Desert Slender Salamander
(*Batrachoseps major aridus*) (=*B. aridus*)

5-Year Review:
Summary and Evaluation

Desert slender salamander (*Batrachoseps major aridus).* Photo credit: Mario Garcia-Paris

U.S. Fish and Wildlife Service
Carlsbad Fish and Wildlife Office
Carlsbad, CA

January 31, 2014

5-YEAR REVIEW
Desert Slender Salamander
(Batrachoseps major aridus)

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 Federal List of Endangered and Threatened Wildlife, 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:

Desert slender salamander (*Batrachoseps major aridus*) is a small, subterranean amphibian from the Plethodontidae (lungless salamander family). This rare species is known from only two canyons on the lower desert slopes of the eastern Santa Rosa Mountains in Riverside, California. Though specific threats to the desert slender salamander were not identified in the listing rule, habitat loss due to erosion, fire, nonnative plants, groundwater pumping, overutilization for scientific purposes, disease, drought or climatological changes, and small population size were described in the Recovery Plan (USFWS 1982) and the previous 5-year review (USFWS 2009). Potential threats also included collection of individuals and disease. No threats have been ameliorated, though there is currently less concern associated with fire, groundwater pumping, and overutilization for scientific purposes. Erosion of the habitat remains the primary threat to this species at Hidden Palm Canyon. This population is presumed to be extant, though it has not been observed since 1997. The habitat at Hidden Palm Canyon is protected within a State ecological reserve that is owned by the California Department of Fish and Wildlife (CDFW). The second known population is presumed extant at Guadalupe Canyon, which is owned by the Bureau of Land Management (BLM) within the Santa Rosa Wilderness Area. Both canyons are encompassed within the Santa Rosa and San Jacinto Mountains National Monument area.

The desert slender salamander was listed as endangered under the Act in 1973, and was listed as endangered by the State of California in 1971, pursuant to the California Endangered Species Act.

Methodology Used to Complete This Review:

This review was prepared by Susan North of the Carlsbad Fish and Wildlife Office, using a modified template from Region 8 guidance issued in March 2008. We used information from the Listing Rule (USFWS 1973), Desert Slender Salamander Recovery Plan (USFWS 1982), the most recent 5-year review (USFWS 2009), observations by field office staff, internal documents and files, and published manuscripts. We also had extensive communications with researchers and species experts, including Dr. David Wake (University of California, Berkeley); Jack Crayon and Eddy Konno (CDFW); Mark Massar (BLM); and Allan Muth and Mark Fisher (Boyd Deep Canyon Desert Ranch Research Center). We received no comments from the public in response to our **Federal Register** (FR) notice initiating this 5-year review. 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 the 2009 5-year review. We focus on current threats to the species pursuant to the five listing factors in the Act. This review synthesizes 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 herein recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years and any necessary change in the Recovery Priority Number for the species.

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Federal Register 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 April 1, 2013 (USFWS 2013a, p. 19510). No responses relevant to the desert slender salamander were received regarding the initiation of this 5-year review.

Listing History:

Federal Listing
FR Notice: 38 FR 14678 (USFWS 1973)
Date of Final Rule: June 4, 1973
Entity Listed: Desert slender salamander *(Batrachoseps aridus)*, an amphibian species
Classification: Endangered
Critical Habitat: Critical habitat has not been designated for this species.

State Listing

Desert slender salamander *(Batrachoseps aridus)* was listed as endangered by the State of California in 1971.

Associated Rulemakings: None.

Review History:

The Service initiated status reviews for the desert slender salamander in 1979, 1985, and 1991 (USFWS 1979, p. 29566; USFWS 1985, p. 29907; USFWS 1991, p. 56882); all reviews were completed with no recommended change in status. In 2009, a 5-year review of the desert slender salamander was completed in response to a notice initiating the review published on February 14, 2007 (USFWS 2007, pp. 7064–7068); no change in status was recommended (USFWS 2009, pp. 1–15).

Species' Recovery Priority Number at Start of 5-year Review:

The recovery priority number for the desert slender salamander is 8 according to the Service's 2013 Recovery Data Call, based on a 1–18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (USFWS 1983a, pp. 43098–43105; USFWS 1983b, p. 51985). This number indicates that the taxon is a species that faces a moderate degree of threat and has a high potential for recovery.

Recovery Plan or Outline:

Name of plan: Recovery Plan for the Desert Slender Salamander
Date: August 12, 1982
Date of previous revisions: None

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) Policy:

The Act defines "species" as including any subspecies of fish, wildlife, or plants, and any DPS of any species of vertebrate wildlife. This definition of species under the Act limits listing as a DPS to species of vertebrate fish or wildlife. The 1996 Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Act (USFWS 1996, p. 4722) clarifies the interpretation of the phrase "distinct population segment" for the purposes of listing, delisting, and reclassifying species under the Act.

The desert slender salamander is not listed as a DPS. The 2009 5-year review stated that no new information was available that would lead the Service to reconsider the classification of this subspecies with regard to designation as a DPS under the 1996 DPS policy (USFWS 2009, p. 2). There is currently no new information regarding the application of the DPS policy to the desert slender salamander, and the DPS policy is not addressed further in this review.

Information on the Species and its Status:

Species Description

Desert slender salamander is a small, subterranean amphibian, from the Plethodontidae (lungless salamander family). Species from this family breathe entirely through their thin moist skin, and have a unique tooth pattern (family name meaning "many teeth") (Stebbins 2003, p. 168). Salamanders from the genus *Batrachoseps* (slender salamanders) are sometimes referred to as "worm salamanders" due to the slim form, segmented appearance, and small limbs of some species (Stebbins 2003, p. 182). Male slender salamanders have a blunt snout, with premaxillary teeth perforating the upper lip (Stebbins 2003, p. 183).

Adult desert slender salamanders are less than 4 inches (in) (10.2 centimeters (cm)) in total length, with a snout to vent (body) length of about 1.9 in (4.8 cm), and a tail length of approximately 1.9 in (4.8 cm) (Brame 1970, pp. 2–4; USFWS 1982, p. 2). The short tail has 16 to 19 costal grooves (18 on average), with 3.5 to 6.5 costal folds between adpressed limbs (Stebbins 2003, p. 189). Desert slender salamanders are sexually dimorphic in that the female is slightly larger in size and the male possesses papillate (minute protuberance) vents (Brame 1970, p. 4). The desert slender salamander is distinguished from other species by a distinctive ventral (underside) color of blackish maroon on the belly and gular area, contrasted with a flesh-colored tail venter (underside or abdominal area) (Brame 1970, pp. 2–4). The dorsum (upperside) is blackish maroon with a suffusion of silver- to brass-colored iridophores (shiny flecks) interspersed with larger patches of metallic golden-orange iridophores (Brame 1970, p. 4). Young are black to dark brown, and typically lack the brassy tint of adults (Stebbins 2003, p. 189). Other distinguishing characteristics include a large, rounded head (0.25 in (6.5 millimeters (mm)) wide; 0.43 in (10.8 mm) long), and relatively longer legs when compared with those of the nearest congener, the garden slender salamander (*Batrachoseps major major*) (Stebbins 2003, pp. 188–189).

Changes in Taxonomic Classification or Nomenclature

The desert slender salamander was initially described as *Batrachoseps aridus* (Brame 1970) and was listed as such in 1973 (USFWS 1973, p. 14678). Genetic analysis and morphological assessments of specimens collected from one of the two known populations indicate that the taxon is better treated as one of two subspecies of *B. major* (southern California slender salamander) (Wake and Jockusch 2000, pp. 105–110). The authors of this study recommended the reclassification of desert slender salamander as *B. m. aridus*, and the more widely distributed garden slender salamander as *B. m. major* (Wake and Jockusch 2000, p. 110). These recommendations have been accepted by the American Society of Ichthyologists and Herpetologists, the Herpetologists' League, and the Society for the Study of Amphibians and Reptiles in the official list of scientific and standard English names for amphibians and reptiles of North America north of Mexico (Crother *et al.* 2012, p. 25).

Currently the desert slender salamander is listed in the Code of Federal Regulations at 50 CFR 17.11 as a species, *Batrachoseps aridus*. As part of the completion of this 5-year review, the Carlsbad Fish and Wildlife Office will submit a recommendation that 50 CFR 17.11 be amended to indicate that the desert slender salamander is recognized as *B. major aridus*, a subspecies. Recognition at the rank of subspecies does not alter the description or range of the listed entity. We hereafter refer to the listed entity as *B. major aridus* (desert slender salamander).

Species Distribution

The *Batrachoseps* genus is composed of 21 species, which are distributed from Oregon to Baja California, with 20 species occurring in California (Wake 2006, pp. 15–16; Crother *et al*. 2012, pp. 24–25; Jockusch *et al*. 2012, p. 1). At the time of listing, the desert slender salamander subspecies was known from only one small area (estimated to be less than 1 acre (ac) (0.4 hectare (ha) in size)) within Hidden Palm Canyon, in the Santa Rosa Mountains of Riverside County, California (Bleich, unpublished data, in USFWS 1982, p. 3). This canyon lies at the box end of a side of Deep Canyon, a large gorge draining the desert slopes of the Santa Rosa Mountains. In 1974, the California Department of Fish and Game (now known as the California Department of Fish and Wildlife; CDFW) created the Hidden Palm Ecological Reserve, which comprises 134.5 ac (54 ha) including and surrounding Hidden Palm Canyon. This reserve continues to be owned by CDFW. Hidden Palm Canyon is also included within the Santa Rosa and San Jacinto Mountains National Monument area. An additional protected area, the University of California Boyd Deep Canyon Desert Research Center and Reserve (Deep Canyon Reserve), is located immediately below Hidden Palm Canyon in the watershed. The Deep Canyon Reserve is included within the United Nations Mojave and Colorado Desert Biosphere Reserve (United Nations Educational, Scientific, and Cultural Organization (UNESCO) 2005, p. 1). The United States is not currently engaged in the UNESCO Biosphere Program (UNESCO 2013, p. 1), so there are no protections afforded by this designation.

In 1980 to 1981, 34 sites that could have harbored other populations of desert slender salamander were surveyed (Giuliani 1981, pp. 1–17). One new population was found in Guadalupe Canyon, approximately 4.5 miles (mi) (7.2 kilometers (km)) from Hidden Palm Canyon (Giuliani 1981, p. 3), and was later confirmed to be desert slender salamander (Brame 1981, pers. comm.). Wake and Jockusch (2000, p. 102) also treated the two populations (Guadalupe Canyon and Hidden Palm Canyon) as the same taxon. At Guadalupe Canyon, desert slender salamander was located in small, disjunct patches that totaled to approximately 0.5 ac (0.2 ha), with potential habitat estimated to be 1.5 ac (0.6 ha) (Duncan and Esque 1986, p. 36). The area supporting desert slender salamander at Guadalupe Canyon is owned by BLM, and is included within the Santa Rosa Wilderness Area (USFWS 2013b, GIS data). Guadalupe Canyon is also included within the Santa Rosa and San Jacinto Mountains National Monument area. Parcels surrounding the occupied portion of Guadalupe Canyon are owned by various State and Federal agencies, including BLM, CDFW, and the U.S. Forest Service (USFWS 2013b, GIS Data). The remaining 33 survey sites were surveyed before determining that the desert slender salamander was not present (Giuliani 1981, p. 2). Guiliani concluded that "although the lack of finding specimens at any field site always must be considered inconclusive, the evidence now suggests that *Batrachoseps* is represented in the Santa Rosa Mountains by only two disjunct highly localized populations." (Guiliani 1991, p. 5).

Following a field study of desert slender salamander at Guadalupe Canyon, Duncan and Esque (1986, p. 30) recommended that other areas with "promising riparian habitats" such as Martinez

Canyon, the south fork of Martinez Canyon, Black Rabbit Canyon, and other canyons to the south should be surveyed during the winter rainy season. To our knowledge, such surveys have not occurred to date and no additional occupied areas have been discovered.

Two salamanders were observed at Limestone Springs in Anza-Borrego Desert State Park in 1982 or 1983 (B. Bolster, CDFG, 1995, pers. comm.) after the location was improved as a watering hole for bighorn sheep (M. Jorgensen, CDFG, 1995, pers. comm.). These individuals were thought to be desert slender salamanders because of their location in the southern Santa Rosa Mountains; however, they may have been garden salamanders (*Batrachoseps major major)* because the location is somewhat near the eastern extent of the known range of the latter, as defined by Wake and Jockusch (2000, p. 110). No collections were made to verify the subspecies, and no additional salamanders have been reported from this location.

Other unidentified *Batrachoseps* species have been rumored to occur in additional nearby localities, including Hidden Spring, Rockhound Canyon, and Cottonwood Spring in Riverside County; near Smuggler's Cove, east of Campo, in Imperial County; and, in the Coyote Mountains of western Riverside County (D. Wake, University of California, Berkeley, 2013, pers. comm.). Undetermined *Batrachoseps* specimens have been collected from along the Montezuma grade between Ranchita and Borrego Springs, in San Diego County, and east of Campo in San Diego County (Wake 2013, pers. comm.). These specimens are held at the Museum of Vertebrate Zoology at the University of California, Berkeley, though they are too small in size to determine the species (Wake 2013, pers. comm.). As of this time, none of these desert localities is known to support additional populations of desert slender salamander; however, each should be strategically surveyed for this species.

Though the slender desert salamander has not been observed since 1997, it is currently presumed to be extant at two locations in Hidden Palm Canyon and Guadalupe Canyon.

<u>Species Biology</u>

There is little information regarding the biology and habitat requirements of desert slender salamander, although as with other plethodontid salamanders, soil moisture levels are thought to be of critical importance to facilitate physiological processes, create movement opportunities, provide underground retreats from predators, trigger reproduction, and provide an adequate prey base. This lungless amphibian requires adequate moisture to absorb all the oxygen it needs through thin, highly vascular, moist skin (Duellman and Trueb 1994, pp. 217–218). Exposure to warm, dry air results in rapid water loss (Cunningham 1960, p. 92) and extended exposure can result in death by desiccation (USFWS 1982, p. 8; Duellman and Trueb 1994, pp. 202–204). Thus, perpetuation of a moist habitat is essential to the desert slender salamander's survival. Consequently, this subspecies is constrained to perennial seeps and springs in a desert region that is otherwise characterized by high temperatures and a pronounced lack of water (USFWS 1982, p. 8). It primarily lives in moist subterranean spaces such as porous soil, bed-rock fractures, crevices under limestone sheets, talus (a sloping mass of rock debris) above seeps, and in animal burrows (Brame 1970, p. 8; Bleich 1978, pp. 4–6, 10; Duncan and Esque 1986, p. 35).

The activity and movement patterns of desert slender salamander are mostly surmised through use of surrogate species, such as other taxa from the *Batrachoseps* genus. Salamanders from this genus are known to be sedentary (Wake and Jockusch 2000, p. 107) and their home range, the area over which an individual animal habitually carries out its usual daily activities, is reported to be somewhat limited (Duellman and Trueb 1994, p. 265). For example, in a study of *B. pacificus*, the average recapture distance of 141 individuals was 19.8 feet (ft) (6 meters (m)) (Cunningham 1960, p. 96). In comparison, in a study of *B. attenuatus*, Hendrickson (1954, p. 8) found that 59 percent of 133 animals never changed shelter. Bleich (1978, p. 14) found it difficult to track movements of desert slender salamander, as most individuals encountered were partially obscured beneath the surface, or "behaved in a sedentary fashion," though one desert slender salamander was observed to move a linear distance of 4 m (13 ft) from the site where it was first found. Long distance female movement in particular is limited, shown by the geographically restricted distributions of mtDNA (mitochondrial deoxyribonucleic acid) haplotypes among individuals from *Batrachoseps* (Wake and Jockusch 2000, p. 107). To what depth the desert slender salamander may descend is unknown, but it is likely several feet below the surface, particularly during the summertime, when moisture levels are reduced (Duncan and Esque 1986, p. 30). Desert slender salamanders have occasionally been found above ground during this time of year, either near permanent seeps, after summer storms, or under porous limestone (Brame 1970, p. 8; Duncan and Esque 1986, p. 30). Duncan and Esque (1986, p. 35) did not find a relationship between desert slender salamander activity and ambient temperature.

Depredation by native predators, including the western skink (*Eumeces skiltonianus*), potentially the ringneck snake (*Diadophis punctatus*), and other unknown animals, may be avoided by use of underground retreats and implementation of defense mechanisms. In response to disturbance, desert slender salamander coils itself, which is typical for all species of *Batrachoseps* (Bleich 1978, p. 12). Desert slender salamander is reported as exhibiting an unusual defensive posture in that it may also curve its tail upward or nearly straight up, presenting a tail that looks like a common earthworm, while the limbs are held flush to the body (Brame *et al.* 1973, p. 2). Brame *et al.* (1973, p. 2) suggested that desert slender salamander may mimic an earthworm in order to trick predators into biting or breaking off the tail, while leaving the remaining body unharmed. Tail autotomy (casting off the tail to facilitate escape when attacked) has not been observed in desert slender salamander, though many salamander species, including *B. pacificus*, do have this ability (Wake and Dresner 1967, p. 267). Tail elevation was not observed during a study of this subspecies for CDFW (Bleich 1978, p. 13).

The reproductive cycle of desert slender salamander has never been studied, though based upon observations of *Batrachoseps major major* and *B. attenuatus*, it is thought that courtship and breeding take place immediately after the first heavy rains of the winter, with egg laying occurring very shortly thereafter (USFWS 1982, p. 5; Amphibiaweb 2013a, p. 2). Hansen and Wake estimate that sexual maturity is attained at 1.2 in (31 mm) (snout-vent length) in males, and at a slightly larger size in females (Amphibiaweb 2013a, p. 3). Age at sexual maturity is unknown. As with other plethodontids, desert slender salamander likely exhibits direct development, an alternate reproductive method in amphibians whereby courtship, mating, and oviposition (depositing of eggs) occur on land, and at hatch, young emerge directly as miniature versions of adults (Wake and Hanken 1996, p. 859). This method of reproduction bypasses the aquatic larval stage that most amphibians exhibit (Wake and Hanken 1996, p. 859). As with other related species, desert slender salamander probably lays its egg clutches underground, likely deep within gaps in limestone where moisture is consistently present (Amphibiaweb 2013b, p. 2). Egg clutch size is unknown, though estimated clutch size of *B. m. major* is 13 to 20 eggs (Davis 1952, pp. 272–273; Amphibiaweb 2013b, p. 2). Additionally, communal nesting may occur. Grant (1958, p. 222) observed 158 *B. attenuatus* hatchlings emerge from one crack after heavy rains in January.

Desert slender salamander adults and juveniles likely feed on a myriad of small arthropods found in moist, dark places (USFWS 1982, p. 5) using a special projectile tongue typical possessed by other plethodontids (Wake *et al*. 1983, pp. 207–208). Flies (*Drosphilia* spp.) and ants (Formicidae family) are known to comprise part the diet (Bleich 1978, p. 15). Duncan and Esque (1986, pp. 34–35) suggest that leaf litter creates a deep, loamy moist soil layer within which a diverse array of soil invertebrates likely serve as a food source for desert slender salamander. In sum, adequate soil moisture is required to facilitate the life history of desert slender salamander, aiding physiological processes, facilitating reproduction, determining distribution, providing retreats from predators, and providing adequate habitat for an invertebrate food source.

<u>Habitat or Ecosystem</u>

Desert slender salamander habitat of known locations at Hidden Palm Canyon and Guadalupe Canyon spans an elevational range of approximately 2,493 to 3,839 ft (760 to 1,170 m) (Duncan and Esque 1986, p. 2; Wake and Jockusch 2000, p. 110). According to the 1982 Recovery Plan, water is supplied to Hidden Palm Canyon from an estimated 440 ac (178 ha) subterranean watershed, which reaches the shaded north and northeast-facing walls of the canyon as groundwater seepage. We estimate the surface watershed size at Hidden Palm Canyon to be 85 ac (34 ha) (USFWS 2013b, GIS data). At Guadalupe Canyon, the Martinez and Sheep Mountains drain into the northeast flowing Guadalupe Creek as seasonal surface water and perennial groundwater seepage (Duncan and Esque 1986, pp. 2, 5–6). Typically dry waterfalls and steep canyon walls of igneous and metamorphic rock are found above and below desert slender salamander habitat.

At Guadalupe Canyon, desert slender salamander is reported to occur on "widely differing substrates" including loamy sand and coarse sand, with greater numbers of salamanders found on organic (loamy) soils than sandy soils, possibly due to porosity of organic soil (Duncan and Esque 1986, p. 15). Duncan and Esque (1986, p. 15) suggest that soil moisture is more important habitat component than soil type, because salamanders are capable of equivalent moisture uptake from different soils if the moisture tension is equivalent (Spight 1967, p. 126; Spotila 1972, p. 95). The surface material on slopes surrounding Hidden Palm Canyon is exposed bedrock, talus, and coarse-grained sand form (USFWS 1982, pp. 6–7). Possibly the most important structural component of the habitat in Hidden Palm Canyon is the porous limestone (sedimentary rock composed of calcium carbonate) sheeting that covers portions of the canyon wall, having built up over time through seepage and precipitation of solutes (USFWS 1982, p. 9). The moist interior environment of the sheeting may be a refuge of last resort for the desert slender salamander when other nearby retreats dry out. Decayed plant roots and developmental patterns of the sheeting may account for the tunnels and pockets that provide refuge within the sheeting

(USFWS 1982, p. 9). Desert slender salamanders have also been found among talus on the canyon floor during the wetter months (Brame 1970, p. 1), and rock crevices and holes in the moist soil of canyon walls (USFWS 1982, p. 9; Stebbins 2003, p. 189).

The limestone sheeting and talus at Hidden Palm Canyon has experienced erosion caused by severe storms. One such storm in 1976 flooded and washed out an estimated 33 percent of the habitat (USFWS 1982, p. 9), including the area where salamanders were first discovered and most commonly found. The canyon floor at the site was eroded down 6 to 10 ft (1.8 to 3.1 m) (USFWS 1982). In December of 1977, CDFW installed gabions (large wire baskets containing rocks) against the base of the canyon wall to prevent undercutting of the remaining limestone sheeting (USFWS 1982, p. 13). Bleich (1978) studied the remaining habitat after the storm of 1976 and identified an area where salamanders were consistently found. However, despite the gabions, later storms also eroded the habitat where Bleich (1978) found salamanders (USFWS 2009, p. 8; J. Crayon, CDFW, 2013, pers. comm.). Thus, the habitat at Hidden Palm Canyon where salamanders were previously found in the greatest numbers is no longer intact (Crayon 2013, pers. comm.). A single desert slender salamander was last seen at this location in 1997 (Nicol 1997, p. 1; CNDDB 2013, EO1). At least one gabion is still intact, though it appears that the gabions did not prevent additional erosion of the lower portion of the canyon wall due to storms occurring as recently as October of 2005 (E. Konno, CDFW, 2013, pers. comm.). There is much less habitat remaining than when the desert slender salamander was listed (USFWS 2009, p. 8; Konno 2013, pers. comm.). Due to the difficulty associated with site access (the sides of the canyon are extremely steep and cliff-like in many places), Hidden Palm Canyon is rarely visited, and thus, the habitat is infrequently monitored.

Plants typical of desert oases occupy desert slender salamander habitat, including *Washingtonia filifera* (California fan palm), *Salix exigua* (narrow-leaved willow), *Larrea tridentata* (creosote bush), *Prosopis pubescens* (screw bean mesquite), and *Populous fremonti* (cottonwood) (USFWS 1982, p. 7; Vogl and McHargue 1966, p. 535). At Hidden Palm Canyon, common names were used to identify *W. filifera*, *L. tridentata*, *P. pubescens*, *S. exigua*, *Rhus ovata* (sugar bush), and various grasses on the canyon floor (Brame 1970, p. 7; Baldwin *et al*. 2012). In addition to numerous other species, *Baccharis sergiloides* (squaw waterweed or desert baccharis), *Epipactis gigantea* (stream orchid), *Adiantum capillus-veneris* (maidenhair fern), and *R. ovata* are identified as plants in the canyon proper or that cling to the canyon walls (Bleich 1978, p. 3; USFWS 1982, p. 7; Stebbins 2003, p. 189). The following plant species were closely associated with desert slender salamander observations at Guadalupe Canyon: *B. sergiloides, Vitis girdiana* (wild grape), *S. exigua, P. fremontii, Zauschneria californica* (California fuschia), *A. capillus-veneris, Muhlenburgia rigens* (deer grass), *R. ovata*, *Agave deserti* (desert agave), and unidentified grasses (Duncan and Esque 1986, pp. 23–27). Other species noted at Guadalupe Canyon included *Acacia greggii* (catclaw acacia), *Eriogonum fasciculatum* (California buckwheat), *Lotus rigidus* (deer vetch), *Sphaeralcea ambigua* (desert mallow), and *Yucca shidigera* (Mojave yucca) (Sawyer *et al*. 2009, p. 427).

The surrounding watershed and adjacent slopes are drier and dominated by more typical desert plants, including *Opuntia* spp. (cholla), *Ferocactus cylindraceus* (California barrel cactus; previously *Ferocactus acanthodes*), *O. polyacantha* var. *erinacea* (Mojave prickly pear; previously *O. erinacea*), *Agave deserti*, *Larrea tridentata, Juniperus* spp. (juniper), *Simmondsia* *chinensis* (jojoba), and *P. glandulosa* var. *torreyana* (mesquite; previously *P. juliflora*) (Brame 1970, p. 7; Bleich 1978, p. 3). *Yucca shidigera*, *Ambrosia dumosa* (white bur-sage), and *Hilaria rigida* (galleta grass) (USFWS 1982, p. 7) are also mentioned as dominating the watershed and slopes surrounding the habitat (Stebbins 2003, p. 189). Approximately 60 to 80 percent of the ground was reportedly devoid of perennial vegetation at the time the Recovery Plan was written (USFWS 1982, p. 7).

To provide a characterization of the vegetation associated with desert slender salamander habitat we use the vegetation classification system developed by Sawyer *et al*. (2009). Although the vegetation described is not readily translated into Sawyer *et al*. (2009) alliance types, the plant taxa most closely associated with desert slender salamander and surrounding slopes are included within three alliances identified by Sawyer *et al.* (2009), including the *Washingtonia filifera* Woodland Alliance, the *Baccharis sergiloides* Shrubland Alliance, and the *Agave deserti* Shrubland Alliance (Sawyer *et al.* 2009, pp. 299–300, 333–334, 427–428).

The *Washingtonia filifera* Woodland Alliance (California fan palm oasis) includes the plants typical of desert oases, of which *W. filifera* is dominant or co-dominant in the tree canopy with species such as *Salix exigua*, and *Prosopis pubescens* (Sawyer *et al.* 2009, pp. 299–300). *Pluchea sericea* (arrowweed), *Suaeda moquinii* (inkweed), and nonnative *Tamarix* spp. (tamarisk) among others are also associated with this vegetation alliance (Vogl and McHargue 1966, p. 535; Sawyer *et al.* 2009, p. 299). This alliance includes habitats such as desert springs in canyon waterways, and areas where underground water is present along fault lines (Sawyer *et al*. 2009, p. 299). The habitat at Hidden Palm Canyon is most closely associated with this vegetation alliance.

In the *Baccharis sergiloides* Shrubland Alliance (broom baccharis thickets), *B. sergiloides* is dominant or co-dominant in the shrub canopy with species such as *Acacia greggii*, *Eriogonum fasciculatum*, *Lotus rigidus*, *Sphaeralcea ambigua*, *Yucca shidigera*, *Populus fremontii*, and *Salix* spp. (Sawyer *et al*. 2009, p. 427). Arroyos, canyon bottoms, springs, and washes are habitat types that support this alliance (Sawyer *et al*. 2009, p. 427). Soils are gravelly sands and sandy loam that is periodically flooded and saturated seasonally (Sawyer *et al*. 2009, p. 427). Although the habitat at Guadalupe Canyon contains many of the same plant species as those that are co-dominant in the *Washingtonia filifera* Woodland Alliance, Guadalupe Canyon does not support any *W. filifera* itself. In contrast, the dominant species associated with desert slender salamander observations at Guadalupe Canyon is *B. sergiloides*. Therefore, the habitat at Guadalupe Canyon is most closely associated with this vegetation type.

The *Agave deserti* Shrubland Alliance (desert agave scrub) (Sawyer *et al*. 2009, p. 333–334) includes vegetation from the surrounding watershed and adjacent slopes, where *A. deserti* is co-dominant in the shrub layer with *Ferocactus cylindraceus*, *Larrea tridentata*, *Juniperus* spp., *Simmondsia chinensis*, *Yucca shidigera*, and *Ambrosia dumosa*, in addition to other species. This alliance includes habitats on slopes, ridges, hills, arroyos, and seasonal watercourse margins, on well drained, rocky, or sandy soils (Sawyer *et al*. 2009, p. 333).

The climate of the area supporting desert slender salamander is characterized by low and erratic rainfall (Figure 1), high summer temperatures (Figure 2), and strong vernal winds. The annual average rainfall from 1982 to 2012 at the Pinyon Crest weather station, located in the recharge area from which the Hidden Palm Canyon seep originates, was 9.7 in (24.7 cm) (University of California, Natural Reserve System, Philip L. Boyd Deep Canyon Desert Research Center 2013). During the high rainfall year of 1976, rainfall was well above average with values of 15.5 in (39.4 cm) near Hidden Palm Canyon. Duncan and Esque (1986, p. 13) measured 3.8 in (9.6 cm) of rainfall at Guadalupe Canyon between November 27, 1984 and January 22, 1985; 0.4 in (1 cm) of rainfall between January 22 and March 22, 1985; and, no rainfall between March 23 and July 1, 1985. Duncan and Esque (1986, pp. 23–27, 43) evaluated surface moisture during surveys at Guadalupe Canyon. Desert slender salamander was never observed under dry conditions, where the leaf litter was characterized as brittle and light, nor under wet conditions, characterized by the presence of standing water. Individuals were always observed in damp (no water droplets present), moist (water droplets present on spider webs and within leaf litter with fresh mycelium present), or very moist conditions (water droplets present on spider webs, mycelium, and leaf litter) (Duncan and Esque 1986, p. 43).

Weather data from the Agave Hill weather station, located at an elevation similar to Hidden Palm Canyon, shows that during the month of July (1974 to 2013), the mean low and high temperatures were 79°F and 95°F (26°C and 35°C), respectively (University of California, Natural Reserve System, Philip L. Boyd Deep Canyon Desert Research Center 2013). During the month of January (1974 to 2013), the mean low and high temperatures were 48°F and 61°F (9°C and 16°C), respectively (University of California, Natural Reserve System, Philip L. Boyd Deep Canyon Desert Research Center 2013; Figures 1–2).

Species Abundance

The last detailed study of desert slender salamander at Hidden Palm Canyon was during 1977 and 1978 (Bleich 1978). Surveys were conducted four times per month, typically during the night, for 1 year (from March 1977 to March 1978). A relative abundance index of the number of salamanders found per unit of search time was calculated. Typically 0 to 10 salamanders were found per 100 minutes (Bleich 1978, Tables 1–13). The greatest number of salamanders found in one night was 21 (Bleich 1978, p. 9), compared with 39 salamanders found per night prior to the heavy rains and habitat damage 1976 (Bleich 1978, p. 9). A total of 343 salamander sightings were made over the course of the study (Bleich 1978, p. 16). Based on length, a large proportion of the salamanders detected during most months of the year were juveniles, indicating a reproducing population at the time (Bleich 1978, p. 8).

To estimate population size for the Hidden Palm Canyon population, Bleich (1978, p. 9) used a study of *Batrachoseps pacificus* by Cunningham (1960), whereby Cunningham estimated that 4 to 11.5 percent of *B. pacificus* are on the surface at any one time. Using this information, Bleich (1978, p. 9) estimated the population of desert slender salamander at Hidden Palm Canyon to be between 133 and 515 individuals. Because the actual percentage of desert slender salamanders that are active on the surface is unknown, this wide estimate is uncertain.

Until approximately 2006, biologists from CDFW performed nearly annual searches for desert slender salamander at the Hidden Palm Canyon during the fall (Konno 2013, pers. comm.).

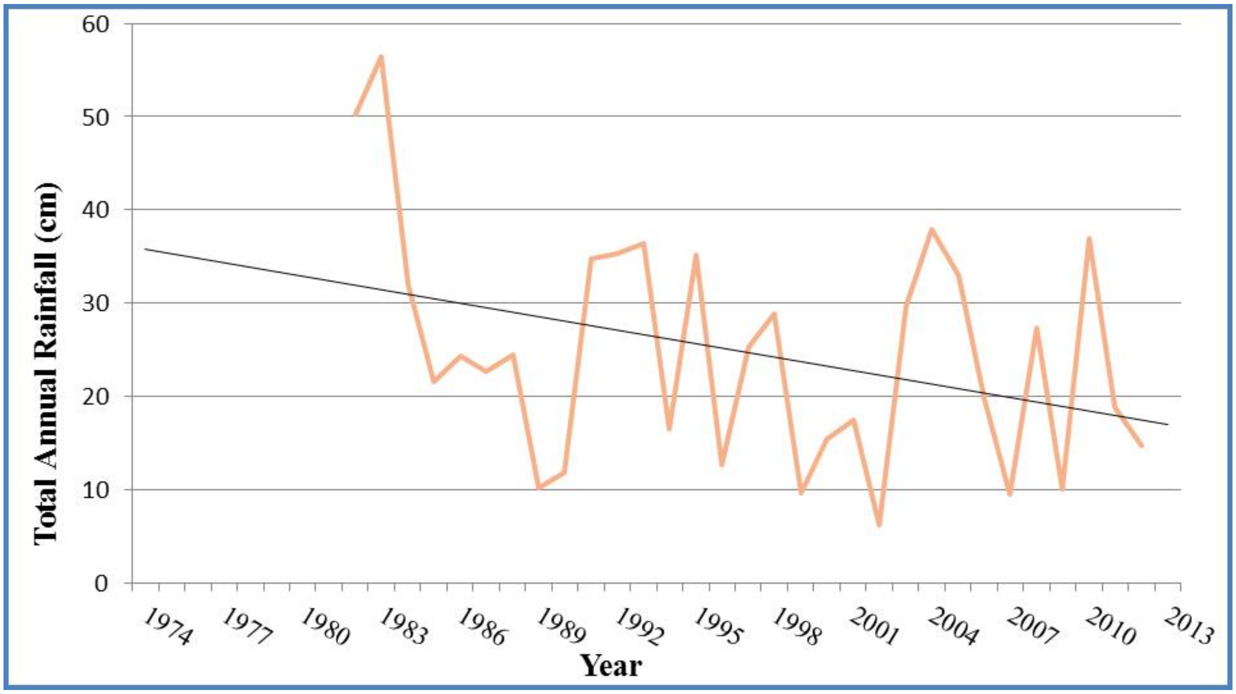

Figure 1. Total annual rainfall (cm) (orange) at the Boyd Deep Canyon Desert Research Center Pinyon Crest weather station from 1982 to 2012. Linear trendline provided. Source: University of California, Natural Reserve System, Philip L. Boyd Deep Canyon Desert Research Center (2013).

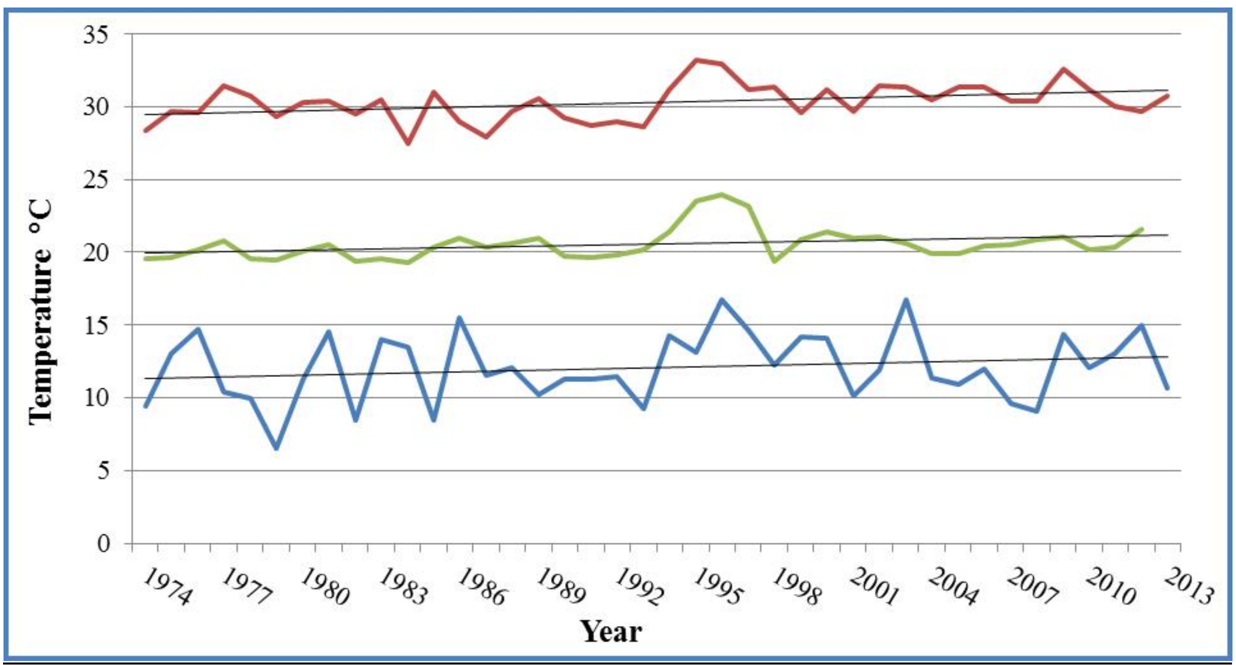

Figure 2. Average temperatures (in degrees Celsius (°C)) at the Boyd Deep Canyon Desert Research Center Agave Hill weather station for the months of January (blue) and July (red) from 1974 to 2013 (University of California, Natural Reserve System 2013). Average annual (green) temperatures from 1974 to 2012 (University of California, Natural Reserve System 2013). Linear trendlines provided. Source: University of California, Natural Reserve System, Philip L. Boyd Deep Canyon Desert Research Center (2013).

However, desert slender salamanders have not been seen at this site since 1997 (Nicol 1997, p. 1; CNDDB 2013, EO1). In November of 2006, biologists from the Service, CDFW, and BLM visited Hidden Palm Canyon, were unable to locate any desert slender salamanders (USFWS 2009, p. 6). In 2012, during a diurnal survey for yellow bats in Hidden Palm Canyon, CDFW biologists briefly searched for but did not find desert slender salamander (Konno 2013, pers. comm.). Because searches have generally been casual and a strategic survey methodology has not been implemented, we cannot conclude that desert slender salamander is extirpated at the site. Therefore, desert slender salamander is still presumed to be extant at this location. Due to the risk for additional habitat damage, anything but a surface search is no longer appropriate. The soil in the canyon wall is essentially held in place by vegetation, which if disturbed too much, would easily allow the soil to erode. Future surveys should occur nocturnally, in the fall or winter, after a light rain event.

No abundance data has been collected for the Guadalupe Canyon population since a study performed in 1984 and 1985, when a total of 30 salamanders were detected in a patchy distribution over 15 nights of sampling (Duncan and Esque 1986, pp. 6, 22). The low detectability of desert slender salamander suggests that there were likely more than 30 salamanders present.

Genetics

The genus *Batrachoseps* is divided into two subgenera, *Plethopsis* and *Batrachoseps*; the latter is represented by five species groups (clades) distributed across the range with little overlap (Wake 2006, pp. 15–18; Jockusch *et al*. 2012, p. 1). There are seven species within the *Batrachoseps pacificus* species group, including *B. major*, which occupies two disjunct regions in California: the central coast region (known as the northern phylogeographic unit of *B. major*), and the far south of California (known as the southern phylogeographic unit of *B. major*). *Batrachoseps major* is the most southerly member of the *B. pacificus* species group (Wake 2006, p. 15). The desert slender salamander is closely related to the southern phylogeographic unit of *B. major* based on mitochondrial data (Wake 2006, p. 19).

Desert slender salamander is morphologically distinct and retains its distinctive mitochondrial DNA, but is only minimally differentiated from *Batrachoseps major* in terms of allozymic similarity (Wake and Jockusch 2000, p. 108). This may be because the closest populations of *B. major* are approximately 17.4 mi (28 km) northwest of the current desert slender salamander populations, potentially allowing interbreeding in the past (Wake and Jochusch 2000, p. 108). Wake and Jockusch (2000, pp. 108–109) found that all alleles in the desert slender salamander have also been found in the northern phylogeographic unit of *B. major,* although only one desert slender salamander specimen was available for testing.

Martinez-Solano *et al*. (2012, p. 147) found that based on mitochondrial DNA, the southern *B. major* species group is composed of six lineages, one of which is desert slender salamander (*B. m. aridus*). The study found that desert slender salamander is the most unique lineage, both morphologically and ecologically (Martinez-Solano *et al*. 2012, p. 147). There is no information available regarding the genetic variability of this subspecies.

Five-factor Analysis

The 1973 listing rule (USFWS 1973, p. 14678) did not contain a five-factor analysis identifying threats to the desert slender salamander. The 1982 Recovery Plan for Desert Slender Salamander (USFWS 1982, p. 11) described the general threats affecting the taxon, and a status review conducted in 2009 identified threats in a five-factor analysis (USFWS 2009, pp. 1–16). Threats described in the 2009 5-year review included:

Factor A: Habitat loss due to erosion; fire; nonnative plants; and groundwater pumping;
Factor B: Overutilization for scientific purposes;
Factor C: Disease;
Factor E: Drought and climate change; and, small population size.

No new threats beyond those identified in the 2009 5-year review are included in this analysis. The following five-factor analysis describes and evaluates the current threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act.

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

The 1982 Recovery Plan identified human disturbance and destruction of the habitat as a threat at Hidden Palm Canyon (USFWS 2009, p. 11). In the 2009 5-year review, we concluded that human disturbance is not a threat because Hidden Palm Canyon and 134.5 ac (54 ha) of surrounding land is included within the Hidden Palm Ecological Reserve, which can only be accessed legally with a permit (CDFG 1975, pp. 5, 8), and the site is difficult to access due to the steep and rugged terrain. We also noted that the remote nature of the Guadalupe Canyon site limits human use, but also limits evaluation of how much use is occurring. We have no new information to suggest that that human disturbance and destruction of the habitat is a threat at Hidden Palm Canyon. Other threats to the habitat identified in the 2009 5-year review included habitat loss due to erosion, fire, nonnative plants, groundwater pumping, and drought and climate change (USFWS 2009, pp. 8–10). Each of these threats is described below under **FACTOR A**, with the exception of drought and climate change, which is described below under **FACTOR E**.

<u>Erosion</u>

Both the Recovery Plan (USFWS 1982, p. 11) and the 2009 5-year review (USFWS 2009, pp. 8–9) identified erosion as a threat to the habitat at Hidden Palm Canyon, due to sizable storms and potentially modification of watershed hydrology. After a large storm in 1976 and subsequent storms in the following years, the habitat (talus, limestone sheets, and limestone honeycomb) where salamanders were previously most commonly found had eroded away, and erosion down to the bedrock was evident in some places (USFWS 1982, p. 9). A gabion structure attempted to stem some of the erosion was thought to be partially successful, but habitat continued to erode over time. In 1989, CDFW staff found that the vegetation at Hidden Palm Canyon had completely recovered to its original state (Nicol 1989, p. 1; CNDDB 2013, EO1). This was likely in the upper portion of the canyon wall. Site visits in both 2006 and 2012 found additional erosion to the lower portion of the wall, while the upper wall remained intact (Konno 2013, pers. comm.). Erosion of the substrate is considered a persistent threat due to the topography of the site, which itself magnifies the potential violence of large storm events (USFWS 2009, p. 9). The desert slender salamander population was known from an area below a large cliff-like drop in the wash, an area that desert flash floods and associated sediment would scour. In 2006, the continued scouring was evidenced by a complete lack of *Tamarix chinensis,* which had been previously known to occur at the site (USFWS 2009, p. 9).

The 2009 5-year review stated that the construction of Highway 74, which bisects the surface watershed of Hidden Palm Canyon, may have modified the hydrology and resulted in the more destructive, sediment-laden flows that have eroded desert slender salamander habitat in recent history (USFWS 2009, p. 9). Substantial down-cutting, several feet in some places, is apparent in the washes entering Hidden Palm Canyon (USFWS 2009, p. 9). The effect is subtle, but may indicate that more sediment is being flushed through (USFWS 2009, p. 9).

<u>Fire</u>

The 2009 5-year review identified fire as a concern to the habitat of desert slender salamander based upon the reasoning that desert fires have occurred more frequently in recent decades due to an increase in nonnative grasses (USFWS 2009, p. 9). The potential for fire to be a risk to desert slender salamander and its habitat is complex and must consider a number of factors including fuel type and load, fire frequency, fire position in the watershed, post-fire effects, and salamander biology.

Recent assessments made by the California Department of Forestry and Fire Protection (CalFire) identified and mapped “fire hazard severity zones” for western Riverside County, including Hidden Palm and Guadalupe Canyons (CalFire 2007, GIS Data; CalFire 2009, GIS Data). The model used to create these zones considers wildland fuels, topography, weather, frequency and severity of previous fires, the production and movement of embers, and how receptive a site is to travelling embers (CalFire 2013, p. 1). Using this information, CalFire has identified Hidden Palm Canyon to be in a Very High fire hazard severity zone in the (State-owned) State Responsibility Area (CalFire 2007, GIS Data). Guadalupe Canyon is also within a Very High fire hazard severity zone in the (federally owned) Federal Responsibility Area (CalFire 2009, GIS Data). These ratings may consider the increased presence of nonnative plants that carry fire, including *Bromus madritensis* subsp. *rubens* (red brome) and *Tamarix chinensis*, each of which has been observed above and in both canyons.

Although the information provided by CalFire indicates fire is a very high risk to the habitat near and within Hidden Palm and Guadalupe Canyons, specific aspects of the habitat suggest the risk may be lower. As discussed above under the section titled <u>Habitat or Ecosystem</u>, the watershed and adjacent slopes surrounding desert slender salamander habitat is drier and dominated by more typical desert plants (Brame 1970, p. 7; Bleich 1978, p. 3; USFWS 1982, p. 7). Additionally, the 1982 Recovery Plan noted that 60 to 80 percent of the ground above Hidden Palm Canyon is devoid of perennial vegetation (USFWS 1982, p. 7). The fire return interval for the vegetation association in this area (*Agave deserti* Shrubland Alliance) is characterized as truncated and long, with typically low intensity and moderately severe fires (Sawyer *et al*. 2009, p. 334). *Agave deserti* sprouts after a fire, although if nonnative fuels grow densely enough, fire can affect this species (Sawyer *et al*. 2009, p. 334). With the exception of the effect nonnative grasses might have on fire frequency, the composition of the plant community in the surrounding watershed suggests that a fire is unlikely to be carried through this area (M. Fisher, Boyd Deep Canyon Desert Research Center, 2013, pers. comm.).

A fire within either canyon may be less likely to occur still. The natural fire return interval in the *Washingtonia filifera* Woodland Alliance is unknown (Sawyer *et al*. 2009, p. 300), though the natural intensity and severity of fire is low in this vegetation alliance. Fire aids the regeneration of *W. filifera* as it creates space for seed germination, reduces competition with other species for water, and temporarily increases the flow of springs or seeps (Sawyer *et al*. 2009, pp. 299–300). However, higher fuel loads created by the presence *Tamarix* spp. can cause high mortality of the *Washingtonia filifera* by producing large flames that can reach the canopies of this species (Sawyer *et al*. 2009, p. 300). Tamarisk was not seen at this site in 2006 (USFWS 2009, p. 9), though seedlings were observed in 2012 (Konno 2013, pers. comm.). Again, the natural risk of fire to the canyon habitat appears low, although the nonnative plants may create a more significant risk. *Baccharis sergiloides* (most commonly associated with desert slender salamander at Guadalupe Canyon) can resprout after disturbance but this typically occurs in response to fluvial processes as opposed to fire. There is limited information available regarding this species' response to fire, though it is fire-sensitive (Sawyer *et al*. 2009, p. 427).

The effect of fire on amphibians is largely unexplored (Pilliod *et al*. 2003, p. 163), though some research has provided useful information regarding prescribed burns and terrestrial amphibians (Ford *et al*. 1999; Russell *et al*. 1999; Moseley *et al*. 2003). Some studies of prescribed burn treatments conclude that there are no significant differences in amphibian abundance before and after burns take place (Ford *et al*. 1999, p. 238–239; Moseley *et al*. 2003, p. 475; Greenberg and Waldrop 2009, pp. 2887–2888), although this may depend on the habitat type occupied. Ford *et al*. (1999, pp. 238–239) typically found no significant difference in collection frequency of various salamander species in burn versus control areas. However, this study did find that collection of some salamander species occupying riparian habitat was higher in unburned areas than burned areas (Ford *et al*. 1999, pp. 289–239).

Research of plethodontid salamanders found that these species declined after forest clear-cutting, potentially as a result of site desiccation after leaf litter mass and depth was reduced (Ash 1995, p. 96). Diminished leaf litter depth results in reduced moisture availability, which can inhibit the dermal respiratory ability of amphibians (Duellman and Trueb 1994, pp. 203–204). Duncan and Esque (1986, pp. 34–35) identified the accumulated leaf litter from broad-leaved plant species to be an essential component of desert slender salamander habitat in Guadalupe Canyon due to its capacity to hold moisture; all desert slender salamander observations were associated with damp to very moist leaf litter (Duncan and Esque 1986, pp. 23–27). This is not surprising given that moisture availability is likely the most important abiotic variable associated with desert slender salamander, and is necessary to facilitate most aspects of this subspecies' life history. Thus, it seems likely that a fire that reduces leaf litter or surface moisture might also create a desiccated environment in the habitat of desert slender salamander, potentially causing a subsequent population decline.

The greatest risk of fire in the upper watershed or within either canyon is probably associated less with the burn itself, and more with the post-fire effects in the habitat. A fire on the slopes of the watershed that is followed by a winter rain event and subsequent flooding could facilitate the transport of massive amounts of sediment through either canyon, particularly exacerbating erosion at Hidden Palm Canyon. Furthermore, such flooding and sediment transport could carry away salamanders and displace them lower in the watershed in areas without the requisite moisture, or salamanders could simply be killed during such events. At this time, it appears unlikely that fire is an imminent concern to this species, although this threat should be monitored. It would be of some value to assess the presence, type, and abundance of nonnative plants in the watershed, and to remove fire prone species.

<u>Nonnative Plants</u>

The presence of *Tamarix chinensis* was previously observed at Hidden Palm Canyon (USFWS 2009, p. 9) and in the riparian habitat of Guadalupe Canyon in 1984 to 1985 (Duncan and Esque 1986, pp. 6, 48). *Tamarix chinensis* was not seen at Hidden Palm Canyon during a 2006 site visit, presumably due to massive flooding and scouring that removed the plants (USFWS 2009, p. 9), though it was observed again in 2012 (Konno 2013, pers. comm.). This invasive nonnative plant has rapid reproductive and dispersal rates allowing it to outcompete native plant species in canyon bottoms and washes throughout the southwestern United States (Barrows 1996, p. 1). Of significant concern for desert slender salamander is the ability of *T. chinensis* to significantly reduce or eliminate groundwater and surface water while also secreting salt and consequently increasing the salinity of the occupied water source (Sanchez 1975, pp. 12–13; Lovich *et al.* 1994, pp. 167–168; Barrows 1996, p.1). Additionally, *T. chinensis* has the potential to increase fire frequency where it occurs, and to resprout more robustly than native species after a fire (Barrows 1996, p. 1). The nonnative grass *Bromus madritensis* subsp. *rubens* has been identified in the habitat surrounding Hidden Palm Canyon and the primary concern associated with this species is its ability to increase fire frequency in desert shrublands (California Invasive Plant Council (CalIPC 2013, p. 1)). Nonnative plant removal has been conducted periodically within Hidden Palm Canyon (Konno 2013, pers. comm.).

In accordance with section 10 of the Act, and the Natural Community Conservation Planning Act (see **FACTOR D: Inadequacy of Regulatory Mechanisms**), the Coachella Valley Multiple Species Habitat Conservation Plan (Coachella Valley MSHCP) provides management guidelines restricting the use of several invasive nonnative plant species, including *Tamarix* spp. and *Bromus madritensis* ssp. *rubens* in the landscape for any new land uses (though not existing land uses) adjacent to or within the conservation plan area (Coachella Valley Association of Governments (CVAG) 2007, p. 4–179, Table 4–113). Communities that are adjacent to but not included within conservation areas in the upper watershed above Hidden Palm Canyon include Pinyon Crest, Mountain Center, Pinyon Pines, and Alpine Village. According to Coachella Valley MSHCP, these communities should not incorporate nonnative invasive plants specifically identified in the plan (CVAG 2007, Table 4–113) in any new landscaping. This preventative measure should help to limit or slow the spread of nonnative plants around and within Hidden Palm Canyon.

Groundwater Pumping

Both the Recovery Plan and the 2009 5-year review noted that an increase in groundwater pumping from the upper watershed would be a threat to desert slender salamander habitat and individuals (USFWS 1982, p. 11; USFWS 2009, p. 9). Maintenance of the habitat was reported to be dependent upon seepage from groundwater originating from a 440 ac (178 ha) subterranean watershed above the box canyon (USFWS 1982, p. 11). Groundwater pumping (or diversion water projects) by developments uphill of Hidden Palm Canyon might decrease the water flow to the seep, indirectly eliminating the preferred habitat for desert slender salamander. Since salamanders require constantly moist conditions in order to maintain physiological processes, such as breathing through their skin, desiccation of the environment by any means, including excessive groundwater pumping, would be detrimental to this population.

A recent analysis has shown that the primary surface watershed draining into Hidden Palm Canyon is approximately 510 ac (206 ha), bisected in the lower portion by Highway 74, which runs in a northeast direction through the watershed. An examination of aerial imagery shows that this area may contain approximately 50 homes (USFWS 2013b, GIS Data). An examination of historical imagery has shown that many of these homes were constructed after listing, but appear to have been present since at least the mid-1990s. Little new construction is evident in this area. There was an initial concern that development of this area could lower the existing water table and threaten habitat occupied by the desert slender salamander (CDFG 1975, p. 4). To our knowledge, groundwater use is not currently monitored in this area. However, estimates for the potential water usage from this area are provided here for reference. One acre-foot of water (the amount of water needed to cover an acre of land 1 foot deep (or 325,851 gallons)) is estimated to be the amount of water used by five to eight people annually in California (Hanak and Davis 2006, p. 18). One household is typically estimated to use approximately 0.5 to 1 acre-foot of water per year (Sierra Club 2010, p. 1; Waskom and Neibauer 2010, p. 1). Thus, an estimated 50 homes in the watershed above Hidden Palm Canyon may use approximately 25 to 50 acre-feet of water per year. In comparison, in 1999, approximately 136,600 acre-feet of water were withdrawn from groundwater supplies without being replaced in the Coachella Valley, which is partially supplied with water from the Santa Rosa Mountains (City of Palm Desert 2004, p. VI–3). This suggests that the amount of water potentially extracted from the upper watershed above Hidden Palm Canyon is relatively small.

The first recommendation of the Hidden Palm Ecological Reserve Management Plan (CDFG 1975, p. 8) was to initiate a hydrological study to determine the source, quality, and quantity of water at Hidden Palm Canyon, and monitor the extent and amount of seepage occurring annually (CDFG 1975, p. 8). The plan stated that if a study of the water source indicated a possible failure in the natural water supply, then alternative recommendations for supplying water should be provided (CDFG 1975, p. 8). Surface water has been observed during every site visit made by CDFW biologist Eddy Kono, including visits in both 2006 and 2012 (Kono 2013, pers. comm.), though quantitative measures regarding the stability of the water supply have not been made. Groundwater level measurements are not available from the watershed. A hydrological study of the area remains important to evaluate the true risk associated with a future increase in groundwater pumping from the upper watershed above Hidden Palm Canyon. Based on the limited information available, the concern related to increased groundwater pumping in the upper watershed seems unwarranted at this time.

Summary of Factor A

Erosion of the habitat is the primary threat to desert slender salamander at Hidden Palm Canyon, and is not known to be a concern at Guadalupe Canyon. Gabions were installed at Hidden Palm Canyon in the 1970s to reduce the expansion of this threat, though it appears these have been ineffective in the long term. It is unlikely that fire is a great threat at either canyon unless fire-prone nonnative plants become more prevalent in the immediate habitat and surrounding watershed. The relative infrequency of site visits to each canyon, and the fact that such nonnatives have been known to occur at each location indicates that this is an important concern that might easily magnify without regular monitoring and management. Groundwater pumping in the upper watershed does not appear to be a current concern, though a hydrological study and groundwater monitoring are needed to evaluate input versus extraction rates. A hydrological study is also needed to identify why the habitat at Hidden Palm Canyon is so prone to erosion, and how to reduce impacts of this important threat. Such a study should also evaluate the potential impacts of groundwater pumping on the reduction of moisture levels in Hidden Palm Canyon.

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

Overutilization for scientific purposes was identified as a potential threat in the Recovery Plan (USFWS 1982, p. 12), and was described as concern in the 2009 5-year review (USFWS 2009, p. 9). There are 40 museum specimens of desert slender salamander collected from both populations between 1970 and 1983 (Herpnet 2013); there have been no collections of desert slender salamander since this time. New DNA collection methods allow for non-lethal tissue sampling, precluding the need to collect animals for future research. Additional collection from either population should not occur. Collection of this taxon for illegal sale is possible, though we have no information to suggest this is occurring. The exact location of habitat has consequently not been made widely available. We are aware of no other utilization of desert slender salamander for commercial, recreational, scientific, or educational purposes. Therefore, we do not believe that overutilization is a threat to the desert slender salamander at this time.

FACTOR C: Disease or Predation

<u>Disease</u>

The 2009 5-year review described the fungal pathogen, *Batrachochytrium dendrobatidis* (*Bd*), which causes the amphibian disease, chytridiomycosis, as a potential concern for desert slender salamander. This disease has caused alarming declines in amphibian populations worldwide (Berger *et al*. 1998, p. 9031; Skerratt *et al*. 2007, p. 125; Wake and Vredenburg 2008, p. 11466). The incidence and effect of *Bd* on each desert slender salamander population is unknown. There are museum specimens housed at the Museum of Vertebrate Zoology at the University of California, Berkeley that have not been screened for the presence of *Bd* (Wake 2013, pers.

comm.). Salamander species elsewhere have become infected (Davidson *et al.* 2003, p. 1), and chytridiomycosis has been implicated in the declines of some populations (Bosch and Martinez-Solano 2006, p. 1). This disease could devastate the small, isolated populations of desert slender salamander. Surveys could introduce this pathogen through infected clothing (e.g., muddy boots) or equipment if proper precautions are not implemented. Prohibited public access to the reserve helps to minimize the potential threat from this disease. However, *Bd* is already known from the nearby San Jacinto Mountains (USFWS 2012, pp. 76–77), which are adjacent to the Santa Rosa Mountains, and a potential vector species for the disease (*Pseudacris cadaverina*) occurs in Hidden Palm Canyon (Konno 2013, pers. comm.). Therefore, there is some possibility that *Bd* is already in Hidden Palm Canyon. Additional research is needed to further evaluate the potential risk of this disease relative to desert slender salamander.

Predation

Predation was not identified as a threat in the Recovery Plan (USFWS 1982) or 5-year review (USFWS 2009). No instances of predation have been observed, though a likely predator, the western skink (*Eumeces skiltonianus*) has been observed in the area of Hidden Palm Canyon (USFWS 1982, p. 5). Another potential predator, the ringneck snake (*Diadophis punctatus*), is known from similar terrain and elevations (USFWS 1982, p. 5). Nearly any bird or reptile would likely depredate desert slender salamander if presented the opportunity, but no data are available to determine if predation is significant to population dynamics.

Summary of Factor C

Neither disease nor predation is known to be a threat to the desert slender salamander, although additional research is needed to evaluate the exposure and susceptibility of this taxon to *Bd*.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms was not considered to be a threat to the desert slender salamander in the listing rule (USFWS 1973, p. 14678) or the 2009 5-year review (USFWS 2009, p. 10). The known range of the desert slender salamander is restricted to protected areas including the Hidden Palm Canyon Reserve, owned by CDFW, and Guadalupe Canyon, owned by BLM, and included within the Santa Rosa Wilderness Area. At the Hidden Palm Canyon Reserve, signs are posted to inform potential trespassers that the reserve is closed to the public (Konno 2013, pers. comm.). These signs are posted out of sight of the nearest roads, so that no attention is attracted to the site. Both populations are also included within the Santa Rosa and San Jacinto Mountains National Monument area. The following State, Federal, and local regulatory mechanisms provide some benefit to desert slender salamander.

State Protections in California

The State's authority to conserve rare wildlife comprises three major pieces of legislation: California Endangered Species Act (CESA), California Environmental Quality Act (CEQA), and the Natural Community Conservation Planning (NCCP) Act. The California Lake and

Streambed Alteration Program (CDFG Code sections 1600–1616), the California Porter-Cologne Act of 1969 also may provide additional benefits to desert slender salamander and its habitat.

California Endangered Species Act (CESA)

The State of California listed the desert slender salamander (*Batrachoseps aridus*) under CESA in 1971. Under CESA, activities are subject to permit requirements and consultation with CDFW if they would result in an adverse effect to a State-listed species (Consultation "Take" Authorization, Section 2080.1 or 2081 of the California Fish and Game Code). Any take (defined in CESA as "to hunt, pursue, capture, or kill, or attempt to hunt, pursue catch, capture, or kill") of a State-listed species requires authorization from CDFW. Sections 2081(b) and (c) of CESA allow CDFW to issue incidental take permits for State-listed threatened and endangered species if: (1) The take is incidental to an otherwise lawful activity; (2) the impacts of the authorized take are minimized and fully mitigated; (3) the measures required to minimize and fully mitigate the impacts of the authorized take are roughly proportional in extent to the impact of the authorized taking on the species; (4) the applicant ensures adequate funding is provided to implement the required minimization and mitigation measures and to monitor compliance with, and the effectiveness of, the measures; *and* (5) issuance of the permit will not jeopardize the continued existence of a State-listed species.

California Environmental Quality Act (CEQA)

CEQA (California Public Resources Code 21000–21177) is the principal statute mandating environmental assessment of projects in California. The purpose of CEQA is to evaluate whether a proposed project may have an adverse effect on the environment and, if so, to determine whether that effect can be reduced or eliminated by pursuing an alternative course of action or through mitigation. CEQA applies to projects proposed to be undertaken by, or requiring the approval of, State and local public agencies (*http://www.ceres.ca.gov/topic/env_law/ceqa/summary.html*). CEQA requires disclosure of potential environmental impacts and a determination of "significant" if a project has the potential to reduce the number or restrict the range of a rare or endangered plant or animal. However, projects may move forward if there is a statement of overriding consideration. If significant effects are identified, the lead agency has the option to require mitigation through changes in the project or decide that overriding considerations make mitigation infeasible (Public Resources Code 21000; CEQA Guidelines at California Code of Regulations, Title 14, Division 6, Chapter 3, Sections 15000–15387). In the latter case, projects may be approved that cause significant environmental damage, such as elimination of endangered species or their habitats. Protection of listed species through CEQA is, therefore, dependent upon the discretion of the lead agency involved. CEQA provides that, when overriding social and economic considerations can be demonstrated, project proposals may go forward, even in cases where the continued existence of the species may be threatened, or where adverse impacts are not mitigated to the point of insignificance.

Natural Community Conservation Planning (NCCP) Act

In 1991, the State of California passed the NCCP Act to address the conservation needs of natural ecosystems throughout the State (CFG 28002835). The NCCP program is a cooperative effort involving the State of California and numerous private and public partners to protect regional habitats and species. The primary objective of NCCPs is to conserve natural communities at the ecosystem scale, while accommodating compatible land uses. NCCPs help identify, and provide for, the regional or area-wide protection of plants, animals, and their habitats, while allowing compatible and appropriate economic activity. Many NCCPs are developed in conjunction with Habitat Conservation Plans (HCPs) prepared pursuant to the Act. Although desert slender salamander is not specifically covered under an NCCP/HCP, it is included within the plan area of the Coachella Valley MSHCP and may benefit from certain measures outlined in this plan (see Nonnative Plants section above). The Coachella Valley MSHCP is discussed in the **Federal Protections** section below.

California Lake and Streambed Alteration Program (CDFG Code sections 1600–1616)

The Lake and Streambed Alteration Program (CDFG Code sections 1600–1616) may promote the recovery of listed species in some cases. This program provides a permitting process to reduce impacts to fish and wildlife from projects affecting important water resources of the State, including lakes, streams, and rivers. This program also recognizes the importance of riparian habitats to sustaining California's fish and wildlife resources, including listed species, and helps prevent the loss and degradation of riparian habitats. Therefore, potential projects that may substantially modify a river, stream, or lake would be evaluated and must comply with CEQA.

The California Porter-Cologne Act of 1969

The primary law regulating water quality in California is the California Porter-Cologne Act (CPCA) of 1969 (Section 13000 *et seq.*, California Water Code). The CPCA authorizes the State Water Resources Control Board to establish water quality standards and guidelines for resource planning, management, and enforcement for surface water, ground water, and wetlands. The CPCA establishes the nine Regional Water Quality Control Boards (Regional Boards) as the principal State agencies with the responsibility for controlling water quality at the local level in California. Desert slender salamander habitat falls within the jurisdiction of the Colorado River Basin Regional Water Quality Control Board (California Regional Water Quality Control Board 2006). The Regional Board is responsible for preparing and updating Basin Plans (water quality control plans), each of which establishes: (1) beneficial uses of water designated for each protected water body; (2) water quality standards for both surface and groundwater; and, (3) actions necessary to maintain these standards to control non-point and point sources of pollution to waters. One of many identified beneficial uses of protected waters is the designation as "RARE," defined as "uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under State or Federal law as rare, threatened, or endangered." Regional Boards are required to protect the designated beneficial uses of waterbodies in their decision making, including issuance of National Pollutant Discharge Elimination System permits. Therefore, those waterbodies known to harbor federally or State-listed threatened or endangered species should be maintained such that the waterbodies are capable of supporting the survival and recovery of those species. Guadalupe Creek is not included as a RARE water body in the Colorado River Basin Regional Water Quality Control Plan. The spring at Hidden Palm Canyon is designated as a RARE water body (California Regional Water Quality Control Board 2006, pp. 2–15). Therefore, CPCA provides an existing regulatory mechanism whereby water quality can be maintained to support the habitat of desert slender salamander at Hidden Palm Canyon.

Federal Protections

<u>Endangered Species Act of 1973, as amended (Act)</u>

The Endangered Species Act of 1973, as amended, is the primary Federal law that provides protection for desert slender salamander. The Service is responsible for administering the Act, including sections 7, 9, and 10. Section 7(a)(1) of the Act requires all Federal agencies to utilize their authorities in furtherance of the purposes of the Act by carrying out programs for the conservation of endangered and threatened species. 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. A non-jeopardy opinion may include reasonable and prudent measures that minimize the amount or extent of incidental take of listed species associated with a project. Since listing, BLM has consulted and coordinated with the Service, under the Act, regarding the effects of certain activities on desert slender salamander (see <u>Federal Land Policy and Management Act of 1976 (FLPMA)</u> below). There have been no formal consultations addressing desert slender salamander since the last 5-year review.

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the "take" of federally listed wildlife. Section 9 of the Act prohibits the taking of any federally listed endangered or threatened species. Section 3(18) defines "take" to mean "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Service regulations (50 CFR 17.3) define "harm" to include significant habitat modification or degradation which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harassment is defined by the Service as an intentional or negligent action that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. The Act provides for civil and criminal penalties for the unlawful taking of listed species. Under the terms of section 7(b)(4) and section 7(o)(2) of the Act, taking that is incidental to and not intended as part of a Federal agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of an incidental take statement.

For projects without a Federal nexus that would likely result in incidental take of listed species, the Service may issue incidental take permits to non-Federal applicants pursuant to section 10(a)(1)(B). To qualify for an incidental take permit, applicants must develop, fund, and implement a Service-approved HCP that details measures to minimize and mitigate the project's adverse impacts to the listed species. Therefore, HCPs provide an additional layer of regulatory protection to plants as well as animals. The Coachella Valley MSHCP is a large-scale, multi-jurisdictional HCP permitted under section 10(a)(1)(B) of the Act. Desert slender salamander is included within the plan area for the Coachella Valley MSHCP, but is not covered for take authorization under this plan (CVAG 2007, p. 3–8) because the species is only known to occur on State and Federal lands.

Coachella Valley Multiple Species Habitat Conservation Plan

The purpose of the Coachella Valley MSHCP is to protect natural communities and various habitats for 27 species found throughout the Coachella Valley, maintain the essential ecological processes to keep these habitats viable, and link habitats to maximize the conservation value of the land (CVAG 2007, pp. 1–2). This is a multispecies plan, and provides coverage for activities specified in the plan for incidental take of 27 species for the 75-year life of the permit, not including the desert slender salamander. The plan will create up to 125,000 ac (50,586 ha) of new conservation lands (added to pre-existing conservation lands) throughout the preserve system. By the end of 2012 579,583 ac (234,548 ha) had been conserved within the plan area. The planning area covers 1.1 million ac (445,154 ha) of the Coachella Valley. The primary goals of the Coachella Valley MSHCP are as follows:

1. Protect Core Habitat for 27 species and their natural communities.
2. Maintain the Essential Ecological Processes to keep the Core Habitat viable and link Core Habitat to maximize the Conservation value of the land.
3. Improve the future economic development in the Coachella Valley by providing an efficient, streamlined regulatory process through which development can proceed in an efficient way.
4. Provide a means to standardize mitigation/compensation measures for the Covered Species so that, with respect to public and private development actions, mitigation/compensation measures established by the Plan will concurrently satisfy applicable provisions of Federal and State laws pertaining to Endangered Species protection.
5. Provide for permanent open space, community edges, and recreational opportunities, which contribute to maintaining the community character of the Coachella Valley.

Although desert slender salamander is not covered in this plan, certain measures may benefit the species and the habitat where it occurs (see <ins>Nonnative Plants</ins> section above).

<ins>National Environmental Policy Act (NEPA)</ins>

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. The Council on Environmental Quality's regulations for implementing NEPA (40 CFR parts 1500–1518) state that agencies shall include a discussion on the environmental impacts of the various project alternatives (including the proposed action), any adverse environmental effects that cannot be avoided, and any irreversible or irretrievable commitments of resources involved (40 CFR part 1502). Its public notice provisions provide an opportunity for the Service and others to review proposed actions and provide recommendations to the implementing agency. NEPA does not impose substantive environmental obligations on Federal agencies—it merely prohibits an uninformed agency action. However, if an Environmental Impact Statement is prepared for an agency action, the agency must take a "hard look" at the consequences of this action and must consider all potentially significant environmental impacts. Effects on threatened and endangered species is an important element for determining the significance of an impact of an agency action (40 CFR § 1508.27). Thus, although NEPA does not itself regulate activities that might affect the desert slender salamander, it does require full evaluation and disclosure of information regarding the effects of contemplated Federal actions on sensitive species and their habitats. Federal agencies may also include mitigation measures in the final Environmental Impact Statement as a result of the NEPA process that help to conserve the desert slender salamander and its habitat and these may include measures that are different than those required through the section 7 consultation process.

At Guadalupe Canyon, BLM must meet NEPA requirements for actions significantly affecting the quality of the environment. Furthermore, as Guadalupe Canyon, Hidden Palm Canyon, and surrounding lands are incorporated within the Santa Rosa and San Jacinto National Monument, the National Park Service (NPS) must also meet NEPA requirements for actions significantly affecting the quality of the environment. However, because each location is protected through various layers of land use designations, it is unlikely that any projects would be implemented in the areas occupied by desert slender salamander.

National Park Service (NPS) Organic Act

The NPS Organic Act of 1916 (39 Stat. 535, 16 U.S.C. 1, as amended), states that the NPS "shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations…to conserve the scenery and the national and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The 2006 NPS Management Policies indicate that the Park Service will "meet its obligations under the NPS Organic Act and the Endangered Species Act to both pro-actively conserve listed species and prevent detrimental effects on these species." This includes working with the Service and undertaking active management programs to inventory, monitor, restore, and maintain listed species habitats, among other actions. Both Guadalupe Canyon and Hidden Palm Canyon are included within the Santa Rosa and San Jacinto Mountains National Monument area.

Wilderness Act

The Wilderness Act of 1964 established a National Wilderness Preservation System made up of Federal-owned areas designated by Congress as "wilderness" for the purpose of preserving and protecting designated areas in their natural condition. Commercial enterprise, road construction, use of motorized vehicles or other equipment, and structural developments are generally prohibited within designated wilderness. Livestock grazing is permitted within designated wilderness, subject to other applicable laws, if it was established prior to the passage of this act. One population, at Guadalupe Canyon, is included within the Santa Rosa Wilderness Area. The Wilderness Act may have helped to protect desert slender salamander habitat from development or other types of habitat conversions and disturbances.

Federal Land Policy and Management Act of 1976 (FLPMA)

BLM is required to incorporate Federal, State, and local input into their management decisions through Federal law. The Federal Land Policy and Management Act of 1976 (FLPMA) (Public Law 94–579, 43 U.S.C. 1701) was written "to establish public land policy; to establish guidelines for its administration; to provide for the management, protection, development and enhancement of the public lands; and for other purposes." Section 102(f) of the FLPMA states that "the Secretary [of the Interior] shall allow an opportunity for public involvement and by regulation shall establish procedures … to give Federal, State, and local governments and the public, adequate notice and opportunity to comment upon and participate in the formulation of plans and programs relating to the management of the public lands." Therefore, through management plans, BLM is responsible for including input from Federal, State, and local governments and the public. Additionally, section 102(c) of the FLPMA states that the Secretary shall "give priority to the designation and protection of areas of critical environmental concern" in the development of plans for public lands. Although BLM has a multiple-use mandate under the FLPMA that allows for grazing, mining, and off-highway vehicle use, BLM also has the ability under the FLPMA to establish and implement special management areas, such as Areas of Critical Environmental Concern, Wilderness Areas, and Research Areas that can reduce or eliminate actions that adversely affect species of concern (including listed species such as desert slender salamander).

FLPMA established the California Desert Conservation Area (CDCA), and a requirement to complete a plan for the conservation area. To accomplish this, BLM subdivided the CDCA into discrete planning units, one of which overlap desert slender salamander habitat: the Coachella Valley. BLM recently completed plan amendments and formal consultation with the Service for this planning unit (USFWS 2010). This planning unit contains the Santa Rosa Wilderness Area, where the Guadalupe Canyon population of desert slender salamander is located. The recently completed consultation on the CDCA for the Coachella Valley did not address effects on the desert slender salamander because this species is protected within the Santa Rosa Wilderness Area. According to the CDCA plan for the Coachella Valley, as amended, established goals for wilderness management, including the following (BLM 2008, p. 3-8):

1. Until Congressional release or designation as wilderness, provide protection of wilderness values so that those values are not degraded so far as to significantly constrain the recommendation with respect to an area's suitability or non-suitability for preservation as wilderness.
2. Provide a wilderness system possessing a variety of opportunities for primitive and unconfined types of recreation, involving a diversity of ecosystems and landforms, geographically distributed throughout the Desert.
3. Manage a wilderness system in an unimpaired state, preserving wilderness values and primitive recreation opportunities, while providing for acceptable use.

Therefore, the CDCA plan for the Coachella Valley reaffirms the protected status of the area occupied by desert slender salamander at Guadalupe Canyon, by virtue of its placement within the Santa Rosa Wilderness Area.

Summary of Factor D

In our 2009 5-year review, we stated that existing regulatory mechanisms are adequate to protect desert slender salamander. Because all lands are under State or Federal ownership, existing regulatory mechanisms, including various laws, regulations, and policies administered by the State of California or the Federal government provide protective mechanisms for the subspecies and its habitat. The primary State laws that provide protection to the subspecies include CESA, CEQA, and NCCP Act. The primary Federal laws that provide some benefit for the subspecies and its habitat include the Act, NEPA, and the Wilderness Act. Therefore, we confirm that the inadequacy of existing regulatory mechanisms is not a threat to desert slender salamander.

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

Drought and Climate Change

Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). The term "climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a, p. 78). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a, p. 78).

Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has been faster since the 1950s. Examples include warming of the global climate system, and substantial increases in precipitation in some regions of the world and decreases in other regions. (For these and other examples, see IPCC 2007, p. 30; and Solomon *et al*. 2007, pp. 35–54, 82–85). Results of scientific analyses presented by the IPCC show that most of the observed increase in global average temperature since the mid-20th century cannot be explained by natural variability in climate, and is "very likely" (defined by the IPCC as 90 percent or higher probability) due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities, particularly carbon dioxide emissions from use of fossil fuels (IPCC 2007, pp. 5–6 and figures SPM.3 and SPM.4; Solomon *et al*. 2007, pp. 21–35). Further confirmation of the role of GHGs comes from analyses by Huber and Knutti (2011, p. 4), who concluded it is extremely likely that approximately 75 percent of global warming since 1950 has been caused by human activities.

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of GHG emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (e.g., Meehl *et al*. 2007, entire; Ganguly *et al*. 2009, pp. 11555, 15558; Prinn *et al*. 2011, pp. 527, 529). All combinations of models and emissions scenarios yield very similar projections of increases in the most common measure of climate change, average global surface temperature (commonly known as global warming), until about 2030. Although projections of the magnitude and rate of warming differ after about 2030, the overall trajectory of all the projections is one of increased global warming through the end of this century, even for the projections based on scenarios that assume that GHG emissions will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be influenced substantially by the extent of GHG emissions (IPCC 2007, pp. 44–45; Meehl *et al*. 2007, pp. 760–764 and 797–811; Ganguly *et al*. 2009, pp. 15555–15558; Prinn *et al*. 2011, pp. 527, 529).

Global climate projections are informative, and in some cases, the only or the best scientific information available for us to use. However, projected changes in climate and related impacts can vary substantially across and within different regions of the world (e.g., IPCC 2007, pp. 8–12). Therefore, we use “downscaled” projections when they are available and have been developed through appropriate scientific procedures, because such projections provide higher resolution information that is more relevant to spatial scales used for analyses of a given species (see Glick *et al*. 2011, pp. 58–61, for a discussion of downscaling). Most models generally predict that the southwest United States will become drier, and that extreme events such as heavier storms, heat waves, and regional droughts will become more common (Glick *et al.* 2011, p. 7). Moreover, it is generally expected that the duration, frequency, and intensity of droughts will increase in the future (Glick *et al.* 2011, p. 45; PRBO 2011, p. 21). With regard to our analysis for desert slender salamander, projections that have been downscaled further are available.

Desert slender salamander populations fall within the Sonoran (Colorado) Desert ecoregion, as identified by Hickman (1993, p. 45), and PRBO (2011, p. 4). Regional climate models for the Sonoran Desert ecoregion project mean annual temperature increases of 1.8 to 2.4°C by 2070 (PRBO 2011, p. 47). Bell *et al*. (2004, pp. 83–85) predicted that the number of extremely hot days (above the 95^{th} percentile) is expected to increase by 22 days, and the number of days above 89.6^{o}F (32.2°C) is expected to increase 20 days per year. Sustained hot periods (6 days or longer), and average temperature were also expected to increase (Bell *et al*. 2004, p. 85). Additionally, the frost-free growing season was predicted to extend significantly, beginning 22 days earlier and lasting 30 days longer (Bell *et al*. 2004, p. 85). Sustained (7-day) cold period events were predicted to decrease in prevalence and duration (Bell *et al*. 2004, p. 85). There is wide uncertainty related to precipitation estimates in the Sonoran Desert ecoregion, with one regional climate model predicting an increase of 0.12 in (3 mm), while another predicts a decrease of 2.17 in (55 mm) (PRBO 2011, p. 47). Another estimate predicts no future change in precipitation patterns (Bell *et al*. 2004, p. 86). There is currently no consensus regarding how climate change will influence wildfire events in the Sonoran Desert ecoregion. Predictions regarding the frequency of large fires consider climate and vegetation, particularly nonnative vegetation (PRBO 2011, p. 48). Under wet conditions, the likelihood of large fires (greater than 494 ac (greater than 200 ha)) tends to increase in models, whereas under dry conditions, the likelihood of large fires tends to decrease (PRBO 2011, p. 48).

Changes in climate that occur faster than the ability of endangered species to adapt could cause local extinctions (USEPA 1989, p. 145). Amphibians are extra-sensitive to certain environmental changes, such as slight shifts in temperature and moisture due to their permeable skin, typically biphasic lifecycles (aquatic and terrestrial), and unshelled eggs (Carey and

Alexander 2003, pp. 113–114). Emergence from hibernation and breeding cues are initiated by changes in the environment. As a desert species that inhabits a moist environment in the midst of a hot, dry landscape, a change in temperature or moisture conditions may directly push desert slender salamander past physiological or ecological tolerance thresholds, and therefore risk from climate change is theoretically enhanced. Early warming might cue breeding earlier in the year (Carey and Alexander 2003, p. 111; Corn 2005, p. 61), potentially increasing the susceptibility of individuals to temperature drops that are more common early in the season (Amphibiaweb 2013c, p. 1). In the summer, enhanced evapo-transpiration following high temperature events may dry out moist retreats required by desert slender salamander. Predicted increases in mean annual temperatures, high temperature events, duration of high temperature events, and potentially decreased precipitation could also diminish the volume and timing of water availability to support all life history processes. Increased exposure to high temperature events may appreciably reduce the availability of suitable habitat and may cause direct mortality from desiccation. Furthermore, an increase in the frequency, intensity, and duration of droughts would magnify stresses associated with such conditions.

Changes in temperature can also affect the virulence of pathogens (Carey 1993, p. 359), which can make amphibians more susceptible to disease. Some research suggests that climate change could affect the distribution of pathogens and their vectors (Blaustein *et al.* 2001, p. 1808), make conditions more advantageous to *Bd* (Pounds *et al*. 2006, pp. 164–165), lead to increased pathogenicity of *Bd* (Fisher *et al.* 2009, p. 299), and result in a range shift of *Bd* (Pounds *et al.* 2006, p. 161; Bosch *et al*. 2007, p. 253). Other research suggests there is little evidence of a link between climate change and *Bd* (Lips *et al*. 2006, p. 3168; Lips *et al*. 2008, p. 0441). It is unknown if *Bd* is present in the habitat of desert slender salamander or if this subspecies is susceptible to chytridiomycosis, therefore it is difficult to theorize what, if any effect climate change might have on *Bd* prevalence and virulence in this environment. However, *Bd* is known to grow best within a particular temperature range (39–77°F (4–25°C)) (Piotrowski *et al*. 2004, p. 9), with pathogenicity (ability to cause disease) and virulence (degree of magnitude caused by the disease) diminishing at 81°F (27°C) (Longcore *et al*. 1999, p. 223; Woodhams *et al*. 2003, p. 66; Berger *et al*. 2004, p. 434). Average high summertime (July) temperatures in the eastern Santa Rosa Mountains are higher (approximately 93°F (34°C)), potentially diminishing the capacity for *Bd* to thrive. Thus, the higher temperatures that might desiccate the moist environment preferred by desert slender salamander, may also limit the prevalence of *Bd*.

The key risk factor for climate change impacts to desert slender salamander is likely the interaction between increasing temperatures, potentially reduced precipitation, and the relative inability of individuals to disperse into more favorable habitat conditions given their high site fidelity, and the disjunct moist environments they already occur within. Thus, an increase in the frequency, magnitude, and duration of droughts caused by global warming may have compounding effects with respect to already small, isolated populations of desert slender salamander.

<u>Small Populations</u>

The 2009 5-year review identified small population size as a threat to Hidden Palm Canyon population of desert slender salamander (USFWS 2009, p. 10). Presently, desert slender salamander is at risk of extinction from the limited number of populations, the small size of each population, and the isolation of each from one another. Furthermore, one of the two known populations (Hidden Palm Canyon) has not been seen since 1997 (Nicol 1997, p. 1), and a substantial amount of habitat lost at the site indicates this population may either be extirpated, or may be very small at this time. The loss of individual populations increases the risk of extinction to the subspecies as a whole. Chance events outside the range of natural variability can substantially reduce or eliminate small populations and increase the likelihood of extinction (Lande 1993). Small populations are more vulnerable to environmental, demographic, and genetic stochastic events (random, natural occurrences), and unforeseen catastrophes (Shaffer 1981). Aspects of the conservation biology literature commonly note the vulnerability of taxa known from one or very few locations or from small populations, and the adverse demographic and genetic effects of declining populations (Lande 1987; Caughley 1994; Groom *et al.* 2006).

Environmental stochasticity refers to annual variation in birth and death rates in response to weather, disease, competition, predation, or other factors external to the population (Shaffer 1981, p. 131). Small populations may be less able to respond to natural environmental changes (Kéry *et al.* 2000, p. 28), such as a prolonged drought or even exposure to *Bd*. Periods of prolonged drought are more likely to have a significant effect on desert slender salamander because all aspects of the subspecies' life history are dependent on constantly moist habitat.

Demographic stochasticity is random variability in survival or reproduction among individuals within a population (Shaffer 1981, p. 131) and could increase the risk of extirpation of the remaining populations. There is no information available regarding survivorship and mortality of different desert slender salamander age classes for either population. Thus, we cannot analyze the sensitivity of either population to demographic stochasticity.

Genetic stochasticity results from changes in gene frequencies due to founder effect (loss of genetic variation that occurs when a new population is established by a small number of individuals) (Reiger *et al.* 1968, p. 163); random fixation (the complete loss of one of two alleles in a population, the other allele reaching a frequency of 100 percent) (Reiger *et al.* 1968, p. 371); or inbreeding depression (loss of fitness or vigor due to mating among relatives) (Soulé 1987, p. 96). Additionally, small populations generally have an increased chance of genetic drift (random changes in gene frequencies from generation to generation that can lead to a loss of variation) and inbreeding (Ellstrand and Elam 1993, p. 225). The genetic variability of either population has not been analyzed. If either population has declined below a minimum threshold of individuals necessary to maintain genetic diversity, then genetic stochasticity may be a serious concern, particularly due to risks associated with inbreeding. Reduced genetic variability could impair the ability to adapt to changes in the environment, such as the introduction of a novel disease, or contribute to more pronounced inbreeding depression over time (Shaffer 1981, p. 133; Noss and Cooperrider 1994, p. 6; Primack 1998, p. 305).

As described above, natural catastrophes such as large storms, or fires followed by large flooding events could further reduce the suitable habitat available or result in extirpation of small populations (Shaffer 1981, p. 131). Habitat alterations caused by natural catastrophes have direct effects (exposure to fire, or flooding individuals from the habitat), and indirect effects (scouring and removal of canyon habitat) all of which can result in mortality of individuals. The previously occupied area at Hidden Palm Canyon has already experienced massive scouring following multiple large storm events. There is no opportunity for off-channel refuge at this site. Natural catastrophes occurring directly in desert slender salamander habitat can have significant effects to this taxon due to the small, isolated populations available to support recovery.

Summary of Factor E

Predicted changes in climate in the Sonoran Desert ecoregion include higher mean annual temperatures, an increase in the number of extremely hot days, an increase in prolonged high temperature events, and a decrease in sustained cold periods. Although there is no clear consensus regarding future precipitation patterns, the strong consensus regarding the change expected in temperature suggests a strong concern for the longevity of desert slender salamander into the future, particularly given the need for a moist environment to both facilitate life history processes and prevent desiccation. Furthermore, the high site fidelity and lack of suitable moist habitat available for dispersal may exacerbate the pressures associated with high temperatures. Should desert slender salamander already be experiencing diminished population sizes, then it may be particularly prone to risks associated with genetic stochasticity and natural catastrophes.

III. RECOVERY CRITERIA

The Service published a final Recovery Plan for desert slender salamander in 1982 (USFWS 1982). In general, recovery plans provide guidance to the Service, States, and other partners and interested parties regarding ways to minimize threats to listed species, and providing criteria that may be used to determine when recovery goals are achieved. Many paths are available to accomplish the recovery of a species and recovery may be achieved without fully meeting all recovery plan criteria. For example, one or more criteria may have been exceeded, while other criteria may not have been accomplished. In that instance, we may determine that, overall, the threats have been minimized sufficiently, and the species is robust enough to be downlisted or delisted. In other cases, new recovery approaches and/or opportunities unknown at the time the recovery plan was finalized may be better suited to achieve recovery. Likewise, new information may change the extent that criteria need to be met for recognizing recovery of the species. Overall, recovery is a dynamic process requiring adaptive management, and assessing a species' degree of recovery is likewise an adaptive process that may, or may not, fully follow the guidance provided in a recovery plan. We focus our evaluation of the species status in this 5-year review on progress that has been made toward recovery since the species was listed by eliminating or reducing the threats discussed in the five-factor analysis. In that context, progress towards fulfilling recovery criteria serves to indicate the extent to which threat factors have been reduced or eliminated.

The Recovery Plan (USFWS 1982) does not contain formal threats-based recovery criteria; however, it does contain a step-down outline for objectives that need to be addressed to minimize further decline of the desert slender salamander and degradation to its habitat. This outline is not explicitly related to the five listing factors; however, these actions would benefit the conservation of this species by helping to reduce or eliminate threats addressed by the listing factors. Once threats have been removed or minimized and habitats are restored, adequately protected, and properly managed, reclassification may be considered. The broad objectives to accomplish reclassification or delisting of desert slender salamander, discussed within the Recovery Plan are as follows:

1. Protect and manage the Hidden Palm Ecological Reserve.

   Hidden Palm Canyon has been protected within the Hidden Palm Ecological Reserve since its creation by CDFW in 1974. The area is inaccessible without a permit, and signage remains posted to limit public access. Hidden Palm Canyon is also included within Santa Rosa and San Jacinto Mountains National Monument area. Over time, management of desert slender salamander at the reserve has diminished, as interest and management options have waned. The reserve management committee has not met since the mid-1980s. At least one of several gabions installed in the late 1970s to prevent additional erosion is still intact, though the habitat continues to deteriorate. Periodic nonnative plant removal occurs. There is no monitoring of the desert slender population.

2. Develop and implement plans for other naturally occurring populations of the desert slender salamander.

   Guadalupe Canyon is protected from development within the Santa Rosa Wilderness Area, and the Santa Rosa and San Jacinto Mountains National Monument. This land is owned by BLM. The Management Plan for this area (BLM 2003; pp. 2-7, 2-8, 4-14) discusses the desert slender salamander, but mandates no specific actions for this taxon beyond monitoring. Although there may still be additional populations elsewhere, none have been confirmed.

3. Assess feasibility and necessity of introducing the desert slender salamander to particular sites.

   No specific experiments have been conducted on the feasibility of translocating desert slender salamanders to any new localities, nor have suitable sites been identified. Considering that one of the two populations has not been seen since 1997, this action remains important for consideration. Research of the courtship and reproductive requirements of a close surrogate (perhaps the garden slender salamander) is necessary. Additionally, further research of the two known populations is needed to determine if there are individuals available for translocation.

4. Minimize unauthorized disturbance to the desert slender salamander and its habitat.

   The Hidden Palm Ecological Reserve is closed to the public, therefore, disturbance is minimized. A road pullout on Highway 74 was also relocated to discourage access to the reserve. The Guadalupe Canyon site is difficult to access, and the Wilderness Area designation also minimizes disturbance to this location.

5. Determine the number and sizes of populations necessary for reclassifying the subspecies to threatened status and to delist.

Some studies have attempted to roughly estimate population sizes, though these estimates are widely variable, and abundance data has not been tracked over time. Due to the difficulty associated with studying a taxon that spends most of its time below the surface, and the limited survey window, accurately estimating the population sizes may not occur without a determined effort. An evaluation to determine the number of populations needed for reclassification has not occurred.

The 2009 5-year review stated that more specific recovery criteria would greatly aid this subspecies (USFWS 2009, p. 4). To downlist to threatened, several actions or objectives similar to criteria are suggested in the Recovery Plan:

1. Identify at least two populations and ensure they will remain self-sustaining in the long term.
    a. If one of those populations is at the Hidden Palm Canyon site, evaluate the long-term sustainability of the water source for the spring and ensure that it will remain stable and sufficient for the salamanders needs. Also evaluate if hydrology can be modified so that storm flows are not so violent.
    b. Verify that the Guadalupe Canyon population is still distributed as before.
    c. Identify suitable habitat and survey for additional populations of desert slender salamander.

2. Restore the habitat at Hidden Palm Canyon. If determined to be beneficial, construct and install additional supporting structures, such as posts, wire fencing, gabions, or a finer fencing material to hold surface material against the side of the canyon. The material held up by posts could be a mixture of gravel, cobble, and organic material (e.g., leaves). The rock would create a matrix of internal spaces for salamanders to live and hide, and the organic material would hold moisture and supply an invertebrate food source. Such structures would have to be periodically repaired after storm events.

    None of the actions identified in the 2009 5-year review have been implemented, though each remains an important priority to understand the current status of desert slender salamander, implement recovery actions, and approach reclassification of this subspecies to threatened status.

Summary of Recovery Criteria

In summary, the primary objectives of the Recovery Plan are to restore the endangered desert slender salamander to nonlisted status through restoration of habitat, implementation of management recommendations, protection of habitat, development of delisting criteria, evaluation of the success of management actions, and implementation of existing laws and regulations. While the Recovery Plan does not include taxon-specific downlisting or delisting criteria for measuring the recovery of the desert slender salamander, broad objectives for reclassification were identified. The habitat at Hidden Palm Ecological Reserve is protected and periodically managed. Similarly, Guadalupe Canyon is included within a management plan for the Santa Rosa and San Jacinto Mountains National Monument.

The feasibility and necessity of translocating desert slender salamander to additional locations is yet to occur, though remains an important option to prevent the extinction of this species. The number, size, and distribution of populations necessary to reduce extinction risk and promote downlisting or delisting has not occurred. There appears to be no human disturbance of the habitat in either canyon, mostly due to the physical limitations with accessibility, but also due to land use designations preventing access. The most important action perhaps, an evaluation of watershed hydrology has not yet occurred. Based upon our review of the Recovery Plan, we conclude that the status of the desert slender salamander has not changed appreciably since the last 5-year review and the primary recovery objectives in the Recovery Plan have not yet been achieved.

IV. SYNTHESIS

The desert slender salamander (*Batrachoseps major aridus*) is a rare subterranean amphibian that has been observed at two locations on the lower desert slopes of the eastern Santa Rosa Mountains in Riverside County, California (Hidden Palm Canyon and Guadalupe Canyon). This species requires adequate soil moisture to facilitate life history processes, including breathing and reproduction, movement patterns, refuge from predators, and an invertebrate food source. The habitat occupied by each population is protected from development and human disturbance within the Hidden Palm Ecological Reserve, the Santa Rosa Wilderness Area, and the Santa Rosa and San Jacinto Mountains National Monument area.

The population identified at listing (Hidden Palm Canyon) was last observed in 1997 and is believed to be extant. The other desert slender salamander population is located at Guadalupe Canyon and is restricted to a very small area. This population has not been seen since it was last surveyed in 1985, but is currently presumed to be extant. Threats associated with these populations include nonnative plants, drought and climate change, and small population size. Fire and disease are additional potential threats to each location. The Hidden Palm Canyon occurrence is also at risk of habitat loss due to erosion. Groundwater pumping should also be monitored at this location.

We conclude that the desert slender salamander still meets the definition of endangered under the Act, primarily because there are only two known populations and each population is small, potentially exacerbating risks associated with ongoing threats. Therefore, we recommend no change in endangered status of the desert slender salamander at this time.

V. 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

New Recovery Priority Number and Brief Rationale: Change from 8 to 6

In the last 5-year review, we recommended a recovery priority number of 12, indicating moderate threat (primarily natural threats) and low potential for recovery for this subspecies; however, this change was not finalized. After consideration of the most current information, we recommend a new recovery priority number of 6, indicating a high degree of threat, and a low potential for recovery for this subspecies (USFWS 1983a, pp. 43098–43105; USFWS 1983b, p. 51985). This species is exposed to a high degree of threat because the best available habitat at Hidden Palm Canyon was eliminated after large storm events of the 1990s, no individuals have been detected since 1997, and there is a reasonable likelihood that a single large flooding event could reduce or eliminate the remaining habitat and population at this site. We indicate that the species continues to have a low recovery potential because habitat is very limited and restoration or creation of habitat may require intensive management and may not be successful.

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

The actions listed below are recommendations to be completed over the next 5 years. These will help guide continuing recovery of the desert slender salamander by providing information to better manage populations. Conservation of the desert slender salamander is dependent on continued cooperation with our partners (i.e. CDFW, BLM, University of California) to minimize impacts from current threats and aid future restoration.

1. Survey Hidden Palm Canyon and Guadalupe Canyon to determine if these populations are extant and evaluate habitat suitability. Identify the distribution and abundance of each population within the remaining habitat; replicate measurements made by Duncan and Esque (1986).

2. Determine whether nonnatives (e.g. *Tamarix* spp.) are impacting desert slender salamander habitat in Hidden Palm Canyon or Guadalupe Canyon and implement a plan for their removal when detected.

3. If a population remains at Hidden Palm Canyon, evaluate and implement habitat restoration options. Perform hydrological evaluation of Hidden Palm Canyon to better understand and prevent future impacts of erosion and monitor groundwater levels in the drainage.

4. Consider permitting non-lethal DNA collection (e.g., toe clips) to aid further evaluation of the subspecies' taxonomic placement, per recommendation by Martinez-Solano (2012).

5. Survey other sites with likely suitable habitat characteristics for additional populations.

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Appendix 1: Occurrence distribution and threat analysis of desert slender salamander (*Batrachoseps major aridus*); prepared for 5-year review, 2014.

Element Occurrence Location	**Factor A** Habitat Destruction or Degradation					**Factor B**	**Factor C**	**Factor D**	**Factor E**	Land Ownership
	Erosion	Fire	Nonnative Plants	Groundwater Pumping	Drought and Climate Change	Overutilization for Commercial, Recreational, Scientific, or Educational Purposes	Disease or Predation	Inadequacy of Regulatory Mechanisms	Small Population Size	
Hidden Palm Canyon	C	P	C	P	C	N	P	N	C	California Department of Fish and Wildlife (Hidden Palm Canyon Ecological Reserve)
Guadalupe Canyon	N	P	C	N	C	N	P	N	C	Bureau of Land Management (Santa Rosa Wilderness Area)

P - Potential threat; C - Current threat; N - Not currently a threat, nor expected to become a future threat.

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

Desert Slender Salamander
(Batrachoseps major aridus)

Current Classification: Endangered

Recommendation Resulting from the 5-year Review:

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

Review Conducted By: Carlsbad Fish and Wildlife Office

FIELD OFFICE APPROVAL:

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

Approve ______________________________ Date JAN 31 2014

Scott A. Sobiech