Buena Vista Lake Ornate Shrew

(*Sorex ornatus relictus*)

5-Year Review:
Summary and Evaluation

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

September 2011

5-YEAR REVIEW

Buena Vista Lake Ornate Shrew (*Sorex ornatus relictus)*

I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing of a species as endangered or threatened is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process defined in the Act that includes public review and comment.

Species Overview

The Buena Vista Lake ornate shrew (shrew) is one of nine subspecies of ornate shrews known to occur in California. It is a small dull black to grey-brown shrew with a relatively short bi-colored tail darker near the tip (Service 2002). The species is about the size of a mouse and has a long pointed snout, five toes on each foot, tiny beadlike eyes, soft fur, visible external ears, and a scaly, well developed tail covered with very short hairs (Ingles 1965; Vaughan 1978; Jamerson and Peeters 1988; Churchfield 1990, as cited in Service 2002). Shrews are active during the day and night but are rarely seen due to their small size and cryptic behavior. The shrew differs from its geographically closest subspecies, the Southern California ornate shrew (*Sorex ornatus spp. ornatus*); by having darker, grayish black coloration, rather than brown, a slightly smaller body size, and a longer tail (Grinnell 1932).

Shrews have a high rate of metabolism because of their small size forcing them to constantly be searching for food to maintain their body temperatures, especially in cold conditions (Newman and Rudd 1978; Aitchison 1987; Genoud 1988; McNab 1991, as cited in Service 2002). Shrews feed indiscriminately on the available larvae and adults of several species of aquatic and terrestrial insects, some of which are detrimental to agricultural crops (Holling 1959; Ingles 1965; Newman 1970; Churchfield 1990, as cited in Service 2002). They are also known to consume spiders, centipedes, slugs, snails, and earthworms on a seasonally available basis (Aitchison 1987; Jamerson and Peeters 1988, as cited in Service 2002). Food probably is not cached and stored, so the shrew must forage periodically day and night to maintain its high metabolic rate (Williams and Harpster 2001).

Due to lack of study, information about the home range size, breeding territory size, and population densities of the shrew are lacking. In other species of ornate shrews, juveniles establish their home range, which is a small area in which they nest, forage, and explore, and remain in this area for most of their life (Churchfield 1990, as cited in Service 2002). Ingles (1961) was able to calculate an average home range size in a closely related species, the vagrant shrew (*Sorex vagrans*), found in the Sierra Nevada of California, at approximately 372 square meters (m^2) (4,000 square feet (ft^2)), with breeding males occupying larger territories than breeding females (Hawes 1977, as cited in Service 2002). The distribution, and size, of a shrew's territory varies, and is primarily influenced by the availability of food (Ma and Talmage 2001, as cited in Service 2002).

Nothing is known specifically about the reproduction and mating system of the shrew. In general, the reproductive period of the ornate shrew extends from late February through September and early October (Rudd 1955b; Brown 1974; Rust 1978, as cited in Service 1998). The breeding season of the shrew may begin in autumn and end with the onset of the dry season in May or June. In high-quality habitat in permanent wetlands, the breeding season may be extended (Center for Conservation Biology 1990; Williams in litt. 1989, as cited in Service 1998). Up to two litters are produced per year containing four to six young (Owens and Hoffman 1983, as cited in Service 1998).

Habitat essential for the shrew contains riparian and wetland vegetation communities with an abundance of leaf litter and dense herbaceous cover (Williams and Harpster 2001). The shrews were most commonly found in close proximity to a reliable body of water. Moist soil in areas with an overstory of willows or cottonwoods appears to be favored, but may not be an essential habitat feature (J. Maldonado, Smithsonian Conservation Biology Institute, pers comm. 2011). Other ornate shrew species have been found in drier upland communities, but upland habitat is considered very poor and is not considered essential for the shrew (Williams and Harpster 2001).

The shrew formerly inhabited the interconnected network of tule marshes and other permanent and seasonal lakes, wetlands, and sloughs around the historic Tulare, Kern, and Buena Vista lakes, and presumably throughout the Tulare Basin (Williams and Harpster 2001). At the time the species was described and named by Joseph Grinnell in 1932, populations of the shrew were already declining due to the diversion and impounding of rivers, the draining of lakes, and the destruction of the wetland and riparian habitat surrounding these water features for agricultural and urban development. The current distribution for the shrew is unknown, but likely to be very restricted due to the loss of over 95% of its wetland habitat, the deficiency of adequate protection of occupied and potential habitat, the lack of connectivity between populations, the channelization of streams and rivers and the removal of vegetation along their edges, and the unreliability of water resources at its remaining localities due to agricultural and urban diversion. At the time it was listed, it was only known to occur in four small localities with no estimate as to population size, and, although it has been found in four additional locations since, habitat loss along with other anthropogenic and natural factors continues to threaten the species.

Methodology Used to Complete This Review:

This review was prepared by the Sacramento Fish and Wildlife Office (SFWO), following the Region 8 guidance issued in March 2008. We used information from the Recovery Plan, survey information from experts who have been monitoring various localities of this species, and the California Natural Diversity Database (CNDDB) maintained by the California Department of Fish and Game. Personal communications with experts were our primary source of information used to update the species' status and threats. This 5-year review contains updated information on the species' biology and threats, and an assessment of that information compared to that known at the time of listing or since the last 5-year review. We focus on current threats to the species that are attributable to the Act's five listing factors. The review synthesizes all this information to evaluate the listing status of the species and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years.

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Federal Register (FR) Notice Citation Announcing Initiation of This Review: A notice announcing initiation of the 5-year review of this taxon and the opening of a 60-day period to receive information from the public was published in the Federal Register on May 21, 2010 75 FR 28636-28642

Listing History:

> **Original Listing**
> **FR Notice:** 67 FR 10101
> **Date Listed:** March 6, 2002
> **Entity Listed:** *Sorex ornatus* subsp. *relictus*
> **Classification:** Endangered

Associated Rulemakings: Critical habitat for the species was proposed August 19, 2004, (69 FR 514170-514420) and designated on January 24, 2005 (70 FR 3438-3461). This Critical habitat designation is currently under revision and a proposed rule was released on October 21, 2009 (74 FR 53999-54017) and should be finalized by March 2012.

Species' Recovery Priority Number at start of review: The Recovery Priority Number (RPN) 3c (based on a 1 to 18 ranking system where 1 is the highest recovery priority and 18 is the lowest) because a high degree of threat, a high recovery potential, a taxonomic rank of

subspecies, and that the subspecies may be in conflict with construction or other development projects or other forms of economic activity (Service 1983a,b).

Recovery Plan or Outline

Name of Plan or Outline: Recovery Plan for Upland Species of the San Joaquin Valley, California

Date Issued: 9/30/1998

*****The species was listed as a species of concern at the time this recovery plan was written and published. Although recovery criteria were not detailed in the plan, long-term conservation-recovery criteria were provided.

Long-term Conservation-Recovery Criteria

-Secure and protect recovery areas totaling at least 2,000 acres of occupied habitat in three or more disjunct sites.

-Approve management plans for those sites that feature survival of the species as an objective, implementation of those plans

- Implementation of a periodical monitoring plan that demonstrates continuing presence of Buena Vista Lake shrews at occupied sites (U.S. Fish and Wildlife Service 1998).

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) Policy

The Endangered Species 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 of species under the Act limits listing as distinct population segments to species of vertebrate fish or wildlife. The 1996 Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Endangered Species act (61 FR 4722, February 7, 1996) clarifies the interpretation of the phrase "distinct population segment" for the purposes of listing, delisting, and reclassifying species under the Act. No distinct populations have been identified or are under review for this subspecies.

Information on the Species and its Status

Spatial Distribution

The shrew historically occurred in wetlands around Buena Vista Lake, and presumably in wetland and riparian areas throughout the Tulare Basin (Grinnell 1932). The Tulare Basin, essentially occupying the southern half to the San Joaquin Valley, had no regular outlet to the ocean and contained Buena Vista, Kern, and Tulare Lakes. These lakes were fed by the Kern,

Kaweah, Tule and Kings rivers and their tributaries and were interconnected by hundreds of square miles of tule marshes and other permanent and seasonal lakes, wetlands, and sloughs (Williams and Harpster 2001). Tulare Lake was the largest freshwater lake in the U.S. west of the Mississippi River. Today the lakes and wetlands have been drained and converted into irrigated agricultural fields, though portions of the historical lake beds fill with water in years of extraordinary runoff (Williams and Kilburn 1992). The species began to decline due to the disappearance of lakes and sloughs when rivers were first impounded and diverted, lakes were drained, and the wetland and riparian areas around them were destroyed for agriculture in the early 1900's. As early as 1933, Grinnell found the distribution of the shrew to be highly restricted due to the widespread disappearance of its habitat (Grinnell 1933a).

For more than 50 years the shrew was known only from the type locality at Buena Vista Lake, where it was presumed to be extinct because its wetland habitat had been replaced by residential and agricultural lands. The shrew was rediscovered at Kern Lake Preserve in 1986, on private property, and at Kern National Wildlife Refuge in 1992 (Williams and Harpster 2001).

When the species was listed in 2002, the shrew was only known to occur in four locations along an approximately 70 mile stretch on the west side of the Tulare Basin. The four locations were the former Kern Lake Preserve in the old Kern Lake bed, the Kern Fan recharge area, the Coles Levee Ecosystem Preserve, and the Kern National Wildlife Refuge (Service 2002). Presently, surveys for the shrew have been conducted at twenty-one sites and the shrew was found to be present in eight of them (Williams and Harpster 2001; ESRP 2005; Cypher, ESRP, pers. comm. 2010; Maldonado, unpubl. data 2006). These eight sites are Goose Lake, Atwell Island, Main Drain Canal/ Chicca & Sons Twin Farms South Field Ranch, Lemoore Wetlands preserve, Coles levee ecosystem preserve, Kern fan water recharge area, the Kern NWR, and the Kern Lake preserve (ESRP 2005; Cypher, pers. comm. 2010; Maldonado, unpubl. data 2006, Maldonado pers. Comm. 2011). A description of these sites is attached as Appendix A.

Trapping of shrews was also attempted on the Tule Elk preserve, Pixley NWR, Lake Woollomes, the Nature Conservancy's Paine Wildflower Preserve, the Kern Water Bank, Voice of America site west of Delano, the Kern River Parkway, a parcel between Kern and Buena Vista Lakes owned by the Bureau of Land Management, Wind Wolves preserve, and the Buena Vista Lake Recreation Area with no shrews detected at any of these locations (Cypher, pers. comm. 2010). Several areas north of the Tulare Lake bed including Tranquility, Helm, and the Los Banos wilderness area hosted extremely high numbers of ornate shrews in several successful trapping outings, but the shrews collected were likely to be of a different Ornate shrew sub-species (*Sorex ornatus ornatus)* (Cypher, pers. comm. 2010; S. Phillips, ESRP, pers. comm. 2010). Dr. Jesus Maldonado is processing tail clippings taken from these samples to confirm this hypothesis through genetic analysis.

Other remnant patches of wetland and riparian communities within the Tulare Basin have not been surveyed and may support the Buena Vista Lake shrew, including Jerry Slough, overflow channels of the Kern River owned and managed by the Semitropic Water District as a ground water recharge basin located 10 miles south of Kern NWR, (Germano and Tabor 1993, as cited in Williams and Harpster 2001); and the privately owned Creighton Ranch, located near the eastern shore of historical Tulare Lake in Tulare County (Williams and Harpster 2001).

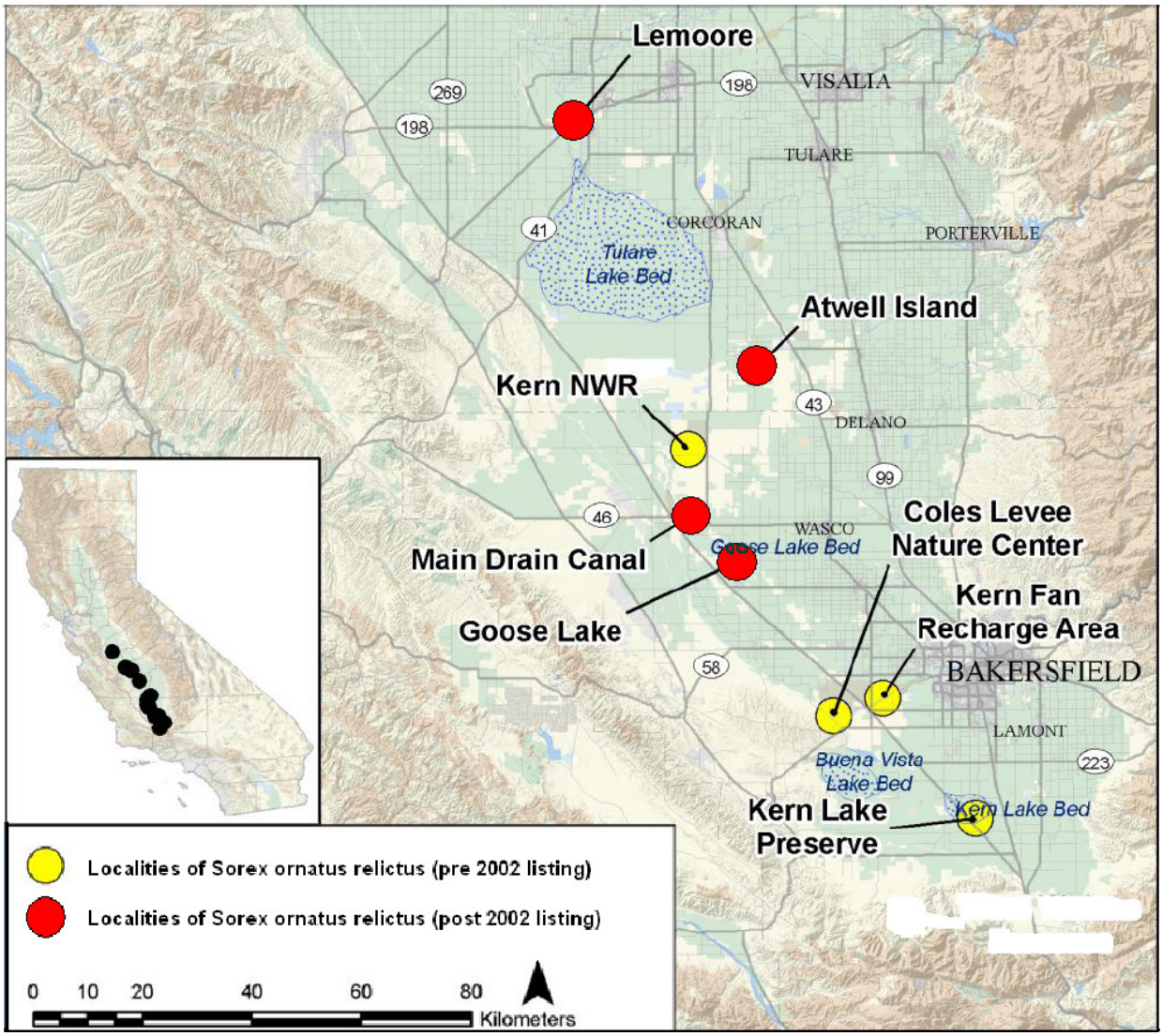

Figure 2: Buena Vista Lake Ornate Shrew Capture Locations 1999-2005 (Cypher, pers. comm. 2010, Maldonado pers. Comm. 2011)

Privately owned lands that may support Buena Vista Lake ornate shrews are located around Sand Ridge flood basin, Buena Vista Slough, and along the Kern River west of Bakersfield, California (J. Maldonado, Smithsonian Conservation Biology Institute, pers. comm., 1998, as cited in Williams and Harpster 2001; Service 1998; Williams and Harpster 2001). The small habitat patches within these areas would not likely support a significant number of animals (Maldonado, pers. comm., 1998, as cited in Service 2002). In addition, these areas represent highly disjunct and fragmented habitat that are unlikely to be reconnected to other areas containing suitable habitat in the foreseeable future.

Abundance

The abundance of the shrew is unknown due to the lack of regular surveys in areas of past occurrences and in areas possessing suitable habitat. To date, surveys for the shrew have been

conducted at twenty-one sites and shrews were found to be present in eight of them (Williams and Harpster 2001; Cypher, pers. comm. 2010; Maldonado, unpubl. data 2006). Surveys were only conducted in places containing very high quality shrew habitat and in places where access was allowed by the land owner. Based on these surveys, the shrew has been documented as far south as the Kern Lake preserve and as far north as Atwell Island (Cypher, pers. comm., 2011; Williams, ESRP, pers. comm., 2011). Population size and health cannot be estimated with the available data, but based on the scarcity of suitable habitat present in the San Joaquin Valley and the low number of specimens collected in areas with high quality habitat; the species is expected to be extremely rare (Maldonado, unpubl. data 2006). A summary of the locations and number of shrews captured from 1982 to 2010 is included as Appendix B. The small sample sizes obtained from each locality is a reflection of the rarity and difficulty of capturing shrews in these areas (Maldonado, unpubl. data 2006).

Habitat or Ecosystem

Buena Vista Lake ornate shrews prefer moist habitat with an abundance of leaf litter and dense herbaceous cover containing terrestrial and aquatic insect prey (Kirkland 1991; Ma and Talmage 2001). Maldonado (2004) also noted that he found a high percentage of the captured shrews were found within 1 meter of the water line and were closely associated with a dense, riparian understory which provides food, cover, and moisture.

Vegetation community types in which shrews were captured are non-native grassland, freshwater marsh, riparian forest, vernal marsh, and valley sink/scrub. Typical grass and shrubs in these communities include sedges (*Carex* ssp.), foxtail barley (*Hordeum murinum*), spikerushes (*Eleocharis* ssp.), black mustard (*Brassica nigra*), rushes (*Juncus* spp.), bromes (*Bromes ssp.)*, stinging nettle (*Urtica dioica*), mulefat (*Baccharis salicifolia*), bush lupine (*Lupinus albifrons*), wild rose (*Rosa californica*) along with cattails (*Typha* ssp.), tules (*Schoenoplectus acutus*), and other aquatic plants. Areas with an overstory of willows (*Salix* spp.) or cottonwoods (*Populus* ssp.) appear to be favored, but may not be an essential habitat feature (ESRP 2005).

Although agriculture and residential development has, and still does, account for a majority of development activity throughout the Central Valley, wetland restoration, mainly designed for waterfowl enhancement, has recently increased and resulted in the creation of areas with similar qualities to those which are productive for the shrew. These areas could potentially support suitable habitat for the shrew as they contain the moisture, dense vegetative cover, and invertebrate prey the shrews require as long as they remain wet year round. These areas do not always maintain perennial water and are drained when waterfowl are not present. Surveys of this habitat have not been conducted to investigate whether the shrews are currently or could ever inhabit these newly created wetland areas, but they appear to possess features ideal for shrew utilization (Cypher, pers. comm. 2011).

Other ornate shrews have been found outside of wetland habitat in more arid, upland communities, but upland natural communities are also extremely scarce and isolated on the San Joaquin Valley floor of the Tulare Basin. Historically these remnants of upland communities were once mostly seasonal wetlands, frequently flooded sand dunes, and low ridges in the delta of the Kern River. After impounding and diverting streams, draining marshes and lakes, and

widespread land-leveling for cultivation on the floor, those few, now water-deprived parcels have become occupied by more drought-tolerant species. Thus, while the remaining parcels supporting upland natural communities might provide low quality habitat for shrew, they do not provide the linkages between fragments of more suitable habitat to ensure connectivity of the historical gene pool (Williams and Harpster 2001).

Genetics

Despite their phenotypic similarity, ornate shrew populations have surprisingly high levels of genetic divergence which could prove useful for explaining the evolutionary history of their relationships (Maldonado et al. 2001, as cited in Service 2002). Genetic evaluations have been done on the ornate shrew complex (consisting of nine subspecies, seven of which only occur in California, one occurs in California and Baja California and one subspecies only occurs in Baja California) using analysis of mitrochondrial DNA sequences of the cytochrome b gene and protein allozymes (Maldonado et al. 2001). From these data, researchers determined that the ornate shrew complex is geographically structured into three haplotype clades (genetic groups) representing southern, central, and northern localities within California, with the Buena Vista Lake ornate shrew indentifying with the Central clade. From this genetic analysis, samples obtained from individual subspecies can be accurately identified within and between these three clades. Maldonado's 2004 univariate and multivariate statistical analyses of cranial measurements confirmed the validity of the 9 subspecies of ornate shrews. These results illustrate the importance of evaluating both morphological and genetic data when identifying ornate shrews within the range of the Buena Vista Lake ornate shrew.

Based on molecular data, Maldonado et al. (2001) found that populations in the northern clade diverged from the central and southern populations > 1 million years ago and genetically are more similar to neighboring populations of wandering shrews (*S. vagrans*). They suggest that the northern clade includes haplotypes from populations from a broad area north of the San Francisco Bay. The central clade contained haplotypes from coastal, valley, and Sierra Nevada populations north of the Tehachapi Mountains in central California and south of the San Francisco Bay area. The central clade included haplotypes from individuals attributable to *S. o. californicus, S. o. salarius, S. o. relictus,* and *S. o. ornatus*. The southern clade contained haplotypes from coastal populations in Santa Barbara, Ventura, Los Angeles, Orange, and San Diego counties, as well as the San Bernardino Mountains, the San Jacinto Mountains, and El Rosario marsh and the San Pedro Martir Mountains in Baja California. Sequences from Santa Catalina Island and the relictual Sierra de la Laguna populations are the most basal in the southern clade. This clade includes representatives of the subspecies *S. o. salicornicus, S. o. willetti, S. o. ornatus,* and *S. o. lagunae* (Maldonado, unpubl. data 2006).

Almost all populations possessed unique haplotypes which were not found in any other populations illustrating that these populations had been isolated from one another for some time. In the San Joaquin Valley region, gene flow is low among several populations and although one mitochondrial DNA haplotype is common and/or present in several localities, six other haplotypes had never been detected in the central ornate shrew clade and five of those haplotypes were unique to single populations (Maldonado, unpubl. data 2006).

Low estimates of inter-locality gene flow suggest that several of the southern San Joaquin populations have been genetically relatively independent for a long period of time. The net sequence divergence between southern and central clades is 4.2%. Assuming a mutation rate of 2% per million years (Wilson et al. 1985), the two clades diverged about 1.1 million years ago (Maldonado et al. 2001). The mean divergence between sequences within the central-southern San Joaquin Valley clade is 0.7%. These values correspond to divergence times of approximately 150,000 years. Furthermore, local populations must have remained sufficiently large to prevent the loss of genetic variation, despite opportunities for drift, but it is unlikely that these populations have remained large with the degree of habitat modification they have experienced over the past 50-100 years. Densities in shrew populations vary with seasons and available habitats, and ornate shrews have been reported to undergo occasional population outbreaks in areas where there is adequate habitat (Owen and Hoffmann 1983). In the past, an increase in densities with increase in available wetland habitat may have lead to periodic increases in the connectivity of small-sized but persistent local populations.

Maldonado's unpublished 2006 microsatellite data found 5 genetic clusters in the 117 samples collected from 10 localities in the central-southern San Joaquin Valley. These 5 clusters are: cluster 1- Tranquility and Helm, 2-Kern NWR, Kern Fan, Atwell, Goose Lake, and Lemoore, 3-Coles Levee, 4- Kern Lake, 5-Main Drain (Maldonado, unpubl. data 2006). The 5 clusters displayed the higher hierarchal level of population structure, suggesting that populations found south of Tranquility and Helm formed 4 distinct groupings of Buena Vista Lake ornate shrew (Maldonado, unpubl. data 2006) while populations at Tranquility and Helm are not the listed species.

Species-specific Research and/or Grant-supported Activities

There are only two groups conducting research on the shrew. Research and trapping has been conducted by the Endangered Species Recovery Program at California State University, Stanislaus intermittently from 1990 to 2005, and most recently in 2010. This effort was aimed at gathering a sampling pool for a status survey and phylogenetic analysis study of the shrew being conducted by Dr. Jesus Maldonado of the Smithsonian Institute. Dr. Maldonado is currently working to determine the genetic variability in subpopulations of shrews in the southern San Joaquin Valley using mitochondrial DNA and microsatellite loci. A few of the samples collected during this effort are currently pending analysis by Dr Maldonado.

Five-Factor Analysis

The following five-factor analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act.

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

At the time of listing, threats listed in this section were the loss of habitat due to agricultural and urban development and lack of water sufficient to maintain the riparian areas in which the shrew

is found. These factors are still relevant and are discussed briefly below.

Historically, the former Tulare, Buena Vista, and Kern lakes, along with their respective overflow marshes, covered 19 percent of the Tulare Basin in the southern San Joaquin Valley (Werschkull et al. 1992). Around the turn of the 20th century, the Tulare Basin had 104,890 ha (259,189 ac) of valley fresh water marsh, 177,005 ha (437,388 ac) of valley mixed riparian forests, and 105,333 ha (260,283 ac) of valley sink scrub, for a total of 387,229 ha (956,860 ac) of potentially suitable Buena Vista Lake ornate shrew habitat (The California Nature Conservancy 1984, cited in Service 1986). By the early 1980s, the combined total had been reduced to 19,019 ha (46,996 ac), less than 5 percent of the original habitat (Werschkull et al. 1992). As of 1995, intensive irrigated agriculture comprised 1,239,961 ha (3,064,000 ac) or about 96 percent of the total lands within the Tulare Basin.

All of the natural plant communities in the Tulare Basin have been affected by the alteration of the area for urban and agricultural development. As more canals are built, and more water is diverted for agricultural irrigation of the historic floodplains of the major rivers of the southern San Joaquin Valley, less water will be available to sustain the riparian and wetland areas the shrew relies on for all aspects of its life (Service 2002). Further, canals responsible for this diversion are steep-sided and kept free of vegetation making them unsuitable for the shrew (Williams and Kilburn 1992, as cited in Williams and Harpster 2001). Even the upland vegetation communities in the Tulare Basin have been affected and replaced by either agriculture or more drought tolerant plant species (Williams and Harpster 2001).

Water delivery to maintain the shrews remaining habitat cannot be assured in many areas because the natural water table has been lowered by past and present agricultural practices on and around these areas. In addition, water is supplied to a majority of the wetland areas in the San Joaquin Valley only during years of high runoff, at times when excess water is available at the end of the growing season, and after commercial crop needs are met (Service 2002). Without a dependable water supply required to sustain wetland communities and the surrounding mesic habitat, the continued existence of suitable habitat for the shrew at many locations is unlikely.

The passage of the Central Valley Project Improvement Act in 1992 provided eight federal refuges and five state refuges and duck clubs with a reliable source of water and a network of waterways to transport this water helping ensure the existence of these wetland areas, but a majority of the known localities of the shrew still have uncertain water resource availability.

Other ornate shrews have been found outside of wetland habitat in more arid, upland communities, but upland natural communities also are extremely reduced and isolated in small parcels on the San Joaquin Valley floor of the Tulare Basin. Thus, while the remaining parcels supporting upland natural communities might provide low quality habitat for shrew, they do not provide the linkages between fragments of more suitable habitat to ensure connectivity of the historical gene pool (Williams and Harpster 2001).

One of the recovery criteria for the species in the Service's 1998 Recovery Plan for Upland Species of the San Joaquin Valley, California is that there be at least 2000 acres of occupied habitat under protection at three or more disjunct sites. The Service is in the process of re-

designating critical habitat for the species with the addition of 4,565 acres at 4 new sites to the previously designated 84 acres at the Kern Lake Preserve. Although the shrew has been found at the five proposed locations as well as three other locations which have some form of protection which total far more than the acreage in the recovery criteria, the amount of habitat occupied by the species at these localities is unknown due to a lack of studies conducted to assess the numbers and health of the populations. Until these areas have been thoroughly surveyed and found to be occupied by the shrew in sufficient numbers to sustain a population, this criteria cannot be considered met.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for commercial purposes was not known to be a factor at the time the species was listed and is not believed to be of concern presently (Service 2002). The species has no known commercial or recreational value; therefore, overutilization by these methods does not appear to be a threat at this time.

Trapping of the shrew for scientific research has resulted in several fatalities since its discovery in 1986. Animals captured in the traps are often left exposed to extremes in both heat and cold, vulnerable to predators, subject to an increased risk of starvation or desiccation, as well as subject to a high level of stress (Pearson et al 2003). Any of these stressors could result in the mortality of the shrew and could be responsible for the high numbers of fatalities in trapping efforts. Efforts need to be made to reduce the likelihood of mortality of the shrew during trapping efforts to allow researchers to collect crucial biological and ecological data without resulting in the death of the animal.

FACTOR C: Disease or Predation

At the time of listing there were no reported cases of disease related to the shrew documented, and none have been identified since, although the possibility of disease and associated threats does exists. The small population size, low gene flow, and restricted distribution increase their vulnerability to epidemic diseases. The shrew, like most small mammals, are host to numerous internal and external parasites, such as round worms, mites, ticks, and fleas, which may infest individuals and local populations in varying degrees with varying adverse effects (Churchfield 1990; J. Maldonado, pers. comm., 1998, as cited in Service 2002). However, the significance of the threat of disease and parasites to the shrew is not known.

Most vertebrate carnivores of the Tulare Basin, such as coyotes (*Canis latrans*), foxes (*Vulpes spp.*), long-tailed weasels (*Mustela frenata*), raccoons (*Procyon lotor*), feral cats (*Felis cattus*), and dogs (*Canis familiaris*), as well as certain avian predators such as hawks (*Buteo sp.*), owls (*Strigidae sp.* and *Tytonidae sp.*), herons (*Ardea sp.*), jays (*Corvidae sp.)*, and egrets (*Egretta sp.*), are all known predators of small mammals. While many predators find shrews unpalatable because of the distasteful secretion and offensive odor from their flank glands and feces, several of the avian predators, such as barn owls (*Tyto alba*), short-eared owls (*Asio flammeus*), long-eared owls (*Asio otus*), and great horned owls (*Bubo virginianus*), have a poor sense of smell and are known to prey on shrews (Ingles 1965; Aitchison 1987; Marti 1992; Holt and Leasure 1993;

Marks et al. 1994; Houston et al. 1998), and probably Buena Vista Lake ornate shrews (Maldonado, pers. comm., 1998, as cited in Service 2002). The overall impact that predation may have on the number of individuals and densities of the shrew remains unknown.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

The Endangered Species Act of 1973, as amended (Act), is the primary Federal law that provides protection for the Buena Vista Lake ornate shrew. As described above, since the animal's designation as an endangered species, a number of projects have undergone review under section 7 of the Act. 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. To jeopardize the continued existence of a species means to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild. If it is determined the proposed project will not result in jeopardy to the affected listed species, the Service may require the agency to implement reasonable and prudent measures, along with the terms and conditions, to minimize the amount of incidental take. Incidental take is the take of a listed species that are incidental to, but are not the purpose of an otherwise lawful activity. If a Federal agency is not involved in the project, and federally-listed species may be taken as part of the project, then the project proponent should obtain an incidental take permit pursuant to section 10(a)(1)(B) of the Endangered Species Act. The Service may issue such a permit upon completion of a satisfactory habitat conservation plan for the listed species that would be taken by the project.

Under section 404 of the Clean Water Act (CWA) (33 U.S.C. 1344 et seq.), the U.S. Army Corps of Engineers (Corps) regulates the discharge of fill material into waters of the United States, including wetlands. Section 404 regulations require applicants to obtain a permit for projects that involve the discharge of fill material into waters of the United States, including wetlands. However, many farming activities do not require a permit due to their exemption under the CWA (53 FR 20764; R. Wayland III, Environmental Protection Agency (EPA), in litt. 1996). Projects that are subject to regulation may qualify for authorization to place fill material into headwaters and isolated waters, including wetlands, under several nationwide permits. The use of nationwide permits by an applicant or project proponent is normally authorized with minimal environmental review by the Corps. No activity that is likely to jeopardize the continued existence of a threatened or endangered species, or that is likely to destroy or adversely modify designated critical habitat of such species, is authorized under any nationwide permit. An individual permit may be required by the Corps if a project otherwise qualifying under a nationwide permit would have greater than minimal adverse environmental impacts (Service 2002).

Recent court cases may further limit the Corps' ability to utilize the CWA to regulate the fill or discharge of fill or dredged material into the aquatic environment within the current range of the shrew (Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers, 531 U.S. 159 (2001) (SWANCC)). The effect of SWANCC on the Corps ability to regulate activities on wetlands within the range of the shrew has not been determined by the Corps, but these wetlands could be determined to be ``isolated'' and, therefore, not subject to the CWA because these wetlands do not currently drain to a navigable water of the United States, or may otherwise be shown to have little connection to interstate commerce (Service 2002).

In addition, common activities such as ditching within aquatic habitats in the area may not be subject to the CWA provided such activities do not deposit more than minimal ``fallback'' into the aquatic environment. The Corps typically confines its evaluation of impacts only to those areas under its jurisdiction (i.e., wetlands and other waters of the United States) (Service 2002).

National Environmental Policy Act (NEPA) (42 U.S.C. 4371 *et seq*.) provides some protection for listed species that may be affected by activities undertaken, authorized, or funded by Federal agencies. Prior to implementation of such projects with a Federal nexus, NEPA requires the agency to analyze the project for potential impacts to the human environment, including natural resources. In cases where that analysis reveals significant environmental effects, the Federal agency must propose mitigation alternatives that would offset those effects (40 CFR 1502.16). These mitigations usually provide some protection for listed species. However, NEPA does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public.

The California Environmental Quality Act (CEQA) (Public Resources Code Sec. 2100021177) requires a full disclosure of the potential environmental impacts of proposed projects. The public agency with primary authority or jurisdiction over a project is designated as the lead agency and is responsible for conducting a review of the project and consulting with the other agencies concerned with the resources affected by the project. Section 15065 of the CEQA Guidelines, as amended, requires a finding of significance if a project has the potential to ``reduce the number or restrict the range of a rare or endangered plant or animal.'' Once significant effects are identified, the lead agency has the option of requiring mitigation for effects through changes in the project or to decide that overriding considerations make mitigation infeasible (CEQA Sec. 21002). In the latter case, projects may be approved that cause significant environmental damage, such as destruction of listed endangered species and/or their habitat. Protection of listed species through CEQA is, therefore, dependent upon the discretion of the agency involved. However, the Buena Vista Lake shrew is not listed as an endangered, threatened, or candidate species under the California Endangered Species Act (Service 2002).

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

When the shrew was listed in 2002, other natural and manmade threats to the species were hybridization, selenium toxicity, and exposure to pesticides. Since its listing, climate change and lack of gene flow have emerged as potential threats to the survival of the species.

Hybridization with Other Subspecies

If shrew population ranges overlap or come in contact through expansion, then hybridization may occur in closely related species and certain subspecies (Rudd 1955a). Over time, a population of a subspecies could become genetically indistinguishable from a larger population of an intruding subspecies such that the true genotypes of the invaded subspecies no longer exist (Lande 1999). Apparent hybrids have been recorded between two subspecies of ornate shrew, the California ornate shrew (*Sorex. ornatus californicus*) and the Suisun Marsh ornate shrew (*S. o. sinuosus*), found on the northern side of the San Pablo and Suisun bays in Solano County, California (Rudd 1955a; Hays 1990). Although there is no documented evidence of hybrids, the

possibility exists for introgression between the upland Southern California ornate shrew and the lowland Buena Vista Lake ornate shrew.

Selenium Toxicity

As addressed in the listing document (Service 2002), selenium toxicity represents a serious threat to the continued existence and recovery of the shrew throughout the Tulare Basin. The soils on the western side of the San Joaquin Valley have naturally elevated selenium concentrations. Due to extensive agricultural irrigation, selenium has been leached from the soils and concentrated in the shallow groundwater along the western side of the San Joaquin Valley. In areas where this groundwater reaches the surface or subsurface, selenium can accumulate in both plants and animals. Selenium can then enter the food chain of the shrew by becoming concentrated in insects that forage on the vegetation or reside in soils that concentrate these salts and result in adverse effects to growth, reproduction, and survival of the shrew (Saiki and Lowe 1987; Moore et al. 1989). Elevated concentrations of selenium in insects have been measured in many potential Buena Vista Lake shrew prey species such as brine flies (Ephydridae), damselflies (Zygoptera), midges (Chironomidae), and other insects collected at 22 agricultural drainage evaporation ponds throughout the Tulare Basin, including ponds a few miles west of the Kern Preserve and along the northern border of the Kern NWR (Moore et al. 1989).

Exposure to Pesticides

The shrew is exposed to the wide-scale use of pesticides throughout its range, as they currently exist on small remnant patches of natural habitat in and around the margins of an otherwise agriculturally dominated landscape. The shrew could be directly exposed to lethal and sub-lethal concentrations of pesticides from drift or direct spraying of crops, canals and ditch banks, wetland or riparian edges, and roadsides where shrews might exist. Reduced reproduction in shrews could be directly caused by pesticides ingested through grooming, and secondarily from feeding on contaminated insects (Sheffield and Lochmiller 2001). Shrews could also die from starvation by the loss of their prey base (Ma and Talmage 2001).

Limited Gene Flow

Due to its low population numbers and the high degree of habitat fragmentation in the San Joaquin Valley the shrew is particularly vulnerable to a sudden change in its environment whether it be a natural event such as extreme weather or anthropogenic changes such as the introduction of a non-native species, chemical runoff or spill, or development of an important area. Limited gene flow and genetic variation in a population has the capacity to limit the species ability to adapt to drastic environmental events, can result in lower breeding success and inbreeding all of which decrease the fitness and survivability of the shrew.

Climate Change

Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). However, predictions of climatic

conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. Due to the shrews reliance on dense riparian vegetation, continuing diversion of water from wetland areas for agricultural use, and that its decline was greatly attributed to the loss of wetland habitat required for its survival, it can be assumed that increased drying of its home range could place immense stress on the species. While we recognize that climate change could have many potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time.

III. SYNTHESIS

When the Buena Vista Lake ornate shrew was listed as endangered in 2002, the primary threat to its survival and recovery was habitat loss (Service 2002). Since then, industrial and agricultural development, urbanization, and lack of allocation of water to riparian and wetland areas have continued to reduce the amount of suitable habitat for the shrew. Selenium toxicity continues to be a threat to the continued existence and recovery of the species. Climate change has also been identified as a potential new threat to the conservation status of the subspecies. Restricted to wetland and riparian communities in the Southern San Joaquin Valley, the shrew currently occurs only in eight of the remaining small and isolated parcels of wetland, riparian, and saltbrush scrub communities. About 96 percent of the original range is no longer suitable for the shrew. Despite the development of reliable water sources for a few of its localities and creation of protected wetland areas (primarily for waterfowl), the shrew is still extremely rare. While the shrew has recently been reported to occur at four sites not included in the listing, not a single one of those sites could be categorized as having large tracts of occupied habitat or a stable or increasing population of shrews. There have still been no monitoring or population studies conducted on the shrew and the biology of the subspecies and keys to effective habitat management remain poorly understood. In summary, based on the highly restricted range of the shrew, the continuation of habitat loss/conversion, the persistence of threats and the identification of new threats, the current protection of only a small portion of the shrews habitat, and the distribution of small populations in highly isolated fragments, we conclude that the Buena Vista Lake ornate shrew continues to meet the definition of endangered.

IV. RESULTS

Recommended Listing Action:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (indicate reason for delisting according to 50 CFR 424.11):
    ____ *Extinction*
    ____ *Recovery*
    ____ *Original data for classification in error*
__X__ No Change

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

Habitat Conservation and Restoration Recommendations

The long-term persistence of the shrew depends first and foremost upon the preservation of riparian and wetland communities in the southern Tulare Basin (south of Tulare Lake bed) and enhancing the size and connectivity between the small and isolated habitats where the shrew is currently found. This can be accomplished by restoring wetlands for migratory waterfowl, developing water recharge facilities, and maintaining and managing flood channels, sloughs, and drainage ditches in the Tulare Basin (Williams and Harpster 2001). These features are some of the few areas in the San Joaquin Valley that possess the water the shrew needs to survive and if riparian and wetland vegetation communities could be established, enhanced, or preserved, the species could begin to colonize and move towards recovery.

Estimate Population Sizes at Existing and Potentially Inhabited Sites

The shrews found at Coles Levee Ecosystem Preserve and Kern Fan water recharge area could represent portions of a single population, which ESRP refers to as the Kern Fan population. The population sizes and the distribution of shrews at occupied areas should be estimated using capture-recapture population estimation models. This will require developing access agreements between researchers, the Kern NWR, Goose Lake Holding Company (Goose Lake), the City of Bakersfield (Kern Fan water recharge area), Aera Energy (Coles Levee ecosystem), the Bureau of Land Management (Atwell Island), the Lemoore Wetland preserve (Natural Resource Conservation Service), California Department of Fish and Game (Main Drain Canal), and the Boswell Corporation (Kern Lake Preserve), and use of a trapping technique that minimizes the chance of mortality (Hays 1998 as cited in Williams and Harpster 2001). Standardization of the time of year, bait, type of traps, and standard number of traps per unit of area for each of the area should be established to help ensure unbiased data and a higher likelihood of success. Temporarily marking individuals by clipping fur would allow the application of capture-recapture population models to estimate population sizes (Williams and Harpster 2001).

The potential for shrews to occur on past and presently irrigated farmland, waterfowl enhancement areas, and in other wetland areas in the Southern San Joaquin Valley should be investigated with an established survey technique. Selected sites located within the historic

range of the shrew should be surveyed to determine if they are occupied by shrews. Information from this investigation should be combined with information from previous studies to determine the population status of the shrew (Williams and Harpster 2001).

Coupled with the above mentioned research should be periodic population monitoring at sites known to be occupied, using the same protocol that is used for estimating population sizes. Surveys should be carried out every 3-5 years to be able to determine if any change in status is taking place over time. Change in status, if any, can be used to determine if any conservation measures that are adopted are working appropriately or need adjustments. These data, together with information on the geographic extent and isolation of subpopulations can be used to estimate their viability (Williams and Harpster 2001).

Connectivity between Populations

One of the most important actions for the preservation of the shrew is to establish connectivity between populations. Currently, connectivity between populations is virtually nonexistent due to extensive development of the wetland areas that historically covered 19 percent of the Tulare basin to their presently fragmented and imperiled state. Habitat connectivity is essential to the survival and recovery of the species as it allows for migration among populations and provides some genetic variation between populations. This variability reduces the likelihood of inbreeding and can make a population more resistant to sudden climactic changes and disease if resistance to such events is possessed by one population and not the other. Although there are many barriers for shrew migration between localities, mainly actively farmed land and residential neighborhoods, the extensive network of channels, canals, and sloughs used for irrigation, could offer an avenue for connection between occupied areas if suitable habitat is established or preserved.

Opportunity for restoring connectivity seems to be poor between the Kern River-Coles Levee population and that at Kern Lake (Williams and Harpster 2001). Historically, Buena Vista and Kern lakes were connected by a broad slough and wetland. Remnants of this slough, called Connecting Slough, may still exist but provide no habitat linkage to the Gator Pond area of historical Kern Lake (Williams and Harpster 2001). Most of the pieces of the Connecting Slough shown on maps have been filled and cultivated. However, at the southern boundary of the broader historical connecting wetlands is found the water-conveyance structure, New Rim Ditch is connected to and immediately adjacent to Old Rim Ditch, and together they connect the beds of Buena Vista and Kern lakes (Williams and Harpster 2001). Other canals connect these ditches to the Buena Vista Aquatic Recreation Area at the north edge of Buena Vista Lake bed (Williams and Harpster 2001). There is no appropriate habitat along these canals and ditches to currently provide population connectivity between the two lake beds. However, restoring appropriate habitat in the Buena Vista Aquatic Recreation Area and along the Inlet Canal between the Recreation Area and Coles Levee Ecosystem Preserve could be accomplished on public lands with relatively little cost (Williams and Harpster 2001). It would take a broader group of cooperators and involve private entities to accomplish habitat connectivity with Kern Lake, yet preservation of both populations may depend on this connectivity, and preservation is critical to the long-term conservation of the shrew (U.S. Fish and Wildlife Service 1998).

Reestablishing connectivity between the Goose Lake, Kern NWR, and other potential habitat areas for shrew around the Tulare and Goose lake beds with the Kern River-Coles Levee Ecosystem Preserve area is more difficult unless actively farmed ground is inhabited. Although there are several canals and sloughs in the corridor area, to our knowledge no combination is particularly suitable for restoring habitat connectivity (Williams and Harpster 2001). The Kern River flood channel that used to empty into Tulare Lake, known now as the Kern River Flood Canal or the Buena Vista Slough is the only continuous structure in existence. This former slough is channelized as a narrow canal for most of its length. Parts are dry for several years at a time and offer no mesic plant communities as habitat for shrews (Williams and Harpster 2001). Other parts routinely carry salt-laden drain water with relatively high concentrations of toxic compounds (Williams and Harpster 2001).

Goose Lake Canal and various historical channels of the Kern River between Goose Lake and Kern NWR perhaps also provide opportunity for reestablishing population connectivity between these two areas and increasing the size and distribution of the shrew populations in that area. It is possible that shrews still are extant in Jerry Slough today. If not, opportunity for reconnecting these areas with Kern NWR and reestablishing shrew populations should be sought in light of a wetland restoration and enhancement project occurring in the Goose Lake area (Germano and Tabor 1993; Williams and Harpster 2001). Several other initiatives in the Tulare Basin to preserve and enhance seasonal wetlands and to develop wetlands in water recharge areas have the potential to greatly enhance populations of the shrew by providing connectivity between localities.

Develop Agreements with Private Entities to Assess and Protect Areas with Potential Habitat.

One of the most important challenges for meeting conservation goals is gaining access to trap shrews and estimate population sizes and distribution on private lands. There are many areas throughout the Southern San Joaquin Valley that may have high quality shrew habitat but have not been surveyed. The Goose Lake-Jerry Slough Area (Semitropic Water District), Creighton Ranch (Boswell Corporation), Sand Ridge Flood Retention Basins (Bowell Corporation) and various remnant river channels, canals, sloughs and wetlands between the main channel of the Kern River and the Goose Lake bed all possess potential habitat and if inhabited could help provide connectivity between populations (Williams and Harpster 2001). Through collaboration with landowners each of these areas should be surveyed and assessed for their potential to contribute to the conservation and recovery of the shrew, including potential habitat linkages between known populations.

Develop Management Plans and Agreements with Land Owners and Managers

Long-term conservation of the shrew requires that their habitat be maintained at sufficient size and quality to ensure survival. It is presently unknown how large the area or the minimum population size required to ensure the health of a population, but the preceding recommendations on population surveying and monitoring, if implemented, should provide information for estimating viability (Williams and Harpster 2001). Maintaining persistence on private lands will require developing conservation easements, memoranda of understanding, or other vehicles that ensure the availability of suitable water supplies for maintaining plant communities that provide

habitat for shrews. For state and federal properties, it will require adoption of management goals and practices that ensure maintenance of habitat for shrews. For example, the California Dept. of Water Resources and Kern County should cooperate on creating and enhancing habitat for the shrew and other wetland terrestrial species at the Buena Vista Lake Aquatic Recreation Area (Williams and Harpster 2001). Critical habitat for the shrew is currently being revised and possibly expanded at several occupied areas and its' designation will also help ensure the conservation and recovery of the species. More generally, opportunities should be sought to ensure water supplies sufficient to maintain the wetland and riparian communities and promote preservation, protection, and expansion of wetlands in the Tulare Basin, particularly the Valley-floor sloughs, channels, and lakes of the Kern River.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW

Buena Vista Lake Ornate Shrew (*Sorex ornatus reticulus*)

Current Classification: Endangered

Recommendation Resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change needed

Review Conducted By: Tyler Willsey

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve _____ Date 8 Sept 2011

Appendix A:

Description of Buena Vista Lake Shrew Localities

Site Name	Description
Kern NWR	Located 18 miles west of the city of Delano in the San Joaquin Valley of California. The 11,249-acre Kern refuge is owned by the U.S. Fish and Wildlife Service and consists of natural valley grasslands, a relict riparian corridor, and developed marsh. The Service manages the area for migrating birds, shorebirds, marsh and waterfowl as well as for upland species (Service 2011).
Kern Fan Water Recharge Facility	A 2800 acre facility is run to replenish the ground water supply, provide flood control, and create wildlife habitat in the Southern San Joaquin Valley. The site is bordered to the Northeast by agricultural lands, to the northwest by the Kern Water Bank, and by the Kern River to the South. It is owned and operated by the City of Bakersfield (Hopkins et al. 2004).
Atwell Island	Owned by BLM and consists of 7,000 acres located just south of Alpaugh, Tulare County, and is situated near the Pixley National Wildlife Refuge and the Kern National Wildlife Refuge in the southeastern portion of now-drained Tulare Lake. It was created by the Central Valley Project Improvement Act of 1992 which authorized a land retirement program to determine the responses of wildlife to restoration efforts on areas extensively used for agriculture. BLM is restoring native valley grassland, wetland, and alkali sink habitats on an area that for the past century was covered by fields of cotton, oats, and alfalfa (Bureau of Land Management 2011).
Lemoore Wetland Preserve	A site owned by NRCS as part of their wetland reserve program. The site was created to provide a place for city storm water to percolate and drop contaminants to shield the Kings River during years of flood run-off. It is also operated for wetland enhancement. This includes planting of native species, removal of invasive species, and the installation or enhancement of irrigation ditches to ensure proper water availability (Natural Resource Conservation Service 2011).
Kern Lake Preserve	Is a privately held area owned by J.G. Boswell Corporation and is the site furthest south known to contain BVLS. The shrew was rediscovered at this site in 1981. This site contains Gator pond which is thought to contain high numbers of BVLS but has not been surveyed recently.
Coles Levee Ecosystem Preserve	The Coles Levee Ecosystem Preserve consists of 6,059 acres of threatened and endangered species habitat located in California's southern San Joaquin Valley about 20 miles southwest of Bakersfield. Established in 1992 by Arco and the California Department of Fish & Game, the Preserve was acquired in 1998 by Aera Energy LLC. It encompasses the last two miles of riparian habitat along the Kern River before it enters the Buena Vista Lake (Aera Energy LCC 2010).

Site Name	Description
Goose Lake	Is a former lake bed owned by Goose Lake holding Co and the Semitropic Water Storage District. A biological opinion was rendered on the site for a project aimed at the restoration of 650 acres and the enhancement of an additional 575 acres of wetland habitat in 2006 (Service 2004).
Main Drain/ Chicca and Sons	Is part of the Semitropic ecological reserve owned by the California Department of Fish and Game in Buttonwillow, Ca, 7 miles South of the Kern NWR. The major vegetation types at the site include valley saltbush scrub and valley sink scrub. The property also contains a canal which although it is sparsely vegetated, contains areas suitable for the BVLS and has hosted successful trapping excursions.

Appendix B:

Number and Locations of Buena Vista Lake Ornate Shrews Captured 1986-2010

Report Name	Source	Date of survey	Sites Surveyed	# BVLS captured
Nature Conservancy small mammal inventory on the Paine Wildflower Preserve and the Voice of America in Kern County, California	Clark et al. 1982	1982	Paine Wildflower Preserve Voice of America Site, Delano	0 0
Incidental trapping	Williams and Harpster 2001	1986	Kern Lake Preserve Kern National Wildlife Refuge	2 1
Status of the San Joaquin Kit Fox (*Vulpes macrotis mulica)* in the urban Kern River Parkway, Bakersfield, California.	Beedy et al. 1992	1987	Kern River Parkway	0
An investigation of the distribution and abundance of the Buena Vista shrew	Center for Conservation Biology 1990	1988-1989	Kern Lake Preserve	25
Maldonado Survey	Maldonado 1992	1992	Tule Elk State Reserve	0
Incidental trapping	Williams and Harpster 2001	1992 and 1994	Kern National Wildlife Refuge	3
Surveys for the Buena Vista Lake shrew at the Kern National Wildlife Refuge	Maldonado et al. 1998	1998	Kern National Wildlife Refuge *	2

Report Name	Source	Date of survey	Sites Surveyed	# BVLS captured
Status of the BVLS	Williams and Harpster 2001	1999-2001	Pixley Wildlife Refuge Kern Fan Water Recharge Facility * Buena Vista Lake recreation Area Kern National Wildlife Refuge * Coles Levee Ecosystem Preserve * Lake Woollomes	0 2 0 5 9 0
Status Survey and Phylogenetic Analysis of the Buena Vista Lake Shrew*	Maldonado 2006	1990-2005	Goose Lake Kern National Wildlife Refuge Coles Levee Ecosystem Preserve Kern Fan Water Recharge Facility Atwell Island Lemoore Wetland Preserve Main Drain Canal/ Chicca and Sons Windwolves Preserve Kern Lake Preserve Los Banos Wildlife Area Tranquillity Helm	11 7 8 2 5 5 2 0 17 0 0 0
Survey of Area Between Kern and Buena Vista Lakes	ESRP	2004	Bureau of Land Management Parcel	0
Ornate shrew surveys conducted in the Southern San Joaquin Valley ESRP	ESRP 2005	2005	Coles Levee Ecosystem Preserve * Goose Lake * Kern Water Bank Lemoore Wetland Recovery Program * Main Drain Canal/ Chicca and Sons * Windwolves Preserve	1 7 0 7 2 0
ESRP- Trapping at Windwolves Preserve	ESRP 2010	2010	Windwolves Preserve	0

* Data collected by ESRP and analyzed in Maldonado 2006 report.

Appendix C:

Lakes, waterways, natural lands, and conservation areas in the Tulare Basin, California. (Williams and Harpster 2001)