 acres per year.

Today, kit foxes persist in 3 core populations (Carrizo Plain, western Kern County, and the Ciervo-Panoche Natural Area) and approximately 9 smaller and more-isolated satellite populations (Service 1998). Both the Carrizo Plain and western Kern County populations have undergone population declines during the past few decades (Cypher and Scrivner 1992, Cypher and Spencer 1998, White and Ralls 1993), while some of the smaller satellite populations (e.g., Camp Roberts, Fort Hunter-Liggett) have decreased to such low abundances (i.e., fewer than 10 known foxes) that local extinction is possible. Also, the distribution and abundance of the kit fox in the entire northern portion of its range (i.e., eastern Contra Costa and Alameda Counties, and the western edge of San Joaquin County) has been reduced during the last 2 decades owing to the rapid conversion of grasslands and agricultural areas to suburban homes and light industry (Orloff *et al.* 1986, Bell 1994). As a result, the kit fox population in this region is highly susceptible to local extinction. The status of the Ciervo-Panoche area population has not been monitored effectively.

In summary, the kit fox is already at a point where its survival and recovery are tenuous and cannot be ensured in the long-term owing to the magnitude of historical habitat losses, an expanding agricultural base, and increasing municipal and industrial development. Hence, any future, unmitigated land conversions that contribute to a net loss of habitat, or result in the removal of native habitat, can reasonably be expected to reduce the likelihood of both the survival and recovery of the kit fox. Given that there is no regulation of agricultural conversion under State or Federal law, and that Federal and State water purveyors do not acknowledge the causal relationship between the provision of water and land conversion, most of the current and future effects to habitat for kit foxes will likely be unmitigated. This continuing, unmitigated loss of suitable habitat for kit foxes will preclude recovery options, result in decreased abundance, and possibly lead to the local extinction of isolated or remnant populations (i.e., decreased distribution). Hence, the status of kit fox, which has been declining since its listing, is expected to continue in a downward trend unless measures to protect, restore, and sustain remaining habitats, and the ecosystem processes upon which they depend, are immediately implemented.

San Joaquin Kit Fox in Merced County

The current distribution of the San Joaquin kit fox can be grouped into three large geographic areas. In the northern range, of which Merced County is a part, kit fox populations are small and isolated, and have exhibited significant decline in past years. Reasons for decline are attributed to a combination of loss of habitat, barriers to migration, competition and predation by red fox (*Vulpes vulpes*) and coyotes (*Canis latrans*), and direct and indirect poisoning by rodenticides. Rodent eradication programs were carried out by many counties in the 1930s through the 1970s. By the late 1970s, the counties passed the choice of rodent control to private landowners, most of whom continued the process (Bell 1994). Kit foxes can be poisoned by either directly ingesting the poison, or feeding on a ground squirrel or other rodent that has ingested poison. Conversion of natural lands to agriculture has also restricted the kit fox to the Santa Nella area on the west side of Merced County, the Sandy Mush Road corridor and the Kesterson National Wildlife Refuge , and the eastern edge of the valley in grasslands and on the edges of farmland and canals.

From 1995 to 2002, the Service entered formal consultation on 36 projects in Merced County of which 6 were located in eastern Merced County. Kit fox habitat was lost to two prisons along Sandy Mush Road, and a prison at the former Castle Air Force Base. In addition, consultation has been initiated by the U.S. Army Corps of Engineers on 30 acres of grassland to be converted to homes within the Study Area.

Habitat in the northern range is highly fragmented by highways, canals, and development. The canal system that distributes water from Lake Yosemite impedes lateral kit fox travel. These and other developments are slowly chipping away at the last remaining kit fox habitat, and we expect development pressures to increase in the future (see Cumulative Effects). The protection of the remaining travel corridor is vital to the survival of this population. In response the drastic loss of habitat, California Department of Transportation (Caltrans) and the Service convened a San Joaquin Kit Fox Conservation and Planning Team to address the rapid decline of kit fox habitat in the northern range, and increasing barriers to kit fox dispersal. Consisting of Federal, State, and local agencies, local land trusts, environmental groups, researchers, and other concerned individuals, the goal of this team is to proactively implement actions that will recover the species, and troubleshoot threats to San Joaquin kit foxes as they emerge. The team is currently working on conservation strategies to protect critical kit fox corridors in the area.

The recent sightings scattered across eastern Merced County and north into Stanislaus and Tuolumne County are described in the Species Account earlier in this document. The recent sightings, most made during surveys required by the Service for development projects, show that kit foxes are present in eastern Merced County. With increased surveying due to increased development, the Service expects the number of recorded sightings to increase. Additional data is still needed to adequately characterize kit fox movement patterns in eastern Merced County.

<u>Mountain Plover</u>

<u>Reasons for Decline and Threats to Survival</u>

Conversion of grassland habitat, agricultural practices, the management of domestic livestock, and decline of native herbivores are factors that likely have contributed to the mountain plover's decline. Pesticides are applied to cultivated fields during the 5 months that mountain plovers occupy these wintering habitats (Knopf 1996*b*). Birds are exposed to pesticides by adsorption through the skin, preening, ingestion, and inhalation (Driver *et al* 1991). Adult birds and eggs were analyzed for concentration of organochlorines, selenium, and heavy metals. Residues of DDE ranged from near 1 to 10 parts per million (Carson in litt. 1992, Archuleta pers. comm. 1995). Twenty-two of the 54 eggs collected in Colorado and Montana had DDE residues similar to those found in the wintering birds. Residues found in adults may cause death to some individuals if they are mobilized to the brain (USEPA 1975).

Recovery Actions. A unique Memorandum of Agreement (MOA) was signed in 1995 by the Secretary of the Department of the Interior and the Governor of Colorado. The purpose of the MOA is to address the conservation needs of declining species in Colorado, with a goal of preventing their decline to a point at which Federal listing could be needed. The mountain plover is mentioned specifically in this MOA, and a work group now exists to address its needs. The Service has participated diligently with the work group to pursue the goals of the MOA and believes that the MOA can be an effective vehicle to promote and implement mountain plover conservation actions in Colorado, and perhaps encourage similar conservation actions in adjoining states (Service 1999*b*). In addition, mountain plovers occur on lands administered by the Service, Forest Service, BLM, and other agencies. Evaluation and modification of activities on Federal lands and their effects on the mountain plover will occur and assist in the recovery of the species.

Conversion of grassland habitat, agricultural practices, the management of domestic livestock, decline of native herbivores, and pesticides are factors that likely have contributed to the mountain plover's decline. The grassland conversion estimates described in the baseline for vernal pool species in this document also apply to mountain plover habitat. Pesticides are routinely applied to cultivated fields during the 5 months that mountain plovers occupy their winter habitat in California (Knopf 1996*b*).

Mountain Plovers in Merced County

The 1998 California Bird Census found 2,179 mountain plovers in 10 California counties, including Imperial, Kings, Los Angeles, Monterey, Riverside, San Benito, San Luis Obispo, San Bernardino, Solano, and Yolo Counties (Hunting in litt. 1998). Mountain plovers are generally considered to be an uncommon migrant in eastern Merced County (Vollmar 2002). Five individuals were seen at the Flying M Ranch on March 8, 1999 (CNDDB 2001), and two other sightings were recently made in the Study Area (EIP Associates 2001)(Bumgardner pers. comm. 2001, 2002).

Effects of the Proposed Actions

General Effects of the Proposed Actions

This section addresses the potential effects of the Proposed Actions in the Study Area. A discussion of species-specific effects follows. Development of the Proposed Actions could result in a variety of effects on biological resources, and may eliminate a substantial amount of habitat for listed species. The specific amounts and types of habitat affected by the Proposed Actions, and the severity of these effects, could differ substantially depending on the location, extent, and configuration of the Campus, Infrastructure Project, and University Community within the Study Area. For example, if the footprint of the Proposed Actions were reduced, effects on biological resources would be lessened. Alternatively, if a location other than the Applicants' Proposed Projects site was selected in the southernmost extent of the Study Area through the NEPA and Section 404 processes, the Preferred Alternative would increase loss of agricultural lands while reducing effects on vernal pool/grassland habitat near the center of the Study Area.

The University and County have committed to applying the Parameters described earlier in this document to the Proposed Actions that are ultimately selected by the Corps during the Section 404(b)(1) and NEPA process. Consequently, the Preferred Alternative will be located and configured in compliance with the Parameters. Moreover, the University and County have further proposed a number of Conservation Measures as part of the Proposed Actions, which will in many cases implement the Parameters. The Parameters and the Conservation Measures are considered to be part of the Proposed Actions and will serve to avoid, minimize, or compensate for effects caused by the Proposed Actions. Specific types of direct and indirect effects are summarized below.

Construction-Related Effects

During construction, uncontrolled trespass of construction equipment and personnel into adjacent vernal wetland habitats could result in disturbance of the habitats and their watersheds as well as in take of individuals of listed species. Other construction-related effects could include dust emissions, erosion, sedimentation, hazardous material spills, introduction of invasive nonnative plant species, and injury or direct mortality of wildlife. However, as discussed in the Conservation Measures, the University and County have adopted conservation measures to avoid or minimize potential for these effects. These measures include preconstruction measures to minimize direct effects on the San Joaquin kit fox, construction monitoring, best management practices (BMPs), training of construction personnel, enforcement of protection measures through construction contracts, a spill-response plan, erosion control measures, measures to prevent introduction of invasive nonnative plant species, and marking and fencing of sensitive exclusion areas.

Altered Hydrology and Nonpoint Source Pollution

Impervious surfaces (e.g., concrete, asphalt, rooftops) decrease water infiltration into soil, thereby increasing the amount and concentrating the duration of stormwater runoff. These alterations can disrupt normal patterns of vernal pool inundation and desiccation, thereby affecting the life cycles of vernal pool-dependent species. Moreover, runoff from urbanized areas can carry sediment and pollutants (e.g., fertilizers, pesticides, oil, fuel) into surrounding habitat and water bodies. However, as discussed in the Conservation Measures, the University and County have committed to conservation measures to avoid and minimize these effects. For example, design and siting of the Proposed Actions would minimize development in watersheds supporting federally listed species; stormwater drainage would be directed to stormwater management facilities; and irrigation runoff would be controlled to prevent discharge into habitat areas adjacent to the Campus and University Community.

Pesticides

In the absence of an adequate landscape management plan, pesticides used at the developed Campus and University Community or for habitat management activities in preserved areas could affect special-status species. For example, drift of herbicides or insecticides could result in direct mortality of plants and wildlife; similarly, rodenticides could affect the prey base or cause injury or direct mortality to the San Joaquin kit fox. However, the University and County have committed to a set of conservation measures that would avoid or minimize effects of the Proposed Actions. A landscape management plan would be prepared for University facilities that would define management measures to minimize pesticide use and risk to adjacent resources. This plan will include restrictions on certain compounds, modes of application, and conditions of application (e.g., wind speeds, location). Similarly, the University will develop a management plan for easement lands it controls (CNR and VST) to ensure that use of pesticides is restricted to protection of habitat values (i.e., for localized control of invasive species). Additionally, the County will implement maintenance and adaptive management practices for the Infrastructure Project; these practices will include restrictions on chemical application in sensitive habitat areas. These measures are expected to reduce the effects of pesticides such that they would not appreciably reduce the reproduction, numbers, or distribution of any listed or proposed species in the Study Area.

Human Disturbance

Without proper controls, management, and enforcement, increased human activity in habitat surrounding the Proposed Actions could disturb habitats and populations of listed species. Potential human uses could include bicycling, off-highway vehicle (OHV) use, hiking, and plant collection. Such activities could result in trampling of vegetation and soil compaction, inadvertent introduction of nonnative invasive plant species, disturbance of wildlife species, introduction of litter and debris, and recruitment of opportunistic wildlife species that can compete with or prey upon native species. However, the University and the WCB have acquired or will acquire ownership or conservation easements on many important habitat areas in the Study Area; these easements will incorporate strict controls on human use. As discussed in the Conservation Measures, the University and County have committed to conservation measures to minimize the adverse effects of public access to these and other areas surrounding the Proposed Actions. These measures could include public education, signage, fencing, litter cleanup, exclusion and enforcement of unauthorized uses, careful control of authorized uses of habitat areas for research and educational purposes, and monitoring and managing protected habitat areas. Additionally, implementation of Parameters 2a and 2e will ensure that the University and County develop management strategies, satisfactory to the Service, that will control indirect effects caused by human disturbance.

Introduction of Nonnative Species

Construction of the Proposed Actions could result in the introduction of nonnative plant and animal species in adjacent habitats. Nonnative plant species could be introduced during ground-disturbing activities associated with construction and could then disperse to adjacent habitats. Also, use of nonnative species for ornamental landscaping associated with the Proposed Actions could create a source for invasion by such species. However, the University and County have committed to conservation measures to address the potential introduction of nonnative invasive plant species. Construction measures include use of certified weed-free materials in erosion control during construction and removal of seed sources from earth-moving construction equipment. Campus operations measures include excluding known invasive species for use in campus landscaping and monitoring adjacent habitat areas to detect and control potential introductions of invasive species from developed areas. Measures associated with management of easement lands under University control (VST and CNR) include developing and implementing management plans to discourage invasive species through livestock grazing practices, prescribed burning, and other management measures as appropriate. The County also will require Infrastructure Project contractors to implement management measures to control the dispersal of invasive species into sensitive habitats.

Urbanization also may favor generalist wildlife species, such as raccoon, red fox, coyote, feral pig, and bullfrog, that may prey upon or compete with listed species. In addition, domestic dogs and cats can disturb and prey upon native wildlife species, and feral populations can become established in undeveloped areas. As discussed in the Conservation Measures, substantial efforts would be made to exclude domestic dogs and cats from protected habitat areas by developing animal control policies, programs, and design measures and by conducting monitoring and control of detrimental nonnative species in the University's easement lands.

Fragmentation of Habitat

Habitat fragmentation can occur when lands, habitats, or species become isolated as a result of urban development that creates a barrier between previously contiguous habitats or populations. Such isolation can increase the risk of stochastic extinction, decrease genetic diversity, and reduce suitability of habitat to support species that are particularly susceptible to fragmentation. The Study Area is partially fragmented by the presence of agricultural lands, canals, existing development, and roads. The northern section of the Study Area is less fragmented than lands to the south. The extent of fragmentation resulting from the construction of the Proposed Actions would depend on the specific site that is ultimately selected within the Study Area.

The extent of fragmentation resulting from the construction of the Proposed Actions would depend on the specific site that is ultimately selected for the Preferred Alternative within the Study Area. The Applicants' Proposed Projects site, for example, is located adjacent to Lake Yosemite, agricultural lands, and subdivided lands on the western edge of the extensive area of grassland habitat in the Study Area. Because areas west of this site already exhibit extensive fragmentation and disturbance, this site would result in less fragmentation than other potential configurations to the east, where grassland/vernal pool habitat is largely undisturbed and contiguous. Also, the University's and WCB's acquisition and protection of the VST Remainder Property, CNR, and CST lands would maintain a 8,854-acre area of contiguous habitat through the northern and central portions of the Study Area.

Although fragmentation is likely to result from construction of the Proposed Actions, the project description and the Conservation Measures will preserve extensive contiguous high-quality habitat to compensate for the potential fragmentation of habitat resulting from project implementation. The Parameters and Conservation Measures specify habitat restoration and enhancement, as appropriate, for effects on vernal pools; such restoration and enhancement will offset some of the effects of habitat loss and fragmentation. In addition, Merced County has agreed with the Service that for discretionary projects permitted by the County within the Study Area which may result in take of listed species, the County will require compliance with the Act (see Parameter 3).

Air Pollution

The Proposed Actions could result in increased levels of air pollution and these increased levels could potentially have adverse effects on listed plant species. In response to these concerns, an extensive literature review was conducted to assess the current available information pertaining to such effects on these vegetation types. While region-specific information was limited, some laboratory studies have been conducted.

Background ozone (O_3) concentrations in the San Joaquin Valley air basin are at the lower end of the range that is considered harmful. However, O_3 is assessed regionally by air pollution control agencies, and management of O_3 levels is addressed through the State Implementation Plan.

The available literature indicates that NO_x (measured as NO_2) can have a localized impact on vegetation. The Applicants conducted a modeling analysis to evaluate the likely effects of increased NO_x emissions on listed vernal pool species. The Service has not reviewed the modeling analysis. However, the Applicants state that the modeling analysis indicated that NO_x emissions that would result from complete Campus buildout would not reach the established level of effects for grasses, trees, or shrubs. However, the Proposed Actions could contribute to a regional increase in NO_x emissions, which may then affect plants. Increased actual distribution and effects of pollutants are difficult to predict and are subject to multiple factors, such as weather patterns and soil characteristics.

If further studies were to indicate that locally increased emissions could adversely affect listed vernal pool plant species, then it is possible that siting the Proposed Actions in a portion of the Study Area as far as is practicable from habitat that supports these species could reduce such effects. For example, locating the Campus and University Community in the extreme southern portion of the Study Area would place the heaviest concentration of emission sources further from vernal pool habitats as compared to the Applicants' Proposed Projects.

Compensation Lands and Management Strategies

The University has committed to acquiring and providing enhanced management of 5,780 acres of vernal pool grasslands on VST and CNR lands. These lands are considered suitable for the San Joaquin kit fox and contain occurrences of listed vernal pool plants and crustaceans. In addition, the WCB is protecting more than 20,000 acres of habitat in and adjacent to the Study Area. Thus, more than 26,000 acres in eastern Merced County have been or will be placed under conservation easements to protect this habitat in perpetuity (Table 1).

The University will develop and implement a Management Plan for the remaining VST areas it has acquired. This land will be protected under conservation easements in perpetuity to preserve existing vernal pool habitats; these easements will also restrict human activities and access to control human use and prevent human disturbance of these areas. CNR and VST lands will be monitored to detect and prevent establishment of detrimental invasive species.

The Management Plan will also establish the management measures and maintenance of preserve lands under WCB easements. WCB easement lands may be managed differently from University-controlled preserve lands. Management of WCB easement lands will be conducted under the terms of the conservation easements in place for each property. Easement terms will be examined to ensure that they meet the requirements of the Parameters and other compensation and mitigation needs of the Proposed Actions. Existing WCB easements do not fulfill all of the requirements of the Parameters at this time. However, existing WCB easements may be adjusted at a future date. Conservation easements should allow the easement holder, the Corps, the Service, and CDFG to work with the landowner to preserve, protect, identify, monitor (including the right to access the property to conduct evaluations of wetland quantity and quality, evaluations of habitat quantity and quality, and to survey for threatened and endangered species and monitor their population), enhance, and restore in perpetuity the conservation values. Parameter 2 (a) will require close coordination with easement holder(s) and state and local agencies to provide access for management and monitoring activities. Compensation lands will have beneficial effects that may help to offset adverse effects of the Proposed Actions.

General Effects Resulting from Phase 1 Construction and Operation

Construction and operation of the Phase 1 Campus have potential to introduce or disseminate nonnative plants that may be detrimental to vernal wetland ecosystems occupied by listed species. Conservation measures to control invasive weeds during construction, discourage use of invasive species in Campus landscaping, and control human and pet disturbance will minimize the risk of effects on wetland-dependant species. Because no grading or construction activities will occur outside of the Phase 1 Campus or within any vernal pool or other wetland habitats, construction of the Phase 1 Campus would not fragment existing vernal pool or wetland habitats. Implementation of the adopted Conservation Measures will further assure that indirect effects are avoided and minimized and do not result in further fragmentation of existing habitats.

Adherence to Conservation Measures governing design, construction, operation, and management of the Phase 1 Campus will avoid or minimize construction related disturbances (see *Conservation Measures*). These measures include but are not limited to installation of temporary construction fencing, installation of permanent fencing as part of Campus design, conducting environmental awareness training for construction personnel, incorporation of protection obligations and violation penalties into construction contracts, enforcement of human and pet use restrictions, signage at the Phase 1 Campus boundary, and education of campus residents. While the potential for human disturbance cannot be fully eliminated, it will be reduced to a level that is not expected to adversely affect any occurrences of listed species.

Species Specific Effects

Phase 1 Effects on Federally Listed Plants

The Phase 1 Campus site will be located on part of an existing golf course that does not support a vernal pool complex. Consequently, development of the Phase 1 Campus will have very limited potential for direct effects to fleshy owl's-clover, Hoover's spurge, Colusa grass, San Joaquin Valley Orcutt grass, hairy Orcutt grass, and Greene's tuctoria. Likewise, the Phase 1 Campus site does not support suitable habitat for vernal pool dependent species and, consequently, will not result in direct effects to the habitats of any of the federally listed plant species considered in this biological opinion. No known occurrences of Hartweg's golden sunburst or suitable habitat occur on or near the Phase 1 Campus site. Generally, indirect effects on adjacent federally listed plant occurrences resulting from dust emissions, erosion, sedimentation, hazardous material spills, and introduction of invasive nonnative plant species during construction will be minimized through implementation of adopted construction and operation conservation measures.

Without implementation of water-management conservation measures, the Phase 1 Campus will result in hydrologic disruption and pollution of wetland habitats occupied by fleshy owl's- clover. In accordance with the Parameters and Conservation Measures, the Phase 1 Campus has been sited outside the watershed of all vernal pools. In most locations, the Phase 1 Campus boundary is generally placed to maintain a 250-foot buffer from vernal pools. Although the northern perimeter of the Phase 1 Campus boundary will be within approximately 20 feet of the nearest vernal pools, building construction and grading will occur approximately 50 feet from these pools. All grading and construction will be outside the watershed of any vernal pools and will therefore not disrupt pool hydrology. In addition, a 30-foot-wide, disced fire control buffer will be established along the interior of the Phase 1 Campus's southeastern perimeter. Limited grading will also occur within this buffer; however, along the western portion of the buffer it will be restricted to 10 feet of the 30-foot buffer, so as to further ensure that no grading occurs near vernal pools.

The stormwater capture and detention system for the Phase 1 Campus will contain and regulate runoff to avoid alteration of the hydrology of adjacent wetlands and discharge of unnatural levels of runoff from the campus. The University will implement standard BMPs to control water quality effects.

The following effects discussion is specific to each plant species in this biological opinion.

Fleshy Owl's-Clover - Effects of the Proposed Actions

Although no systematic botanical survey has been conducted for fleshy owl's-clover across its range or in the Study Area, the Study Area represents a significant portion (approximately one-third of the known occurrences) of the taxon's known range. Construction of the Proposed Actions will result in both direct and indirect effects on fleshy owl's-clover. Direct effects entail loss of habitats as a result of construction, indirect effects could include dust emissions, sedimentation, equipment trespass during construction activities, disturbance from humans and pets, runoff from landscape irrigation, introduction of pesticides resulting from Campus and University Community operations, and management of preserved areas. Additionally, the University has agreed that lands under conservation easements will not be developed. By enacted or proposed acquisition and application of easements on CNR, VST, and CST lands, additional occurrences of fleshy owl's-clover will be protected. However, construction of the Proposed Actions in the central or eastern portions of the Study Area can eliminate occurrences of fleshy owl's-clover. Because known suitable habitats are lacking in the southern portion of the Study Area, fleshy owl's-clover would not be adversely affected if the Proposed Actions were sited there.

The University and County have committed to the Parameters and Conservation Measures to avoid and minimize effects to fleshy owl's-clover to the greatest extent practicable and to ensure the establishment of a comprehensive conservation program for the conservation of the species. The University and WCB have committed to the preservation and management of 8,854 acres of extensive high-quality contiguous habitats on CNR, VST, and CST lands and the protection of 17,214 acres of other lands in eastern Merced County. In accordance with Parameter 2a, this commitment will be examined to ensure that occupied habitat for fleshy owl's- clover will be preserved in areas approved by the Service. The Applicants' Proposed Projects will result in adverse effects to fleshy owl's-clover; however, with implementation of the Parameters and Conservation Measures, these adverse effects will be offset by the University's protection afforded to the species. Selecting an alternative site for the Proposed Actions with less vernal pool habitat could greatly reduce direct and indirect effects to fleshy owl's-clover.

Fleshy Owl's-Clover - Effects of Phase 1

There are no known occurrences of fleshy owl's-clover on the Phase 1 Campus site. Therefore, the development of Phase 1 is not likely to adversely affect fleshy owl's-clover.

Hoover's spurge - Effects of the Proposed Actions

Hoover's spurge is endemic to larger vernal pools, often in association with rare *Orcuttieae* grasses. There are no known occurrences of Hoover's spurge in the Study

Area. However, no systematic botanical surveys have been conducted within all suitable habitats in the Study Area. Nearby occurrences include one record 15 miles west of Highway 99 in Merced County and several records just north of the Merced County line in Stanislaus County (Vollmar Consulting 2002). The species was not located during surveys of the Applicants' Proposed Projects site and surrounding lands (EIP Associates 2002) or surveys of eastern Merced County ranches (Vollmar Consulting 2002). However, given the observed dynamic nature of Hoover's spurge occurrences, rainfall conditions during recent survey periods, and the incompleteness of botanical surveys, potential exists for the species to occur in the Study Area. Any additional discoveries of Hoover's spurge would be highly significant from a conservation perspective (Vollmar Consulting 2002).

Hoover's Spurge - Effects of Phase 1

There are no known occurrences of Hoover's spurge on the Phase 1 Campus site. Therefore, the development of Phase 1 is not likely to adversely affect Hoover's spurge.

Colusa Grass - Effects of the Proposed Actions

No systematic targeted botanical surveys have been conducted for Colusa grass within the Study Area. Although 28 of the 44 known extant occurrences of Colusa grass are within eastern Merced County, only six occurrences of Colusa grass were observed in the Study Area in special-status plant surveys conducted in 1999-2001. All six of these occurrences are on VST land which the University has committed to preserve. The CNDDB also lists a historic occurrence in the western portion of the Study Area; however, this occurrence has not been observed since 1943 and is described as possibly extirpated. Two CNDDB occurrences were not reverified during the 1999-2001 surveys. Colusa grass was not found on lands for which WCB has acquired or will acquire title or conservation easements. The current documented occurrences should not be viewed as an exhaustive inventory because not all pools were surveyed in the 1999-2001 surveys. Because Colusa grass is restricted to long-duration vernal pools and some selected stockponds, and because vernal pools in the central, southern, and western portions of the Study Area occur on low-gradient land that supports shallower pools of shorter duration, these areas have little likelihood of supporting Colusa grass occurrences.

Development of the Proposed Actions occurring in the Study Area may directly and indirectly adversely affect some presently unknown occurrences of Colusa grass. However, the Applicants' Proposed Projects can avoid direct effects on known Colusa grass occurrences. Construction of the Proposed Actions, operation and management of the Campus and University Community, and management of preserved habitats will result in indirect effects on Colusa grass. The nature, extent, and character of these effects would depend on the site and configuration selected for development. Potential mechanisms of these effects (e.g., alteration of hydrology, introduction of invasive nonnative species, human disturbance, pesticide drift, etc.) are discussed above in

General Effects of the Proposed Actions. Given the sparse and localized known distribution of Colusa grass in the Study Area and the lack of direct effects at the Applicants' Proposed Projects site, it is likely that the Proposed Actions can be located to avoid and minimize direct and indirect adverse effects to the species. Adopted conservation measures to address potential effects of project design, construction, and operation measures would be implemented to avoid and minimize these effects to the greatest extent practicable.

In keeping with the Conservation Measures and Parameters, the University and County have committed to development and implementation of a protective management plan for the VST and CNR lands occupied by occurrences of Colusa grass. Moreover, in accordance with Parameter 2a, the University will preserve occupied habitats in areas approved by the Service and the Corps for any effects to Colusa grass that result from development of the Proposed Actions. The protection of six occurrences of this species is considered to be beneficial.

Colusa Grass - Effects of Phase 1

There are no known occurrences of Colusa grass on the Phase 1 Campus site. Therefore, the development of Phase 1 is not likely to adversely affect Colusa grass.

San Joaquin Valley Orcutt Grass - Effects of the Proposed Actions

Although 23 occurrences of San Joaquin Valley Orcutt grass occur in eastern Merced County, only 9 occurrences have been reported for the Study Area. Of these, two CNDDB occurrences were first reported in 1980, but were not relocated during surveys in 1986. An additional CNDDB occurrence coincides with a more recent observation, where the species was reported to occur with Colusa grass. Three of the nine occurrences of San Joaquin Valley Orcutt grass in the Study Area are on CNR and VST lands. An additional five occurrences lie in the east-central portion of the Study Area; another is just outside the eastern boundary.

Although systematic surveys have not been conducted for San Joaquin Valley Orcutt grass in the Study Area or across the range of the species, all vernal pool and other areas exhibiting typical habitat characteristics were surveyed. Because this species is restricted to deeper, long-duration vernal pools and stockponds, and because vernal pools in the central, southern, and western portions of the Study Area occur on low-gradient terrain that supports shallower pools of shorter duration, these areas have little likelihood of supporting occurrences of San Joaquin Valley Orcutt grass.

Development of the Proposed Actions in the Study Area can have direct and indirect adverse effects on San Joaquin Valley Orcutt grass. However, the Applicants' Proposed Projects can avoid direct effects on known San Joaquin Valley Orcutt grass occurrences. Construction of the Proposed Actions, operation and management of the Campus and

University Community, and management of preserved habitats could result in indirect effects on San Joaquin Valley Orcutt grass. The extent and character of these effects would depend on the site and configuration selected for development. Potential mechanisms of these effects (e.g., alteration of hydrology, introduction of invasive nonnative species, human disturbance, pesticide drift, etc.) are discussed above in *General Effects of the Proposed Actions*. Given the sparse and localized known distribution of San Joaquin Valley Orcutt grass in the Study Area and the lack of direct effects at the Applicants' Proposed Projects site, the Proposed Actions can be located in the Study Area to avoid and minimize potential indirect effects. Adopted conservation measures to address potential effects of project design, construction, and operation measures would be implemented to avoid and minimize these effects to the greatest extent practicable.

In keeping with the Conservation Measures and Parameters, the University and County have committed to development and implementation of a protective management plan for the three known occurrences of San Joaquin Valley Orcutt grass on VST and CNR lands. Moreover, in accordance with Parameter 2a, the University will preserve occupied habitats in areas approved by the Service for any effects on San Joaquin Valley Orcutt grass that result from development of the Proposed Actions. The protection of the three presently unprotected known occurrences of San Joaquin Valley Orcutt grass is considered to be beneficial. As a result, the Proposed Actions are not expected to appreciably adversely affect the distribution, reproduction, or numbers of the species in the Study Area or eastern Merced County. Selection of an alternate site with known occurrences of San Joaquin Valley Orcutt grass would result in loss of occurrences and would be inconsistent with the Parameters. Possible project alternatives that entail development in the eastern portion of the Study Area will have a higher likelihood of affecting known occurrences of San Joaquin Valley Orcutt grass in that area.

San Joaquin Valley Orcutt Grass - Effects of Phase 1

No known occurrences of San Joaquin Valley Orcutt grass exist on the Phase 1 Campus site. Therefore, the development of Phase 1 is not likely to adversely affect San Joaquin Valley Orcutt grass.

Hairy Orcutt Grass - Effects of the Proposed Actions

Hairy Orcutt grass occurs primarily in large vernal pools. Twenty-seven extant occurrences are known, predominantly in the northern Sacramento Valley and southeastern Madera County. Only two historic records are known for the species in Merced County; both are believed extirpated. No systematic surveys for this species have occurred in the Study Area and unsurveyed potential habitat occurs in the Study Area in large pools that support other Orcutt grasses.

One extirpated occurrence of hairy Orcutt grass is more than 2 miles southwest of the Phase 1 site. The nearest single extant occurrence of hairy Orcutt grass is known from an area southwest of the Study Area. Therefore, no direct or indirect adverse effects to hairy Orcutt grass are anticipated from the Proposed Actions and related construction activities or disturbances because of implementation of the adopted Conservation Measures and Parameters. No indirect effects are anticipated above and beyond those general indirect effects described above.

The Applicants' Proposed Projects would not disturb known occurrences of hairy Orcutt grass. Larger pools that may provide suitable habitats for the species would be protected on VST and CNR lands (see discussions of San Joaquin Valley Orcutt grass and Colusa grass). Location of the Proposed Actions in portions of the Study Area where more suitable habitat is present could adversely affect these species if they were present; however, siting the Proposed Actions in an area more sensitive than the Applicants' Proposed Projects would be inconsistent with Parameter 2f. Potential habitat (i.e., deeper vernal pool and stockpond habitats) for this species is a recognizable subset of vernal wetland habitats where other listed species may occur. Finally, the Proposed Actions include protection of extensive high-quality vernal pool/grassland habitats that could serve as compensatory habitat in the event that adverse effects occur. Accordingly, the Proposed Actions are not likely to adversely affect the distribution, reproduction, or numbers of hairy Orcutt grass plants or throughout the species' range.

Hairy Orcutt Grass - Effects of Phase1

There are no known occurrences of hairy Orcutt grass on the Phase 1 Campus site. Therefore, the development of Phase 1 is not likely to adversely affect hairy Orcutt grass.

Hartweg's Golden Sunburst - Effects of the Proposed Actions

Hartweg's golden sunburst is a very rare species that occurs on mima mounds in upland sites in valley and foothill annual grasslands. Although no systematic range-wide or Merced County surveys for this species have been conducted, about 20 extant occurrences are known, primarily in areas near the Fresno-Madera County line and northeast Merced and southeast Stanislaus Counties. In recent surveys, Vollmar Consulting (2002) discovered four new occurrences in eastern Merced County north of the Study Area. Vollmar (2002) stated that most suitable habitat in eastern Merced County was north of the Merced River (i.e., outside the Study Area); however, he identified potential habitat for Hartweg's golden sunburst at the Chance and Nelson Ranches which are compensation sites for which conservation easements have been acquired by WCB.

Hartweg's golden sunburst was not observed in surveys of the Applicant's Proposed Projects or on surrounding lands. The potential for Hartweg's golden sunburst to occur in these areas is low. Hartweg's golden sunburst is more likely to occur on the Chance and Nelson Ranches, where WCB has acquired easements (Vollmar Consulting 2002). Locating the Proposed Actions elsewhere in the Study Area has potential to adversely affect presently unknown occurrences of the species. Application of Parameter 2f would ensure that, if an occurrence of the Hartweg's golden sunburst could not be avoided, occupied habitat would be protected and managed as compensation.

Hartweg's Golden Sunburst - Effects of Phase 1

Although no systematic surveys for this species have occurred through the range of the species, Hartweg's golden sunburst is not known to occur on the Phase 1 Campus site. Therefore, the development of Phase 1 is not likely to adversely affect Hartweg's Golden Sunburst.

Greene's Tuctoria - Effects of the Proposed Actions

Greene's tuctoria occupies shallower and smaller vernal pools than other *Orcuttieae* grasses. Although no range-wide systematic surveys for this species have been conducted, twenty-one extant occurrences are known. All known extant occurrences are in the northern Sacramento Valley or eastern or southern Merced County. Of seven known extant occurrences of Greene's tuctoria in Merced County, four are believed extirpated. Vollmar Consulting (2002) found no occurrences of the species in eastern Merced County in 2001; however, 22 large vernal pools that could provide suitable habitat were identified. Application of Parameter 2f would ensure that, if an occurrence of Greene's tuctoria could not be avoided, occupied habitat would be protected and managed as compensation.

Greene's Tuctoria - Effects of Phase 1

There are no known occurrences of Greene's tuctoria on the Phase 1 Campus site. Therefore, the development of Phase 1 is not likely to adversely affect Greene's tuctoria.

Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp - Effects of the Proposed Actions

Although vernal pool fairy shrimp and vernal pool tadpole shrimp exhibit slightly differing habitat requirements and life cycles, they often inhabit the same vernal pool complexes and have been known to co-occur in individual vernal pools. These species are supported by similar habitat types including vernal pools, seasonally ponded areas within vernal swales, rock outcrop ephemeral pools, playas, alkali flats, and other depressions that hold water of similar volume, depth, area, and duration. Therefore, both species are subject to a common set of threats and considerations. Although some portions of the Study Area have not been surveyed, these species should be presumed to be present in all suitable habitat. Therefore, construction of the Proposed Actions in any portion of the Study

Area that supports suitable habitat is likely to adversely affect populations of vernal pool fairy shrimp and vernal pool tadpole shrimp.

Construction of the Proposed Actions, operation and management of the Campus and University Community, and management of preserved habitat could potentially result in direct and indirect adverse effects on vernal pool fairy shrimp and vernal pool tadpole shrimp. The extent and character of these effects would depend on the site and configuration selected for development. Potential mechanisms for these effects are discussed above (*General Effects of the Proposed Actions*); they may include habitat fragmentation; altered hydrology; nonpoint source pollution; pesticide drift; human disturbance; establishment of invasive nonnative plants; and possible effects of habitat enhancement, restoration, and creation activities. Adopted conservation measures to address potential effects of project design, construction, and operation measures would be implemented to avoid and minimize these effects to the greatest extent practicable.

The development of the UC Merced campus could potentially result in habitat fragmentation. The populations of vernal pool crustaceans in eastern Merced County are currently among the least fragmented in California. The results of fragmentation are inhibition of genetic exchange between populations and impediments to recolonization of habitats from which populations have been extirpated. Small, isolated populations are substantially more vulnerable to stochastic events (e.g., aberrant weather patterns, fluctuations in availability of food) and may exhibit reduced adaptability to environmental (natural or anthropogenic) changes.

Location of the Proposed Actions in the northern portion of the Study Area would result in loss of known occurrences. Siting the Proposed Actions at the extreme southern portion of the Study Area, if feasible, would reduce the likelihood of direct and indirect effects, because most of the land in that area has been converted to agricultural uses and no longer supports extensive potential habitat for vernal pool fairy shrimp and vernal pool tadpole shrimp.

The Parameters mandate that a comprehensive strategy for the conservation of these species be in place before project implementation. The Conservation Strategy will specify compensatory conservation, subject to Service and Corps approval, for effects on vernal pool crustaceans. The University will preserve an extensive tract (8,854 acres) of high-quality contiguous vernal pool/grassland habitat (VST, CST, CNR), as well as provide for restoration, enhancement, and creation of suitable habitat. Moreover, these lands will be monitored to detect and prevent establishment of detrimental invasive species. Additional completed and pending WCB easement acquisitions will add another 17,214 acres of grassland/vernal pool habitat.

This extensive compensatory conservation program, in conjunction with BMPs, judicious siting and design of the Proposed Actions, long-term monitoring and management, compliance with the Parameters, and restoration/creation of vernal pool habitat, is expected to achieve the goals of the Conservation Strategy.

Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp - Effects of Phase 1

The Phase 1 Campus site, comprising a portion of the existing Merced Hills Golf Course, does not support any known populations of vernal pool fairy shrimp or vernal pool tadpole shrimp, nor does it contain suitable habitat to support these species. Vernal pool fairy shrimp are well represented in vernal wetlands north and east of the Phase 1 campus site. Vernal pool tadpole shrimp have been documented in a cluster of occurrences concentrated in the Rascal Creek watershed southeast of the Phase 1 site, but vernal wetlands elsewhere in the vicinity are considered potentially suitable to support the species.

Indirect effects on crustacean populations adjacent to Phase 1 resulting from dust emissions, erosion, sedimentation, hazardous material spills, and introduction of invasive nonnative plant species during construction will be minimized through implementation of adopted construction and operation conservation measures.

Without implementation of water-management conservation measures, the Phase 1 Campus could result in hydrologic disruption and pollution of wetland habitats occupied by vernal pool fairy shrimp and vernal pool tadpole shrimp. In accordance with the Parameters and Conservation Measures, the Phase 1 Campus has been sited outside the watershed of any vernal pools. In most locations, the Phase 1 Campus boundary is generally placed to maintain a 250-foot buffer from vernal pools.

The Phase 1 campus grading will occur closer than 250 feet to vernal pools in three locations; at the southwest corner, at the southeast corner, and on the northern perimeter, west of the Construction Staging Area. At the southwest corner, grading will occur within 6 feet of, but downslope from a single vernal pool. The vernal pool is adjacent to and outside the boundary of Phase1 activities. At the southeast corner, the closest vernal pool in a complex of pools is approximately 20 feet from the Phase 1 boundary, and approximately 120 feet across an artificial shallow pond from grading activity. On the northern perimeter of the Phase 1 Campus boundary the closest vernal pool in a complex of pools is approximately 20 feet from the Phase 1 boundary. The grading boundary is at the Phase 1 boundary in this area; therefore, grading will occur within 20 feet of the closest vernal pool, and within 50 feet of three other pools in the complex. Eight vernal pools are within 250 feet of the Phase 1 boundary in this locale. The local topography is quite flat. All grading and construction will be outside the watershed of any vernal pools and will therefore not disrupt pool hydrology. A 30-foot-wide fire control buffer will be established along the inside of the Phase 1 Campus's southeastern perimeter. The fire control buffer will be primarily managed through discing, although portions of it will also be graded.

The stormwater capture and detention system for the Phase 1 Campus will contain and regulate runoff to avoid alteration of the hydrology of adjacent wetlands and discharge of unnatural levels of runoff from the campus. The Campus will implement standard BMPs to control water quality effects.

Without adequate controls in place, potential exists for pesticides and herbicides to drift from the Campus to adjacent vernal pools that are known to be occupied or could be occupied by these two species. However, conservation measures minimizing and restricting use of herbicides in Campus management will avoid such effects. As described in the Conservation Measures, no pesticides or herbicides will be used on the remaining areas of the golf course outside the Phase 1 boundary.

During construction, uncontrolled trespass of construction equipment and personnel into adjacent vernal wetland habitats could result in disturbance of the habitats and their watersheds as well as in take of individuals of listed species. Similarly, following construction, trespass of people and their pets into adjacent habitat areas could disturb habitat and cause direct take of individuals.

Adherence to Conservation Measures governing design, construction, and operation and management of the Phase 1 Campus will avoid or minimize such disturbances. These measures include but are not limited to installation of temporary construction fencing, installation of permanent fencing as part of Campus design, conducting environmental awareness training for construction personnel, incorporation of protection obligations and violation penalties into construction contracts, enforcement of human and pet use restrictions, signage at the Phase 1 Campus boundary, and education of campus residents. While the potential for human disturbance cannot be fully eliminated, it will be reduced to a level that is not expected to adversely affect local populations of these species.

Construction and operation of the Phase 1 Campus have potential to introduce or disseminate nonnative plants that may be detrimental to vernal wetland ecosystems occupied by listed species. Conservation measures to control invasive weeds during construction, discourage use of invasive species in Campus landscaping, and control human and pet disturbance will minimize the risk of effects on wetland-dependant species.

Construction of the Phase 1 campus would occur on 104 acres of the existing Merced Hills Golf Course. The golf course is considered a developed, landscaped area that does not contribute to the vernal pool ecosystem surrounding the golf course. No grading or construction activities will occur outside of the Phase 1 Campus or within any vernal pool or other wetland habitats. Consequently, construction of the Phase 1 Campus would not fragment existing vernal pool or wetland habitats. Implementation of the adopted Conservation Measures will further assure that indirect effects are avoided and minimized and do not result in further fragmentation of existing habitats.

The University will allow the remaining 94 acres of the golf course to be maintained in a semi-natural state. No pesticides will be applied except as necessary to control noxious weeds and any such application will be reviewed and approved by the Service. Additionally, the University has purchased a 96-acre vernal pool/grassland area. The University has committed to preserve this area as well.

Finally, the University will manage the CNR and remaining VST areas it has acquired as discussed in the conservation measures. This land will be protected under conservation easements in perpetuity to preserve existing vernal pool habitats; these easements will also restrict human activities and access to control human use and prevent human disturbance of these areas.

Conservancy Fairy Shrimp - Effects of the Proposed Actions

Because of the limited distribution of this species, every population is considered significant in terms of species survival and recovery. A single population has been documented in the Study Area; this population occupies a pool in the southern portion of the CNR, which was established to protect the occupied pool and its watershed from development effects. No direct effects on Conservancy fairy shrimp are anticipated. All lands within the watershed of the occupied pool are in the CNR, which will be under protective management.

Siting the Proposed Actions in the eastern portion of the Study Area could potentially result in indirect effects on Conservancy fairy shrimp located at the Study Area's eastern boundary. Any project configuration that would result in direct effects or substantial indirect effects would be in conflict with the Parameters and Conservation Measures and, accordingly, would be excluded from consideration. Siting of the Proposed Actions on agricultural lands in the southern portion of the Study Area, if feasible, would reduce the risk of any adverse effects.

Without careful management, the Proposed Actions could have indirect effects on Conservancy fairy shrimp habitat. If the Proposed Actions were constructed near watershed subbasins supporting Conservancy Fairy Shrimp, those populations could be subject to effects resulting from design, construction, and operation of the Proposed Actions. Potential mechanisms of these effects (e.g., alteration of hydrology, introduction of invasive nonnative species, human disturbance, pesticide drift) are discussed above in *General Effects of the Proposed Actions*. However, in keeping with Parameter 2e, such effects that are unavoidable would be off-set through compensation in accordance with Service approval and the requirements of the Conservation Measures.

The Conservation Measures and Parameters have been adopted to address potential adverse effects that could result from design and construction of the Proposed Actions, operation and management of the Campus and University Community, and management of the CNR. In adopting the Parameters, the University has also explicitly committed to avoiding direct effects, minimizing indirect effects, and compensating for any effects through habitat preservation approved by the Service and the Corps.

The Parameters and Conservation Measures mandate a highly protective management approach for the CNR. This approach will further reduce the potential for habitat disruption resulting from invasive species. Monitoring will be conducted to detect any incursions of nonnative species that pose a threat to Conservancy fairy shrimp habitat, and appropriate control measures will be implemented.

Conservancy Fairy Shrimp - Effects of Phase 1

Conservancy fairy shrimp occur only in one clay playa pool within the Study Area. The pool is located 1.25 miles east of the Phase 1 Campus site. The University has committed to protect the occupied pool and its entire watershed within the CNR. Other occurrences of Conservancy fairy shrimp have been documented 4-5 miles east of the Phase 1 Campus site.

Areas to be disturbed by construction activities are nearly a mile from the nearest portion of the watershed in the CNR that supports the occupied clay playa pool. Accordingly, no effects associated with construction-related disturbance, altered hydrology and nonpoint source pollution, or pesticides are anticipated to result from the Phase 1 project. Because the golf course is not suitable habitat, its conversion to the Phase 1 Campus would not result in fragmentation of suitable habitat for or existing populations of Conservancy fairy shrimp. Remaining potential effects are discussed below.

Without proper controls, the increased human population at the Phase 1 Campus could result in human disturbance in the watershed that supports Conservancy fairy shrimp. To protect the pool and watershed, the University has acquired the CNR and dedicated it for protective management. The Conservation Measures described above (e.g., fencing the campus perimeter, educating campus residents, enforcing trespass laws) will avoid and minimize potential for human disturbance of Conservancy fairy shrimp habitat and populations. The Conservation Measures also entail substantial measures to protect the CNR, including development of a specific management plan to protect sensitive resources, restrictions on human use, enforcement of pet restrictions, and other practices. The CNR management plan will be developed in cooperation with and subject to the approval of CDFG and the Service.

As previously discussed, the University has committed to implement conservation measures (e.g., use of certified weed-free erosion-control material during construction, use of noninvasive species in campus landscaping, control of human and pet disturbance) for the Phase 1 Campus project to reduce the potential for introduction of invasive plant species to adjacent lands. In view of the distance between the Phase 1 site and the watershed supporting Conservancy fairy shrimp, it does not appear likely that the Campus would result in introduction of nonnative invasive species that would affect the habitat of this species.

Valley Elderberry Longhorn Beetle - Effects of the Proposed Actions

Elderberry shrubs are expected to occur along larger streams (e.g., Bear Creek, Black Rascal Creek, Fahrens Creek), along smaller drainages (Owens Creek, and Duck Creek), and locally in uplands. Although there are no occurrence records for valley elderberry longhorn beetles in the Study Area, there are numerous elderberry shrubs in the Study Area. Of the ten elderberry shrubs inventoried along Bear Creek, at least two of the shrubs contained exit holes that may have been created by the beetle.

The potential effects of the Proposed Actions on the beetle depend on the extent to which the Preferred Alternative site overlaps with the occurrence of elderberry shrubs. The University would attempt to avoid elderberry shrubs within the footprint of the Preferred Alternative to the extent practicable; for example, project design could ensure that riparian areas remain in undeveloped portions of the Campus and University Community. There is some possibility, however, that removal of some elderberry shrubs could not be avoided. Elderberry shrubs could be directly impacted by removal, or indirectly impacted by the activities listed above in the *General Effects of the Proposed Actions*.

To minimize potential for take and to compensate for lost habitat value when elderberry shrubs must be removed, the Service has developed a standard conservation protocol that applies to all removal of any elderberry shrub with stems more than 1 inch in diameter that is within the species' range (see Section IV, *Conservation Measures, Supplemental BA*). All elderberry shrubs that may be affected by the Proposed Actions would be considered potential valley elderberry longhorn beetle habitat and would consequently be subject to this compensation program. No elderberry shrubs occur on or near the Phase 1 Campus site. Consequently, the Phase 1 project will not adversely affect this species. Additionally, because the Phase 1 project is not expected to adversely affect this species, it will not contribute to any significant cumulative effects in the region.

Valley Elderberry Longhorn Beetle - Effects of Phase 1

No known occurrences of the valley elderberry longhorn beetle are found in the Phase 1 area. Therefore, no direct or indirect effects from the Proposed Actions are anticipated from the construction of Phase 1.

Bald Eagle - Effects of the Proposed Actions

Development of the UC Merced Campus could result in a direct loss of grassland habitat, vernal pools and swales, stock ponds, and other wetland habitats that may receive some winter foraging use by the bald eagle. The level of use of this habitat, as is typically the case for the bald eagle in California, is low. Bald eagles do not breed in the Study Area and no suitable breeding habitat is present. The only documented breeding site in eastern Merced County is on the Chowchilla River approximately 8 miles from the Study Area boundary. It is likely, however, that wintering bald eagles use Lake Yosemite as foraging habitat; day roosts have been observed. Although Lake Yosemite supports low-quality night-roosting habitat for bald eagles, it may be used on occasion. Observations of bald eagles flying above vernal pool/grassland habitat suggest that they may occasionally use these habitats in and adjacent to the Study Area for foraging.

The only direct impact on bald eagles that is likely to result from construction of the Proposed Actions is the potential loss of foraging habitat. However, bald eagles use grassland/vernal pool habitat to only a limited extent; moreover, the Conservation Measures entail preservation of more than 8,000 acres of high-quality contiguous habitat in and adjacent to the Study Area, as well as offsite acquisition of easements on more than 17,000 acres to preserve additional habitat in perpetuity.

Indirect effects could result from an increase of human recreational activity, particularly in the vicinity of Lake Yosemite. Increased human population in the project vicinity resulting from Campus development is likely to result in an increase in recreational use of Lake Yosemite, which could in turn result in disturbance of bald eagle roosting sites at the lake. Bald eagles have been known to respond adversely to human disturbance; however, the Conservation Measures make provision for restricting human access to sensitive areas. Recreation and other human activities would be restricted to protect and preserve vernal pool species within the University's conserved lands, as outlined in the Conservation Measures, minimizing the adverse effects of human activity on bald eagle foraging. Furthermore, bald eagles are more likely to respond negatively to activities that occur infrequently; they have been observed to become habituated to regularized human presence.

Development of the Infrastructure Project may result in indirect effects to the bald eagle because suitable foraging habitat in the vicinity of any new roadway corridors would be affected by increased human activity, fragmentation, and other edge effects. It is known that the magnitude of these effects generally diminishes with distance from the edge of disturbance.

Bald Eagle - Effects of Phase 1

Because of the Phase 1 site's proximity to Lake Yosemite, bald eagles could occur infrequently within the site. Any such occurrence would be considered opportunistic, and individuals are not dependent on the Phase 1 site for any life requisite. Consequently, development of the golf course site is not considered to have an adverse effect on bald eagles.

Increased human use of terrestrial habitats as a result of the Phase 1 project would be limited and is not expected to influence the existing limited use of these areas by bald eagles. While some increased human use of Lake Yosemite will occur, there is no indication from occurrence records or the size and vegetative characteristics of the site that this water body serves as an important wintering area.

San Joaquin Kit Fox - Effects of the Proposed Actions

Direct Effects

Direct effects on San Joaquin kit fox could potentially occur as a result of construction of the UC Merced Campus. If kit foxes were to occur at or near the selected construction site, construction activities could disturb or destroy active or potential dens, resulting in take. There are few records of kit foxes in the Study Area, and therefore such an impact is not considered likely to occur unless disturbances were to take place near known use areas. Construction of the proposed project could result in loss of potential breeding and/or foraging habitat. The most deleterious effect of the proposed action to kit foxes is the blockage of the remnant valley floor portion of the corridor along the eastern edge of the San Joaquin Valley. A kit fox corridor on the valley floor along the east side of the San Joaquin Valley is identified in the *Upland Species Recovery Plan*. This effect makes preservation of the more hilly portion of the corridor east of Lake Yosemite crucial to the survival of kit fox. Direct effects to kit fox are consequently addressed in the Conservation Measures.

San Joaquin Kit Fox Corridor: The Service reviewed the easements in relation to San Joaquin kit fox needs as detailed in the *Recovery Plan for Upland Species of the San Joaquin Valley* (Service 1998). The Service identified a need for a corridor along the east side of the San Joaquin Valley for the kit fox in the *Upland Species Recovery Plan*, and the easements being purchased by the University and the WCB to assist in the protection of the corridor.

The Parameters require that the applicant develop and implement a Conservation Strategy that is consistent with the *Upland Species Recovery Plan*, as well as any future federal recovery planning efforts. The *Upland Species Recovery Plan* specifies the need to protect 90 percent of existing natural lands, as of 1998, along the northeastern Valley edge in San Joaquin, Stanislaus, Merced, and Madera Counties. The *Upland Species Recovery Plan* also identifies the objective of maintaining a suitable corridor along Sandy Mush Road for movement of kit foxes from valley floor habitats to eastern Merced County. Parameter 2b, in accordance with the *Upland Species Recovery Plan*, also directs the University to protect the corridor north and east of the Applicants' Proposed Projects and to ensure that such acquisitions are "consistent with the establishment of a connection to the Sandy Mush Road area."

Kit foxes prefer more gentle terrain and decrease in abundance as terrain ruggedness increases (Grinnell *et al* 1937, Morrell 1972, Warrick and Cypher 1998). Kit foxes were found to inhabit an area with fewer than 6 degrees of slope for most movements. Only

1.2 percent of all recorded movements were in areas with a slope greater than 6 degrees (Koopman 1993). The University's commitment to protecting CNR, VST, and CST lands would protect a movement corridor for San Joaquin kit foxes that is a minimum of 1 mile wide (assuming that kit foxes would travel on slopes up to 10 percent) (see Figure 22 in the Project BA). Kit foxes may travel through or reside in areas with small sections of open grassland habitat at 10 to 30 percent slopes; the CNR/VST/CST corridor is more than 3 miles wide under these slope criteria.

The existing canals in the area are barriers to kit fox movement in the east side corridor. The canals include Le Grand Canal and the Fairfield Canal to the east of Lake Yosemite and the Main Canal to the west. Close to the applicant's proposed project, the canals have approximately 3-foot berms on either side, have steep slopes into the canal, a fast current, and have few crossing structures at the present time. Le Grand Canal and the Fairfield Canal restrict access to the hills to the east of the Applicants' Proposed Projects, and funnel foxes moving north from Le Grand and Planada into the Applicants' Proposed Projects site between the two canals as they come together at Lake Yosemite. Le Grand Canal on the south and the Main Canal, which extends to the northwest of Lake Yosemite, both prevent foxes from moving off the valley floor into the hills. The canals dissect the eastside kit fox corridor into several corridors. The eastern portion of the corridor pushes foxes into steep hills where they are more vulnerable to predators and are less successful at finding food themselves. The middle portion of the corridor funnels foxes to a dead end at Lake Yosemite. The western finger of the corridor keeps the foxes in agricultural lands for a long stretch. As part of the Phase 1 Campus project, the University is proposing an additional crossing, subject to approval from Merced Irrigation District, to improve kit fox accessibility to the grasslands in the hills to the east on the 96-acre site which will be permanently protected. In addition, Parameter 2b and other conservation measures discuss the need to look at additional kit fox crossings over these canals.

Construction of the Proposed Actions in the eastern portion of the Study Area would entail removal of the area of vernal pool/grassland habitat in which the only two occurrences of San Joaquin kit fox in the Study Area were reported. The Parameters and Conservation Measures prohibit the selection of an alternative that would create significant disruption to kit fox movements in the Study Area. Siting the Proposed Actions on agricultural lands in the southern portion of the Study Area, if feasible, would reduce the potential for effects on the San Joaquin kit fox.

Indirect Effects

Indirect effects could result from construction and operation of the Proposed Actions. Negative effects can be expected, not just in the footprint of the project, but also from the numbers of people who will be living on campus and in the supporting community. Up to 25,000 students, and 30,000 support staff and their families will be living in or around the Study Area when the campus and community are completed. Effects on neighboring lands will likely include:

- disturbance of nearby habitat lands from recreational activities by additional people;
- attraction of coyotes and red foxes, kit fox predators, to the urban fringes;
- additional domesticated dogs from the Campus Community will kill kit foxes;
- increased use of rodenticides around buildings, and to control squirrels, both of which poison kit foxes; and
- increased vehicular traffic on area roadways will kill more kit foxes.

These effects will be significant in at least a 2-mile radius from the campus.

Recreation effects from additional people will be significant on the grassland kit fox habitat within at least a 2-mile radius of the campus for foot traffic, and within a wider radius for mountain bikers, motorcyclists, and automobile drivers. People will be attracted to the grassland areas, and their presence there will create noise, trash, light pollution at night, and will generally disturb kit foxes by their presence. Degradation of nearby lands will lead to den loss, prey reduction, invasions by nonnative species, and environmental contamination.

It is known that coyotes and red fox can generally tolerate more human disturbance, and can fare well on urban fringes in comparison to the kit fox. Red foxes are not adapted to arid conditions, the conditions that occur on native lands in the San Joaquin Valley. Human modifications make arid conditions more hospitable to red foxes and facilitate the invasion of these habitats by red foxes.

Dogs allowed to roam will chase and kill kit foxes, and are known to be a significant source of mortality to kit foxes in the Bakersfield area. If one third of the households in the Campus Community own one dog each, approximately 3,000 dogs will be added to east Merced. Domesticated dogs will form packs, and are known to kill kit fox on the edges of other population centers in the Valley. It is unlikely that the kit foxes will learn to live with this amount of disturbance, as some of them have in Bakersfield. The Bakersfield development occurred more slowly in a larger population of foxes, and the acclimation phenomenon that occurred there has not occurred in other Valley communities.

The use of rodenticides and pesticides also poses threats to kit foxes either directly, secondarily, or indirectly by reducing prey. Rodenticides used for rural uses are controlled by application guidelines administered on County Bulletins. However, rodenticides used by homeowners are different compounds and are not controlled by County Bulletins. Compounds used by homeowners include anticoagulants that are no longer allowed by County Bulletins for agricultural use. Anticoagulants probably contributed to the deaths of five foxes picked up and sampled by one researcher in

Bakersfield in 2000. In the earlier part of the century seven kit foxes were found dead within a distance of one mile, killed from ingesting strychnine-poisoned baits put out for coyotes (Grinnell et al 1937). In 1992, two kit foxes at Camp Roberts died as a result of secondary poisoning from rodenticides (Berry *et al.* 1992, Standley *et al.* 1992). The elimination of ground squirrels in an area will reduce the prey base available to resident or dispersing kit foxes. In 1975 in Contra Costa County, where the main prey item of kit foxes is the California ground squirrel, the ground squirrel was thought to have been eliminated county-wide after extensive rodent eradication programs (Bell *et al.* 1994). Reproductive success of kit foxes is correlated with abundance of their prey (Egoscue 1975).

The increased vehicular traffic on agricultural, urban, and rural roads by the additional people in the area will cause wildlife mortalities on the roads. Roads have detrimental effects on kit foxes because they have relatively large space requirements and are highly mobile, increasing the probability of encountering roads. They usually are most active just after sunset and in the evening hours after sunset, and it is likely that the student and worker populations will be using the roads during that time of day.

The projected increase in vehicular traffic associated with campus and community activity could result in mortality of kit foxes. Additionally, kit foxes could be harassed or killed by feral or unrestrained dogs. To address this concern, the Conservation Measures provide for construction of exclusion fencing between developed areas and protected habitat, enforcement of leash laws in developed areas, and monitoring and control programs for feral and domestic animals. The University has also committed to creation of artificial dens to provide kit foxes with protection from predators if the campus is located at the University's proposed campus site as presented in the Biological Assessment; the ultimate location of the campus will determine if this measure would be beneficial.

In keeping with the Conservation Measures for the San Joaquin kit fox presented in the Description of the Proposed Action, all construction activities in kit fox habitat would be conducted in accordance with the Service's *Standardized Recommendations for Protection of the San Joaquin Kit Fox prior to or during Ground Disturbance*. The University and County have committed to the Parameters and the Conservation Measures to avoid, minimize, and compensate for effects on the San Joaquin kit fox. These measures include siting the proposed project to maintain a movement corridor; providing a substantial amount of compensatory habitat that will be managed to protect and enhance habitat values; avoiding direct take of kit foxes during construction; and minimizing the potential for disturbance of kit foxes during campus operations. With adherence to these measures, construction and operation of the Proposed Actions are not expected to appreciably affect the distribution, number, or reproduction of the San Joaquin kit fox in the Study Area or surrounding lands, and thus will not jeopardize the species.

Although some habitat fragmentation is likely to result from cumulative development and growth in the Study Area, the Proposed Actions and the Conservation Measures will preserve extensive contiguous high-quality habitat to compensate for the potential fragmentation of habitat resulting from project implementation. Moreover, the Parameters and the Conservation Measures specify habitat restoration and enhancement, as appropriate, for impacts on vernal pools; such restoration and enhancement will offset some of the effects of habitat loss and fragmentation. Parameter 3 specifies that Merced County will provide assurances that it will require discretionary projects under county jurisdiction within the Study Area to comply with The Act. Accordingly, Merced County must comply with the Parameters before future development within the Study Area may proceed.

San Joaquin Kit Fox - Effects of Phase 1

Construction of Phase 1 of the proposed campus on a portion of the golf course may affect the San Joaquin kit fox; however, that effect needs to be evaluated within the context of the minimal habitat value the golf course has for the kit fox. That small adverse effect will also be offset by following the conservation measures already completed or planned. A large amount of land has been protected through direct acquisition or acquisition of easements in the identified kit fox corridor to support development of the Applicants' Proposed Projects. This land will be managed for endangered species habitat as a temporal gain to support development of Phase 1 of the campus. In addition, the remaining portion of the golf course will be allowed to revert to a semi-natural state which will have more habitat value to kit foxes, and the 96 acres of vernal pool/grassland habitat that was purchased to mitigate for the conversion of the golf course from habitat several years ago additionally provides habitat for kit foxes. Also, the Applicants are pursuing construction of an additional crossing across the canal in a strategic location for kit foxes adjacent to habitat. Therefore, the effects of Phase 1 on the kit fox are determined to be insignificant, and are therefore not likely to adversely effect the kit fox.

Mountain Plover - Effects of the Proposed Actions

Mountain plover are present on California grasslands and on disturbed ground areas from mid-October to mid-March of each year. Within the Study Area, development of the Proposed Actions in any configuration would result in some loss of potential foraging habitat for mountain plover during migration, although much of the grassland habitat in the Study Area is too densely vegetated to provide optimal foraging habitat. However, as specified in the Conservation Measures, any such direct effects would be offset by the preservation of extensive, contiguous, high-quality habitat that likely contains some suitable (i.e., sparsely vegetated) habitat for mountain plover foraging.

Indirect effects could include disruption of foraging behavior by human encroachment and risk of predation by domestic dogs and cats. Use of pesticides or insecticides near potential foraging areas could impact mountain plovers. Mountain plovers exhibit low sensitivity to human presence. Additionally, the Conservation Measures include provisions to limit human encroachment into sensitive resource areas. The measures also specify measures to limit, monitor, and manage incursions of domestic or feral dogs and cats into preserved habitats. Construction of the Applicant's Proposed Projects in any configuration is unlikely to jeopardize the survival of populations of mountain plover.

Mountain Plover - Effects of Phase 1

Construction of Phase 1 of the Applicant's Proposed Projects on a portion of the existing golf course will have no effect on the mountain plover because the golf course does not contain any habitat for this bird.

Cumulative Effects

Cumulative effects of the Applicants' Proposed Projects are addressed in Chapter X of the original BA. Future state, local, or private actions that are reasonably certain to occur within the Study Area may result in direct and indirect effects on wetland-dependent and upland species; such effects would be comparable to those described above and in Chapter 10 of the original BA. Cumulative construction-related impacts could include direct loss of habitat, dust emissions, erosion, sedimentation, hazardous material spills, introduction of invasive nonnative plant species, and injury or direct mortality of wildlife. Long-term cumulative effects could include hydrologic changes and water quality effects, impacts resulting from pesticide use, and adverse effects related to human disturbance and invasive species in sensitive habitat areas. Without proper controls, management, and enforcement, increased human activity in habitat surrounding development in the Study Area could disturb habitats and populations of listed species. Cumulative effects resulting from habitat fragmentation would also occur when lands, habitats, or species in the Study Area become isolated as a result of urban development that creates a barrier between previously contiguous habitats or populations.

Although some fragmentation is likely to result from cumulative development and growth in the Study Area, the Proposed Actions and the Conservation Measures will preserve extensive contiguous high-quality habitat to compensate for the potential fragmentation of habitat resulting from project implementation. Moreover, the Parameters and Conservation Measures specify habitat restoration and enhancement, as appropriate, for impacts on vernal pools; such restoration and enhancement will offset some of the effects of habitat loss and fragmentation. Parameter 3 specifies that the County will provide assurances that it will require discretionary projects under County jurisdiction within the Study Area to comply with the Act. Accordingly, the County must comply with the Parameters before future development of projects not addressed in this Biological Opinion may proceed within the Study Area. With implementation of the Conservation Measures and Parameters, the cumulative effects of the Proposed Actions will be similar to or less than the effects of the Applicants' Proposed Projects for the reasons described above (*General Effects of the Proposed Actions*).

Fleshy owl's-clover, Colusa grass, San Joaquin Orcutt grass, hairy Orcutt grass, Hoover's spurge, Greene's tuctoria, vernal pool tadpole shrimp, vernal pool fairy shrimp, and Conservancy fairy shrimp are all wetland-dependent species. Many of the activities affecting these species within the Study Area will therefore be reviewed under section 7 of the Act as a result of the federal nexus provided by section 404 of the Clean Water Act. However, an undetermined number of future projects that alter the habitat of these vernal pool species (aquatic and surrounding upland habitats) could go forward without the need for a section 404 permit. Specifically, recent changes related to the definition of waters of the United States and the corresponding treatment of isolated waters may result in the implementation of projects with effects to federally-listed vernal pool species that would have previously been addressed in section 7 consultations related to Section 404 of the Clean Water Act. In the absence of a federal nexus, projects would still require federal take permits if they result in take of any listed vernal pool crustaceans.

Activities that would potentially affect listed vernal pool species in the Study Area include, but are not limited to: development associated with urban, water, flood control, highway/roadway and utility projects; application of herbicides/insecticides (i.e., chemical contaminants); conversion of vernal pools and/or vernal pool grasslands to agricultural uses; and application of seasonal water to create irrigated pastures. In addition, conversion of rangeland to active agricultural uses in Merced County does not require a special use permit, grading permit, or any other type of discretionary decision by the County, nor does it require a conditional use permit from the County prior to implementation of the action. Therefore, this type of conversion may go unnoticed by the local and federal agencies and an unknown amount of vernal pool and vernal pool grassland habitat may be affected by deep-ripping for the planting of vines and orchards.

It is expected that agricultural conversion within the Study Area would be limited to the periphery of the existing Redding-Pentz-Corning soil association (soils that support the formation of vernal pools). Because the hardpan associated with these soils has been shown to reestablish within a few years of disturbance, the soils are very restrictive in terms of the cost and effort needed for preparation and maintenance (e.g., cobble removal), and most conversion appears to be associated with inclusions of less constrained soils. The lack of available water for irrigation within rangelands underlined by Redding-Pentz-Corning soils also constrains the development of active agricultural uses on these lands. Vernal pool habitat in the Study Area is currently used primarily for livestock grazing, which could adversely affect listed vernal pool species if the timing, amount, and intensity of grazing degrades habitat values or removes listed plants.

All federally listed species in this biological opinion may be adversely affected by future State, local, or private actions such as urbanization, water development, flood control, and highway/roadway and utility projects that result in the loss of habitat. Due to the widespread presence of wetlands in the Study Area, most projects in this area would require a federal 404 permit and would not be considered cumulative under section 7 of the Act. The bald eagle may also be adversely affected by the human intrusion and disturbance associated with increased recreational uses at Lake Yosemite and surrounding grasslands within the Study Area. This latter disturbance may result in the abandonment of foraging habitat or roost sites that are otherwise suitable for the species. However, given that the bald eagle is widespread and recovery goals have been met, effects within the Study Area are not likely to appreciably reduce the numbers or distribution of this species.

Available data indicates that San Joaquin kit foxes occasionally and irregularly occur in southeastern Merced County. This species may be adversely affected by future State, local, and private actions in the Study Area. In addition, the recovery plan for this species identifies a recovery strategy and actions that are intended to protect existing San Joaquin kit fox habitat (including existing connections between habitats) in the northeastern segment of the species' geographic range. Future activities in the Study Area that would either remove suitable habitat or create barriers to the movement of kit foxes from established populations on the valley floor could adversely affect the species.

Grasslands with low, sparse cover and disced agricultural fields provide foraging habitat for mountain plover that occasionally and irregularly occur in the Study Area during migration and winter. Therefore, the species may be adversely affected by future State, local, and private actions in the Study Area.

Conclusion

The Service has reviewed the current status of fleshy owl's-clover, Colusa grass, San Joaquin Valley Orcutt grass, hairy Orcutt grass, Hoover's spurge, Greene's tuctoria, Hartweg's golden sunburst, vernal pool fairy shrimp, Conservancy fairy shrimp, vernal pool tadpole shrimp, valley elderberry longhorn beetle, bald eagle, and San Joaquin kit fox, the Description of the Proposed Action with Parameters, the environmental baseline for the action area, the effects of the proposed UC Merced Campus and associated infrastructure and the cumulative effects. It is the Service's biological opinion that the UC Merced Campus and associated infrastructure, based upon implementation of and compliance with all of the conservation measures and parameters, as identified in the Description of the Proposed Action, is not likely to jeopardize the continued existence of listed species. No critical habitat is now designated within the Study Area, therefore, none will be affected. As critical habitat areas are designated, the Service will examine the effects of the Proposed Actions on critical habitat and determine an appropriate response at that time.

INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened fish and wildlife species without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

Sections 7(b)(4) and 7(o)(2) of the Act, which refer to terms and conditions and exemptions on taking listed fish and wildlife species, do not apply to listed plant species. However, section 9(a)(2) of the Act prohibits removal, reduction to possession, and malicious damage or destruction of listed plant species on Federal lands and the removal, cutting, digging up, or damaging or destroying such species in knowing violation of any State law or regulation, including State criminal trespass law. Actions funded, authorized or implemented by a Federal agency that could incidentally result in the damage or destruction of such species on Federal lands are not a violation of the Act, provided the Service determines in a biological opinion that the actions are not likely to jeopardize the continued existence of the species.

A Preferred Alternative for the Proposed Actions will be chosen in the future as a result of the NEPA and LEDPA processes. Until such time as the Service has completed its review of the Preferred Alternative and confirmed compliance with the Parameters and conservation measures no incidental take is authorized by this biological opinion. Based on the best scientific data available at the time, the Service will determine if the Preferred Alternative is in compliance with the Parameters. Further consultation will be required for the Service to issue incidental take authority for any of the species covered by this biological opinion.

Reporting Requirements

The following reporting requirements will assist the Service in tracking the success or failure of the Conservation Measures proposed by the Applicants in the Description of the Proposed Action for Phase 1 of UC Merced. The activity, type of reporting requirement, reporting format, and timing of reporting are listed in Table 10 (attached).

The Applicants must provide the Service with annual reports to describe the progress of implementation of all the commitments in the Conservation Measures of this biological opinion. The first report is due January 31, the first year after groundbreaking, and annually thereafter, until performance criteria are met.

The Sacramento Fish and Wildlife Office is to be notified within three working days of the finding of any dead listed wildlife species or any unanticipated harm to the species addressed in this biological opinion. The Service contact person for this is the Chief, Endangered Species Division at (916) 414-6620.

The Corps must require the Applicants to report to the Service immediately any information about take or suspected take of listed wildlife species not authorized in this opinion. The Corps must notify the Service within 24 hours of receiving such information. Notification must include the date, time, and location of the incident or of the finding of a dead or injured animal. The Service contact is the Service's Law Enforcement Division at (916) 414-6660.

Any contractor or employee who during routine operations and maintenance activities inadvertently kills or injures a listed wildlife species must immediately report the incident to their representative. This representative must contact the California Department of Fish and Game immediately in the case of a dead or injured animal. The California Department of Fish and Game contact for immediate assistance is State Dispatch at (916) 445-0045.

The U.S. Fish and Wildlife Service Regional Office in Portland, Oregon, must be notified immediately if any dead or sick listed wildlife species is found in or adjacent to pesticide-treated areas. Cause of death or illness, if known, also should be conveyed to this office. The appropriate contact is Richard Hill at (503) 231-6241.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information and data bases.

1) The University and County should assist the Service in implementing recovery actions identified in the *Valley Elderberry Longhorn Beetle Recovery Plan*, *Recovery Plan for Upland Species of the San Joaquin Valley*, California, the *Pacific Bald Eagle Recovery Plan*, and the *Recovery Plan for Vernal Pool Species* (in preparation).

2) Conduct scientific studies on the California tiger salamander and midvalley fairy shrimp to support conservation activities.

3) Evaluate species of concern, particularly the midvalley fairy shrimp and the California tiger salamander, and their associated habitats to assess possible adverse effects of the UC Merced campus and community and implement Conservation Measures that could protect these species.

4) Implement actions to conserve the California tiger salamander and midvalley fairy shrimp in eastern Merced County.

5) Provide outreach to the public and to schools on protecting listed species, establishing safe harbors, forming partnerships that foster conservation, and habitat conservation planning.

6) The University of California should review current management on lands it holds conservation easements for, to determine compatibility with wildlife use, and adjust if appropriate and feasible.

7) The University should coordinate with the Service, CDFG, the County, and private landowners to continue to participate in the development of an NCCP/HCP consistent with the Planning Agreement.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION--CLOSING STATEMENT

This concludes formal consultation on the action(s) outlined in the Description of the Proposed Action. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

Please contact Karen Harvey or Susan Jones of this office at (916) 414-6600, if you have any questions.

Figure 1 - Study Area Map
Figure 2 - Phase 1 Campus Design
Figure 3 - Kit Fox Canal Crossings, Existing and Proposed
Figure 4 - Conservation/Mitigation Areas

Table 1 - Land and Easement Acquisitions, attached
Table 2 - Summary Table of Species Occurrence, attached
Table 3 - in text
Table 4 - in text
Table 5 - in text
Table 6 - in text
Table 7 - in text
Table 8 - Losses and Estimate of Extant Vernal Pool Grasslands in Five Counties in the San Joaquin Valley, California, attached
Table 9 - Unpermitted Conversions of Wetlands/Endangered Species Habitat in Five Counties in the San Joaquin Valley, California, attached
Table 10 - Reporting Requirements, attached

Enclosure
Abbreviation List

cc:
University of California, Merced (Attn: Ric Notini)

Sincerely,

Cay C. Goude

Cay C. Goude
Acting Field Supervisor

UC Development Office, Merced County (Attn: Bob Smith)
California Department of Fish and Game (Attn: Pat Brantley)

<u>Enclosure</u>

Abbreviation List

BA - Biological Assessment
BMP - Best Management Practices
CAA - Comprehensive Alternatives Analysis
CNDDB - California Natural Diversity Database
CEQA - California Environmental Quality Act
CLR - Campus Land Reserve
CNR- Campus Natural Reserve
CST - Cyril Smith Trust
CWA - Clean Water Act
DA - Department of the Army
DEIR - Draft Environmental Impact Report
EIR - Environmental Impact Report
EIS - Environmental Impact Statement
HCP - Habitat Conservation Plan
HMP - Habitat Mitigation Plan
IPM - Integrated Pest Management
LEDPA - Least Environmentally Damaging Practicable Alternative
LRDP - Long Range Development Plan
NCCP - Natural Communities Conservation Plan
NEPA - National Environmental Policy Act
OCAP - Operations Criteria and Plan; refers to the Service's March 6, 1995, 1-1-94-F-70, biological opinion on the Effects of Long-term Operations of the Central Valley and State Water Projects on the Threatened Delta Smelt and the Proposed Threatened Sacramento Splittail.
RMP - Resource Mitigation Plan
UC - University of California
UCP - University Community Plan
VST - Virginia Smith Trust
WCB - Wildlife Conservation Board