Slender Orcutt Grass
(*Orcuttia tenuis*)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
Sacramento, California

November 2009

5-YEAR REVIEW

Species reviewed: Slender Orcutt grass (*Orcuttia tenuis*)

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I. GENERAL INFORMATION

I.A. Methodology used to complete the review:

This review was prepared by Sacramento Fish and Wildlife Office, U.S. Fish and Wildlife Service (Service) staff using information from the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (Recovery Plan) (Service 2005a), species survey and monitoring reports, peer-reviewed journal articles, documents generated as part of section 7 and section 10 consultations, and species experts including botanists, biologists, and land-managers from the Bureau of Land Management (BLM), U.S. Forest Service (USFS), California Department of Fish and Game (CDFG), and the Service. The Recovery Plan and personal communications with species experts and land-managers were our primary sources of information used to update the "species status" and "threats" sections of this review.

I.B. Contacts

Lead Regional or Headquarters Office –Diane Elam, Deputy Division Chief for Listing, Recovery, and Habitat Conservation Planning; 916-414-6464.

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I.C. Background

I.C.1. FR Notice citations announcing initiation of this review: 71 FR 14538, March 22, 2006, and 71 FR 16584, April 3, 2006. We received no information from the public regarding this species in response to the notice.

I.C.2. Listing history

Original Listing
FR notice: 62 FR 14338
Date listed: April 25, 1997
Entity listed: *Orcuttia tenuis*, a listed plant species
Classification: Threatened

I.C.3. Associated rulemakings:

Critical habitat for slender Orcutt grass was originally designated in a final rule published in 68 FR 46683 on August 6, 2003. Economic exclusions from the 2003 final rule were evaluated in 70 FR 46923; published on August 11, 2005. Administrative revisions with species-by-unit

designations were published in 71 FR 7117 on February 10, 2006. Clarifications on the economic and non-economic exclusions for the final designation of critical habitat were published on May 31, 2007 (72 FR 30269). Six critical habitat units (with 19 subunits) totaling 94,213 acres were designated as critical habitat for the species.

I.C.4. Review History

We have not conducted any status reviews for this species since listing. Updated information on its status and threats was included in the 2005 Recovery Plan.

I.C.5. Species' Recovery Priority Number at start of review:

The recovery priority number for slender Orcutt grass is 8 according to the Service's 2006 Recovery Data Call for the SFWO, based on a 1 to 18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 FR 43098, September 21, 1983). This number indicates that the taxon is a species that faces a moderate degree of threat and has a high potential for recovery.

I.C.6. Recovery Plan or Outline

Name of plan: *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon*
Date issued: December 15, 2005

II. REVIEW ANALYSIS

Species Overview

Slender Orcutt grass, *Orcuttia tenuis*, is a member of the small Orcuttieae tribe (three genera and nine species) of annual, semi-aquatic grasses that are unique among grasses in exhibiting single-cell C_4 photosynthesis, which occurs in only 0.003 percent of known species of C_4 flowering plants (Boykin *et al.* 2004 in review). Plants with C_4 photosynthesis utilize a more complex biochemical process than most plants (with C_3 photosynthesis) in converting CO_2 to energy, which increases photosynthetic efficiency at low CO_2 concentrations (Boykin *et al.* 2008). The species is endemic to California vernal pools. As summarized in the Recovery Plan (Service 2005a), disjunct occurrences of the species occur in vernal pools on remnant alluvial fans, high stream terraces, and recent basalt flows from the Modoc Plateau in northeastern California, west to Lake County, and south through the Central Valley to Sacramento County. The species has also been reported from other natural and artificial seasonal wetlands, such as creek terraces, stock ponds, and borrow pits. However, occurrence records suggest that most such locations are altered vernal pool habitats (California Natural Diversity Database [CNDDB] 2008). Slender Orcutt grass occurs across a wide range of elevations (90 – 5,761 feet), but is associated primarily with vernal pool habitat on Northern Volcanic Ashflow and Northern Volcanic Mudflow substrates. The species is typically associated with larger or deeper vernal pools (typically deeper than 11.8 inches) that have relatively long periods of inundation. The main habitat requirement for this species appears to be inundation of sufficient duration and quantity to eliminate most competition and to meet the plant's physiological requirements for prolonged inundation, followed by gradual desiccation (Griggs and Jain 1983; Corbin and Schoolcraft

1990). Although the plant is often restricted to the deepest portion of the pools, it is not found in areas of pools that have a long hydroperiod. Pools that normally retain moisture until the end of summer allow out-competition of slender Orcutt grass by marsh vegetation (e.g., bulrushes and tule rushes [*Scirpus* spp.], and cattails [*Typha* spp.]) (Griggs and Jain 1983).

II.A. Application of the 1996 Distinct Population Segment (DPS) policy

II.A.1. Is the species under review listed as a DPS?

____ *Yes*
_X_ *No*

The Endangered Species Act of 1973, as amended (Act), defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listings as distinct population segments only to vertebrate species of fish and wildlife. Because the species under review is a plant and the DPS policy is not applicable, the application of the DPS policy to the species listing is not addressed further in this review.

II.B. Recovery Criteria

II.B.1. Does the species have a final, approved recovery plan containing objective, measurable criteria?

_X_ *Yes*
____ *No*

II.B.2. Adequacy of recovery criteria.

II.B.2.a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?

_X_ *Yes*
____ *No*

II.B.2.b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? Listing factors are (A) present or threatened destruction, modification or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence.

____ *Yes*
_X_ *No*

Listing factors B and C are not relevant to this species. There is new information to consider regarding existing or new threats.

II.B.3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

The Recovery Plan describes the geographic distribution of vernal pool taxa according to the vernal pool regions defined by the California Department of Fish and Game (CDFG) (Keeler-Wolf *et al.* 1998). Vernal pool regions are discrete geographic regions identified largely on the basis of endemic species, with soils and geomorphology as secondary elements. Within the vernal pool regions, the Recovery Plan identifies core areas that support high concentrations of federally listed vernal pool species, are representative of a given species' range, and are generally where recovery actions are focused. Core areas are distinct areas that provide the features, populations, and distinct geographic and/or genetic diversity necessary to the recovery of a species. More than one federally listed vernal pool species may be found within a single core area, and the core areas encompass areas larger that just the location of any single species. Within each core area, the Recovery Plan identifies specific percentages of suitable habitat that should be protected to achieve recovery for listed species. Core areas are ranked as Zone 1, 2, or 3 in order of their overall priority for recovery, with Zone 1 reflecting the highest priority areas. Protection of the majority of suitable habitat within Zone 1 core areas, and Zone 2 and 3 core areas where appropriate, is recommended to provide corridors and dispersal habitat, support metapopulation dynamics, provide for reintroduction or introduction sites, and to protect currently undiscovered occurrences. Many of the species covered by the Recovery Plan can be recovered primarily through the protection of Zone 1 core areas.

In this review, most slender Orcutt grass locations are those reported in the California Natural Diversity Database (CNDDB). For the purposes of this 5-year review, "occurrence" refers to a report contained in the CNDDB. The CNDDB defines occurrence as any documented collection, observation, or museum specimen of a species that is submitted to CDFG by the public. Each collection or observance may be recorded and mapped separately, but if there are multiple observations or collections within 1/4 mile of each other they may be combined into a single occurrence record. Individual occurrences represent locations where a species has been documented to occur; they do not represent distinct population units as they are observation records of individuals, not population-level records (D. McGriff, CDFG, *in litt.* 2007). The species has recently been found in additional locations within California. Places where the species is found but that were unreported to CNDDB at the time of writing this status review are noted as "localities" in order to differentiate them from "occurrences" as reported and defined in the CNDDB.

Recovery criteria for slender Orcutt grass are included in a Recovery Plan for multiple vernal pool plant and crustacean species (Service 2005a). The plan utilizes an ecosystem-level approach because many of the listed species and species of concern co-occur or overlap in distribution within natural vernal pool habitats, and are therefore generally threatened by the same human activities. The over-arching recovery strategy for slender Orcutt grass is habitat protection and management. The five key elements that comprise this ecosystem-level recovery

and conservation strategy are: (1) habitat protection; (2) adaptive management, restoration, and monitoring; (3) status surveys; (4) research; and (5) participation and outreach.

Delisting criteria for slender Orcutt Grass include:

1. Habitat protection: Accomplish habitat protection that promotes vernal pool ecosystem function sufficient to contribute to population viability of the covered species. This criterion (1A-E) addresses listing factor A. Delisting requires that 80 percent of occurrences of slender Orcutt grass be protected in such manner as to provide diverse vernal pool habitats in large habitat blocks that encompass local watersheds. Habitat blocks should also include unoccupied pools within vernal pool complexes, and appropriate upland buffers around and between vernal pool complexes. Habitat blocks should be effectively managed to maintain hydrologic function and prevent domination by invasive species.

1A. Suitable vernal pool habitat within each prioritized core area for the species is protected.

This recovery criterion has not been met. We do not yet have sufficient information to quantify either the acreage of suitable habitat within each core area or the acreage of protected habitat that is suitable for slender Orcutt grass. From the information available, we believe suitable habitat for this species has been protected in less than half of its core recovery areas.

Slender Orcutt grass occurrences occur within eleven core areas over five vernal pool regions (see Table 1). Three of the core areas are ranked as Zone 1 areas (Boggs Lake-Clear Lake, Vina Plains, and Mather), while the remaining eight core areas are Zone 2. In general, recovery recommendations in Zones 2 and 3 are more flexible than those in Zone 1. If sufficient, protection of suitable habitat in Zone 2 core areas may be used to offset the need to protect some habitat in Zone 1 core areas. Core areas for slender Orcutt grass are described in detail in sections II.C.1. and II.C.2.

1B. Species occurrences distributed across the species geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there.

Protection across the geographic range - The Recovery Plan recommends that 80 percent of extant occurrences be protected in perpetuity. There are 86 known occurrences and localities for slender Orcutt grass, although at least two of these, including the type locality, may be extirpated (Stone et al. 1988; C. Beyer, USFS, *in litt.* 2006a; CNDDB 2008; J. Perkins, USFS, *in litt.* 2009). Currently, 14 percent of known occurrences and localities are protected in perpetuity through conservation easements or location in preserves, although not all preserves encompass local watersheds or large habitat blocks, as described in this criterion (Service 2005c; Service 2007c). Additionally, 20 percent receive some protection under the joint-agency *Orcuttia tenuis* Species Management Guide on Lassen National Forest and Susanville District BLM lands (Corbin and Schoolcraft 1990). Another 23 percent of the known occurrences and localities are located on Federal lands (Modoc National Forest and BLM [Redding] lands) that are not managed through

Table 1. Slender Orcutt grass core areas within California vernal pool regions.

Core Recovery Areas	Number of Occurrences/localities	Ownership/Protection Status
Lake-Napa Vernal Pool Region (there are 2 occurrences in this region)		
Boggs Lake-Clear Lake (zone 1)	2	The Nature Conservancy (TNC) (1), Private (PVT) (1)
Modoc Plateau Vernal Pool Region (there are 39 occurrences/localities in this region**)		
Northern Modoc Plateau (zone 2)	14	USFS (13), Caltrans (1)
Western Modoc Plateau (zone 2)	8	USFS (5), BLM (1), PVT (2)
Southwestern Modoc Plateau (zone 2)	7	USFS (7)
Southern Modoc Plateau (zone 2)	2	USFS (1), PVT (1)
Occurrence/locality not in a core area	8	
Northeastern Sacramento Valley Vernal Pool Region (there are 32 occurrences in the region**)		
Vina Plains (zone 1)	4	TNC (1), PVT (2), Unknown (UNK) (1)
Dales (zone 2)	25	BLM (4), BLM/PVT (1), PVT (15), CDFG* (4), UNK (1)
Palermo (zone 2)	2	PVT (2)
Occurrence/locality not in a core area	1	PVT (1)
Northwestern Sacramento Valley Vernal Pool Region (there are 9 occurrences in this region)		
Redding (zone 2)	7	BLM/PVT (1), PVT (2), City of Redding (2), Shasta Bible College Preserve (***), Stillwater Plains Conservation Bank (1)
Millville Plains (zone 2)	2	PVT (2)
Southeastern Sacramento Valley Vernal Pool Region (there are 3 occurrences in this region)		
Mather (zone 1)	3	Private (2), Montelena preserve (1)
Occurrence/locality not in a designated vernal pool region**	1	

* CDFG occurrences are all located at the Dales Lake Ecological Reserve.

** Some occurrences are located outside of core areas, and one occurrences is not located in any of the defined vernal pool regions.

*** Shasta Bible College Preserve includes a portion of one occurrence. See further information under section 2B.

species-specific management guides, although occurrences on the Modoc National Forest receive some protection based on the current direction under the Sierra Nevada Forest Plan Amendment, which designates vernal pools as special aquatic features within riparian conservation areas (USFS 2003). Therefore, this recovery criterion has not been met because no more than 57

percent of occurrences and localities receive some type of protection. No occurrences are protected in perpetuity at the north/northeastern extent of the range, and only one occurrence each is protected at the far western and far southern extent of the range. The Service does not have sufficient information to determine that the habitat protection completed to date is promoting vernal pool ecosystem function sufficient to contribute to slender Orcutt grass population viability.

Protection of genetic differences - Only a limited number of extant occurrences have been included in the genetic evaluations of this species (Griggs and Jain 1983; Boykin *et al.* 2004 in review). Thirty-nine extant occurrences (and localities) are in the Modoc Plateau Vernal Pool Region. These occurrences are located at the extreme northeast geographic range of the plant, and also at the plant's upper elevation range. To our knowledge, no occurrences on the Modoc Plateau have been included in genetic evaluations or provided protection in perpetuity. The occurrences occur primarily on National Forest lands and are managed according to standards that differ between the Lassen National Forest and the Modoc National Forest (USFS 2003; Corbin and Schoolcraft 1990). Two occurrences of the plant occur within the Coast Range, in the Lake-Napa Vernal Pool Region, at the western extreme of the species' range. Only one of the two known occurrences is in a preserve. Extant occurrences also occur southward through the Central Valley to the Southeastern Sacramento Valley Vernal Pool Region; however, only three known occurrences remain at the southern extent of the range. Only one of these occurrences is currently protected in perpetuity. The limited amount of undeveloped land available for preserves may preclude the successful protection of additional occurrences in this area.

1C. Reintroduction and introductions must be carried out and meet success criteria.

The recovery criterion specifies that slender Orcutt grass should be reintroduced to vernal pool regions and soil types from which status surveys indicate the species has been extirpated. We do not have any information to indicate that slender Orcutt grass has been extirpated from specific vernal pool regions or soil types. Introductions may be needed if future vernal pool assessments show that the species has been extirpated from specific regions or soil types. Therefore, at this time the applicability of this criterion to the species is not known. Nonetheless, the species has been intentionally and unintentionally introduced to several sites within its existing range. Slender Orcutt grass introductions were first attempted at two privately-owned sites in 1978 and in 1982, before the species was listed, in both natural and created vernal pools (Griggs 1980; CNDDB 2006). These introductions have not been surveyed and the current population size is not known (Service 2005a). In 1995, slender Orcutt grass appeared in 11 of 21 created pools at Dale's Lake Ecological Reserve due to an apparent accidental contamination of inoculum with the plant seeds (Carol Witham *in litt.* 2000a, as cited in Service 2005a). In 1999, only one pool had slender Orcutt grass remaining (Carol Witham *in litt.* 2000a, as cited in Service 2005a; see also CNDDB 2006, 2008). The plant has also been introduced to 18 newly-created pools in the Stillwater Plains Conservation Bank (Helm Biological Consulting 2005; C. Martz, CDFG, pers. comm. 2006). There are currently no success criteria with which to evaluate introductions or re-introductions of this species.

1D. Additional occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to recovery are protected. Any newly found occurrences may count towards recovery goals if the occurrences are permanently protected as described in this plan.

Additional localities were located within the Modoc Plateau region beginning in 2006. Vernal pools on the Modoc National Forest were first delineated in 2006 (C. Beyer *in litt.* 2006a, b; J. Perkins, USFS, *in litt.* 2008, 2009). The potential for discovering additional plant occurrences/localities on the Modoc National Forest is high because the vernal pool habitat is largely intact and plant surveys have been conducted at relatively few of the many pools that are expected to occur on the Forest. Modoc National Forest vernal pools were delineated in 2006 by Holland (2006). In this assessment, 660 possible pools were identified by photo interpretation (some additional sites were added later by Modoc National Forest botany staff from on-the-ground survey data [Perkins, USFS, *in litt.* 2008, 2009]). The pools on the Modoc National Forest represent the far northern, high-elevation extent of the plant's range. The occurrences/localities are not protected in the manner described in the recovery criteria (Service 2005a). The potential for locating additional slender Orcutt grass occurrences in the Southeastern Sacramento Valley is expected to be very low due to the development that has already occurred in the area (Sacramento County 2006a). There is also potential to locate additional occurrences of the plant on private lands in the Northeastern and Northwestern Sacramento Valley Vernal Pool Regions, but no new occurrences have been found to date. No new occurrences/localities have been protected in the manner described in the Recovery Plan (Service 2005a); therefore this recovery criterion has not been met.

1E. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring.

To our knowledge, monitoring of hydrology has not occurred at any of the known extant occurrences; therefore this recovery criterion has not been met.

2. Adaptive Habitat Management and Monitoring: This criterion (2A-D) implicitly addresses all relevant listing factors.

2A. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected in Sections 1(A-E), above.

This criterion has not been met. Although several occurrences are protected within conservation banks or preserves, and have management and monitoring plans in place, in most cases plans are too new to determine whether they adequately facilitate maintenance of vernal pool ecosystem function.

2B. Mechanisms are in place to provide for management in perpetuity and long-term monitoring of habitat protected in Sections 1(A-E) (e.g., funding, personnel, etc).

This criterion has been partially met.

The Vina Plains Preserve was established by The Nature Conservancy in 1982. It has a management and monitoring plan in place. An endowment fund was not established when the preserve was purchased, so funds for preserve operations are obtained each year through private fund-raising efforts. A small portion of the operating funds are received from a lease for on-site livestock grazing. To date, fundraising success has been sufficient to fund operations. Formal monitoring of the slender Orcutt grass occurrence occurs every five years (R. Reiner, TNC, pers. comm. 2006).

Stillwater Plains Conservation Bank within the Northeastern Sacramento Valley region is a relatively new conservation bank. The bank is actively creating and restoring vernal pool habitat, and has developed suitable habitat for slender Orcutt grass. The bank is being developed in phases and has completed endowments, management and monitoring plans, and conservation easements for three phases, providing a total of 649 acres that include restored blue oak woodlands and shrublands; restored creek habitat; and restored, enhanced, and created wetland and vernal pool habitat (ENPLAN 2003; C. Martz pers. comm. 2006). Monitoring of the created/restored/enhanced vernal pools in Phase I of the bank's implementation has been reported for four years. One natural slender Orcutt grass occurrence is located within the completed phases (I-IV) of the bank (ENPLAN 2003; CNDDB 2008).

The Dales Lake Ecological Preserve was acquired by CDFG as mitigation for a pipeline project. Ongoing management is funded by an endowment fund, which is adequate for site maintenance but has not been used to fund monitoring (R. Lis, CDFG, *in litt.* 2006). Eighteen created pools on the preserve were apparently last checked for slender Orcutt grass in 1999, when the grass was found to remain in only one pool (Service 2005a; R. Lis, CDFG, *in litt.* 2006; CNDDB 2008). A multiple-year study of other vernal pools at the site was funded by Endangered Species Act Section 6 monies (J. Nelson, CDFG, *in litt.* 2006); however, the analysis of slender Orcutt grass data for those pools is not finished at this point in time (R. Lis *in litt.* 2006, 2009).

The Boggs Lake Preserve in the Lake-Napa vernal pool region does not have an endowment fund, but is funded through The Nature Conservancy operations monies (L. Serpa, TNC, pers. comm. 2006). In the Southeastern Sacramento Valley region, the Klotz Preserve has completed conservation easements on portions of the property through consultation with the Service; however, the slender Orcutt grass occurrence has not yet been protected under an easement (S. Egan, ECORP, pers. comm. 2006; S. Egan, ECORP, *in litt.* 2008).

On the Lassen National Forest, the *Orcuttia tenuis* Species Management Guide provides direction for long-term management and monitoring of occurrences (Corbin and Schoolcraft 1990). The management guide directs managers to avoid direct disturbance of plants due to excessive grazing, vehicle traffic within vernal pools, and hydrological manipulation of pools. Fencing will be the primary means of protection, when needed. In addition, all occurrences are

to be monitored annually. Occurrences on public lands are not necessarily protected in perpetuity, as management guidelines change over time.

The Shasta Bible College Vernal Pool Preserve, Stillwater Business Park Preserve, and Montelena Preserve are all protected under conservation easements and have operations and maintenance plans and Service-approved funding mechanisms in place (Service 2005c; Service 2007c; C. Witham pers. comm. 2008).

2C. Monitoring indicates that ecosystem function has been maintained in the areas protected under Sections 1(A-D) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring.

To our knowledge, monitoring of ecosystem function has not occurred at any protected location. This criterion has not been met.

2D. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria.

The Recovery Plan directs collection of seeds from each vernal pool region. The Boggs Lake-Clear Lake, Millville Plains, Palermo, Mather, and Redding core areas are listed as the first-priority sources for seed bank collecting. The Service is not aware of any seed banking collections that would indicate that this criterion has been met.

3. Status Surveys: This criterion (3A-B) implicitly addresses all relevant listing factors.

3A. Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring.

In most regions this criterion has not been met, although it may have been partially met in several core areas. The Lassen National Forest monitored 21 occurrences in most years between the late 1980s and 2001. They have monitored at least half the sites at least once between 2002 and 2007. Some occurrences fluctuate with rainfall, and in years with low rainfall no living plants are present at some sites. Other occurrences appear to be stable over time (A. Sanger, USFS, *in litt.* 2006, 2008). Although monitoring has occurred for multiple years over an extended period of time, information on drought cycles is missing from plant survey data. Additionally, seven occurrences have been monitored for more than ten years by the BLM within the Dales and Redding Core Areas. For most of these occurrences, the number of living plants appears to fluctuate from year to year with two occurrences producing no living plants in some years, while the abundance at several occurrences appears to have increased over time (C. Lentz, BLM, *in litt.* 2006). However, the Service has not received data to indicate that either monitoring effort has occurred during a time period that meets the requirements specified in the

2005 Recovery Plan (one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring).

Vernal pool region working groups will be important for tracking the progress of recovery efforts, including monitoring the status of occurrences of this species, particularly on private lands that are not currently monitored.

3B. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated.

This criterion has not been met. Most extant occurrences on private lands, which are most subject to threats from development, have not been monitored. Monitoring of known occurrences of slender Orcutt grass on public lands suggests that at some sites, exclusion of cattle grazing may adversely affect plant occurrences (C. Lentz *in litt.* 2006). On the Modoc Plateau, threats due to off-highway vehicle use, past alteration of vernal pool hydrology, and grazing apparently continue (C. Beyer *in litt.* 2006b; A. Sanger *in litt.* 2006). At this time, there are no standardized site assessments. In addition, if monitored occurrences are deemed to be threatened, there are no habitat planning or rapid response measures planned. The threats to this species described in the 1997 listing rule are still present, even at most monitored sites.

4. Research:

4A. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions.

This criterion (4A-C) addresses all relevant listing factors. The Recovery Plan discusses a variety of research needs that would help to refine recovery actions and criteria, and guide overall recovery and long-term conservation efforts. The Recovery Plan recommends research on genetics, taxonomy, biology of vernal pool species, the effects of habitat management practices on vernal pool species and their habitat, and threats to vernal pool species and ecosystems.

The majority of information needs discussed in the 2005 Recovery Plan are still outstanding for this species. Dr. Heather Davis at California State University, Sonoma, has begun research on the population genetics of several other species in the Orcuttieae tribe, but has not included slender Orcutt grass in her study (Sonoma State University 2006). A study assessing the distribution and possible competition between slender Orcutt grass and common spikerush

(*Eleocharis macrostachya*) has shown that distribution of the two species is negatively correlated in the two large, relatively deep study pools examined, although both species occur within the same range of depths within the pools. Study results suggest that common spikerush presence is positively related to depth of hardpan from soil surface, suggesting to the authors that sedimentation may increase habitat suitability for the spikerush (Carter *et al.* 2008).

4B. Research on genetic structure has been completed (for species where necessary – for reintroduction and introduction, seed banking) and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully representative by populations protected in the Habitat Protection section of this document, described previously in Sections 1(A-E).

This criterion has not been met. Boykin *et al.* (2004 in review) completed phylogenetic analysis of the Orcuttieae tribe using three slender Orcutt grass occurrences from Shasta and Tehama Counties. The research provides information important to some protected occurrences, but did not include representation from all regions where the plant occurs, particularly the Lake-Napa Region, Southeastern Sacramento Valley Region, and the Modoc Plateau Region, so may not represent the full range of genetic structure. Prior work on the genetics of the genus *Orcuttia* was completed in the 1970s using two slender Orcutt grass populations that were several kilometers apart (Griggs and Jain 1983). Results from the two studies appear to be consistent with each other, but results have not been specifically incorporated into habitat protection plans to date.

4C. Research necessary to determine appropriate parameters to measure population viability for each species have been completed.

No such research has been completed for this species.

5. Participation and outreach: This criterion (5A-D) implicitly addresses all relevant listing factors.

5A. Recovery Implementation Team is established and functioning to oversee range-wide recovery efforts.

The Recovery Plan discusses a variety of participation programs to achieve the goal of recovery of the listed species in the plan. An essential component of this collaborative approach is the formation of a single recovery implementation team overseeing the formation and function of multiple working groups formed at the vernal pool region level. The selected implementation team started meeting in June 2009. The implementation team will select the members of the regional working groups with assistance from the Service. This criterion has not yet been met.

5B. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts.

See 5A, above.

5C. Participation plans for each vernal pool region have been completed and implemented.

This has not been completed.

5D. Vernal pool region working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria 1-4.

This has not been completed.

II.C. Updated Information and Current Species

II.C.1. Biology and Habitat

II.C.1.a. Abundance, population trends (e.g., increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

When the slender Orcutt grass was listed as threatened in 1997, there were 59 known occurrences (62 FR 14338). The Service is currently aware of a total of 86 locations where the plant occurs. Of these, 74 are occurrences that are recorded in the California Natural Diversity Database (CNDDB); however, at least two of these occurrences may have been extirpated (CNDDB 2008). The plant has also been extirpated from its type locality in Shasta County and from four other sites in the vicinity of the Redding Municipal Airport (Service 1997). Twelve natural extant localities have not yet been added to CNDDB records. These sites were discovered on the Modoc National Forest in the last several years (C. Beyer *in litt.* 2006a; J. Perkins *in litt.* 2008, 2009). One new locality was formerly documented in Sacramento County (Sacramento County 2006b), but was originally misidentified and has since been identified as *Orcuttia viscida* (C. Witham pers. comm. 2008). In the last two years, one occurrence on the Lassen National Forest, formerly identified as slender Orcutt grass, has been identified as Greene's tuctoria (*Tuctoria greenei*).

Occurrences of slender Orcutt grass can vary greatly in size from year to year; fluctuations in occurrence size of up to four orders of magnitude have been recorded. The grass appears to germinate even in dry years, but the proportion surviving to maturity varies (Griggs and Jain 1983). Population trends for this species on managed or protected lands may be stable over time, although quantitative monitoring has apparently been discontinued at many sites. Ongoing monitoring of these occurrences does show large, inter-annual fluctuations in the number of living plants at many sites, with some years producing no living plants in some locations (C. Lentz *in litt.* 2006; L. Serpa pers. comm. 2006).

Recent surveys on the Modoc National Forest have located additional localities, thereby increasing the number of occurrences and localities within the Modoc Plateau Vernal Pool Region (C. Beyer *in litt.* 2006a; J. Perkins *in litt.* 2008, 2009). Most occurrences on private lands were last evaluated in the late 1980s. At this time, the population trends for 61 occurrences are listed as unknown (CNDDB 2008).

Core Recovery Areas

Lake-Napa Vernal Pool Region: One natural occurrence is located in the Boggs Lake Preserve, which is owned and managed by The Nature Conservancy. Quantitative surveys have not been completed since 1988; however, continuing qualitative surveys suggest that the area occupied by slender Orcutt grass is stable over time, although plant numbers fluctuate widely from year to year (L. Serpa pers. comm. 2006). The one other known occurrence in this core area is located within a deepened area (an artificial pond) in a volcanic ash vernal pool on private land. A few hundred plants were noted there in 1987, when information on the occurrence was last reported (CNDDB 2008).

Modoc Plateau Vernal Pool Region: There are two occurrences located within the Northern Modoc Plateau core area on the Modoc National Forest (CNDDB 2008). In addition, there are 12 new localities that have been identified in this core area through recent vernal pool surveys on the Modoc National Forest (J. Perkins *in litt.* 2008). In general, these localities on the Modoc appear to consist of large numbers of individual plants in comparison to the occurrences known from other vernal pool regions (see J. Perkins *in litt.* 2008). There are eight occurrences within the Western Modoc Plateau core area; five are located wholly or partially on the Lassen National Forest, one is located on lands administered by the BLM, and two are located on private lands (although one is administered by the Lassen National Forest) (CNDDB 2008). Seven extant occurrences are within the Southwestern Modoc Plateau core area, all on the Lassen National Forest. The Southern Modoc Plateau core area contains two occurrences; one is on private land, while the other is located on the Lassen National Forest (CNDDB 2008). Eight other new localities identified in the region do not appear to be located within core areas. Given the recent discoveries of new localities and the number of vernal pools in the region, there is a relatively high potential for additional localities to be found as plant surveys are completed on additional vernal pools. In 2009, the Service completed surveys to the north of the Modoc National Forest in Klamath County, Oregon, but no slender Orcutt grass was found (R. Larson, Service, *in litt.* 2009).

Northeastern Sacramento Valley Vernal Pool Region: A natural occurrence is protected within the Vina Plains core area, within the Vina Plains preserve managed by The Nature Conservancy, but is apparently no longer monitored annually. Although no plants were observed in 2003 (R. Reiner, TNC, *in litt.* 2006), the occurrence was extant during 2006 (R. Schlising, CSU Chico, *in litt.* 2006). Three other occurrences are located within the Vina Plains core area. One occurrence is on lands owned by the California Department of Transportation, but is not protected by an easement (C. Warren, California Department of Transportation, *in litt.* 2006). Ownership of the other occurrences is unknown.

Within the Dales core area, four occurrences are recorded for the California Department of Fish and Game's Dales Lake Ecological Preserve (CNDDB 2008). The occurrences at the preserve include a large natural occurrence at Dale's Lake and small numbers of additional plants at up to 11 artificial pools located within the preserve (R. Lis *in litt.* 2006; CNDDB 2008). Another six occurrences within the core area are on BLM-administered lands, but have no special protection. Fifteen occurrences are located on private lands. The number of plants per occurrence is noted

to fluctuate at four sites, with two sites reporting no plants in some years. Two occurrences reported increases in the number of plants over time (C. Lentz *in litt.* 2006; CNDDB 2008).

The Palermo core area contains two small roadside occurrences located adjacent to Highway 70, also on private land (CNDDB 2008). One additional occurrence is located within this region, but is not located within any core recovery area.

Northwestern Sacramento Valley Vernal Pool Region: The Redding core area includes seven extant occurrences. Two occurrences are on lands owned by the City of Redding. The occurrences are located on private land, with one exception, where a vernal pool occurs on both private and BLM land. The Millville Plains core area contains two occurrences, both on private lands. Both occurrences are in sites with altered hydrology (CNDDB 2008).

Southeastern Sacramento Valley Vernal Pool Region: Currently there are three known occurrences within the core area. One occurrence is located in a single occupied pool within the 300-acre Klotz Open Space Preserve. Another occurrence just to the south on the Were property had also been proposed for a preserve; however, land ownership has changed and the status of the property is currently unresolved (C. Witham pers. comm. 2008). The third occurrence, a single occupied pool, has been proposed as the Montelena Preserve, an on-site 50-acre preserve within a 250-acre residential development (Sacramento County 2006b). All occurrences in the Mather Core Area are within the area that is covered by the Draft South Sacramento Habitat Conservation Plan (HCP) (Sacramento County 2006b).

II.C.1.b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

Previous work on two occurrences that were located within relatively close proximity to each other has shown that, although most genetic diversity for the species appears to occur between individuals of the same seed parent, for certain genetic components the mean values of between-population diversity are relatively large, regardless of the geographical distance between pairs of populations (Griggs and Jain 1983).

Results of research on the phylogenetic relationships of the Orcuttieae tribe (Boykin *et al.* 2004 in review, Boykin *et al.* 2008) confirm that *Orcuttia* is a monophyletic genus (a genus that includes all descendants of a common ancestor), and that the genus is distinct from most other grasses based on both its physical characters and its isolated phylogenetic position. Genetic variation within a "family" of seedlings from a single parent accounted for about half of the total genetic variation within each species, which represents a high level of out-crossing for a wind-pollinated group. (Out-crossing is a measure of the proportion of genetic variation that is contributed by plants other than the parent plant.) This research included only five slender Orcutt plant samples, one from each of three occurrences in Shasta County, one occurrence in Tehama County, and one occurrence in Lake County. The study did not include representation from the full range of the species, nor did it sample many plants from each location, so results may not capture the full range of genetic variation within the species. However, based on results from a small number of specimens located up to 160 miles from each other, the rates of gene flow are low between occurrences, regardless of distance (Boykin *et al.* 2004 in review; Boykin

et al. 2008). Results for the Orcuttieae tribe as a whole indicate that the rates of gene flow are low between populations, regardless of distance, resulting in considerable variation among populations of a single species (Boykin *et al.* 2004 in review).

II.C.2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

II.C.2.a. Present or threatened destruction, modification or curtailment of its habitat or range:

The reduction and fragmentation of habitat due to urban development, flood control projects, landfill projects, highway development, and agricultural land conversion were identified as the primary threats to this species in the 1997 listing rule (62 FR 14338). Habitat degradation from agricultural and human-related changes to vernal pool hydrology was identified as an additional threat. Consistent with the 1997 rule, the largest continuing threat to this species is land use conversion and urban development along the periphery of urban areas, especially in the Redding and Sacramento areas (Service 2005a; C. Martz pers. comm. 2006). By 2040, the human population of California is expected to increase to 58 million, almost double the 1990 State population (Field *et al.* 1999). Between 1994 and 2005, the Sacramento Fish and Wildlife Office engaged in Endangered Species Act section 7 consultations for projects with impacts to approximately 50,000 acres of vernal pool habitat, including loss of 25,000 acres of habitat due to residential, commercial, and industrial development (Service 2005a). These effects are expected to continue as urban boundaries expand further through high and low terrace formations on the eastern side of the valley. The Service works with Federal, State, and local agencies, and with private project proponents, to minimize effects to listed vernal pool species, and to compensate for the loss of habitat through preservation of vernal pool habitat elsewhere and through creation (or restoration) of an equal acreage of vernal pool habitat. Habitat degradation from agricultural and human-related changes to vernal pool hydrology also continues. For example, additional threats that have been noted since listing for the occurrences and localities on the Modoc National Forest include the ongoing creation of islands for nesting ducks (C. Beyer *in litt.* 2006b).

More subtle threats also have the ability to change habitat suitability in the natural lands that remain within the developed landscape. For example, loss of vernal pool habitat to residential, commercial, and industrial development can also lead to modification of remaining suitable habitat. Development can result in the loss of hydrological connections that sustain the remnant vernal pools. Vernal pool plants are sensitive to variations in the period of vernal pool inundation (Bauder 2000); occurrences of slender Orcutt grass could be impacted by such changes. On private lands, numerous pools with slender Orcutt grass occurrences have either been altered, or remain on relatively small parcels of lands adjacent to development (CNDDB 2008). Some pools have been partially drained or filled, while others are inundated during longer periods of time due to nearby irrigation or runoff from development (CNDDB 2008).

Changes to vernal pool habitat associated with residential development include facilitation of the introduction of non-native plants to vernal pool habitats (Zedler and Black 2004). Non-native grasses now occur commonly in vernal pool complexes and have become a threat to native vernal pool plants through their capacity to change pool hydrology. Exotic grasses maintain

dominance at pool edges, sequestering light and soil moisture, promoting thatch build-up, and shortening inundation periods. Although the mechanism responsible for the change in inundation is not documented, reduction in inundation period is thought to be due to increased evapo-transpiration at the vernal pools (Marty 2005). In areas near the urban boundary, cattle-grazing is often discontinued in anticipation of land use changes (C. Martz pers. comm. 2006). Cessation of cattle grazing has been found to exacerbate the negative effects of invasive non-native plants on vernal pool inundation period by removing a source of vegetation control. The change in vernal pool inundation due to loss of grazing is an emerging threat for this species, especially in the Sacramento Valley (C. Lentz *in litt.* 2006; C. Martz pers. comm. 2006). For example, vernal pool inundation was reduced by 50 to 80 percent in the Southeastern Sacramento Valley when grazing was discontinued (Marty 2005), although this relationship may change at different latitudes or elevations.

Suitable habitat for this species may also be modified through changes to vernal pool hydrology at a relatively large scale. Recent research by Rains *et al.* (2006) has illustrated the manner in which many, if not most, vernal pools located on duripan or claypan in the Central Valley appear to be supported by perched aquifers. In these hydrological features, seasonal surface water and perched groundwater hydrologically connect uplands, vernal pools, and streams at the catchment scale. Perched groundwater discharges from uplands to vernal pools, thereby stabilizing the pools and causing them to remain inundated for longer periods than would be the case if they were recharged only by precipitation. Accordingly, small changes in local land use, such as development of irrigated agriculture or parkland may have considerable impacts on vernal pools, although the degree to which such changes affect pools is poorly understood. (Rains *et al.* 2006).

Slender Orcutt grass occurrences on conservation banks and small preserves are often subject to the same threats as occurrences on unprotected, fragmented habitat. Disruption of perched aquifers underlying small protected parcels may impact occurrences within preserves. In addition, development of offsite banks may not adequately protect the rare landform types associated with specific plant species or meet the functional equivalence of the original wetlands ecosystems (see discussion in Wacker and Kelly 2004).

Lake-Napa Vernal Pool Region: The occurrence in the Boggs Lake Preserve could potentially be threatened by changes in land management practices, such as groundwater pumping from the Boggs Lake drainage, or logging on or near the Preserve (Serpa, TNC, *in litt.* 2006); however, there are currently no substantial threats to this occurrence (L. Serpa pers. comm. 2006). The one other known occurrence in this core area is located within a deepened area (an artificial pond) in a volcanic ash vernal pool on private land (CNDDB 2008). Few surveys for federally-listed plants have been conducted in this region, and the potential for other localities of the species are not known. Threats to vernal pool habitats in this region include highway construction, vineyards, and residential development (Service 2007a, b; Service 2008).

Modoc Plateau Vernal Pool Region: The vernal pools of the Modoc Plateau are not threatened by development, but habitat suitability for some occurrences has been affected by off-highway vehicle use, road construction; and the alteration of pools by damming and excavating to provide cattle watering holes (and maintenance of alterations), or to construct islands in pools for nesting ducks (A. Sanger *in litt.* 2006; C. Beyer, USFS, *in litt.* 2006b; J. Perkins, USFS, pers. comm.

2008). Although such activities may have the potential to create additional habitat for slender Orcutt grass by creating deeper pools, to date this has not been documented on the Modoc Plateau (J. Perkins, Modoc National Forest, pers. comm. 2009). Although these activities pose continued threats to individual occurrences, the degree of impact can vary with the particular site. The Service expects the potential for restoration of these impacts to be relatively high where impervious layers are not compromised. In this region, numerous pools that harbor slender Orcutt grass occurrences have been fenced to exclude grazing and protect occurrences from trampling; cessation of grazing may have less effect on pool inundation in the Modoc Plateau region (Marty 2005; A. Sanger *in litt.* 2006; C. Beyer *in litt.* 2006b; J. Perkins pers. comm. 2008).

Occurrences on the Modoc National Forest receive no special protection other than that provided by their status as a federally threatened species. Primary past threats have included the extensive damming, ditching, and excavation of watering holes and stock ponds, and creation of islands for nesting ducks in potential slender Orcutt grass habitat. Maintenance of existing facilities continues as needed, although surveys for plants are conducted before new projects are initiated or implemented (C. Beyer *in litt.* 2006b). Forest guidelines under the 2004 Sierra Nevada Forest Plan Amendment provide some protection to vernal pools based on their designation as riparian conservation areas (USFS 2003). In general, ground-disturbing activities are prohibited within 300 feet of pool edge, and standards require that pools meet proper functioning condition. Vernal pools on the Modoc National Forest were delineated in 2006 in order to plan off-highway vehicle routes to avoid vernal pool habitat. (C. Beyer *in litt.* 2006b). However, new proposed travel routes on the Forest have the potential to threaten known slender Orcutt grass localities and unsurveyed vernal pools (J. Perkins pers. comm. 2008; USFS 2009), although the net effect compared to current off-road vehicle use is not clear. Other threats to slender Orcutt grass habitat on the forest include the invasion of one occurrence/locality by western wheat grass, and trampling by cattle at some sites (J. Perkins pers. comm. 2008).

Occurrences administered by the Lassen National Forest are managed under the *Orcuttia tenuis* Species Management Guide written by the Lassen National Forest and the Alturas Office of the BLM (Corbin and Schoolcraft 1990) before the species was listed. Six pools with occurrences are fenced to exclude cattle, and vehicle barriers have been placed at 3 pools. Aspen thinning is planned adjacent to one pool (A. Sanger, USFS, *in litt.* 2006, 2008). Monitoring occurs in most years and results indicate that the number of plants at a site is likely tied to rainfall; in years with no rain some pools have no plants while other pools have fluctuating interannual abundance but appear to be stable in wet years. Approximately half of the occurrences have past or current impacts due to grazing and/or off-highway vehicle use, but neither commercial nor residential development is a threat to the occurrences (A. Sanger *in litt.* 2006).

Despite established buffer zones and species management guidelines for the species and its critical habitat contained in the 2004 Sierra Nevada Forest Plan Amendment (USFS 2003), the Service expects that fuels management treatments and other ground disturbing activities may result in changes in surface and subsurface hydrology, increased potential for soil erosion, and/or invasion by noxious weeds that may affect habitat quality and survivorship of the species. Effects due to potential herbicide applications, as part of fuels treatments or noxious weed control programs should be limited or avoided by forest standards and guidelines (Service 2003).

Northeastern Sacramento Valley Vernal Pool Region: Within the Dales core area, most occurrences occur on private land where the status is unknown. Modification of pools has been recorded in this core area and may threaten individual occurrences. Grazing may threaten occurrences where cattle are able to concentrate at vernal pools; however, loss of grazing may also present an unquantified risk to vernal pool species in the area (see Marty 2005). On BLM lands, grazing has been excluded at four sites with occurrences, while competitive exclusion from common spikerush is a threat at five sites, including the four sites without grazing (CNDDB 2008). The number of plants per occurrence is noted to fluctuate at four sites, with two sites reporting no plants in some years. Two occurrences reported increases in the number of plants over time (CNDDB 2006; C. Lentz *in litt.* 2006).

Northwestern Sacramento Valley Vernal Pool Region: Threats to slender Orcutt grass within this region are primarily due to commercial and residential development in and around the Redding area and along area roads (Service 2004a, b; Service 2005b, c; Service 2007c). The Redding core area includes five extant occurrences located on private land, with one exception where a vernal pool occurs on both private and BLM land. In addition to urban development, they are threatened by pool alteration via fill, draining, or impoundment, and dominance of pool substrates by common spikerush. For example, surveys indicate the species numbers have declined in the Shasta Bible College Vernal Pool Preserve as common spikerush has increased at the site (Service 2004a). The Preserve protects one (larger) portion of a vernal pool that has been bisected by a roadway, leaving portions of a slender Orcutt grass occurrence on each side of the road. Grazing has been excluded from a portion of the pool for one occurrence; however, slender Orcutt grass plants are more robust and occur at the highest density on the grazed portion of the pool (C. Lentz *in litt.* 2006). Recent restoration activities at the Preserve, along with future proposed management activities may either positively or negatively affect the slender Orcutt grass occurrence to the extent that pool contours have been deepened to depths favoring competitive plant species (e.g. spikerush), and to the extent that vegetation management is effective in controlling spikerush (J. Gallaway, Gallaway Consulting, Inc., *in litt.* 2005; ENPLAN 2007; J. Luper, ENPLAN, *in litt.* 2007).

In the last ten years, the Service has entered into Endangered Species Act section 7 consultations on four development projects in the Redding area that affect seven occurrences and/or designated critical habitat for slender Orcutt grass (Service 2004a; 2004b; 2007c). Service files indicate that compensation, in the form of preserved and created/restored habitat, has been proposed for all projects, but has not yet been completed for two of the projects. The Service expects the compensation to offset the loss of occurrences and/or critical habitat. Service files indicate that the Stillwater Business Park (Service 2007c) has protected three occurrences at the project site through a conservation easement. Additional compensation for this project, and compensation for effects to critical habitat on one other project have been met through preservation and restoration at the 15.02–acre Shasta Bible College Preserve (Service 2005c; Service 2007c; see also J. Gallaway *in litt.* 2005). In addition, a development project that will negatively affect habitat for vernal pool crustaceans, but not slender Orcutt grass, has proposed to purchase preservation credits at a conservation bank that has at least one occurrence of slender Orcutt grass, (Service 2005c), which is expected to provide protection to an additional occurrence when/if the project is completed.

The Millville Plains core area contains two occurrences, both on private lands. Both occurrences are in pools with altered hydrology (CNDDB 2008).

Loss of suitable habitat in this region has been offset to a small extent by the development of conservation banks. Stillwater Plains Conservation Bank within the Northeastern Sacramento Valley Region has created suitable habitat for slender Orcutt grass. However, in the last several years the inflated price of land along the urban front in the Redding area has provided an unexpected threat to preservation of suitable slender Orcutt grass habitat by reducing the land-purchasing capability of conservation and governmental organizations (C. Martz pers. comm. 2006).

Southeastern Sacramento Valley Vernal Pool Region: Currently there are three known occurrences within the core area. One occurrence is located in a single occupied pool within the 300-acre Klotz Open Space Preserve. Although a Conservation Easement (with approved management and monitoring plan) has been established for a portion of this property, the slender Orcutt grass occurrence is located in a portion of the property proposed for future protection (S. Egan pers. comm. 2006; S. Egan *in litt.* 2008). Another occurrence just to the south on the Were property has also been proposed for a preserve, but is not complete. The third occurrence, a single occupied pool, has been proposed as the Montelena Preserve, an on-site 50-acre preserve within a 250-acre residential development (Sacramento County 2006b). The conservation easement, and the management and monitoring plan, have not yet been reviewed by the Service. The long-term effects of the small size of the preserve and the recent trenching of the preserve perimeter are unknown (C. Witham pers. comm. 2006). All occurrences in the Mather Core Area are within the area that is covered by the Draft South Sacramento HCP (Sacramento County 2006b). The draft HCP states that it may not be possible to meet the Recovery Plan's land protection goals for the species in the Mather core area. Their determination is based on previous land use decisions in the area, and further notes that the goal of protecting all known occurrences in preserves as large as possible is already restricted by adjacent land use designations and development (Sacramento County 2006a). All occurrences within this core area are thought to be threatened by the surrounding urbanization, hydrological alteration of vernal pools, potential inappropriate management (including use of herbicides), and/or competition with introduced and native vegetation (Sacramento County 2006b; Carol Witham, pers. comm. 2006).

For development projects in the Southeastern Sacramento Valley Region, Wacker and Kelly (2004) illustrated that the majority of project site characteristics were replicated at the corresponding mitigation sites. However, when compared at the landscape scale across all development projects, they found that relatively rare pool types, such as Northern Volcanic Mudflow pools, are decreasing while drainageway pools (pools formed in recent alluvial deposits over other formations, which typically support lower species richness) are becoming more common. The three occurrences of slender Orcutt grass in Sacramento County are found on the high terrace Laguna Formation (Sacramento County 2006b). High terrace formations generally support larger and deeper (longer lasting) pools (Wacker and Kelly 2004). Although projects have occurred fairly equally on high and low terrace sites in the study area, compensation sites were established disproportionately on low terrace formations (Wacker and Kelly 2004). Such shifts in availability of landform types could have negative consequences for persistence of slender Orcutt grass, although the degree of risk is unknown.

Summary of Factor A

The Service is currently aware of a total of 86 occurrences and localities of slender Orcutt grass. Thirty-three occurrences/localities (38 percent) are located on private lands, while 38 occurrences/localities (44 percent) are located on public lands managed by the Forest Service or BLM. Four additional occurrences/localities (5 percent) straddle property boundaries between private and Federal lands. Six recorded occurrences (7 percent) are located on preserves owned and managed either by the California Department of Fish and Game or The Nature Conservancy. Two occurrences (2 percent) are located on unprotected lands owned by the City of Redding, and two (2 percent) are owned by the California Department of Transportation (C. Warren *in litt.* 2006; CNDDB 2008), while ownership of one occurrence is unknown (CNDDB 2008). Six (6 percent) of the occurrences on private lands have been protected under conservation easement through section 7 consultations for slender Orcutt grass or vernal pool crustaceans. At one of these sites, the Stillwater Conservation Bank, active creation/restoration of vernal pools has resulted in localities of slender Orcutt grass in eight restored, one enhanced, and 18 created pools (Helm Biological Consulting 2005). Several additional landowners are expected to complete conservation easements that will protect additional extant occurrences as compensation for impacts to existing occurrences or critical habitat (Service 2005c; S. Egan pers. comm. 2006, S. Egan *in litt.* 2008). There also may be additional conservation easements that are unknown to us.

In summary, urban, infrastructure, and agricultural development continue to be major threats to slender Orcutt grass in the vernal pool regions of the Central Valley. On the Modoc Plateau, land management activities may threaten individual occurrences and localities of slender Orcutt grass to the extent that land management activities alter pool depths and configurations to meet competing land management objectives (e.g., provision of waterfowl nest islands and watering holes, fuel control, road development, etc.). In addition, both protected and unprotected occurrences in the Central Valley may be increasingly subject to decreased suitability of habitat because of changes in the hydrology of remaining vernal pool habitat due to increased or decreased surface run-off due to altered topography, changes in subsurface hydrological connections, unregulated alterations to individual vernal pools, changes in length of pool inundation due to invasion of pools by non-native plant species, and changes in vernal pool inundation due to cessation of grazing near urban boundaries, on public lands, and in protected areas (Service 2005a; Rains *et al.* 2006; C. Witham pers. comm. 2006).

II.C.2.b. Overutilization for commercial, recreational, scientific, or educational purposes:

Overutilization of slender Orcutt grass for commercial or other purposes was not known to be a threat at the time of the 1997 final rule (62 FR 14338). The 1997 listing rule does state that uncontrolled visits by groups or individuals to vernal pool areas could result in possible trampling of vernal pool plants. Vandalism is also listed as a potential threat. However, this factor does not appear to be a substantial threat, and is not addressed in the 2005 Recovery Plan recovery criteria. We are not aware of any information that would suggest that this factor has become a greater threat since listing.

II.C.2.c. Disease or predation:

The 1997 final rule to list slender Orcutt grass did not include any information on disease (62 FR 14338). We are not aware of any disease factors that threaten occurrences of this species. The 1997 final rule indicates that livestock grazing and associated trampling may or may not adversely affect vernal pool plants, depending on, among other things, the type of pasture, kind of livestock, the stocking level, season of use, and duration of grazing. Overgrazing by livestock does not appear to be a problem at most sites, but may substantially impact some plant occurrences (Griggs 1980; C. Beyer *in litt.* 2006b; A. Sanger *in litt.* 2006; CNDDB 2008; J. Perkins pers. comm. 2008). Non-consumptive effects of livestock grazing are covered in sections II.C.a and II.C.e.

Although grasshoppers have been noted to reduce population abundance in the past (Griggs 1980; C. Lentz *in litt.* 2006), such events are seldom documented. Loss of local plants to grasshopper predation can be complete in some years (Griggs 1980), and may present a substantial threat to the species; however, the Service has no information with which to quantify the threat.

II.C.2.d. Inadequacy of existing regulatory mechanisms:
In the final listing rule, the Service (1997) found that many Federal and State regulatory mechanisms, such as Federal Clean Water Act, California Environmental Quality Act, California Native Plant Protection Act, and State listing as endangered under the California Endangered Species Act provided insufficient protection to slender Orcutt grass (62 FR 143438). The final listing rule considered slender Orcutt grass and the other plants included in the rule could be incidentally afforded protection of the Act if they co-existed with vernal pool wildlife species, such as the vernal pool fairy shrimp (*Branchinecta lynchi*), the Conservancy fairy shrimp (*B. conservatio*), the longhorn fairy shrimp (*B. longiantenna*), and vernal pool tadpole shrimp (*Lepidurus packardi*), that were already listed under the Act. However, the rule noted that slender Orcutt grass and branchiopod species only sporadically occur in the same vernal pools. Conservation easements were also found not to adequately ensure protection for vernal pool plants, including slender Orcutt grass, because they frequently allowed continued grazing, which was determined to be damaging to vernal pool plant populations.

Federal Protections

Endangered Species Act: The Endangered Species Act of 1973, as amended (Act), is the primary Federal law that provides protection for slender Orcutt grass since its Federal listing as a threatened species in 1997. Section 7(a)(2) requires Federal agencies to consult with the Service to ensure any project they fund, authorize, or carry out does not jeopardize a listed species. Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the "take" of federally endangered wildlife; however, the take prohibition does not apply to plants. Instead, plants are protected from harm in two particular circumstances. Section 9 prohibits (1) the removal and reduction to possession (i.e. collection) of endangered plants from lands under Federal jurisdiction, and (2) the removal, cutting digging, damage, or destruction of endangered plants on any other area in knowing violation of a state law or regulation, including state trespass law. Section 9 also makes illegal the international and interstate transport, import export and

sale or offer for sale of endangered plants and animals. The protection of Section 9 afforded to endangered species is extended to threatened wildlife and plants by regulation.

If a Federal agency is not involved in a proposed project, and federally listed animals may be taken as part of the project, then the project proponent may obtain an incidental take permit pursuant to section 10(a)(1)(B) of the ESA. The Service may issue such a permit upon completion of a satisfactory habitat conservation plan (HCP) for the listed species that would be taken by the project. Currently there are no completed regional or county-wide HCPs or NCCPs (see California State Laws below) in any of the counties where slender Orcutt grass occurs. The Draft South Sacramento HCP specifically addresses slender Orcutt grass (see sections II.B.3. and II.C.2.a., above); however, protection of land for slender Orcutt grass through conservation easements appears to be most dependent on compensation that is negotiated with Federal agencies through the section 7 process.

Clean Water Act: Section 404 of the Clean Water Act may afford some protection to slender Orcutt grass. The U.S. Army Corps of Engineers (Corps or USACE) issues permits for the discharge of dredged or fill material into navigable waters of the United States. The Corps interprets "the waters of the United States" expansively to include not only traditional navigable waters, but also other defined waters that are adjacent or hydrologically connected to traditional navigable waters. Before issuing a 404 permit to a project applicant that may affect federally listed species, the Corps is required under Section 7 of the Endangered Species Act to consult with the Service. However, recent Supreme Court rulings have called into question the Corps' definition of Waters of the U.S. On June 19, 2006, the U.S. Supreme Court vacated two district court judgments that upheld this interpretation as it applied to two cases involving "isolated" wetlands. Currently, the Corps regulatory oversight of vernal pools is in doubt because of their "isolated" nature. In response to the Supreme Court decision, the Corps and the U.S. Environmental Protection Agency (USEPA) have recently released a memorandum providing guidelines for determining jurisdiction under the Clean Water Act. The guidelines provide for a case-by-case determination of a "significant nexus" standard that may protect some, but not all, vernal pool habitat (USEPA and USACE 2007). The overall effect of the new permit guidelines on loss of vernal pool habitat is not known at this time. If the Corps loses their regulatory authority over vernal pools, unmitigated destruction of potential habitat for slender Orcutt grass may increase over the range of the species. In addition, an unquantified, but potential source of loss of habitat for slender Orcutt grass is the unpermitted fill of vernal pool wetlands that results from actions that either do not trigger a State or Federal permit or are completed without the benefit of a required permit.

Endangered Species Management on Federal Lands: Slender Orcutt grass occurrences occur on Federal lands in northeastern California, and the listing rule noted that the *Orcuttia tenuis* Species Management Guide (Corbin and Schoolcraft 1990) for the Lassen National Forest and the Susanville District of the BLM provided long-term protection for five slender Orcutt grass occurrences in Plumas, Shasta, and Siskiyou Counties. Fencing the vernal pools to exclude grazing and off highway vehicle use has been the primary means of protecting these occurrences since the management guide was completed.

Since the 1997 final rule was published, plant surveys on the Modoc National Forest have resulted in the discovery of additional occurrences/localities of slender Orcutt grass. In addition, occurrences of the plant occur in the Redding BLM Resource Area. These occurrences/localities are not covered by the *Orcuttia tenuis* Species Management Guide, but have received some protection based on their location on Federal lands. Populations on Federal lands are afforded some protection through the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 et seq.) and management direction specific to each agency. NEPA requires all Federal agencies to formally document, consider, and publicly disclose the environmental impacts of major Federal actions and management decisions that have significant effects on the human environment, and to similarly address mitigation alternatives, but NEPA does not require that mitigation alternatives be implemented.

Other than protection under the Act, slender Orcutt grass occurrences and localities on the Modoc National Forest receive some incidental protection based on designation of vernal pools as riparian conservation areas under the Sierra Nevada Forest Plan Amendment (USFS 2003), which was finalized subsequent to the 1997 final rule. Recent changes to the National Forest Management Act (NFMA)(36 CFR 219.20(b)(i)) have the potential to affect future management of rare plant occurrences/localities on National Forests. The NFMA has required the Forest Service to incorporate standards and guidelines into Forest Land Management, or Land and Resource Management Plans, including provisions to support and manage plant and animal communities for diversity, and for the long-term range-wide viability of native and desired non-native species. On April 21, 2008, the Forest Service revised National Forest land management planning under NFMA through a Final Rule and Record of Decision (73 FR 21468). The 2008 planning rule changed the nature of Land Management Plans so that plans generally would be strategic in nature and might be categorically excluded from NEPA analysis. The primary means of sustaining ecological systems, including species, would be through guidance for ecosystem diversity, with additional provisions for threatened and endangered species, species-of-concern, and species-of-interest provided within the overall multiple-use objectives, if needed. The rule did not include a requirement to provide for viable populations of plant and animal species. The requirement to provide for viable populations had previously been included in both the 1982 planning rule and the 2000 planning rule. The Forest Service expected the new planning rule to be used in completing approximately 40 ongoing revisions to Forest Plans (73 FR 67120), including previously-scheduled Forest Land and Resource Management Plan revisions on the Lassen, Modoc, and Shasta-Trinity National Forests in the next three years. The extent to which the new planning rule would change management of slender Orcutt grass occurrences on these National Forests is not known. However, at this time the Northern District Court of California has vacated the 2008 Final Rule and has remanded it to the Forest Service for further proceedings, thereby reinstating the 1982 or 2000 Final Rule until further action is taken (U. S. District Court 2009).

The 1997 final listing rule did not mention regulatory mechanisms protecting the slender Orcutt grass occurrences on BLM lands that were not included in the *Orcuttia tenuis* Species Management Guide (Corbin and Schoolcraft 1990). Such occurrences derive protection from BLM policy for special status plant management (USDI BLM 1996) and from land use plans, or Resource Management Plans, written for each resource area. Land use plans are the basis for actions and authorizations involving BLM-administered lands and resources: they establish

allowable resource uses and related maintenance levels of production or use ; resource condition goals and objectives to be attained; program constraints and general management practices needed to attain the goals and objectives; general implementation sequences; and intervals and standards for monitoring and evaluating the plan to determine its effectiveness and the need for amendment or revision (48 FR 20368; 70 FR 14561). The Redding Resource Management Plan (USDI BLM 1993) provides for the transfer or disposal of BLM parcels in order to shift the pattern of BLM holdings "from more than 1,000 scattered parcels to less than twenty-five large aggregates of accessible and useful public lands". The Redding Resource Management Plan specifies that parcels will be evaluated for threatened and endangered plants before actual land transfers are considered, and that conservation easements may be used to protect special status species in certain cases. Additional guidance in the Redding Resource Management Plan addresses section 7 consultations for federally listed species (USDI BLM 1993). The Service is not aware at this time that any parcels containing slender Orcutt grass occurrences will be subject to ownership transfer.

California State Laws

The State's authority to conserve plants is comprised of four pieces of legislation: the California Endangered Species Act (CESA), the Native Plant Protection Act (NPPA), the California Environmental Quality Act (CEQA), and the Natural Community Conservation Planning Act (NCCPA).

California Endangered Species Act: slender Orcutt grass, *Orcuttia tenuis,* was State-listed as endangered in 1979. CESA (California Fish and Game Code, section 2080 *et seq.*) and NPPA (Division 2, Chapter 10, section 1908) prohibit the unauthorized take of State-listed threatened or endangered plant species. Unlike the take prohibition in the Federal Endangered Species Act, the State prohibition includes plants; however, landowners are exempt from this prohibition for plants taken via habitat modification. Where landowners have been notified by the State that a rare or endangered plant is growing on their land, the landowners are required to notify the California Department of Fish and Game 10 days in advance of changing land use in order to allow salvage of listed plants (NPPA Division 2, Chapter 10, section 1913). It is not known whether slender Orcutt grass individuals would survive such transplanting.

The California Environmental Quality Act: (CEQA) (chapter 2, section 21050 *et seq.* of the California Public Resources Code) requires government agencies to consider and disclose environmental impacts of projects and to avoid or mitigate them where possible. Under CEQA, public agencies must prepare environmental documents to disclose environmental impacts of a project and to identify conservation measures and project alternatives. Through this process, the public can review proposed project plans and influence the process through public comment. However, CEQA does not guarantee that such conservation measures will be implemented.

Natural Community Conservation Planning Act (NCCPA): The Natural Community Conservation Program is a cooperative effort to protect regional habitats and species. The program helps identify and provide for area wide protection of plants, animals, and their habitats while allowing compatible and appropriate economic activity. Many Natural Community

Conservation Plans (NCCPs) are developed in conjunction with Habitat Conservation Plans (HCPs) prepared pursuant to the Federal Endangered Species Act.

II.C.2.e. Other natural or manmade factors affecting its continued existence:

Other natural or manmade threats cited in the 1997 final listing rule include competition from native and non-native plants, particularly non-native, aggressive weeds; damage from off-highway vehicles; soil disturbance from cattle grazing; urbanization; and altered hydrology (62 FR 14338). The Recovery Plan lists off-highway vehicle use as a particular problem near Redding and in the Modoc Plateau Vernal Pool Region (Service 2005a). Listed non-consumptive effects of grazing include trampling, nutrient input, and indirect effects of grazing that alter competitive relationships between slender Orcutt grass and non-native plants. Additional threats covered in the Recovery Plan, but not included in the listing rule, include inappropriate management and monitoring of preserved habitat, including inappropriate grazing levels or the cessation of beneficial grazing levels; prescribed burns; and lack of funding for vernal pool habitat management. New information is available since listing on the threats imposed by non-native grasses, grazing, and damage from off-highway vehicle use. Current threats include those discussed in the 1997 final listing rule, the Recovery Plan, and in addition include fragmentation and isolation of occurrences, and drought and climate change.

Competition with Native and Non-native Plants

The 1997 final listing noted that the native perennials common spikerush (*Eleocharis macrostachya*) and coyote thistle (*Eryngium spp.*) appeared to limit the distribution and abundance of 13 occurrences of slender Orcutt grass in Shasta and Tehama counties (62 FR 14338). Slender Orcutt grass is specialized for life in vernal pools with long inundation periods (Boykin *et al.* 2004 in review). Common spikerush, a native vernal pool perennial, occurs commonly with the annual slender Orcutt grass. Stone *et al.* (1988) noted that this perennial spikerush co-occurs with slender Orcutt grass about 50 percent of the time, and often forms dense, nearly continuous cover over portions of pool beds, effectively limiting slender Orcutt grass density and vigor (see also Service 2004a). Monitoring by the BLM, the Lassen National Forest, and others suggests that competition from common spikerush continues to be a threat to numerous slender Orcutt grass occurrences, and because cattle will consume common spikerush, the threat may be exacerbated by cessation of grazing in pools where the two species co-occur (C. Martz pers. comm. 2006; C. Lentz *in litt.* 2006; A. Sanger *in litt.* 2006; CNDDB 2006). Vernal pools that are subject to additional water inputs due to nearby irrigation or residential runoff, or those that have been artificially excavated or dammed to provide livestock watering holes would provide hydrological conditions favoring common spikerush at the expense of slender Orcutt grass. Where the two species co-occur, common spikerush, which occupies areas of slightly deeper water (L. Serpa *in litt.* 2006) can become dominant in a run of wet years and then recede back to deepest portions of pools in dry years (Zedler and Black 2004). The Service is not aware of additional information to indicate that coyote thistle species pose a current threat to slender Orcutt grass.

Invasive non-native plants have become greater immediate threats to persistence of slender Orcutt grass occurrences in the Central Valley. The Nature Conservancy has issued a Weed

Alert announcing that waxy manna grass (*Glyceria occidentalis*) has invaded deep vernal pools, swales, ditches and stock ponds along entire east side of Central Valley (TNC 2006). Waxy manna grass is adapted to long periods of inundation and is currently found in Shasta, Tehama, Butte, Yuba, and Sacramento Counties. During the last 20 years it has spread rapidly through rice fields, vernal pools, ponds, and roadside ditches. This species is likely dispersed over long distances by waterfowl, which feed on the seeds. The seed also readily adheres to wet clothes, boots, fur, and feathers, making humans and wildlife likely dispersers over short distances. Dense invasions appear to eliminate or significantly reduce occurrences of all native annual plants (TNC 2006). Waxy manna grass has already been reported as a known problem for several Sacramento Orcutt grass occurrences (Sacramento County 2006b). It is now present in the Montelena Preserve in Sacramento County, in vernal pools near to the slender Orcutt grass occurrence (C. Witham pers. comm. 2006), and has also been reported from the Vina Plains Preserve (R. Reiner, TNC, pers. comm. 2008). Vernal pool margins are also being invaded by the non-native yellow glandweed (*Parentucìella viscosa*), leading to changed pool hydrology (C. Witham, pers comm. 2006). Other exotic plant species, including cockleburs (*Xanthium strumarium*) and field bindweed (*Convolvulus arvensis*) have also encroached into vernal pools in the northern Sacramento Valley (R. Reiner pers. comm. 2008). Thatch build-up from these non-native weedy species may also indirectly affect vernal pool plants, including slender Orcutt grass, by reducing the amount of water entering the system through surface and subsurface flows (Robins and Vollmar 2002). In the Southeastern Sacramento Valley Vernal Pool Region, invasions of vernal pools by such non-native plants may be facilitated by reductions in vernal pool inundation due to cessation of grazing (Marty 2005).

Small reserves may be particularly susceptible to degradation by non-native species, particularly when the reserves are located within a matrix of development and are associated with chronically disturbed transportation corridors (Zedler and Black 2004). For example, in San Diego County the non-native grass *Agrostis avenacea* can grow not only in water less than 12 inches deep, but also in human-disturbed uplands. The species currently occurs in the Central Valley, Coast Ranges, and the Sierra Nevada foothills (Harvey 1993). *Agrostis avenacea* may increase the frequency and intensity of fire, which could make it a greater threat to vernal pool endemics. This non-native grass grows higher and denser than plants native to our vernal pool landscapes and is known to increase fire hazard in its native Australia (Zedler and Black 2004). There is no information available to date on the resistance of stored and surface slender Orcutt grass seeds to relatively intense fire.

Off-Highway Vehicles

Off highway vehicle use has been a past threat to slender Orcutt grass occurrences in the Redding and Modoc Plateau areas. In both areas, fencing of pools on public lands to protect occurrences has apparently ameliorated this threat on public lands where species occurrences were documented previously (A. Sanger *in litt.* 2006; C. Lentz *in litt.* 2006) although unauthorized use remains a threat (A. Sanger *in litt.* 2006). Fencing of additional occurrences is planned on the Lassen National Forest, and planned off-road travel restrictions are expected to afford additional protection to the species (A. Sanger *in litt.* 2006, 2008). On the Modoc National Forest, where vernal pools were delineated for the first time in 2003 and where plant surveys have not yet been conducted on many vernal pools, off highway vehicle travel remains a

threat to localities of the plant (C. Beyer *in litt.* 2006; J. Perkins *in litt.* 2008; USFS 2009). The Service expects that in some cases, impacts may be confined to a small area and may not result in permanent habitat damage, depending on site-specific circumstances.

Vegetation Succession

Potential threats to slender Orcutt grass habitat in the Boggs Lake Preserve were previously noted to include the natural process of sedimentation and meadow succession in the lake bed (CNDDB 2006), although these threats are no longer part of the site description (CNDDB 2008). Additional threats include the effects of potential land-use changes in the surrounding drainage, and increased rooting activities from feral pigs. These threats were not noted at the time of listing (62 FR 14338) and no threats are imminent (L. Serpa pers. comm. 2006). However, at Boggs Lake, slender Orcutt grass grows below the high water line and above the spikerush zone, while the feral pigs root in the vicinity of the high water line much more commonly than areas of the middle elevation shoreline (L. Serpa pers. comm. 2006; L. Serpa *in litt.* 2006). The extent to which extended drought would change these interactions is unknown at this time (also see Sacramento County 2006b). The California Department of Fish and Game has acquired additional land surrounding the lake, providing an additional buffer upslope of the lake (CDFG 2006a; CDFG 2006b; L. Serpa pers. comm. 2006).

Fragmentation of populations and small population size

Habitat for slender Orcutt grass continues to be highly fragmented throughout most of its range due to conversion of natural habitat for urban and agricultural uses. This fragmentation results in small isolated occurrences of this species in all areas but the Modoc Plateau. Highly fragmented, small occurrences may be highly susceptible to extirpation due to stochastic events, inbreeding depression, or additional environmental disturbance (Gilpin and Soule 1986; Goodman 1987). If an extirpation event occurs in an occurrence that has been fragmented, the opportunities for natural re-colonization will be greatly reduced due to physical isolation from other source occurrences.

Drought and Climate Change

Prolonged drought as a result of long-term climate change was not identified as a threat to the slender Orcutt grass in the final listing rule. The Recovery Plan provides some information on the possible effects of climate change on slender Orcutt grass occurrences (Service 2005a). Climate scientists predict that California's climate will become warmer within the 21st century (Cayan *et al.* 2005; Field *et al.* 1999). Potential responses of California ecosystems to climate change fall into three categories: geographical responses, changes in the way ecological processes work, and changes in the kinds of plants and animals that comprise natural communities (Field *et al.* 1999).

Vernal pool communities were naturally isolated due to microhabitat conditions and soil chemistry even prior to human development of the landscape (Stebbins 1976; Holland and Jain 1981). However, predictions for change within the next 50 to 100 years, as shown by computer models for predicting climate-induced vegetation change, indicate that savannah communities

should expand at expense of foothill chaparral communities (Field *et al.* 1999). Scientists expect geographic shifts in the distribution and abundance of many species (McLaughlin *et al.* 2002; Loarie *et al.* 2008), while relatively rare endemic plants with low dispersal capabilities are expected to sustain range reductions (Loarie *et al.* 2008). Long-distance dispersal of slender Orcutt grass occurs only rarely (Griggs and Jain 1983). Therefore, the range shifts required by climate change may be difficult or impossible for this species due to low dispersal ability, especially where combined with factors such as the loss of potential habitat from development, occupation of potential habitat by non-native species, and lack of appropriate soil substrates (Field *et al.* 1999). Remnants of suitable habitat, even within conservation banks, may be too far apart to allow dispersal or natural re-colonization after a disturbance (Field *et al.* 1999).

The likely impacts of warming associated with climate change are closely connected to availability of water. Vernal pools in California's Central Valley are particularly sensitive to slight increases in evaporation or reductions in rainfall due to their shallowness and seasonality (Field *et al.* 1999). Even modest changes in warming could result in more runoff in winter with less runoff in spring and summer, more winter flooding, and drier summer soils (Field *et al.* 1999; Cayan *et al.* 2005). Most vernal pool plants are highly sensitive to drought. Slender Orcutt grass presence and abundance appears to be associated with rainfall patterns (A. Sanger *in litt.* 2006). In fact, drought is known to cause 100 percent mortality of local slender Orcutt grass populations (Griggs and Jain 1983). Climate change is expected to lead to increased variability in precipitation (McLaughlin *et al.* 2002), and to increased loss of soil moisture due to evaporation and transpiration of water from plants (Field *et al.* 1999), which may exacerbate effects due to drought. Current inter-annual fluctuations in numbers could be amplified by changes in precipitation and may lead to rapid extinctions of individual occurrences/localities (McLaughlin *et al.* 2002). Drought-mediated decreases in water depth and inundation period at vernal pools may also facilitate invasion of pools by non-native plants and lead to altered competitive outcomes (Gerhardt and Collinge 2003), although grazing could potentially reduce the effects of non-native plant invasions to some extent (Pyke and Marty 2005). Although the specific effects of climate change on slender Orcutt grass are unknown, the effects of increased winter flooding and drought conditions in the spring and summer have the potential to adversely affect this species.

II.D. Synthesis

We have no information indicating that threats to slender Orcutt grass have substantially changed since the time of listing in 1997. Since 1997, threats such as habitat loss and fragmentation appear to have increased over a substantial portion of the range. The primary threats to the species continue to be the modification and destruction of suitable habitat, and the resulting fragmentation of habitat and isolation of occurrences. At the time of listing, 59 native extant occurrences were known. There are currently 86 known extant occurrences, although two of these may have been extirpated (Sacramento County 2006b; C. Beyer *in litt.* 2006a; CNDDB 2008). Twelve new localities have recently been identified on the Modoc Plateau. However, many occurrences on private property were last surveyed 10 to 15 years ago and their current status is unknown, although they are presumed to be extant. Most occurrences on public lands have been consistently monitored over time and appear to be persisting, although a portion of them exhibit inter-annual fluctuations in abundance and may have no living plants in some years

of low rainfall. Occurrences and localities on public lands have been threatened by land management activities, including the development of cattle watering holes in vernal pools, construction of waterfowl nesting islands, and off road vehicle use. These occurrences and localities receive primary protection via their status as Federally listed species.

Competition with non-native and native plants is a continuing threat for slender Orcutt grass within Central Valley occurrences, especially in small, remnant vernal pool habitats in developed landscapes. With predicted changes in climate, drought conditions are expected to place additional strains on vernal pool ecosystems. Where slender Orcutt grass occurrences persist on marginal habitat, the addition of drought conditions may result in high rates of mortality. Efforts to preserve and create suitable habitat for the grass are ongoing, but most preserves and conservation banks are only newly established, so have not met any criteria for successful protection of the slender Orcutt grass in perpetuity. Therefore, based on the results of this 5-year status review, we conclude that slender Orcutt grass continues to meet the Act's definition of threatened, and no status change is recommended at this time.

III. RESULTS

III.A. Recommended Classification:

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist** (*Indicate reasons for delisting per 50 CFR 424.11):*
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X__ **No change is needed**

The status of slender Orcutt grass is essentially unchanged since the time of its listing in 1997. Although the degree of threat on the Modoc Plateau appears to be relatively low, in other vernal pool regions it is either moderately high or very high.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

The Recovery Plan recommends research on genetics, taxonomy, biology of vernal pool species, the effects of habitat management practices on vernal pool species and their habitat, and threats to vernal pool species and ecosystems. Additional data gaps have been identified in the Draft South Sacramento County HCP (Sacramento County 2006a) and through communication with land managers and species experts.

1. Develop and implement standardized population trend survey protocols to complete updated status surveys, especially for occurrences on private lands where trends have not been recently updated.

2. Conduct additional research to assess the long-term effects on the hydrology of vernal pools from development-related alterations to vernal pool sub-watersheds. Efforts should lead to determinations of appropriate hydrology (or upland) buffers. Specific hydrological and physical requirements should be assessed for slender Orcutt grass in order to address relationships between landform, soil chemistry, geographic location, and precipitation regimes; and the presence of slender Orcutt grass occurrences.

3. Conduct research on population viability parameters for slender Orcutt grass, especially where occurrences exhibit inter-annual fluctuations. Trends in soil seed banks and plant abundance, and length of seed viability, should also be rigorously assessed.

4. Conduct within-species genetic research to fully assess genetic differences between vernal pool regions. Prior genetics work has not included representation from all regions where the plant occurs, particularly the Lake-Napa Region, Southeastern Sacramento Valley Region, and the Modoc Plateau Region, so may not represent the full range of genetic structure or fully indicate genetic isolation between occurrences in different regions. Given the potential that additional localities may be documented on the Modoc Plateau where ecological conditions differ substantially from those in the Central Valley, genetic research should establish the relationship between these regions.

5. Manage invasive plants on preserves. Management should include research to determine effective eradication methods, and pool conditions that favor one plant over another. Research should be completed to define the conditions in which cattle-grazing is either deleterious or beneficial to slender Orcutt grass populations, including study on the effects of trampling on seed banks and germination, and effects on competition between the native and non-native plants with which slender Orcutt grass coexists.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Orcuttia tenuis*

Current Classification Threatened
Recommendation resulting from the 5-Year Review

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist**
__X__ **No change is needed**

Appropriate Listing/Reclassification Priority Number, if applicable ____

Review Conducted By Sacramento Fish and Wildlife Office staff

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 11.24.09